

APPENDIX 2

DAVID BELL PRELIMINARY GEOTECHNICAL REPORT

Site specific to 23K Walkers Road, Lyttelton.

Detailed Rockfall report to be submitted at a later date for submission Hearings.*

Geotechnical Information relevant to submission has been highlighted.*

**This Geotechnical report deals primarily with building planning but has additional information on rockfall highlighted and has been included until full detailed rockfall report is available for submission hearings.



BELL GEOCONSULTING LIMITED

ENVIRONMENTAL AND ENGINEERING GEOLOGY

PO BOX 31-031, ILAM, CHRISTCHURCH 8444

10 October 2014

BGL Reference 1469/03

Julia Oakley
23K Walkers Road
Lyttelton
Christchurch 8082

Email: julia.oakley@clear.net.nz

Dear Julia

Re: **Julia Oakley – Geotechnical Report – New Dwelling – 23K Walkers Road – Lyttelton**

1. Introduction

Further to your request, Bell Geoconsulting Limited (BGL) is pleased to provide our geotechnical report on the proposed dwelling site at 23K Walkers Road, Lyttelton. The property forms part of a consented subdivision, but no previous dwelling construction has taken place on this land. The proposed dwelling site is close to the cul-de-sac head in Walkers Road, and occupation of the western part of the property is not planned (Figure A1). BGL has completed six test pits on the proposed building site to depths between 1.1 and 3.1m below ground level (Appendix One), and seven dynamic cone penetration (DCP) tests using the Scala penetrometer on the same bench. The objectives of this report are as follows:

- To describe and discuss the engineering geology model for the proposed dwelling site, and related geotechnical constraints associated with the selected building footprint.
- To consider foundation conditions and requirements for the dwelling as proposed in drawings by Bull/O'Sullivan Architecture Ltd last updated in September 2014.
- To provide an assessment in terms of s71 of the Building Act 2004, including specific review of the Christchurch City Council proposed Rockfall Hazard Management Areas.
- To identify long-term site management requirements consistent with building site development on loess-colluvium soils, and rockfall runout beyond the western property boundary.

We enclose Figure A1 and A2, which show respectively the general zoning constraints, and the specific location of testing sites within the building footprint. Appendix One contains the engineering geology logs of the six test pits, and Appendix Two the seven Scala penetrometer profiles.

2. Site Description

The land at 23K Walkers Road slopes uphill to the west and north-west, and slope angles increase from <5° close to the cul-de-sac head to about 15° in the western two-thirds of the property (Figure A1). Loess-colluvium soils mostly greater than 3m thick are exposed closer to Walkers Road, and volcanic boulders are evident on the western part of the property associated with loess-colluvium and mixed loess-volcanic colluvium. The proposed dwelling site is located on loess-colluvium soils, and bedrock is present at shallow depth (<1m below ground level or bgl) at the south-western extremity of the footprint. The land proposed for building has not been impacted during the Canterbury Earthquake Sequence (CES), but rockfall debris has been deposited in two lobes to the west of the property (>50m from the proposed dwelling site) during the earthquake of 22 February 2011 (Areas 1 and 2; Figure A1).

3. Rockfall Hazard Assessment

Figure A1 identifies two lobes of angular blocky rockfall debris (Areas 1 and 2) sourced during the earthquake of 22 February 2011, both of which are to the west of the property boundary. The isolated boulders identified appear to have only displaced locally, and there is no evidence for boulder runout onto Area 3 (Figure A1). The positioning of the dwelling was selected to avoid any potential rockfall runout prior to the proposed Council hazard management areas, which appear to be conservative. BGL is satisfied that there is no rockfall hazard associated with the selected building platform, which is on land designated "Banks Peninsula Residential", but we are advising planting of the western part of the property for added protection even though there is no identified rockfall risk to the proposed dwelling.

4. Building Platform Investigations

Figure A2 shows the building footprint and the location of both test pits and DCP profiles. Full details of the six test pits are given in Appendix One, including logs and a cross section (A-A') along the centreline of the proposed building platform. The cross section (Appendix One) can be considered representative of expected foundation conditions, and identifies the following geotechnical considerations:

- Volcanic bedrock (basalt) is present within 1m of the ground surface to the south-west of the proposed building platform, and outcrops discontinuously close to the property boundary.
- The basaltic bedrock is relatively unweathered where inspected, and where excavated beneath the building platform the depth of moderately to highly weathered rock is typically $\leq 0.5\text{m}$.
- The thickness of loess-colluvium clayey silt increases from 1.0m in TP1 at the south-western end of the logged profile to greater than 3.0m at the north-eastern end of the cross section.
- Design of the foundation pole system should consider possible differential seismic response on bedrock and in loess-colluvium, and the bracing requirements for the as-built dwelling.
- Pole embedment should be in natural undisturbed ground, and is to avoid areas where test-pitting has been carried out because the backfilled soil will not have adequate bearing.

The seven Scala penetrometer profiles (Appendix Two) were completed on a bench excavated for the purpose of soil profile investigation, and do not therefore include the full topsoil depth of $\sim 500\text{mm}$ shown in some of the test-pit logs. All DCP profiles terminated at depths between 1100 and 1500mm, with the exception of DCP-1 which refused on bedrock at 200mm. Depth to allowable bearing pressure $\geq 100\text{kPa}$ (equivalent to ultimate bearing $\geq 300\text{kPa}$) was typically at a depth between 600 and 900mm bgl, and below this depth ultimate bearing consistently increased to $\geq 500\text{kPa}$.

5. Foundation Design Implications

A minimum pole embedment depth of 2.0m into undisturbed loess-colluvium is indicated, or to the base of weathered bedrock where encountered at shallower depth. All pole excavations should be inspected, and adequate bearing confirmed at the time of dwelling construction. Pole dimensions, bracing design and related matters are to be determined by the structural engineer to the project.

The proposed garage excavation (as projected on the cross section in Appendix One) is entirely in loess-colluvium soil, with an estimated depth to bedrock $\geq 2\text{m}$ below the floor. This implies a need for control of seepage or stormwater at these depths, and the use of a lime-stabilised base beneath the concrete floor to minimise any potential for softening or erosion in the clayey silt soils.

This is a typical site in loess-colluvium soils displaying variable depth to bedrock within the footprint.

6. Building Act 2004 Evaluation

In terms of s71 of the Building Act 2004, Council has an obligation to refuse its consent unless satisfied that the geotechnical hazards identified (erosion; falling debris; subsidence; slippage; inundation) have been or will be addressed by design and/or construction measures. BGL advises as follows in regard to these five geotechnical matters:

Erosion: Surface rill erosion can occur in loess soils on bare ground or in cut batters, whilst tunnel-gully development due to subsurface seepage or flow of water is also well documented on the Port Hills (Bell & Trangmar, 1987). At 23K Walkers Road there is no evidence for surface or subsurface erosion in the loess-colluvium, and the vegetation cover and thick topsoil indicates a long-term stable slope. BGL does recommend, however, that potential erosion is addressed by careful drainage and stormwater control, and that batters in loess-colluvium are cut vertically to minimise rilling. We also advise the use of lime-stabilisation beneath the garage slab, for example by the use of SAP20 compacted in 150mm layers.

Falling Debris: As shown in Figure A1, rockfall debris from the 22 February 2011 earthquake was deposited in two lobes to the west of 23K Walkers Road, but did not enter the property. The isolated boulders identified were not displaced significantly, and the proposed CCC rockfall hazard management areas do not accurately reflect the debris field shown in Figure A1. The selected dwelling site was chosen for ease of access off Walkers Road, and to avoid any potential rockfall runout from future large magnitude earthquakes. BGL recommends that systematic tree and shrub planting, including flaxes and similar species, is undertaken in the western part of the property (Area 3, Figure A1). Close planting is suggested for the area immediately west of the 'Residential Banks Peninsula' zone (Figure A1).

Subsidence: The ultimate bearing pressures below 600-900mm bgl in the thicker loess-colluvium soils exceed 500kPa, and this can be considered as 'good ground' in terms of NZS 3604:2011. BGL advises a minimum pole embedment depth of 2.0m, and as such no land subsidence or vertical settlement can be anticipated. In the south-west of the building footprint volcanic bedrock is present at depths ≤ 2.0 m bgl, and subject to appropriate embedment no subsidence is anticipated. Foundation loads and final design, including provision for any differential seismic response of the building because of variable rock depth, are matters for the structural engineer. BGL advises that all pole holes be inspected, and that satisfactory bearing is confirmed during site development and dwelling construction.

Slippage: There is no evidence for slippage in the loess soils on the property, or on neighbouring land. Provided satisfactory vegetation cover is maintained, or enhanced, and stormwater is controlled and disposed of appropriately, no land stability issues are anticipated. The bedrock is stable where present within the immediate building platform, and the loess-colluvium shows no evidence for past instability.

Inundation: The site at 23K Walkers Road is not presently subject to inundation from any source, but control of overland flow during storm events requires appropriate surface drainage measures. BGL does not expect any issues with inundation at this site, either during construction or subsequently.

7. Conclusions

- The proposed building site at 23K Walkers Road is located on loess-colluvium soils varying in depth from less than 1.0m to greater than 3.0m in thickness, and overlying volcanic bedrock in which the depth of weathering is typically ≤ 0.5 m to fresh (essentially unweathered) basalt.
- Subsurface investigations carried out by BGL comprised six test pits and seven dynamic cone penetration (Scala) tests along the approximate centreline of the proposed dwelling to develop a site engineering geology model and to allow determination of soil bearing.

- 'Good ground' as defined by NZS 3604:2011 is present from depths between 600 and 900mm bgl in the loess-colluvium soils, and bedrock where present has more than adequate strength for pole foundations. The garage excavation is entirely in loess-colluvium, and lime stabilisation is advised.
- Pole foundations are to taken a minimum of 2.0m into undisturbed loess-colluvium, and at least 300mm into the weathered bedrock surface where present at shallower depth. All pole holes are to be inspected, and adequate bearing confirmed at the time of installation and embedment.
- A walkover inspection, and reference to imagery dated 24 February 2011, has identified rockfall runoff to the immediate west of the property, but the selected dwelling site is more than 50m from any boulders released in the 22 February 2011 Port Hills earthquake.
- The land is not subject to erosion, falling debris, subsidence, slippage or inundation, and provisions of s71 of the Building Act 2004 are met in relation to hazard mitigation. Tree and shrub planting on the western part of the property is advised, and stormwater control is necessary to prevent erosion.

8. References

BELL, D H; TRANGMAR, B B (1987) Regolith materials and erosion processes on the Port Hills, Christchurch, New Zealand Proceedings of Fifth International Conference and Field Workshop on Landslides, Christchurch, August 1987: 93-105

STANDARDS NEW ZEALAND (2011) Timber-framed buildings NZS 3604:2011

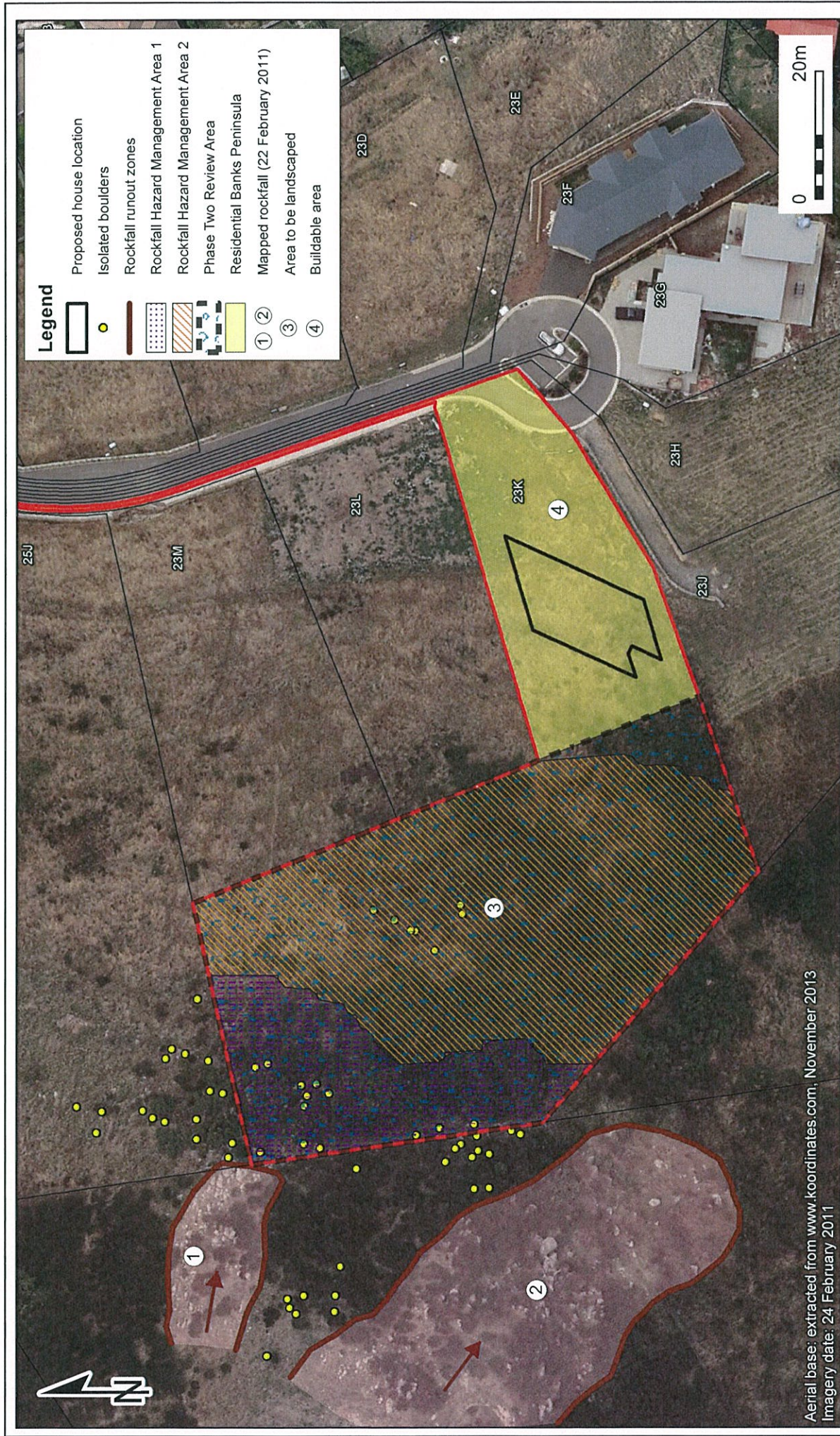
We trust this report is sufficient for your immediate needs. Do not hesitate to contact the undersigned on (027) 249 3896 or by email to davidbell@bgconsult.co.nz should you require further advice. We will be pleased to arrange inspection of the pole foundation holes, and to confirm adequate bearing.

Yours sincerely



David H Bell
Principal Engineering Geologist and Director
Professional Engineering Geologist – PEngGeol
IPENZ Registration Number 113121 (2014)

Figures A1 and A2 – 23K Walkers Road – Lyttelton



Bell Geoconsulting Ltd

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Figure A1

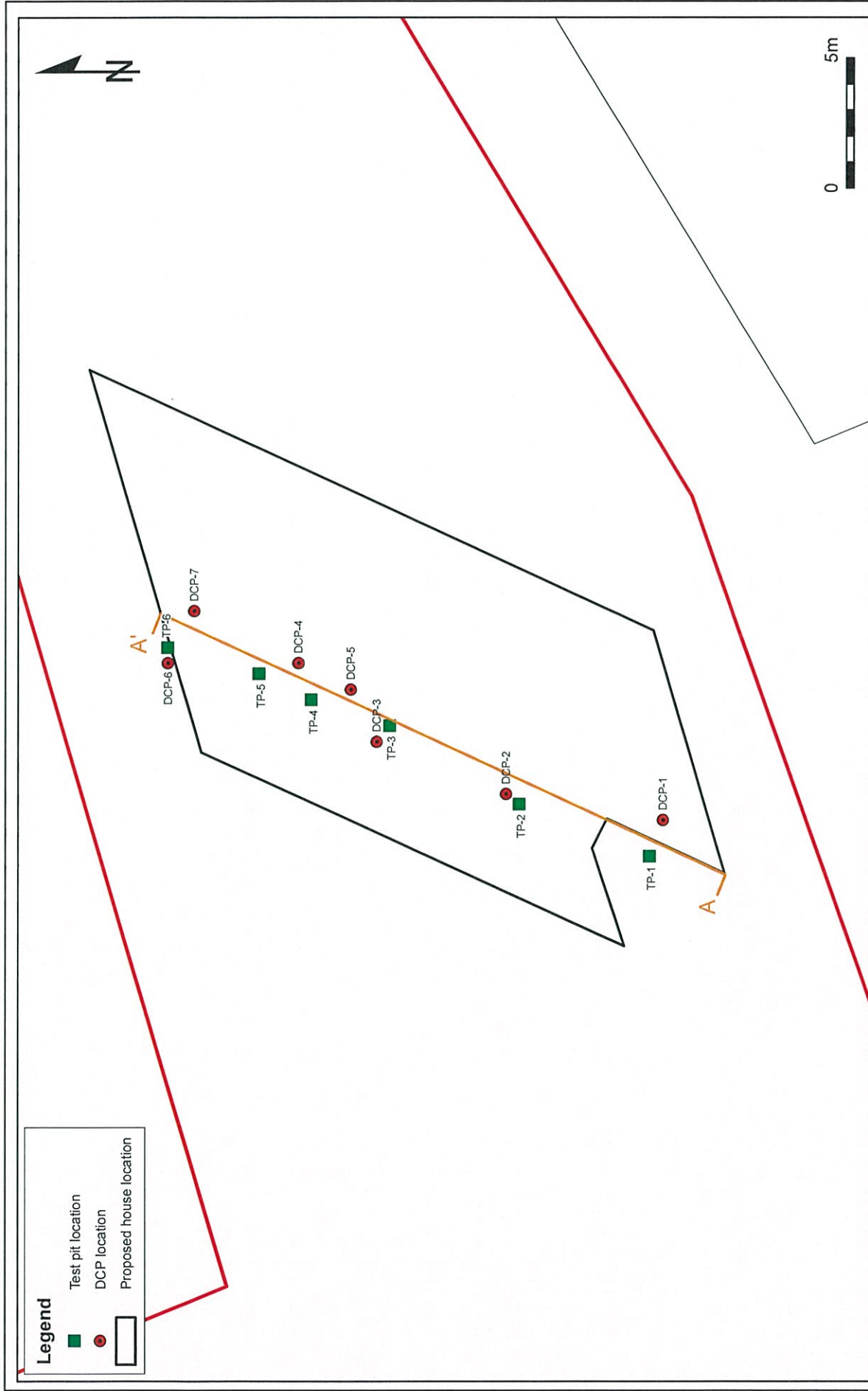
23K Walkers Road, Lyttelton

Date: October 2014

Drafted: Jasmine Snowsill

Approved: David Bell

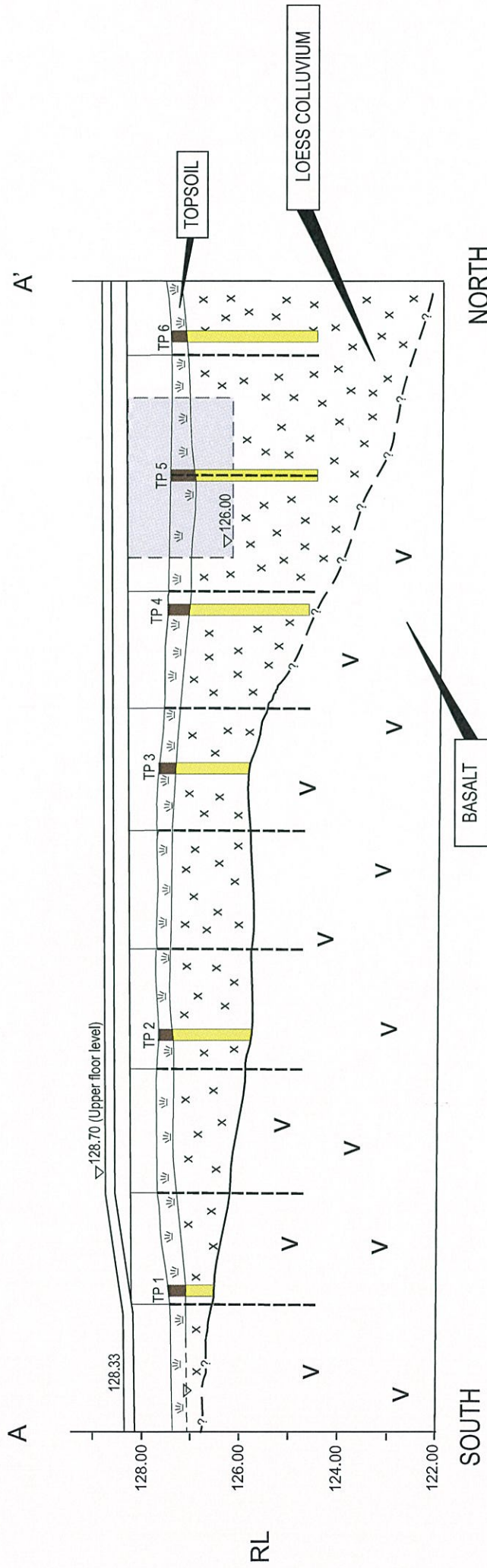
Reference: BGL 1469



Bell Geoconsulting Ltd PO Box 31-031 Ilam, CHRISTCHURCH	Figure A2		Date:	October 2014
	Geotechnical testing locations		Drafted:	Jasmine Snowsill
	23K Walkers Road, Lyttelton		Approved:	David Bell
			Reference:	BGL 1469

Appendix One – Logs of Test Pits TP1 to TP6 inclusive

23K Walkers Road Section (A - A')



Reduced levels (RL) given in metres above Lyttleton 1937 MSL datum

Test Pit							HOLE NO.: TP1		
CLIENT: Julia Oakley PROJECT: Geotechnical Investigation							JOB NO.: BGL 1469		
SITE LOCATION: 23k Walkers Road CO-ORDINATES: 1576406mE, 5172210mN DATUM: Ground RIG: Excavator							START DATE: 15/11/2014 END DATE: 15/11/2014		
OPERATOR:									
DESCRIPTION	METHOD	TCR (%)	DEPTH	GRAPHIC	SPT N-VALUE (Uncorrected)	SPT DATA (Uncorrected)	SAMPLES	WATER	INSTALLATION
Dark grey organic-rich clayey SILT; firm, dry TOPSOIL		25 50 75			10 20 30 40				
Brown clayey SILT with some fine sand and gravel; firm (-stiff), moist, volcanic fragments (gravel) <30mm. LOESS COLLUVIUM.									
Brown moderately weathered BASALT; strong, iron oxide coatings and slight weathering of feldspar BEDROCK.			1.0						
	EOH: 1.1m								
			2.0						
REMARKS									
							HOLE DEPTH: 1.1m		
							Page 1 of 1		


Test Pit										HOLE NO.: TP2	
CLIENT: Julia Oakley PROJECT: Geotechnical Investigation										JOB NO.: BGL 1469	
SITE LOCATION: 23k Walkers Road CO-ORDINATES: 1576407mE, 5172216mN DATUM: Ground RIG: Excavator										START DATE: 15/11/2014 END DATE: 15/11/2014	
OPERATOR:											
DESCRIPTION	METHOD	TCR (%)	DEPTH	GRAPHIC	SPT N-VALUE (Uncorrected)	SPT DATA (Uncorrected)	SAMPLES	WATER	INSTALLATION		
		25 50 75			10 20 30 40						
Dark grey organic-rich clayey SILT; firm, dry. TOPSOIL				TS							
Brown clayey SILT with some fine sand and gravel; firm (-stiff), moist, volcanic fragments (gravel) <30mm. LOESS COLLUVIUM.			1.0								
Gravelly silty CLAY.			2.0								
Highly weathered BASALT. BEDROCK.	EOH: 2m										
REMARKS											
										HOLE DEPTH: 2m	
										Page 1 of 1	

Test Pit							HOLE NO.: TP3		
CLIENT: Julia Oakley PROJECT: Geotechnical Investigation							JOB NO.: BGL 1469		
SITE LOCATION: 23k Walkers Road CO-ORDINATES: 1576409mE, 5172221mN DATUM: Ground RIG: Excavator							START DATE: 15/11/2014 END DATE: 15/11/2014 OPERATOR:		
DESCRIPTION	METHOD	TCR (%)	DEPTH	GRAPHIC	SPT N-VALUE (Uncorrected)	SPT DATA (Uncorrected)	SAMPLES	WATER	INSTALLATION
Dark brown organic-rich clayey SILT with some gravel; stiff, dry. TOPSOIL.		25 26 27			10 20 30 40				
Brown clayey SILT with some gravel; firm (-stiff), moist, volcanic fragments (gravel), 30mm. LOESS COLLUVIUM.			1.0						
BASALT	EOH: 1.9m		2.0						
REMARKS									

HOLE DEPTH: 1.9m

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Test Pit										HOLE NO.: TP5	
CLIENT: Julia Oakley PROJECT: Geotechnical Investigation										JOB NO.: BGL 1469	
SITE LOCATION: 23k Walkers Road CO-ORDINATES: 1576412mE, 5172229mN DATUM: Ground RIG: Excavator										START DATE: 15/11/2014 END DATE: 15/11/2014 OPERATOR:	
DESCRIPTION	METHOD	TCR (%)	DEPTH	GRAPHIC	SPT N-VALUE (Uncorrected)	SPT DATA (Uncorrected)	SAMPLES	WATER	INSTALLATION		
Dark grey organic-rich clayey SILT; firm, dry, rare gravel, <30mm. TOPSOIL.											
Yellowed brown clayey SILT with some fine sand; firm (-stiff), moist, rare gravel <30mm. LOESS COLLUVIUM.											
			1.0								
			2.0								
			3.0								
	EOH: 3m		4.0								
REMARKS											
Bottom of pit, no bedrock exposed.											
										HOLE DEPTH: 3m	
										Page 1 of 1	

	Test Pit						HOLE NO.: TP6		
	CLIENT: Julia Oakley PROJECT: Geotechnical Investigation						JOB NO.: BGL 1469		
	SITE LOCATION: 23k Walkers Road CO-ORDINATES: 1576412mE, 5172229mN DATUM: Ground RIG: Excavator						START DATE: 15/11/2014 END DATE: 15/11/2014 OPERATOR:		
DESCRIPTION	METHOD	TCR (%)	DEPTH	GRAPHIC	SPT N-VALUE (Uncorrected)	SPT DATA (Uncorrected)	SAMPLES	WATER	INSTALLATION
Dark grey organic-rich clayey SILT; firm, dry, TOPSOIL.		25 50 75			10 20 30 40				
Yellowed brown clayey SILT with some fine sand; stiff, moist, rare gravel <30mm. LOESS COLLUVIUM.			1.0 2.0 3.0						
	EOH: 3.1m		4.0						
REMARKS Bottom of pit, no bedrock exposed									
							HOLE DEPTH: 3.1m		
							Page 1 of 1		