ENGEO Limited
25 Glenda Drive, Frankton,
Queenstown 9371
T: +64 3 328 9012
www.engeo.co.nz

Project Number 19377.000.001

Geotechnical Investigation

Lot 4 Water Race Hill, Bannockburn,

Submitted to:
DJ Jones Family Trust & Searell Family Trust No 2
C/- David Riley
Villa 159, 147 Cavendish Road
Christchurch 8051

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Client	DJ Jones Family Trust & Searell Family Trust No 2	Client Contact	Meg Buddle	
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1 Introduction & Scope

ENGEO Ltd was requested by Adderley Head (AD) on behalf of DJ Jones Family Trust & Searell Family Trust No 2 to undertake a geotechnical investigation of the property at Lot 4 Water Race Hill, Bannockburn, (herein referred to as 'the site'). The purpose of this service is to support your Resource Consent application for the subdivision of this site into 20 rural residential lots.

Based on discussions with AD, our scope of works comprised:

- Desktop review of published geotechnical and geological information relevant to the site, historical aerial photos and review of Otago Regional Council (ORC) hazard database.
- Site assessment and mapping of relevant geomorphological features by an experienced ground engineering professional.
- Coordinate local buried services location contractor.
- Coordination of a test-pitting contractor to complete 11 test pits (TPs).
- Assessment of geohazards in relation to Section 106 of the RMA.
- Preparation of a standalone report outlining our findings and analysis of the ground conditions and providing geotechnical advice and recommendations suitable for Resource Consent application.

Investigation, analysis and reporting work was carried out in accordance with our signed agreement (ENGEO, 2021; ref: P2021.005.476_01). Additionally, ENGEO carried out an environmental preliminary site investigation (PSI), which was completed under a different scope of works (ENGEO, 2021; ref 19377.000.002_01 dated 4 November 2021).

2 Site and Development Description

The proposed site is situated on an alluvial terrace remnant on the eastern side of Bannockburn area, approximately 3 km northwest from the base of the Carrick Range and immediately west of the Bannockburn Inlet. The site, legally described as Lot 4 DP 339137 comprises an area of land approximately 17.6 hectares in size and is accessed off Terrace Street.

The site shows evidence of former gold mining works dating back to (we assume) pre1900's. This is identified by a network of historic water races and deeply incised sluice gullies in the northwest (Figure 1) with sluice faces and channels.

The ground surface within the subdivision area comprises an undulating terrace between 270 m and 275 m approximately, before dropping steeply to the north towards Revell's Gully, east towards Bannockburn inlet and south towards Shepherds Creek (Figure 1).

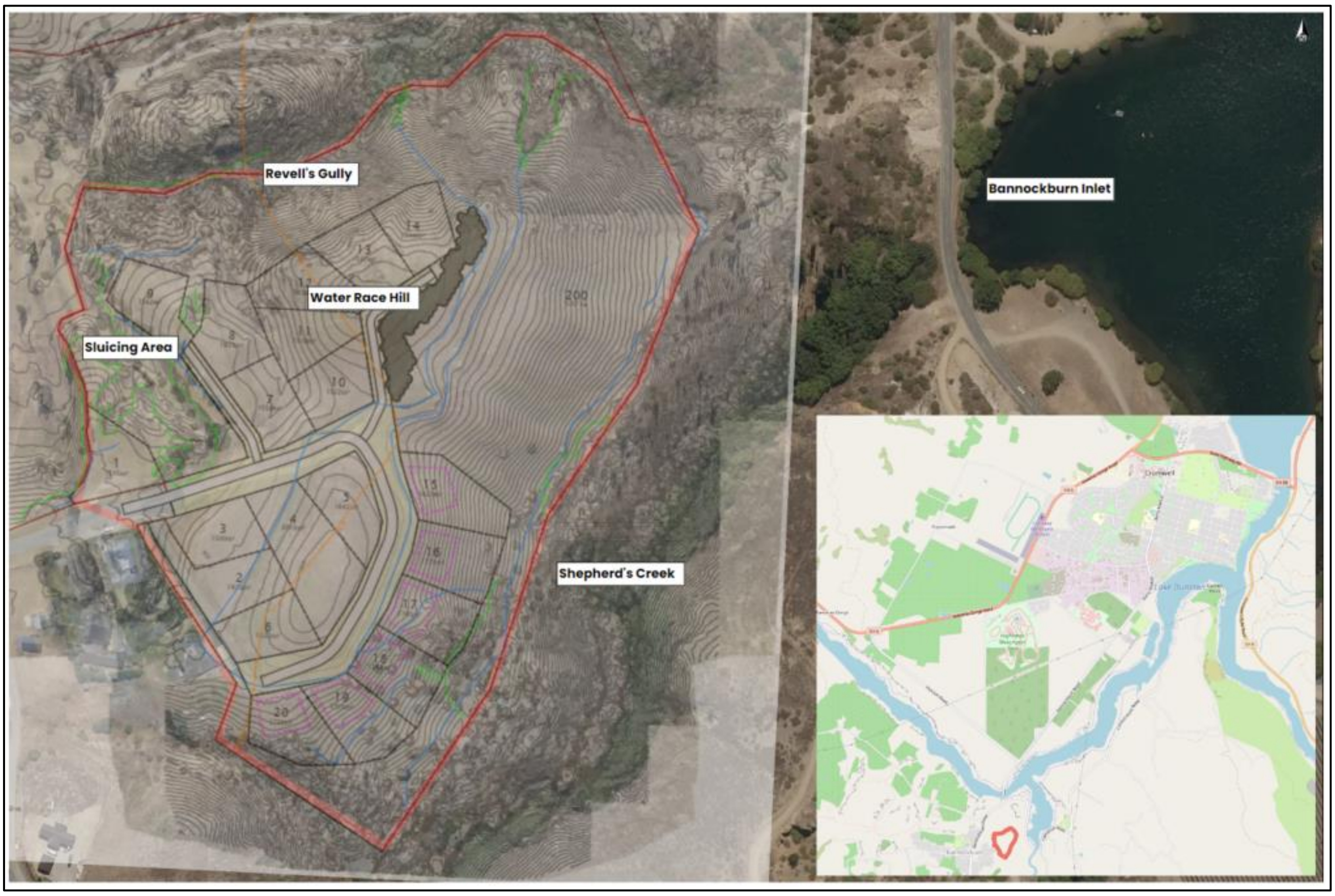

Figure 1: Site Location Plan (LINZ data service, 2021 & Rough & Milne Landscape Architects, 2021)

ENGEO has been supplied with a conceptual subdivision layout drawings by Rough & Milne landscape architects (R&M), dated 21 September 2021. Subdivision layout plan indicates 20 rural residential lots ranging from 1500 m^2 to 3010 m^2 in size with associated accessways (Figure 1).

3 Desktop Study

3.1 Geologic Setting

The subject site is geologically mapped at 1:250,000 as being underlain by Bannockburn and Dunstan Formations of the Manuherikia Group and basement Schist bedrock (Turnbull, 2000). Manuherikia Group consists of lake clays, silts, oil shales and lignite. These sediments are Miocene in age (24 - 5.3 million years old) and were deposited in a freshwater lake that extended across most of the Wakatipu region east of The Remarkables and north toward Lindis Pass.

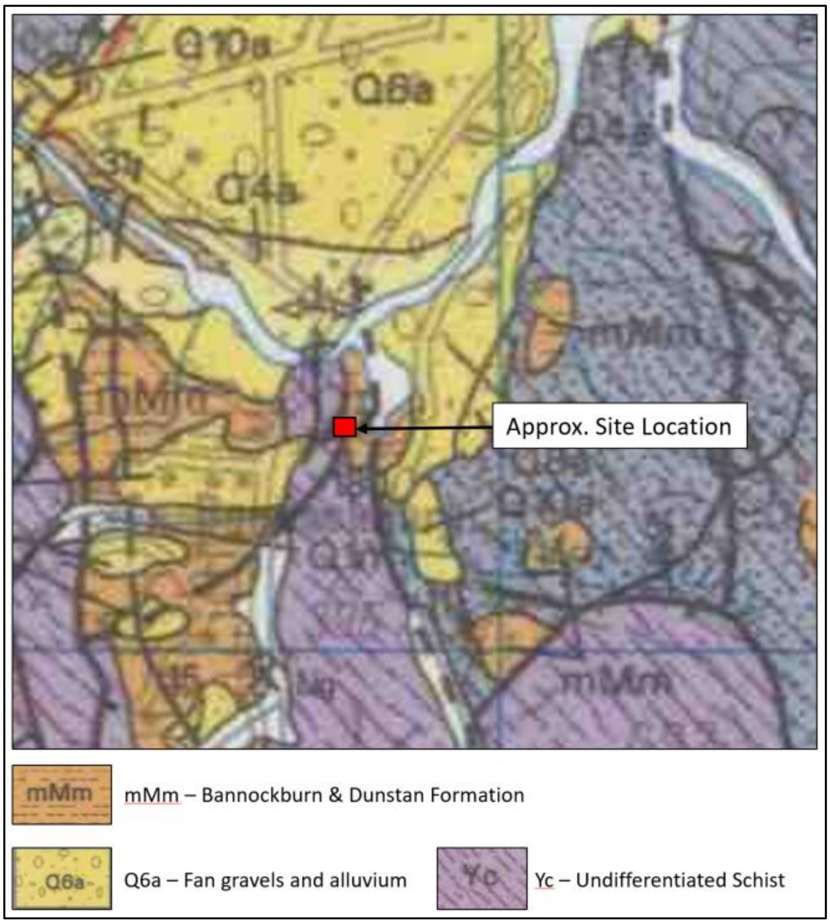

Figure 2: Regional Geology Map (image modified from Turnbull, 2000)

Alluvial Gravels, derived from alluvial fan deposits sourced from the nearby Carrick Range have been mapped in close vicinity to the site (Pedley, K, GNS Science 2017). It is possible a mantle of colluvium is also present, particularly on the steeper south-eastern aspect slopes of the site. Colluvium (if present) is likely to comprise remobilised lacustrine sediments and / or alluvial gravels.

3.2 Seismicity

No active fault traces were observed in the field nor have been reported in the vicinity of the site. The only known active faults within the 20 km of the site are the Dunstan Fault (comprising north and south splays) which is approximately 15 km to the east and the Pisa Fault which is approximately 5 km to the west (Figure 3). The Dunstan Fault is noted in the GNS Active Faults Database to be a reverse fault and has a recurrence interval of c. 5,000 to 10,000 years. It is estimated that a magnitude 7 earthquake on either the Dunstan North or South Faults could result in shaking equivalent to a Modified Mercalli VIII or 'severe' level of shaking. The Pisa Fault is also noted by GNS to be a reverse fault and has a recurrence interval of c. 10,000 to 20,000 years (Barrell, 2019a). While these are the closest known faults to the site, the Alpine Fault is expected to be the greatest seismic hazard to the region (Mackey, 2015).

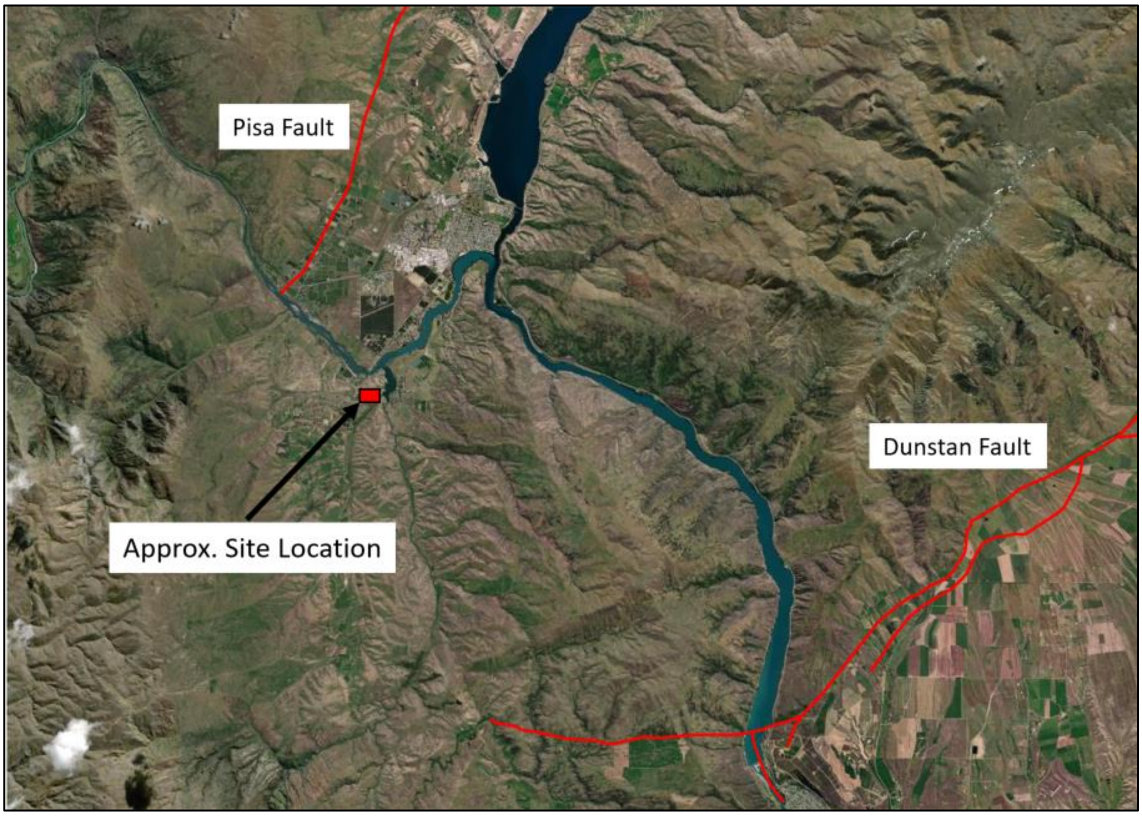

Figure 3: Active Fault Traces in the Region (image modified from GNS NZ Active Fault Database)

The Alpine Fault is an oblique strike-slip fault and is located approximately 100 km northwest of the site. The fault has an estimate recurrence interval of < 2,000 years, with four documented earthquakes occurring in the past 900 years. A magnitude (Mw) 8.1 alpine fault earthquake along the Alpine Fault is expected to result in a ground shaking intensity of MMVII (Modified Mercalli intensity scale) across the Cromwell area (Mackey, 2015).

3.3 Third Party Hazard Database

ENGEO has reviewed Otago Regional Council (ORC) natural hazards database and GNS Science New Zealand Active Fault Database. Relevant hazard categories are summarised as follows:

- The site is mapped as having a liquefaction susceptibility of '*Domain A*' (nil to low susceptibility) due to being underlain by rock or firm sediments (Barrell, 2019b) (Figure 4).
- An inactive alluvial fan is mapped as entering the site in the far western extent (Figure 4.) No landslides (active or inactive) have been mapped within the site area.

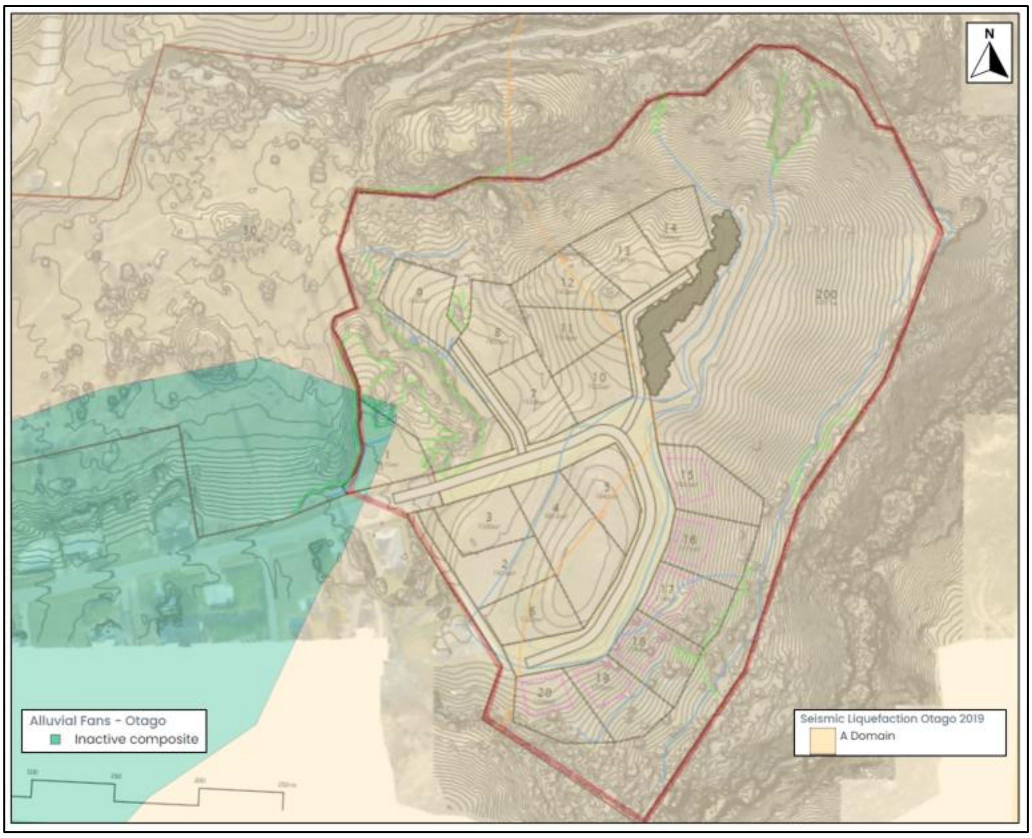

Figure 4: ORC Hazard Map (Sourced from ORC Hazard Database).

3.4 Historic Aerial Photographs

Review of historic aerial images through Retrolens between 1950 and 2003 have been used to assess historic changes in geomorphological features and landform use.

Images from 1950 show the presence of historic water races across the site. It is noted that the site has remained an undeveloped green field site over this time period.

No significant geomorphological changes have been observed, however this interpretation has been made with caution as aerial images were captured from a far distance, making smaller localized changes difficult to identify.

4 Site Investigation

4.1 Site Assessment Observations

ENGEO undertook a site assessment on 12 October 2021 to map the surface geomorphology and identify geohazards concerned with the development. The following observations were made:

- Lots 15 to 19 are located on moderately sloping (approximately 20°) relief on the southeast aspect of the site.
- Ground cracking observed within Lot 18 was initially considered to indicate possible signs of slope movement (Photo 1). This is discussed further in Section 5.

- Lots 1 and 9 are constrained to the west by vertical unsupported banks that are between approximately 4 to 6 m high (Photo 2). Evidence of ground displacement (tension cracking) was observed approximately 3 m from the crest of the bank in Lot 9 (Photo 3).

- *In situ* schist bedrock outcrops were mapped in various locations across the site. Foliation in these outcrops were measured as generally dipping approximately 16º – 22º towards 125º – 165º (Photo 4).

Photo 1: Ground cracking within Lot 18 boundaries.

Photo 2: Image looking north through main sluicing gully between proposed Lots 1 and 9. Lot 9 is located above on right hand side.

Photo 3: Image showing slope displacement on crest of bank in Lot 9.

Photo 4: Schist outcrop located at the high point of Water Race Hill within Lot 13.

Figure 5: Select Images from Site Assessment

Location of mapped geomorphological features are included within Appendix 1.

4.2 Geotechnical Site Investigation

ENGEO completed a geotechnical site investigation on 14 October and 24 November 2021 including the following scope:

- Eleven TPs to between 0.9 m and 2.5 m depth with associated dynamic cone penetrometer (DCP) testing to estimate the *in situ* density of subsurface material.

- Four hand auger (HA) boreholes to between 0.3 m and 1 m depth with associated dynamic cone penetrometer (DCP) testing to estimate the *in situ* density of subsurface material.

TPs were completed by Donerite Contractors using a 10 ton excavator. Investigations were observed by ENGEO and logged in the field in accordance with the New Zealand Geotechnical Society (NZGS) field-description of soil and rock guidelines.

Investigation locations are included in Appendix 1, TP and HA logs are included within Appendix 2.

4.3 Subsurface Geology

Our site investigation generally identified a layer of topsoil between 0.2 m to 0.3 m thick covering the majority of the site.

TPs located in the western extent of the site intercepted between 0.3 to 0.8 m of weathered alluvium, comprising medium dense to dense fine sand with some silt and minor gravels. Coarser grained but thinly bedded alluvium was encountered below this to the target depth of 2.5 m. This material was typically recovered as well graded fine to coarse gravel and sand. The material interpreted in these TPs is consistent with soil exposure 1 & 2 logged in the vertical bank walls adjacent to Lots 1, 7 and 8 and is considered to represent terrace Alluvium.

WRH-ENG21-TP10 (Lot 9) interpreted fine sandy silt, yellowish brown, very stiff, dry and friable with low plasticity. Fine grained, lacustrine material was homogenous down to a target depth of 2.5 m.

Surficial soils interpreted within TPs across the remainder of the site were reasonably consistent. Below topsoil between 0.0 m to 0.9 m of lacustrine material, typically recovered as medium dense to dense silty fine sand was encountered. Highly to slightly weathered, extremely weak to moderately strong Schist was interpreted below lacustrine material. TPs refused between 0.8 and 1.7 m in schist bedrock.

The orientation of foliation within the Schist was measured in TPs WRH-ENG21-TP02 and WRH-ENG21-TP09 as generally between 18º – 22º dip to the southeast, consistent with measurements taken from surrounding schist outcrops (Section 4.1).

WRH-ENG21-HA02 and WRH-ENG21-HA03 interpreted colluvium overlying shallow bedrock to depths between 0.3 m and 1 m. Colluvium typically comprised remobilized lacustrine sediments and was recorded as silty fine sand, light brown, medium dense, dry and poorly graded. An interpreted geologic cross section intersecting Lot 18 is provided in Appendix 3.

Groundwater was not encountered in any of the test pits completed by ENGEO.

5 Geohazard Assessment

Based on our desktop study of ORC hazard database (Section 3.3) and site investigation (Section 4), ENGEO considers it unlikely the proposed development will be adversely affected by alluvial fan risks, liquefaction potential and rockfall hazards. However, during our site assessment (Section 4.1) we identified signs of a possible shallow, small scale localized failure within Lot 18 boundary that required further slope stability assessment. The results of this additional assessment are provided in the following section.

5.1 Slope Stability

5.1.1 Lot 18 Slope Stability Investigation

As indicated in Section 4.1, there appeared to be evidence of a shallow landslide in the vicinity of proposed Lot 18. ENGEO completed geomorphic mapping, four HAs, associated DCP testing and preparation of an interpreted geologic ground model (Appendix 3) across Lot 18 to further understand the likely cause of shallow failure signs identified during the site assessment.

Geomorphic mapping in Lot 18 observed *in situ* schist bedrock outcrops in close vicinity to where ground cracking was observed suggesting shallow depth to rock. An historic water race feature was also identified approximately 20 m directly up slope that has potential to provide seepage to the area. However, ENGEO could not observe a toe bulge down-slope of the ground cracking to suggest localised slope failure.

HA and DCP investigation across Lot 18 slope alignment confirmed shallow depth to inferred bedrock, between 0.3 m (where ground cracking was observed) to 1 m. Investigation results returned a lack of evidence in the subsoil to suggest localized slope failure e.g., no changes in moisture, no disturbed or void zones and the density of subsurface material was consistent and generally increased with depth. These findings have been illustrated on the interpreted geologic cross section included in Appendix 3.

As such, it is our opinion that ground cracking has occurred from long term creep of surficial soils over shallow bedrock and not as a result of larger scale landslide failure.

5.1.2 Slope Hazard Assessment

To further characterise the landslide potential across the proposed subdivision, we have utilised contour data gathered by Landpro Ltd. As part of an aerial drone survey undertaken in 2016 to group the sloping site into areas of similar gradient. For the purposes of this analysis we have adopted the following slope gradient categories:

- Instability unlikely where slope angles are less than 10°.
- Instability unlikely where slope angles are between 10° and 17.5°.
- Instability possible where slope angles are between 17.5° and 25°.
- Instability unlikely under earthquake or rainfall events where slope angles are between 25° and 32.5°.
- Instability likely where slope angles are between 32.5° and 37.5°.
- Instability expected where slope angles are greater than 37.5°.

Our resulting slope hazard assessment is presented in Appendix 4. The resultant hazard mapping is limited by resolution of the drone and the vegetation coverage in specific areas that slightly alter the contours.

5.2 Seismic Hazards

Potential seismic hazards resulting from nearby moderate to major earthquakes can generally be classified as primary and secondary. The primary effect is ground rupture, also called surface faulting. The common secondary seismic hazards include ground shaking, regional subsidence or uplift, soil liquefaction, lateral spreading, landslides.

5.2.1 Ground Rupture

There are no known active faults within the site. Based on our site walkover and review of relevant publications (Section 3.2) it is our opinion that fault-related ground rupture is unlikely at the subject site.

5.2.2 Site Subsoil Classification

Based on the investigation information detailed in Section 4 interpreting the shallow depth to bedrock, we consider the soil classification in line with NZS 1170.5:2004 to be 'Class C – Shallow Soil' for the purpose of seismic design.

5.2.3 Seismic Design Considerations

For the purposes of characterising seismic design, we have assumed that the subdivision will be developed with Importance Level 2 (IL2) structures only. Further analysis will be required if the development is to incorporate structures of higher importance levels.

According to NZS 1170.0:2002, Importance Level 2 (IL2) buildings should sustain little or no structural damage under a Serviceability Limit State (SLS) design load case, which is based on earthquake shaking with a 25 year return period. Further, IL2 buildings are required to be designed to resist earthquake shaking with an annual probability of exceedance of 1/500 (i.e., a 500 year return period). This is the Ultimate Limit State (ULS) design seismic loading.

The design peak ground accelerations (PGA) for the site under both ultimate limit state (ULS) and serviceability limit state (SLS) design load cases have been calculated from NZS 1170.5:2004 using the recommendations of the New Zealand Geotechnical Society as follows:

Peak horizontal ground accelerations (a_{max}) have been calculated in accordance with MBIE / NZGS Module 1 (2016) using the following formula:

$$a_{max} = C0_{,1000}\ R\ f\ g\ /\ 1.3.$$

Where

$C_{0,1000}$ = 0.33 for Cromwell (Commentary to the NZTA Bridge Manual (2018) Table C6.1)

R = 1 for a 500 year return period event (NZS1170.5) (ULS)

= 0.25 for a 25 year return period event (NZS1170.5) (SLS)

f = 1.3 for Class C

Thus $a_{max\,=}$ = 0.33 x 0.25 x 1.3 / 1.3 = 0.08 g (SLS)

= 0.33 x 1.0 x 1.3 / 1.3 = 0.33 g (ULS)

The effective earthquake magnitude for the Cromwell area has been assumed to be 6.25.

5.3 Development Constraints Assessment

To provide guidance for future development, we have prepared a constraints map outlining potential risk to the proposed subdivision by combining our knowledge of past and present site conditions to guide future works. The constraints map considers interactions between the following:

- Site geology (subsurface conditions, identified through our site observations and subsurface investigations).
- Geomorphological conditions (the locations of landslides and other features identified through our site observations and aerial photograph reviews).
- Topographical conditions (utilising drone survey data to characterise areas of similar slope gradients).

Combining these factors, we have developed the risk classes presented in Table 1 below. We have been advised that the proposed subdivision will be entirely low density and rural residential development, and our assessment of risk has taken this into consideration when assessing vulnerability.

Table 1: Development Risk Classes

Development Risk Class	Hill Slope Characteristics	Limitations to Development
1	Low slope gradients (less than 17.5°) No obvious evidence of instability	Little to no limitations to residential development (subject to foundation suitability)
2	Areas of moderate slope gradient (17.5° to 25°) May be evidence of instability following heavy rainfall or large earthquake events No obvious evidence of instability	May require shallow earthworks to form a suitable building platform
3	Moderate to steep slope gradients (25° to 32.5°) Instability is likely under earthquake or rainfall events (includes potential for inundation from upslope) or Some evidence of small scale instability	Will likely require specific engineering design to form a suitable building platform
4	Steep slope gradients (32.5° to 37.5°) Instability is likely under earthquake or rainfall events (includes potential for inundation from upslope) or Evidence of large-scale inactive or relict slope instability	Will require specific engineering design and substantial foundations and / or earthworks to form a suitable building platform
5	Steep slope gradients (greater than 37.5° from horizontal) and indications of recent instability or Evidence of large-scale, active slope instability	Complex or large-scale engineering works required to develop. Consideration should be given to avoiding these other areas owing to severe physical limitations that are likely to be difficult to overcome

Note that these are based on the current site topography and assume only minimal earthworks to develop the site into residential lots. Should extensive earthworks be proposed (such as valley in-fills), the Constraint areas would need to be reassessed.

A site map presenting our interpreted development classes is presented in Appendix 5.

In some areas the map within Appendix 5 indicates higher development risk classes immediately adjacent to a lower risk category. In this instance, we recommend that that the lot specific geotechnical investigation takes into consideration risk posed by the adjacent area such that appropriate mitigation solutions are incorporated into the development works.

6 Geotechnical Recommendations

Based on our geotechnical assessment to date, ENGEO consider the site at Lot 4 Water Race Hill, Bannockburn to be suitable for the proposed development from a geotechnical perspective, subject to recommendations in Sections 6.1 through 6.6.

6.1 Section 106 Hazard Assessment

In accordance with Section 106 of the Resource Management Act we have assessed the potential for geological hazards which may impact the proposed development. Of the assessed natural hazards, we consider slope stability to be the most likely impact to the development.

We have considered our site investigation (Section 4), slope stability hazard assessment (Section 5.1, Appendix 4) and development constraint map (Section 5.3, Appendix 5) while assessing the potential risk from identified geohazards to the proposed subdivision.

Majority of proposed lots across the site have been assessed as development risk Class 1. If geotechnical recommendations outlined in following sections are adopted, these lots are not expected to be subject to significant risk from geohazards identified in this report in accordance with the provisions of Section 106 of the Resource Management Act 1991.

Proposed lots along the southern boundary (Lots 15, 16, 17 and 19), occupy moderately sloping relief and have been assessed as development risk class 2. We consider these proposed lots unlikely to accelerate, worsen or result in material damage to the land, provided good engineering practice for hill slope development (AGS, 2007) is applied (Appendix 6). Shallow earthworks may be required to create a stable building platform as part of subdivision works.

Proposed Lot 18 has been categorised as development risk class 3 due to its location on moderately sloping ground and ground cracking identified during our site assessment (Section 4.1). ENGEO completed further specific investigation within Lot 18 (Section 5.1.1) and noted that the source of ground cracking is likely due to creep of surficial soil overlying shallow bedrock up to 0.3 m depth. It is not clear that there is a significant risk from the geohazard identified, and it is our opinion this hazard will be able to be mitigated through a combination of good engineering practises for hill slope development (Appendix 6) and specific engineering mitigation design.

6.2 Foundations

We understand that at this stage of the development process site plans are preliminary only and foundations are yet to be designed. A range of preliminary foundation recommendations are provided below based on our investigations and observations.

- Foundations bearing on the native gravelly alluvial, engineered fill or bedrock materials can be designed for a geotechnical Ultimate Bearing Capacity (UBC) of 300 kPa. As required by Section B1/VM4 of the New Zealand Building Code, a strength reduction factor of 0.33 or 0.50 must be applied to all recommended geotechnical ultimate soil capacities (for shallow foundations) in conjunction with their use in factored design load cases for serviceability and ultimate limit state conditions, respectively.

- Foundations bearing on lacustrine silts and sand material should be further assessed for specific bearing capacities during detailed design works.

6.3 Setback Zone

Based on our site assessment observations, ENGEO recommends setback zones are applied along the western crests of both Lot 1 and 9 to reduce crest loading from nearby structures and promote slope stability of the adjacent banks.

ENGEO recommends that foundation construction in Lot 1 and 9 are setback from the crest at a horizontal distance at least twice the adjacent vertical slope height (V), Photo 5. The vertical slope height may be measured from the top of the talus apron that buttresses the base of the vertical slope. We note that this is steeper than allowed for in Section 3.1.2 of NZS3604, however we consider it to be appropriate for the granular materials encountered in both lots. Setback distances should be further assessed and defined by a surveyor during detailed design works for Lot 1 and 9.

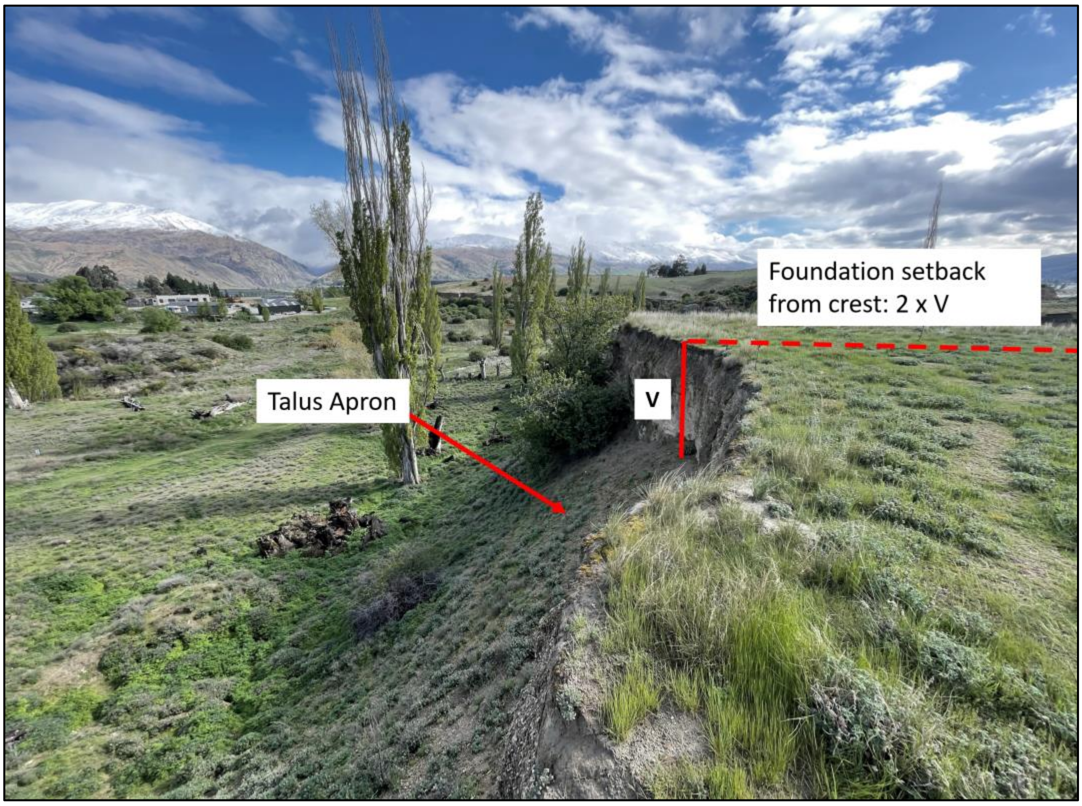

Photo 5: Image showing example setback calculation for Lot 1 & 9.

Setback zone dimensions may be optimized if retaining solutions are explored during Building Consent and detailed designed works.

6.4 Sustainability

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We encourage you to consider sustainability when assessing the options available for your project. Where suitable for the project, we recommend prioritising the use of sustainable building materials (such as timber in favour of concrete or steel), locally sourced (materials readily available to Contractors as opposed to materials requiring import), and installed in an environmentally friendly way (e.g., reduced carbon emissions and minimal contamination). If you would like to discuss these options further, ENGEO staff are available to offer suggestions.

6.5 Future Geotechnical Involvement

The investigations completed to date are intended to support the Resource Consent application (by AD), and to inform the conceptual design of foundations. Further investigation and analysis may be required to support detailed design and Building Consent (by others) once development plans are further progressed.

7 Limitations

i. We have prepared this report in accordance with the brief as provided. This report has been prepared for the use of our client, DJ Jones Family Trust & Searell Family Trust No 2, their professional advisers and the relevant Territorial Authorities in relation to the specified project brief described in this report. No liability is accepted for the use of any part of the report for any other purpose or by any other person or entity.

ii. The recommendations in this report are based on the ground conditions indicated from published sources, site assessments and subsurface investigations described in this report based on accepted normal methods of site investigations. Only a limited 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 judgement and it should be appreciated that actual conditions could vary from the assumed model.

iii. 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.

iv. This Limitation should be read in conjunction with the Engineering NZ/ACENZ Standard Terms of Engagement.

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

We trust that this information meets your current requirements. Please do not hesitate to contact the undersigned on (03) 328 9012 if you require any further information.

Report prepared by

Ryan Dingle
Engineering Geologist

Report reviewed by

Richard Justice, CMEngNZ (PEngGeol)
Principal Engineering Geologist

8 References

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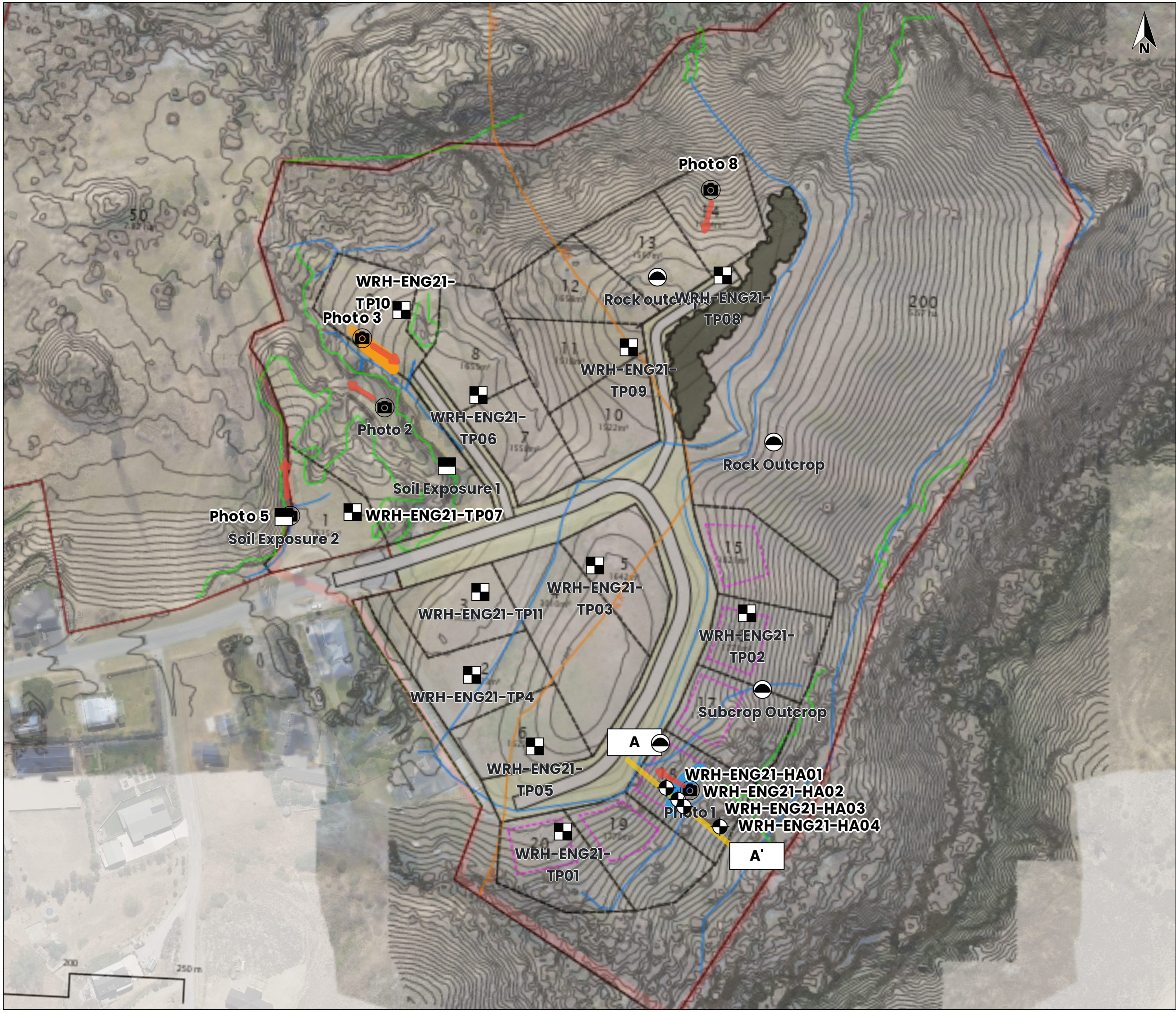
We also acknowledge the New Zealand GeoNet project and its sponsors EQC, GNS Science and LINZ, for providing data used in this report.

APPENDIX 1:

Site Investigation and Geomorph Mapping



Legend

- ENGEO Hand Auger Investigation Locations
- ENGEO Test Pit Investigation Locations
- Soil Exposure Location
- Outcrops
- Site Photo Locations
- Cross Section Alignment
- Lot 9 Soil Creep
- Lot 18 ground cracking
- Site Boundary

0 25 m 50 m

ENGEO

Produced by **Datanest.earth**

Title: Site Investigation & Geomorphological Features Location		
Client: DJ Jones Family Trust & Searell Family Trust No 2		Figure No: 1 Size: A3
Project: Lot 4 Water Race Hill	Drawn: RD	
Date: 30-11-2021	Checked: RJ	
Proj No: 19377	Scale: 1:1500	Version: Final

APPENDIX 2:

Site Investigation Results

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Geotechnical Soil Logging Key

ENGEO borehole and test pit logs are written in general accordance with the New Zealand Geotechnical Society field classification guidelines (2005).
Please refer to this document for the methods of field classification and description for engineering purposes.

Grain Size (mm)

0.06 | 0.2 | 0.6 | 2 | 6 | 20 | 60 | 200

SILT and CLAY	SAND			GRAVEL			COBBLE	BOULDER
	Fine	Medium	Coarse	Fine	Medium	Coarse		

Additional Info

▼	Standing water level
UTP	Unable to Penetrate
NA	Not Assessed

Graphic Logs

The graphic log shows soil types and their corresponding UCS classification

Granular Soil (>65% of soil >0.06 mm)		Cohesive Soil (>35% of soil <0.06 mm)	
GW	Well graded GRAVEL	MH	High plasticity SILT
GP	Poorly graded GRAVEL	ML	Low plasticity SILT
GM	Silty GRAVEL	CH	High plasticity CLAY
GC	Clayey GRAVEL	CL	Low plasticity CLAY
SW	Well graded SAND		**Rock**
SP	Poorly graded SAND	OH	Schist Bedrock
SM	Silty SAND	OL	
SC	Clayey SAND	PT	
Other Soils			
TS/BTS	Topsoil/ Buried Topsoil	F	Fill

G = Gravel W = Well Graded P = Poorly Graded C = Clay S = Sand M = Silt H = High Plasticity L = Low Plasticity O = Organic

Cohesive Soils - Consistency Index

		Undrained shear strength (kPa)	Field Diagnostic Features
VS	Very Soft	<12	Easily exudes between fingers when squeezed
S	Soft	12 – 25	Easily indented by fingers
F	Firm	25 – 50	Indented by strong finger pressure and can be indented by thumb pressure
St	Stiff	50 – 100	Cannot be indented by thumb pressure
VSt	Very Stiff	100 – 200	Can be indented by thumb nail
H	Hard	200+	Difficult to indent by thumb nail

Moisture Content

D	Dry	Looks and feels dry
M	Moist	Feels cool and darkened in colour and granular soils tend to be cohere
W	Wet	Feels cool and darkened in colour. Granular soils tend to cohere and free water forms when remoulding cohesive soils
S	Saturated	Feels cool, darkened in colour and free water present on the sample

Granular Soils - Density Index

		SPT 'N' Value (blows /300mm)	Scala Penetrometer (blows/100 mm)
VL	Very loose	<4	0 - 2
L	Loose	4 – 10	1 – 3
MD	Medium Dense	10 - 30	3 - 7
D	Dense	30 - 50	7 – 17
VD	Very Dense	<50	>17

Proportional Terms Definition

Fraction	Term	% of Soil	Example
Major	(UPPERCASE)	>50	GRAVEL
Subordinate	(lowercase)y	20 - 50	Sandy
Minor	With some....	12 - 20	With some sand
	With minor....	5 - 12	With minor sand
	With trace....	<5	With trace sand

Soil Structure

Zoning		Cementing	
Layers	Continuous across exposure or sample	Weakly Cemented	Easily broken up by hand in air or water
Lenses	Discontinuous layers of lenticular shape	Moderately cemented	Effort is required to break up the soil by hand in air or water
Pockets	Irregular inclusions of different material		

ENGEO	Client: Searell Jones Project: Lot 4 Water Race Hill Location: Bannockburn Project Number: 19377	Hole I.D: **Soil Exposure 1**

Method: Soil Exposure Contractor: Operator: Equipment: Bucket Size: mm Vane Number: N/A	Coordinates E: -45.087057 (NZTM) N: 169.166603 Elevation (mRL): 269 Elevation Datum: NZTM	Maximum Depth: 3 m Survey Method: Leica FLX100 Start Date: 12/10/2021 Finish Date: 12/10/2021 Logged By: RD Reviewed By: RJ

Elevation (mRL)	Geological Unit	Excavatability (relative scale) Easier – Harder	DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity, additional features (grain size, roundness, composition etc. as applicable)	Depth (m BGL)	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density	Sample	Testing / Additional Comments	Dynamic Cone Penetrometer Blows per 100mm 2 4 6 8 10 12
	ALLUVIUM		Fine to medium SAND with minor gravel; brown. Loosely packed; dry; poorly graded; gravel, fine, subrounded to subangular [ALLUVIUM]	0.5							
268			Sandy fine to coarse GRAVEL; brown. Tightly packed; dry; well graded; sand, fine to coarse [ALLUVIUM].	1.0 1.5			D				
267			Fine to medium SAND with minor gravel; brown. Tightly packed; dry; poorly graded; gravel, fine, subrounded [ALLUVIUM].	2.0 2.5							
266				3.0							

Depth of Excavation: 3 m
Termination Condition:

Photos / Sketches

TP = Tightly Packed, LP = Loosely Packed

ENGEO

Client: Searell Jones
Project: Lot 4 Water Race Hill
Location: Bannockburn
Project Number: 19377

Hole I.D:
Soil Exposure 2

Method: Soil Exposure Contractor: Operator: Equipment: Bucket Size: mm Vane Number: N/A	Coordinates E: -45.086988 (NZTM) N: 169.16572 Elevation (mRL): 266 Elevation Datum: NZTM	Maximum Depth: 3 m Survey Method: Leica FLX100 Start Date: 12/10/2021 Finish Date: 12/10/2021 Logged By: RD Reviewed By: RJ

Elevation (mRL)	Geological Unit	Excavatability (relative scale) Easier – Harder	DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity, additional features (grain size, roundness, composition etc. as applicable)	Depth (m BGL)	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density	Sample	Testing / Additional Comments	Dynamic Cone Penetrometer Blows per 100mm 2 4 6 8 10 12
	ALLUVIUM		Sandy fine to coarse GRAVEL; brown. Tightly packed; dry; well graded; sand, fine to coarse [ALLUVIUM].	0.0–1.5			D	TP			
265				1.0							
			Fine to coarse SAND with minor gravel; brown. Loosely packed; dry; well graded; gravel, fine to coarse, 300 mm thick discontinuous lens [ALLUVIUM].	1.5–2.7				LP			
264				2.0							
			Gravelly fine to coarse SAND; brown. Loosely packed; dry; well graded; gravel, fine to medium, subangular [ALLUVIUM].	2.7–3.0							
263			Depth of Excavation: 3 m Termination Condition:	3.0							

Photos / Sketches

TP = Tightly Packed, LP = Loosely Packed

ENGEO

Test Pit Log

Client: Searell Jones
Project: Lot 4 Water Race Hill
Location: Bannockburn
Project Number: 19377

Hole I.D:
WRH-ENG21-TP01

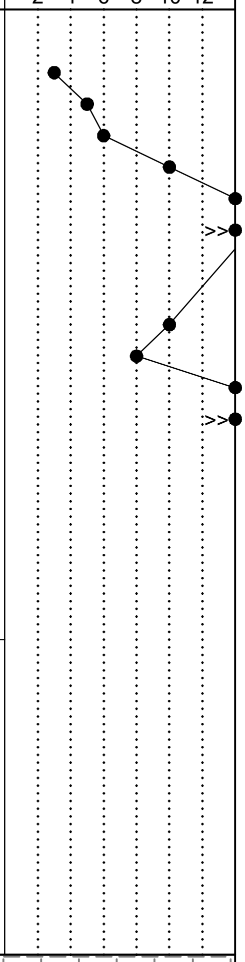
Method: Bucket Excavator Contractor: Donerite Operator: Chase Equipment: 10t Excavator Bucket Size: mm Vane Number: N/A	Coordinates E: -45.08838 (NZTM) N: 169.16722 Elevation (mRL): 269 Elevation Datum: NZTM	Maximum Depth: 2 m Survey Method: Leica FLX100 Start Date: 14/10/2021 Finish Date: 14/10/2021 Logged By: RD Reviewed By: RJ

Elevation (mRL)	Geological Unit	Excavatability (relative scale) Easier – Harder	DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity, additional features (grain size, roundness, composition etc. as applicable)	Depth (m BGL)	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density	Sample	Testing / Additional Comments
	TS		TOPSOIL							
	ALLUVIUM		Silty fine SAND; light brown, homogenous. Medium dense; dry; poorly graded [ALLUVIUM]							
268	ALLUVIUM		Fine to medium SAND with some gravel and trace cobbles; brown. Medium dense to dense; dry; well graded; gravel, fine to coarse, subrounded, moderately weathered schist. Maximum particle size 60 mm [ALLUVIUM].	0.5 – 2.0			D	MD to D		
267				2.0						

Depth of Excavation: 2 m
Termination Condition: Practical refusal

Dynamic Cone Penetrometer

Blows per 100mm



Photos / Sketches

Refused on hard material

ENGEO

Test Pit Log

Client: Searell Jones
Project: Lot 4 Water Race Hill
Location: Bannockburn
Project Number: 19377

Hole I.D:
WRH-ENG21-TP02

Method: Bucket Excavator Contractor: Donerite Operator: Chase Equipment: 10t Excavator Bucket Size: mm Vane Number: N/A	Coordinates E: -45.08756 (NZTM) N: 169.1682 Elevation (mRL): 268 Elevation Datum: NZTM	Maximum Depth: 1 m Survey Method: Leica FLX100 Start Date: 14/10/2021 Finish Date: 14/10/2021 Logged By: RD Reviewed By: RJ

Elevation (mRL)	Geological Unit	Excavatability (relative scale) Easier – Harder	DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity, additional features (grain size, roundness, composition etc. as applicable)	Depth (m BGL)	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density	Sample	Testing / Additional Comments	Dynamic Cone Penetrometer Blows per 100mm 2 4 6 8 10 12
	TS		TOPSOIL					MD			
	SCHIST		Highly weathered, foliated, brown / orange, SCHIST; very weak; foliation dips 18 degrees to the south [SCHIST].	0.5			D	VW			
267			Moderately to slightly weathered, grey, SCHIST; weak to moderately strong [SCHIST].	1.0				W to MS			>>

Depth of Excavation: 1 m
Termination Condition: Practical refusal

Photos / Sketches

Refused on hard material

Test Pit Log

Client: Searell Jones	Hole I.D:
Project: Lot 4 Water Race Hill	WRH-ENG21-TP03
Location: Bannockburn	
Project Number: 19377	

Method: Bucket Excavator Contractor: Donerite Operator: Chase Equipment: 10t Excavator Bucket Size: mm Vane Number: N/A	Coordinates E: -45.08738 (NZTM) N: 169.16739 Elevation (mRL): 272 Elevation Datum: NZTM	Maximum Depth: 1.1 m Survey Method: Leica FLX100 Start Date: 14/10/2021 Finish Date: 14/10/2021 Logged By: RD Reviewed By: RJ

Elevation (mRL)	Geological Unit	Excavatability (relative scale) Easier – Harder	DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity, additional features (grain size, roundness, composition etc. as applicable)	Depth (m BGL)	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density	Sample	Testing / Additional Comments	Dynamic Cone Penetrometer Blows per 100mm (2 4 6 8 10 12)
	TS		TOPSOIL								
	LACUSTRINE		Silty fine SAND; light brown, homogenous. Medium dense; dry; poorly graded [LACUSTRINE].					MD			
	SCHIST		Highly weathered, foliated, brown / orange SCHIST; very weak [SCHIST].	0.5			D	VW			>>
271	SCHIST		Moderately to slightly weathered, grey SCHIST; weak to moderately strong [SCHIST].	1.0				W to MS			

Depth of Excavation: 1.1 m
Termination Condition: Practical refusal

Photos / Sketches

Refused on hard material

ENGEO

Test Pit Log

Client: Searell Jones
Project: Lot 4 Water Race Hill
Location: Bannockburn
Project Number: 19377

Hole I.D:
WRH-ENG21-TP04

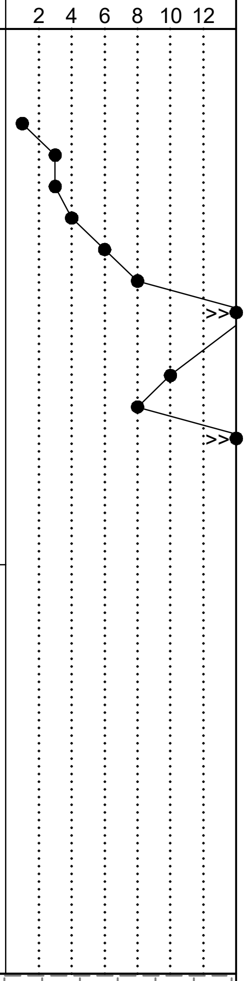
Method: Bucket Excavator Contractor: Donerite Operator: Chase Equipment: 10t Excavator Bucket Size: mm Vane Number: N/A	Coordinates E: -45.0876 (NZTM) N: 169.1666 Elevation (mRL): 272 Elevation Datum: NZTM	Maximum Depth: 1.7 m Survey Method: Leica FLX100 Start Date: 14/10/2021 Finish Date: 14/10/2021 Logged By: RD Reviewed By: RJ

Elevation (mRL)	Geological Unit	Excavatability (relative scale) Easier – Harder	DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity, additional features (grain size, roundness, composition etc. as applicable)	Depth (m BGL)	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density	Sample	Testing / Additional Comments
	TS		TOPSOIL							
	LACUSTRINE		Silty fine SAND; light brown, homogenous. Medium dense; dry; poorly graded [LACUSTRINE].	0.5			D	MD		
271	SCHIST		Highly weathered, foliated, brown SCHIST; very weak [SCHIST].	1.0				VW		
	SCHIST		Moderately to slightly weathered, grey, SCHIST; weak to moderately strong [SCHIST].	1.5				W to MS		

Depth of Excavation: 1.7 m
Termination Condition: Practical refusal

Dynamic Cone Penetrometer

Blows per 100mm



Photos / Sketches

Refused on hard material

TEST PIT LOG (NZ) TP LOGS.GPJ NZ MASTER DATA TEMPLATE.GDT 29/11/21

ENGEO Test Pit Log

Client: Searell Jones
Project: Lot 4 Water Race Hill
Location: Bannockburn
Project Number: 19377

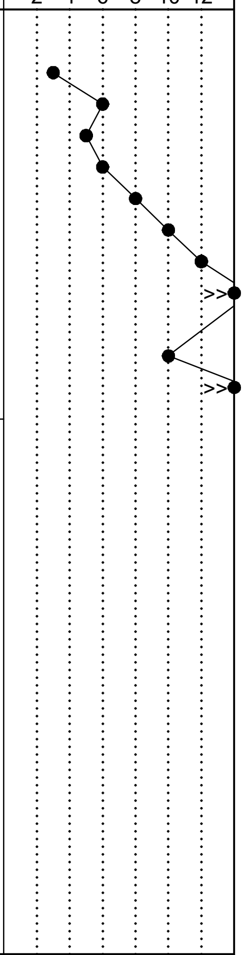
Hole I.D:
WRH-ENG21-TP05

Method: Bucket Excavator Contractor: Donerite Operator: Chase Equipment: 10t Excavator Bucket Size: mm Vane Number: N/A	Coordinates E: -45.08806 (NZTM) N: 169.16707 Elevation (mRL): 272 Elevation Datum: NZTM	Maximum Depth: 1.3 m Survey Method: Leica FLX100 Start Date: 14/10/2021 Finish Date: 14/10/2021 Logged By: RD Reviewed By: RJ

Elevation (mRL)	Geological Unit	Excavatability (relative scale) Easier – Harder	DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity, additional features (grain size, roundness, composition etc. as applicable)	Depth (m BGL)	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density	Sample	Testing / Additional Comments
	TS		TOPSOIL							
	LACUSTRINE		Silty fine SAND; light brown, homogenous. Medium dense; dry; poorly graded [LACUSTRINE].	0.5			D	MD to D		
271				1.0						
	SCHIST		Highly weathered, foliated, brown SCHIST; very weak [SCHIST].					VW		

Dynamic Cone Penetrometer

Blows per 100mm



Depth of Excavation: 1.3 m
Termination Condition: Practical refusal

Photos / Sketches

Refused on hard material

TEST PIT LOG (NZ) TP LOGS.GPJ NZ MASTER DATA TEMPLATE.GDT 29/11/21

ENGEO

Test Pit Log

Client: Searell Jones
Project: Lot 4 Water Race Hill
Location: Bannockburn
Project Number: 19377

Hole I.D:
WRH-ENG21-TP06

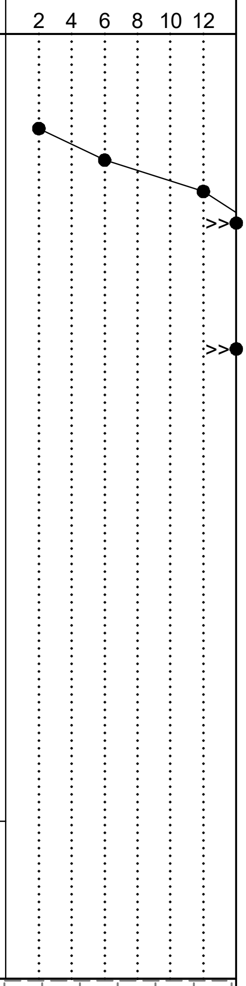
Method: Bucket Excavator Contractor: Donerite Operator: Chase Equipment: 10t Excavator Bucket Size: mm Vane Number: N/A	Coordinates E: -45.08718 (NZTM) N: 169.1661 Elevation (mRL): 270 Elevation Datum: NZTM	Maximum Depth: 2.5 m Survey Method: Leica FLX100 Start Date: 14/10/2021 Finish Date: 14/10/2021 Logged By: RD Reviewed By: RJ

Elevation (mRL)	Geological Unit	Excavatability (relative scale) Easier – Harder	DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity, additional features (grain size, roundness, composition etc. as applicable)	Depth (m BGL)	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density	Sample	Testing / Additional Comments
	TS		TOPSOIL							
	ALLUVIUM		Fine SAND with some silt and minor gravel; light brown. Medium dense; dry; poorly graded; gravel, fine to medium, subangular. Maximum particle size 15 mm [ALLUVIUM].	0.5				MD		
269			Gravelly fine to coarse SAND; light brown. Dense; dry; well graded; thinly bedded; gravel, fine to coarse, subangular [ALLUVIUM].	1.0			D	MD to D		
				1.5						
268				2.0						
				2.5						

Depth of Excavation: 2.5 m
Termination Condition: Target depth

Dynamic Cone Penetrometer

Blows per 100mm



Photos / Sketches

ENGEO

Test Pit Log

Client: Searell Jones
Project: Lot 4 Water Race Hill
Location: Bannockburn
Project Number: 19377

Hole I.D:
WRH-ENG21-TP07

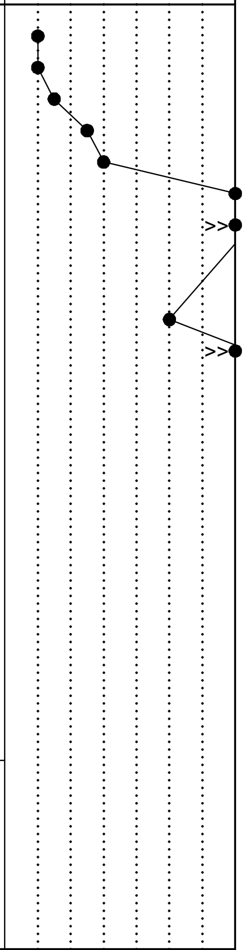
Method: Bucket Excavator Contractor: Donerite Operator: Chase Equipment: 10t Excavator Bucket Size: mm Vane Number: N/A	Coordinates E: -45.08674 (NZTM) N: 169.16677 Elevation (mRL): 268 Elevation Datum: NZTM	Maximum Depth: 2.4 m Survey Method: Leica FLX100 Start Date: 14/10/2021 Finish Date: 14/10/2021 Logged By: RD Reviewed By: RJ

Elevation (mRL)	Geological Unit	Excavatability (relative scale) Easier – Harder	DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity, additional features (grain size, roundness, composition etc. as applicable)	Depth (m BGL)	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density	Sample	Testing / Additional Comments
	TS		TOPSOIL							
	ALLUVIUM		Fine SAND with some silt and minor gravel; light brown. Medium dense; dry; poorly graded; gravel, fine to medium, subangular. Maximum particle size 15 mm [ALLUVIUM].	0.5			D	MD		
267 266	ALLUVIUM		Gravelly fine to coarse SAND; light brown. Dense; dry; well graded; thinly interbedded; gravel, fine to coarse, subrounded [ALLUVIUM].	1.0 1.5 2.0			D	D		

Depth of Excavation: 2.4 m
Termination Condition: Target depth

Dynamic Cone Penetrometer

Blows per 100mm



Photos / Sketches

ENGEO Test Pit Log

Client: Searell Jones
Project: Lot 4 Water Race Hill
Location: Bannockburn
Project Number: 19377

Hole I.D:
WRH-ENG21-TP08

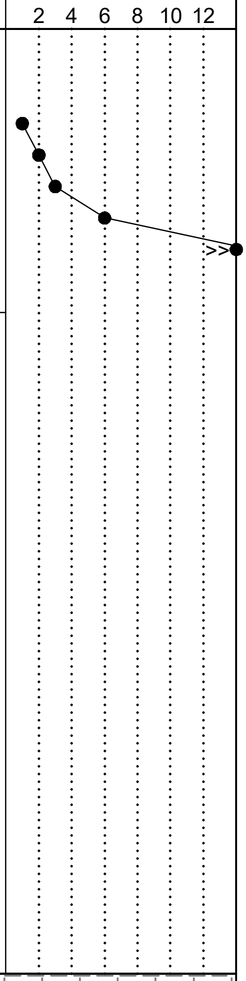
Method: Bucket Excavator Contractor: Donerite Operator: Chase Equipment: 10t Excavator Bucket Size: mm Vane Number: N/A	Coordinates E: -45.08629 (NZTM) N: 169.16807 Elevation (mRL): 274 Elevation Datum: NZTM	Maximum Depth: 0.9 m Survey Method: Leica FLX100 Start Date: 14/10/2021 Finish Date: 14/10/2021 Logged By: RD Reviewed By: RJ

Elevation (mRL)	Geological Unit	Excavatability (relative scale) Easier – Harder	DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity, additional features (grain size, roundness, composition etc. as applicable)	Depth (m BGL)	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density	Sample	Testing / Additional Comments
	TS		TOPSOIL							
	LACUSTRINE		Silty fine SAND; light brown, homogenous. Medium dense; dry; poorly graded [LACUSTRINE].	0.5			D	MD		
	SCHIST		Moderately to slightly weathered, foliated, grey SCHIST; moderately strong [SCHIST]					MS		

Depth of Excavation: 0.9 m
Termination Condition: Practical refusal

Dynamic Cone Penetrometer

Blows per 100mm



Photos / Sketches

Refused on hard material

Test Pit Log

Client: Searell Jones
Project: Lot 4 Water Race Hill
Location: Bannockburn
Project Number: 19377

Hole I.D:
WRH-ENG21-TP09

Method: Bucket Excavator Contractor: Donerite Operator: Chase Equipment: 10t Excavator Bucket Size: mm Vane Number: N/A	Coordinates E: -45.08656 (NZTM) N: 169.16757 Elevation (mRL): 272 Elevation Datum: NZTM	Maximum Depth: 1.1 m Survey Method: Leica FLX100 Start Date: 14/10/2021 Finish Date: 14/10/2021 Logged By: RD Reviewed By: RJ

Elevation (mRL)	Geological Unit	Excavatability (relative scale) Easier – Harder	DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity, additional features (grain size, roundness, composition etc. as applicable)	Depth (m BGL)	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density	Sample	Testing / Additional Comments	Dynamic Cone Penetrometer Blows per 100mm 2 4 6 8 10 12
	TS		TOPSOIL								
	LACUSTRINE		Silty fine SAND; light brown, homogenous. Medium dense; dry; poorly graded [LACUSTRINE].	0.5			D	MD			>>
	SCHIST		Highly weathered, foliated, brown / orange SCHIST; very weak; foliation dips 22 degrees south [SCHIST].					VW			
271			Moderately to slightly weathered, foliated, grey, SCHIST; weak to moderately strong [SCHIST].	1.0				W to MS			

Depth of Excavation: 1.1 m
Termination Condition: Practical refusal

Photos / Sketches

Refused on hard material

TEST PIT LOG (NZ) TP LOGS.GPJ NZ MASTER DATA TEMPLATE.GDT 29/11/21

ENGEO

Test Pit Log

Client: Searell Jones
Project: Lot 4 Water Race Hill
Location: Bannockburn
Project Number: 19377

Hole I.D:
WRH-ENG21-TP10

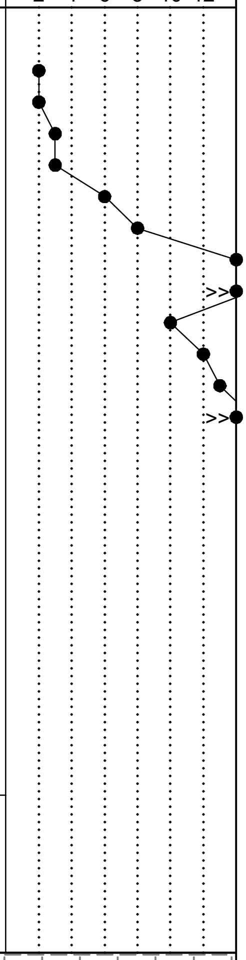
Method: Bucket Excavator Contractor: Donerite Operator: Chase Equipment: 10t Excavator Bucket Size: mm Vane Number: N/A	Coordinates E: -45.08642 (NZTM) N: 169.16636 Elevation (mRL): 265 Elevation Datum: NZTM	Maximum Depth: 2.5 m Survey Method: Leica FLX100 Start Date: 14/10/2021 Finish Date: 14/10/2021 Logged By: RD Reviewed By: RJ

Elevation (mRL)	Geological Unit	Excavatability (relative scale) Easier – Harder	DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity, additional features (grain size, roundness, composition etc. as applicable)	Depth (m BGL)	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density	Sample	Testing / Additional Comments
	TS		TOPSOIL							
264 263	LACUSTRINE		Sandy SILT; yellowish brown, homogenous. Very stiff, dry, low plasticity, moderately sensitive, friable [LACUSTRINE].	0.5 1.0 1.5 2.0 2.5			D	VSt		

Depth of Excavation: 2.5 m
Termination Condition: Target depth

Dynamic Cone Penetrometer

Blows per 100mm



Photos / Sketches

ENGEO

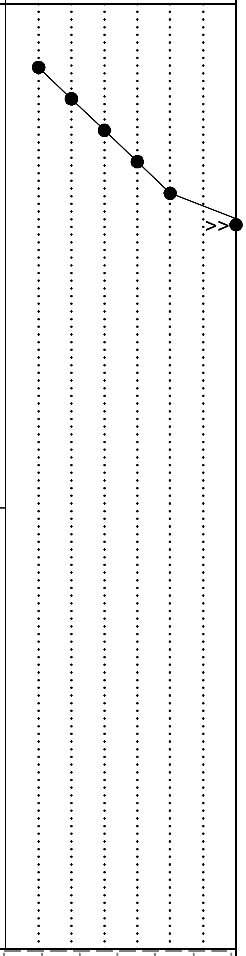
Test Pit Log

Client: Searell Jones
Project: Lot 4 Water Race Hill
Location: Bannockburn
Project Number: 19377

Hole I.D:
WRH-ENG21-TP11

Method: Bucket Excavator Contractor: Donerite Operator: Chase Equipment: 10t Excavator Bucket Size: mm Vane Number: N/A	Coordinates E: -45.08748 (NZTM) N: 169.16678 Elevation (mRL): 269 Elevation Datum: NZTM	Maximum Depth: 1.6 m Survey Method: Leica FLX100 Start Date: 14/10/2021 Finish Date: 14/10/2021 Logged By: RD Reviewed By: RJ

Elevation (mRL)	Geological Unit	Excavatability (relative scale) Easier – Harder	DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity, additional features (grain size, roundness, composition etc. as applicable)	Depth (m BGL)	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density	Sample	Testing / Additional Comments	Dynamic Cone Penetrometer Blows per 100mm (2 4 6 8 10 12)
	TS		TOPSOIL				D				
	LACUSTRINE		Silty fine SAND; light brown, homogenous. Medium dense; dry; poorly graded [LACUSTRINE].	0.5				MD			
268	SCHIST		Highly to moderately weathered, brown / orange SCHIST; very weak to weak. Some of rock mass has weathered to Sandy fine to coarse GRAVEL; Medium dense; dry; well graded; subangular; sand, fine to coarse [SCHIST]	1.0 1.5				VW to W			>>



Depth of Excavation: 1.6 m
Termination Condition: Practical refusal

Photos / Sketches

Refused on hard material

ENGEO

Hand Auger Log

Client: Searell Jones
Project: Lot 4 Water Race Hill
Location: Bannockburn
Project Number: 19377

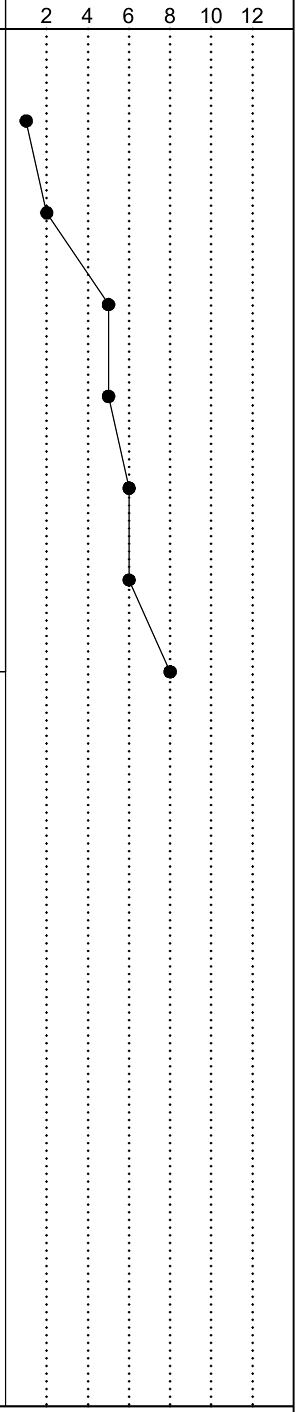
Hole I.D:
WRH-ENG21-HA01

Method: Hand Auger Contractor: Operator: Equipment: Hole Size: 75 mm mm Vane Number: N/A	Coordinates E: -45.0882 (NZTM) N: 169.1678 Elevation (mRL): 266 Elevation Datum: NZTM	Total Depth: 0.7 m Survey Method: Leica FLX100 Start Date: 24/11/2021 Finish Date: 24/11/2021 Logged By: RD Reviewed By: RJ

Elevation (mRL)	Geological Unit	DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity, additional features (grain size, roundness, composition etc. as applicable)	Depth (m BGL)	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density	Sample	Testing / Additional Comments
	TS	TOPSOIL							
	LACUSTRINE	Silty fine SAND; light brown. Medium dense; dry; poorly graded; friable, [LACUSTRINE].				D	MD		
265.5		at 0.5 m depth: with minor fine to medium gravel; subangular to subrounded, moderately weathered schist	0.5						
		End of Hole Depth: 0.7 m Termination Condition: Practical refusal							

Dynamic Cone Penetrometer

Blows per 100mm



Refused on infered bedrock

ENGEO

Hand Auger Log

Client: Searell Jones
Project: Lot 4 Water Race Hill
Location: Bannockburn
Project Number: 19377

Hole I.D:
WRH-ENG21-HA02

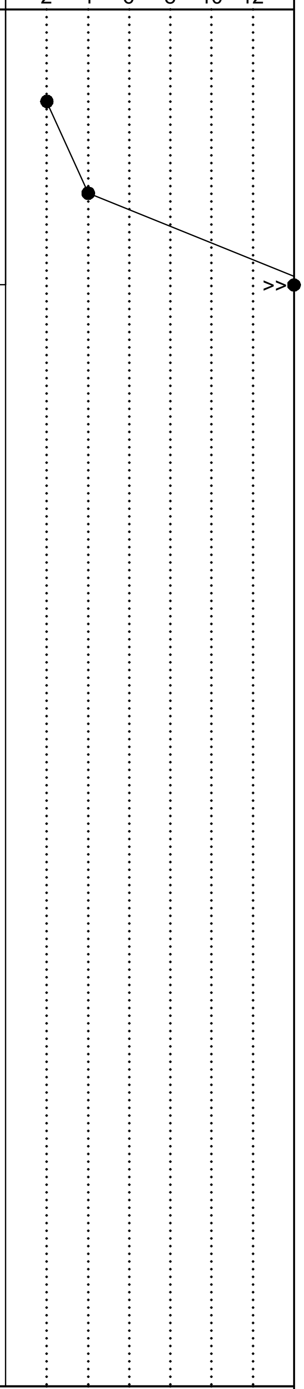
Method: Hand Auger Contractor: Operator: Equipment: Hole Size: 75 mm mm Vane Number: N/A	Coordinates E: -45.08825 (NZTM) N: 169.16784 Elevation (mRL): 266 Elevation Datum: NZTM	Total Depth: 0.3 m Survey Method: Leica FLX100 Start Date: 24/11/2021 Finish Date: 24/11/2021 Logged By: RD Reviewed By: RJ

Elevation (mRL)	Geological Unit	DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity, additional features (grain size, roundness, composition etc. as applicable)	Depth (m BGL)	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density	Sample	Testing / Additional Comments
	TS	TOPSOIL							
	COLLUVIUM	Silty fine SAND; light brown. Medium dense; dry; poorly graded; friable, [COLLUVIUM].				D	MD		

End of Hole Depth: 0.3 m
Termination Condition: Practical refusal

Dynamic Cone Penetrometer

Blows per 100mm



Refused on infered bedrock

Hand Auger Log

Client: Searell Jones
Project: Lot 4 Water Race Hill
Location: Bannockburn
Project Number: 19377

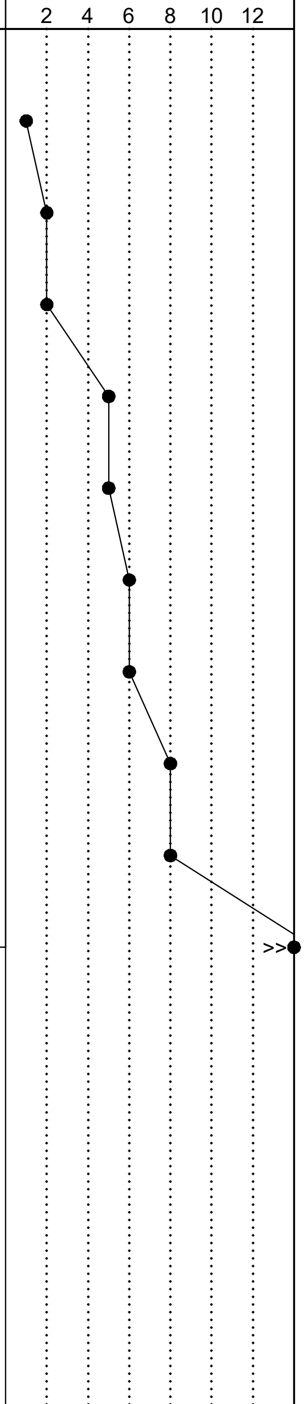
Hole I.D:
WRH-ENG21-HA03

Method: Hand Auger Contractor: Operator: Equipment: Hole Size: 75 mm mm Vane Number: N/A	Coordinates E: -45.08827 (NZTM) N: 169.167893 Elevation (mRL): 266 Elevation Datum: NZTM	Total Depth: 1 m Survey Method: Leica FLX100 Start Date: 24/11/2021 Finish Date: 24/11/2021 Logged By: RD Reviewed By: RJ

Elevation (mRL)	Geological Unit	DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity, additional features (grain size, roundness, composition etc. as applicable)	Depth (m BGL)	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density	Sample	Testing / Additional Comments
	TS	TOPSOIL							
265.5	COLLUVIUM	Silty fine Sand; light brown. Medium dense; dry; poorly graded; friable, [COLLUVIUM]. at 0.4 m depth: with fine to medium gravel; subangular, moderately weathered schist	0.5			D	MD		
265.0		End of Hole Depth: 1 m Termination Condition: Practical refusal	1.0						

Dynamic Cone Penetrometer

Blows per 100mm



Refused on infered bedrock

ENGEO

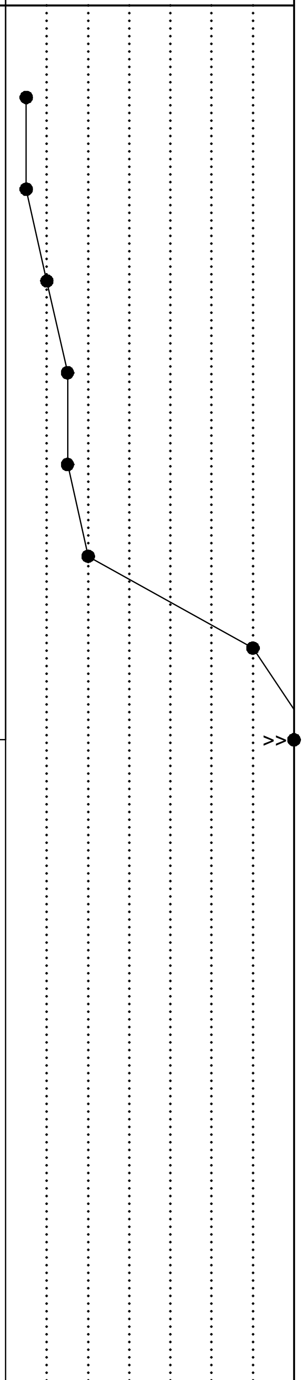
Hand Auger Log

Client: Searell Jones
Project: Lot 4 Water Race Hill
Location: Bannockburn
Project Number: 19377

Hole I.D:
WRH-ENG21-HA04

Method: Hand Auger Contractor: Operator: Equipment: Hole Size: 75 mm mm Vane Number: N/A	Coordinates E: -45.088362 (NZTM) N: 169.168055 Elevation (mRL): 266 Elevation Datum: NZTM	Total Depth: 0.8 m Survey Method: Leica FLX100 Start Date: 24/11/2021 Finish Date: 24/11/2021 Logged By: RD Reviewed By: RJ

Elevation (mRL)	Geological Unit	DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity, additional features (grain size, roundness, composition etc. as applicable)	Depth (m BGL)	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density	Sample	Testing / Additional Comments	Dynamic Cone Penetrometer Blows per 100mm 2 4 6 8 10 12
	TS	TOPSOIL								
265.5	LACUSTRINE	Silty fine SAND; light brown. Medium dense; dry; poorly sorted; friable, [LACUSTRINE]. at 0.6 m depth: fine to medium gravel; subangular to subrounded, moderately weathered schist	0.5			D	MD			
		End of Hole Depth: 0.8 m Termination Condition: Practical refusal								>>



Refused on infered bedrock

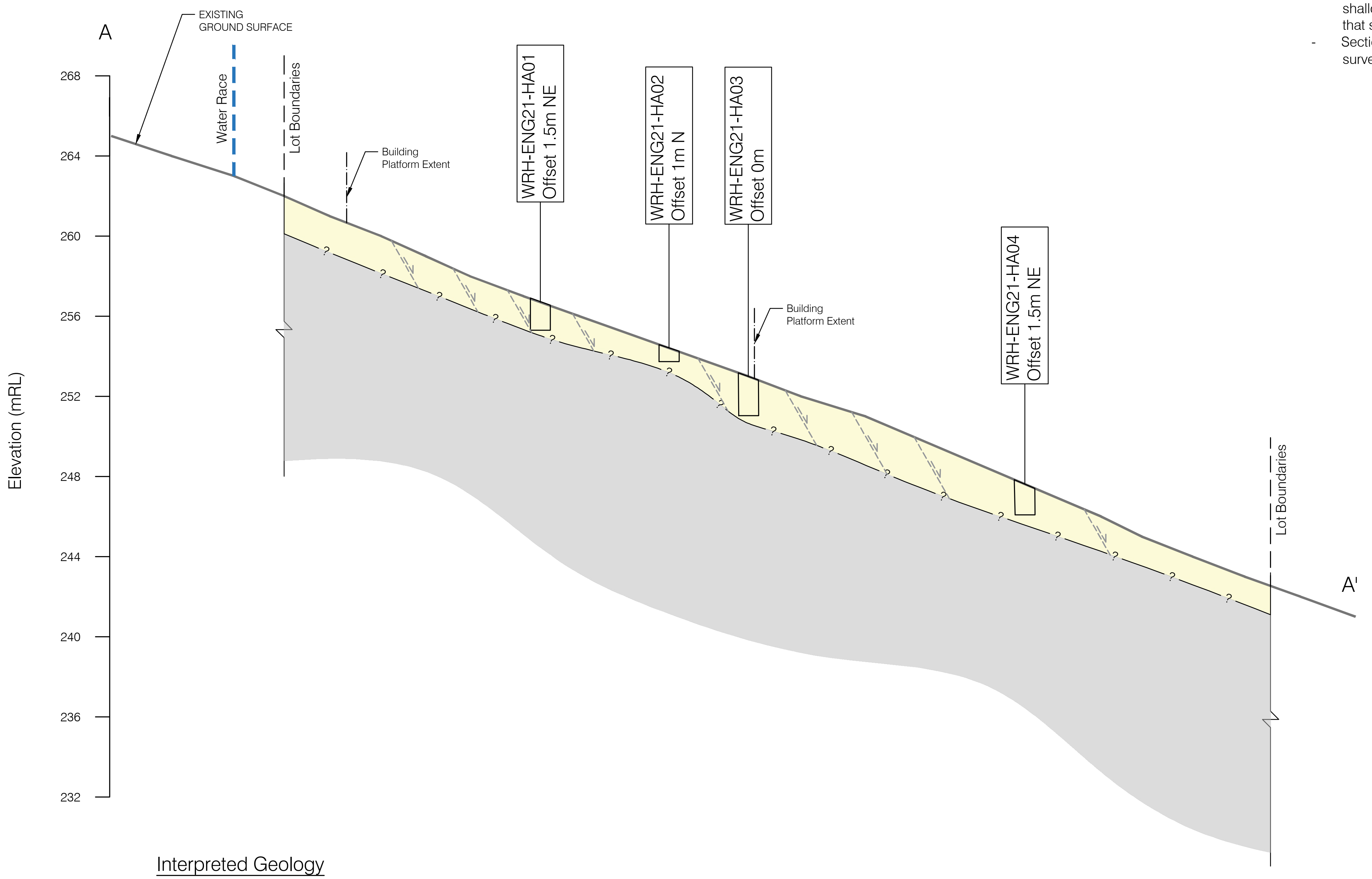
APPENDIX 3:

Interpreted Geologic Cross Section

DATE PLOTTED: 3 December 2021 2:54 AM BY: CAROLINE DJERDJERIAN

Notes:

- Subsurface profile inferred from site observations and shallow soil testing. Actual conditions may vary from that shown.
- Section profile generated from 2016 drone survey completed by Land Pro Ltd. A & A' Section



Interpreted Geology

Lacustrine derived Colluvium(Silty Fine Sand, medium dense)

Schist Bedrock

Inferred Contact

Indicative Creep Movement

CROSS SECTION A-A'
SCALES 1:250

Rev	Date	Description	Drwn	Chkd
A	25.11.21	Draft for review	CD	-

DRAFT

ENGEO

Queenstown Office
25 Glenda Drive
Frankton
Queenstown 9300
Tel: 03 328 9012,
www.engeo.co.nz

Title:

Interpreted Geological Cross Section

Client: D J Jones Family Trust & Searell Family Trust

Project: Lot 4 Water Race Hill

Designed: RD
Drawn: CD
Checked: -
Date: 25.11.21
Scale: 1:250

Proj No: 19377

Appendix: 3

Size: A3

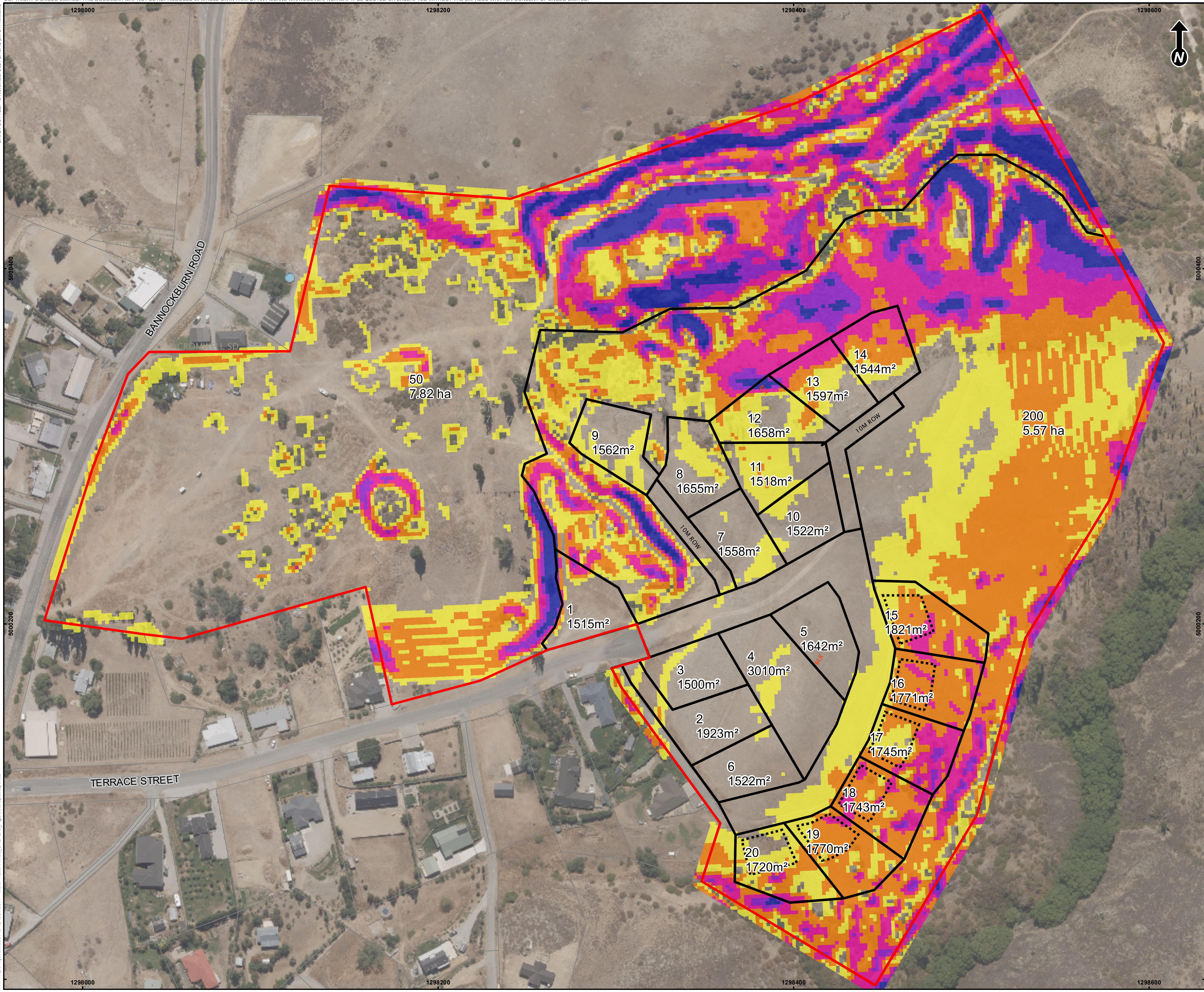
Rev: A

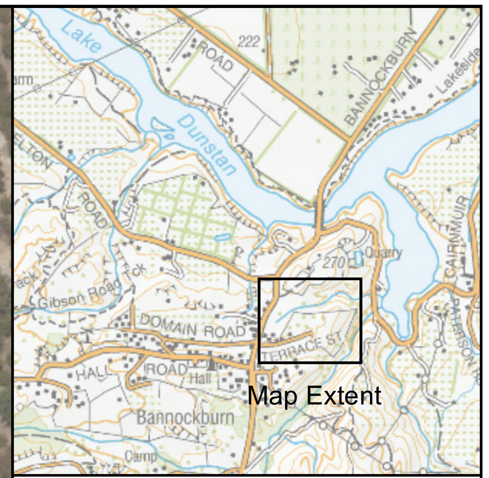
CAD File: Z:\Drafting\19001 to 20000\19377- Water Race Hill\19377-Water Race Hill-XSection-1121.dwg
XREF's:

ORIGINAL FIGURE PRINTED IN COLOUR

APPENDIX 4:

Slope Hazard Assessment





Legend

- Site outline
- Existing property title boundary
- Building Platform
- Subdivision Lot Boundary

Slope

- <10 degrees
- 10 – 17.5 degrees
- 17.5 – 25 degrees
- 25 – 32.5 degrees
- 32.5 – 37.5
- >37.5 deg

Aerial: LINZ and Eagle Technology, CC BY 4.0.
Map image: Eagle Technology.
Elevation Data: LandPro Sep 2016
Proposed subdivision: Adapted from Rough Milne Mitchell.

0 50 100
Metres

PROJECTION: NZGD 2000 New Zealand Transverse Mercator

ENGEO

Queenstown Office
25 Glenda Drive, Frankton, Queenstown 9300
Tel: 03 328 9012, www.engeo.co.nz

Title: Site Slope Plan		
Client: DJ Jones Family Trust & Searell Family Trust No. 2		Figure No: 1
Project: Water Race Hill Lot 4 Terrace Street	Designed: RD Drawn: RW Checked: XX Date: Nov 21	Size: A3
Proj No: 19377.000.001	Scale: 1:2,000	Revision: A

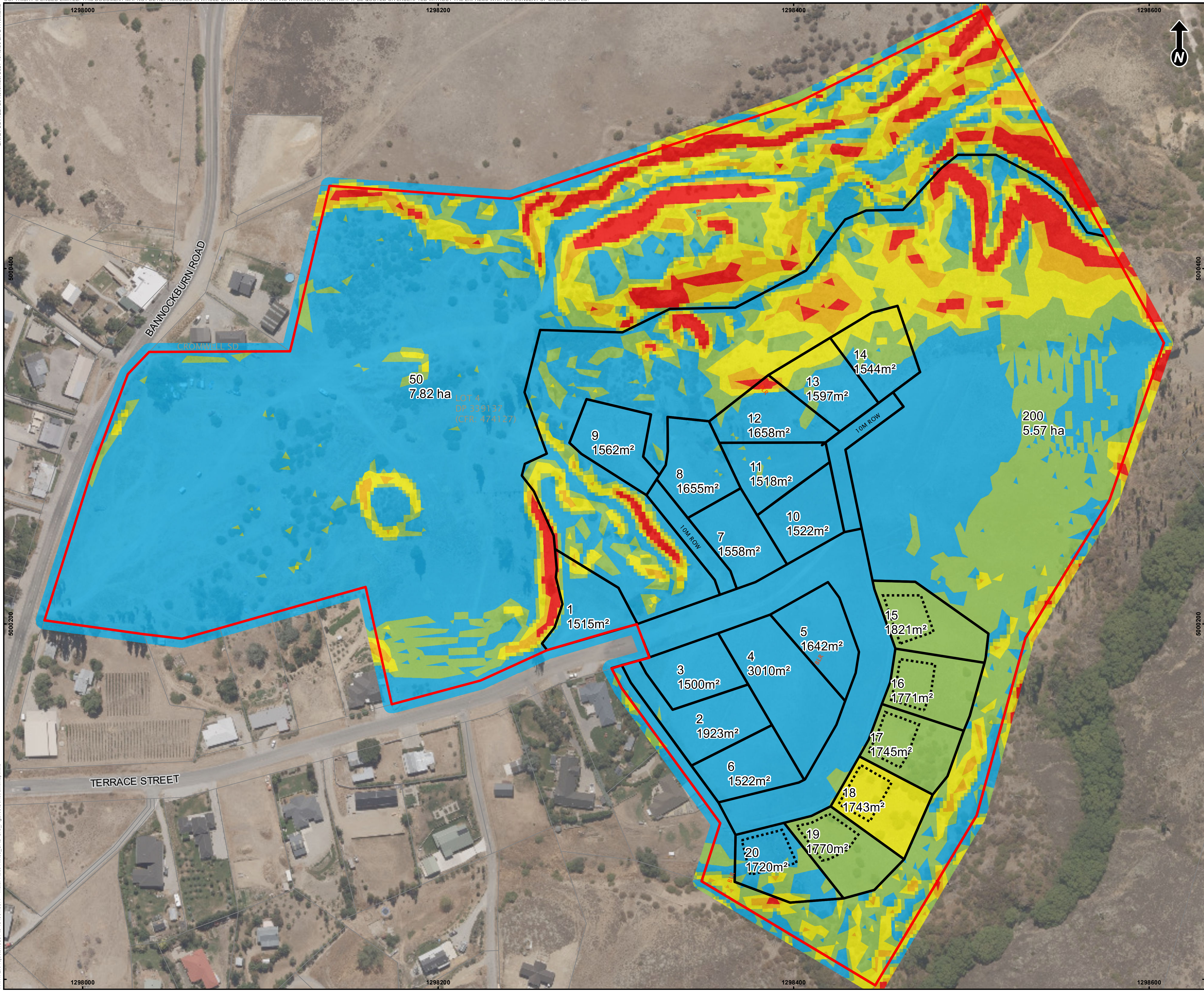
ORIGINAL FIGURE PRINTED IN COLOUR

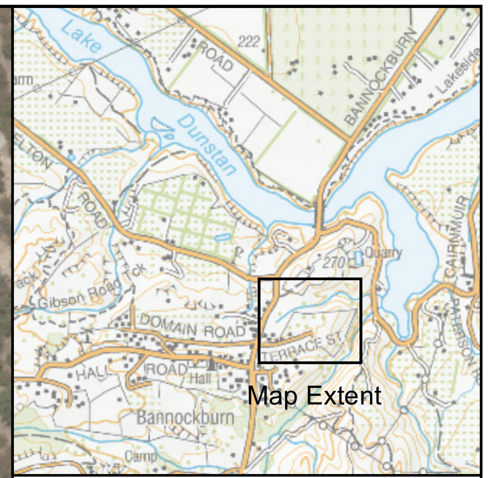
DATE PLOTTED: 15 November 2021 2:15:12 pm BY: rwilliams

PATH: Z:\Projects\19301 to 19400\19377 - Water Race Hill\06_CAD-GIS_Figures\SlopeMap.mxd

APPENDIX 5:

Constraint Map





Legend

- Site outline
- Existing property title boundary
- Building Platform
- Subdivision Lot Boundary

Risk Class

- 1
- 2
- 3
- 4
- 5

Aerial: LINZ and Eagle Technology, CC BY 4.0.
Map image: Eagle Technology.
Elevation Data: LandPro Sep 2016
Proposed subdivision: Adapted from Rough Milne Mitchell.

0 50 100 Metres

PROJECTION: NZGD 2000 New Zealand Transverse Mercator

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25 Glenda Drive, Frankton, Queenstown 9300
Tel: 03 328 9012, www.engeo.co.nz

Title: Development Risk Classes			
Client: DJ Jones Family Trust & Searell Family Trust No. 2			Figure No: 2
Project: Water Race Hill Lot 4 Terrace Street	Designed: RD	Drawn: RW	
	Checked: XX	Date: Nov 21	Size: A3
Proj No: 19377.000.001	Scale: 1:2,000		Revision: A

ORIGINAL FIGURE PRINTED IN COLOUR

APPENDIX 6:

Hillslope Development

Australian
Geomechanics
Society

Extract from

Australian Geomechanics

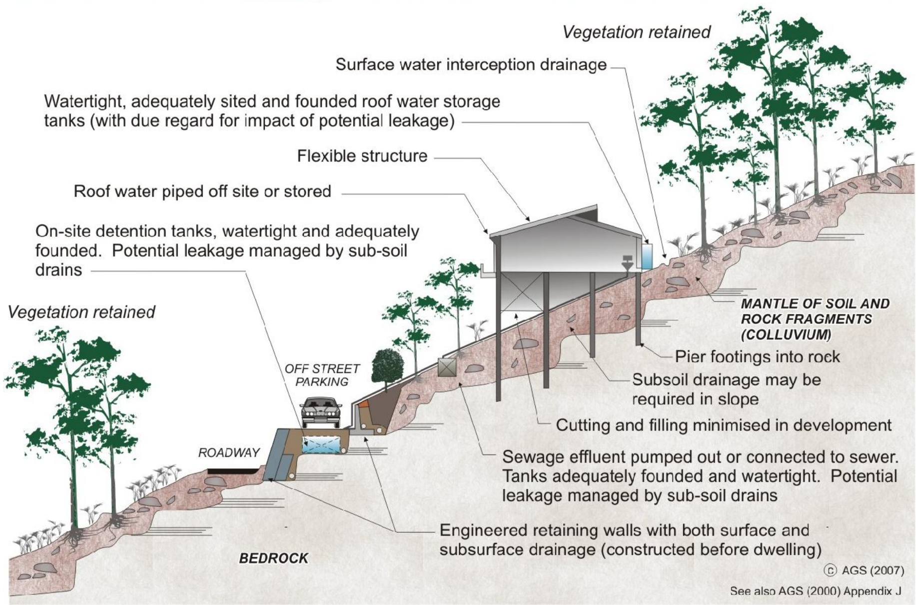
Journal and News of the Australian Geomechanics Society
Volume 42 No 1 March 2007

Extract containing:

"Practice Note Guidelines for Landslide Risk Management 2007"

Ref: AGS (2007c)

EXAMPLES OF **GOOD** HILLSIDE CONSTRUCTION PRACTICE



Landslide Risk Management

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