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## ROCKFALL RISK ASSESSMENT

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# Rockfall Risk Assessment

70 Landsdowne Terrace, Cashmere



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Report reference: 250274-A

Date: 22 August 2025

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Riley Consultants Ltd Electronic copy

Issue	Details	Date
1.0	Final	22 August 2025

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# Rockfall Risk Assessment

## 70 Lansdowne Terrace, Cashmere

### 1.0 Introduction

Riley Consultants Ltd (Riley) has been engaged by Timothy Farrant to undertake a Rockfall Risk Assessment at 70 Lansdowne Terrace, Cashmere, Christchurch. The assessment adopts the method used by GNS Science International Ltd (GNS), that is based on the Australian Geomechanics Society (AGS) Guidelines for Landslide Risk Assessment (2007) to determine the Annual Individual Fatality Risk (AIFR) due to Rock fall at the site. This report is intended to evaluate the rockfall risk at 70 Lansdowne Terrace and provide comment with the context of the Christchurch City Council District Plan's Rockfall Hazard Area designation.

### 2.0 Scope

The scope of work for this assessment included:

- A site walkover assessment to map potential upslope rockfall source areas and verify LiDAR cross section on-site (i.e. Site-specific assessment). Gather information on the rockfall source areas including joint spacing to assess potential block size.
- Using updated data undertake a desktop assessment using the methodology GNS adopted (i.e. AGS, 2007) and undertake a qualitative assessment of the AIFR, where we will provide a 'most likely' and range of AIFR's.
- Report on findings of this assessment.

A quantitative assessment of the rockfall hazard at the site including rockfall modelling to provide more detailed data is outside the scope of this assessment.

### 3.0 Existing Information

The following information is publicly available for the site.

#### 3.1 Geology

The published geology for the area indicates shallow soils comprise "Yellow-brown windblown silt (loess) underlain by "Basaltic (Hawaiite) to trachytic lava flows interbedded with tuff and breccia (including lahars), many dikes and minor lava domes (IMi)".

Bedrock is exposed at the ground surface in isolated areas upslope of the property and are located around 50m west and 135m south-west of the dwelling. The composition of the outcropping is consistent with the geological description of the area.

## 3.2 Rockfall

The Port Hills Geotechnical Group (PHGG) mapped the area during and following the Canterbury Earthquake Sequence (2010/2011) to determine the location and nature of any rockfall that occurred as a result of the earthquakes. The property is included on Map 30 (PHGG, 2013) and there are no fallen boulders recorded at or near the site. The nearest recorded boulders are located around 280m south of the site.

During site inspection, a single fallen boulder was identified on the upslope neighbouring property and discussions with the homeowner indicate it likely mobilised in summer 2019/20 and was associated with earthworks upslope and unrelated to a natural event such as a storm or earthquake which are typically associated with rockfall initiation.

## 3.3 Land Classification

The site was originally classified by CERA in 2011 as “Green Zone – N/A Port Hills & Banks Peninsula” which indicates the site was considered suitable for residential occupation. Subsequent to this, Christchurch City Council released the District Plan’s Hazard Mapping (2016) that identifies the upslope area of the property is within Rockfall Management Area 2 (RMA2) where the risk to life from rockfall is greater than  $1 \times 10^{-4}$ .

## 4.0 Site Description

A site assessment was undertaken by a Principal Engineering Geologist on 17 August 2025 that included a walkover of the property and the upslope area to the west of the site. The key observations are described in Table 1. An annotated site plan and cross section are included in Appendix B and Appendix C.

Table 1: Summary of Site Description

Site Description	
Topography	The slope to the west is generally planar with a measured average slope angle of 24–26 degrees. There is a subtle ridge around 125m to the south-west of the site at elevation 95mRL. The property itself is benched into the slope with a series of timber retaining walls to the west.
Geology	The on-site geology is consistent with the mapped geology comprising loess silts overlying igneous bedrock
Vegetation	Vegetation at the site generally comprised approximately 2m high scrub (gorse, blackberry). Some mature pine trees were situated above the site near the ridgeline.
Notable Features	A flatter, benched area is located 30m upslope of the property. There is also a cut bench with drainage channel located 20m upslope of the dwelling that has been cut into the slope.

## 5.0 Rockfall Source Area

Three rockfall source areas were identified during the site inspection on 17 August 2025. The first consists of near vertical rock outcropping located around 35m upslope (west) of the property at 50mRL elevation. The outcrop is located on the upslope of a near horizontal benched area (<10 degree slope), the benched area is wider than the outcrop is high, and it is assessed any rock that mobilises will come to rest immediately beneath the outcrop. We consider this outcrop does not pose any risk to the dwelling. Refer to Figure 1.



**Figure 1: Rock outcropping on upslope side of flatter, benched area**

A small outcrop (or buried boulder) was observed around 90m south-west of the dwelling at elevation 70mRL. The outcrop appeared significantly buried and is considered very unlikely to mobilise. The rock did not show any obvious signs of weathering or jointing and is not considered to pose a significant risk to the dwelling. Refer to Figure 2.





**Figure 2: Buried rock outcrop or boulder at 70mRL**

The third rockfall source was observed around 135m south-west and upslope of the dwelling at an elevation of 95-100mRL. The outcrop consisted of in-situ rock and boulders located 3-5m downslope of the source. The average boulder size appeared to be around  $0.8\text{m}^3$  and generally triangular or tabular in shape with the maximum size up to around  $1.5\text{m}^3$ . This source is considered to be the most likely to potentially pose a risk to the dwelling and has been used for the rockfall hazard assessment. Refer to Figures 3 and 4.



**Figure 3: Boulders located downslope of the rock outcrop in top-right corner**





Figure 4: Example of rockfall source noting the jointing and tabular nature of potential rocks

## 6.0 Potential Triggers

We have considered potential triggering events that may initiate rockfall at the site. The two main triggers are considered to be earthquake and rainfall/storm event. Given no rockfall was recorded following the Canterbury Earthquakes we consider there is a low likelihood of rockfall initiating in a large earthquake. We note the peak ground acceleration of the February 2011 earthquake exceeded 2,500 year building design codes (Kaiser et al, 2012).

Christchurch experienced three significant rainfall events in three weeks in July 2022. Around this time there was no observed evidence to suggest rockfall had occurred at the site in July 2022 therefore we consider the risk of rockfall initiating due to rainfall is also low.

## 7.0 Risk Assessment

The risk to life safety has been calculated with reference to the AGS Guidelines<sup>1</sup> which have been adopted by GNS in New Zealand for their life risk assessment work in the Port Hills of Christchurch after the CES.

Calculating risk of loss of life using the AGS equation:

$$R_{(LOL)} = P_{(H)} \times P_{(S,H)} \times P_{(T,S)} \times V_{(D,T)}$$

Where:

$R_{(LOL)}$  = Probability of the risk to life from rockfall;

$P_{(H)}$  = Probability of a rockfall initiating event – either a large storm or earthquake, in this case we will use 1/100 for the event that a rockfall initiates.

$P_{(S,H)}$  = Probability of a person or building being in the path of the rockfall. This has been assessed using a potential 30 degree horizontal spread from the rock fall source to assume to path of rockfall. The probability the rockfall impacts the building is then taken as width of the dwelling divided by the total width of the spread area at the location of the building.

$P_{(T,S)}$  = Temporal occupancy of the building. This is adopted as 0.67 from GNS report 2012/214 for the best estimate and 1.0 from GNS report 2011/311 for the worst-case scenario.

$V_{(D,T)}$  = Vulnerability indicating the probably that a person is killed if struck by rockfall. This is adopted as 0.5 from GNS report 2011/311.

Refer to the table below for the risk assessment.

**Table 2: GNS Rockfall Risk Estimation based on AGS 20007c**

Scenario Title	Rockfall Risk at 70 Landsdowne Terrace, Cashmere, Christchurch		
	Best Estimate Value	Plausible Range <sup>1</sup>	Justification for Selected Values
Return Period of Rockfall, $P_{(H)}$	1/100	1/50 to 1/150	Estimated based on available information for the site and site walkover.
Probability of Rockfall Impacting Building, $P_{(S,H)}$	0.01	0.01	Estimated based on 30 degree spread of rockfall path and width of dwelling.
Temporal Occupancy of Building, $P_{(T,S)}$	0.67	0.67 to 1.0	Adopted from GNS reports 2012/214 and 2011/311.
Vulnerability, Probability of Loss of Life, $V_{(D,T)}$	0.5	0.5	Adopted from GNS report 2011/311.
Annual Risk of Loss of Life, $R_{(LoL)}$	$3.35 \times 10^{-5}$	$1 \times 10^{-4}$ to $2.23 \times 10^{-5}$	Calculated using AGS 2007c

While there was no recorded rockfall at or near the site following the Canterbury Earthquake Sequence, the source areas observed still have the potential to initiate rockfall. However, based on the risk assessment in accordance with AGS 2007c the risk to life from rockfall is below the tolerable threshold of  $1 \times 10^{-4}$  (1 in 10,000) as set by the Christchurch City Council and designated in the District Plan. Given this, we consider the residential property at 70 Landsdowne Terrace does not meet the definition set by CCC for being within Rockfall Management Area 2.

While we note the 'worst case' scenario borders the tolerable threshold in the plausible range of risk, this scenario is based on a conservative estimate of the inputs due to the qualitative nature of the assessment.

The calculation spreadsheet for the rockfall risk is included in Appendix D.

<sup>1</sup> Nominally 95<sup>th</sup> percentile range. It is not anticipated that there will be sufficient data to make a statistical analysis, so this range will be based on expert judgement.

## 8.0 Limitation

This report has been prepared solely for the benefit of Timothy Farrant as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such parties' sole risk.

Recommendations and opinions in this report are based on a visual appraisal only. The nature and continuity of subsoil conditions are inferred, and it must be appreciated that actual conditions could vary considerably from the assumed model.



# Appendix A

## Site Plan







Notes

- 1. Aerial imagery, property boundaries and elevation contours sourced from linz.govt.nz.
- 2. All layers and markups are approximate and subject to survey confirmation.



Client	Timothy Farrant
Address	70 Landsdowne Terrace, Cashmere, Christchurch
Project	Riley Ref. 250274
Figure Title	Site Location Markup

Created	Checked	Approved
CAO	PTA	DRT
19.08.2025	21.08.2025	22.08.2025

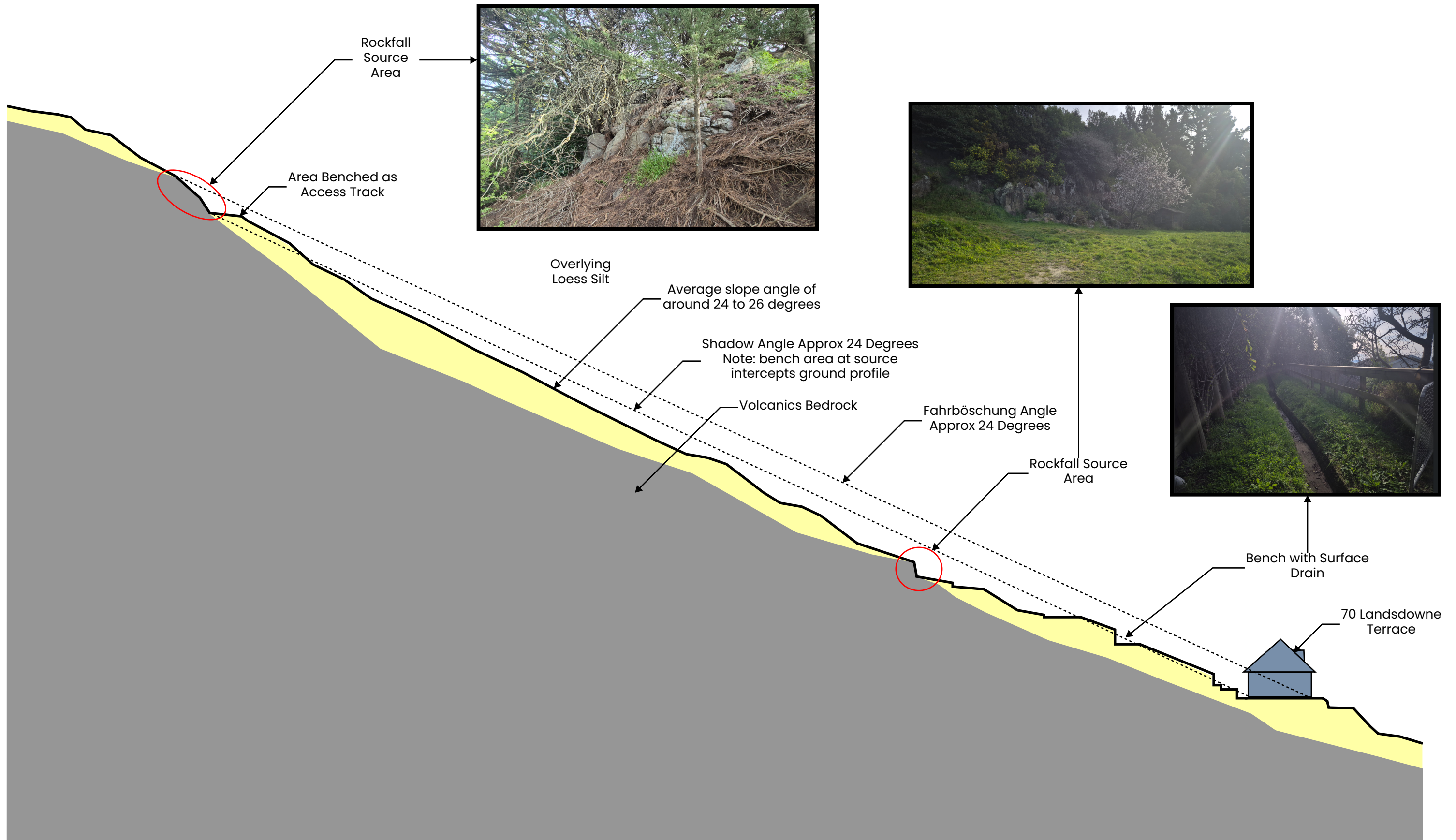




# Appendix B

## Cross Section





0 4 8 12 16m

Approx. scale at A4 - 1:250  
DO NOT SCALE OF THIS DRAWING



Client	Timothy Farrant
Address	70 Landsdown Terrace, Cashmere, Christchurch
Project	Riley Ref. 250274
Figure Title	Cross Section

Created	Checked	Approved
CAO	PTA	DRT
19.08.2025	21.08.2025	22.08.2025

FOR INFORMATION ONLY



# Appendix C

## AGS 2007c Risk Calculation

# AUSTRALIAN GEOMECHANICS SOCIETY LANDSLIDE RISK MANAGEMENT, 2007



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## Christchurch:

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Project No: 250274

Project: 70 Landsdowne Terrace

Calc: CAO Date: 18-Aug-25

Check: PTA Date: 21-Aug-25

## QUANTITATIVE RISK ESTIMATION OF LIFE RISK BASED ON AGS 2007c

Mitigation: None

Parameter	Description	Best Estimate	Plausable Range	
P(H)	Return period of landslide (years)	100	50	150
P(S:H)	Probability of rockfall impacting building	0.01	0.01	0.01
P(T:S)	Temporal occupancy of building	0.67	1	0.67
V(D:T)	Vulnerability - probability of loss of life	0.5	0.5	0.5

R(LoL)	Annual risk of loss of life	3.35E-05	1.00E-04	2.23E-05
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Is R(LoL) tolerable? (i.e., less than 1:10,000)	Yes	Yes	Yes
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Typical Range / Recommended Value  
 Magnitude level accuracy only (e.g., 1, 10, 100, 1000...)  
 Chance of rockfall impacting building spatially (0-1.0)  
 0.67 from GNS 2012/214 and 1 from GNS 2011/311  
 Probability of loss of life (0-1.0) from GNS 2011/311

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