***Statement of Bronnie Pooley***
*in support of Alan West's Submission (Submitter 321)*

1 My name is Bronnie Pooley and I am a local homeowner living at 563/565 Rocks Road. As Alan has said, I am presenting in conjunction with him today about the hazards chapter of Plan Change 29, specifically in relation the Slope Instability Areas Overlay.

2 Alan's submission (321) asked for the slope instability overlays be redrawn to "*more accurately reflect the hazards that exist for individual properties rather than grouping all properties in an area in the same risk category.* Alan's submission also asked for the overlays to *"take into account the substantial amount of geotechnical and engineering documentation that the Council has on file as well as the site visits..."* Alan and I have very similar issues in relation to our respective properties, despite us living in different areas. My experience – as a homeowner under a Slope Instability Area 1 overlay who has had significant engineering and geotechnical investigations done on our property – is a case study that shows why Alan's requested approach should be followed.

**Our property**

3 We have made significant investments into our property over the years. It is more than just a property to us; it is home.

4 In 2005, we made the decision to demolish the CIRCA 100-year-old single level timber-frame home and construct something more modern. At the time, the old dwelling was still tenanted and in good structural condition from which it can be surmised it had not suffered any slope instability damage in the 100 or so years it had been there. The demolition and rebuild started in 2006 and was completed in 2008.

5 The rebuild entailed extensive Council approved engineering across 561, 563, and 565 to ensure site stability. These works are party detailed in Table 1 of Tonkin + Taylor's report. These works included Green Terramesh walls up to 6 metres in height in various locations on the property, a shotcrete retaining wall up to 4.5 metres in height supported by 28 5.5 – 11-metre-long anchors along with subsoil drains. As you will appreciate, these works came at significant cost to us and were undertaken to ensure our property would be geotechnically sound and protected from natural disasters. Since 2008 we have undertaken other smaller scale works including constructing a concrete tilt slab garage and retaining walls, and the construction of an extremely robust Council approved, engineered concrete driveway.

6 To the best of my knowledge, our property has never been flagged as being at risk, or having suffered any damage from slope movement. The Tahunanui Slump is fairly well known in the community, yet I have never received any indication from Council about significant instability concerns until the slope instability overlay was proposed.

**On-site works**

7 As detailed above, during construction of our new home, extensive on-site works were undertaken to secure and maintain the integrity of the site. Being on a hillside, and at the toe of the hill, at least 350-400 tonnes of mass was brought on to the site during the new build and we also had a subsoil drain installed to improve site stability.[1] This does not include the mass of the dwelling structure itself.

8 In 2014 we installed another subsoil drain along the upslope of our boundary as part of the engineering required to build the tilt slab garage and in 2019 we constructed the 200mm thick concrete driveway (roughly 290 tonnes of concrete involved).

9 These were all substantial steps, not just in terms of cost but also time and expertise, to further 'set' the development in place. Council approved all of the soil and building engineering works along the way. We have put significant spend into this property, our home, and want this new house to be here for the next 100 years, as was the original home on this site.

**Site-specific geotechnical advice**

10 After the 2022 storm, we engaged Tonkin + Taylor (**T+T**) to undertake a geotechnical condition assessment of our property. We didn't have any concerns about instability, but because our annual insurance falls due in the last quarter of the year, immediately following the Council's upgrade area to Tier 1, our insurance broker informed me our insurer would not reinsure. As a consequence, since this action by Council, our broker has been unable to secure natural hazard insurance for us, regardless of our individual property's proven resilience. I've brought copies of our T+T report along today, which was issued to us in March 2023.

11 T+T's assessment consistently indicates that our house is geotechnically sound despite Nelson having experienced three natural disaster events since its completion: one earthquake in 2016[2] and two significant storms in 2011[3] and 2022[4]. Despite the magnitude of each event, our house performed well. We did lodge an insurance claim after the Kaikoura earthquake though this was confirmed as being non-structural (cosmetic) surface cracking only.

12 The T+T report states that records indicate our property is outside (downslope) of the area of the Tahunanui Slump[5]. It also states that some, but minimal, movement has occurred before, during and after the August 2022 storm:

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[1] Tonkin + Taylor Geotechnical condition and performance assessment (dated 27 March 2023), page 3 ("T+T Report").
[2] Kaikoura earthquake categorised as a 1 in 15, to 1 in 20 year event.
[3] Nelson 2011 storm event categorised as a 1 in 250-year event.
[4] Nelson 2022 storm event categorised as a 1 in 120-year event.
[5] T+T Report (dated 27 March 2023), page 8.

- *Approximately 28 mm in 11 years total downslope displacement* – i.e. the whole slump area, not just our property.
- *Approximately 7 mm downslope displacement over a seven (7) day period (15 to 22 August 2022) as a result of the August 2022 event* – again, this includes the whole slump zone, and is included in the 28mm above.
- *…monitoring rounds carried out in BH2 over the period following the August 2022 event (26 August 2022, 30 August 2022, 27 October 2022, 22 November 2022, 24 January 2023) do not show any further ground movement.*[6] It should be noted the BH2 is actually on our property.

13 The T+T report concludes:

> *The Site is likely to perform better than other neighbouring residential sites within the Tahunanui Slump...*[7]
>
> and
>
> *In future, seismic and rainfall events similar in magnitude to those that have occurred since the construction of the dwelling, it is likely the land and hard structures within the site will perform in a similar manner to their previous performance during such events*[8]

14 In light of the fact that:

a. the prior dwelling on this property remained in good condition for approximately 100 years;
b. our dwelling then had extensive engineered earthworks which have performed as expected with no damage from either a 1 in 250 year rain event or a 1 in 120 year rain event; and
c. a report from T&T that our dwelling is likely to perform in a similar manner (such that it will not suffer any structural damage) due in part to the engineering input, design and construction of the dwelling,

it is fair to say that we have done everything possible to ensure that our property is structurally sound and protected from natural hazard events and accordingly should be insurable. Prior to the proposed slope instability overlays tier 1 - 3 from Council insurance has never been an issue for us.

**Subsequent Insurance issues**

15 However, due to the proposed Slope Instability Tier One overlay proposed by Council, it has essentially rendered our property uninsurable. This has been incredibly distressing for us as we look to protect our most valuable asset and home.

16 Our insurance broker, Crombie Lockwood (now Gallagher), has tried to re-insure our property with multiple insurance companies without success. They have tried every possible insurer, including

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[6] T+T Report (dated 27 March 2023), page 5.
[7] T+T Report (dated 27 March 2023), page 8.
[8] T+T Report (dated 27 March 2023), page 8.

NZI, Vero, AIG, Chubb, and Tower, to name a few. The messaging from the insurance companies is that they have a blanket policy of not insuring anyone located in the Tier 1 area.

17 We had no issues with insuring our property prior to this overlay appearing in PC29. Now we are being penalised for an issue that was well known, but never a total insurance show-stopper prior to PC29. It feels like the Council has deemed us to be 'red zone' similar to property owners after the Canterbury Earthquakes, and now no insurance company is prepared to even begin negotiations, including considering geotechnical reports, because of the blanket overlay approach on our land.

18 The findings in our T+T report, coupled with the no damage seen after the recent natural disaster's events, confirm the stability of our land and no doubt the land of many other residents in Nelson. Putting our property in the Teir 1 area contradicts the evidence provided by our T+T report and the actual performance of the land during significant natural events.

**Conclusion**

19 I appreciate there is some risk involved in building and living on sloped sections, and that the Tahunanui Slump has had its challenges over the years. These are well known, however, we trusted in Council process when we went ahead with our build. They issued consent subject to the significant engineering we had to carry out, and we believed this would be respected and honoured by Council moving forward. Why would we have ever considered such a significant build otherwise? It was not until the Council proposed the new Slope Instability Overlays, that insurance became difficult. for most people and impossible for Tier 1. As a result of PC29, I am sure we are only one of many other landowners now dealing with the very real consequences of not being able to adequately insure our home at all. The Council's approach to drawing Tier 1, 2 and 3 areas has unfairly painted lots of properties with very different risk profiles with the same broad-brush, which is frustrating and morally wrong, and has potentially devastating consequences for the investments we have made into our homes.

20 While the consequences of these proposed overlays by Council may not have been anticipated, nonetheless they have resulted. If whole sections of Nelson cannot be insured, Council also needs to take into account the further impacts this will have on these areas, which will be devastating. Homeowners with bank financing will likely be in default of their mortgage terms which require owners to hold sufficient insurance. Banks may subsequently become uncomfortable with their uninsured security resulting in mortgagee sales. If the properties cannot be insured it will be difficult to find buyers as any buyers would likely need to be cash buyers and naturally the value of these homes will reduce significantly.

21 In light of the significant consequences of these proposed overlays, I consider that Council has a duty of care to its ratepayers to ensure that any marked natural hazard does, in fact, accurately reflect each specific property and any overlays can be subject to exceptions if the geotechnical and engineering site specific reports provide for such.

22 While we appreciate that there is a cost in undertaking site specific investigations to ensure appropriate designations are made for each property, we consider that the cost of not doing so is far greater on homeowners and the Nelson region given the consequences that have resulted from Council's broad-brush approach.

23 This supports Alan's submission that the Council should reconsider the Slope Instability Overlays it has drawn, especially in light of site-specific geotechnical reports and on-site works that have been carried out.

**Bronwyn Pooley**
17 September 2024

Tonkin+Taylor

Job No: 1090587.0000
27 March 2023

Rob and Bronwyn Pooley
565 Rocks Road
Nelson 7010

**Geotechnical condition and performance assessment**
**563 and 565 Rocks Road, Nelson**
**Robert and Bronwyn Pooley**

## 1 Introduction

This letter presents the findings on an assessment of a geotechnical condition assessment of 563 and 565 Rocks Road (the 'Site').

The scope of work and terms and conditions of engagement are set out in Tonkin & Taylor Ltd's (T+T) proposal dated 24 March 2023.

Although no physical damage has been reported arising from the recent (August 2022) natural rainfall disaster, the owners have requested this report to provide a condition assessment of structures at 563 and 565 Rocks Road (legally described as Lots 1 and 2 DP 561620 respectively), and an assessment of the Site's performance in recent natural hazard events for the purposes of obtaining natural disaster insurance cover for the above properties.

### 1.1 Scope of assessment

We have carried out the following scope of works as part of this assessment.

- Completed a job safety assessment for the work.
- Carried out a Site walkover by a Senior Engineering Geologist experienced in the assessment of natural hazard risk with particular experience in assessing slope instability risk within the Tahunanui Slump.
- Recorded the condition of the structures present on site with respect to potential damage resulting from natural disasters that have occurred since the dwelling constructed in 2007.
- Reviewed as built copies of Montgomery Watson Harza (MWH – now Stantec) design plans[1] of the retaining structures present at the Site including the anchored retaining wall that forms part of the dwelling.
- Reviewed information from your architect with respect to where earth has been excavated and where fill and structures have been placed within the Site resulting from the current development.
- Reviewed information held on our files relevant to the stability of the Site and surrounding area.

[1] MWH as-built structural drawings C02-C09, C12, C16 & C33 dated 22 September 2006



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- Reviewed the Site performance in previous natural disaster events that have occurred since the house was constructed in 2007.
- Assessed the Sites potential performance in future natural disaster events.

We have not reviewed the structural design of the dwelling and appurtenant structures that would have been subject to Building Consent at the time of dwelling construction.

Site investigation locations, and the extent of the proposed cuts are shown on T+T Figure 1090587-F1 attached in Appendix A.

# 2 Site history

## 2.1 Site development history

Prior to its demolition in 2005 to facilitate the current residential development, a large single level timber-frame weatherboard dwelling had been present at 565 Rocks Road since the early 1900's. This dwelling was tenanted in its later life, right up until 2005. At the time of its demolition the dwelling was in good structural condition and had not suffered damage related to slope instability (personal communication – Rob Pooley).



*Figure 1 – The previous dwelling at 565 Rocks Road as seen in photography dating from the early 1900's.*

The current development – a complete redevelopment of the Site was carried out in 2006 and 2007.

As shown in MWH as-built plans provided to us, extensive engineered site works (including the addition of significant mass within the Site) and installation of subsoil drainage were carried out during site development to improve site stability. Table 1 below presents a history of the timing of the current development of the site to provide context for our assessment.

**Table 1 - Site development phases**

| Year(s) | Development phase |
|---|---|
| 2005 | Single level timber-frame dwelling in the order of 100 years old demolished to make way for current residential development |
| 2006/07 | Green Terramesh® walls were constructed as part of site development in 2006/early-2007 as follows:<br>• Up to 6.0 m height supporting the downslope edge of 563 Rocks Road, and the north-east side of the upper part of the main access way.<br>• Up to 4.8 m height supporting the slope upslope of the lower part of the main access.<br>• Up to 4.8 m height supporting the downslope side of the lower part of the main access.<br>A shotcrete retaining wall up to 4.5 m in height supported with 28 (No.) 5.5-11 m long ground anchors at the upslope wall of the workshop was constructed in 2006/early-2007 prior to the dwelling.<br>A subsoil drain is installed along the eastern section of the upslope (south-eastern) boundary of the site to between approximately 2.0 and 2.5 m depth below ground level.<br>The dwelling was constructed by Coman Construction Ltd. in 2007. |
| 2009 | The masonry block retaining walls present to the north-east of the dwelling were constructed. |
| 2014 | Construction of the concrete tilt-slab garage adjacent to the south-east boundary of the Site.<br>Construction of the subsoil drain along the upslope boundary of 563 Rocks Road.<br>The masonry block retaining walls to the south (upslope) of the dwelling were constructed. |
| 2019 | The concrete driveway was sealed.<br>We understand from David Wallace that the concrete driveway is on average in the order of 200 mm thick (and is significantly thicker locally) and involved placement of in the order of 290 Tonnes of concrete. |

Based on correspondence[2] with your architect for the dwelling and garage (David Wallace of Arthouse Architects) a conservative estimate of additional of mass within the Site resulting from the Site development is between 350 and 400 Tonnes. This estimate does not include the mass of the dwelling structure above the concrete slab level.

## 2.2 Natural disaster events

Since the development of the Site in 2007, Nelson City has been subject to three (3) natural disaster events as follows.

### 2.2.1 Nelson 2011 storm event

This heavy rainfall event occurred in December 2011. During this event the Site experienced in the order of 300 mm over a 48-hour period. The event was recorded as being an approximately **1 in 250-year return period event** for the Nelson City area[3].

We are aware that in the order of forty to fifty (40-50) EQC natural disaster insurance claims were lodged within the Tahunanui Slump relating to land and property damage caused by this event.

No natural disaster EQC insurance claim was lodged for natural disaster damage to land or property within the Site following this event.

[2] Email Wallace-Lovell, dated 23 March 2023
[3] Terry, F. and Cuff, T. (2012) After the Flood. New Zealand Geographic, March/ April p.30-41.

### 2.2.2 Kaikoura Earthquake

The Kaikoura Earthquake occurred in November 2016. Seismic accelerations experienced at the Site are estimated to be in the order of 0.08 g. The return period of this level of shaking is estimated to be in the order of a 1 in 15-years to 1 in 20-years[4].

We are not aware of any EQC natural disaster damage within the Tahunanui Slump relating to land and property damage caused by this event.

A natural disaster EQC insurance claim was lodged for the Site in 2017. T+T's imminent loss report prepared in relation to this claim (T+T ref: 1011602.1991, dated 28 August 2017) found no qualifying damage to land or insured property. The damage that was the subject of this claim was restricted to *'non-structural surface cracking damage'* to retaining walls upslope of the dwelling (cosmetic damage to retaining walls does not qualify as land damage under the EQC Act).

### 2.2.3 August 2022 Nelson storm

This heavy rainfall event comprising rainfall in the order of 300 mm falling in 3 waves over a 3-day period resulted in shallow and deep-seated instability within portions the Tahunanui Slump. The three waves were approximately equivalent to a 1 in 120-year return period event for the Nelson City area[5].

We are aware that in the order of forty to fifty (40-50) EQC natural disaster insurance claims were lodged within the area of Tahunanui Slump relating to land and property damage caused by this event.

**No natural disaster EQC insurance claim was lodged for natural disaster damage to land or property within the Site following this event.**

## 3 Site conditions

### 3.1 Surface conditions

The following is a summary of surface conditions at the Site:

- The Site is situated on moderately inclined north-west facing slopes immediately upslope of Rocks Road, which borders Tasman Bay.
- A four-level dwelling of mainly concrete construction (including the garage level) is situated on 565 Rocks Road.
- A 70 m long concrete access way forms access to the dwelling from Rocks Road downslope.
- 563 Rocks Road comprises a flat platform largely surfaced with hard-fill.
- A concrete tilt-slab garage is located at the upslope boundary of 565 Rock Road.
- Masonry block retaining walls form terraced plantings both upslope (to the south of) and along the north-eastern side of the dwelling.
- Three Green Terramesh® walls are present supporting the slopes downslope and upslope of the lower part of the concrete access way, and the downslope side of 563 Rocks Road.
- The majority of the site is covered in hard-standing areas (dwelling, garage, concrete driveway and parking areas, and hardfill platform) with the remainder of the site in localized plantings.

[4] 1 in 15-year event based on NZGS Module 1, and 1 in 20-year event based on NZS1170.5.
[5] https://niwa.co.nz/news/exceptional-august-atmospheric-river-sets-record

## 3.2 Subsurface conditions

### 3.2.1 Published geology

The published geology of the area[6] indicates that the site is underlain by active rotational slump comprised of landslip deposits derived from the underlying geology. The bedrock mapped as underlying the Tahunanui Slump within the Site comprises well-bedded and graded sandstone-siltstone-mudstone sequence of the Magazine Point Formation.

### 3.2.2 Previous site investigations and monitoring

The following is a summary of previous geotechnical investigations and assessment available to us at the time of writing of this report.

- A borehole (BH2) was drilled to 74.6 m bgl (below ground level) at 563 Rocks Road for the Earthquake Commission (EQC) in 2012 following the December 2011 Nelson Storm. This borehole encountered the following:
  - Silty material interpreted as Fill to approximately 6 m bgl, overlying;
  - Mixed silty Clay to silty clayey Gravel to approximately 20 m depth interpreted as a layered sequence of soil deposits derived from a very ancient landslide in the the Port Hills Gravel Formation bedrock upslope of the site, overlying;
  - Cemented Sandy and Silty Gravel to approximately 62 m depth bgl interpreted as Port Hills Gravel bedrock, overlying;
  - Siltstone, Sandstone and Coal interpreted as Port Hills Gravel bedrock to the base of the hole at 74.6 m bgl.
- An inclinometer was installed in BH2 (attached in Appendix C) at 563 Rocks Road to monitor potential ground movement. Monitoring of the inclinometer carried out for both EQC and subsequently Nelson City Council (NCC) between 19 March 2012, and 23 January 2023 indicates the following:
  - Ongoing episodic ground movement occurring between the surface and 10.5 m depth bgl.
  - Approximately 28 mm in 11 years total downslope displacement.
  - Approximately 7 mm downslope displacement over a seven (7) day period (15 to 22 August 2022) as a result of the August 2022 event.
  - Subsequent inclinometer monitoring rounds carried out in BH2 over the period following the August 2022 event (26 August 2022, 30 August 2022, 27 October 2022, 22 November 2022, 24 January 2023) do not show any further ground movement.

## 3.3 Site walkover / condition assessment

Marcus Lovell of our Nelson Office carried out a site walkover on 21 February 2023 to inspect and record photographic evidence of the condition of hard structures present on the site, with particular reference to potential damage that could be attributed to ground movement.

The following is a list of observations of the condition of structures noted during our site walkover.

[6] Johnston, M.R. (compiler) 1979. Geology of the Nelson Urban Area. Institute of Geological & Nuclear Sciences 1:25,000, Urban Series Map 1 sheet, Lower Hutt, New Zealand. Institute of Geological & Nuclear Sciences Limited.

- The concrete access way and kerbing was generally in sound condition (Photograph 6), with localized hairline cracks visible in locations (Photographs 7 to 9) that are not uncommon on any site due to natural concrete shrinkage. There were no off-sets across these cracks indicating differential movement of the concrete slabs.
- Floors (as measured with a 600 mm length spirit level) were level throughout the dwelling.
- No sticky doors or windows were noted during our site walkover or were reported by the property owners.
- The exterior cladding of the dwelling was generally in sound condition. Localized hairline cracks were observed locally on the north-west and north-east facing walls of the dwelling (Photographs 24 to 27, 33 and 34) that appeared to align with likely structural joints.
- Hairline cracks are visible in the internal cladding of the fourth-level ensuite on the north-west side of the dwelling (Photographs 31 and 32).
- A single hair-line crack is visible in the second level tiled patio area on the north-west side of the dwelling. Other than this crack the tiles were in excellent condition (Photograph 20).
- Hard-wood decking on the north-west decks of both third and fourth levels show signs of warping (Photographs 28 to 30).
- Masonry block walls forming terraced plantings to the south and east of the dwelling show no signs of rotation or displacement of underlying ground.
- A single crack up to 1 mm in width and approximately 100 mm in length was noted to the internal wall lining above the door-frame to the fourth level office (Photograph 21).
- Hairline cracks are locally visible in the plastered concrete facing of the masonry block walls to the south and east of the dwelling in seven (7) locations as shown in Photographs 10 to 16).
- A single crack was observed in in the plastered concrete facing of a masonry block wall to the west of the garage (Photograph 17). There was no offset across the crack, and the wall was measured as being vertical at the time of our inspection.

# 4 Conclusions and recommendations

Opinions expressed in this report are based on a site walkover inspection of the Site, a review of published information and information held on file at Tonkin + Taylor relevant to the site, and a review of the Sites performance during natural disaster events that have occurred since the current site development in 2006. The nature and continuity of subsurface conditions away from test locations are inferred and it must be appreciated that actual conditions may vary from the assumed model.

## 4.1 Ground model

The following summarizes our knowledge of the site.

- Previous geotechnical investigations indicate that the site is situated on an approximately 20 m thick layered sequence of soil derived from Port Hills Gravel Formation bedrock and likely emplaced by a very ancient landslide. Port Hills Gravel bedrock is present at depth below the Site.
- Inclinometer readings taken from BH2, in the north-east corner of the Site show that this portion of the Site has experienced small downslope displacement in the recent past. There is no evidence at the ground surface of ground movement at this location.

- Inclinometer monitoring carried out both during after the August 2022 event in BH2 indicates that the movement recorded at this portion of the Site appears to be episodic and related to groundwater levels.
- The recent site development, on the south-western half of the Site, including construction of the dwelling, workshop concrete paving and four large retaining structures, has added in the order of 350-400 Tonnes amount of mass (this mass does not include the mass of the dwelling above the concrete slab level) at the toe portion of the hillside. Such addition of mass at this location on the overall hillslope is likely to provide a stabilising force with respect to slope instability.

## 4.2 Assessment of damage causation

We make the following conclusions with respect to the likely cause(s) of the localized features described in Section 3.3 above:

- Hairline cracks present on external cladding on the north-east and north-west side of the dwelling are likely to be the result of thermal expansion and contraction of the external cladding on the north (sunny) side of the dwelling. As discussed with the property owner (Robert Pooley) these cracks appeared soon after construction of the dwelling and have occurred due to the lack of thermal expansion joints on the external cladding of the dwelling. They are not consistent with ground movement.
- Warping of the hard-wood deck occurred soon after installation and relates to timber shrinkage and warping of the hardwood deck timbers. We note that the hardwood decks are supported on floating joists, and as such would be unlikely to be sensitive to small-scale ground movement beneath the dwelling.
- Hairline cracks present locally in the lower part of the driveway may be the result of thermal expansion and contraction which is not uncommon in concrete. No off-sets or other indications of movement of underlying ground were noted during our site inspection.
- The seven hairline cracks that are locally visible in the facing of the masonry walls to the south and east of the dwelling have all occurred on the north-east and north-west faces of these retaining walls. No off-set indicative of wall movement is present on any of these cracks, and they may be the result of thermal expansion and contraction of the retaining wall facing.
- A single crack up to 1 mm in width and approximately 100 mm in length noted to the internal wall lining above the door-frame to the fourth-level office is isolated, and no other cracks in this part of the house that would be expected if the crack had occurred as a result of structural stresses within the dwelling due to ground movement were observed.
- A single crack observed in a masonry block wall to the west of the garage has occurred at a change in wall height (refer Photograph 17). The crack shows no -off-set across indicative of downslope wall rotation. The crack widens at the top however indicating it may be the result of differential settlement of retaining wall foundations supporting wall sections of differing heights/loads.
- Hairline cracks to internal linings on the north-west and north-east facing walls of the fourth-level ensuite may be the result of thermal expansion or contraction due to the ensuites north-facing aspect.
- The cracked tiles located on the second-level patio are likely to be the result of locally poor installation, or thermal expansion and contraction. There is no pattern to the cracks in the tiles across the patio area that would be expected if the cause was due to movement of underlying ground supporting the dwelling.

None of the damage described above is attributed to any natural disaster cause

## 4.3 Conclusions

The following is a summary of conclusions with respect to the Site:

- The Site appears to be located on a layered soil deposit derived from Port Hills Gravel Bedrock and emplaced in the geological past by a landslide.
- The timber-frame dwelling present on the site for in the order of 100 years was tenanted until the time of its demolition in 2005 and is not known to have suffered any natural disaster damage related to slope instability during that time.
- Land damage mapping in the wider area beyond the Site after the 2011 and 2022 natural disaster events carried out for the Earthquake Commission (EQC) by T+T events suggests that the area where development has occurred on the Site is outside (downslope) of the area of the Tahunanui Slump that has been adversely affected by Movement of the Tahunanui Slump.
- Since construction of the current dwelling in 2007 the Site has been subject to two rainfall events with recurrence intervals in the order of 1 in 120 years and 1 in 250 years, and seismic shaking with a recurrence interval of between 1 in 15-years and 1 in 20-years but to our knowledge the Site has not sustained damage to land or structures that can be attributable to any natural disaster.
- Hard structures present within the Site, including the dwelling and garage (concrete tilt-slab construction) and retaining walls of masonry block construction, show no indications of racking, rotation, or damage that would be consistent with a natural disaster - landslip cause.
- The observed damage is consistent with normal wear and tear typical of what we have observed on residential sites around Nelson (i.e. not just within the Tahunanui Slump) associated with aging of structures and does not indicate a cause related to underlying ground movement.

## 4.4 Assessment of likely future Site performance

The general pattern of land damage on the Tahunanui Slump arising from the natural disaster rainfall event in 2022 is broadly consistent with that observed following the 2011 natural disaster rainfall event. No land damage affecting the amenity of the Site has occurred on the Site that can be attributed to either the 2011 or 2022 natural disaster events.

In our opinion:

- In future, seismic and rainfall events similar in magnitude to those that have occurred since the construction of the dwelling, it is likely that land and hard structures within the site will perform in a similar manner to their previous performance during such events.
- The Site is likely to perform better than other neighbouring residential sites within the Tahunanui Slump based on:
  - i The Sites performance in natural disaster events to date;
  - ii The engineering input into site development, dwelling design and construction;
  - iii Subsoil drainage installed across the Site during construction of the retaining walls that form the dwelling platform and access;
  - iv The significant mass added to the Site during the current development; and,
  - v The reported good condition of (in the order of 100 years) the previous dwelling on the Site during the previous 100 years or so.

## 5 Applicability

This report has been prepared for the exclusive use of our client Robert and Bronwyn Pooley, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

| Report prepared by: | Authorised for Tonkin & Taylor Ltd by: |
|---|---|
|  |  |
| ..... | ..... |
| Marcus Lovell | Mark Foley |
| Senior Engineering Geologist | Project Director |

27-Mar-23
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# Appendix A: Tonkin & Taylor figure

- **Figure 1090587-F1 – Site plan**

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Tonkin+Taylor

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NOTES:
Basemap NZ Imagery: Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors

| REV | DESCRIPTION | GIS | CHK | DATE |
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| 0 | First version | CRB | | FEB.23 |

LOCATION PLAN

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| PROJECT No. | 1090587.0000 | |
| DESIGNED | CRB | FEB.23 |
| DRAWN | MJL | FEB.23 |
| CHECKED | | |
| APPROVED | | DATE |

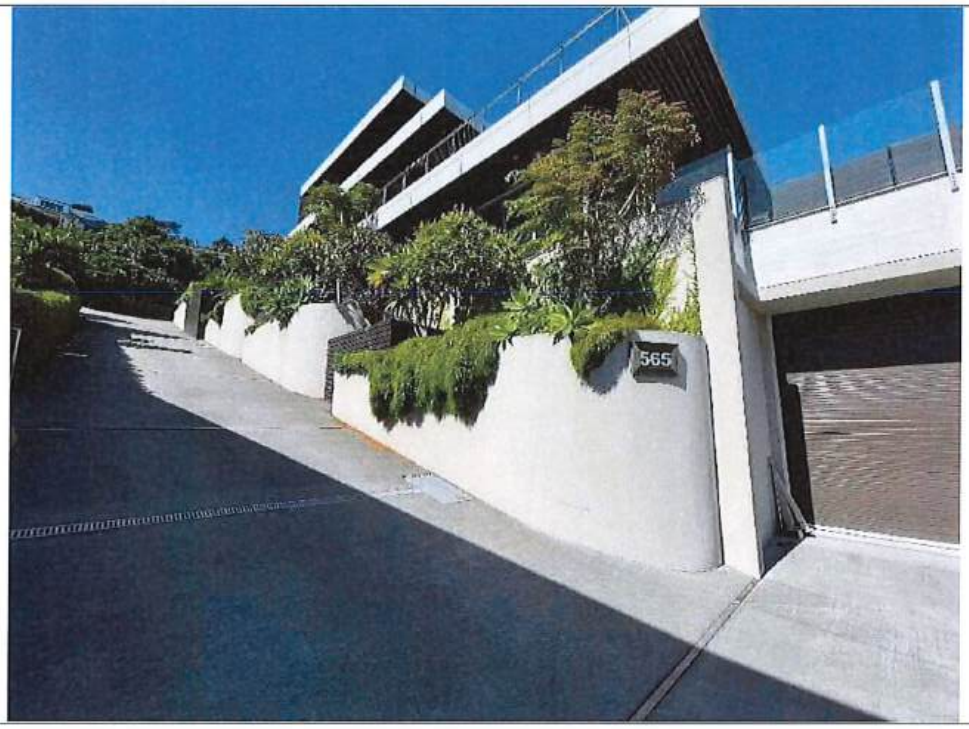
CLIENT ROBERT AND BRONWYN POOLEY
PROJECT 563 - 565 ROCKS ROAD, NELSON
TITLE GEOTECHNICAL CONDITION ASSESSMENT
SITE PLAN
SCALE (A3) 1:400 FIG No. 1090587-F1 REV 1

# Appendix B: Photographs

- **Photographs 1-34 – 563 and 565 Rocks Road, Nelson**



*Photograph 1: View of the north-west face of the dwelling from the second level from tiled patio. A single crack 1 mm in width was noted (see Photograph 10). No other damage to the tiled patio was observed.*




*Photograph 2: View of concrete driveway and masonry block retaining walls forming planters adjacent to the dwelling. No structural damage was noted to the retaining walls.*



*Photograph 3: View of garage structure. Rear walls of garage are concrete retaining walls. No damage was noted to the garage during our site visit.*



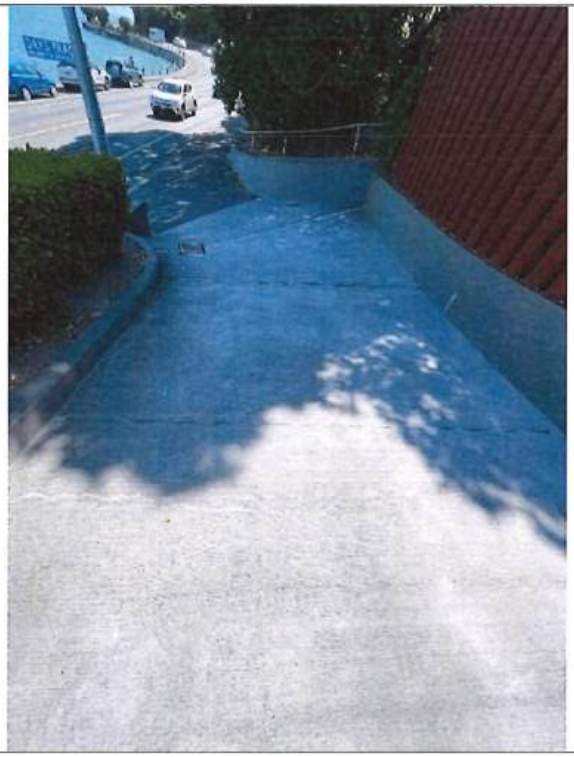
*Photograph 4: View of concrete driveway and parking area, with garage in background. No cracks or other damage were noted to the concrete driveway and parking areas.*



*Photograph 5: Driveway to north of dwelling. No cracks or other damage to the driveway surface was observed during our site inspection.*



*Photograph 6: View of the section of driveway adjacent to the dwelling. No cracks or other damage were noted to this section of the driveway.*



*Photograph 7: View of the lowest part of the driveway on Waka Kotahi / NZTA land. A hairline crack to the concrete slab with no offset across it is visible in the left of view. A further hairline crack is visible in the cast in situ concrete wall along the upslope side of the driveway.*



*Photograph 8: Hairline crack in access way to the north of the dwelling*



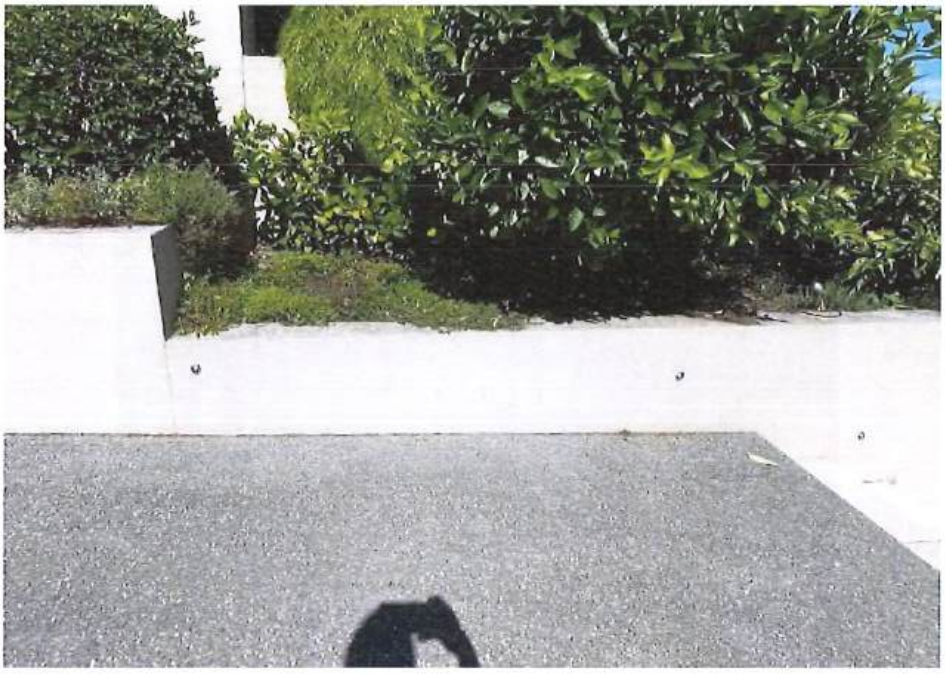
*Photograph 9: Hairline cracks to the façade of the cast in situ in lower driveway area. No wall displacement of structural damage observed.*



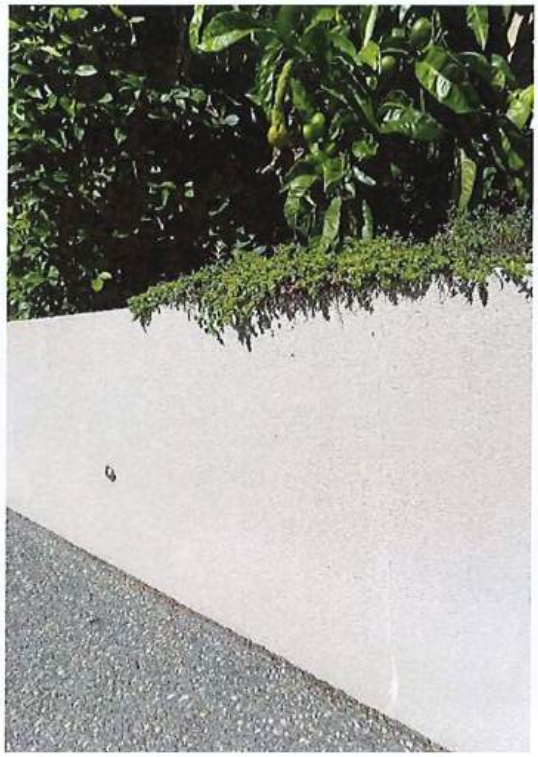
*Photograph 10: Hairline crack at construction joint in a masonry block retaining wall retaining car parking area to south of the dwelling.*



*Photograph 11: Hairline crack to the façade of the masonry block wall retaining plantings upslope of dwelling.*



*Photograph 12: Hairline crack to the façade of the masonry block wall retaining plantings upslope of dwelling.*



*Photograph 13: Hairline crack to the façade of the masonry block wall retaining plantings upslope of dwelling.*



*Photograph 14: Photograph of the patio upslope of the dwelling with a hairline crack to the façade of the masonry block retaining wall visible in the centre of the view.*



*Photograph 15: Hairline crack to masonry block retaining wall on north-east side of dwelling patio.*



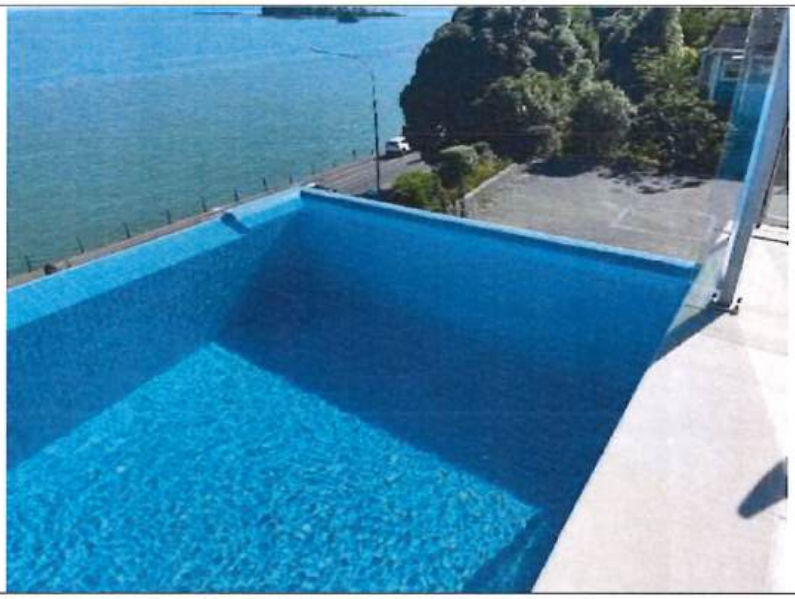
*Photograph 16: Hairline crack to a masonry block retaining wall on north-east side of dwelling patio (to right of view above grate).*



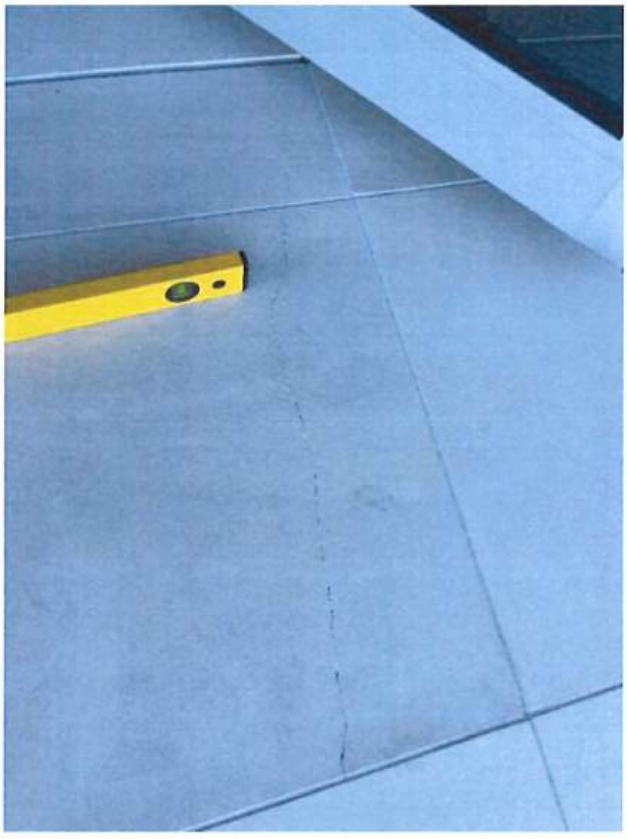
*Photograph 17: Crack up to 1 mm in width in a masonry block retaining wall retaining garden area in southern corner of property. No other evidence of wall damage or rotation was observed during our site inspection.*



*Photograph 18: Floors in living area of dwelling. Floors were level throughout the dwelling.*



*Photograph 19: Swimming pool in downslope part of dwelling on second level. Water level in tiles indicates that the swimming pool appears to be level.*



*Photograph 20: Crack 1 mm in width in 2 tiles in patio on second level on north-west side of dwelling. No other cracks to tiles in the patio area were observed during our site walkover.*



*Photograph 21: Crack in interior wall lining in third level office area along north-eastern wall of dwelling*



*Photograph 22: Hairline crack to external cladding on north-west facing wall of third level of dwelling.*



*Photograph 23: Hairline crack to external cladding on north-west facing wall of third level of dwelling.*



*Photograph 24: Hairline crack to external cladding on north-east facing wall of third level of dwelling.*



*Photograph 25: Hairline crack to external cladding on north-east facing wall of third level of dwelling.*



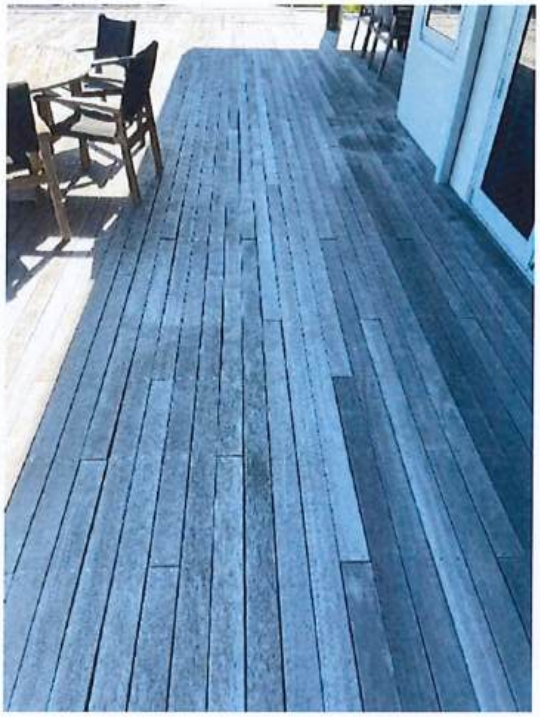
*Photograph 26: Hairline crack to external cladding on north-east facing wall of third level of dwelling.*



*Photograph 27: Hairline crack to external cladding on north-east facing wall of third level of dwelling.*



*Photograph 28: Bowing of deck boards on the north-west side of the third level of the dwelling.*



*Photograph 29: Bowing of deck boards on the north-west side of the third level of the dwelling.*



*Photograph 30: Bowing of deck boards on the north-west side of the fourth level of the dwelling.*



*Photograph 31: Hairline cracks to internal wall linings in northern corner of the fourth level bathroom*



*Photograph 32: Hairline cracks to internal wall linings on north-west wall of the fourth level bathroom.*



*Photograph 33: Hairline cracks to exterior cladding visible beneath folding doors on fourth level north-west facing bathroom wall.*



*Photograph 34: Hairline crack to exterior cladding visible on fourth level north-east facing bathroom wall.*

# Appendix C: Site investigation data

- Borehole BH2 log
- BH2 Inclinometer results - 24 January 2023
- Engineering terminology log sheet

# TONKIN & TAYLOR LTD

# DRILL HOLE LOG

BOREHOLE No: BH2
Hole Location: 561 Rocks Road

SHEET 1 OF 8

PROJECT: Grenville Block | LOCATION: Rocks Road, Nelson | JOB No: 870981

CO-ORDINATES 5992106.9 mN, 2531374.3 mE | DRILL TYPE: Rotary | HOLE STARTED: 16/2/12

DATUM: NZMG49 | HOLE FINISHED: 2/3/12

DIRECTION: | R.L. GROUND: 32.00 m | DRILLED BY: CW Drilling Ltd

ANGLE FROM HORIZ.: -90.00° | R.L. COLLAR: 32.00 m | LOGGED BY: FAW | CHECKED:

DESCRIPTION OF CORE | ROCK DEFECTS

| GEOLOGICAL UNIT | ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...): | ROCK WEATHERING (UW SW MW HW) | ROCK STRENGTH (R4 R3 R2 R1 R0) | PT LOAD / UCS TEST (MPa) | CORE LOSS / LIFT (%) (0 20 100) | METHOD, CORE & CASING | TEST SYMBOL | DEPTH (m) | GRAPHIC LOG | DEFECT LOG | FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1) | SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS<br>DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING<br>ANGLES ARE NORMAL TO CORE AXIS | DATE / DEPTH | RQD (%) | WATER | DRILL WATER LOSS (%) (25 50 75) | CORE BOX | RL (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOPSOIL AND FILL | Bag Sample 1-3m: SILT, with minor to some gravel, light brown, stiff, dry, non-plastic [TOPSOIL and FILL?] | | | | | CONCENTRICS | | 1 | | | | | | | | | 32 |
| FILL | Bag Sample 3-4.5m: SILT, with some clay, minor organics and gravel, brown, moist to wet, low plasticity [FILL] | | | | | | | 2 | | | | | | | | | 31 |
| | 4.7m Start of HQ Coring: Gravelly SILT, with some clay, minor sand, light brown and brown, dry to wet, non-plastic with low plasticity zones [FILL] | | | | | HQ3 CORING | | 3 | | | | | | | | | 30 |
| TAHUNANUI SLUMP - PORT HILLS FMN DERIVED | Contact ~6m to GRAVEL with some silt, minor clay, greenish blue, medium dense, dry, non-plastic [TAHUNANUI SLUMP] | | | | | | | 4 | | | | | | | | | 29 |
| | 6.7-7.7m Bag Sample: SILT, with some sand and gravel, minor clay, green blue, moist, low plasticity | | | | | HQ3 | | 5 | | | | | | | | | 28 |
| | 7.7-7.8m: Silty CLAY, with some gravel, brown grey, firm, wet, moderate plasticity<br>7.8m: Carbonaceous fragmented coal measures with minor silt/clay matrix, dark brownish grey, extremely weak, moderately weathered, moist, 1mPa coal fragment, firm soil matrix | | | | | HQ3 | | 6 | | | | | | | | | 27 |
| | 8.2-9.4m: Gravelly, clayey SILT (with higher clay content in zones), firm, moist to wet, moderate plasticity | | | | | HQ3 | | 7 | | | | 8.2-9.4m: Sheared surfaces. Historic shears and partially healed, remoulded shears. Micro-fractures 2-4mm, fragmented shears (sliding surface). | | | | | | 26 |
| | 9.4-9.9m: Gravelly SILT to silty GRAVEL, brown grey, loose, saturated, non-plastic | | | | | HQ3 | | 8 | | | | | | | | | 25 |
| | | | | | | | | 9 | | | | | | | | Box 1 | 24 |
| | | | | | | | | 10 | | | | | | | | | 23 |
| | | | | | | | | | | | | | | | | Box 2 | 22 |

T+T DATATEMPLATE.GDT amm

Log Scale 1:50

ROCKLG 870981A.GPJ 1/11/12

# TONKIN & TAYLOR LTD

# DRILL HOLE LOG

BOREHOLE No: BH2
Hole Location: 561 Rocks Road

SHEET 2 OF 8

PROJECT: Grenville Block | LOCATION: Rocks Road, Nelson | JOB No: 870981

CO-ORDINATES 5992106.9 mN 2531374.3 mE
DIRECTION:
ANGLE FROM HORIZ.: -90.00°

DRILL TYPE: Rotary
DATUM: NZMG49
R.L. GROUND: 32.00 m
R.L. COLLAR: 32.00 m

HOLE STARTED: 16/2/12
HOLE FINISHED: 2/3/12
DRILLED BY: CW Drilling Ltd
LOGGED BY: FAW CHECKED:

DESCRIPTION OF CORE | ROCK DEFECTS

| GEOLOGICAL UNIT | ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...); | ROCK WEATHERING (UW SW MW HW) | ROCK STRENGTH (R4 R3 R2 R1 R0) | PT LOAD / UCS TEST (MPa) | CORE LOSS / LIFT (%) (2 10 30 100) | METHOD, CORE & CASING | TEST SYMBOL | DEPTH (m) | GRAPHIC LOG | DEFECT LOG | FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1) | SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS<br>DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING<br>ANGLES ARE NORMAL TO CORE AXIS | DATE / DEPTH | RQD (%) | WATER | DRILL WATER LOSS (%) (25 50 75) | CORE BOX RL (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TAHUNANUI SLUMP - PORT HILLS FMN DERIVED | 9.9m: Gravelly, clayey SILT, as at 8.2m<br>10.4-10.6m: Silty CLAY, grey, firm, moist, low to moderate plasticity<br>10.6-10.7m: Gravelly, clayey SILT, green grey, firm, moist to wet, low plasticity<br>10.9-11.4m: Sandy, silty GRAVEL, with minor clay, light grey, loose, saturated, non-plastic; gravel is sub-angular to angular<br>11.6-11.9m: Silty, clayey GRAVEL, with minor sand, greyish green, loose, saturated, non-plastic; gravels are angular to sub-angular<br>11.9-13.4m: Gravelly, clayey SILT, with minor sand to clayey, silty GRAVEL, greyish greem, firm, wet to saturated, low plasticity<br>13.5-13.6m: Fine SAND, with minor gravel, silt, grey, dense, dry, non-plastic<br>13.6-14.8m: SILT, SAND and GRAVEL composit, grey, carbonaceous flecks, medium dense, moist, non-plastic; gravel is sub-rounded, polished, random grading and clast orientation<br>14.6m: 5cm coal fragment<br>14.8-15.3m: Sandy, silty GRAVEL, blue grey, loose, saturated (Drilling disturbance?)<br>15.3-15.9m: Silty GRAVEL, with minor clay, sand, grey with green/blue tinges, saturated, low to moderate plasticity (Drill disturbance?)<br>15.9-17.5m: Silty, sandy GRAVEL, blue-grey, loose (friable and easily crushed by hand); gravel clasts from fine polished, sub-rounded to large angular sandstone, wet/saturated zone<br>17.5m: Sandy, silty, fine to coarse GRAVEL, with minor to rare clay, greenish grey, loose to medium dense, wet, non-plastic; gravel is predominantly angular, minor sub-rounded, beds of predominantly sub-rounded gravels, can crush some clasts by hand, mudstone clasts crushable in core<br>18.2m: With minor boulders and cobbles | | | | | HQ3 / HQ | | 11 12 13 14 15 16 17 18 19 20 | | | | 10.4-10.6m: Sheared zone, micro-fractures 1-3mm, fragmented shears (sliding surface?).<br>13.6m: Shear zone.<br>13.5-14.8m: Chaotic grading orientation, slumping and sheared zones.<br>15.9-17.3m: Random sheared sections.<br>17.3-17.5m: Shearing micro-fractures. | 20/02/2012<br>21/02/2012 | | | | 22 21 20 19 18 17 16 15 14 13 12<br>Box 2 Box 3 Box 4 Box 5 |

T+T DATATEMPLATE.GDT amm

Log Scale 1:50

ROCKLG 870981A.GPJ 1/11/12

# TONKIN & TAYLOR LTD

## DRILL HOLE LOG

BOREHOLE No: BH2
Hole Location: 561 Rocks Road



| | | | |
|---|---|---|---|
| PROJECT: Grenville Block | | LOCATION: Rocks Road, Nelson | JOB No: 870981 |
| CO-ORDINATES | 5992106.9 mN<br>2531374.3 mE | DRILL TYPE: Rotary | HOLE STARTED: 16/2/12 |
| | | DATUM: NZMG49 | HOLE FINISHED: 2/3/12 |
| DIRECTION: | | R.L. GROUND: 32.00 m | DRILLED BY: CW Drilling Ltd |
| ANGLE FROM HORIZ.: -90.00° | | R.L. COLLAR: 32.00 m | LOGGED BY: FAW CHECKED: |

DESCRIPTION OF CORE

ROCK DEFECTS

| GEOLOGICAL UNIT | DESCRIPTION OF CORE: ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...); | ROCK WEATHERING (UW SW MW HW) | ROCK STRENGTH (R4 R3 R2 R1 R0) | PT LOAD / UCS TEST (MPa) | CORE LOSS / LIFT (%) (0 10 30 100) | METHOD, CORE & CASING | TEST SYMBOL | DEPTH (m) | GRAPHIC LOG | DEFECT LOG | FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1) | ROCK DEFECTS: SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS; DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING; ANGLES ARE NORMAL TO CORE AXIS | DATE / DEPTH | RQD (%) | WATER | DRILL WATER LOSS (%) (25 50 75) | CORE BOX | RL (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PORT HILLS GRAVEL FORMATION | Gravel becoming predominantly sub-rounded at 20m (all gravels to 20m depth are uncemented) | | | | | HQ3 | | 20 | | | | | | | | | 12 |
| | 20.5-22.7m: Core disturbed by drilling | | | | | | | | | | | | | | | | |
| | 21m: With minor to some boulders and cobbles | | | | | HQ3 | | 21 | | | | | | | | Box 5 | 11 |
| | | | | | | HQ | | 22 | | | | | | | | | 10 |
| | 22.7-23.1m: Sandstone boulder, fractured in core | | | | | HQ3 | | | | | | | | | | Box 6 | |
| | 23.1-23.5m: Sandy, silty GRAVEL, with some cobbles/boulders, loose to medium dense, wet | | | | | HQ3 | | 23 | | | | | | | | | 9 |
| | 23.5-23.7m: Only minor fines, possibly washed out during drilling process, drilling disturbance | | | | | | | | | | | | | | | | |
| | 23.7m: Sandy, silty, fine to coarse GRAVEL, greenish grey, loose to medium dense, wet, non-plastic, clasts are sub-rounded to sub-angular, sandstone and siltstone, some clasts can be crushed by hand; sand is fine | | | | | HQ3 | | 24 | | | | | | | | | 8 |
| | | | | | | HQ3 | | 25 | | | | | | | | Box 7 | 7 |
| | 25.7-25.9m: Core drill disturbed | | | | | HQ3 | | | | | | | 22/02/2012 | | | | |
| | 25.9-26.1m: No fines, washed out? | | | | | HQ3 | | 26 | | | | | | | | | 6 |
| | 26.8-27.1m: GRAVEL, with minor silt, sand, cobbles, possible drill disturbance washing out fines | | | | | HQ3 | | | | | | | 23/02/2012 | | | | 5 |
| | 27.1-27.15m: Clayey SILT, slightly plastic matrix | | | | | HQ3 | | 27 | | | | | | | | | |
| | 27.2m: Sandy, fine to coarse GRAVEL/gravelly fine to coarse SAND, greenish grey, dense, moist, non-plastic, clasts are sub-rounded [Weathered Granite?] | | | | | HQ3 | | 28 | | | | | | | | Box 8 | 4 |
| | 28.1-28.4m: Sandy GRAVEL [Weathered Granite?] | | | | | HQ3 | | | | | | | | | | | 3 |
| | 29.2m: Becoming medium dense, wet, minor silt content | | | | | HQ3 | | 29 | | | | | | | | | |
| | 29.6-30.1m: Drilling disturbance<br>29.6m: Becoming loose to medium dense, | | | | | HQ3 | | 30 | | | | | 24/02/2012 | | | Box 9 | 2 |

T+T DATATEMPLATE.GDT amm

# TONKIN & TAYLOR LTD

# DRILL HOLE LOG

BOREHOLE No: BH2
Hole Location: 561 Rocks Road



PROJECT: Grenville Block | LOCATION: Rocks Road, Nelson | JOB No: 870981

CO-ORDINATES 5992106.9 mN, 2531374.3 mE | DRILL TYPE: Rotary | HOLE STARTED: 16/2/12

DATUM: NZMG49 | HOLE FINISHED: 2/3/12

DIRECTION: | R.L. GROUND: 32.00 m | DRILLED BY: CW Drilling Ltd

ANGLE FROM HORIZ.: -90.00° | R.L. COLLAR: 32.00 m | LOGGED BY: FAW | CHECKED:

DESCRIPTION OF CORE | ROCK DEFECTS

| GEOLOGICAL UNIT | DESCRIPTION OF CORE | ROCK WEATHERING | ROCK STRENGTH | PT LOAD / UCS TEST (MPa) | CORE LOSS / LIFT (%) | METHOD, CORE & CASING | TEST SYMBOL | DEPTH (m) | GRAPHIC LOG | DEFECT LOG | FRACTURE LOG spacing of natural fractures (cm) | ROCK DEFECTS | DATE / DEPTH | RQD (%) | WATER | DRILL WATER LOSS (%) | CORE BOX RL (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PORT HILLS GRAVEL FORMATION | wet<br>30m: Sandy GRAVEL/gravelly SAND, as above<br>31.1m: Fine to coarse GRAVEL, with minor silt, fine sand, cobbles, greenish grey, low to medium dense, wet, non-plastic, clasts are sub-rounded<br>31.8-32m: Core drill disturbance<br>32.2m: Some sand/silt<br>33.1m: GRAVEL, with rare to some silt/sand matrix, medium dense to dense, wet, gravels moderately weathered, cobbles to 150mm? dia., difficult to measure in core<br>34.2-34.9m: Sandy, silty GRAVEL, medium dense, wet, drilling disturbance<br>34.9-35m: GRAVEL, with rare to some silt/sand matrix, as at 33.1m<br>35m: Rare fines, GRAVEL, dense<br>35.9-37.1m: BOULDER (possibly from 35.5m and fractured during drilling), fine sandstone boulder with carbonaceous flecks<br>37.1m: Sandy fine to coarse GRAVEL/gravelly coarse SAND, greenish grey, dense, moist to wet, sub-rounded clasts, density increases with overburden [Weathered Granite?]<br>38.6-39.3m: GRAVEL, with minor sand, dense, wet<br>39.3-40.7m: Sandy GRAVEL, dense, drilling disturbance [Weathered Granite?] | UW SW MW HW | R4 R3 R2 R1 R0 | | 0 50 100 | HQ3 | | 31 32 33 34 35 36 37 38 39 40 | | | SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS<br>DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING<br>ANGLES ARE NORMAL TO CORE AXIS<br>35.1m: Gravel clast has a 75° dipping polished surface. | 24/02/2012<br>27/02/2012<br>28/02/20 | | | 25 50 75 | Box 9<br>Box 10<br>Box 11<br>Box 12<br>Box 13 |

T+T DATATEMPLATE.GDT amm

Log Scale 1:50

ROCKLG 870981A.GPJ 1/11/12

# TONKIN & TAYLOR LTD

# DRILL HOLE LOG

BOREHOLE No: BH2
Hole Location: 561 Rocks Road



| | | |
|---|---|---|
| PROJECT: Grenville Block | LOCATION: Rocks Road, Nelson | JOB No: 870981 |
| CO-ORDINATES 5992106.9 mN 2531374.3 mE | DRILL TYPE: Rotary | HOLE STARTED: 16/2/12 |
| | DATUM: NZMG49 | HOLE FINISHED: 2/3/12 |
| DIRECTION: | R.L. GROUND: 32.00 m | DRILLED BY: CW Drilling Ltd |
| ANGLE FROM HORIZ.: -90.00° | R.L. COLLAR: 32.00 m | LOGGED BY: FAW CHECKED: |

DESCRIPTION OF CORE

ROCK DEFECTS

GEOLOGICAL UNIT

ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);

ROCK WEATHERING: UW SW MW HW

ROCK STRENGTH: R4 R3 R2 R1 R0

PT LOAD / UCS TEST (MPa)

CORE LOSS / LIFT (%): 0 50 100

METHOD, CORE & CASING

TEST SYMBOL

DEPTH (m)

GRAPHIC LOG

DEFECT LOG

FRACTURE LOG spacing of natural fractures (cm): 50 10 5 1

SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS

DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING

ANGLES ARE NORMAL TO CORE AXIS

DATE / DEPTH

RQD (%)

WATER

DRILL WATER LOSS (%): 25 50 75

CORE BOX RL (m)

PORT HILLS GRAVEL FORMATION

40-40.7m: Sandy GRAVEL, dense, drilling disturbance [Weathered Granite?] Uncemented to 40.7m

40.7m: SW GRAVEL CONGLOMERATE, greenish grey, extremely to very weak rock mass, cemented to partially cemented, unknown cement agent (overburden?)
Soil description: Fine to coarse GRAVEL, with minor coarse sand

42.3-43.8m: Drill induced fracturing, highly fractured, weaker zone, angular rock fragment
Soil description: GRAVEL, with some sand

43.8-49.1m: SW GRAVEL CONGLOMERATE, greenish grey, extremely weak possible low range very weak rock strength, cemented with partially cemented beds, minor drilling induced broken zones, sub-rounded to sub-angular clasts
44.7-45.3 and 46.1-46.3m: Weaker bends, associated with mudstone clasts, mudstone can be crushed by hand, strength possibly as low as dense soil strength?

47.5-47.6m: Weaker bed

47.7-48m: Weaker bed

49.1m: SW GRAVEL CONGLOMERATE, with minor silt and sand in matrix, extremely weak, cemented to partially cemented, clasts are

HQ3

HQ3 CORING

40.9-41.6m: Drill induced fracturing.

28/02/2012

29/02/2012

Box 13 Box 14 Box 15 Box 16 Box 17

T+T DATATEMPLATE.GDT amm

# TONKIN & TAYLOR LTD

# DRILL HOLE LOG

BOREHOLE No: BH2
Hole Location: 561 Rocks Road



PROJECT: Grenville Block | LOCATION: Rocks Road, Nelson | JOB No: 870981

CO-ORDINATES 5992106.9 mN, 2531374.3 mE | DRILL TYPE: Rotary | HOLE STARTED: 16/2/12

DATUM: NZMG49 | HOLE FINISHED: 2/3/12

DIRECTION: | R.L. GROUND: 32.00 m | DRILLED BY: CW Drilling Ltd

ANGLE FROM HORIZ.: -90.00° | R.L. COLLAR: 32.00 m | LOGGED BY: FAW | CHECKED:

DESCRIPTION OF CORE | ROCK DEFECTS

| GEOLOGICAL UNIT | ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...): | ROCK WEATHERING (UW SW MW HW) | ROCK STRENGTH (R4 R3 R2 R1 R0) | PT LOAD / UCS TEST (MPa) | CORE LOSS / LIFT (%) (1 10 50 100) | METHOD, CORE & CASING | TEST SYMBOL | DEPTH (m) | GRAPHIC LOG | DEFECT LOG | FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1) | SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS<br>DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING<br>ANGLES ARE NORMAL TO CORE AXIS | DATE / DEPTH | RQD (%) | WATER | DRILL WATER LOSS (%) (25 50 75) | CORE BOX RL (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PORT HILLS GRAVEL FORMATION | sub-angular to sub-rounded, clasts predominantly sandstone, siltstone with minor mudstone, granite; gravel is fine to coarse, minor cobbles and boulders; granite/mudstone clasts are weathered, can be crushed by hand<br>50m: SW GRAVEL CONGLOMERATE, with minor silt and sand matrix, as above<br><br>51.4m: Minor to some medium to coarse sand matrix, very dense, gravel strength?<br><br>53-54.5m: SANDSTONE and SILTSTONE BOULDERS, x3?<br><br>53.9m: Carbonaceous fleck<br><br>From 54.5m: Fine to coarse GRAVEL, with some coarse sand, minor silt, clasts are sub-angular, predominantly granite-weathered/crushable, medium dense to dense soil (extremely weak rock in-situ), moist, granite clasts weathered to residual soil strength | SW / MW / HW | R2 / R1 | | | HQ3 CORING | | 51 / 52 / 53 / 54 / 55 / 56 / 57 / 58 / 59 / 60 | | | | 51.4-53m: Drill induced fracturing, possibly associated with higher sand content in matrix.<br><br>54.5-61.3m: Drill induced fracturing, higher sand content. | 29/02/2012<br>1/03/2012 | | | | -18 / -19 / -20 / -21 / -22 / -23 / -24 / -25 / -27<br>Box 17 / Box 18 / Box 19 / Box 20 |

T+T DATATEMPLATE.GDT amm

Log Scale 1:50

ROCKLG 870981A.GPJ 1/11/12

# TONKIN & TAYLOR LTD

# DRILL HOLE LOG

BOREHOLE No: BH2
Hole Location: 561 Rocks Road



PROJECT: Grenville Block | LOCATION: Rocks Road, Nelson | JOB No: 870981

CO-ORDINATES 5992106.9 mN, 2531374.3 mE | DRILL TYPE: Rotary | HOLE STARTED: 16/2/12

DATUM: NZMG49 | HOLE FINISHED: 2/3/12

DIRECTION: | R.L. GROUND: 32.00 m | DRILLED BY: CW Drilling Ltd

ANGLE FROM HORIZ.: -90.00° | R.L. COLLAR: 32.00 m | LOGGED BY: FAW | CHECKED:

DESCRIPTION OF CORE | ROCK DEFECTS

| GEOLOGICAL UNIT | DESCRIPTION OF CORE | DEPTH (m) | DEFECTS |
|---|---|---|---|
| PORT HILLS GRAVEL FORMATION | Fine to coarse GRAVEL, with some coarse sand, minor silt, as above | 61 | |
| | 61.4m: UW Granite BOULDER | | |
| | Internal Port Hills Gravel Contact from gravel to interbedded coal and mudstone/siltstone | 62 | |
| | 62.4m: SW, brownish black COAL, extremely weak, cemented<br>NB: Numerous hairline fractures in core | | 62.4-62.5m: Drilling induced fracturing.<br>62.55m: Core slickensided when broken, Joint 25°.<br>Bedding 50°, planar, smooth, tight, clean.<br>62.9m: Drill induced fractures. |
| | Gradual transition to SILTSTONE | 63 | Bedding 50°, slightly curved, smooth, tight, clean. |
| | 64m: SW. light grey SILTSTONE, very weak, cemented<br>NB: Core intact but can break along hairline joint/bedding defects and possible stress relief related defects, partially rehealed/cemented? Carbonaceous, coal flecks in siltstone | 64 | Joint 70°, slightly curved, rough, tight, clean.<br>Bedding 45°, planar, rough, tight, clean.<br>Joint 15°, slightly curved, rough, tight, clean.<br>Bedding 48°, planar, smooth, tight, clean.<br>Joint 75°.<br>Bedding 40°, stepped, rough, tight, clean. |
| | 65.1m: SW, blackish brown MUDSTONE, with coal /cabonaceous content, extremely weak, cemented<br>65.1-65.18m: Very stiff soil strength<br>65.7m: Becomes very weak<br>Transition to coal | 65 | Joint/Bedding 60°, planar, smooth, tight, clean.<br>65.1m: Shear zone, very stiff soil strength.<br>65.2-65.4m: Shear zone with polished slightly curved bedding surface.<br>NB: Shear zones in mudstone rehealed and hard to break open.<br>Bedding 40°, slightly curved, smooth (polished, no slickensided movement), tight possibly open?, 3mm clay gouge?<br>Shear zone.<br>Bedding 40°, slightly curved, smooth, tight, clean.<br>65.7-66.5m: Can break along hairline joints - multiple orientations, very tight, joints, coal lenses. |
| | 67.2m: SW, brownish black COAL, very weak, cemented | 67 | Joint 40°, stepped, rough, tight, clean.<br>66.5-67m: Can break along 5x 20-25° Joints, stepped, rough, very tight, clean.<br>2x Joints 30°, planar, rough, tight, clean. |
| | 67.8m: Transition to blackish brown, sandy SILTSTONE/silty SANDSTONE, with coal, carbonaceous beds/content, very weak, cemented, with extremely weak bands, partially cemented bands | 68 | Joint/bedding 40°, slightly curved, rough, tight, clean.<br>Bedding 45°, slightly curved, rough, tight, clean.<br>68.2 and 68.5m: Coal fragments. |
| | 68.7-69.3m: SW, black COAL, very weak, cemented, with sandstone inclusions | 69 | Joint 10°, along coal lense, stepped, slickensided, tight, clean.<br>Bedding 45° on coal seam, slightly curved, slickensided, tight, clean. NB: Slickensided movement oblique to joint, bedding. |
| | 69.3m: SW, light grey SILTSTONE, very weak, cemented, 60° stratigraphic contact | | Bedding 40°, slightly curved, rough, tight, clean.<br>Joint 20°, slightly curved, slickensided, tight, |

| | ROCK WEATHERING | ROCK STRENGTH | PT LOAD / UCS TEST (MPa) | CORE LOSS / LIFT (%) | METHOD, CORE & CASING | TEST SYMBOL | DEPTH (m) | GRAPHIC LOG | DEFECT LOG | FRACTURE LOG spacing of natural fractures (cm) | DATE / DEPTH | RQD (%) | WATER | DRILL WATER LOSS (%) | CORE BOX RL (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UW SW MW HW | R4 R3 R2 R1 R0 | | 0 50 100 | HQ3 / HQ3 CORING / HQ3 | | 61 62 63 64 65 66 67 68 69 70 | | | 50 10 5 1 | 1/03/2012 / 2/03/2012 | 0 35 0 90 0 100 0 100 93 90 85 | | 25 50 75 | -28 -29 -30 -31 -32 -33 -34 -35 -36 -37 Box 20 Box 21 Box 22 Box 23 Box 24 |

Log Scale 1:50

# TONKIN & TAYLOR LTD

# DRILL HOLE LOG

BOREHOLE No: BH2
Hole Location: 561 Rocks Road

SHEET 8 OF 8

PROJECT: Grenville Block | LOCATION: Rocks Road, Nelson | JOB No: 870981

CO-ORDINATES 5992106.9 mN, 2531374.3 mE | DRILL TYPE: Rotary | HOLE STARTED: 16/2/12

DATUM: NZMG49 | HOLE FINISHED: 2/3/12

DIRECTION: | R.L. GROUND: 32.00 m | DRILLED BY: CW Drilling Ltd

ANGLE FROM HORIZ.: -90.00° | R.L. COLLAR: 32.00 m | LOGGED BY: FAW | CHECKED:

DESCRIPTION OF CORE | ROCK DEFECTS

| GEOLOGICAL UNIT | ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...); | ROCK WEATHERING (UW SW MSW HW) | ROCK STRENGTH (R4 R3 R2 R1 R0) | PT LOAD / UCS TEST (MPa) | CORE LOSS / LIFT (%) (0 50 100) | METHOD, CORE & CASING | TEST SYMBOL | DEPTH (m) | GRAPHIC LOG | DEFECT LOG | FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1) | SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS<br>DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING<br>ANGLES ARE NORMAL TO CORE AXIS | DATE / DEPTH | RQD (%) | WATER | DRILL WATER LOSS (%) (10 50 75) | CORE BOX | RL (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PORT HILLS GRAVEL FORMATION | 69.8m: SW, black COAL, very weak, cemented<br>SW, black COAL, as above<br>70.5m: Transitional contact COAL - SW, brown with black flecks silty SANDSTONE, with coal inclusions, very weak, cemented<br>71.6m: Weak<br>72.2m: SW, brown, sandy SILTSTONE, very weak, cemented, with coal inclusions | | | | | HQ3 | | 71<br>72<br>73<br>74 | | | | clean; slickenside 40° oblique to plane of joint and bedding.<br>60°, stratigraphical contact.<br>Joint 15°, planar, slickensided, tight, clean (oblique to stratigraphical contact and bedding).<br>69.3-69.8m: Very narrow coal beds (coal bedding 45°-73° on Port Hills), bedding 45° . . . . ????)<br>Joint 20°, planar, smooth, tight, clean.<br>70.1m: Drill induced fracturing disturbance.<br>Joint 60°, slightly curved, stepped, tight, clean.<br>2x Joints 65°, slightly curved, smooth, tight, clean.<br>Intersecting joint 50°, slightly rough, tight, clean.<br>Bedding 55°?, coal bedding seam?<br>Joint 45°, planar, slickensided, tight, clean, coal bed 50mm, slickenside 50° oblique to joint plane.<br>Joint 45°, planar, stepped, tight, clean (coal).<br>Joint/Bedding 50°, slightly curved, smooth, tight, clean (coal).<br>Joint/Bedding 50°, planar, slickensided/smooth, very tight, clean.<br>Joint 25°, slightly curved, smooth, tight, clean.<br>Joint/Bedding 50°, planar, smooth, tight, clean. | 2/03/2012 | 85<br>96<br>95<br>100 | | | Box 24<br>Box 25 | -38<br>-39<br>-40<br>-41<br>-42 |
| | **END OF BOREHOLE AT 74.6m.** | | | | | | | 75<br>76<br>77<br>78<br>79 | | | | | | | | | -43<br>-44<br>-45<br>-46<br>-47 |

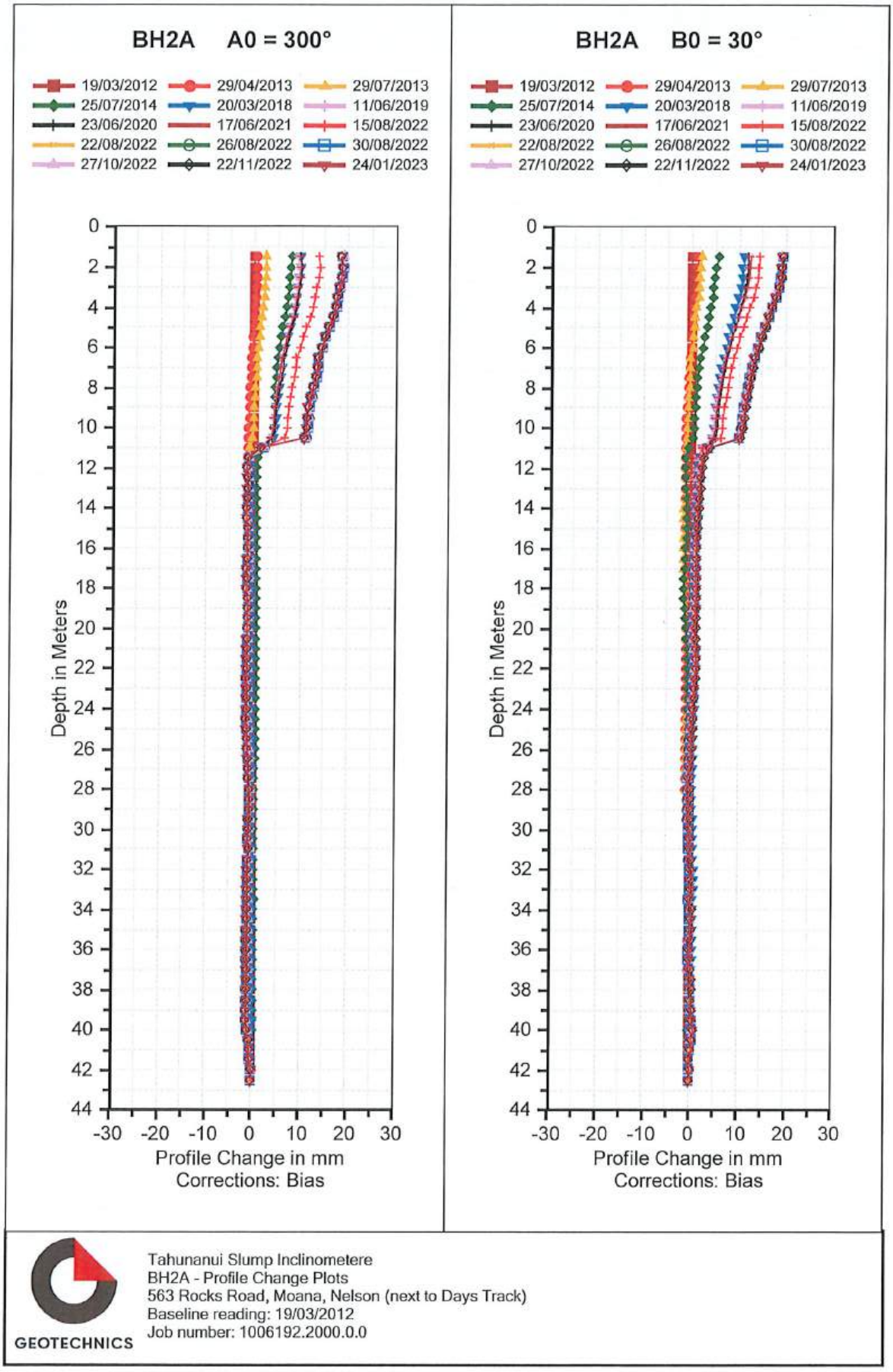
T+T DATATEMPLATE.GDT amm

Log Scale 1:50

ROCKLG 870981A.GPJ 1/11/12

PROVISIONAL

These results have not yet passed our entire quality assurance process.
They should be used with caution and may be subject to change.




GEOTECHNICS

Tahunanui Slump Inclinometere
BH2A - Profile Change Plots
563 Rocks Road, Moana, Nelson (next to Days Track)
Baseline reading: 19/03/2012
Job number: 1006192.2000.0.0