Expert Opinion Report - Landslide Assessment

10-12 View Point Road, McCrae

PSM5226-006R Rev0 11 June 2024

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1. Introduction

1. This report provides my opinion on causes of a landslide (**the Landslide**) at 10-12 Viewpoint Road, McCrae (**the Site**). The Landslide affects the following properties:
   (a) 10-12 Viewpoint Road (referred to herein as property "**P1**").
   (b) 2 Penny Lane (referred to herein as property "**P2**").
   (c) 3/613 Pt Nepean Road (referred to herein as property "**P3**").
2. A plan showing the properties referenced in my report is presented in Inset 1.
3. I have been requested to prepare this report by Ms Leesa Hovenden of Harwood Andrews (**HA**), who act for Mornington Peninsula Shire Council (MPSC).
4. My brief and supporting documents were provided by HA on 9 November 2023. Appendix A presents the letters and document index of the brief (**the Brief**). HA subsequently provided additional background information and instructions (**Additional Instructions)** on 15 May 2024, a copy of this is presented in Appendix B.
5. This report has been prepared by Mr Dane Pope; resume attached in Appendix C. I have 17 years of experience in the Civil and Mining industries with the following experience I consider relevant to this project:
   (a) Bogong Village temporary access cut in deeply weathered granite.
   (b) Deviation Road landslide risk assessment of a significant escarpment with an extensive history of landslide events.
   (c) Cliff Road landslide risk assessments, Frankston.
   (d) Great Ocean Road and inland routes landslide slope remediation projects.
6. In preparing this report I have been provided with a copy of the Expert Witness Code of Conduct (refer to the Brief) and the VCAT Practice Note (PNVCAT2). I have read both the Expert Witness Code of Conduct and the VCAT Practice Note and agree to be bound by them. I have made all the enquiries that I believe are desirable and appropriate, and I am satisfied that no matters of significance which I regard as relevant have, to my knowledge, been withheld from the Court/Tribunal.

Inset 1: **Plan of properties affected by the Landslide (Aerial Image from Nearmap dated 25 August 2023).**

2. Work Undertaken

7. I have undertaken the following work in providing my opinions on this matter:
   (a) I reviewed the Brief and the Additional Instructions.
   (b) I assembled my understanding of facts as they relate to the opinions I provide. I prepared this information with the assistance of the following staff under my direct supervision:
      i. Mr Andrew Wilson (Associate Geotechnical Engineer) who assisted with:
         (A) Completing a Site visit to characterise the Landslide and map local slope exposures.
         (B) Reviewing documents.
         (C) Compilation of facts.
   (c) I reviewed all work undertaken under my direction, and notwithstanding the assistance provided by my colleague under my instruction, the opinions in this report are my own and ones that I believe to be true and correct.
   (d) I considered the questions I have been asked to address in the Brief and the Additional Instructions in the light of my experience and understanding of engineering principles.
   (e) I prepared this report presenting my opinions.

3. Parties

8. My understanding of the relevant parties is described below.
   (a) MPSC who with regards to the Building Act act as the Municipal Building Surveyor, and with regards to the landslide risk assessments act as the Regulator. I note that the consultant Stantec Australia (Stantec) provided advice to MPSC that is relevant to the Brief.
   (b) Mr Gerry and Bronwyn Borghesi (Borghesi) who is the owner of property P1. I note that the consultant CivilTest Pty Ltd (CivilTest) provided advice to Borghesi that is relevant to the Brief.

4. Document Review

4.1 CivilTest Documents

9. I have reviewed a series of CivilTest Pty Ltd (**CivilTest**) documents. Document 2 of the Brief is the CivilTest report 1222044-1 Issue 2 (5 December 2022). CivilTest opine that:
   (a) "The inspected landslide can be classified as Translational Earth FLOW".
   (b) The Landslide failure surface is *"…likely to be the interface of the upper Aeolian sandy material and the granitic residual soil".*
   (c) The main cause of the Landslide is *"… the excessive amount of precipitation on 14 November 2022".*
10. Document 9 of the Brief is the CivilTest Land Stability Assessment report 1222044-3 (24 March 2023). The report indicates to me:
   (a) Boreholes drilled at the toe of the slope in Penny Lane encountered landslide debris, Inset 2 (Section 2.1, pdf page 102 of the Brief).
   (b) Boreholes 1 and 2 encountered landslide debris 1.2 m and 0.7 m thick respectively (Appendix C, pdf pages 128 to 130 of the Brief). I have assumed that all fill reported at the toe of the slope is landslide debris.
   (c) Geotechnical laboratory testing completed on borehole 1 (Appendix D, pdf page 132 to 135 of the Brief) indicates to me that all four samples (with depths of 3 m, 10 m, 15 m and 19 m) are a Sandy CLAY of low plasticity with between 36 to 48% fines and fine to coarse sand (typically medium grained).
   (d) The boreholes were drilled on 1 March 2023.
   (e) Wet soils were reported in:
      i. Borehole 1 at 2.6 m below ground level (**bgl**).
      ii. Borehole 2 at 2.8 m bgl.
      iii. Borehole 3 between 1.8 m and 5.2 m bgl.
11. I have relied on the accuracy of the borehole log reports and the laboratory testing reports except for the assigned geotechnical units and the laboratory description of the soils. Details of my adopted geotechnical units are included in Section 6.4 of this report.

> **2.1 Soil Profile**
>
> Three boreholes (BH) were drilled by a mechanical auger at the approximate locations shown on the attached plan. The two boreholes drilled at the toe of the slope on Penny Lane revealed that the soil profile consists of residual material from the landslip made up of silty SAND FILL and sandy CLAY FILL, overlying Colluvial material consisting of natural sandy CLAY, SAND and gravelly SAND. This is further underlain by Aeolian silty SAND.
>
> The borehole drilled at the top of the slope revealed that the soil profile consists of silty SAND FILL, overlying natural Aeolian SAND followed by sandy CLAY and silty CLAY with sand.
>
> Groundwater was encountered in the boreholes at depths of 2.6 metres in borehole 1 and 2.8 metres in borehole 2.

Inset 2: CivilTest description of debris flow as "fill" (Document 9, pdf page 3).

12. My Additional Instructions includes the CivilTest Technical Memorandum 1222044-6 (21 December 2023) referred to herein as "**the December 2023 CivilTest report**". I note:
    (a) In Section 3.1 (pdf page 5 of the December 2023 CivilTest report) CivilTest opines that:
        i. Water flowing along the kerb drain on View Point Rd would infiltrate the ground through cracks in the damaged kerb.
        ii. This infiltrated water would "*flow towards the landslide area" and* "*would be the most likely trigger for the landslide".*
    (b) Section 3.2 (pdf page 7 of the December 2023 CivilTest report) indicates that:
        i. The property owner of 10-12 View Point road observed a void during excavations for MPSC stormwater upgrade works in View Point Road. I have observed a low-resolution video of this inferred void. Based on the CivilTest report and the provided video I have marked on Figure 1 the approximate location of this void.
        ii. Ground Penetrating Radar (GPR) was conducted by Safety Scan Pty Ltd to identify the presence of sub-surface voids. A copy of the scanning report by Safety Scan is included in Appendix B of the December 2023 CivilTest report. The Safety Scan report indicates:
            (A) Scanning was conducted along the road surface, nature strip and front of property. Scanning was not undertaken in the property between the void location and the Landslide area, due to access restrictions, Inset 3
            (B) One void was identified by GPR and confirmed using a probe. as follows:
                (I) The void is approximately 1.6 m from the SEW sewer pit, Inset 4.
                (II) The top of the void is approximately 0.55 m below ground surface level, and the base of the void is approximately 1 m below ground surface level, Inset 3
            (C) Sewer, gas, water, and stormwater sub-surface utilities were identified in the nature strip, Inset 5.
13. I note that I have not observed any direct evidence of connectivity between this "void" and the Landslide.

Results:	Scanning was conducted along the road surface, nature strip and front of property. GPR scan results indicated the presence of potential voids within the nature strip area. The location of the indicated voids commenced behind the kerb between trees (pictured). Due to the number of services located within the nature strip disturbing natural soil layers, a probe was utilised to physically confirm the GPR findings. The probe confirmed a void was present. When removed the probe was dry and the bottom of void was solid. The void was approximately 550mm below ground surface and 450mm deep (1.0m below ground surface). The identified void travels from the kerb line to the sewer line on the property line along View Point Road. The sewer pipe has an invert level of 1.37m entering the sewer pit, the downstream pipe exits the pit at 3.01m invert. The full extent of the void network was unable to be mapped. It is typical of water to follow the easiest route downhill. Any further voids toward the North West would be expected at a depth exceeding the 1.5m effective range of the GPR equipment within the soil conditions.

Inset 3: Extract of summary from Safety Scan scanning report

Inset 4: Figure 3 of Safety Scan scanning report showing location of identified void. I have added my commentary in blue

Inset 5: Figure 2 of Safety Scan scanning report showing location of sub-surface utilities

4.2 Stantec Documents

14. Document 4 of the Brief is the Stantec Geotechnical Assessment ((V220600Report01.1, 7/12/2022) referred to herein as the "Stantec GA"). The Stantec GA indicates:
    (a) Two landslide mechanisms were observed:
        i. Translational slide of the upper slope (Section 4.1 of the Stantec GA, pdf page 21 of the Brief) in *"the upper soils overlying the underlying completely weathered granite"*.
        ii. Debris flow of the lower slope (Section 4.2 of the Stantec GA, pdf page 25 of the Brief) initiated:
            (A) "By a significant increase in ground moisture".
            (B) "Within the accumulation zone of the upper landslide". I note that the upper landslide refers to the Translational slide mechanism.
            (C) "… potentially [by] the failure of an irrigation pipe after the upper landslide occurred".
    (b) The thickness of the Landslide was possibly less than 0.5 m (Section 4.1 of the Stantec GA, pdf page 22 of the Brief), Inset 6.
    (c) Seepage was observed in the head scarp, Inset 7. I have indicated these locations on Figure 1.
    (d) Multiple locations of seepage were observed in the eastern portion of the slope, Inset 8. I have indicated these locations on Figure 1
    (e) A water line travelling down the slope through the Landslide area, Inset 7. Referred to herein as **"the Water Line"**.

> Figure 4-2 shows the main scarp of the landslide where it has undermined the existing stairs. It can be seen that the failure surface of the landslide runs parallel to the ground surface. The weathered granite is exposed in the failure surface. Looking at the side flank it can be seen that the thickness of soil that would have overlain the weathered granite is relatively shallow, possibly less than 0.5m.
>
> Water was observed to be seeping from the head scarp at several locations more than 24 hours after the storm occurred. These seeps appear to be associated with natural springs further up slope.

Inset 6: Excerpt from Section 4.1 of the Stantec GA (pdf page 22 of the Brief).

Inset 7: Figure 4-2 from the Stantec GA (pdf page 23 of the Brief), I have added my commentary in blue.

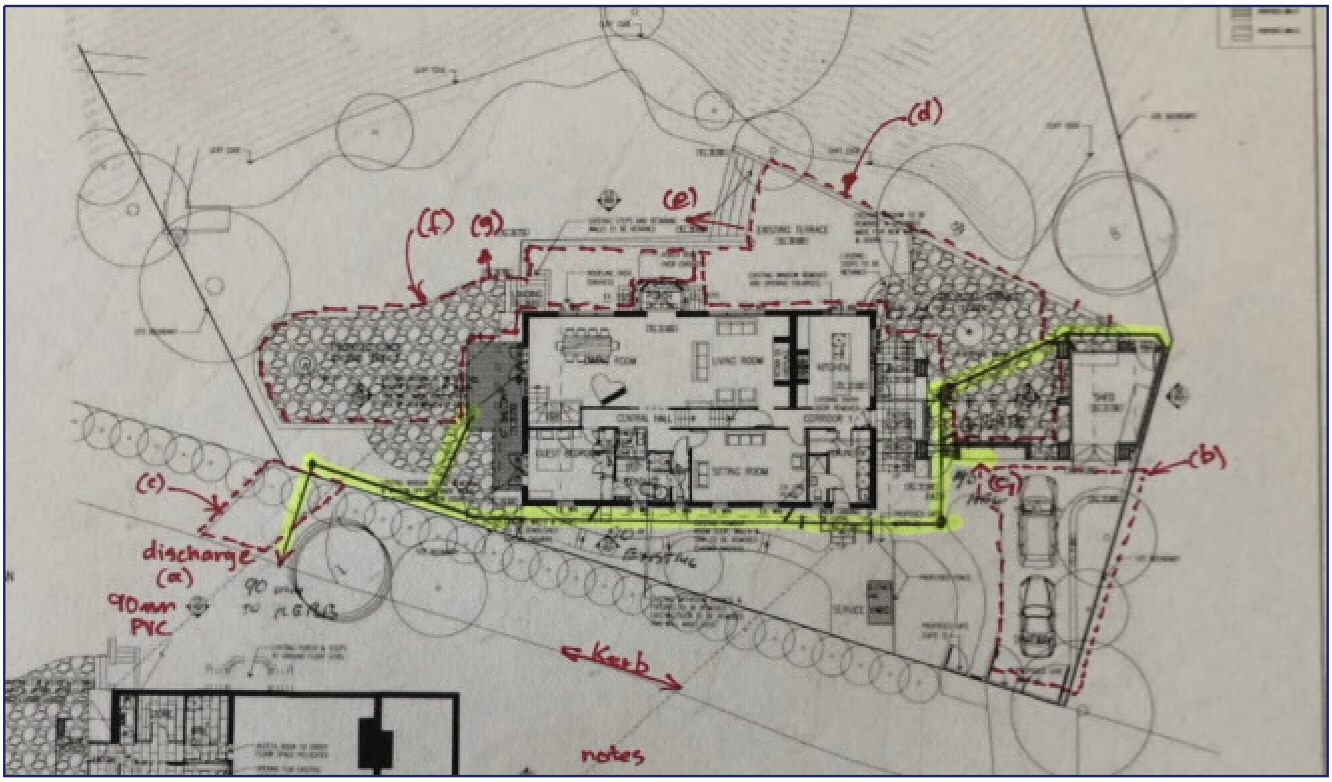
> On the right (western) side the conditions were quite dry and there was no evidence of water seepage. However, on the left (eastern) side there were a number of water seeps observed. These water seeps were observed to be flowing freely more than 24 hours after the heavy rainfall event.

Inset 8: Excerpt from Section 4.2 of the Stantec GA (pdf page 26 of the Brief).

15. Section 3 of the Stantec GA (pdf page 20 of the Brief) states that:
    (a) The translational slide is *"… likely to have occurred the late afternoon on Monday 14 November 2022".*
    (b) The debris flow occurred *"… in the early morning of Tuesday 15 November 2022".*
16. I have relied on the accuracy of these timing observations. I have assumed that a period of six to twelve hours elapsed between the translational slide and the debris flow.
17. Figure 4-7 of the Stantec GA (pdf page 27 of the Brief) includes a photograph of the debris flow zone. I note that there is no scale in the photograph, however, the photograph indicates to me that the depth/thickness of material evacuated from the debris flow zone is inferred to be on average less than 0.5 m.
18. I have relied on the accuracy of the observations regarding landslide dimensions.
19. Section 4.1 of the Stantec GA (pdf page 24 of the Brief) indicates that:
    (a) Retaining walls (**RWs)** on the left flank of the Landslide are *"… significant[ly] leaning and there was evidence of water seeping through the wall".* I note that the left flank is the eastern side of the Landslide.
    (b) There is tension cracking in front of the leaning RWs.
20. Figure 4-5 of the Stantec GA (pdf page 25 of the Brief) shows a photograph of the leaning RWs.

4.3 Borghesi Emails

21. Document 6 of the Brief is an email from Borghesi to MPSC, dated 14 December 2022. This email chain includes:
    (a) A plan of P1's stormwater system, Inset 9. The stormwater system plan indicates to me that:
        i. Stormwater from the roof is collected by gutters and downpipes before it is discharged into the kerb of View Point Rd via PVC pipe.
        ii. Stormwater from the western driveway is discharged into the kerb of View Point Road.
        iii. Stormwater from the eastern driveway is collected in a spoon drain, the outlet of the spoon drain is not clear to me.
        iv. Stormwater from paved outdoor terrace areas to the east, west and north of the building discharge into the grassed lawn area directly above the Landslide area.
22. I have assumed that the P1 stormwater system drawing is an as constructed representation.
23. Document 6 of the Brief includes a letter from Ian Chudleigh Plumbers detailing the results of a pressure test that was performed on the water lines within P1 (pdf page 96 of the Brief). It indicates to me that:
    (a) There are no leaks within the tested water lines.
    (b) An automatic irrigation system is present on Site.



Inset 9: **Plan of P1 stormwater system (pdf page 95 of the Brief).**

4.4 Additional Instructions

24. The Additional Instructions has provided the following background information that I have relied upon:
    (a) Prior to the Landslide occurring an irrigation system was installed on the slope. I have assumed this is the same as the Water Line identified in the Stantec GA (refer paragraph [14(e)]. The irrigation system is connected to the mains water supply of the property. The pipe was reported leaking at the connection near the stairs after the landslide occurred.
    (b) Stormwater upgrade works were undertaken by MPSC in 2023 to install underground pit and pipe system along View Point Rd and to reconstruct the kerb.
    (c) Prior to 2023 MPSC stormwater upgrade works the upstream stormwater drainage system near the intersection of View Point Rd and Prospect Hill Rd would run underground in a pipe before terminating into a pit. The water would surcharge the pit and flow to the surface before flowing westward along the View Point Rd kerb towards the end of the court bowl before being directed back into a pit and pipe network.

4.5 Published Information

4.5.1 Coastal LiDAR

25. I have relied on the accuracy of the Coastal LiDAR elevation data captured by the Department of Sustainability and Environments between April 2007 and October 2008 and published on www.data.vic.gov.au as VicMap Elevation Coastal 1 m DEM and 0.5m Contours. This data provides a 0.5 m contour in coastal areas.
26. In my experience (refer to Wye River Landslide Assessments in my CV, Appendix B) the Coastal LiDAR is an appropriate survey tool to use for landslide assessments.

4.5.2 Rainfall Data

4.5.2.1 Rosebud Weather Station

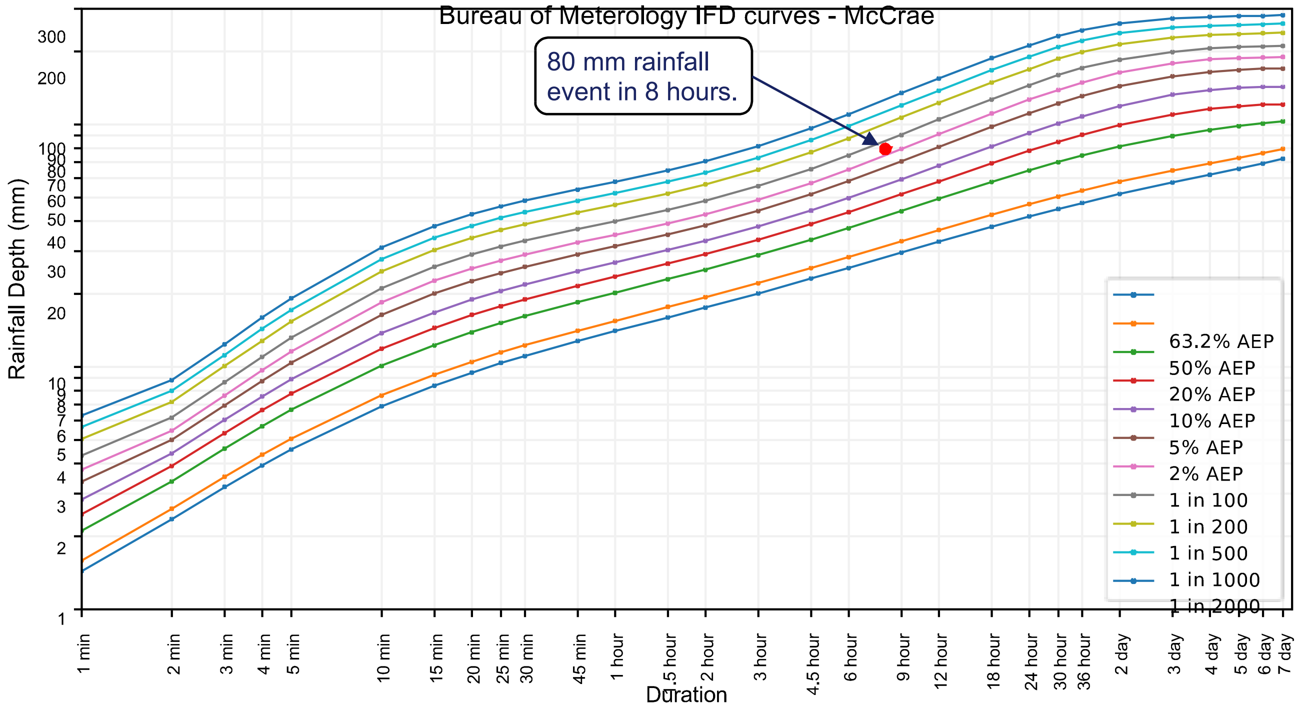
27. The Bureau of Meteorology (BOM) Rosebud weather station climate data (Station ID: 086213, Climate Data Online - Map search (bom.gov.au), accessed 31 October 2023) indicates to me:
    (a) On 14 November 2022 approximately 80mm of rainfall was recorded and reported to 9am over the preceding 24-hour period. I herein refer to this rainfall as the "**Rain Event**".
    (b) The Rain Event was the fourth highest 24 hour recorded rainfall since records began.
    (c) The 30-day cumulative rainfall on the 14 November 2022 was 133 mm.
    (d) The 30-day cumulative rainfall on the 1 March 2023, when the CivilTest boreholes were drilled was 47 mm.
    (e) The 30-day cumulative rainfall on 23 October 2023, when the PSM site visit was undertaken was 12.5 mm.
    (f) The dataset commenced in 1927 (albeit is missing significant data) and there are at least 19 events where the 30-day cumulative rainfall has exceeded 150 mm.

4.5.2.2 Rainfall Chasers

28. Review of the Melbourne radar archive (Melbourne Radar - 128km Rain Rate (theweatherchaser.com), accessed 31/10/2023) indicates that:
    (a) The majority of moderate to heavy rainfall was observed between 11pm on 13/11/2023 and 7am on 14/11/2023, Figures C1 to C2 of Appendix C.
    (b) Some showers were recorded for the remainder of the 14/11/2023, Figure C3 of Appendix C.

4.5.2.3 Australian Rainfall and Runoff

29. I have considered the Australian Rainfall and Runoff Intensity Frequency Duration (IFD) curves, published by BOM (http://www.bom.gov.au/water/designRainfalls/revised-ifd/, accessed 4 December 2023). These are presented in Inset 10.
30. These records indicate to me that:
    (a) The Rain Event intensity over the 8-hour period had 1 in 100 years to 1 in 200 years probability of occurring.
    (b) 80 mm of rainfall in a 24-hour period has a 1 in 20 probability of occurring in any given year.
    (c) The Rain Event was an infrequent and intense event.



Inset 10: BOM IFD curves for McCrae, with Rain Event marked.

4.5.2.4 BOM El Niño Southern Oscillation Outlook

31. I have considered the BOM El Nino Southern Oscillation (ENSO) Outlook and ENSO History (http://www.bom.gov.au/climate/enso/outlook/, accessed 5 December 2023). These records provide historical records of El Niño and La Niña weather patterns. These records indicate:
    (a) A La Niña event occurred from September 2020 to February 2023.
    (b) La Niña events that extend for a period of three years in a row have occurred in 1998-2001, 1973-1976 and 1954-1956.

4.5.3 Sub-Surface Utilities Records

32. I have considered records of South Easter Water (SEW) sub-surface sewer and mains water assets in the area provided by SEW (https://southeastwater.com.au) accessed on 21 November 2023. These records indicate:
    (a) A 150 mm diameter vitrified clay sewer pipe is located in the sewer easement along the boundary of 14-16 View Point Road and P1. The pipe collects sewerage from properties at the top of the escarpment and transports it to the toe of the escarpment at Penny Lane.
    (b) A 100 mm diameter asbestos cement articulation mains water pipe is located on the northern side of View Point Road.
33. Based on the age and depth of the sewer pipes, I have assumed that the sewer was constructed using typical trench and backfill construction methods.
34. I note that SEW *"provide a minimum flow rate, as defined in our service standards. For a standard house that's 20 litres per minute. This is measured at the front garden tap or your meter assembly"* (Our service guarantees | South East Water, 12/12/2023). I have assumed that this flow rate is available to the "Water Line".

35. I have considered records of sub-surface utilities in the area provided by Before You Dig Australia (www.byda.com.au) on 3 June 2024. These records indicate:

    (a) A MPSC stormwater drainage system is located in View Point Road.

        i. Recorded sub-surface drainage pits and pipes are shown in Inset 11.

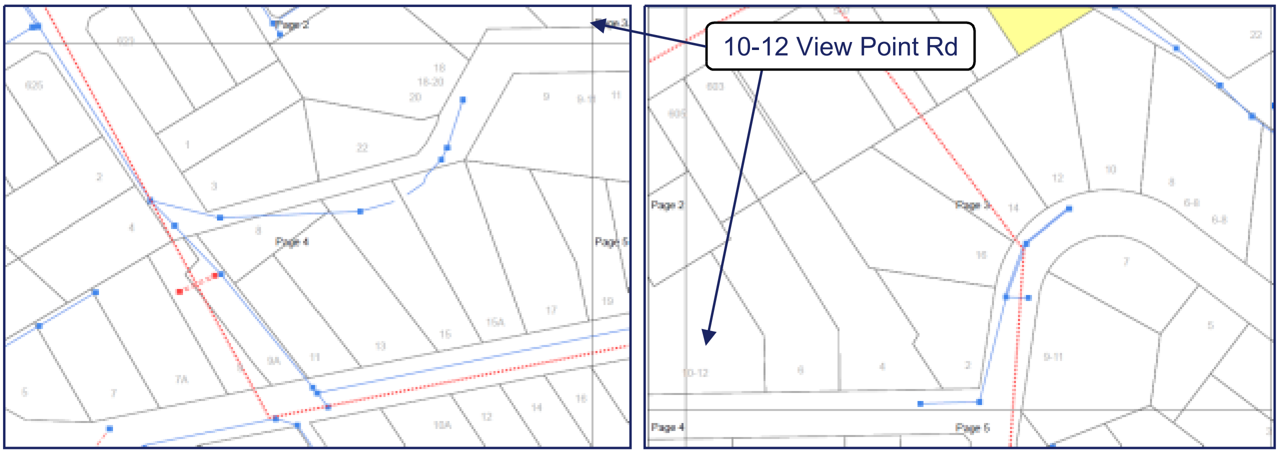
        ii. There are no stormwater pipes or pits in View Point Road between 4 View Point Road and 18-20 View Point Road. This is supported by Google Streetview imagery from April 2023.

        iii. It is understood stormwater would surcharge out of the pit at 4 View Point Road and travel west along the kerb to the end of View Point Road before entering a pit or discharging down the gully located immediately to the south of the end of View Point Road (refer paragraph [24(c)]).

    (b) APA gas line is present in nature strip on the north side of View Point Rd, it is located approximately 3.0 m from the property boundary line.

36. I understand that the stormwater system was reconstructed in mid-2023 and it now includes stormwater pits and pipes for the whole length of View Point Road, refer paragraph [24(b)].

37. I note these records match the findings of Safety Scan who verified the location of these sewer, gas, water and stormwater utilities in the nature strip in front of 10-12 View Point Rd, refer paragraph [12(b)ii(C)]. I have marked the approximate location of sub-surface utilities on Figure 1.



Inset 11: MPSC drainage network. Drainage pits are shown as blue squares, and drainage pipes as blue lines ((www.byda.com.au) on 16 November 2023).

5. Site Visit

38. A Site visit was completed by Mr Andrew Wilson on 23 October 2023. Selected photographs are included in Appendix D. The Site Visit was conducted during dry weather and with no rainfall reported by the BOM Rosebud Country Club weather station in the 7 days prior to the Site Visit.

39. The Landslide had the following characteristics:

    (a) It initiated in the upper to middle portion of the slope, with the rear scarp approximately at the base of the Stairs, Photo 1 Appendix E.

    (b) It was inferred to have initiated as a translational slide followed by mobilisation of failed material into a debris flow which was deposited at the toe of the slope, Photo 2 Appendix E.

    (c) The Landslide had three distinct zones being:

        i. A steep "**Upper Zone**" where the initial translational sliding occurred with approximate dimensions of 8 to 10 m wide x 8 to 10 m long x 0.3 m thick, Photo 3 Appendix E.

        ii. A steep "**Middle Zone**" approximately 15 m long by 3 m wide through which the debris flow travelled, with some scour and erosion, Photo 3 Appendix E.

        iii. A flatter "**Lower Zone**" of debris runout where the debris flow deposited at the toe of the slope, Photo 3 Appendix E. The approximate dimensions of deposited debris are 8 to 10 m wide, 9 to 10 m long, and 0.2 to 0.7 m thick.

(d) Disturbed ground that had undergone translational sliding but did not mobilise into a debris flow was observed on the right (western) flank of the Landslide, Photo 4 Appendix E.

(e) The total area of instability was not able to be mapped in detail due to poor access and vegetation. There is still uncertainty as to the width of the unstable ground. It is possible that there is additional unstable ground to left (east) of the observed Landslide.

(f) A lack of prominent backscarp, Photo 5 Appendix E, with minor steepening observed in the backscarp area and with a slope angle of approximately 45 degrees.

40. The following soils were observed and logged in the Landslide area.

(a) Residual Granite on the failure surface in the Upper Zone. This material was logged as Sandy CLAY, low to medium plasticity, pale grey, brown to mottled orange grey brown, fine to coarse grained granitic sands, dry to moist, very stiff to hard. I note it is possible this material is cemented Surficial Sands, Table 1, as in my opinion this unit is derived from eroded Residual Granite.

(b) Surficial sands were found to cover the upper escarpment slope. This material was logged as Silty SAND to Sandy SILT, fine to medium grained SAND/low plasticity SILT, brown to pale grey, brown, dry, weakly cemented.

(c) Possible older (pre 2022 Landslide) Colluvium was observed in the lower slopes. It was logged as Silty/Clayey SAND, fine to coarse grained granitic sand, brown, trace 10-100 mm granitic gravel/cobbles, dry to moist, loose to medium dense.

(d) Newer Colluvium was observed in the debris flow deposits and logged as Silty SAND, fine to medium grained, pale brown, dry, loose.

41. I note that the Landslide characteristics observed during the Site visit were in general agreement with those described in the Stantec GA (refer Section 4.2).

42. The Site had the following characteristics:

(a) Located on a prominent escarpment. The escarpment is approximately 25 m high, with an overall slope angle of 35°. The escarpment has a concave (in section) profile, with slope angles of approximately 30° in the lower slope and 40° in the upper slope. The ground above and below the escarpment has flat to gentle slopes with typical slope angles of 0° to 5°.

(b) No evidence of current or historic large-scale landslide features that affect the full height of the escarpment, e.g., stepped ground, hummocky ground, landslide scarps, etc.

(c) Groundwater was observed to be seeping from the slope to the east of the stairs, Photo 6 Appendix E. This location has been marked on Figure 1. I note this location is different from the headscarp seepage noted in the Stantec GA, refer paragraph [14(c)], however is consistent with Seepage on the eastern portion of the sloe noted by Stantec GA, refer paragraph [14(d)].

(d) A variety of water infrastructure was observed across the Site, Photo 7 Appendix E including:

i. Subsurface 'agi-drains'

ii. Water pipes including taps. A 20 mm to 25 mm diameter blueline polyethylene pipe with a damaged connection was observed near the top of the stairs, immediately above the rear scarp of the landslide.

(e) A series of paths had been constructed across the slope to provide access from the top to the bottom of the escarpment, Photo 8 & 9 Appendix E. The paths are constructed from varying materials. Other infrastructure associated with the paths include minor RWs, board walks and stairs.

(f) The slope above the Landslide area was consistent with adjacent slopes outside of the Landslide area, with an approximate slope angle of 40°. I note that a combination of minor RWs and vegetation have been constructed/planted in this area.

(g) The condition of RWs across the Site was generally poor, with overturning and bulging RWs observed. A section of RW to the east of the Landslide had significant tilts. This indicates to me possible instability in the ground above the RW and possible structural or geotechnical failure of the RW, Photo 10 Appendix E. I note the RWs appear to be leaning more than as documented by Stantec (refer paragraph [20]).

(h) Numerous fallen trees were observed across the escarpment slope, Photo 11 Appendix E. I note that most of the failed trees appear to have failed from causes unrelated to the Landslide, i.e., wind or poor root embedment. I note at least one tree appears to have fallen because of the Landslide.

(i) Minor erosion was observed on unvegetated areas of the escarpment.

(j) Leaning and curved trees were observed on the escarpment, suggesting possible creep movement of the slope, Photo 12 Appendix E.

43. Additional observations were made in the broader Site area to understand larger scale slope processes. These observations include:
   (a) Anthony's Nose, approximately 600 m to the northeast of the site, is a headland where the escarpment protrudes into Port Phillip Bay. It is the only coastal exposure of Dromana Granite as such it provides useful insights into ground conditions and slope performance. Key observations include:
      i. Natural voids and internal erosion (i.e., piping) is common in upper soil profile, Photo 13 Appendix E.
      ii. A sub vertical cliff profile in extremely weathered and highly weathered granite, Photo 14 Appendix E. I note this sub-vertical may be the result of road construction activities in the 1920's and 1930's.
      iii. Granite rock is exposed in shore platform below the road.
      iv. Steep to sub-vertical upper slopes is inferred to fail by undercutting and erosion of the lower slope leading to toppling/wedge style failures, Photo 15 Appendix E.
   (b) A new stormwater drainage system has been constructed in View Point Rd. I note that a constant flow of water was observed to be running in this drainage system.
   (c) The Site is located on the lower slopes of Arthurs Seat where those slopes meet Port Phillip Bay and have formed an escarpment, Photo 14 Appendix E. In proximity to the Site the general topography of the areas slopes to the northwest. There is extensive residential development above the Site on the lower slopes of Arthurs Seat.

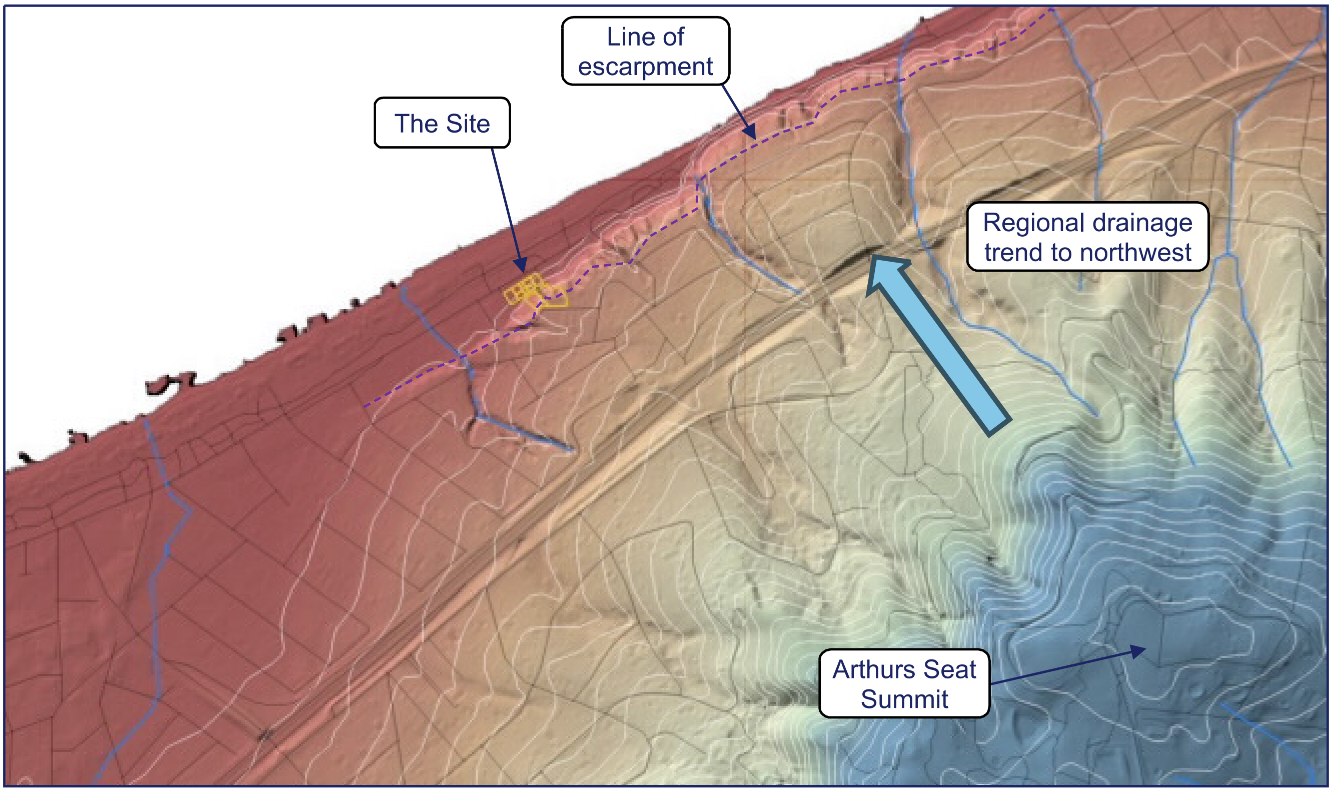
6. Geotechnical Model

6.1 Aerial and Street Photography

44. I have considered readily available Nearmap images which indicate:
   (a) The translational slide scarp has approximate dimensions of 8 m x 5 m, Appendix F1.
   (b) The debris flow had approximately 35 m of runout from the translational slide scarp. The debris flow runout area has approximate dimensions of 10 m x 10 m. Run out extended approximately 5 m into properties P2 and P3, Appendix F1.
45. I have considered readily available historical images which indicate to me:
   (a) In 1939, Appendix F2:
      i. The escarpment had several exposed slopes with sparce vegetation.
      ii. The property at P1 is visible, therefore its age is greater than 84 years old.
      iii. There are northwest trending incised gullies along the escarpment.
   (b) In 1951, Appendix F3:
      i. Residential development including roads has occurred above and below the escarpment.
      ii. The escarpment still has exposed slopes with sparce vegetation.
   (c) In 1984, Appendix F4
      i. There has been substantial residential development in the area.
      ii. The exposed escarpment slopes are no longer visible as they are now covered by extensive vegetation.
46. Both Nearmap and Google Street view images indicate that a series of trees were removed on property P1, including a mature gum tree, between April 2021 and September 2021, Appendix F5 to F8. The April 2021 imagery indicates to me that the lawn of P1 on the escarpment is notably darker green than adjacent properties on the escarpment.
47. Google street view images from 2013 to 2023, Appendix F9 to F10 indicates that:
   (a) Surface water flows down the northern side of View Point Road and continues past the documented stormwater discharge point of P1, Inset 9.
   (b) Minor to moderate damage to kerb is visible. Locations of kerb damage are shown on Figure 1.

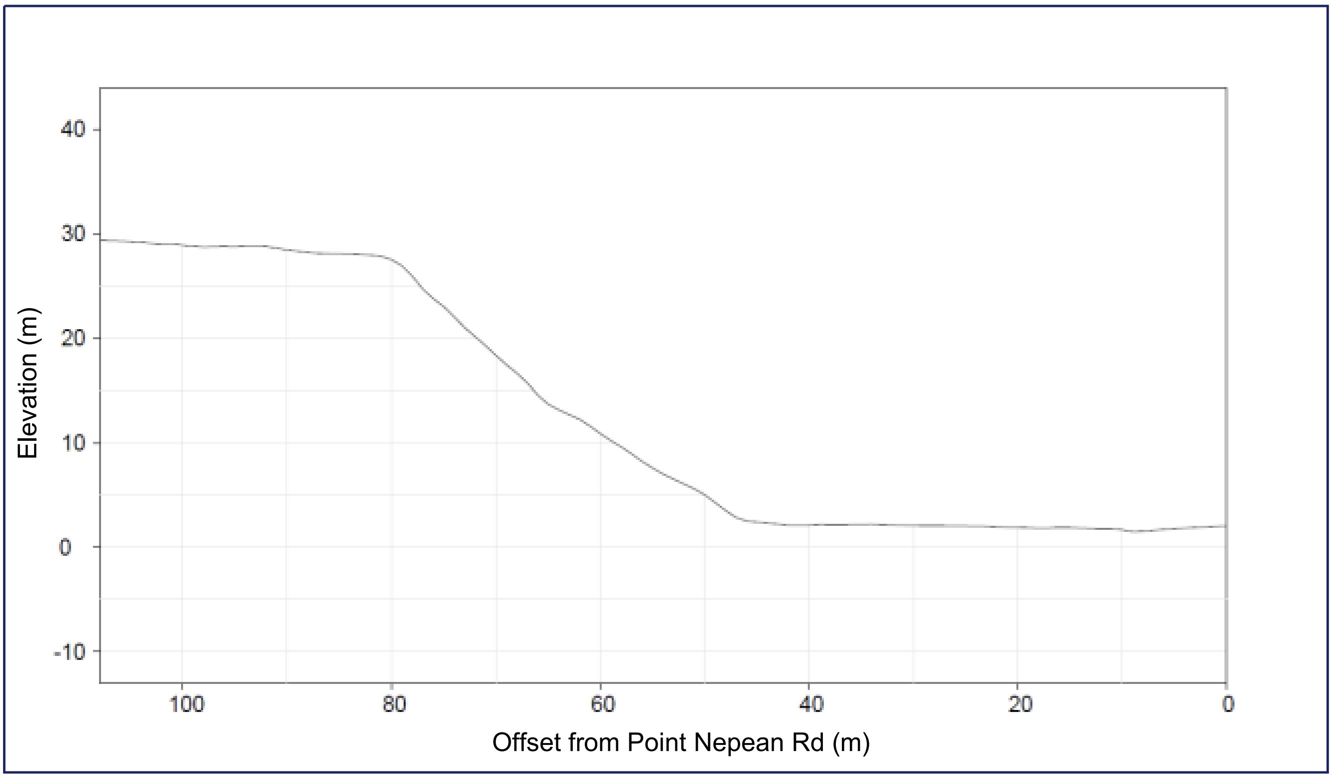
6.2 Topography and Drainage

48. The Coastal LiDAR indicates that the Site is located at the lower escarpment of Arthurs Seat, Inset 12. There is approximately 270 of metres of relief measured in a northwest direction from the summit of Arthurs Seat to the escarpment at the Site. I note that drainage paths typically strike in a north to northwest direction and that the Mornington Peninsula Freeway provides significant disruption to surface and sub-surface water flows in the region.



Inset 12: Topography and drainage paths of Arthurs Seat.

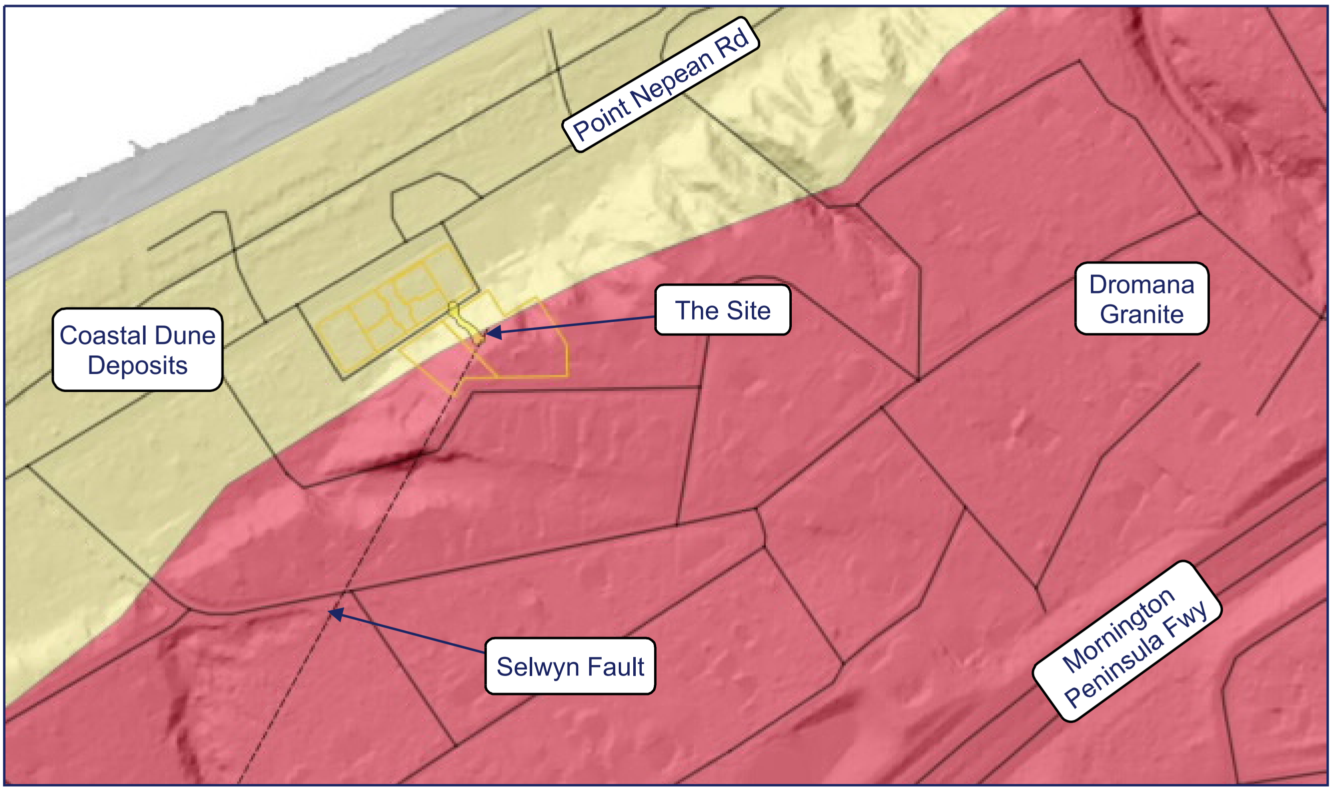
49. In the immediate area of the Landslide on P1 the Coastal LiDAR data indicates:
    (a) The strike of the escarpment line changes from 030° to 100°. I note that this creates a local convex geometry or "bullnose" slope at the location of the Landslide.
    (b) 25 to 30 metres of relief between the toe and crest of the escarpment.
    (c) A typical overall slope angle of 30 to 35°. Slope aspects are generally to the northwest.
    (d) A concave (in section) slope profile with the upper half of the escarpment being steeper (typically 35 to 40°) than the lower half of the escarpment (typically 25 to 30°).
    (e) Pre-failure slope geometry of the Landslide is shown in Inset 13.
    (f) A lack of large-scale features other than gullies, that may indicate the presence of a large, full height slope failure mechanism.
50. I note that the:
    (a) Coastal LiDAR can be readily used to identify the inferred past landslide at Anthony's Nose (refer to paragraph [43(a)]).
    (b) Slope trends in the Coastal LiDAR are consistent with my Site observations, Section 5.



Inset 13: Prefailure slope geometry through the centre of the Landslide from Coastal LiDAR 1 DEM.

6.3 Regional Geology

51. The Victoria Seamless Geology (Earth Resources publications (efirst.com.au), (2014)) model indicates that the Site is close to the boundary of Quaternary aged coastal dune deposits (with siliceous and calcareous sands) and Devonian aged Dromana granite. The Earth Resources mapping portal (GeoVic Anonymous (gsv.vic.gov.au), accessed 1 November 2023) indicates that the inferred location of the Selwyn Fault traverses the Site, Inset 14.



Inset 14: Earth resources seamless geology map of the area, with Selwyn Fault highlighted.

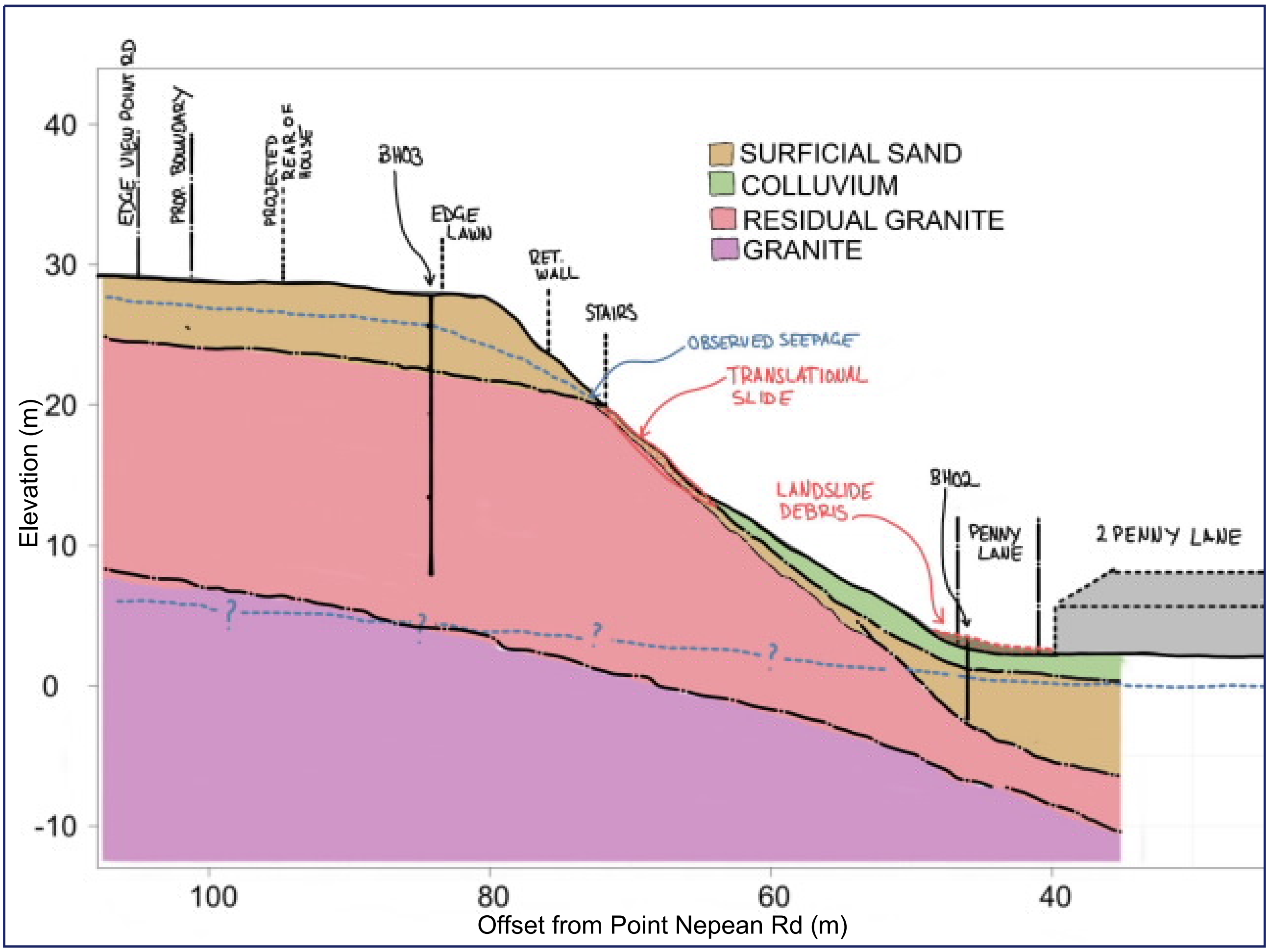
6.4 Sub-Surface Conditions

52. The conditions documented by others in the boreholes and slope exposures indicated subsurface conditions is generally consistent with those described on the geological map. Table 1 presents my interpretation of the geotechnical units.

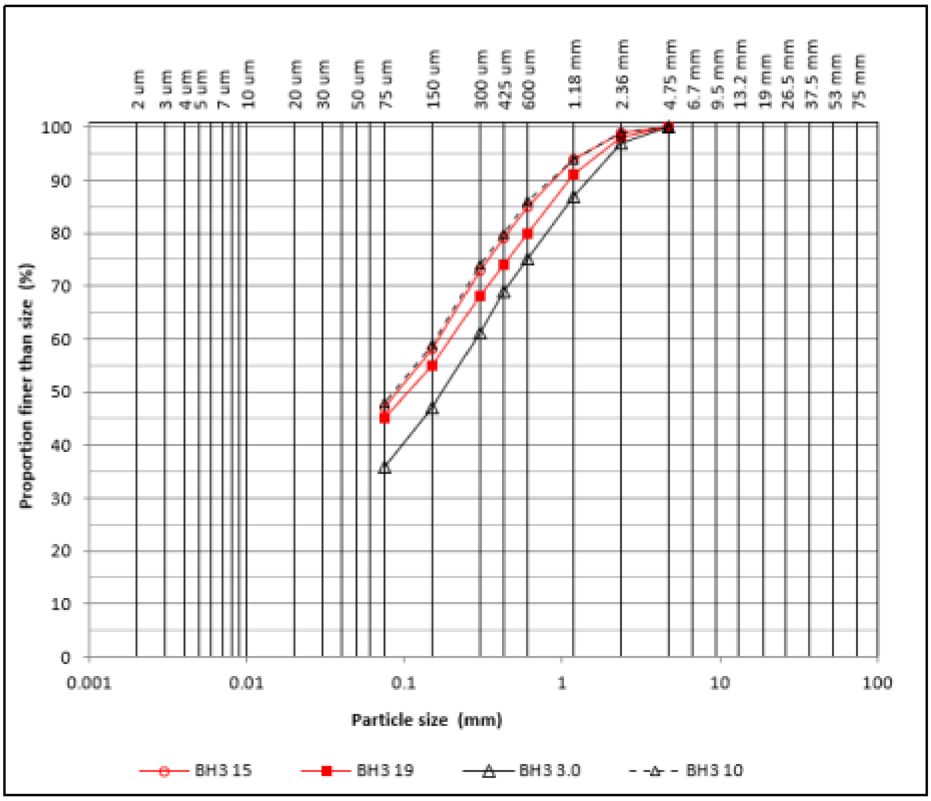
Table 1 – Geotechnical Units

Unit	Description
SURFICIAL SAND (1)	SAND and Silty/Gravelly SAND, fine to coarse grained, brown to pale grey, brown, moist to wet, inferred medium dense. SPT N value of 10 at 1.5 m bgl. Contact with underlying Residual Granite (3) is difficult to define.
COLLUVIUM (2)	Inferred to be a mixture of Units 1 and 3. Recent Colluvium (the debris flow from 2022 landslide) is Silty SAND/Sandy CLAY. Old Colluvium buried by 2022 landslide is Sandy CLAY and SAND. This unit has no strength testing.
RESIDUAL GRANITE (3)	Sandy to Silty CLAY/Clayey SAND, low plasticity, pale grey, brown to mottled orange grey brown, fine to coarse grained, wet at contact with overlying Surficial Sands otherwise moist, typically medium dense to dense/stiff to very stiff. SPT N values vary from 12 to 34 with a mean of 25 from 3 m to 20 m bgl.

53. My interpretation of the geological conditions is presented in Inset 15. With regards to the geotechnical model, I note the following key observations:
    (a) There is uncertainty regarding the contact between the SURFICIAL SAND and the RESIDUAL GRANITE owing to the likelihood of some of the parent material of the SURFICIAL SAND being derived from erosion of the Dromana Granite. I have assumed that the wet soils are an indicator of the contact between the two geotechnical units.
    (b) The laboratory testing indicates that all samples between 3 m and 19 m bgl have very similar Particle Size Distributions, Inset 16, and Atterberg limits indicate low plasticity CLAY fines.



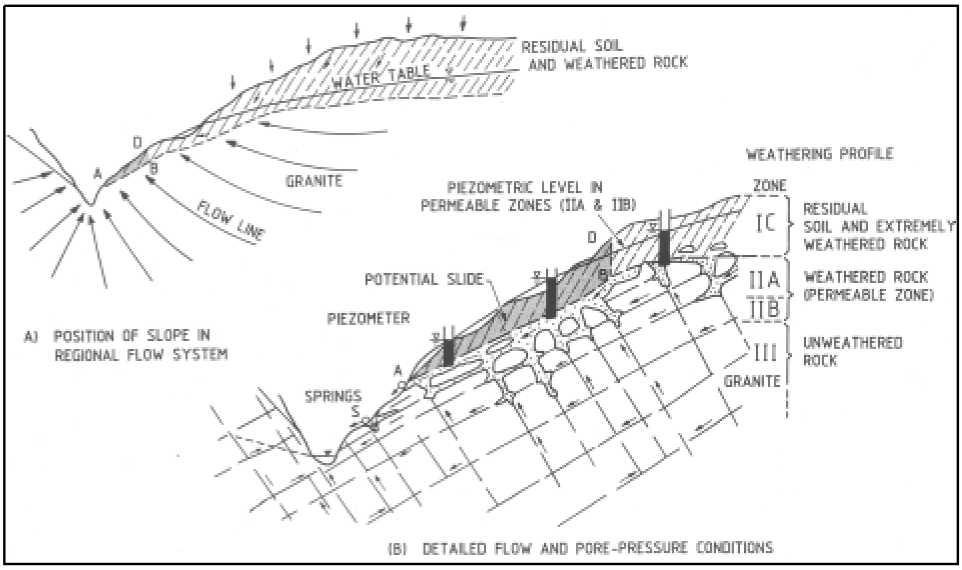
Inset 15: Cross section of my geotechnical model.



Inset 16: CivilTest Particle Size Distributions.

6.5 Groundwater

54. I note that no groundwater monitoring has been conducted on the Site.
55. Based on published literature and the observations on the CivilTest borehole logs, in my opinion, a perched water table is likely to exist at the contact of the SURFICIAL SAND and the underlying RESIDUAL GRANITE. This is supported by:
    (a) Wet soils observed in CivilTest borehole 3 (refer to paragraph [10(e)iii]).
    (b) Erosion pipes in the SURFICIAL SAND, (refer to paragraph [43(a)i], which indicate to me a pathway of past and preferential sub-surface water flow.
    (c) Observations in the Stantec report (refer to paragraph [14(c) & 14(d)]).
    (d) Observations of seepage during the Site Visit (refer to paragraph [42(c)]).
56. In my opinion the presence of the perched water table will not necessarily be limited to periods of wet weather due to:
    (a) The size of the catchment of Arthurs Seat and slopes and drainage paths that fall towards the northwest, the Site and the escarpment (refer to paragraph [48]).
    (b) Local sources of water common to residential development and subdivisions (garden watering, street catchment run off, leaky pipes (private and public sources).
57. This is supported by:
    (a) The observation by CivilTest of wet soils encountered in borehole 3 between 1.8 m and 5.2 m bgl in March 2023. I note that this was not during or following a period of high rainfall, Section 4.5.2.1.
    (b) Furthermore, the CivilTest observation is consistent with published groundwater models in weathered granitic profiles, Inset 17.
    (c) Observations of seepage during the Site visit (refer to paragraph [42(c)]).
58. With regards to groundwater flow, it is my opinion that:
    (a) The deposition of the SURFICIAL SAND unit will have conformed to the pre-existing slopes of the RESIDUAL GRANITE unit.
    (b) The slope aspect of the RESIDUAL GRANITE is towards the northwest (refer paragraph [49(c)]).
    (c) Groundwater flow will follow the SURFICIAL SAND/RESIDUAL GRANITE interface; therefore it is expected groundwater flow direction will be to the northwest.



Inset 17: Possible piezometric conditions in weathered granitic soils (Fell et al, 2004)[1].

[1] Fell,R. MacGregor, P.Stapledon, D. Bell, G. 2005. Geotechnical Engineering of Dams. CRC Press.

59. Groundwater was observed on Penny Lane between 2.4 m to 2.6 m bgl (paragraph [10(e)]). I note that this is consistent with water levels of the adjacent Port Phillip Bay and that these levels are anticipated to fluctuate with tidal levels.

7. Mechanisms of Failure

60. In my opinion the Landslide is shallow in nature with the key mechanisms of failure and controls summarised in Table 2. I note that the mechanisms I have identified are consistent with the Stantec GA (refer to Section 4.2).
61. Surficial Soils on the slope at the Site above the water table are typically unsaturated. Unsaturated soils contain soil grains, water, and gas (air or water vapour). The shear strength of unsaturated soils is significantly improved by suction (i.e., negative pore pressure). Based on engineering principles unsaturated slopes can maintain much steeper slope angles than for saturated slopes. For unsaturated soils an increase in soil water content to saturation or field saturation results in a decrease in suction, Inset 18, and a decrease in shear strength.
62. The soil water content in a slope change in response to the hydrologic processes of rainfall, infiltration, groundwater flow, evaporation, transpiration, and runoff. I have marked up my interpretation of the hydrologic process contributing to the soil water content of the slope, Inset 19. Based on engineering principles the shear strength of the unsaturated soil is not necessarily a fixed value and will change in response to variation in soil water content.
63. In my opinion there are several natural characteristics of the slope formed by geomorphologic processes that control the Landslide (refer to dot points 1 to 5 of M1, Table 2). Based on published literature convex (in plan) slope geometries *"are considered high potential for sliding instabilities as a result of loss of confinement"* (Huaman, 2023)[2].
64. In my opinion a significant control of Mechanisms M1 and M2 is groundwater and soil moisture as this affects the shear strength of the soil on the slope with time. Where the change in soil moisture happens quicker than the soils can naturally drain (e.g., during intense rainfall events) landsliding may occur. This is particularly the case where the soil slope angle is greater than the effective friction angle of the soils. In my opinion this condition is met in the Upper Zone of the slope.
65. I note that trees have been removed in 2021 including a large mature gum and further vegetation has been removed by the Landslide (refer to Paragraph [46]). In my opinion tree removal is a significant conditional event that has occurred at the Site and suction will change in the escarpment slopes over a period of 12 months to 5 years from tree removal (Richards, 1983)[3]. Trees typically influence the soil moisture over a distance of 1 to 2 times height of the tree (Appendix H2.6 of AS 2870 (2011). In my opinion the Landslide area is well within the influence zone of removed trees.
66. In my experience (refer to Wye River Landslide Assessments and Deviation Road Fyansford projects of Appendix C) it is common for surficial soil landslides to follow tree/vegetation removal (either by fire, storm, or physical removal). This is supported by published literature including:
    (a) Australian Geomechanics Society (AGS, 2007e)[4], refer to Inset 20 and Inset 21.
    (b) Forbes and Broadhead (2013)[5] that state *"the loss of soil reinforcement and water extraction by tree roots increases the probability of landslides during trigger events such as prolonged heavy rainfall".*
67. In my opinion Mechanism M2 is conditional on the initial event associated with Mechanism M1. i.e., where M1 does not occur, it is unlikely that M2 would have occurred. This is supported by:
    (a) A six-to-twelve-hour delay between Mechanism M1 and M2, refer Paragraph [15].

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[2] Huaman, A. 2023. Geotechnical design considerations for 'nose' geometries in pit design. SSIM 2023. Australian Centre for Geomechanics.

[3] Richards, B.G., Peter, P., Emerson, W.W. 1983. The effects of vegetation on the swelling and shrinkage of soils in Australia. Geotechnique, 33(2), 127-139.

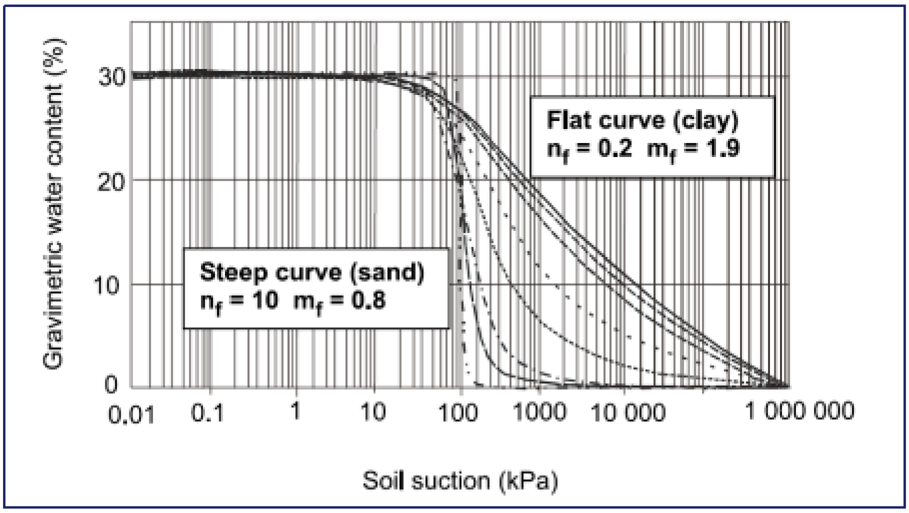
[4] AGS Landslide Taskforce. 2007. The Australian Geoguides for Slope Management and Maintenance. AGS. Vol. 42 No 1 March 2007.

[5] Forbes. K. Broadhead. J. 2013. Forests and landslides: The role of trees and forests in the prevention of landslides and rehabilitation of landslide-affected areas in Asia. FAO UN.

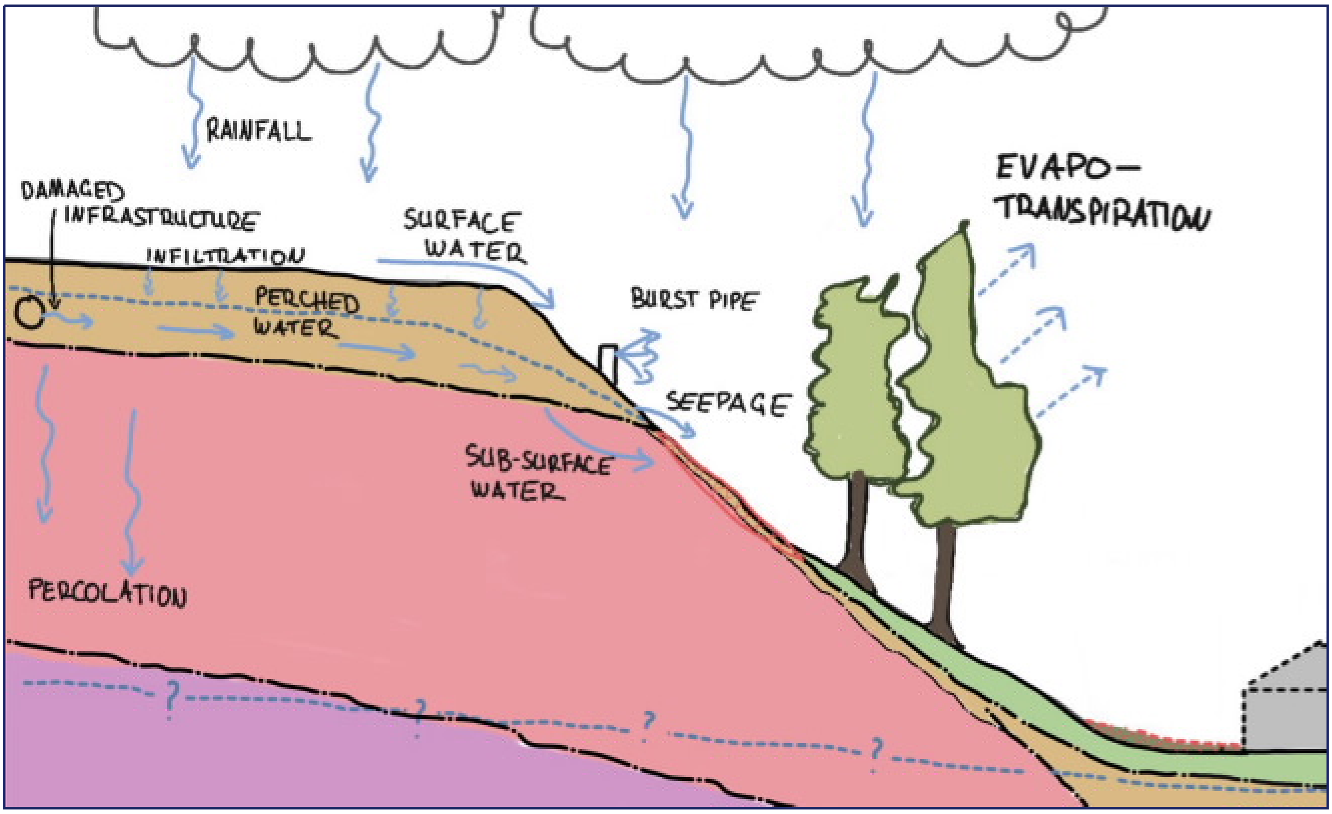
(b) Damage to the Water Line occurring because of Mechanism M1 (refer to Paragraph [24(a)]). Based on a flow rate of 20 litres per minute (paragraph [13]) and a period of 6 to 12 hours, where water from the Water Line was directly flowing into the Landslide area:

i. This may have contributed in the order of 7,200 to 14,400 litres of water to the slope.

ii. When spread over the estimated area of translational sliding (80 m^2 refer to Paragraph [14]) this is approximately equivalent to 90 to 180 mm of water per m^2 (i.e. equivalent rainfall of approximately 1 to 2 times the Rain Event).



Inset 18: Typical soil water characteristic curves for different soil type showing relationship between soil water content and suction, taken from (Fredlund et al. 2002)[6]



Inset 19: Conceptual illustration of hillslope hydrologic processes at the Site.

[6] Fredlund M. D., Wilson G. W., Fredlund D. G. 2002. Use of the grain-size distribution for estimation of the soil-water characteristic curve. Canadian Geotechnical Journal

Groundwater Flow and Landslides

The landslide risk in a hillside can be affected by increase in soak-away drainage or the construction of retaining walls which inhibit groundwater flow. The groundwater is likely to rise after heavy rain, but it can also rise when human interference upsets the delicate natural balance. Activities such as felling trees and earthworks can lead to:

- a reduction in the beneficial suctions in the partially saturated zone above the water table.
- increased static water pressures below the water table,
- increased hydraulic pressures due to groundwater flow,
- loss of strength, or softening, of clay rich strata,
- loss of natural cementing in some strata,
- transportation of soil particles.

Any of these effects, or a combination of them, can lead to landslides like those illustrated in GeoGuides LR2, LR3 and LR4.

Inset 20: Excerpt from AGS Geoguide LR5 (Water and Drainage).

Vegetation clearance - on soil slopes has been kept to a reasonable minimum. Trees, and to a lesser extent smaller vegetation, take large quantities of water out of the ground every day. This lowers the ground water table, which in turn helps to maintain the stability of the slope. Large scale clearing can result in a rise in water table with a consequent increase in the likelihood of a landslide (GeoGuide LR5). An exception may have to be made to this rule on steep rock slopes where trees have little effect on the water table, but their roots pose a landslide hazard by dislodging boulders.

Inset 21: Excerpt from AGS Geoguide LR8 (Construction Practice).

Table 2 – My Opinion on Mechanisms of Failure and Controls

Mechanism ID	Mechanism	My Opinion on Controls
M1	Translational slide of the Surficial Sand and Colluvium units, Inset 15	• Convex (in plan) geometry ("bullnose") slope, Inset 12 • Uncontrolled deposition of Colluvium on the slopes either through erosion or landscaping • Depth of Surficial Sand • Steep slope angle, Inset 15 • Steep basal contact angle at the interface with underlying Residual unit • Saturation of Surficial Sands and Colluvium due to hydrologic processes, Inset 17 • Transient cohesion of the unit, with cohesion possibly being affected by loss of vegetation (refer to paragraph [46]) and loss of suction from saturation of Surficial Sand.
M2	Debris flow of material that initially failed by translational sliding, Inset 15	• Loose or disturbed ground, i.e., existing colluvium or ground that has been disturbed from M1 • Saturated soils due to hydrologic processes: – Periods of high antecedent rainfall, i.e., high cumulative 30-day rainfall totals. – Intense rainfall event(s). – Concentrated source of water inflow, i.e., burst water pipe on slope, groundwater seepage, surface water, damaged drainage, etc.

8. Opinion

68. Landsliding, or instability, occurs when the driving forces that promote movement in a slope exceed the resisting forces. In my opinion it is important to define stability states of slopes. Crozier (1986) [7] states that slopes can be observed in one of three stability states, being:
    (a) Stable slopes where the level of stability is sufficiently high to withstand all transient forces.
    (b) Marginally stable slopes that will fail at some time in response to transient forces exceeding a critical threshold.
    (c) Actively unstable slopes in which transient forces produce continuous or intermittent instability.
69. In the context of the mechanisms of failure identified in Section 7, in my opinion most of the escarpment, Inset 12, including the slope at the Site, is marginally stable, this is supported by:
    i. Similar slope conditions along the line of the escarpment, Inset 12.
    ii. Observations of colluvium at the toe of the escarpment (refer to Inset 15 and Section [5]).
    iii. Observations of instability during the Site visit including the Landslide (refer to Section [5]) and creep or slow continuous deformation of soil under sustained loading (refer to paragraph [42(j)].
    iv. Identification of Landslide features in the Coastal LiDAR DEM albeit far more advanced than those at the Site (refer to paragraph [50(a)]) and during the Site visit (refer to paragraph [43(a)]).
70. I provide my opinion to the questions in the Brief in the context of marginally stable slope conditions.

8.1 Instruction 1

"Consider the potential causes of the landslips, including forming an opinion in relation to each factor being considered the cause of the landslips".

8.1.1 Opinion

71. In my opinion there is no singular cause of the Landslide. I believe that a combination of both natural and anthropogenic factors or controls, have contributed to the Landslide. I believe there are primary contributing factors, and secondary contributing factors. I provide my opinion on contributing factors and their relative contribution to the landslide occurring in Table 3. My opinions on contribution are based on engineering principles, my assumption of facts and my experience in landslide remediation (Appendix C). I provide detail to support my opinion in my discussion on the mechanisms of failure, Section 7.
72. In my opinion it is most likely that the initial landslide (Mechanism M1) occurred primarily as the result of natural geomorphological processes in combination with the Rain Event. For the slope setting at the Site it is my opinion that the Rain Event could have triggered the initial translational slide without major contributions from other controls. In my opinion and experience, high rainfall events with 1 in 100 to 1 in 200-year probability of occurrence are common triggers for landslides in steep slopes (refer to flood recovery projects and Wye River Landslide Assessments in my CV, Appendix C).
73. In my opinion the subsequent landslide (Mechanism M2) is a conditional event, that is dependent on the initial landslide (Mechanism M1) occurring. It is my opinion that the initial landslide damaged the irrigation system which has then contributed a large amount of water into the landslide area. This additional inflow in combination with natural geomorphological processes and the Rain Event has created the conditions necessary for the subsequent landslide (Mechanism M2) to occur.
74. In my opinion other factors, both natural and anthropogenic, are secondary contributors to the Landslide occurring. I consider these secondary contributors likely to have made minor to moderate contributions to the landslide occurring. i.e. The secondary contributors by themselves are unlikely to have caused the landslide. These secondary contributors include:
    (a) Natural groundwater seepage.
    (b) Landscaping features that direct or concentrate water into the landslide area.
    (c) Loss of vegetation on the slope.

[7] Adapted from Crozier, M. C. 1986. Landslides causes, consequences & environment. Routledge.

Table 3 – Contributing Factors to the Landslide

Slope Control	My Opinion	My Opinion on Relative Contribution
Geomorphological processes	• Creates the environment, i.e. marginally stable slope conditions, for which landsliding may occur due to transient forces (refer to paragraph [63]) • Soil slope angles are greater than likely effective friction angle of some of the soils (refer to paragraph [64]) • Significant periods of time passing without observed failures is evidence that other transient forces are required to initiate landslidingon the escarpment.	M1 – Major M2 – Major
Hydrologic process - the Rain Event, Inset 19	• 1 in 100 years to 1 in 200 years probability of occurring for an 8-hour event (refer to paragraph [30] • High antecedent rainfall (Refer to paragraph [27(c)]) • The Rain Event contributed to the Landslide by rapidly increasing all the hydrological inputs of Inset 19.	M1 – Major M2 – Moderate to Major
Hydrologic process - groundwater seepage	• Seepage observed in November 2022 (refer to paragraph [14(c) & 14(d)] and October 2023 (refer to paragraph [42(c)]) and wet soils in March 2023 (refer to paragraph [57(a)]) during periods of significantly different antecedent rainfall ((refer to paragraph [27(c)] and 27(e) respectively) • Seepage likely to be a permanent spring (Inset 17) fed by multiple water sources. Seepage location is unique to the headscarp of the Landslide • Groundwater seepage provides a direct source of water and contribute to increases in soil moisture content (refer to Inset 20 and paragraphs [61], [62]and [64]) • Seepage rate during and immediately following the Rain Event likely to be higher than October 2023. • Seepage noted in October 2023 after the completion of MPS stormwater upgrade works in View Point Road suggesting other sources of groundwater.	M1 – Moderate to Major M2 - Minor

<table>
<tr><th>Slope Control</th><th>My Opinion</th><th>My Opinion on Relative Contribution</th></tr>
<tr><td>Hydrologic process - Water inflows from damaged infrastructure</td><td>

Water inflows from damaged infrastructure are known causes of Landslides (Mostyn and Sullivan (2002)[8]).
Broken Water Line a major contributor to M2 due to water loading (refer to paragraph [67(b)]). This is unique to the Site.
Excluding the Water Line, I have not viewed direct evidence of significant damaged infrastructure or water flow from that infrastructure entering the Landslide area.
The old MPSC stormwater design would surcharge pits (refer to paragraph 35(a)iii) and overflow would run down View Point Road.
The presence of a void in a recently excavated stormwater trench is consistent with natural voids observed in the escarpment(refer Paragraph [43(a)i]). The void is also close to the location of the SEW sewer trench, Figure 1. The orientation of the void is unknown. I would expect the orientation of the void to be consistent with groundwater flow directions and perpendicular to the escarpment or parallel with the sewer trench. i.e., more likely to daylight on 14-16 View Point Road or within the sewer easement, Figure 1.
Street view imagery does not support that surface water flows significantly decreased at the location of the reported void in View Point Road. i.e., a similar amount of surface flow is noted in the kerb before and after the void location suggesting little to no road surface water flows into the ground at the location of the void (Appendix F9 to F10). The location of the void does not correspond with locations of damage kerb, Figure 1.
Surface flows down View Point Road are not unique to the Site.
Significant water inflows from other damaged infrastructure are speculative, in my experience very difficult to monitor and may not be occurring at the Site. Possible sources include:

MPSC stormwater drainage system in View Point Rd.
Stormwater drainage system in Property P1.
Potable water supply system (e.g., SEW assets in street).
SEW sewer asset.
Backfilled trenches associated with any of these services.

Seepage observed in October 2023 after the completion of MPSC stormwater upgrades indicates to me that there is a low probability that surface flows in View Point Road contribute significantly to groundwater seepage rates and soil moisture content above what would be expected from infiltration in landscaped areas.
SEW Sewer likely to act as a “cut off” for shallow groundwater in View Point Road (refer to paragraph [78(f)i]).
</td><td>M1 – Minor to negligible
M2 – Major</td></tr>
<tr><td>Landscaping</td><td>

Aerial photographs (refer to paragraph [46]) and plumbing records paragraph [23(b)]) indicate to me that the P1 lawn on the escarpment is likely to be frequently watered. This increases the cumulative water in the Surficial Sand. However, I consider it unlikely that there was a need to water this region during the period of the Landslide event.
The paths, RWs and stairs above the Landslide (refer to Section 5) allow surface water from outside the Landslide area to concentrate and direct flow into the Landslide area.
Three sub-surface ‘agi drains’ were observed to outlet onto the slope above the Landslide area (refer to paragraph [42(d)]). The outlet of water onto the slope provides an additional source of surface water to the Landslide area (refer paragraphs [61], [62]and [64]).
N.B. These landscaping features are unique to the location of the Landslide.
</td><td>M1 – Moderate
M2 – Minor</td></tr>
</table>

[8] Mostyn.G. Sullivan. T.2002.Quantitative Risk Assessment of the Thredbo Landslide. Australian Geomechanics May 2002. Pp 169-181.

Slope Control	My Opinion	My Opinion on Relative Contribution
Loss of vegetation	• Natural and man-made vegetation loss was observed at the Site in both historical aerial imagery (paragraph [46]) and the Site Visit (paragraph 42(j)). • Small trees affected by creep are noted on adjacent sites on the escarpment (paragraph 42(j)). • **N.B.** Mature gum tree removal is unique to this Site (Appendix F7 to F8). • Refer to paragraphs [65] and [66].	M1 – Moderate to Major M2 – Minor

8.2 Instruction 2

"Consider whether you agree with the cause of the landslips set out in paragraph 3.1 of the December 2023 Civil Test report including:

- *Whether the water travelling along the kerb of View Point Road would seep into the nature strip and flow along the interface of the sandy and clay soils, or through the void, toward the landslips area*
- *Whether this would be the most likely cause of the landslips".*

8.2.1 Opinion

75. CivilTest opines the cause of the landslide is *"the excessive amount of precipitation on 14 November 2022"*, and *"the inadequate management of the drainage on View Point Road"*. CivilTest state that the seepage of water from the damaged road drainage system is *"the most likely trigger for the landslide"*.
76. I agree with CivilTest that the Rain Event was a major contributor to the landslide. In my opinion the initial translational landslide (Mechanism M1) and the subsequent debris flow (Mechanism M2) is unlikely to have occurred had the Rain Event not occurred or had the Rain Event been of lower intensity, Refer Paragraph [67]&[72].
77. I agree with CivilTest that surface water entering the nature strip could flow along the contact between the SURFICIAL SAND/RESIDUAL GRANITE (refer to Paragraph [58]). I note that the nature strip has a significant number of underground services and associated trenches that may act as cut off trenches for sub-surface flows and redirect flows along strike of the service trenches.
78. I do not agree with CivilTest's opinion that seepage of water from the damaged road drainage system is the "most likely trigger for the landslide". This is supported by the following:
    (a) I have not seen evidence that surface water entering the ground at the location of the damaged road is seeping out of the ground at the Landslide, Figure 1.
    (b) Although voids may indicate past groundwater flow, CivilTest do not provide any factual information supporting where groundwater travels if and when entering the void.
    (c) Natural slopes in the area fall to the northwest, Figure 1. Gulleys (i.e. natural drainage paths) also strike to the northwest, Inset 12. Groundwater flow is expected to be to the northwest (refer Paragraph [58]). The location of voids are directly south of the Landslide area. From the location of the voids, in my opinion, groundwater would flow in a northwest direction and I would expect seepage to be observed somewhere in the property of 14-16 View Point Road or the sewer easement, Figure 1. i.e. to the west of the Landslide.
    (d) The location of mapped voids does not correspond with locations of distressed kerb where road surface water may infiltrate into the ground, refer Figure 1 and paragraph [47(b)].
    (e) Seepage was observed in the landslide area after completion of the MPSC stormwater upgrade works on View Point Road, refer Paragraph [42(c)]. This indicates that other sources are contributing to groundwater flow in the Landslide area.
    (f) The location of mapped voids corresponds with the location of the SEW sewer pipes/trench, Figure 1. In my experience:
        i. In hillside construction sub-surface utility trenches create preferential pathways for subsurface water flow. In my opinion the sewer trench would provide a cut off for infiltrating road surface water. In my opinion once water is within the sewer trench the water would then preferentially flow along the

sewer alignment away from the landslide area. In my opinion water that may have entered these voids from the road surface drainage system would flow along the sewer trench away from the landslide area.

ii. In forensic investigations of stormwater and sewer easements (refer to Barwon Water Easement investigations, Appendix C), voids are often observed in service easements where collapse settlement has occurred within the trench backfill.

79. In my opinion water travelling along the kerb or entering the voids did not make a material contribution to the landslide occurring. Refer to "Hydrologic process - Water inflows from damaged infrastructure" of Table 3.

8.3 Instruction 3

"Consider whether the flow of water and existence of voids identified in the December 2023 Civil Test report, would have, in your opinion, caused the landslips to occur, or would have made a material contribution to the landslips occurring."

8.3.1 Opinion

80. Refer to my response to Instruction 2 in Section 8.2.1. In my opinion the contribution of damaged infrastructure to groundwater flows and the Landslide is minor to negligible (refer to *"Hydrologic process - Water inflows from damaged infrastructure*" of Table 3. i.e. In my opinion the flow of water along View Point Road and existence of voids identified in the December 2023 CivilTest report did not make a material contribution to the landslide occurring.

8.4 Instruction 4

"Consider whether in your opinion the landslips would have occurred regardless of the flow of water along View Point Road"

8.4.1 Opinion

81. Refer to my opinion in Section 8.1.1, 8.2.1 and 8.3.1. In my opinion the landslide would have occurred regardless of the flow of water along View Point Road. This is supported by my opinion on major contributing factors and which include:

(a) Slope morphology, refer paragraphs [63], [69] & [72] and Table 3.

(b) The Rain Event, refer paragraphs [64] & [72] and Table 3.

Please don't hesitate to contact the undersigned should you have any questions.

Yours Sincerely

Irrelevant and Sensitive

DANE POPE
PRINCIPAL

)1.0668

NOTES:
1. AERIAL IMAGERY FROM NEARMAP DATED 25 AUGUST 2023
2. CONTOURS ARE 0.5 m CONTOURS FROM COASTAL LIDAR DATASET

Scale 1:500

N

0 10 20 m

Map Projection:
Horizontal Datum:
Grid: EPSG:7855

Created By: AW	Revision: A
Date: 05 Jun 2024	Paper Size: A3

HARDWOOD ANDREWS
EXPERT OPINION - ASSESSMENT
10-12 VIEW POINT RD, MCCRAE

SITE PLAN

PSM5226-006R

FIGURE 1

Appendix A
Brief

HARWOOD ANDREWS

Our ref: TXG 22304540
Contact: Tanya Cimino
Direct Line: 03 5225 5232
Direct Email: tcimino@ha.legal
Principal: Benjamin Broadhead

70 Gheringhap Street
Geelong VIC 3220

PO Box 101
Geelong VIC 3220

T 03 5225 5225
F 03 5225 5222

ABN 98 076 868 034

harwoodandrews.com.au

9 November 2023

Mr D Pope
Pells Sullivan Meynink
Email: Dane.Pope@psm.com.au

Subject to legal professional privilege

Dear Dane,

Mornington Peninsula Shire Council (Council)
Advice regarding landslips at 10-12 View Point Road, McCrae (the property)

As you are aware, we act for the Council in relation to the landslips that occurred at the property on 15 November 2022.

By letter dated 23 October 2023, we provided you with a bundle of documents in relation to the landslips. We now attach a formal brief of documents, which contains the documents previously provided to you, as well as several additional documents.

Instructions

1. In reports prepared to date, it has been alleged that one or more of the following matters may have contributed to the landslips occurring:

   1.1. Alleged lack of drainage works by Council on View Point.

   1.2. Removal of vegetation by Mr Borghesi.

   1.3. A burst pipe on Mr Borghesi's land.

   1.4. Higher than average rainfall.

2. We are instructed to engage you to consider the potential causes of the landslips and form an opinion in relation to the likelihood of each factor being considered the cause of the landslips.

Background

3. The background to this matter is largely set out in the reports that have been provided to you.

4. We note that, at some time prior to the landslips, vegetation was removed from the slope by Mr Borghesi, although we do not yet have instructions as to whether this removal was performed pursuant to a permit, or without Council's approval.

Instructions

5. We are instructed to request that you prepare a fee proposal to:

   5.1. Consider this letter and its attachments.

5.2. Undertake any site inspection or testing required as necessary to form your expert opinion (unless already undertaken).

6. Prepare a report, in expert witness report format, in relation to consider the potential causes of the landslips, including forming an opinion in relation to the likelihood of each factor being considered the cause of the landslips.

7. Your report must comply with VCAT Practice Note PNVCAT2. Please have particular regard to the duty of an expert witness to the Tribunal at paragraphs 8-10 of that practice note, the mandatory inclusions at paragraph 11 and the report you should also:

7.1. identify any assumptions made;

7.2. confine your opinions to matters which are within your professional expertise;

7.3. when expressing an opinion, clearly set out the reasons and basis for that opinion, showing that the opinion is one which has been reached by you bringing your expertise to bear;

7.4. consider whether there are any limitations in your opinion and describe those together with the potential impact those limitations have on your opinion.

8. It may be that you require the assistance of others in forming your opinions. If so, please identify those persons and clearly explain their role in your report.

Fees

9. Before you commence substantive work on preparing this opinion, please provide us with an estimate of your fees in this matter as well as an estimate of the time it will take you to prepare the report.

Please contact Tanya Cimino on 5225 5232 or Ben Broadhead on 5226 8549 with any query.

Yours faithfully,

HARWOOD ANDREWS

Encl.

Appendix B
Additional Information and Instructions

HARWOOD ANDREWS

Our ref: LMH 22304540
Contact: Leesa Hovendene
Direct Line: 03 5225 5230
Direct Email: lhovendene@ha.legal
Principal: Benjamin Broadhead

70 Gheringhap Street
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PO Box 101
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T 03 5225 5225
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harwoodandrews.com.au

15 May 2024

Mr D Pope
Pells Sullivan Meynick
Email: Dane.Pope@psm.com.au

Subject to legal professional privilege

Dear Dane,

Mornington Peninsula Shire Council (Council)
Advice regarding landslips at 10-12 View Point Road, McCrae (property)

We refer to our letter of instruction dated 9 November 2023 (**November letter**).

Background

Since providing our November letter we have been provided with the following additional information by way of background:

1.1. The owners of the property instructed Civil Test to prepare a subsequent report. A copy of the Civil Test technical memorandum 1222044-6 dated 21 December 2023 (**December 2023 Civil Test report**) is attached.

1.2. Prior to the landslide occurring, Mr Borghesi installed an irrigation system on the slope to the east of the location where the landslide occurred. It is our understanding having spoken with Mr Borghesi that the purpose of this irrigation pipe was to irrigate grapes vines he had planted on the slope. The irrigation system was connected to the mainlines water supply of the property, with a tap located approximately at the top of the location of the subsequent debris flow landslide. The pipe in this location was reported leaking by a neighbouring property after the landslide occurred.

1.3. Further, by way of addition to your brief we are instructed of the following in respect of drainage along View Point Road:

1.3.1. View Point Road was included in Council's kerb, channel and drainage renewal program to connect the surface drainage along View Point Road to existing underground piped drainage systems located upstream and downstream from View Point Road.

1.3.2. Prior to kerb, channel and drainage works being undertaken by Council in 2023, the drainage upstream of View Point Road ran underground, terminating and surcharging to the surface. The waters was then directed to flow along the kerb and channel, draining to a further underground piped drainage system at the end of the court bowl on View Point Road.

1.3.3. Between 2010 – 2014, Council installed an asphalt verge running diagonally across View Point Road to divert water from the northern kerb along to the southern kerb of View Point Road, to assist in directing the water flow to the drainage point at the end of the court bowl. We attach an image of the asphalt verge and note a further image is contained in the Civil Test report dated 5 December 2023 previously provided in your brief.

1.3.4. An assessment of View Point Road by Council in August 2019, showed the growth of green algae on the kerb from the intersection of View Point Road Prospect Hill, to the court bowl at the end of View Point Road. Council does not hold any records of the level of water flow along View Point Road, however algae appears along both the northern kerb (up to the point where the asphalt verge was installed), and on the southern kerb which lead to the point of drainage. Photographs taken by Council and Google Earth images of the kerb are included in your brief.

Instructions

2. You are instructed to consider the December 2023 Civil Test report in preparing your report including:

2.1. whether you agree with the cause of the landslips set out in paragraph 3.1 of the December 2023 Civil Test report including:

2.1.1. whether the water travelling along the kerb of View Point Road would seep into the nature strip and flow along the interface of the sandy and clay soils, or through the void, towards the landslips area; and

2.1.2. whether this would be the most likely cause of the landslips;

2.2. in relation to paragraph 3.2 of the December 2023 Civil Test report, whether the flow of water along the kerb of View Point Road and the existence of voids as identified in the Safe Scan Pty Ltd Report included in your brief would, in your opinion, have caused the landslips to occur, or were a material contribution to the landslips occurring; and

2.3. whether in your opinion the landslips would have occurred regardless of the flow of water along View Point Road.

3. As set out in our November letter, your report must comply with VCAT Practice Note PNVCAT2.

Fees

4. Before you undertake further work on preparing this opinion, please provide us with an estimate of your further fees in this matter as well as an estimate of the time it will take you to prepare the additions to your report. Council seeks provision of the report as soon as possible.

Please contact Leesa Hovendene on 5225 5230 or Ben Broadhead on 5226 8549 with any query.

Yours faithfully,

Harwood Andrews

HARWOOD ANDREWS

Encl.

Appendix C
Resume

Curriculum Vitae

Dane Pope
Principal Geotechnical Engineer

Dane Pope is a Principal Geotechnical Engineer at Pells Sullivan Meynink. He graduated from Griffith University, Gold Coast in 2006 with Bachelor of Engineering in Civil Engineering (Honours 1) and was awarded the University Medal. Dane joined PSM in November 2011, during which time he completed his master's degree in geotechnical engineering at UNSW in 2015.

Dane moved to Victoria in early 2016 and has actively been involved in civil infrastructure and property development projects throughout Victoria. Dane re-joined PSM in late 2019 to help to establish PSM's Victorian office.

Educational Qualifications:

- BE Hons Bachelor of Engineering (Civil), Griffith University, Gold Coast, 2006
- MEngSc. in Geotechnical Engineering, University of New South Wales, 2015

Professional Associations:

- Chartered Professional Engineer (CPEng)
- Registered Professional Engineer Queensland (RPEQ)
- Engineers Australia

Experience:

- 2020 – Current: Principal Geotechnical Engineer, Pells Sullivan Meynink
- 2019 – 2020: Associate Geotechnical Engineer, Pells Sullivan Meynink
- 2015 – 2019: Senior to Associate Geotechnical Engineer, P.J. Yttrup & Associates
- 2011 – 2015: Senior Geotechnical Engineer, Pells Sullivan Meynink
- Mar 2011 – Oct 2011: Geotechnical Engineer, MEC Mining
- 2006 – 2011: Geotechnical Engineer, Golder Associates
- 2005 – 2006: Undergraduate Engineer, Macdonald Sheet Piling

Field of Competence:

- Landslide Risk Assessment for Local Government and Road Authorities
- Unsaturated Soil Mechanics
- Industrial and residential subdivisional geotechnics including pavement design
- Surface Coal Mining and Quarry Operations and slope design
- Detailed instrumentation planning, installation and analysis
- Deep basement excavations

CIVIL PROJECTS

Great Ocean Road and inland routes, Landslide Remediation, VIC

Ongoing landslide remediation for over 20 sites from mid-2020 onwards. Sites include sideling fill batters, cut slopes and embankments in steep to very steep terrain. Remediation included rock bolt/anchor systems, rock fall netting, catch bunds, light weight fills, bored pile walls with capping beams and reconstruction of fill batters. All projects included the provision of IFC drawings and Construction Supervision Services.

Strzelecki Ranges flood recovery, Landslide Remediation, VIC

Detailed design of landslide remediation for a flood recovery site in the Strzelecki Ranges. Provision of IFC drawings.

Otway Ranges 2016 flood recovery, Landslide Remediation, VIC

Detailed design of landslide remediation for three flood recovery sites in the Otway Ranges in 2016. Designs included post and panel retaining walls, gabion walls and reconstruction of fill embankments. Provision of IFC drawings.

Cliff Road, Frankston, VIC

Landslide Risk Assessments for complex soil profile in existing landslide domain. Detailed field reconnaissance of the area. Managing complexities relating to the application of the Erosion Management Overlay (EMO) to existing properties which predate the recent application of the EMO.

Peer review, Mornington Peninsula, VIC

Peer review of Landslide Risk Assessment for development application in calcareous dune deposits.

Deviation Road, Fyansford, VIC

Landslide Risk Assessment for complex profile of Newer Volcanic Basalt overlying Gellibrand Marl. Groundwater monitoring to identify multiple aquifers.

McCurdy Road, Fyansford, VIC

Regression analysis of escarpment to inform permanent development offsets.

Wye River, Landslide Assessments, VIC

Landslide risk assessments for properties affected by the recent bushfires. Established structural domains of township to aid in better understanding mode of failure across the town. Assessment for proposed new stormwater network.

Cumberland River, Rockfall Assessment, VIC

Rock fall assessment for VicRoads included mapping by hand and photogrammetry methods. Detailed assessment of the structural controls of a 90 m high slope.

Sunshine North, Quarry infill sub-division, VIC

Rock Face Assessment of abandoned Basalt quarry for potential sub-division. Key inputs into landslide risk assessment.

Western Sydney Airport, Pavement Tender

Part of the successful bid team for the Pavement Tender. Worked with the Pavement Designers to assess risk of collapse settlement of engineered fill and differential settlement at cut/fill interfaces.

Geelong & Melbourne, Site Classification, VIC

Managing geotechnical investigations, analysis and reporting for residential developments in highly to extremely reactive soils with a focus on residual Basalt and Limestone profiles. Coordinating activities for a small team of engineers and a technician. Establishing and managing borehole reporting standards. Specialise in measuring total suction profiles to provide ground movement estimates for sites with abnormal moisture conditions.

Geelong Subdivisions, VIC

Geotechnical support from site investigation, pavement design and construction supervision for numerous greenfield sub-divisions in the Geelong region including Manzene Village, Lara West, Armstrong creek, Charlemont Rise, Leopold and Point Lonsdale Golf Course.

Bulk Earthworks Supervision, City of Greater Geelong, Colac Otway Shire, VIC

Provision of Level 1 certification of bulk earthworks for residential and commercial projects. Assessment and re-classification of lots to AS2870-2011.

Wintringham Social Housing, Travancore VIC

Geotechnical investigation and temporary works for basement excavation in Old Volcanics.

Barwon Water Easement Investigations, City of Greater Geelong, Colac Otway Shire, VIC

Forensic investigations into collapse settlement in stormwater and sewer easements at three sites.

Development of backfill specification to reduce risk of collapse settlement.

Brownfield Basalt quarry redevelopment, Tottenham VIC

Geotechnical investigation and design advice for industrial development on complex landfill site. Ground improvement strategies including rigid inclusions.

Armstrong Creek Town Centre, Investigation & Pavement Design, VIC

Geotechnical investigation for $20M town centre including earthworks specification, detailed ground movement assessment in extremely reactive ground and pavement design.

Due Diligence - Dandenong South, VIC

Due diligence assessments for property developers across several large industrial sites throughout Dandenong South. Constraints typically including buildings approaching the end of their design life, poor quality subgrades and one backfilled sand quarry with inferred collapse settlement issues.

Deer Park, Boral, VIC

Ongoing auditing of bulk earthworks for backfill of existing Basalt quarry. Bulk earthworks design and specification for industrial development.

Campbellfield Industrial Development, Campbellfield, VIC

Investigation, settlement analysis and bulk earthworks design and supervision for proposed automated glass manufacturing facility with a high-performance building specification in a Basalt profile.

High Bay Developments and Expansion, Truganina, VIC

Investigation, design advice and specification for three different high bay shed sites in a Basalt profile. Including validation of total suction profile four years after construction of the initial pavement slabs.

High Bay Development, Moorebank, NSW

Investigation, design advice and specification for proposed high bay sheds.

Greystanes Industrial Development, NSW

Investigation, design advice and specification for proposed industrial subdivision.

ACFS Logistics Terminal, Port of Brisbane, QLD

Subgrade remediation in poor soils. Footing and subgrade inspections including plate load testing.

Soleil Tower, Ten Story Basement Excavation, Brisbane, QLD

Monitored excavation activities for a 10 storey basement car park excavation. Completed anchor inspections and review, 'hit and miss' sequencing, detailed instrumentation planning, implementation and reporting.

Vision Apartments, Seven Story Basement Excavation, Brisbane QLD

Geotechnical investigation. Diaphragm wall design using PLAXIS and MSHEET. Supervision of diaphragm wall and secant pile wall construction. Rock bolt design, mapping, anchor supervision and review, 'hit and miss' excavation sequencing on all shoring walls.

Infinity Tower, Twelve Storey Basement Design, Brisbane QLD

Geotechnical investigation including pressuremeter testing. Design of shoring walls using PLAXIS.

Springfield to Darra Rail, Pile Design, Brisbane QLD

Successful tender pile design for 6 bridges varying in size from single span to ten span viaducts.

MINING PROJECTS

Lysterfield Quarry, Boral, VIC

Development of photogrammetry model. Geotechnical review of quarry slopes and providing slope stability advice. Review and update of structural model.

Montrose Quarry, Boral, VIC

Geotechnical review of quarry slopes and providing slope stability advice including rock fall mitigation and pit re-design to manage rock fall risk.

Wollert Quarry, Boral, VIC

Geotechnical review of quarry slopes and providing slope stability advice. Biannual inspection.

Clermont Coal Mine, QLD

Western wall review including three dimensional domains using ATV, field mapping and Vulcan. Site visit to calibrate structural model. Stability analysis of structurally complex pit slopes.

Burton Coal Mine, QLD

Maximised coal recovery from large slope failures without incident. Site based geotechnical support for two open cut terrace mines. Maintenance of highwall and lowwall hazard management systems (radar and survey) and monitoring of slope failures. Civil projects included; anchor pull-out tests, wet weather road construction, crane pad selection, plate load testing.

Baralaba Central and North Operations, QLD

Design reviews of pit slopes. Site inspections to provide operational advice for unstable slopes and their interaction with large dams.

Baralaba Expansion, Geotechnical Investigations – Feasibility, QLD

Geotechnical investigation and design of the proposed 200 m deep terrace mining operations. Training of site based rig geologists.

Norwich Park (BMA), Geotechnical Management System, QLD

Seconded to BMA's Norwich Park open cut coal mine. Pit inspections, mapping, radar monitoring and implementation of a revised TARP.

Tutupan Coal Mine, Pressuremeter Testing, South Kalamantan Indonesia

Trained a Jakarta based geotechnical engineer in the use of the pressuremeter at the South Kalimantan Coal Mine.

QC LNG and Pipelines, Pressuremeter Testing and Fieldwork, Gladstone, QLD

Large pressuremeter testing program in various materials from residual clays to high strength rock. Mobilisation of drilling rigs in difficult access conditions for the narrows pipeline project including use of a hover-barge.

TUNNEL PROJECTS

Clem 7 Tunnel, Investigation & Monitoring, Brisbane QLD

Coordinated drilling activities over the tunnel alignment, including permitting, service clearances, supervision and reporting. Installed and monitored settlement monitoring equipment including magnetic and rod extensometers, vibrating wire piezometers, profile gauges and inclinometers.

Burnley Tunnel, VIC

Site based tunnel crack mapping of the tanked section of the tunnel.

Melbourn Metro Tunnel, VIC

Annual inspections and reporting on behalf of the insurer.

EXPERT OPINION/ADVICE

Cut slope instability, Geelong VIC

Geotechnical investigation into wedge failure of cut slope adjacent to a commercial development. Provision of conceptual remediation advice.

Retaining wall settlement, Victoria

Expert Opinion regarding settlement of gravity retaining wall including collapse settlement.

Residential subdivision, Western Sydney NSW

Forensic investigation into collapse settlement including review of property damage and site classification for 100's of dwellings.

Industrial subdivision, Melbourne

Forensic investigation into collapse settlement including review of property damage and remediation.

Preloading soft soils, Pinkenba QLD

Review of settlement controls and effectiveness of preloading activities for deep compressible sediments.

Damaged building assessments, Victoria

Numerous geotechnical investigations to support expert opinion reports for damaged homes on reactive ground. These typically including testing shrink swell, total suction and providing ground movement estimates for seasonal movement and movements due to the growth or removal of trees and removal of old timber floor dwellings prior to construction.

Publications, Articles and Patents

1. Developments in Engineering Geology the Geological Society (2016). Published Paper: Geological structural controls on stability of footwall slopes, an example from the Bowen Basin.
2. Field Measurements in Geomechanics (FMGM) Sydney, (Sept. 2015). Published Paper: Real-time monitoring of cut slopes and the importance of identifying the mode of failure.

Appendix D
Radar Imagery

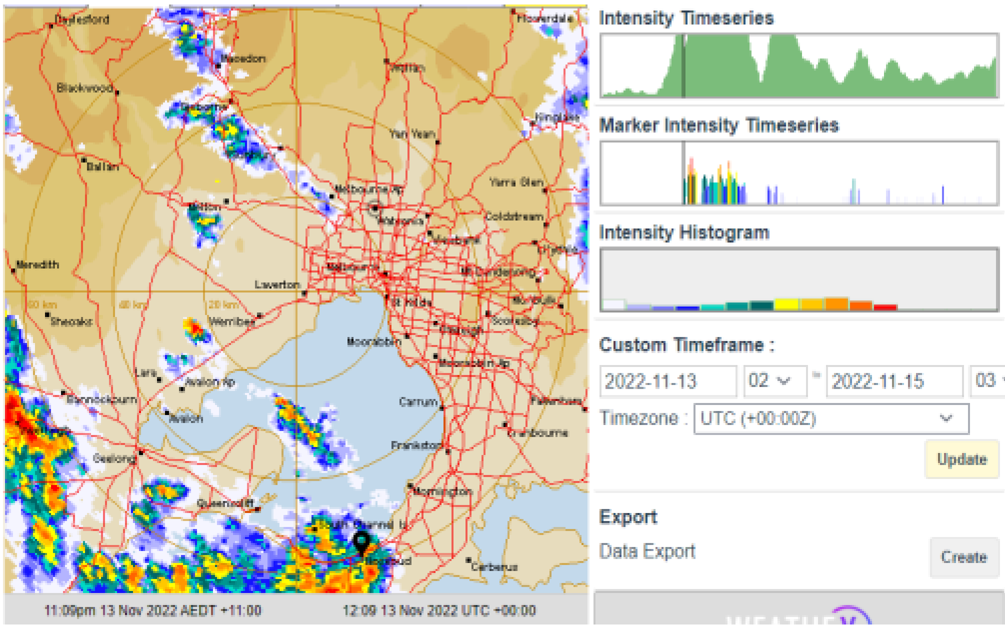

Figure D1: Radar plot 11:09 pm on 13/11/2022

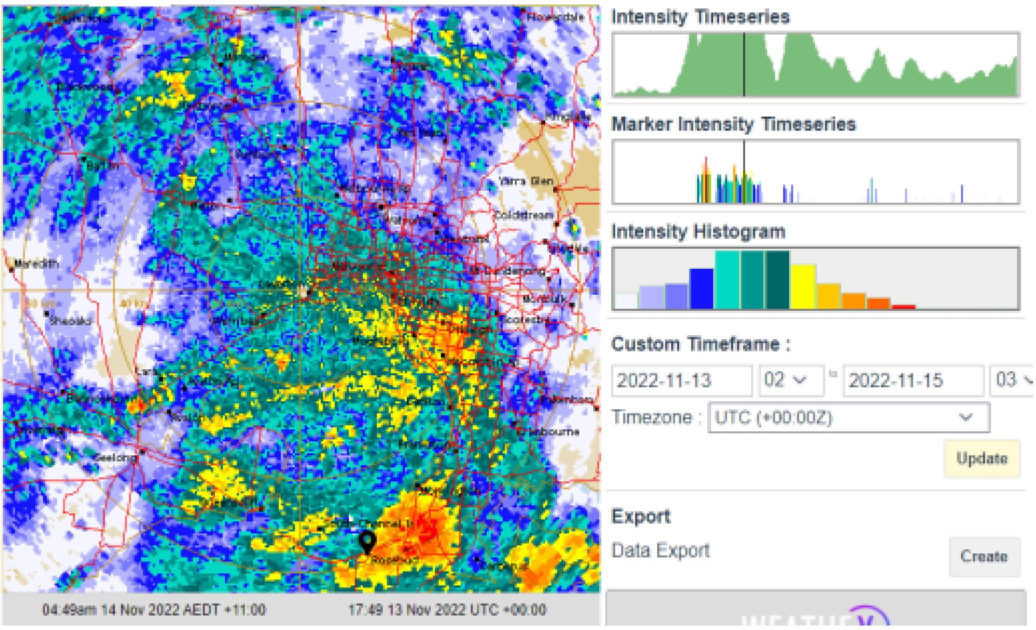

Figure D2: Radar plot 04:49 am on 14/11/2022

PSM

Harwood Andrews

Expert Opinion Report - Landslide Assessment

10-12 View Point Road, McRae

Radar Imagery

PSM5226-006R	Appendix D

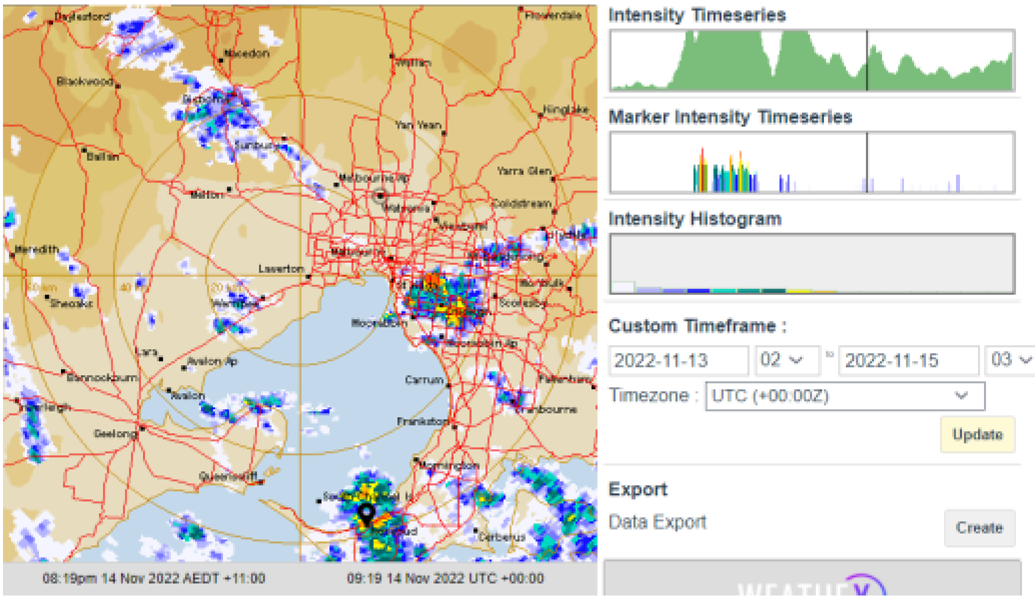

Figure D3: Radar plot 8:19 pm on 14/11/2022

Harwood Andrews Expert Opinion Report - Landslide Assessment 10-12 View Point Road, McRae Radar Imagery	
PSM5226-006R	Appendix D

Appendix E
Selected Site Photographs

Photo 1 - Landslide Overview, with zones indicated

Hardwood Andrews **Expert Witness - Landslide Assessment** **10-12 View Point Rd, McCrae** **Selected Site Photographs (1 of 8)**	
PSM5226-006R	**Appendix E**

Photo 3 - Upper translational sliding area

Photo 4 - Debris flow runout area, Property P2 visible in background

Hardwood Andrews

Expert Witness - Landslide Assessment

10-12 View Point Rd, McCrae

Selected Site Photographs (2 of 8)

PSM5226-006R	**Appendix E**

Photo 4 - Failed material still on slope

Photo 5 - Rear scarp of landslide, note lack of oversteepened backscarp

Hardwood Andrews

Expert Witness - Landslide Assessment

10-12 View Point Rd, McCrae

Selected Site Photographs (3 of 8)

PSM5226-006R	**Appendix E**

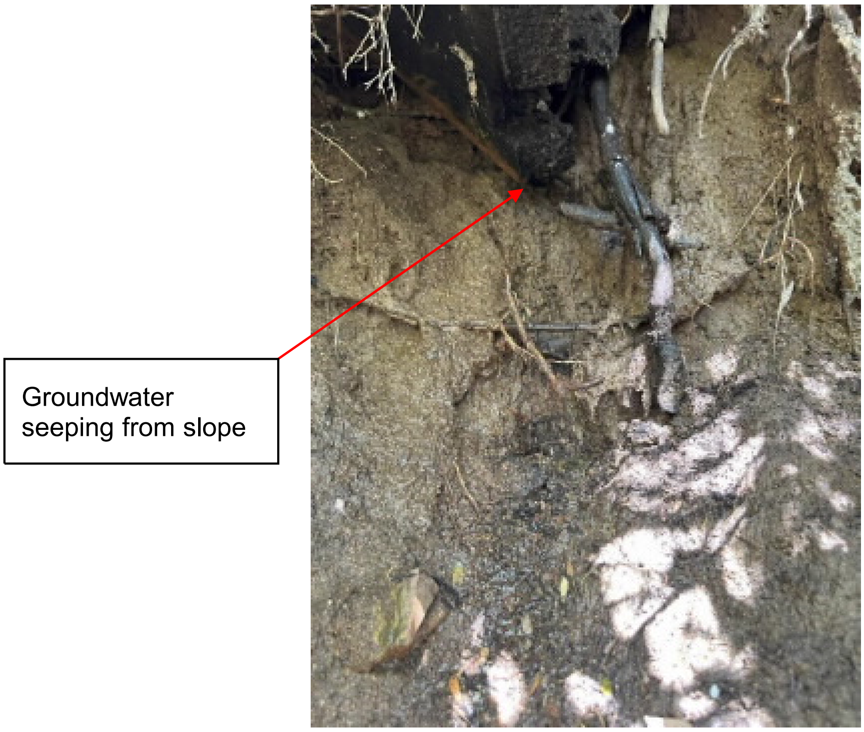

Photo 6 - Groundwater seepage

Photo 7 - Water infrastructure including water pipes (on left), and subsurface 'agi drains' (on right)

Hardwood Andrews

Expert Witness - Landslide Assessment

10-12 View Point Rd, McCrae

Selected Site Photographs (4 of 8)

PSM5226-006R	**Appendix E**

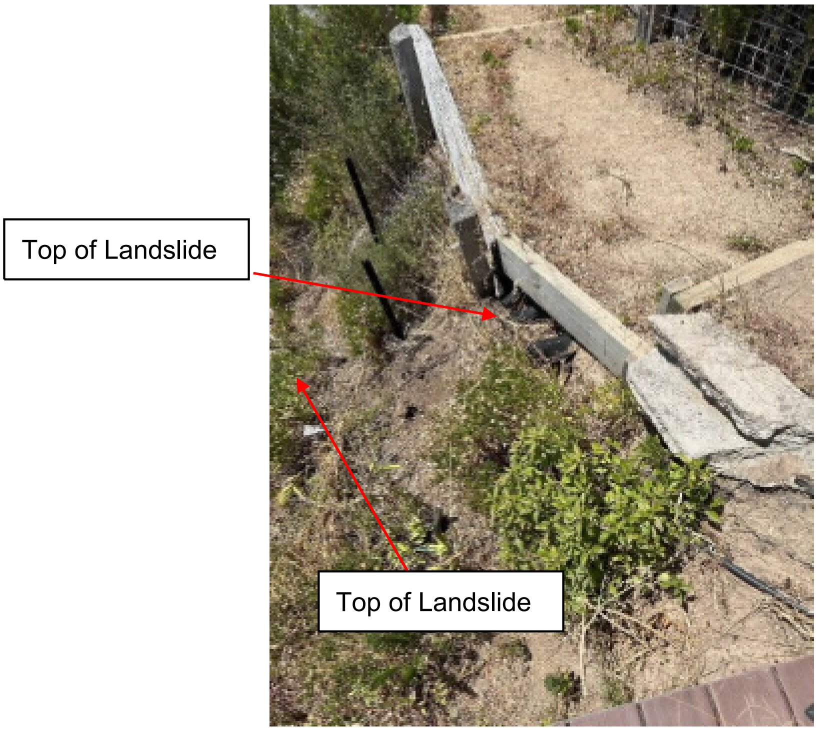

Photo 8 - Path above Landslide, note minor retaining walls and 'agi drains' from Photo 7

Photo 9 - Granite stairs leading from garden area to path at top of landslide

Hardwood Andrews
Expert Witness - Landslide Assessment
10-12 View Point Rd, McCrae
Selected Site Photographs (5 of 8)

PSM

PSM5226-006R	Appendix E

Photo 10 - Tilitng retaining walls on left side of Landslide

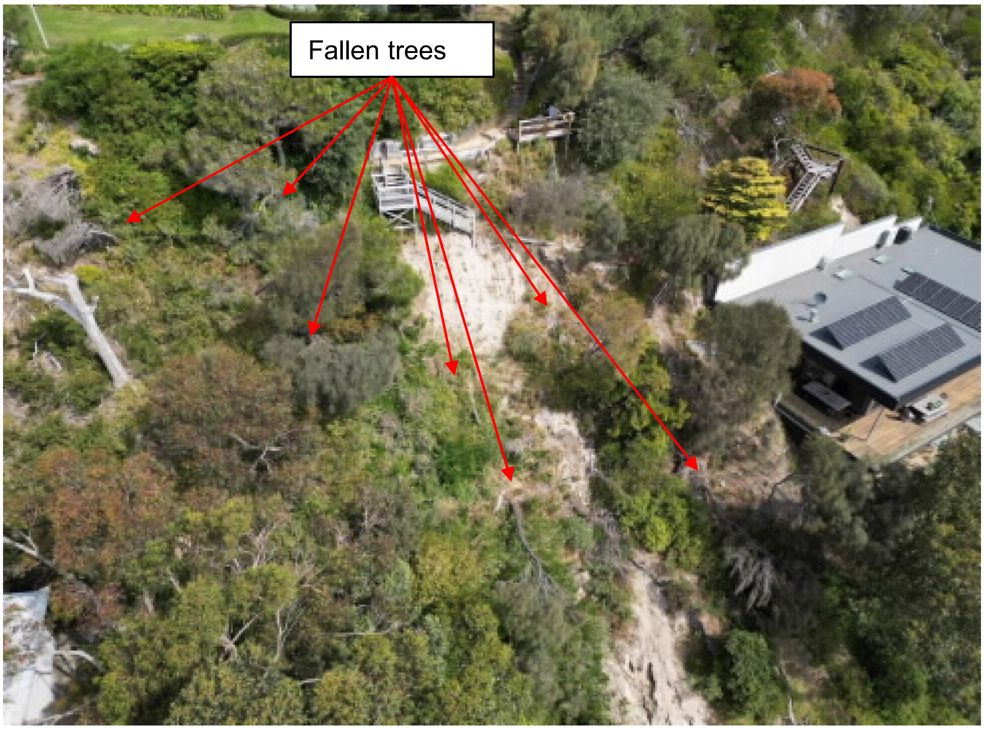

Photo 11 - Fallen trees

Hardwood Andrews

Expert Witness - Landslide Assessment

10-12 View Point Rd, McCrae

Selected Site Photographs (6 of 8)

PSM

PSM5226-006R	**Appendix E**

Photo 12 - Curved or tilting trees

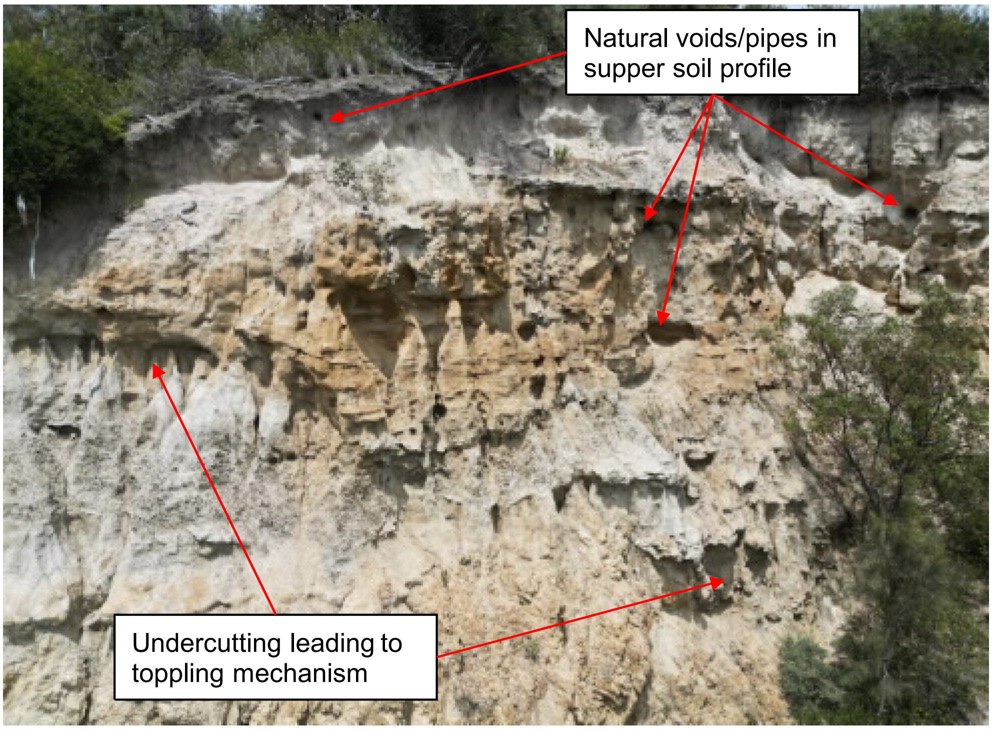

Photo 13 - Natural cliff profile near Anthony's Nose

Hardwood Andrews

Expert Witness - Landslide Assessment

10-12 View Point Rd, McCrae

Selected Site Photographs (7 of 8)

PSM5226-006R	**Appendix E**

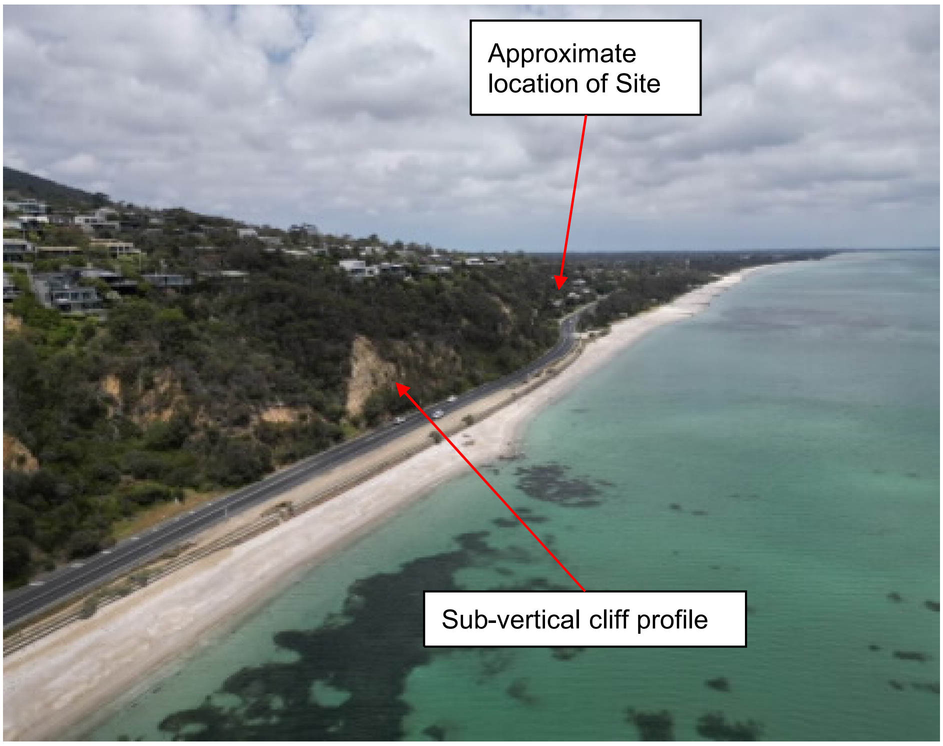

Photo 14 - Anthony's Nose

Photo 15 - Arthur's Seat in background

Hardwood Andrews

Expert Witness - Landslide Assessment

10-12 View Point Rd, McCrae

Selected Site Photographs (8 of 8)

PSM5226-006R	**Appendix E**

Appendix F
Aerial and Street Imagery

Legend

Site Boundaries

- Property
- Landslide

NOTES:
1. AERIAL IMAGERY FROM NEARMAP DATED 25 AUGUST 2023

Scale 1:500

N

0 10 20 m

Map Projection:
Horizontal Datum:
Grid: EPSG:7855

PSM

Created By: AW	Revision: A
Date: 05 Jun 2024	Paper Size: A3

HARDWOOD ANDREWS
EXPERT OPINION - ASSESSMENT
10-12 VIEW POINT RD, MCCRAE

HISTORICAL AERIAL IMAGERY
25 AUGUST 2023

PSM5226-006R | FIGURE F1

C:\Users\andrew.wilson\Pells Sullivan Meynink\GIS - PSM5226\02_WorkSpace\01_Projects\PSM5226.qgz Layout: Figure 2

Legend

Site Boundaries

- Property
- Landslide

NOTES:
1. Photo from Geoscience Australia (https://aerialphotography-geoscience-au.hub.arcgis.com/)

Scale 1:2,000

N 0 50 100 m

Map Projection:
Horizontal Datum:
Grid: EPSG:7855

PSM	Created By: AW	Revision: A
	Date: 05 Jun 2024	Paper Size: A3

HARDWOOD ANDREWS
EXPERT OPINION - ASSESSMENT
10-12 VIEW POINT RD, MCCRAE

HISTORICAL AERIAL IMAGERY
1939

PSM5226-006R | FIGURE F2

Legend

Site Boundaries

- Property
- Landslide

NOTES:
1. Photo from Geoscience Australia (https://aerialphotography-geoscience-au.hub.arcgis.com/)

Scale 1:2,000

N 0 50 100 m

Map Projection:
Horizontal Datum:
Grid: EPSG:7855

PSM

Created By: AW	Revision: A		
Date: 05 Jun 2024	Paper Size: A3	PSM5226-006R	FIGURE F3

HARDWOOD ANDREWS
EXPERT OPINION - ASSESSMENT
10-12 VIEW POINT RD, MCCRAE

HISTORICAL AERIAL IMAGERY
1951

NOTES:
1. Photo from Geoscience Australia (https://aerialphotography-geoscience-au.hub.arcgis.com/)

Scale 1:2,000

0 50 100 m

Map Projection:
Horizontal Datum:
Grid: EPSG:7855

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Created By: AW	Revision: A
Date: 05 Jun 2024	Paper Size: A3

HARDWOOD ANDREWS
EXPERT OPINION - ASSESSMENT
10-12 VIEW POINT RD, MCCRAE

HISTORICAL AERIAL IMAGERY
1984

PSM5226-006R | FIGURE F4

C:\Users\andrew.wilson\Pells Sullivan Meynink\GIS - PSM5226\02_WorkSpace\01_Projects\PSM5226.qgz Layout: Figure D4

Figure F5 - Nearmap 29/04/2021

Figure F6 - Nearmap 16/09/2021

Hardwood Andrews **Expert Opinion Report - Landslide Assessment** **10-12 View Point Rd, McCrae** **Aerial and Street Imagery**	
PSM5226-006R	**Appendix F**

Figure F7 - Google Street View February 2018

Figure F8 - Google Street View October 2022

Hardwood Andrews
Expert Opinion Report - Landslide Assessment
10-12 View Point Rd, McCrae
Aerial and Street Imagery

PSM5226-006R	**Appendix F**

Figure F9 - Google Street View August 2013

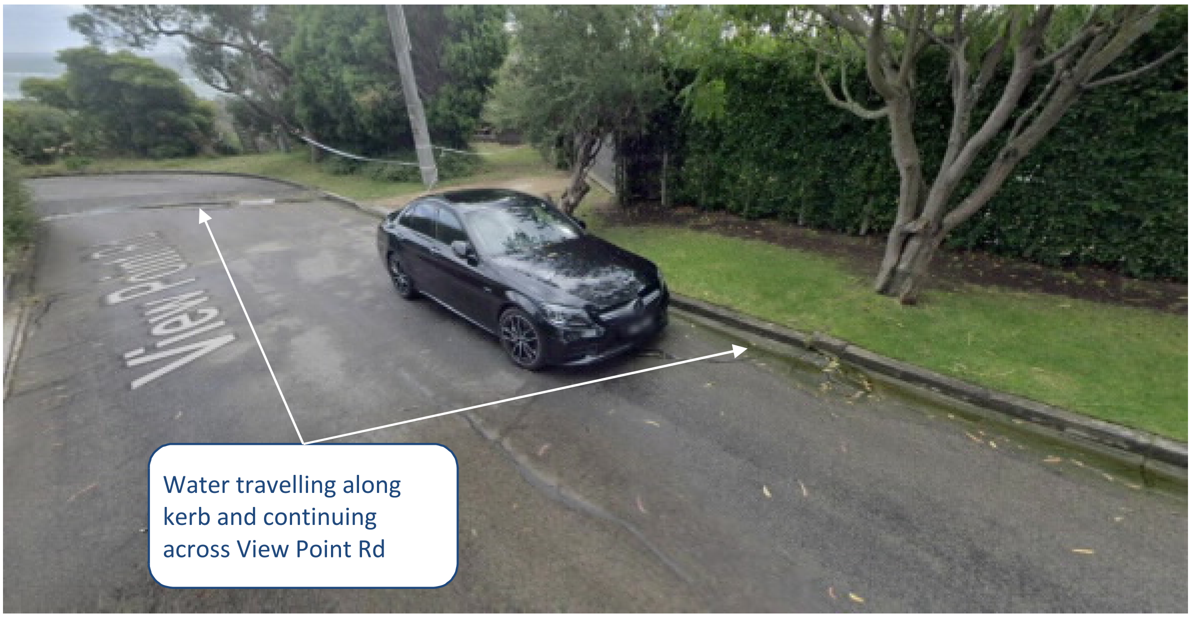

Figure F10 - Google Street View April 2023

Hardwood Andrews **Expert Opinion Report - Landslide Assessment** **10-12 View Point Rd, McCrae** **Aerial and Street Imagery**	
PSM5226-006R	**Appendix F**