GEOTECHNICAL SITE INVESTIGATION REPORT

FOR

PROPOSED DRIVEWAY CROSSING

AT

130-132 ELANORA ROAD, ELANORA HEIGHTS NSW 2101

Report Prepared for: KELLY GALLO

Project No: SRE/680/EH/20

Date:04/08/2020

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Distribution and Revision Register

Document details

- **Project number:** 680
- **Document number:** SRE/680/EH/20
- **Document title:** Geotechnical Site Investigation Report for Proposed Driveway Crossing
- **Site address:** 130-132 Elanora Road, Elanora Heights, NSW 2101
- **Report prepared for:** Kelly Gallo

Document status and review

Revision	Prepared by	Reviewed by	Approved by	Date issued
0	AT	JC	JC	04/08/2020

Distribution of copies

Revision	Electronic	Paper	Issued to
0	1	0	Nik Lukich

The undersigned, on behalf of Soilsrock Engineering Pty Ltd, confirm that this document and all attached documents, drawings, and geotechnical results have been checked and reviewed for errors, omissions, and inaccuracies.

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1. INTRODUCTION

This report presents and interprets the result of a geotechnical investigation assessment carried out by Soilsrock Engineering Pty Ltd (SOILSROCK) of the existing site at 130-132 Elanora Road, Elanora Heights NSW 2101. The investigation was commissioned by Mr. Nik Lukich, who is the representative of the owners of the property. SOILSROCK conducted the work in general accordance as per Letter Proposal Ref: SRE/680/EH/20 dated of 10th July 2020 and email acceptance dated of 21st July 2020.

This assessment report comprised a detailed geotechnical inspection of the existing site and is based on the following documents supplied by the client on the email of 21st July 2020:

- Survey Drawings by Northwest Surveys, Project Number 1473:
  - "Plan of Detail Over N0. 130 Elanora Road Elanora Heights NSW 2101", DWG No. 1473 DETAIL, Rev 0 dated 10 November 2018.
  - "Plan of Detail Over N0. 132 Elanora Road Elanora Heights NSW 2101", DWG No. 1473_Elanora Rd_No132_DE, Rev 0 dated 6 March 2019.
- Civil/Structural Drawings by PORTES CIVIL & STRUCTURAL ENGINEERS, "Proposed Driveway Crossing", Project Number No. 19-240:
  - "Vehicular Crossing Residential", DWG No. C1.0, Issue -, dated 17th July 2020.
  - "Residential Vehicular Crossings/Driveways Conceptual Plan", DWG No. C1.0, Issue D, dated 17th July 2020.
  - "Proposed Driveway Crossings 1 Plan", DWG No. C2.0, Issue D, dated 17th July 2020.
  - "Proposed Driveway Crossings 1 Sections", DWG No. C2.1, Issue A, dated 17th July 2020.
  - "Proposed Driveway Crossing 2 Plan & Sections", DWG No. C3.0, Issue A, dated 17th July 2020.

The purpose of this investigation was to assess the existing subsurface ground conditions and risks associated with the existing slope along the site area in particular to provide geotechnical recommendations and advice on excavation and foundations conditions and design advice for the proposed Driveway Crossing, landslide risk assessment and any adverse impact due to the current slope conditions and advices on possible remediation solutions to undertake in the future.

The following sections describe the proposed development, scope of works and factual results of this site investigation. Comments and recommendations on excavation and foundations conditions, including landslip risk assessment for the proposed driveway crossing are given in the last part of this report.

2. PROPOSED DEVELOPMENT

Based on the civil/structural drawings provided by the client, it is understood that a driveway crossing will separate the two proposed lots 11 and 14 located next to each other. The existing driveway will be removed and replaced by a new large and longer driveway connecting entirely the front of the site to the rear back. Vehicular access can be made via the existing concrete driveway located in between the two existing residences land lots perpendicular to Elanora Road.

3. SCOPE OF WORKS

The field work for investigation was carried on the 23rd July 2020 and consisted of the following:

- Conduct Dial Before You Dig and check for buried services.
- Conduct an OH&S and walkover survey to assess local topography, geology, and existing site conditions, including exposed soil/rock conditions, vegetation, and surface drainage.
- Conduct a geotechnical inspection of the site area and adjacent land.
- 13 x Dynamic Cone Penetrometer tests (DCP1 to DCP3) to maximum depth of 2.1m were carried out by using a 9 kg Dynamic Cone Penetrometer specialised steel cone device. The testing followed the procedure as per AS 1289-1997, method 6.3.2.
- One Borehole carried by hand auger to depth of 0.1m reaching top rock at very shallow depth.
- Photographic record of the site conditions.

The field work was conducted in presence of a senior geotechnical engineer, one geotechnical engineer and an engineering assistant from Soilsrock office, who observed visually the existing geotechnical conditions and recorded the DCP in-situ test results.

The ***Appendix A*** defines and explains the logging terms and symbols used. The ***Appendix B*** show the plan of the DCP test and photos locations and the actual site photographs of the area are attached to this report in the ***Appendix D***.

4. REGIONAL GEOLOGY

From the analysis of Geology of the Sydney 1:100 000 sheet 9130, it is indicated that the site is part of the ***Hawkesbury Sandstone*** (*Rh*), age of Triassic, described as "*medium to coarse-grained quartz sandstone with minor shale and laminate lenses".*

According to the explanatory notes of Sydney sheet 9130, the *Hawkesbury Sandstone (Rh)* dominates the region covered by the Sydney 1: 100,000 Geological Sheet. It comprises quartz sandstone with minor shale lenses. The Hawkesbury Sandstone was deposited by fluvial processes and is a quartz sandstone containing detrital grains averaging 68% quartz, 2% rock fragments and clay pellets, 1% feldspar, and 1% mica. The sandstone is dominantly medium to coarse grained but varies from fine to very coarse grained. The sandstone is moderately to poorly sorted, with sub-angular to sub-rounded grains.

A reproduction of the geological map is showed on ***Figure 1*** below and is based on a portion of the Sydney 1:100,000 Geological Series map 9130 (interactive Resource provided by the Geological Survey of NSW), which shows that the site area belongs to Hawkesbury Sandstone (*Rh*).

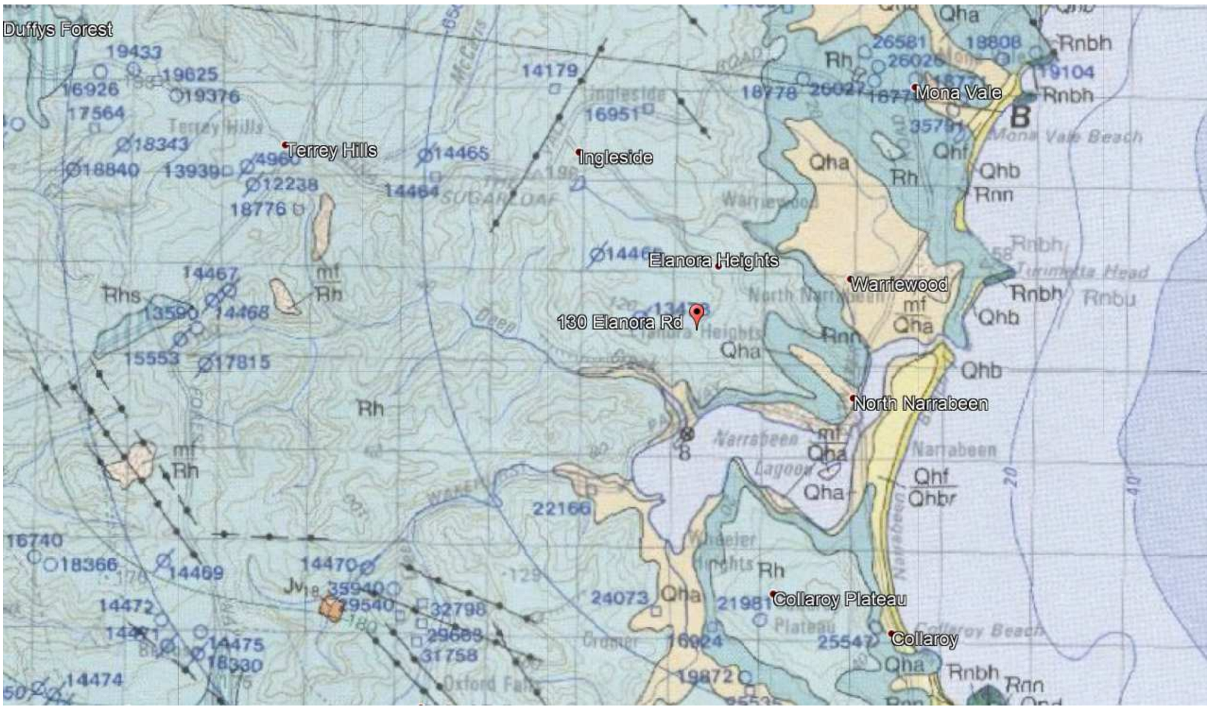

Figure 1– Portion of the Sydney 1:100,000 Geological Series map 9130. Site area location highlighted as a red dot.

5. RESULTS AND ANALISYS OF THE INVESTIGATION

5.1 Site Location and Description

The subjected site is located at 130-132 Elanora Road, Elanora Heights NSW 2101, which belongs to the Northern Beaches Council. They are two sites legally registered as DP 24360 within a E4 – Environmental Living land-use zoning. One is located at 132, has a rectangular shape which covers a plan area of approximately 1,505 m^2. The other is located at 130, has also a rectangular shape which covers a plan area of approximately 1,500 m^2.

At the time of the site inspection, the site has existing residential buildings. The site topography was sloping down from East to West. The surrounding area is mainly for residential purposes. Site and Dynamic Cone Penetrometer testing (DCP) locations are shown in ***Appendix B***, and site photographs of the area are attached to this report in ***Appendix E.***

5.2 Subsurface Investigation

13 x Dynamic Cone Penetrometer (DCP) tests were carried out to complement the investigation of subsurface ground conditions. The following ***Table 1*** summarised the in-situ DCP test results and ***Table 2*** describes generically the principle strata sequentially observed and interpreted by the test results carried out on site.

Table 1 - Dynamic Cone Penetrometer tests results – DCP1 to DCP4.

Depth (m)	**DCP1** (Blows/ 300mm)	**DCP2** (Blows/ 300mm)	**DCP3** (Blows/ 300mm)	**DCP4** (Blows/ 300mm)
0.00 – 0.30	11	4	5	19
0.30 – 0.60	Bouncing @ 0,2m	Bouncing @ 0,15m	Bouncing @ 0.525m	Bouncing @ 0.25m
Depth (m)	**DCP5** (Blows/ 300mm)	**DCP6** (Blows/ 300mm)	**DCP7** (Blows/ 300mm)	**DCP8** (Blows/ 300mm)
0.00 – 0.30	60	6	7	6
0.30 – 0.60	Refusal @ 0.3m	10	20	17
0.60 – 0.90	-	5	13	Bouncing @ 0.425m
0.90 – 1.20	-	Bouncing @ 0.625m	24	-
1.20 – 1.50	-	-	32	-
1.50 – 1.80	-	-	33	-
1.80 – 2.10	-	-	60	-
2.10 – 2.40	-	-	Refusal @ 2.1m	-

Depth (m)	DCP9 (Blows/ 300mm)	DCP10 (Blows/ 300mm)	DCP11 (Blows/ 300mm)	DCP12 (Blows/ 300mm)
0.00 – 0.30	13	40	7	40
0.30 – 0.60	13	Bouncing @ 0.25m	15	31
0.60 – 0.90	22	-	28	60
0.90 – 1.20	Bouncing @ 0.775m	-	45	Bouncing @ 0.85m
1.20 – 1.50	-	-	Bouncing @ 0.925m	-
Depth (m)	**DCP13** (Blows/ 300mm)	-	-	-
0.00 – 0.30	26	-	-	-
0.30 – 0.60	14	-	-	-
0.60 – 0.90	51	-	-	-
0.90 – 1.20	60	-	-	-
1.20 – 1.50	Bouncing @ 1.125m	-	-	-

Equipment & Procedure Notes:

Equipment used: 9kg hammer, 510mm drop distance, conical tip: Standard used: AS1289.6.3.2 – 1997; the total number of blows are considered for 300mm penetration steps.

DCP notes:

- 60 blows within 300mm soil interval defined as "Refusal", no further penetration and "Solid" ringing sound from slide hammer, which may indicate reaching into "Very dense" sand layer or "Hard Clay" or on top of bedrock.
- All DCP tests above which were at refusal depths may probably still be on top of hard clay.
- "Bouncing" indicates reached top of rock or in some cases can be due to presence of a hard obstacle like steel, rubble, flouters, boulders, cobbles, or other hard materials.

Table 2 - Geotechnical subsurface interpretation by in-situ DCP results – DCP1 to DCP4.

Depth (m)	**DCP1** (Blows/ 300mm)	**DCP2** (Blows/ 300mm)	**DCP3** (Blows/ 300mm)	**DCP4** (Blows/ 300mm)
0.00 – 0.30	Medium Dense Silty Sand	Loose Silty Sand	Loose Silty Sand	Medium Dense Silty Sand
0.30 – 0.60	Bouncing @ 0,2m	Bouncing @ 0,15m	Bouncing @ 0.525m	Bouncing @ 0.25m
Depth (m)	**DCP5** (Blows/ 300mm)	**DCP6** (Blows/ 300mm)	**DCP7** (Blows/ 300mm)	**DCP8** (Blows/ 300mm)
0.00 – 0.30	Very Dense Silty Sand	Loose Silty Sand	Loose Silty Sand	Loose Silty Sand
0.30 – 0.60	Refusal @ 0.3m	Medium Dense Silty Sand	Medium Dense Silty Sand	Medium Dense Silty Sand
0.60 – 0.90	-	Medium Dense Silty Sand	Medium Dense Silty Sand	Bouncing @ 0.425m
0.90 – 1.20	-	Bouncing @ 0.625m		-
1.20 – 1.50	-	-	Dense Silty Sand	-
1.50 – 1.80	-	-		-
1.80 – 2.10	-	-	Very Dense Silty Sand	-
2.10 – 2.40	-	-	Refusal @ 2.1m	-
Depth (m)	**DCP9** (Blows/ 300mm)	**DCP10** (Blows/ 300mm)	**DCP11** (Blows/ 300mm)	**DCP12** (Blows/ 300mm)
0.00 – 0.30	Medium Dense Silty Sand	Dense Silty Sand	Loose Silty Sand	Dense Silty Sand
0.30 – 0.60		Bouncing @ 0.25m	Medium Dense Silty Sand	
0.60 – 0.90		-	Dense Silty Sand	Very Dense Silty Sand
0.90 – 1.20	Bouncing @ 0.775m	-	Very Dense Silty Sand	Bouncing @ 0.85m
1.20 – 1.50	-	-	Bouncing @ 0.925m	-
Depth (m)	**DCP13** (Blows/ 300mm)	-	-	-
0.00 – 0.30	Dense Silty Sand	-	-	-
0.30 – 0.60	Loose Silty Sand	-	-	-
0.60 – 0.90	Very Dense Silty Sand	-	-	-
0.90 – 1.20		-	-	-
1.20 – 1.50	Bouncing @ 1.125m	-	-	-

Equipment & Procedure Notes:

Equipment used: 9kg hammer, 510mm drop distance, conical tip: Standard used: AS1289.6.3.2 – 1997; the total number of blows are considered for 300mm penetration steps.

DCP notes:

- 60 blows within 300mm soil interval defined as "Refusal", no further penetration and "Solid" ringing sound from slide hammer, which may indicate reaching into "Very dense" sand layer or "Hard Clay" or on top of bedrock.
- All DCP tests above which were at refusal depths may probably still be on top of hard clay.
- "Bouncing" indicates reached top of rock or in some cases can be due to presence of a hard obstacle like steel, rubble, flouters, boulders, cobbles, or other hard materials.

The above DCP's Tests locations are shown in the ***Appendix B***.

The ***Table 3*** below assesses the strength of the relevant materials crossed by the DCP tests, according to in-situ test results, soil classification, visual interpretation, and extrapolation. The geotechnical parameters interpretation and extrapolation is based and limited to DCP tests carried on site, which are only indicative for design proposes.

For detailed description of the subsurface conditions, explanation sheets about geotechnical parameters are presented in ***Appendix A***.

Table 3 - Allowable Bearing Pressure and Strength Interpreted and Extrapolated by in-situ tests.

Depth Range (m)	Material Conditions	Extrapolated Bearing Pressure (kPa)	Strength - Cu/UCS (kPa)
Based on DCP1 Test Results			
0.00 - 0.20	Medium Dense Silty Sand	100	50
>0.2	Top Rock Sandstone	1,000	1,000
Based on DCP2 Test Results			
0.00 - 0.15	Loose Silty Sand	50	25
>0.15	Top Rock Sandstone	1,000	1,000
Based on DCP3 Test Results			
0.00 - 0.525	Loose Silty Sand	50	25
>0.525	Top Rock Sandstone	1,000	1,000
Based on DCP4 Test Results			
0.00 - 0.25	Medium Dense Silty Sand	100	50
>0.25	Top Rock Sandstone	1,000	1,000
Based on DCP5 Test Results			
0.00 - 0.30	Medium Dense Silty Sand	100	50
>0.30	Top Rock Sandstone	1,000	1,000
Based on DCP6 Test Results			
0.00 - 0.625	Medium Dense Silty Sand	100	50
>0.625	Top Rock Sandstone	1,000	1,000

Based on DCP7 Test Results			
0.00 - 1.20	Medium Dense Silty Sand	100	50
1.20-1.80	Dense Silty Sand	300	150
1.80-2.10	Very Dense Silty Sand	500	250
>2.10	Top Rock Sandstone	1,000	1,000
Based on DCP8 Test Results			
0.00 - 0.30	Loose Silty Sand	50	25
0.30-0.425	Very Dense Silty Sand	500	250
>0.425	Top Rock Sandstone	1,000	1,000
Based on DCP9 Test Results			
0.00 - 0.775	Medium Dense Silty Sand	100	50
>0.775	Top Rock Sandstone	1,000	1,000
Based on DCP10 Test Results			
0.00 - 0.25	Dense Silty Sand	300	150
>0.25	Top Rock Sandstone	1,000	1,000
Based on DCP11 Test Results			
0.00 - 0.30	Loose Silty Sand	50	25
0.30-0.60	Medium Dense Silty Sand	100	50
0.60-0.90	Dense Silty Sand	300	150
0.90-0.925	Very Dense Silty Sand	500	250
>0.925	Top Rock Sandstone	1,000	1,000
Based on DCP12 Test Results			
0.00 - 0.30	Loose Silty Sand	50	25
0.30-0.85	Very Dense Silty Sand	500	250
>0.85	Top Rock Sandstone	1,000	1,000
Based on DCP13 Test Results			
0.00 - 0.30	Dense Silty Sand	300	150
0.30-0.60	Loose Silty Sand	50	25
0.60-1.125	Very Dense Silty Sand	500	250
>1.125	Top Rock Sandstone	1,000	1,000

Notes:

- The geotechnical parameters interpretation and extrapolation is based and limited to the DCP test carried on site, which are only indicative for design proposes.
- The depth ranges of geological units as shown in the table are average thickness based on DCP test results obtained. It is understood that the subsurface conditions can vary from places to places.
- NR – Not Recommended.

5.3 Groundwater

Groundwater was not observed through all DCP tests, normally groundwater is indicated by the wet soil materials attached on the rods. However, DCP tests rods were moist in some of the DCP tests, which could be probably due to the rainy weather and it is possible that water seepage could be present above the rock following periods of heavy rain.

Groundwater can only be investigated properly by further geo-hydrological assessment using a proper borehole drilling and water well standpipe installation to monitor groundwater behaviour if required.

6. COMMENTS AND RECOMMENDATIONS

6.1 Landslip Risk Assessment

During the site inspection and in-situ testing, no signs of landslip/soil erosion or slope stabilization hazards were observed within the areas located from Northeast to Southwest of the lot. The entire area presents apparently in good and stable conditions. No evidence of slope instability was identified near the existing dwellings at the time of inspection.

However, it is important to refer that the site area where the proposed development is located doesn't show Hazard Classification in accordance with the Geotechnical Hazard Mapping LGA 2007 – GHD Longmac, from the Pittwater Council (Please refer to ***Figure 1***).

Figure 1 – Portion of the Pittwater Geotechnical Hazard map. Site area is highlighted in red

Similarly, landslide risks have not been identified within the Warringah Landslide Risk Map available through the Northern Beaches Council Mapping online (please refer to ***Figure 2***).

Figure 2 – Portion of the Warringah Landslip Risk map. Site area is highlighted in red

However, some geotechnical hazards have been identified and assessed for risk to property and life using the general methodology outline by the Australian Geomechanics Society (Landslide Risk Management AGS Subcommittee 2007), the risk assessment is outlined on the following ***Table 4.***

Table 4 – Geotechnical Hazards Summary Risk Analyses

HAZARDS	*Qualitative Measures of likelihood	*Qualitative Measures of Consequences to Property	*Risk to Property	*Risks To Life	*Level Risk Implications
Soil creek cause cracking on residential dwellings due to big rain events	Unlikely - (annual probability $P_{(H)} = 10^{-4}$)	Minor (5%)	Low ($2x10^{-5}$)	$8.3x10^{-7}$/annum	**Risk Acceptable
Soil erosion exposes rock boulders and outcrops and causes potential rockfall.	Unlikely – (annual probability $P_{(H)} = 10^{-4}$)	Minor (5%)	Low ($2x10^{-5}$)	$8.3x10^{-7}$/annum	** Risk Acceptable
Rapid failure of open excavation while demolition of old road	Unlikely – (annual probability $P_{(H)} = 10^{-4}$)	Medium (20%)	Low ($2x10^{-5}$)	$8.3x10^{-7}$/annum	** Risk Acceptable

Soil erosion causes land surface on or above the property failing and impacting on the proposed subdivision	Unlikely – (annual probability $P_{(H)} = 10^{-4}$)	Minor (5%)	Low ($2x10^{-5}$)	$8.3x10^{-7}$/annum	**Risk Acceptable

Note: ***Refer to Australian Geo-Mechanics Vol. 42 No. 1 March 2007, for full explanation of terms above; **Level of Risk Acceptable: AGS Suggested Tolerable loss of life individual risk = 10^{-4} /annum for existing slope/ existing development (***Appendix E***)

Following the above, it is considered that the current site meets "Acceptable Risk Management" criteria with respect to both property and life under current and foreseeable conditions. As indicated by the DCP tests results, it is also noted the shallow soils consists of loose to very dense silty sand to maximum 0.525m located from Northeast side uphill to Southwest side downhill nearby the end of the existing dwellings houses. Soils depth became deeper to maximum 2.1m deep at Southwest side downhill but at the rear back of the property. Therefore, it is concluded that most of the site is cover by shallow soils above rock, which presents little potential issues related with soil erosion or creeping to occur.

The above confirms that the property has an "Acceptable Risk Level" in accordance with the 2009 Geotechnical Risk Management Policy for Pittwater.

6.2 Excavation Conditions

The supplied civil/structural drawing plans indicate that shallow excavation of maximum 1.5m deep is proposed to construct the new driveway across the site.

Based on the in-situ testing, the overall excavation is expected to intersect loose to very dense silty sands and rock sandstone, excavation within the soils and very low to low strength rock sandstone can be easily undertaken by using hydraulic excavators with attached buckets. Excavation in medium to high strength rock, excavators equipped by hydraulic hammers or rock saw cutting would need to be used.

During the excavation process, it will be necessary to use excavation methods and equipment to maintain the vibration limits below the maximum permitted. Assuming the surrounding structures are in normal structural conditions, it is recommended during the excavation, construction techniques should be adopted without causing more than 5mm/sec PPV (Peak Particle Velocity) as a provisional allowed vibration limit to the neighbouring building structures and infrastructures.

Excavation to be undertaken close to the existing buildings must take in consideration, that if excavation is undertaken below the existing building footings, underpinning works could be necessary to carry to avoid cracking and damage to the existing structures.

Moreover, a Waste Classification should be carried for all the excavated materials to be disposed in accordance with NSW Environment Protection Authority (EPA) Waste Classification Guidelines Nov 2014, and under the Protection of the Environment Operations Act 1997 (POEO Act). Environmental sampling and chemical laboratory testing will need to be carried out to classify the spoil resulted from the excavation prior to disposal. This includes filling and excavated natural materials (GSW/VENM/ENM) if it is intended to be removed from the site. The type and extent of testing undertaken will depend on the final use or destination of the spoil, and requirements of the site.

6.3 Subgrade/Subbase/Base Preparation for Pavements

Depending on the ground conditions to be encountered after excavation, subgrade preparation could be required.

Following bulk excavation, if Sandstone of medium strength is encountered, subgrade preparation will not be necessary unless if there is over-excavation requiring replacement levels with engineering fill. However, it is recommended to apply a blinding and levelling granular layer of sand with minimum 100mm thick above the subgrade rock materials prior installation of any plastic membrane and concrete/asphalt pavement specified by the design engineer.

If the subgrade encountered comprises soil or extremely low to very low strength sandstone, a well compacted granular course material (with maximum particle size of 37.5mm) subgrade with maximum 150mm thick layers of crushed recycled concrete or crushed sandstone (DGB20 or similar) layers it is recommended to install and be properly compacted. The subgrade layers should be compacted using a vibratory roller (minimum 6-8 tonnes deadweight) to target minimum relative compaction of minimum dry density ratio of 100% obtained from Standard Compactive Effort "SMDD – Standard Maximum Dry Density".

Moistening of each layer will facilitate compaction. Density/compaction tests should be carried out on each layer to confirm the above specification has been achieved in accordance with AS3798 Guidelines on Earthworks for Commercial and Residential Developments.

For pavement design, minimum CBR values of the subgrade material must be determined by the design engineer depending on the pavement design type considered.

Above the well compacted subgrade materials a subbase granular course material layer with minimum 150mm thickness by crushed concrete or crushed sandstone (DGB20 or similar) should be installed. Subbase layers should be also compacted using the same compaction methods described above. Final thickness of subbase should be determined by the pavement design.

All pavements subgrade, subbase and base preparation geotechnical inspection and testing minimum level 2 geotechnical inspection and testing should be allowed for all pavements accordingly with AS3798 Guidelines on Earthworks for Commercial and Residential Developments. A qualified geotechnical engineering should supervise on site the subgrade, base and subase preparation as defined in AS3798, Soilsrock Engineering can supervise, testing and certify the works if required.

6.4 Final Comments and Conclusions

Further to the above, additional geotechnical input is required and summarized as follow:

- The site has an 'Acceptable Risk Level' in accordance with the 2009 Geotechnical Risk Management Policy for Pittwater and Australian Geo-Mechanics criteria. No further actions are required.
- Geotechnical site inspections during excavation works to determine if underpinning works are necessary to be undertaken for the existing residential adjoining buildings.
- Geotechnical site inspections to confirm bearing pressures of the foundation ground after excavation works and prior to construct the driveway.
- Geotechnical site inspections and compaction tests to confirm density targets for subgrade, subbase and base preparation and installation below pavements.

Further to the results of the investigations and geotechnical recommendations above, providing the works are carried accordingly with this report, and good engineering and building construction practice is maintained the proposed development is suitable for the site.

7. LIMITATIONS

The site geotechnical investigation undertaken for the present report is an interpretation and estimation of the characteristics of the soil and or rock of subsurface conditions encountered during the test locations points investigated. No matter how comprehensive the investigation is, site ground conditions in other test locations investigated can differ and geological/geotechnical conditions can be unpredictable or can reveal unforeseen conditions.

The present report analyses form an engineering model interpretation and opinion of the actual subsurface conditions of the locations points where the tests were carried. The selected in-situ tests results are indicative of actual conditions encountered on the location points investigated. Recommendations are given based on the data testing results and visual interpretation carried by professional geotechnical and geological engineers from this office. Interpretation of the present report by others may differ from the interpretation given, there is the risk the report may be misinterpreted and Soilsrock cannot be held responsible for this.

Geotechnical reports rely on factual interpreted and judgement of information based on professional visual interpretation of soils and rock samples, in situ and sampling tests, which can have some uncertainty due to unexpected natural and normal changing ground conditions. Soilsrock Engineering accepts no responsibility if different unexpected ground conditions occur in locations where the investigations were not carried out.

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APPENDIX A

GEOTECHNICAL EXPLANATORY NOTES

APPENDIX A – GEOTECHNICAL EXPLANATORY NOTES

The following geotechnical notes are provided, to give a better understanding of the description and classification methods and field procedures used for the interpretation and compilation of this report which is entirely based on the AS 1726-1993 – Geotechnical Investigations.

INVESTIGATIONS METHODS

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3m for a backhoe and up to 6m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site. Samples can be taken from the test pits for soils testing and analyses.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 3000mm or large in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-125mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be mixed with soils from the sides of the hole. Information from the drilling (as a distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Dynamic Cone Penetromer Tests

Dynamic penetrometer tests (DCP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rood penetrates the soil the number of blows required to penetrate each successive 300mm depth are recorded. Normally there is a depth limitation of 1.2m, but this may be extended in certain conditions by the use of extension rods. A 16mm diameter rod with a 20mm diameter cone end is driven using a 9kg hammer dropping 510mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities. Also Correlations with SPT tests can be made for Cohesion less and cohesive soils.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Proposes – Test 6.3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube under the impact of a 63kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments equal to 450mm in total. The first 150mm increment it not considered for the so-called “N” value (standard penetration resistance), which is taken from the number of blows of the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm may not be practicable and the test will be discontinued. The results are represented in the following example:

- In the case where full penetration is obtained with successive blow counts for each 150mm as follow:
  - 1 st Increment (150mm) = 2 blows
  - 2 nd Increment (150mm) = 8 blows
  - 3 rd Increment (150mm) = 15 blows
  - Representation – 2,8,15 “N” Value = 23
- In the case where the test is discontinued before the full penetration:
  - 1 st Increment (150mm) = 20 blows
  - 2 nd Increment (100mm) = 40 blows – test interrupted
  - 3 rd Increment (150mm) = not carried – test refusal
  - Representation – 20, 40/100 mm “N” Value = 40

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Correlation between DCP vs SPT for Cohesionless Soils

DCP (Blows/300mm)	SPT Value (Blows/300mm)	RELATIVE DENSITY
0-3	0-4	Very Loose
3-9	4-10	Loose
9-24	10-30	Medium Dense
24-45	30-50	Dense
>45	>50	Very Dense

Correlation Between DCP vs SPT for Cohesive Soils

DCP (Blows/300mm)	SPT Value (Blows/300mm)	CONSISTENCY
0-3	0-2	Very Soft
3-6	2-5	Soft
6-9	5-10	Medium/Firm
9-21	10-20	Stiff
21-36	20-40	Very Stiff
>36	>40	Hard

Continuous Diamond Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally affective only in cohesive soils.

DESCRIPTION AND CLASSIFICATIONS METHODS FOR SOILS AND ROCK

Descriptions include strength or density, colour, structure, soil or rock type and inclusions.

SOIL DESCRIPTIONS

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 – 200
Gravel	0.6 – 63
Sand	0.075 – 0.6
Silt	0.002 – 0.075
Clay	<0.002

Type	Sand & Gravel Particle size
Coarse gravel	36mm – 19mm
Medium gravel	19mm – 6.7mm
Fine gravel	6.7mm – 2.36mm
Coarse sand	2.36mm – 600µm
Medium sand	600µm – 212µm
Fine sand	212µm – 75µm

The proportions of secondary constituents of soils are described as:

Coarse grained soils		Fine grained soils	
%Fines	**Modifier**	**%Coarse**	**Modifier**
≤5	Omit, or use 'trace'	≤15	Omit, or use 'trace'
>5 - ≤12	Describe as 'with clay/silt' as applicable	>15 - ≤30	Describe as 'with clay/silt' as applicable
>12	Describe as 'with silty/clayey' as applicable	>30	Describe as 'with silty/clayey' as applicable

Definitions of grading terms used are:

- Well graded – a good representation of all particle sizes.
- Poorly graded – an excess or deficiency of particular sizes within specified range.
- Uniformly graded – an excess of a particular particle size.
- Gap graded – a deficiency of a particular particle size with the range.

Cohesive Soils

Cohesive soils, such as clays, are classified on the basics of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defines as follows:

Description	Abbreviation	Undrained shears strength (kPa)
Very soft	vs	≤12
Soft	s	>12 – ≤25
Firm	f	>25 – ≤50
Stiff	st	>50 – ≤100
Very stiff	vst	>100 – ≤200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basics of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT), or dynamic penetrometers (PSP). The relative density terms are given below:

Relative density	Abbreviation	Density index %
Very loose	vl	≤15
Loose	l	>15 – ≤35
Medium dense	md	>35 – ≤65
Dense	d	>65 – ≤85
Very dense	vd	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil – derived from in-situ weathering of the underlying rock.
- Transported soils – formed somewhere else and transported by nature to the site.
- Filling – moved by man.

Transported soils may be further subdivided into:

- Alluvium – river deposits.
- Lacustrine – lake deposits.
- Aeolian – wind deposits.
- Littoral – beach deposits.
- Estuarine – tidal river deposits.
- Talus – coarse colluvium.
- Slopwash or Colluvium – transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

ROCK DESCRIPTIONS

Rock Strength

Rock strength is defined by the Point Load Strength (Is50) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standards 1726. The terms used to describe rocks strength are as follow:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approx. Unconfined Compressive Strength MPa*
Extremely low	EL	$\leq$0.03	<0.6
Very low	VL	>0.03 – $\leq$0.1	0.6 – 2
Low	L	>0.1 – $\leq$0.3	2 – 6
Medium	M	>0.3 – $\leq$1.0	6 – 20
High	H	>1 – $\leq$3	20 – 60
Very high	VH	>3 – $\leq$10	60 – 200
Extremely high	EH	>10	>200

*Assumes a ratio of 20:1 for UCS to Is(50)

Degree of Weathering

The degree of weathering of rocks is classified as follows:

Term	Abbreviation	Description
Residual	RS	Soil developed on extremely weathered rock; the mass structure and substance are no longer evident.
Extremely weathered	XW	Rock is weathered to such an extent that it has 'soil' properties, i.e. it either disintegrates or can be remoulded in water, but the texture of the original rock is still evident.
Distinctly weathered	DW	Staining and discolouration of rock substance has taken place.
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20mm
Highly fragmented	Core lengths of 20 – 40mm with some fragments
Fractured	Core lengths of 40 – 200mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200 – 400mm with some shorter and longer sections
Unbroken	Core lengths mostly >1000mm

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$RQD\ \% = \frac{cumulative\ length\ of\ 'sound'coresections\ \geq 100mm\ long}{total\ drilled\ lenght\ of\ section\ being\ assessed}$$

Where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation or RQD.

Rock Quality Designation

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6mm
Laminated	6mm to 20mm
Very thinly bedded	20mm to 60mm
Thinly bedded	60mm to 0.2m
Medium Bedded	0.2m to 0.6m
Thickly bedded	0.6m to 2m
Very thickly bedded	> 2m

LOG SYMBOLS

Moisture Condition - Cohesive Soils:

MC > PL – Moisture content estimated to be greater than plastic limit
MC = PL - Moisture content estimated to be approximately equal to plastic limit
MC < PL - Moisture content estimated to be less than plastic limit

Moisture Condition - Cohesionless Soils:

D – Dry – Runs freely through fingers
M – Moist – Does not run freely but no free water visible on soil surface
W – Wet – Free water visible on soil surface

Strength (Consistency) - Cohesive Soils:

VS – Very Soft – Unconfined compressive strength less than 25 kPa
S – Soft – Unconfined compressive strength 25-50 kPa
F – Firm – Unconfined compressive strength 50-100 kPa
St – Stiff – Unconfined compressive strength 100-200 kPa
VSt – Very Stiff – Unconfined compressive strength 200-400 kPa
H – Hard - Unconfined compressive strength greater than 400 kPa

Density Index/Relative Density - Cohesionless Soils

Symbol	Density Index (ID)	Range %	SPT “N” Value Range (Blows/300mm)
VL	Very Loose	<15	0-4
L	Loose	15-35	4-10
MD	Medium Dense	35-65	10-30
D	Dense	65-85	30-50
VD	Very Dense	>85	>50

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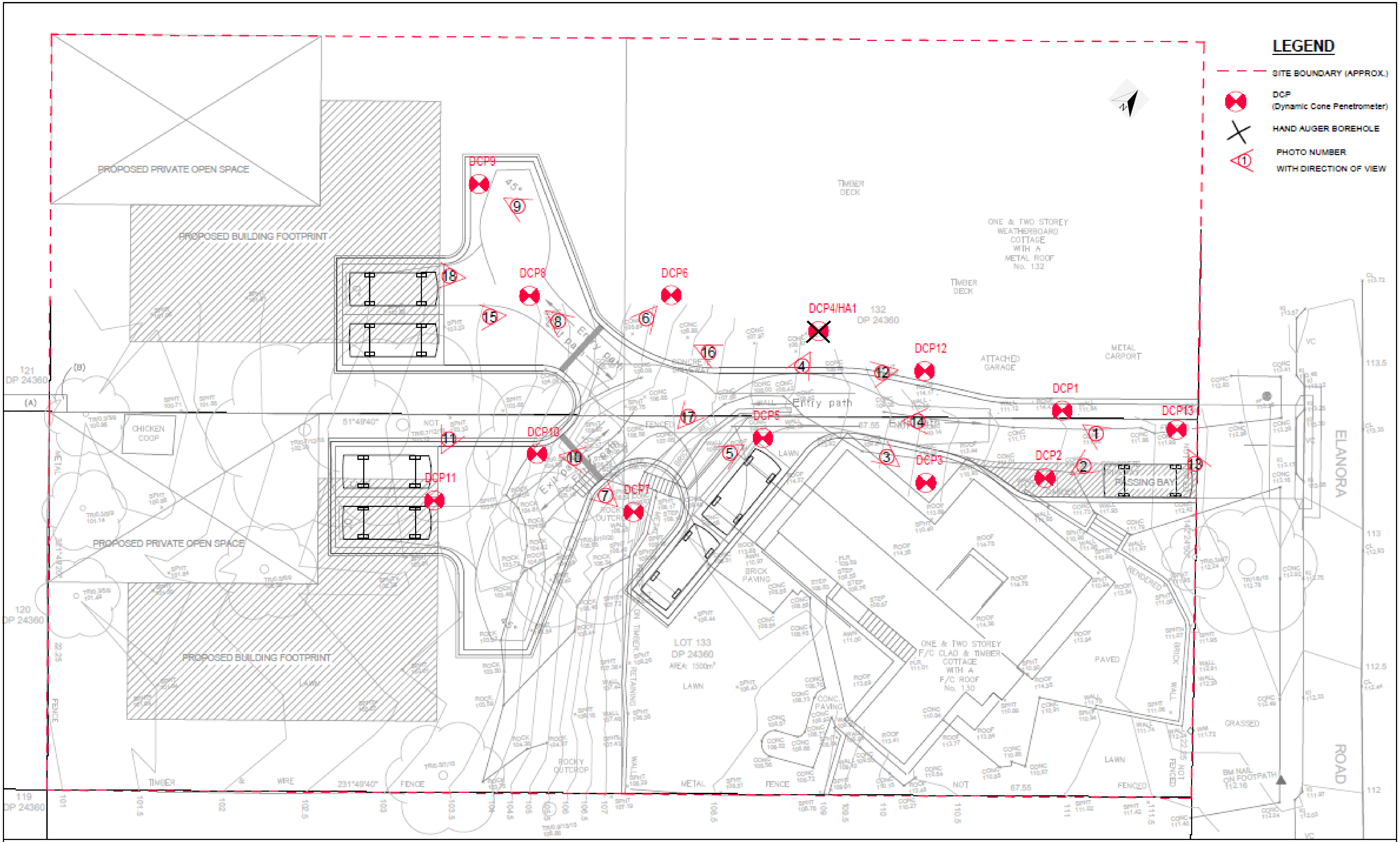
APPENDIX B

DCP TESTS & SITE PHOTOS LOCATION PLAN



Soilsrock Engineering Pty. Ltd 2A/32 Fisher Road, Dee Why, NSW 2099 M: 0457 115 044 | T: (02)8065 2922 Email: info@soilsrock.com.au www.soilsrock.com.au	CLIENT: KELLY GALLO	TITLE: BOREHOLE, DCP AND PHOTOS LOCATION PLAN 130-132 ELANORA ROAD ELANORA HEIGHTS, NSW	Revision / Date	DATE: 07/08/2020 SCALE: 1/200 PROJECT No: SRE/680/EH/20
				CHECKED BY: JC DESIGNED BY: MJ Drawing No: G01

APPENDIX C

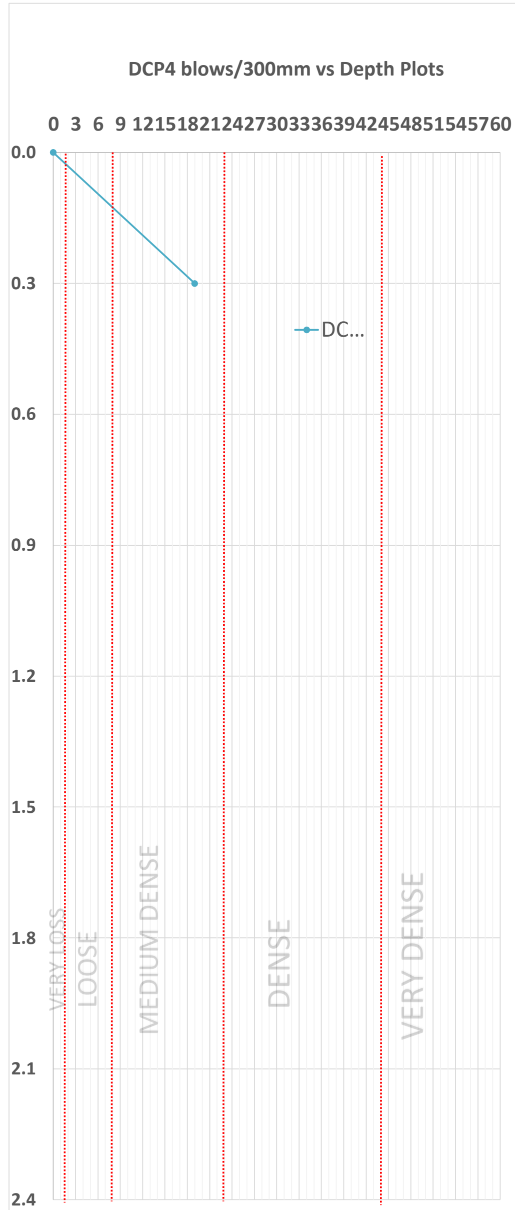
BOREHOLE LOG & DCP TESTS GRAPHIC

HAND AUGER & DCP LOG

Client:	KELLY GALLO	**BOREHOLE NO.**	**HA1/DCP4**
Project:	GEOTECHNICAL SITE INVESTIGATION REPORT FOR PROPOSED DRIVEWAY CROSSING	**Page:**	1 of 1
Location:	130 - 132 ELANORA ROAD, ELANORA HEIGHTS NSW 2029	**Date Started:**	23/7/2020
Date:	3/08/2020	**Date Completed:**	23/7/2020
Project No.:	SRE/680/EH/20	**Logged/Checked by:**	AT

Equipment:	HA & DCP	**Hole Diameter:**	50mm	**Coring Size:**	NA	**RL Surface:**	
Driller:	AT/HC	**Drilling Method:**	Hand Auger / DCP Test	**Inclination:**	90˚	**Datum:**	AHD

Method	Groundwater recorded	RL	Depth (m)	Graphic Log	Material Description	Soils Classification: Moisture Condition	Strength (Consistency)	Density Index
DCP4 & HA1	NO GROUNDWATER		0.1		**TOPSOIL:** Brown silty sand mixed with grass, fine-grained, sub-	D	-	MD
					SAND: Brown/Red silty sand, fine-grained, sub-rounded.	M		
DCP4			0.2		**HAND AUGER REFUSAL @ 0.1m**			
			0.3		**DCP4 TERMINATES @ 0.25m**			
			0.4					
			0.5					
			0.6					
			0.7					
			0.8					
			0.9					
			1.0					
			1.1					
			1.2					
			1.3					
			1.4					
			1.5					
			1.6					
			1.7					
			1.8					
			1.9					
			2.0					
			2.1					
			2.2					
			2.3					



Symbols & Abbreviations:

Moisture Condition	Strength	Density Index
	Cohesive Soils	Cohesionless Soils
D=Dry	VS = Very Soft	VL = Very Loose
M=Moist	S = Soft	L = Loose
W=Wet	F = Firm	MD = Medium Dense
	St = Stiff	D = Dense
	VSt = Very Stiff	VD = Very Dense
	H = Hard	

GRAPHIC LOG SYMBOLS

PAVING	SILTY SAND
TOP SOIL	CLAYEY SAND
FILL	SILTY CLAY
CLAY (CL, CH)	SILTSTONE
SILT (ML, MH)	CLAYEY GRAVEL
SAND (SP, SW)	SANDSTONE
GRAVEL	SHALE
SANDY CLAY	

IN-SITU DCP TESTS RESULT SUMMARY (DYNAMIC CONE PENETROMETER TEST)

CLIENT:	KELLY GALLO	PAGE:	1 of 1
PROJECT:	GEOTECHNICAL SITE INVESTIGATION REPORT FOR PROPOSED DRIVEWAY CROSSING	TESTING DATE:	3/08/2020
LOCATION:	130 - 132 ELANORA ROAD, ELANORA HEIGHTS NSW 2029	LOGGED/CHECKED BY:	AT/JC
DATE:	24/07/2020	Standards:	AS 1289.6.3.2 - 1997
PROJECT NO.:	SRE/680/EH/20		

Equipment: 9kg Dynamic Cone Penetrometer
Soil Type: SAND

Np (blows/300mm) - Interpretation

Item	Depth (m)	DCP1	DCP2	DCP3	DCP4	DCP5	DCP6	DCP7	DCP8	DCP9	DCP10	DCP11	DCP12	DCP13
1	0.0 - 0.3	11	4	5	19	60	6	7	6	13	40	7	40	26
2	0.3 - 0.6	Bouncing @ 0.2m	Bouncing @ 0.15m	38	Bouncing @ 0.25m	Refusal @ 0.3m	10	20	17	13	Bouncing @ 0.25m	15	31	14
3	0.6 - 0.9			Bouncing @ 0.525m			5	13	Bouncing @ 0.425m	22		28	60	51
4	0.9 - 1.2						Bouncing @ 0.625m	24		Bouncing @ 0.775m		45	Bouncing @ 0.85m	60
5	1.2 - 1.5							32				Bouncing @ 0.925m		Bouncing @ 1.125m
6	1.5 - 1.8							33						
7	1.8 - 2.1							60						
8	2.1 - 2.4							Refusal @ 2.1m						
9	2.4 - 2.7													
10	2.7 - 3.0													
11	3.0 - 3.3													
12	3.3 - 3.6													
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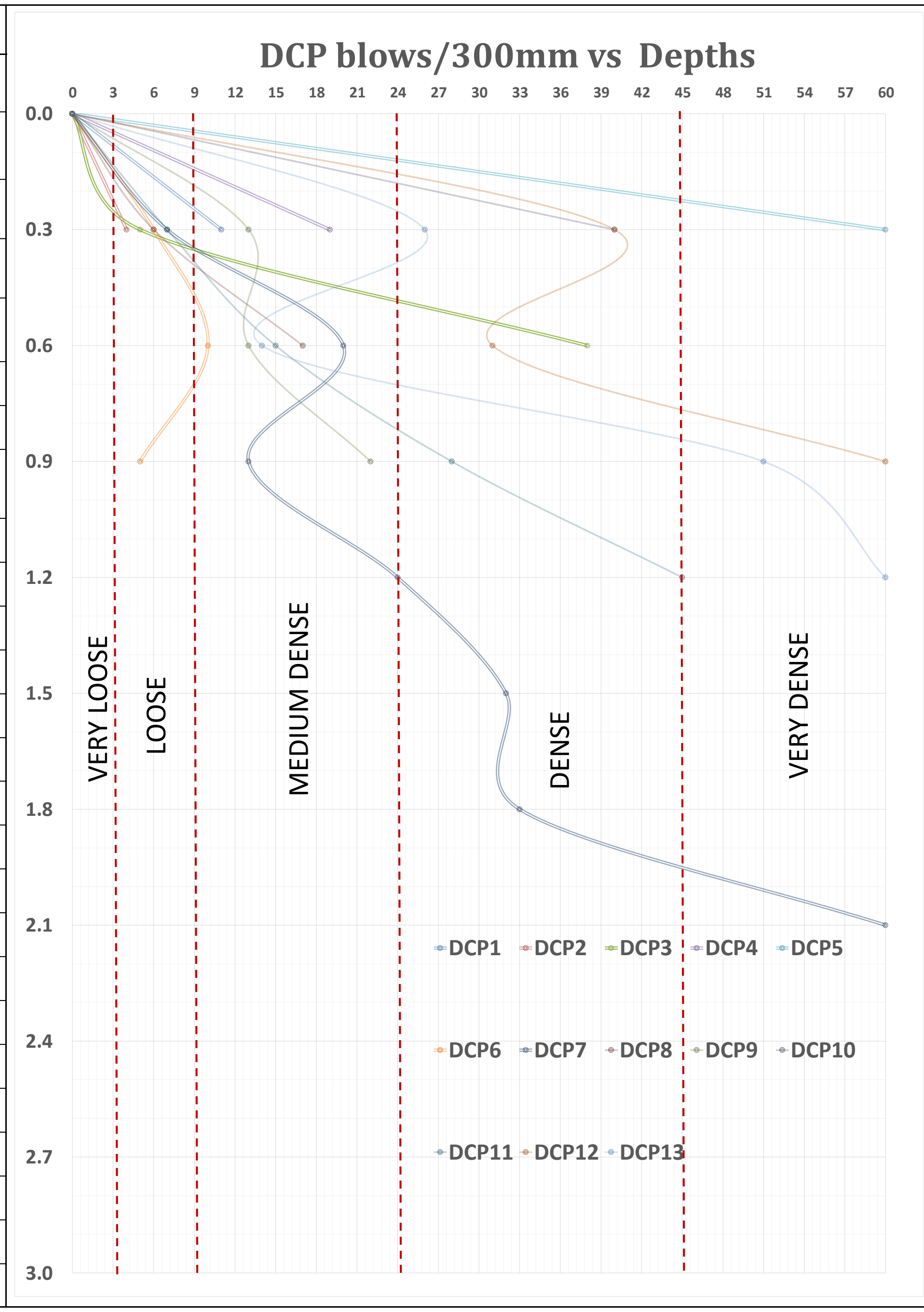
25														



Comments: By conducting in-situ Dynamic Cone Penetration (DCP), the blow number (Np) per 300mm has been recorded and shown on the table above.

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APPENDIX D

SITE PHOTOGRAPHS

CLIENT:	KELLY GALLO	**PAGE:**	1 of 3
PROJECT:	GEOTECHNICAL SITE INVESTIGATION FOR PROPOSED DRIVEWAY CROSSING	**DATE RECORD:**	3/08/2020
LOCATION:	130-132 ELANORA ROAD, ELANORA HEIGHTS NSW		
DATE:	29/07/2020	**LOGGED BY:**	RC
PROJECT NO.:	SRE/680/EH/20	**CHECKED BY:**	JC

SITE PHOTOGRAPHS

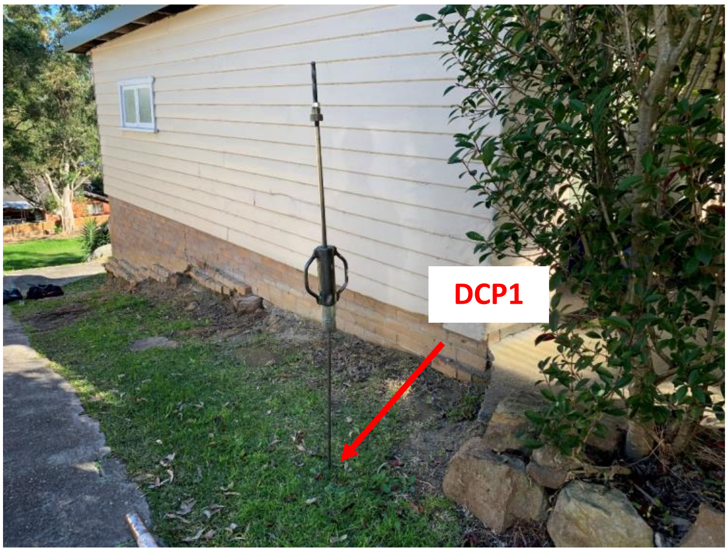

Photo 1 - Southwest view to DCP1 test location.

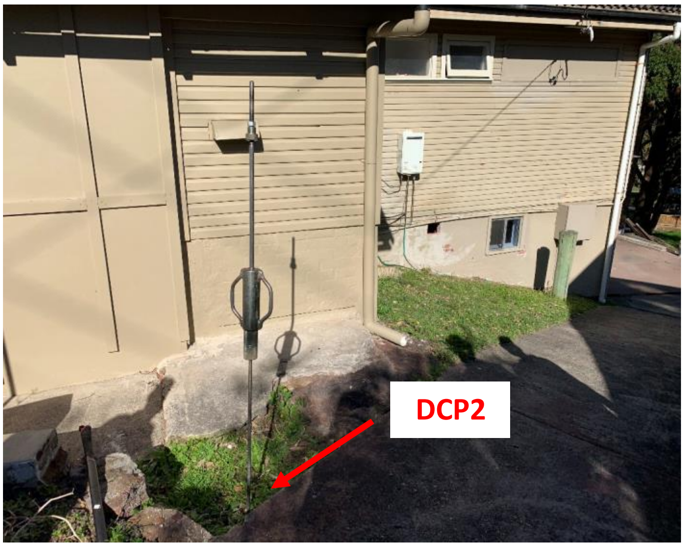

Photo 2 - South view to DCP2 test location.

Photo 3 - Northeast view to DCP3 test location.

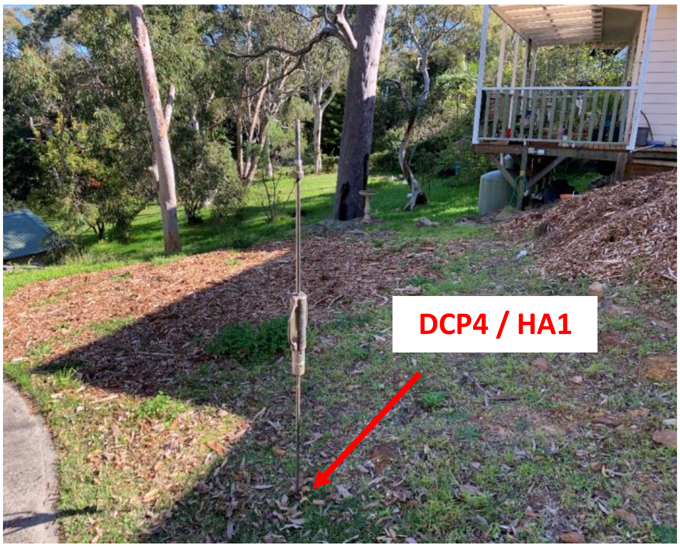

Photo 4 - Southwest view to DCP4 test location.

Photo 5 - Norheast view to DCP5 test location.

Photo 6 - North view to DCP6 test location.

soilsrock	**CLIENT:**	KELLY GALLO	**PAGE:**	2 of 3
	PROJECT:	GEOTECHNICAL SITE INVESTIGATION FOR PROPOSED DRIVEWAY CROSSING	**DATE RECORD:**	3/08/2020
	LOCATION:	130-132 ELANORA ROAD, ELANORA HEIGHTS NSW		
	DATE:	29/07/2020	**LOGGED BY:**	RC
	PROJECT NO.:	SRE/680/EH/20	**CHECKED BY:**	JC

SITE PHOTOGRAPHS

Photo 7 - East view to DCP7 test location.

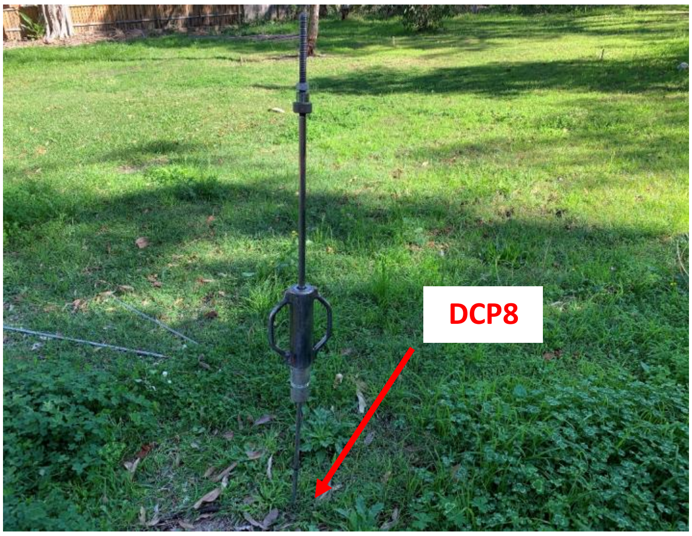

Photo 8 - West view to DCP8 test location.

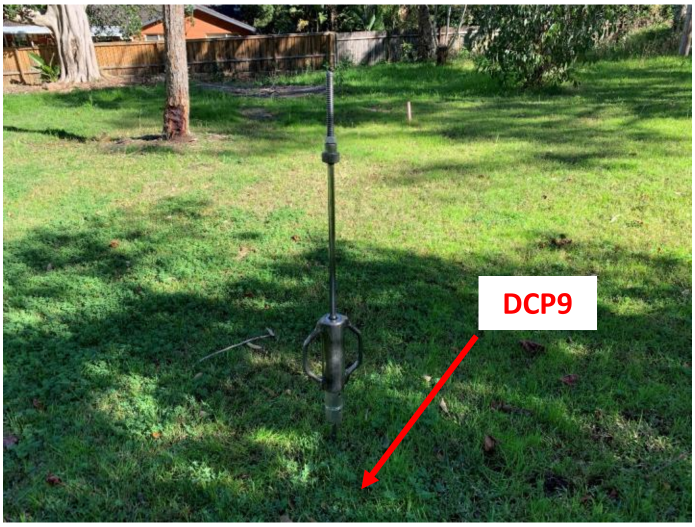

Photo 9 - West view to DCP9 test location.

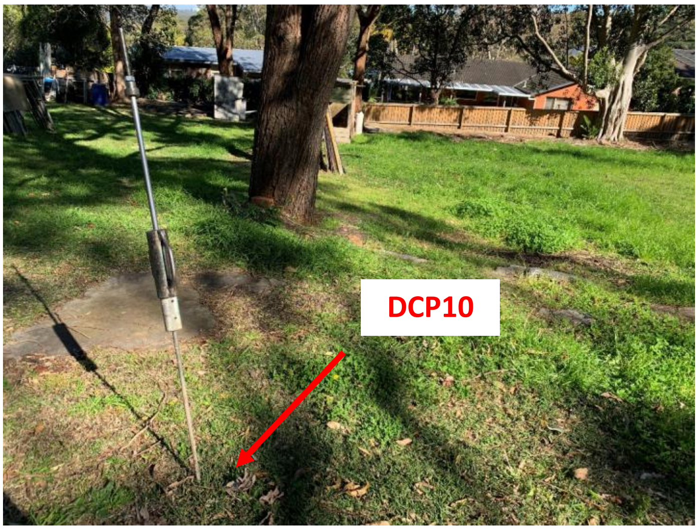

Photo 10 - West view to DCP10 test location.

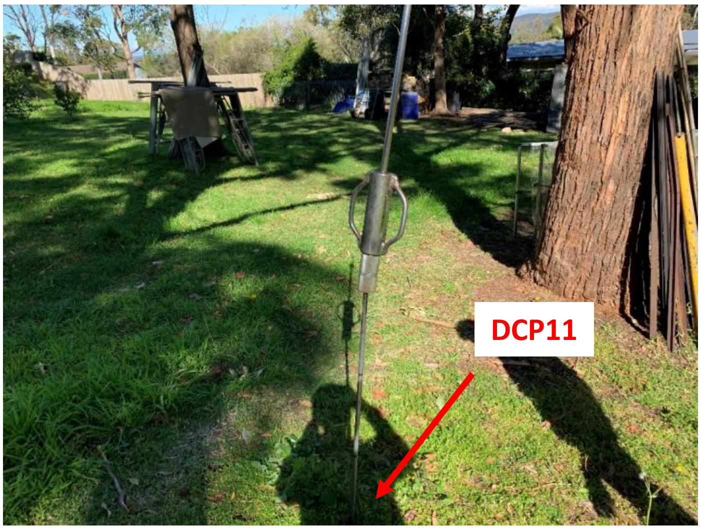

Photo 11 - Southwest view to DCP11 test location.

Photo 12 - Northeast view to DCP12 test location.

CLIENT:	KELLY GALLO	**PAGE:**	3 of 3
PROJECT:	GEOTECHNICAL SITE INVESTIGATION FOR PROPOSED DRIVEWAY CROSSING	**DATE RECORD:**	3/08/2020
LOCATION:	130-132 ELANORA ROAD, ELANORA HEIGHTS NSW		
DATE:	29/07/2020	**LOGGED BY:**	RC
PROJECT NO.:	SRE/680/EH/20	**CHECKED BY:**	JC

SITE PHOTOGRAPHS

Photo 13 - North view to DCP13 test location.

Photo 14 - Southwest view down to the rear back of the site.

Photo 15 - Northeast view up to the front of the site.

Photo 16 - West view to rear back of the site.

Photo 5 - South view of the rear back of the site.

Photo 6 - North view of the rear back of the existing north residence.

APPENDIX E

LANDSLIDE RISK ASSSSMENT TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

(PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007 AGS

(AUSTRALIAN GEOMECANICS SOCIETY)

APPENDIX C: LANDSLIDE RISK ASSESSMENT

QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF LIKELIHOOD

Approximate Annual Probability		Implied Indicative Landslide Recurrence Interval		Description	Descriptor	Level
Indicative Value	Notional Boundary					
10^{-1}		10 years		The event is expected to occur over the design life.	ALMOST CERTAIN	A
	5×10^{-2}		20 years			
10^{-2}		100 years		The event will probably occur under adverse conditions over the design life.	LIKELY	B
	5×10^{-3}		200 years			
10^{-3}		1000 years		The event could occur under adverse conditions over the design life.	POSSIBLE	C
	5×10^{-4}		2000 years			
10^{-4}		10,000 years		The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
	5×10^{-5}		20,000 years			
10^{-5}		100,000 years		The event is conceivable but only under exceptional circumstances over the design life.	RARE	E
	5×10^{-6}		200,000 years			
10^{-6}		1,000,000 years		The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

Note: (1) The table should be used from left to right; use Approximate Annual Probability or Description to assign Descriptor, not *vice versa*.

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

Approximate Cost of Damage		Description	Descriptor	Level
Indicative Value	Notional Boundary			
200%		Structure(s) completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.	CATASTROPHIC	1
	100%			
60%		Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.	MAJOR	2
	40%			
20%		Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.	MEDIUM	3
	10%			
5%		Limited damage to part of structure, and/or part of site requiring some reinstatement stabilisation works.	MINOR	4
	1%			
0.5%		Little damage. (Note for high probability event (Almost Certain), this category may be subdivided at a notional boundary of 0.1%. See Risk Matrix.)	INSIGNIFICANT	5

Notes: (2) The Approximate Cost of Damage is expressed as a percentage of market value, being the cost of the improved value of the unaffected property which includes the land plus the unaffected structures.

(3) The Approximate Cost is to be an estimate of the direct cost of the damage, such as the cost of reinstatement of the damaged portion of the property (land plus structures), stabilisation works required to render the site to tolerable risk level for the landslide which has occurred and professional design fees, and consequential costs such as legal fees, temporary accommodation. It does not include additional stabilisation works to address other landslides which may affect the property.

(4) The table should be used from left to right; use Approximate Cost of Damage or Description to assign Descriptor, not vice versa

APPENDIX C: – QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY (CONTINUED)

QUALITATIVE RISK ANALYSIS MATRIX – LEVEL OF RISK TO PROPERTY

LIKELIHOOD		CONSEQUENCES TO PROPERTY (With Indicative Approximate Cost of Damage)				
	Indicative Value of Approximate Annual Probability	1: CATASTROPHIC 200%	2: MAJOR 60%	3: MEDIUM 20%	4: MINOR 5%	5: INSIGNIFICANT 0.5%
A – ALMOST CERTAIN	10^{-1}	VH	VH	VH	H	M or **L** (5)
B - LIKELY	10^{-2}	VH	VH	H	M	**L**
C - POSSIBLE	10^{-3}	VH	H	M	M	**VL**
D - UNLIKELY	10^{-4}	H	M	**L**	**L**	**VL**
E - RARE	10^{-5}	M	**L**	**L**	**VL**	**VL**
F - BARELY CREDIBLE	10^{-6}	**L**	**VL**	**VL**	**VL**	**VL**

Notes: (5) For Cell A5, may be subdivided such that a consequence of less than 0.1% is Low Risk.

(6) When considering a risk assessment it must be clearly stated whether it is for existing conditions or with risk control measures which may not be implemented at the current time.

RISK LEVEL IMPLICATIONS

Risk Level		Example Implications (7)
VH	VERY HIGH RISK	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the property.
H	HIGH RISK	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property.
M	MODERATE RISK	May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable.
L	LOW RISK	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (7) The implications for a particular situation are to be determined by all parties to the risk assessment and may depend on the nature of the property at risk; these are only given as a general guide.

APPENDIX F

FORMS 1 & 1(A) - GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER

GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER
FORM NO. 1 – To be submitted with Development Application

Development Application for KELLY GALLO	Name of Applicant
Address of site 130 - 132 ELANORA ROAD, ELANORA HEIGHTS NSW 2101	

Declaration made by geotechnical engineer or engineering geologist or coastal engineer (where applicable) as part of a geotechnical report

I, JORGE CABRACO *on behalf of* SOILSROCK ENGINEERING Pty Ltd
(Insert Name) (Trading or Company Name)

on this the 6/08/2020 certify that I am a geotechnical engineer or engineering geologist or coastal engineer as defined by the Geotechnical Risk Management Policy for Pittwater - 2009 and I am authorised by the above organisation/company to issue this document and to certify that the organisation/company has a current professional indemnity policy of at least $10million.

I:
Please mark appropriate box

- ✓ have prepared the detailed Geotechnical Report referenced below in accordance with the Australia Geomechanics Society's Landslide Risk Management Guidelines (AGS 2007) and the Geotechnical Risk Management Policy for Pittwater - 2009
- ✓ am willing to technically verify that the detailed Geotechnical Report referenced below has been prepared in accordance with the Australian Geomechanics Society's Landslide Risk Management Guidelines (AGS 2007) and the Geotechnical Risk Management Policy for Pittwater - 2009
- ✓ have examined the site and the proposed development in detail and have carried out a risk assessment in accordance with Section 6.0 of the Geotechnical Risk Management Policy for Pittwater - 2009. I confirm that the results of the risk assessment for the proposed development are in compliance with the Geotechnical Risk Management Policy for Pittwater - 2009 and further detailed geotechnical reporting is not required for the subject site.
- have examined the site and the proposed development/alteration in detail and I am of the opinion that the Development Application only involves Minor Development/Alteration that does not require a Geotechnical Report or Risk Assessment and hence my Report is in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009 requirements.
- have examined the site and the proposed development/alteration is separate from and is not affected by a Geotechnical Hazard and does not require a Geotechnical Report or Risk Assessment and hence my Report is in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009 requirements.
- have provided the coastal process and coastal forces analysis for inclusion in the Geotechnical Report

Geotechnical Report Details:

Report Title:	GEOTECHNICAL SITE INVESTIGATION REPORT FOR PROPOSED DRIVEWAY CROSSING AT 130-132 ELANORA ROAD, ELANORA HEIGHTS
Report Date:	4/08/2020
Author:	JORGE CABRACO
Author's Company/Organisation:	SOILSROCK ENGINEERING Pty LTD

Documentation which relate to or are relied upon in report preparation:

SURVEY DRAWINGS PREPARED BY NORTHWEST SURVEYS DATED 10/11/2018 & 6/03/2019
CIVIL/STRUCTURAL DRAWINGS BY PORTES CIVIL & STRUCTURAL ENGINEERS
DATED 17/07/2020

I am aware that the above Geotechnical Report, prepared for the abovementioned site is to be submitted in support of a Development Application for this site and will be relied on by Pittwater Council as the basis for ensuring that the Geotechnical Risk Management aspects of the proposed development have been adequately addressed to achieve an "Acceptable Risk Management" level for the life of the structure, taken as at least 100 years unless otherwise stated and justified in the Report and that reasonable and practical measures have been identified to remove foreseeable risk.

Signature ....

Name ....JORGE CABRACO....

Chartered Professional Status...BENG, MENG, CPENG, NPER

Membership No. ...3789414 (ENGINEERS AUSTRALIA)

Company...SOILSROCK ENGINEERING Pty Ltd

GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER

FORM NO. 1(a) - Checklist of Requirements For Geotechnical Risk Management Report for Development Application

Development Application for Kelly Gallo
Name of Applicant
Address of site 130 - 132 Elanora Road, Elanora Heights

The following checklist covers the minimum requirements to be addressed in a Geotechnical Risk Management Geotechnical Report. This checklist is to accompany the Geotechnical Report and its certification (Form No. 1).

Geotechnical Report Details:

Report Title: Geotechnical Site Investigation Report for Proposed Driveway Crossing at 130-132 Elanora Road, Elanora Heights
Report Date: 4/08/2020
Author: Jorge Cabaco
Author's Company/Organisation: Soilsrock Engineering Pty Ltd

Please mark appropriate box

- ✓ Comprehensive site mapping conducted 23/07/2020 (date)
- Mapping details presented on contoured site plan with geomorphic mapping to a minimum scale of 1:200 (as appropriate)
- Subsurface investigation required
  - No Justification ....
  - ✓ Yes Date conducted 23/07/2020
- Geotechnical model developed and reported as an inferred subsurface type-section
- Geotechnical hazards identified
  - Above the site
  - ✓ On the site
  - ✓ Below the site
  - Beside the site
- ✓ Geotechnical hazards described and reported
- ✓ Risk assessment conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
  - ✓ Consequence analysis
  - ✓ Frequency analysis
- ✓ Risk calculation
- ✓ Risk assessment for property conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
- ✓ Risk assessment for loss of life conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
- ✓ Assessed risks have been compared to "Acceptable Risk Management" criteria as defined in the Geotechnical Risk Management Policy for Pittwater - 2009
- ✓ Opinion has been provided that the design can achieve the "Acceptable Risk Management" criteria provided that the specified conditions are achieved.
- Design Life Adopted:
  - 100 years
  - ✓ Other 50 years (specify)
- ✓ Geotechnical Conditions to be applied to all four phases as described in the Geotechnical Risk Management Policy for Pittwater - 2009 have been specified
- Additional action to remove risk where reasonable and practical have been identified and included in the report.
- Risk assessment within Bushfire Asset Protection Zone.

I am aware that Pittwater Council will rely on the Geotechnical Report, to which this checklist applies, as the basis for ensuring that the geotechnical risk management aspects of the proposal have been adequately addressed to achieve an "Acceptable Risk Management" level for the life of the structure, taken as at least 100 years unless otherwise stated, and justified in the Report and that reasonable and practical measures have been identified to remove foreseeable risk.

Signature [signature]
Name Jorge Cabaco
Chartered Professional Status BEng, MEng, CPEng, NPER
Membership No. 3785414 (Engineers Australia)
Company Soilsrock Engineering Pty Ltd