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

Development Application for _____
Name of Applicant

Address of site 7 ROCK BATH ROAD, PALM BEACH

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

I, Peter Thompson *on behalf of* Jack Hodgson Consultants Pty Ltd
(insert name) (Trading or Company Name)

on this the 28TH NOVEMBER, 2018 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 $2million.

Please mark appropriate box

☐ 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

☒ I 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 paragraph 6.0 of the Geotechnical Risk Management Policy for Pittwater - 2009. I confirm the results of the risk assessment for the proposed development are in compliance with the Geotechnical Risk Management Policy fro 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 am of the opinion that the Development Application only involves Minor Development/Alterations that do not require a Detailed Geotechnical Risk Assessment and hence my report is in accordance with the Geotechnical Risk Management Policy for Pittwater – 2009 requirements for Minor Development/Alterations.

☐ Have examined the site and the proposed development/alteration is separate form and 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

☐ Provided the coastal process and coastal forces analysis for inclusion in the Geotechnical Report

Geotechnical Report Details:

Report Title: RISK ANALYSIS & MANAGEMENT FOR PROPOSED ADDITIONS & ALTERATIONS AT 7 ROCK BATH ROAD PALM BEACH – MT 31598

Report Date: 23RD NOVEMBER, 2018

Author : PETER THOMPSON

Author's Company/Organisation : JACK HODGSON CONSULTANTS PTY LTD

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

Architectural drawings developed by DYLAN FARRELL INTERIOR DESIGN, JOB NO: 22-MHR DWG NO: DA0000, DA0100 TO DA0101, DA0201 TO DA0202, DA1101 TO DA1102, DA2001 TO DA2004, DA3001 TO DA3003, DA4101, DA5001 TO DA5002, DA6001 TO DA6002 & DA8051 TO DA8052 DATED 26TH JUNE, 2018

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 Peter Thompson

Name Peter Thompson

Chartered Professional Status MIE Aust CPEng

Membership No. 146800

Company Jack Hodgson Consultants 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 _____
Name of Applicant
Address of site **7 ROCK BATH ROAD PALM BEACH**

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: RISK ANALYSIS & MANAGEMENT FOR PROPOSED ALTERATIONS & ADDITIONS AT 7 ROCK BATH ROAD PALM BEACH – MT 31598

Report Date: 23RD NOVEMBER, 2018

Author: PETER THOMPSON

Author's Company/Organisation: JACK HODGSON CONSULTANTS PTY LTD

Please mark appropriate box

☒ Comprehensive site mapping conducted 12/11/2018 (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 12/11/2018

☒ 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 ..... 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 Peter Thompson
Name Peter Thompson
Chartered Professional Status MIE Aust CPEng
Membership No. 146800
Company Jack Hodgson Consultants Pty Ltd

Jack Hodgson Consultants Pty Limited
CONSULTING CIVIL, GEOTECHNICAL AND STRUCTURAL ENGINEERS
ABN: 94 053 405 011

RISK ANALYSIS & MANAGEMENT FOR PROPOSED ADDITIONS AND ALTERATIONS AT 7 ROCK BATH ROAD PALM BEACH

1. INTRODUCTION.

1.1 This assessment has been prepared to accompany an application for development approval. The requirements of the Geotechnical Risk Management Policy for Northern Beaches Council - Pittwater, 2009 have been met.

1.2 The definitions used in this Report are those used in the Geotechnical Risk Management Policy for Northern Beaches Council - Pittwater, 2009.

1.3 The methods used in this Assessment are based on those described in Landslide Risk Management March 2007, published by the Australian Geomechanics Society and as modified by the Geotechnical Risk Management Policy for Northern Beaches Council - Pittwater, 2009.

1.4 The experience of Jack Hodgson Consultants spans a time period of over 40 years in the Northern Beaches Council area and greater Sydney region.

2. PROPOSED DEVELOPMENT.

2.1 Alterations and additions to the existing residence including extension into the subfloor space.

2.2 Construction of new landscaping retaining walls and swimming pool.

2.3 Construction of new garage and car parking and driveway.

2.4 Details of the proposed development are shown on a set of architectural drawings prepared by Dylan Farrell Interior Design, Job No:- 22-MHR, Dwg No: DA0000, DA0100 to DA0101, DA0201 to DA0202, DA1101 to DA1102, DA2001 to DA2004, DA3001 to DA3003, DA4101, DA5001 to DA5002, DA6001 to DA6002 & DA8051 to DA8052 dated 26th June, 2018.

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3. DESCRIPTION OF SITE & SURROUNDING AREA.

3.1 The site was inspected on the 12th November, 2018.

3.2 The property has a northerly aspect. The slope of the land falls across the property from south west to north east at maximum average angles of 20 degrees. Outcropping sandstone and floaters are visible at several locations on the site.

3.3 Vehicular access to the property is via a short concrete to the existing double garage on the north eastern corner of the property, Photo 1. Pedestrian access is via a pathway and stairs that leave the northern side of the driveway and lead up the slope towards the existing residence, Photo 2. Outcropping sandstone in the form of displaced joints blocks (rock floaters) are at the rear of the garage, Photo 3. A timber sleeper retaining wall is to the south of the existing garage and is in poor condition requiring replacement, Photo 4. The existing swimming pool forms a terraced level at the ground floor level, Photo 5. Another terrace steps up to the south, level with the existing first floor, Photo 6. A high feature masonry wall runs adjacent the southern boundary of the southern side of the existing residence, Photo 7. Settlement of the sandstone paving was observed on the south eastern corner of the swimming pool terrace, Photo 8. Another timber sleeper retaining wall supports the pool terrace and is in poor condition requiring replacement, Photo 9. Outcropping sandstone bedrock and displaced joints blocks (rock floaters) were observed to the north of the front entry door, Photo 10. A small masonry retaining wall creates a planter at the rear of the existing residence on the northern side of the existing residence with a surface drainage system between this retaining wall and the existing residence, Photo 11. Another small masonry retaining wall along the rear boundary on the southern side of the existing residence support the neighbouring property again with surface drainage system between the retaining wall and the existing residence, Photo 12. These rear retaining walls were observed to be stable at the time of our inspection.

3.4 The part two storey masonry house steps down the slope and is most likely supported on strip footings. The house and grounds of the subject property are in fair to good condition and displayed no signs of significant movement that could be attributed to slope instability.

4. GEOLOGY OF THE SITE.

4.1 Referencing the Sydney 1:100,000 Geological Series Sheet 9130 indicates the site is underlain by Hawkesbury Sandstones of the Wianamatta Group that can be seen outcropping on the site. These sandstones are of Middle Triassic age and were probably laid down in braided streams. The sand grains are mainly quartz with some sand grade claystone fragments. There are lenticular deposits of mudstones and

4. GEOLOGY OF THE SITE. (Continued)

laminites which are thought to have been deposited in abandoned channels of the main streams. The sandstones generally have widely spaced sub vertical joints with some current bedding. The joint directions are approximately north/south and east/west. The beds vary in thickness from 0.5 to in excess of 5 metres. The site is just above the junction with the Narrabeen Group of Rocks.

4.2 The soil materials are sands, sandy loams and possibly some sandy fill material over thin sandy clays at the weathered interface. On this site the sandy clays merge into the weathered zone of the under lying rocks at depths expected to be in the range of 0.50 metres to 2.0 metres or deeper where filling has been undertaken.

5. SUBSURFACE INVESTIGATION AND SITE CLASSIFICATION.

5.1 Three Dynamic Cone Penetrometer (DCP) test was conducted in the location shown on the site plan. The test was conducted to the Australian Standard for ground testing: AS 1289.6.3.2 – 1997 (R2013). The results of these tests are as follows:

NUMBER OF BLOWS - Conducted using a 9kg hammer, 510mm drop and conical tip -			
DEPTH (m)	**DCP#1**	**DCP#2**	**DCP#3**
0.0 to 0.3	**1/0.200**	4	2
0.3 to 0.6		12	14
0.6 to 0.9		17	15
0.9 to 1.2		**8/0.140**	11
1.2 to 1.5			**15/0.205**
	End of Test @ 0.200m	**End of Test @ 1.040m**	**End of Test @ 1.405m**
~ Top RL	**82.86**	**82.71**	**80.00**
~ EOT RL	**82.66**	**81.67**	**78.595**

DCP TESTING NOTES:

DCP#1	1 Blow for 0.200m then 8 blows for 0.000m. Double bounce. Refusal on concrete foundations or floater rock or rock. Tip – Dry and clean.
DCP#2	8 Blows for 0.140m then 8 blows for 0.010m. Double bounce. Refusal on floater rock or rock. Tip - Moist with orange/cream fragments.
DCP#3	15 Blows for 0.205m then 8 blows for 0.008m. Strong Double bounce. Refusal on floater rock or rock. Tip - Moist with white fragments.
Further Notes	When ringing bouncing rock is not encountered, end of test occurs when there is less than 0.02m of penetration for 8 blows or danger of equipment damage is imminent. No significant standing water table was identified in our testing.

5. SUBSURFACE INVESTIGATION AND SITE CLASSIFICATION. (Continued)

5.2 The equipment chosen to undertake ground investigations provides the most cost effective method for understanding the subsurface conditions. Our interpretation of the subsurface conditions is limited to the results of testing undertaken and the known geology in the area. While every care is taken to accurately identify the subsurface conditions on-site, variation between the interpreted model presented herein, and the actual conditions onsite may occur. Should actual ground conditions vary from those anticipated, we would recommend the geotechnical engineer be informed as soon as possible to advise if modifications to our recommendations are required.

5.3 SITE CLASSIFICATION

The natural soil profile of the existing site is classified Class M, defined as 'Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes' as defined by AS 2870 - 2011. Where the foundations are taken to the underlying rock then the site can be classified as Class A.

6. DRAINAGE OF THE SITE.

6.1 ON THE SITE.

The site is well drained with no natural water courses on the property. Roof water from the existing house appears to be taken to Rock Bath Road.

6.2 SURROUNDING AREA.

Overland stormwater flow entering the site from the adjoining properties was not evident. Normal overland runoff could enter the site from above during heavy or extended rainfall. The surface drainage system at the rear of the existing residence would indicate surface flows during some storm events entering the subject property from the property above.

7. GEOTECHNICAL HAZARDS.

7.1 ABOVE THE SITE.

Above the site the slope extends to the crest of the hill at angles of some 15 to 20 degrees. No geotechnical hazards likely to adversely affect the subject property were observed above the site.

7. GEOTECHNICAL HAZARDS. (Continued)

7.2 ON THE SITE.

7.2.1 The property is mapped as an H1 hazard area on the Council Geotechnical Hazard Map. A failure of the slope across the property is considered a potential hazard **(HAZARD ONE)**

7.2.2 The excavation for the proposed living space and garage is considered a potential hazard. **(HAZARD TWO).**

7.3 BELOW THE SITE.

No geotechnical hazards likely to adversely affect the subject property were observed below the site.

7.4 BESIDE THE SITE.

The areas beside the site are also classed slip affected hazard areas. These blocks have similar elevation and geomorphology to the subject property. No geotechnical hazards likely to adversely affect the subject property were observed beside the site.

8. RISK ASSESSMENT.

8.1 ABOVE THE SITE.

As no geotechnical hazards likely to adversely impact upon the subject site were observed above the site, no risk analysis is required.

8.2 ON THE SITE.

8.2.1 HAZARD ONE Qualitative Risk Assessment on Property

The slope of the land surface falls across the property at angles of an average 20 degrees in a moderate slope. No evidence of tension cracking, slumping or any other signs of movement were observed on the site. The likelihood of the slope failing and impacting on the house is assessed as 'Unlikely' (10^{-4}). The consequences to property of such a failure are assessed as 'Minor' (5%). The risk to property is 'Low' (5×10^{-6}).

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8. RISK ASSESSMENT. (Continued)

8.2.2 HAZARD ONE Quantitative Risk Assessment on Life

For loss of life risk can be calculated as follows:-
$\mathbf{R_{(LoI)} = P_{(H)} \times P_{(SH)} \times P_{(TS)} \times V_{(DT)}}$ (See Appendix for full explanation of terms)

8.2.2.1 Annual Probability
Competent rock is encountered at relatively shallow depths across the block. No evidence of significant movement was observed on the site.
$\mathbf{P_{(H)}} = 0.0001$/annum

8.2.2.2 Probability of Spatial Impact
The existing residence is situated toward the upper half of the slope.
$\mathbf{P_{(SH)}} = 0.2$

8.2.2.3 Possibility of the Location Being Occupied During Failure
The average household is taken to be occupied by 4 people. It is estimated that 1 person is in the house for 20 hours a day, 7 days a week. It is estimated 3 people are in the house 12 hours a day, 5 days a week.
For the person most at risk:

$$\frac{20}{24} x \frac{7}{7} = 0.83$$

$\mathbf{P_{(TS)}} = 0.83$

8.2.2.4 Probability of Loss of Life on Impact of Failure
Based on the volume of land sliding and its likely velocity when it fails, it is estimated that the vulnerability of a person to being killed in the house when a landslide occurs is 0.01
$\mathbf{V_{(DT)}} = 0.01$

8.2.2.5 Risk Estimation
$\mathbf{R_{(LoI)}}$ = 0.0001 x 0.2 x 0.83 x 0.01
= 0.000000166
$\mathbf{R_{(LoI)}}$ = 1.66 x 10^{-7}/annum **NOTE:** This level of risk is **'ACCEPTABLE'.** Provided the recommendations given in **Section 10** are followed.

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8. RISK ASSESSMENT. (Continued)

8.2.3 HAZARD TWO Qualitative Risk Assessment on Property

Excavation and possible underpinning for the proposed family room, swimming pool and garage will be through fill material, loose top soils, rock and rock floaters. It is expected the underlying rock being of the Hawkesbury Sandstones of the Wianamatta Group will be encountered approximately 1.0 to 2.0m metres below current surface levels or deeper where filling has been undertaken. Provided the unconsolidated portions of the cut are battered back or temporarily supported using good engineering and building practices and the recommendations in **Section 10** are followed the likelihood of the excavations for the proposed works collapsing and impacting on the work site is assessed as 'Unlikely' (10^{-4}). The consequences to property of such a failure are assessed as 'Minor' (5%). The risk to property is 'Low' (5×10^{-6}).

8.2.4 HAZARD TWO Quantitative Risk Assessment on Life

For loss of life risk can be calculated as follows:-
$\mathbf{R_{(LoI)} = P_{(H)} \times P_{(SH)} \times P_{(TS)} \times V_{(DT)}}$ (See Appendix for full explanation of terms)

8.2.4.1 Annual Probability

Low to medium strength rock will be encountered from approximately 2.0m.
$\mathbf{P_{(H)}} = 0.0001$/annum

8.2.4.2 Probability of Spatial Impact

People will be working below the cut.
$\mathbf{P_{(SH)}} = 0.15$

8.2.4.3 Possibility of the Location Being Occupied During Failure

The average worksite is taken to be occupied by 6 people. It is estimated that 1 person is below the cut for 8 hours a day, 6 days a week. It is estimated 5 people are below the cut 5 hours a day, 5 days a week.
For the person most at risk:

$$\frac{8}{24} x \frac{6}{7} = 0.29$$

$\mathbf{P_{(TS)}} = 0.29$

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8. **RISK ASSESSMENT. (Continued)**

8.2.4.4 Probability of Loss of Life on Impact of Failure
Based on the volume of the batter that could fail and its likely velocity when it hits the worksite, it is estimated that the vulnerability of a person to being killed below the cut when it fails is 0.5
$V_{(DT)} = 0.5$

8.2.4.5 Risk Estimation
$R_{(Lol)}$ = 0.0001 x 0.15 x 0.29 x 0.5
= 0.000002175
$R_{(Lol)} = 2.18 \times 10^{-6}$/annum **NOTE:** This level of risk is **'ACCEPTABLE'**. Provided the recommendations given in **Section 10** are undertaken.

8.3 BELOW THE SITE.

As no geotechnical hazards likely to adversely impact upon the subject site were observed below the site, no risk analysis is required.

8.4 BESIDE THE SITE.

As no geotechnical hazards likely to adversely impact upon the subject site were observed beside the site, no risk analysis is required.

9. SUITABILITY OF DEVELOPMENT FOR SITE.

9.1 GENERAL COMMENTS.

The types of structures are considered suitable for the proposed development.

9.2 GEOTECHNICAL COMMENTS.

No geotechnical hazards will be created by the completion of the proposed development in accordance with the requirements of this Report and good engineering and building practice.

9.3 CONCLUSIONS.

The site and the proposed development can achieve the Acceptable Risk Management criteria outlined in the Northern Beaches Council - Pittwater Geotechnical Risk Policy provided the recommendations given in **Section 10** are undertaken.

10. RISK MANAGEMENT.

10.1 TYPE OF STRUCTURE.

The proposed structures are suitable for this site.

10.2 EXCAVATIONS.

10.2.1 All excavation recommendations as outlined below should be read in conjunction with Safe Work Australia's *'Excavation Work – Code of Practice'*, published March, 2015.

10.2.2 Excavations cuts are expected to be through sandy topsoil and sandy clays before encountering the Hawkesbury Sandstones of the Wianamatta Group which are expected to be encountered approximately 0.5m to 2.0m below current surface levels.

10.2.3 We would recommend that a detailed construction methodology/excavation management plan be developed, reviewed and approved before bulk excavations commence. This should include contingency planning for rock bolting, shotcreting or similar support for the excavation cut walls if deemed necessary, and the environmental and logistical elements of the project.

10.2.4 Temporary/permanent structural support and any possible underpinning will be required during the excavation and construction phase of the project. This is to be designed, approved and supervised by the structural engineer.

10.2.5 The cuts required for the construction of the proposed alterations and additions will be of approximately 2.0m steps in general. The bulk of the cut is expected be through competent bedrock that underlie the unconsolidated soil profile. The following parameters are recommended for the design of retaining systems. In areas where adjacent structures are set back from the property boundary by at least the depth of the excavation so that some soil movement can be tolerated, we suggest 'active' (Ka) earth pressure coefficients be used to calculate lateral pressures. Where movement cannot be tolerated, 'at rest' (Ko) earth pressure coefficients will need to be adopted. These values are shown in the table below:-

10. RISK MANAGEMENT. (Continued)

Material	Unit Weight (kN/m^3)	Loan Term Drained Value ø'	Active Ka		At Rest K_0	Passive Kp
			Temporary	Permanent		
Clay	20	29	0.3	0.35	0.52	2.9
Weathered Shale/Rock	22	N/A	0.25	0.25	0.40	150 to 600kPa
Low Strength Rock	22	N/A	0.25	0.25		1000
Medium Strength Rock	22	N/A	0.1	0.1		6000

Weathered shale/rock, Low and medium strength passive pressure is an Ultimate design load.

10.2.6 It is recommended that detailed dilapidation reporting be undertaken on the adjacent structures before demolition or excavation work commences.

10.2.7 Any new or replaced retaining walls are to be installed as soon as possible after the excavations are complete. The cut batters for the dwelling footings are to be covered to prevent loss of moisture in dry weather and to prevent access of moisture in wet weather. Upslope runoff must be diverted from the cut faces by sandbag mounds or similar diversion works. Temporary support may be necessary on the cut batters for the footings, depending upon the material encountered in the cuts, the likelihood of heavy rain and the length of period before permanent support is installed. The design Coefficient of Lateral Pressure is 0.6. The top soil material may be temporally battered at 45 degrees with the weathered shales and rocks able to stand near vertical for short periods time in dry weather and if unaffected by groundwater.

10.2.8 Given bulk excavations are required through what is expected to be low to medium strength shale/sandstone and the proximity to neighbouring occupied residential buildings it would be considered prudent to monitor and limit vibration effects on the adjacent structures.

10. RISK MANAGEMENT. (Continued)

The Australian Standard AS2670.2-1990 "Evaluation of human exposure to whole-body vibrations – continuous and shock induced vibrations in buildings (1-80 Hz)" suggests a day time limit of 8 mm/s component PPV for human comfort is acceptable.

We would suggest allowable vibration limits be set at 5mm/s PPV. It is expected that rock hammers with an approximate weight of 600-800kg will be adequate to operate within these tolerances.

10.2.9 We recommend that any excavation through rock that cannot be readily achieved with a bucket excavator or ripper should be carried out initially using a rock saw to minimise the vibration impact and disturbance on the adjoining properties. Any rock breaking must be carried out only after the rock has been sawed and in short bursts (2-5 seconds) to prevent the vibration amplifying. The break in the rock from the saw must be between the rock to be broken and the closest adjoining structure.

10.2.10 All excavated materials left onsite will need to comply with the conditions in **Section 10.3** or be retained by an engineer designed retaining wall or structure.

10.2.11 All excavated material removed from the site is to be removed in accordance with current Office of Environment and Heritage (OEH) regulations.

10.3 FILLS.

10.3.1 If filling is required all fills are to be placed in layers not more than 250 mm thick and compacted to not less than 95% of Standard Optimum Dry Density at plus or minus 2% of Standard Optimum Moisture Content.

10.3.2 The fill batters are to be not steeper than 1 vertical to 1.7 horizontal or they are to be supported by properly designed and constructed retaining walls.

10.3.3 New retaining walls will be required to contain the fill in some parts of the proposed development. These retaining walls are to be designed by the structural engineer with any foundations support by piers and footings taken as a minimum to weathered rock material.

10.4 FOUNDATION MATERIALS AND FOOTINGS.

It is recommended that any new footings to be supported on and potted into the underlying rock, using piers as necessary. The design allowable bearing pressures are 850 kPa for spread footings or piers. All footings are to be founded on material of similar consistency to minimise potential for differential settlement. It is expected that this material will be encountered at approximate depths between 0.5 to 2.0m, though may be deeper if fill is encountered. Higher strength rock being 1.2 MPa allowable bearing pressure is found deeper approximately 3.0 metres if required. Further testing would need to be carried out to find an exact depth. We would recommend that mechanical drilling be undertaken for this purpose if required.

10.5 STORM WATER DRAINAGE.

All storm water generated from any new works is to be piped to the stormwater system for the block and through any water tanks or onsite detention systems that may be required by the regulating authorities. A suitable method of disposal is to be confirmed with council most likely taken to Rock Bath Road. This drainage work is to comply with the relevant Australian standards (AS/NZS 3500 Plumbing and Drainage).

10.6 SUBSURFACE DRAINAGE.

10.6.1 All retaining walls new and replaced are to have adequate back wall drainage.

10.6.2 Retaining walls are to be back filled with non-cohesive free draining material to provide a drainage layer immediately behind the wall. The free draining material is to be separated from the materials by geotextile fabric ground.

10.7 INSPECTIONS.

10.7.1 It is recommended that the excavation be inspected at regular intervals during the course of the works.

10.7.2 It is essential that the foundation materials of all footing excavations be inspected and approved before concrete is placed. This includes retaining wall footings. Failure to advise the geotechnical engineer for these inspections could delay the issuance of relevant certificates.

11. GEOTECHNICAL CONDITIONS FOR ISSUE OF CONSTRUCTION CERTIFICATE.

It is recommended that the following geotechnical conditions be applied to the Development Approval:-

The work is to be carried out in accordance with the Risk Management Report MT 31598 dated 23rd November, 2018.

The Geotechnical Engineer is to inspect the excavations works on regular basis and approve the support structures for the excavations.

The Geotechnical Engineer is to inspect and approve the foundation materials of any additional footing excavations before concrete is placed.

12. GEOTECHNICAL CONDITIONS FOR ISSUE OF OCCUPATION CERTIFICATE.

The Geotechnical Engineer is to certify the following geotechnical aspects of the development:-

The work was carried out in accordance with the Risk Management Report MT 31598 dated 23rd November, 2018

The Geotechnical Engineer has inspected and approved the excavations works on regular basis and approved the support structures for the excavations.

The Geotechnical Engineer inspected and approved the foundation materials of all footing excavations before concrete was placed.

REPORT CONTINUES ON NEXT PAGE

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13. RISK ANALYSIS SUMMARY.

HAZARDS	HAZARD ONE	HAZARD TWO
TYPE	By reference to Pittwater Councils Geotechnical Hazard mapping, the block is identified as an H1 Hazard Zone. The slope of the land surface that falls across the property is considered a potential hazard.	The proposed excavations are considered a potential hazard.
LIKELIHOOD	'Unlikely' (10^{-4})	'Unlikely' (10^{-4})
CONSEQUENCES TO PROPERTY	'Minor' (5%)	'Minor' (5%)
RISK TO PROPERTY	'Low'(5×10^{-6})	'Low'(5×10^{-6})
RISK TO LIFE	1.66×10^{-7}/annum	2.18×10^{-6}/annum
COMMENTS	This level of risk is **'ACCEPTABLE'** provided the conditions in **Section 10** are followed.	This level of risk is **'ACCEPTABLE'** provided the conditions in **Section 10** are followed.

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Peter Thompson MIE Aust CPEng
Member No. 146800
Civil/Geotechnical Engineer

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

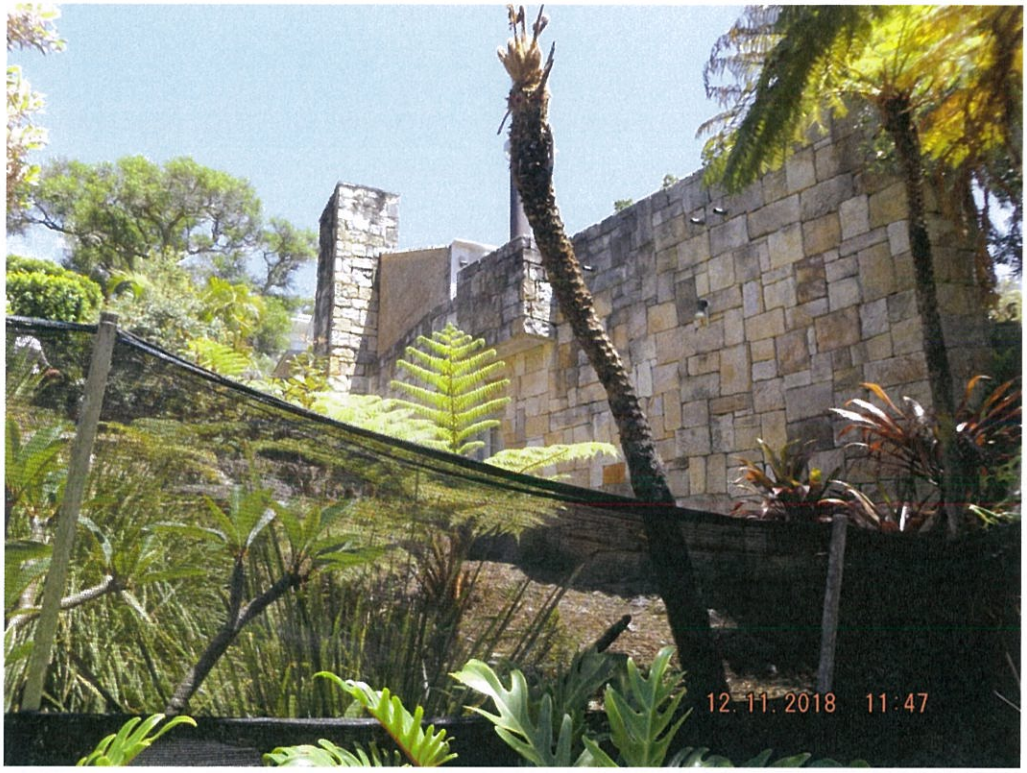


Photo 7

Photo 8

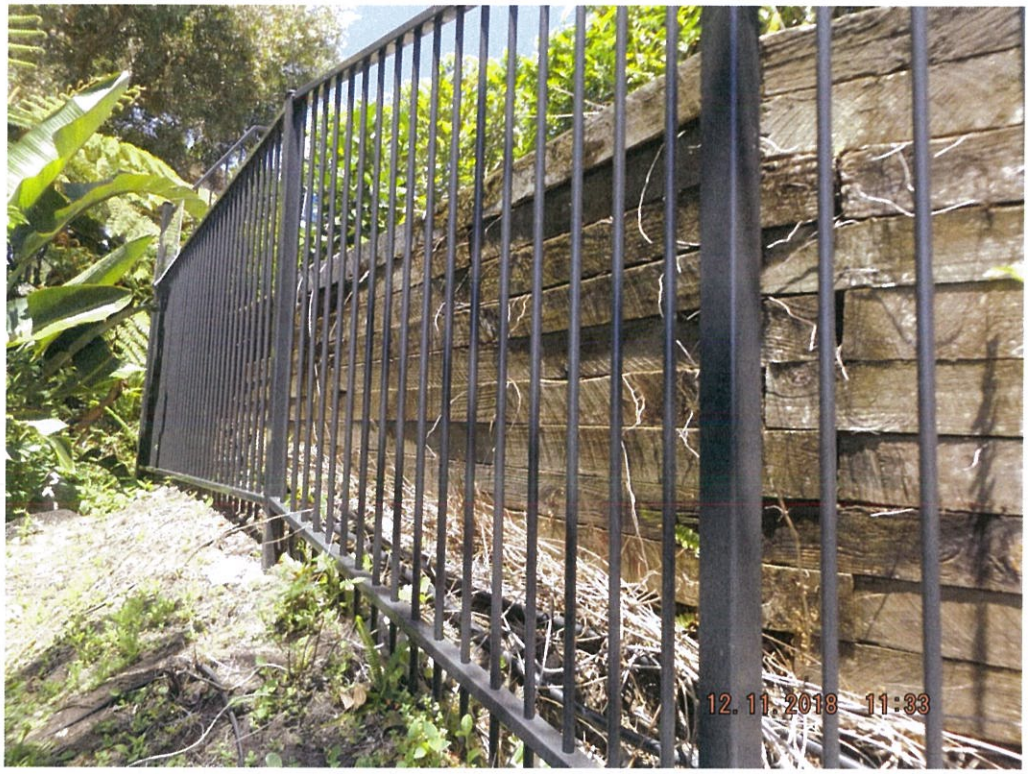


Photo 9

Photo 10

Photo 11

Photo 12

7. RISK ESTIMATION

7.1 QUANTITATIVE RISK ESTIMATION

Quantitative risk estimation involves integration of the frequency analysis and the consequences. For property, the risk can be calculated from:
R(Prop) = **P**(H) x **P**(S:H) x **P**(T:S) x **V**(Prop:S) x **E** **(1)**

Where
R(Prop) is the risk (annual loss of property value).

P(H) is the annual probability of the landslide.

P(S:H) is the probability of spatial impact by the landslide on the property, taking into account the travel
distance and travel direction.

P(T:S) is the temporal spatial probability. For houses and other buildings **P**(T:S)= 1.0. For Vehicles and other
moving elements at risk1.0< **P**(T:S) >0.

V(Prop:S) is the vulnerability of the property to the spatial impact (proportion of property value lost).

E is the element at risk (e.g. the value or net present value of the property).
For loss of life, the individual risk can be calculated from:

R(LoL) = **P**(H) x **P**(S:H) x **P**(T:S) x **V**(D:T) **(2)**
Where

R(LoL) is the risk (annual probability of loss of life (death) of an individual).

P(H) is the annual probability of the landslide.

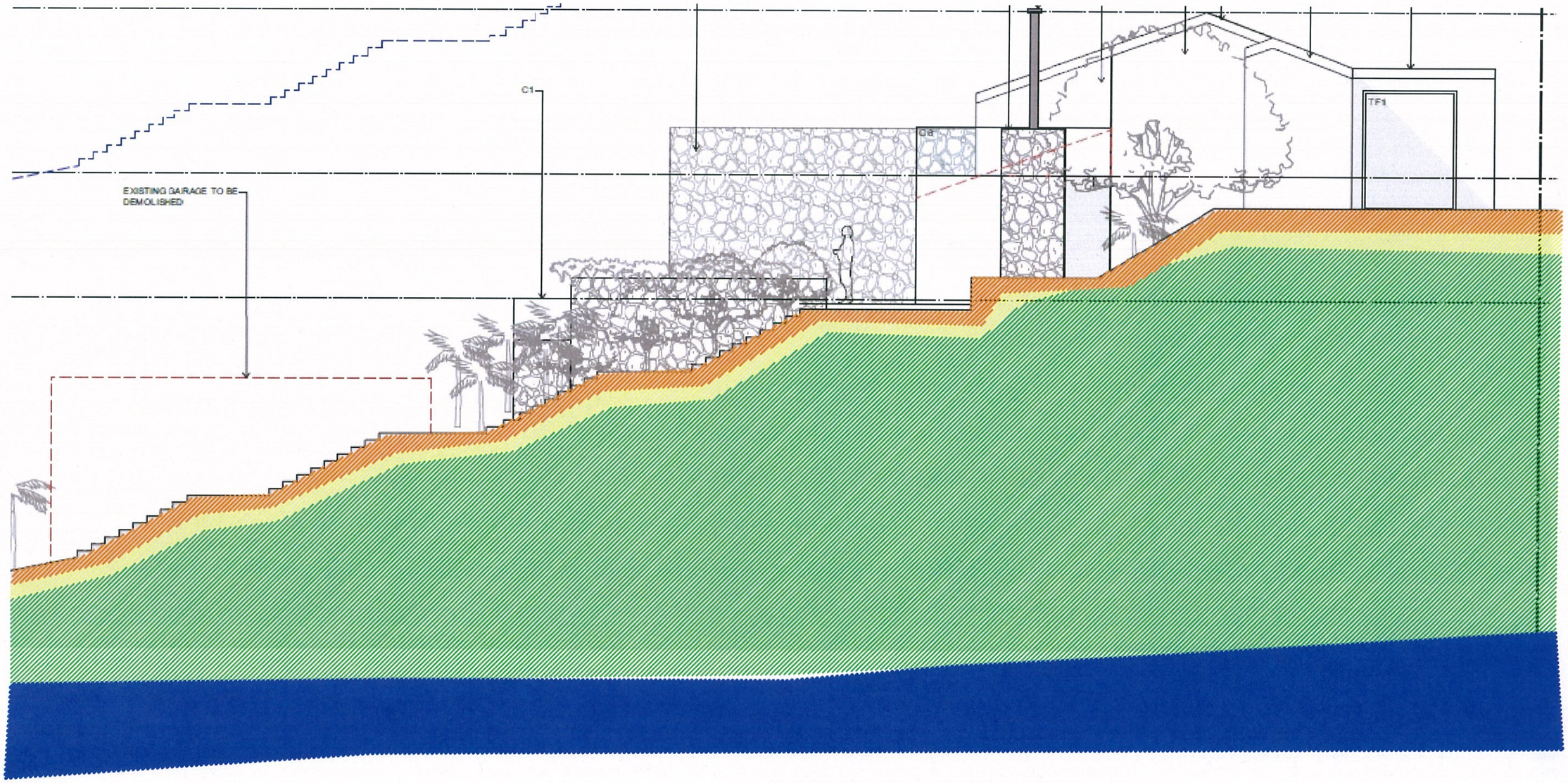
P(S:H) is the probability of spatial impact of the landslide impacting a building (location) taking into account
the travel distance and travel direction given the event.

P(T:S) is the temporal spatial probability (e.g. of the building or location being occupied by the individual)
given the spatial impact and allowing for the possibility of evacuation given there is warning of the landslide occurrence.

V(D:T) is the vulnerability of the individual (probability of loss of life of the individual given the impact).
A full risk analysis involves consideration of all landslide hazards for the site (e.g. large, deep seated landsliding, smaller slides, boulder falls, debris flows) and all the elements at risk.

For comparison with tolerable risk criteria, the individual risk from all the landslide hazards affecting the person most at risk, or the property, should be summed.

The assessment must clearly state whether it pertains to 'as existing' conditions or following implementation of Recommended risk mitigation measures, thereby giving the 'residual risk'.



NOTE
INTERPRETED SUB SURFACE SECTION ONLY.
ACTUAL GROUND CONDITIONS MAY VARY.

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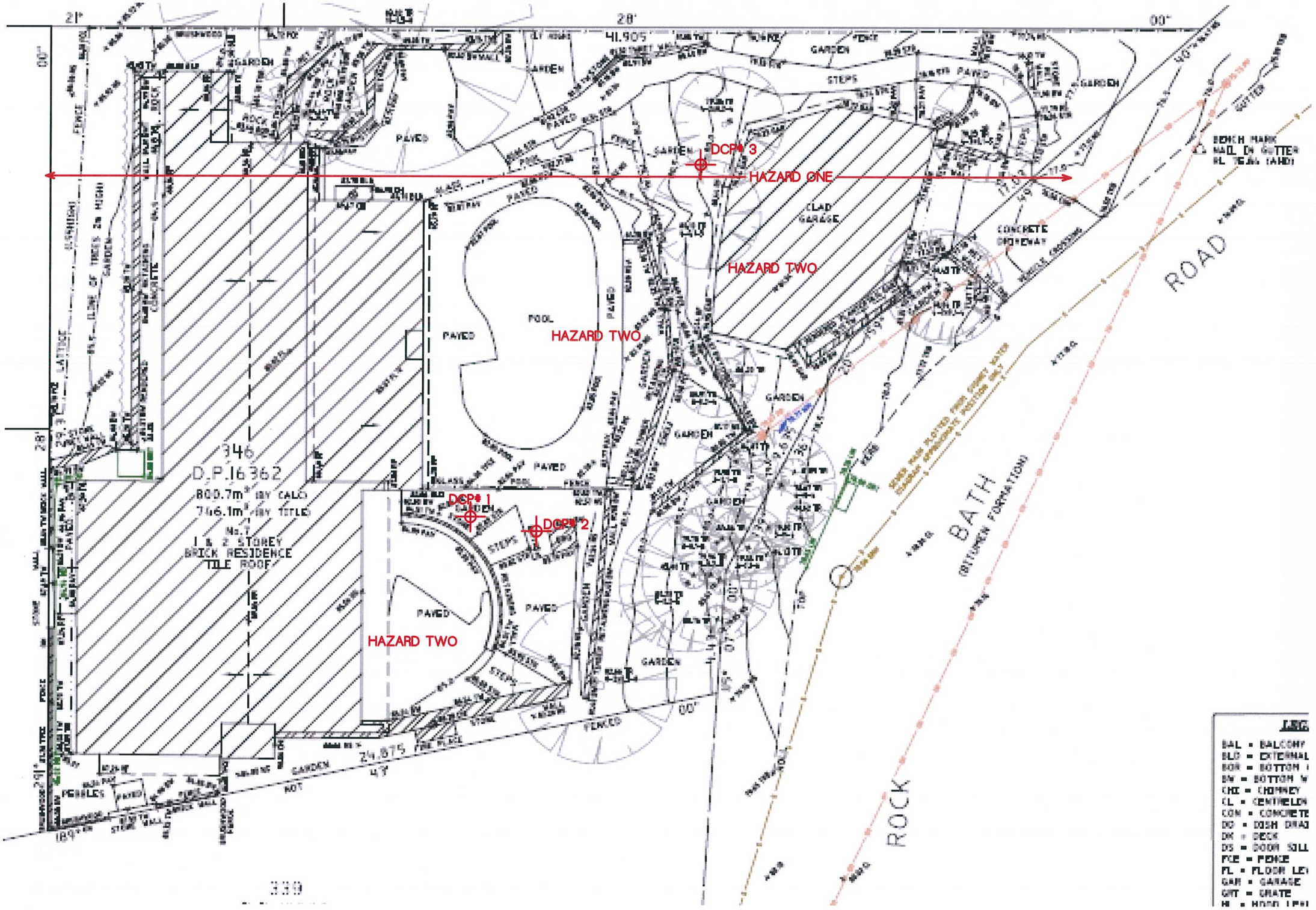
CONSULTING CIVIL, GEOTECHNICAL AND STRUCTURAL ENGINEERS

TYPE SECTION

Job No	Address
MT 31598	7 ROCK BATH ROAD
Scale	PALM.BEACH
NTS	NSW

STRATA PROFILE LEGEND

- Fill
- Sandy Topsoil
- Sandy Clay
- Narrabeen Group Rocks
- Hawkesbury Sandstone



ABN: 94 053 405 011

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SITE PLAN - DCP LOCATIONS & HAZARDS

Job No	Address
MT 31598	7 ROCK BATH ROAD
Scale	PALM BEACH
NTS	NSW