GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER

FORM NO. 1 – To be submitted with Development Application

Development Application for Hayden and Danielle Cox
Name of Applicant

Address of site **28 Pacific 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 (insert name) *on behalf of* Hodgson Consulting Engineers Pty Ltd (Trading or Company Name)

on this the 25th January, 2021 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 ALTERATIONS AND ADDITIONS AND SWIMMING POOL AT 28 PACIFIC ROAD, PALM BEACH– QY 00170

Report Date: 25th January, 2021

Author : GARTH HODGSON
Reviewer: PETER THOMPSON

Author's Company/Organisation : HODGSON CONSULTING ENGINEERS PTY LTD

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

Architectural drawings prepared by JJ Drafting Job No: 827/20 Dwg No: PRELIM.01 to PRELIM.10, and dated August, 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 Peter Thompson

Name Peter Thompson

Chartered Professional Status MIE Aust CPEng

Membership No. 146800

Company Hodgson Consulting Engineers 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 Hayden and Danielle Cox
Name of Applicant
Address of site **28 Pacific 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 AND ADDITIONS AND SWIMMING POOL AT 28 PACIFIC ROAD, PALM BEACH– QY 00170

Report Date: 25th January, 2021

Author : GARTH HODGSON
Reviewer: PETER THOMPSON

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Please mark appropriate box

- ☒ Comprehensive site mapping conducted 27/11/2020 (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 27/11/2020
- ☒ 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 15 to 20 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 Hodgson Consulting Engineers Pty Ltd

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RISK ANALYSIS & MANAGEMENT FOR PROPOSED ALTERATIONS AND ADDITIONS AND SWIMMING POOL AT 28 PACIFIC ROAD, PALM BEACH

1. INTRODUCTION.

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

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

1.4 The experience of the principal of Hodgson Consulting Engineers spans a time period over 25 years in the Northern Beaches Council area and Greater Sydney Region.

2. PROPOSED DEVELOPMENT.

2.1 Demolition the existing carport.

2.2 Construction of new double garage, driveway and swimming pool with associated landscaping.

2.3 Construction of new alterations and additions to the existing lower ground, ground and first floor levels of the existing residence.

2.4 Details of the proposed development are shown on a series of architectural drawings prepared by JJ Drafting Job No: 827/20 Dwg No: PRELIM.01 to PRELIM.10, and dated August, 2020.

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3. DESCRIPTION OF SITE & SURROUNDING AREA.

3.1 The site was inspected on the 27th November, 2020.

3.2 This trapezoidal shaped block is on the high side of Pacific Road and has a northerly aspect. It is located in the upper half of the steep to very steep slope that rises from the cliff tops above the waters of Pacific Ocean to the north at average angles of some 15 to 25 degrees up to the crest near Cynthea Road. The front of the subject property is on a very steep slope and then fattens towards the rear boundary to a steep slope.

3.3 Vehicular access is from Pacific Road via the concrete crossing and paved driveway, Photo 1. A set of stairs on the western side of the driveway provides pedestrian access to the landscaped path and stairs which leads to the main entrance of the residence, Photo 2. The carport is at the top of the driveway where the exposed Hawkesbury Sandstone can be seen on the uphill side of the carport, Photo 3. An inclinator runs adjacent the western boundary toward the main entrance of the existing residence, Photo 4. The front yard is a sloped lawn and garden area with some smaller landscaping retaining walls, Photo 5. Access to the rear of the existing residence is via landscaped stairs of the western side of the residence, Photo 6. The rear yard is a lawn and garden area sloping up to be level with the first of the existing residence, Photo 7. The natural slope is evident on the eastern side of the existing residence, Photo 8. Some cracking in the masonry was observed near the south eastern rear comer of the existing residence, Photo 9. Evidence of water flowing under the existing residence was observed which has also been previously controlled by a series of dish drains, Photos 10 to 11.

3.4 The part three-storey timber framed existing residence is on masonry walls and is supported on concrete raft slabs, strip and pad footings and is good condition. No signs of significant movement attributed slope instability were observed in the existing residence.

3.5 The subject property and adjoining properties are mapped as H1 hazard areas on the Council Geotechnical Hazard Map. Our observations indicate the surrounding slopes do not present a significant risk of instability to the subject property.

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4. GEOLOGY OF THE SITE.

4.1 The Sydney geological series sheet, at a scale of 1:100,000 indicates the site is underlain by Hawkesbury Sandstones which can be seen outcropping on 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 laminates 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.

4.2 The slope materials are colluvial at the surface and residual at depth. They consist of sandy loams over sandy clays that merge into the weathered zone of the underlying rocks at depths expected to be in the range of shallow to ~0.0 to 1.5 metres or deeper where filling has be carried out.

5. SUBSURFACE INVESTIGATION AND SITE CLASSIFICATION.

5.1 Three Dynamic Cone Penetrometer (DCP) tests were conducted in the locations shown on the site plan. The tests were 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	**12/0.285**	7	7
0.3 to 0.6		**11/0.125**	39
0.6 to 0.9			8
0.9 to 1.2			10
1.2 to 1.5			**12/0.205**
End of Test Depth	**0.285**	**0.425**	**1.405**
~ RL top of test AHD	**97.30**	**96.40**	**94.70**
~ RL end of test AHD	**97.015**	**95.975**	**93.295**

5. SUBSURFACE INVESTIGATION AND SITE CLASSIFICATION. (Continued)

DCP TESTING NOTES:

DCP#1	12 Blows for 0.285m then 8 blows for 0.018m. Slight Double Bounce. Refusal on rock or floater. Tip dry with white sandstone on tip.
DCP#2	11 Blows for 0.125m then 8 blows for 0.003m. Double Bounce. Refusal on rock or floater. Tip dry with white sandstone on tip.
DCP#3	12 Blows for 0.205m then 8 blows for 0.010m. Double Bounce. Refusal on rock or floater. Tip dry with white sandstone on tip.
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.

5.2 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 A, defined as ‘Most sand and rock sites with little or no ground movement from moisture changes’ as defined by AS 2870 - 2011.

6. DRAINAGE OF THE SITE.

6.1 ON THE SITE.

The site is naturally well drained with surface and subsurface runoff draining toward the northern boundary and to Pacific Road. No natural watercourses were observed on site.

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.

7. GEOTECHNICAL HAZARDS.

Table 7.1 GEOTECHNICAL HAZARDS

HAZARDS	DESCRIPTION	POSSIBLE IMPACTS
ABOVE THE SITE	No geotechnical hazards likely to affect the subject property were observed above the property	N/A
ON THE SITE		
HAZARD ONE	The whole of the site is classed slip affected under Council's Policy and a H1 Hazard. A failure of the slope across the property is considered to be a potential hazard	Damage to property and life.
HAZARD TWO	The excavation for the proposed garage will require a maximum depth of excavation to be approximately 5.0m and is considered a potential hazard.	Damage to property and life during excavation works.
BELOW THE SITE	No geotechnical hazards likely to affect the subject property were observed above the property	N/A
BESIDE THE SITE	The properties beside the site are at similar elevations and have similar geomorphology to the subject property. The house and grounds of the properties beside the site were in good condition as observed from the subject property and street. No geotechnical hazards likely to adversely affect the subject property were observed beside the site.	N/A

8. RISK ASSESSMENT.

Table 8.1 SUMMARY OF QUALITATIVE RISK ASSESSMENT TO PROPERTY

Hazard	Assessed Likelihood	Assessed Consequence	Risk
HAZARD ONE The main slope of the land surface falls across the subject property at approximate average angles of 15 to 25 degrees. While considered stable in its current condition the likelihood of the slope failing and impacting on the subject property is assessed as	'Unlikely' (10^{-4})	'Minor' (5%)	**'Low' ($5x10^{-6}$)**
HAZARD TWO The excavation for the proposed garage will require a maximum depth of excavation to be approximately 5.0m. Provided good engineering and building practices are followed and the recommendations given in Section 10 are undertaken the likelihood of the cut failing and impacting on the worksite	'Unlikely' (10^{-4})	Medium' (20%)	**'Low' ($2x10^{-5}$)**

NOTE: The level of these risks are **'ACCEPTABLE'** provided the recommendations given in **Section 10** are undertaken.

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Table 8.2 SUMMARY OF QUALITATIVE RISK ASSESSMENT TO LIFE

For loss of life, risk can be calculated as follows:

$R_{(LoI)} = P_{(H)} \times P_{(SH)} \times P_{(TS)} \times V_{(DT)}$ (See Appendix for full explanation of terms)

$P_{(H)}$ - Annual Probability
$P_{(TS)}$ - Possibility of the Location Being Occupied During Failure
$P_{(SH)}$ - Probability of Spatial Impact
$V_{(DT)}$ - Probability of Loss of Life on Impact of Failure
$R_{(LoI)}$ - Risk Estimation

Hazard		Description	Value
HAZARD ONE	The main slope of the land surface falls across the subject property at approximate average angles of 15 to 25 degrees. Provided good engineering and building practices are followed and the recommendations given in Section 10 are undertaken the likelihood of the slope failing and impacting on the subject property		
	$P_{(H)}$	No evidence of significant movement was observed on the site, a slope failure is considered unlikely.	0.0001/annum
	$P_{(SH)}$	The house is situated near the toe of the slope	0.1
	$P_{(TS)}$	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
	$V_{(DT)}$	Based on the volume of land sliding and its likely velocity when it hits the house, it is estimated that the vulnerability of a person to being killed in the house when a landslide hits is	0.1
	Risk $R_{(LoI)}$	$0.0001 \times 0.1 \times 0.83 \times 0.1 = 0.00000083$, 8.3×10^{-7}/annum	**8.3×10^{-7}**
HAZARD TWO	The excavation for the proposed garage will require a maximum depth of excavation to be approximately 5.0m. Provided good engineering and building practices are followed and the recommendations given in Section 10 are undertaken the likelihood of the cut failing and impacting on the worksite		
	$P_{(H)}$	Provided the recommendations in Section 10 are followed and any soil portions of the cut are battered back and kept dry, batter failure is considered unlikely.	0.0001/annum
	$P_{(SH)}$	People will be working below the cut	0.3
	$P_{(TS)}$	The average domestic worksite is taken to be occupied by 5 people. It is estimated that 1 person is below the cut for 10 hours a day, 6 days a week. It is estimated 4 people are below the cut 7 hours a day, 5 days a week. For the person most at risk: $\frac{10}{24} x \frac{6}{7}$	0.36
	$V_{(DT)}$	Based on the volume of land failing and its likely velocity when it hits the work area, it is estimated that the vulnerability of a person to being killed below the cut when the batter fails	0.2
	Risk $R_{(LoI)}$	$0.0001 \times 0.3 \times 0.36 \times 0.2 = 0.00000216$, 2.16×10^{-6}/annum	**2.16×10^{-6}**

NOTE: The level of these risks are **'ACCEPTABLE'** provided the recommendations given in **Section 10** are undertaken.

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9. SUITABILITY OF DEVELOPMENT FOR SITE.

9.1 GENERAL COMMENTS.

The proposed development is considered suitable for the site.

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 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 considered 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 October, 2013.

10.2.2 Due to the type of excavation required and proximity to adjoining structures, it is strongly recommended that an excavation contractor with demonstrable experience in this type of project be engaged to undertake the proposed works with the appropriate care and diligence. 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, underpinning or similar support for the back and side walls if deemed necessary, and the environmental and logistical elements of the project. Any soil and clay material at the top of the cut that cannot be removed or battered back will need temporary or permanent support.

10. RISK MANAGEMENT. (Continued)

10.2.3 After an initial site meeting with the building and excavation contractors, we recommend that the geotechnical engineer inspect the excavation face at hold points of 1.5m drops to ensure the competency of the rock strata and advise if any temporary or permanent support is required.

10.2.4 Temporary/permanent, underpinning structural support maybe 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 majority of excavation work will consist of cuts into the existing rock face. All potential rock cuts will require careful planning to avoid making currently stable rock layers less stable during excavation. The use of rock bolts, anchors and other stabilising methods will be necessary. The bulk of the cuts are expected be through competent Hawkesbury Sandstone. Care needs to be taken due to the varying quality of the sandstone and the presence of clay and weathered shale seams running between rock layers.

10.2.6 While it is anticipated the sandstone rock cut faces will stand unsupported at sub vertical or vertical angles for periods of time, we would recommend any required retaining structures to support the proposed cuts are to be installed as soon as possible after the excavation is complete. Any stabilising methods deemed necessary to ensure the stability of rock faces during excavation are to be installed prior to cutting where possible. Where not possible they are to be installed immediately after the cut is completed so long as a suitable methodology is used to ensure stability during excavation. The cut batter of any unconsolidated portion of cuts into soil and clay are to be battered back from vertical and, if exposed for an extended period, they are to be covered to prevent loss of moisture in dry weather and to prevent excess 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 depending upon the material encountered in the cuts, the likelihood of heavy rain and the length of period before permanent support is installed.

10. RISK MANAGEMENT. (Continued)

10.2.7 If the rock cut face after inspection from the geotechnical engineer is able to be left unsupported then the cut face is to be trimmed to have minimum 2.0 degree batter from vertical and for long term protection from erosional effects a suitable treatment against this deterioration is to be applied.

10.2.8 The cuts required for the construction of the proposed alterations and additions will be of approximately 1.5m steps to a maximum depth of approximately 5.0m. The bulk of the cut is expected to be through competent Hawkesbury Sandstone that underlies the unconsolidated soil profile. The following parameters are recommended for the design of retaining systems. In areas where the adjacent structures are set back from the property boundary by at least the depth of the excavation so that some soil movement maybe tolerated, we suggest 'active' (Ka) earth pressure coefficients to be used to calculate lateral pressures. Where movement cannot be tolerated, 'at rest' (Ko) earth pressure coefficients will need to be adopted. The structural engineer is to decide the amount of movement that could be tolerated. These recommended values are shown in the Table 10.2.8 below:-

Material	Unit Weight (kN/m^3)	Active Ka		At Rest Ko	Passive Kp
		Temporary	Permanent		
Unconsolidated material	20	0.36	0.42	0.6	2.37
Clay	20	0.3	0.35	0.52	2.9
Extremely low to low strength Sandstone	22	0.1	0.15	0.20	400 kPa
Medium Strength Sandstone	24	0*	0*	0*	4000 kPa

Sandstone Passive pressure is an Ultimate design load.
** Confirm with engineers after inspection*

Table 10.2.8

10.2.9 We recommend that dilapidation reports of nearby neighbouring structures should be carried out before and after the excavation work.

10. RISK MANAGEMENT. (Continued)

10.2.10 Given the bulk excavations required through competent sandstone and their proximity to both the neighbouring occupied residential buildings to the east of the existing dwelling, it may be considered prudent to monitor and limit vibration effects on the adjacent structures.

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. ft is expected that rock hammers with an approximate weight of 600-800kg will be adequate to operate within these tolerances.

10.2.11 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.

10.2.12 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.

10.2.13 All excavated material removed from 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. RISK MANAGEMENT. (Continued)

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 If new retaining walls are 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 to the rock material.

10.4. FOUNDATION MATERIALS AND FOOTINGS.

It is recommended that all footings are to be supported on the underlying sandstone bedrock. The design allowable bearing pressures are 800 kPa for spread footings or shallow piers. All footings are to be founded on material of equal consistency to prevent differential settlement.

All footings are to comply with minimum setbacks from existing sewer or any other infrastructure. Infrastructure owners are to be contacted regarding all requirements and standards in relation to works in proximity to their property

Note: The local geology is comprised of highly variable interbedded clays, shales and sandstones, with abundant detached joint blocks and sandstone floaters at surface and in the upper profile. Conditions may alter significantly across short distances. This variability should be anticipated and accounted for in the design and construction of any new foundations.

10.5. STORM WATER DRAINAGE.

All storm water runoff from the development is to be connected to the existing storm water system for the block through any tanks or onsite detention systems that may be required by the regulating authorities. 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 are to have adequate back wall drainage. Sub soil drains are to be placed lower than surface levels that are not to be affected by these waters.

10. RISK MANAGEMENT. (Continued)

10.6.2 Retaining walls are to be backfilled with non-cohesive free draining material and slotted pipe to provide a drainage layer immediately behind the wall. The free draining material is to be separated from the ground materials by geotextile fabric. These subsoil drainage systems are to be graded to an appropriate outlet.

10.7. INSPECTIONS.

10.7.1 We would recommend the geotechnical engineer meet on site with the building contractor and the excavation contractor to discuss and approve construction methodology and equipment used before bulk excavations commence.

10.7.2 It is recommended that the geotechnical engineer inspect the cut face at hold points of approximately 1.5m drops.

10.7.3 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 QY 00170 dated 25th January, 2021.

The Geotechnical Engineer is to meet with the building and excavation contractors' onsite before bulk excavations commence.

The Geotechnical Engineer is to inspect the cut face at regular 1.5m hold points.

The Geotechnical Engineer is to inspect and approve the foundation materials of all 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 QY 00170 dated 25th January, 2021.

The Geotechnical Engineer met with the building and excavation contractors' onsite before bulk excavations commenced.

The Geotechnical Engineer inspected and approved the cut face at regular 1.5m hold points.

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

13. RISK ANALYSIS SUMMARY.

HAZARDS	Hazard One	Hazard Two
TYPE	The site is classed slip affected under Council's Policy and a H1 Hazard. A failure of the slope across the property is considered to be a potential hazard.	The excavation for the proposed garage will require a maximum depth of excavation to be approximately 5.0m and is considered to be a potential hazard.
LIKELIHOOD	'Unlikely' (10^{-4})	'Unlikely' (10^{-4})
CONSEQUENCES TO PROPERTY	'Minor' (5%)	'Medium' (20%)
RISK TO PROPERTY	'Low'(5×10^{-6})	'Low'(2×10^{-5})
RISK TO LIFE	8.3×10^{-7}/annum	2.16×10^{-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.

HODGSON CONSULTING ENGINEERS PTY. LTD.

Author

Garth Hodgson MIE Aust
Member No. 2211514
Civil/Geotechnical & Structural Engineer

Reviewer

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

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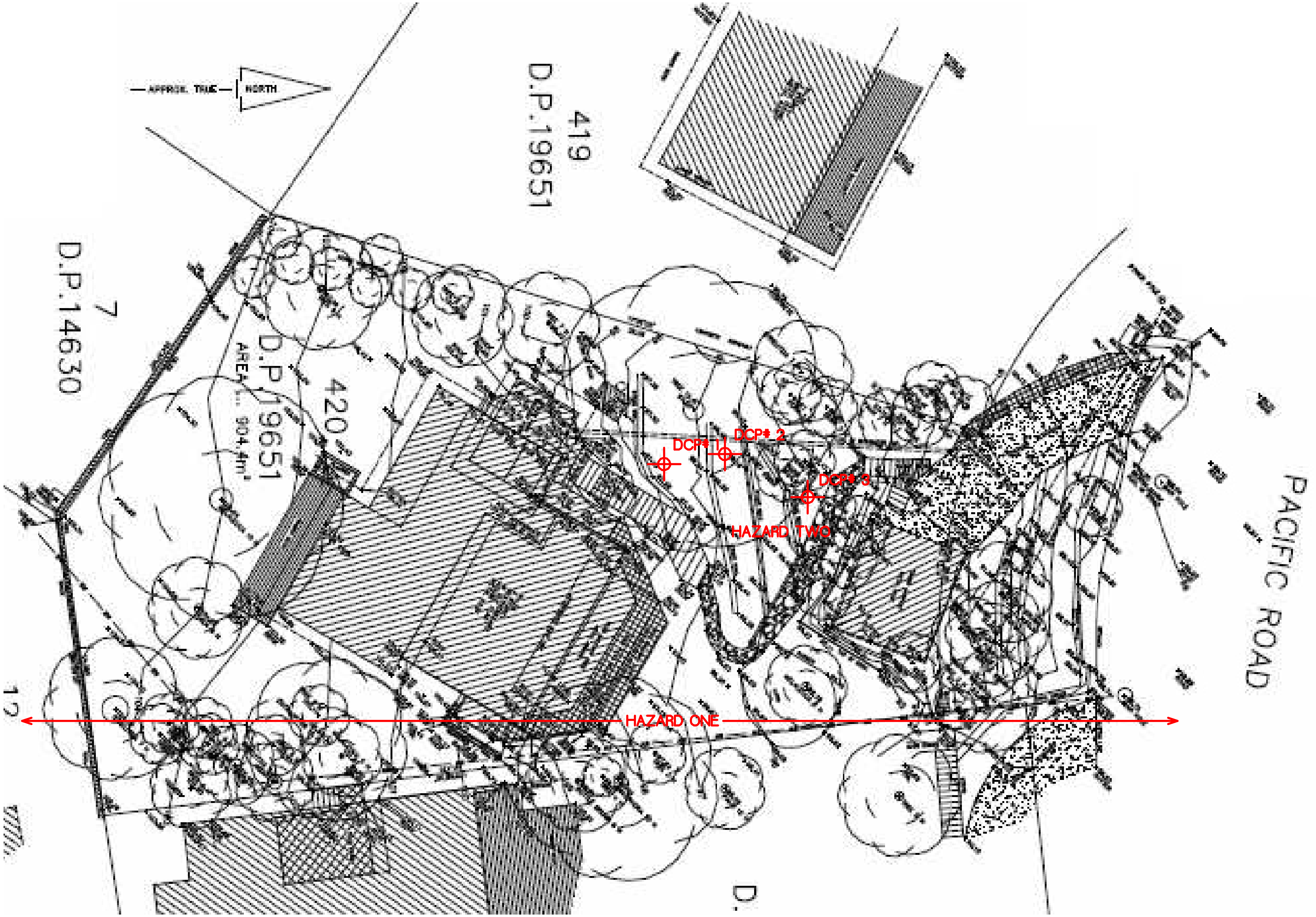
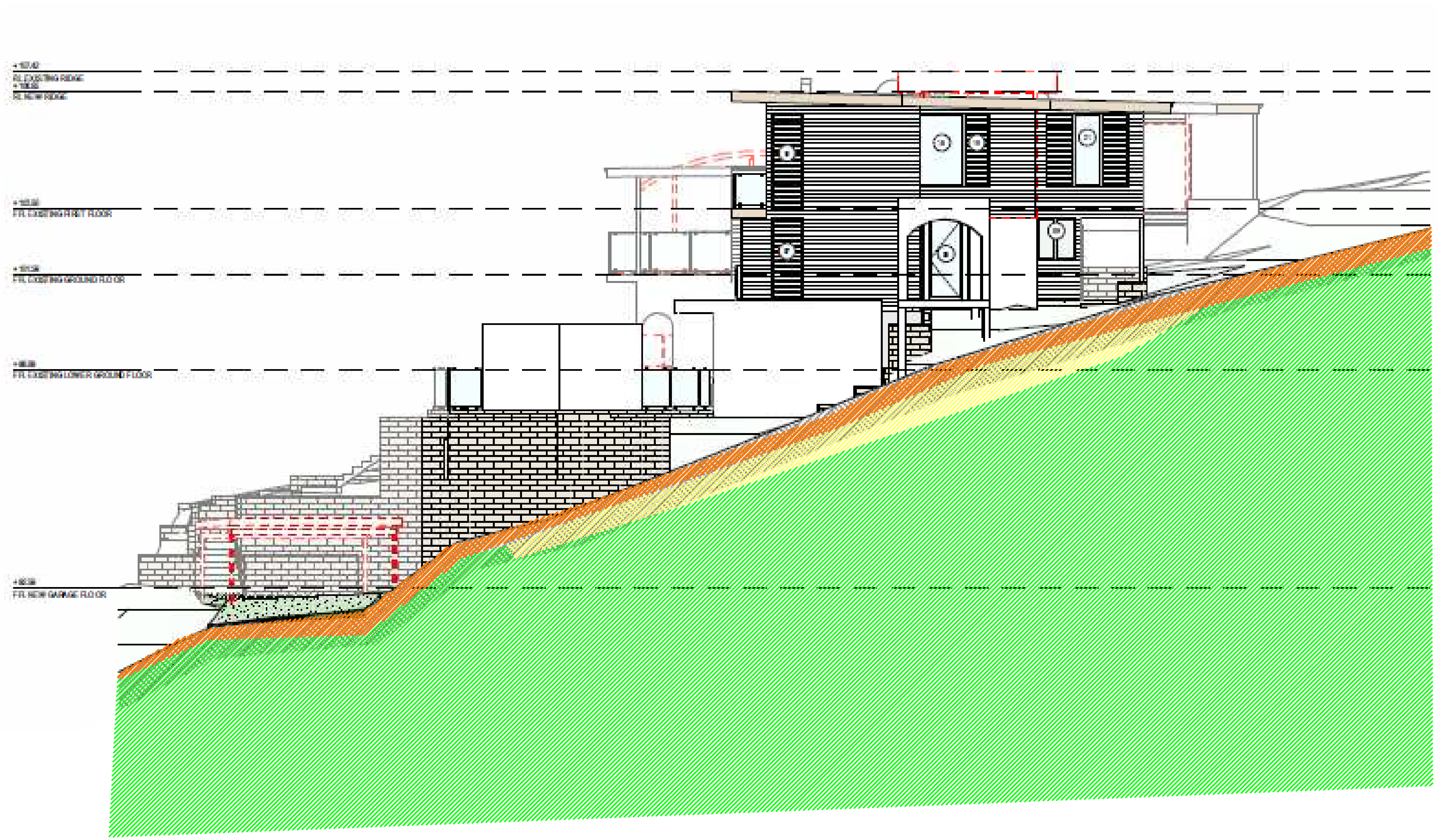


HODGSON CONSULTING ENGINEERS
GEOTECHNICAL | CIVIL | STRUCTURAL

PART SITE PLAN – DCP LOCATIONS AND HAZARDS	
Job No QY 00170	Address 28 PACIFIC ROAD PALM BEACH NSW
Scale NTS	



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

HODGSON
CONSULTING ENGINEERS
GEOTECHNICAL | CIVIL | STRUCTURAL

TYPE SECTION

Job No	Address
QY 00170	28 PACIFIC ROAD
Scale	PALM BEACH
NTS	NSW

STRATA PROFILE LEGEND

Fill	Narrabeen Group Rocks
Sandy Topsoil	Hawkesbury Sandstone
Sandy Loam	

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:
$\mathbf{R}_{(Prop)} = \mathbf{P}_{(H)} \times \mathbf{P}_{(S:H)} \times \mathbf{P}_{(T:S)} \times \mathbf{V}_{(Prop:S)} \times \mathbf{E}$ **(1)**

Where
$\mathbf{R}_{(Prop)}$ is the risk (annual loss of property value).

$\mathbf{P}_{(H)}$ is the annual probability of the landslide.

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

$\mathbf{P}_{(T:S)}$ is the temporal spatial probability. For houses and other buildings $\mathbf{P}_{(T:S)}$= 1.0. For Vehicles and other moving elements at risk1.0< $\mathbf{P}_{(T:S)}$ >0.

$\mathbf{V}_{(Prop:S)}$ 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:

$\mathbf{R}_{(LoL)} = \mathbf{P}_{(H)} \times \mathbf{P}_{(S:H)} \times \mathbf{P}_{(T:S)} \times \mathbf{V}_{(D:T)}$ **(2)**
Where

$\mathbf{R}_{(LoL)}$ is the risk (annual probability of loss of life (death) of an individual).

$\mathbf{P}_{(H)}$ is the annual probability of the landslide.

$\mathbf{P}_{(S:H)}$ 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.

$\mathbf{P}_{(T:S)}$ 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.

$\mathbf{V}_{(D:T)}$ 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.

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

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’.