HODGSON CONSULTING ENGINEERS

GEOTECHNICAL | CIVIL | STRUCTURAL

GEOTECHNICAL ASSESSMENT REPORT FOR PROPOSED ALTERATIONS AND ADDITIONS AT 12 WORROBIL STREET, NORTH BALGOWLAH

1. INTRODUCTION.

1.1 This Geotechnical Assessment Report has been prepared to accompany an application for Development Approval with Northern Beaches Council – Warringah Area.

1.2 The methods used in this Assessment are based on those described in *Landslide Risk Management March 2007*, published by the Australian Geo-mechanics Society.

1.3 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.

1.4 The site is located in land that is classified as Area B on the Landslip Risk Map published by Northern Beaches Council - Warringah. The methods used in this Assessment are based on those described in Landslide Risk Management March 2007, published by the Australian Geomechanics Society. Also Council checklist contained within Clause E10 of Warringah DCP and the WLEP Map identifying the Landslip Risk Class as highlighted (red) below:-

	LANDSLIP RISK CLASS *(Highlight indicates Landslip Risk Class of property)*
☐	*A Geotechnical Report not normally required*
☒	*B Geotechnical Engineer (Under Council Guidelines) to decide if Geotechnical Report is required*
☐	*C Geotechnical Report is required*
☐	*D Council officers to decide if Geotechnical Report is required*
☐	*E Geotechnical Report required*

2. PROPOSED DEVELOPMENT.

2.1 A proposed new garage under the existing residence.

2.2 Proposed new driveway and front landscaping including a new main entry.

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2. PROPOSED DEVELOPMENT. (Continued)

2.3 Various alterations and additions to the existing residence on the all the existing levels.

2.4 Details of the proposed development are shown on a series of architectural drawings prepared by Living Architectural Planning, Reference No: AF0222, Dwg No: 1 to 10, Issue A and dated February, 2022.

3. DESCRIPTION OF SITE & SURROUNDING AREA.

3.1 The site was inspected on 15th March, 2022.

3.2 This property is located on the high side of the road and has a southerly aspect. From the road frontage, the steep to very steep slope of the land rises across the property at maximum average angles of some 15 to 25 degrees. The slope lessens towards the rear of the property. The block is located towards the toe of a moderate to steep slope that falls from just beyond Woodbine Street to Burnt Bridge Creek Reserve.

3.3 Vehicular access to the block is via a concrete driveway on the south western side of the subject property. The concrete driveway to the subject property heads north to the car parking hardstand at south western front corner of the existing residence, Photo 1. Pedestrian access to the main residence is via the concrete driveway, a pathway and stairs on the eastern side of the driveway to the main entrance near the middle of the existing residence, Photo 2. Access to the rear of the property is via a concrete pathway and stairs on the western side of the existing residence, Photo 3. Observed under the rear of the existing residence was no evidence of movement due to instability, Photo 4. At the rear of the existing residence are four distinct levels stepping up to the rear boundary. A timber deck is surrounded by rendered masonry retaining walls at Level C, Photo 5. A level grass area is accessed by a timber deck from Level D of the existing residence and also by landside stairs, Photo 6. The existing swimming pool is the next level with exposed Hawkesbury Sandstone visible on the northern side, Photo 7. At the final level there is a level lawn area and cabana accessed by landscaped stairs, Photo 8.

3. DESCRIPTION OF SITE & SURROUNDING AREA. (Continued)

3.4 The existing stepped two storey brick and timber residence is in fair to good condition for its age. It is supported on brick walls and concrete piers in places founded directly on the underlying Hawkesbury Sandstone bedrock in places. Evidence of minor surface and subsurface flow of waters were observed under the existing residence.

3.5 The subject property and adjoining properties are mapped as a similar classification on the Landslip Risk Map 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.

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 ~0.5 to 1.2 metres or deeper where filling has be carried out.

5. SUBSURFACE INVESTIGATION AND SITE CLASSIFICATION.

5.1 Five 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:

5. SUBSURFACE INVESTIGATION AND SITE CLASSIFICATION. (Continued)

NUMBER OF BLOWS - Conducted using a 9kg hammer, 510mm drop and conical tip -					
DEPTH (m)	**DCP#1**	**DCP#2**	**DCP#3**	**DCP#4**	**DCP#5**
0.0 to 0.3	**4/0.300**	1	**1/0.210**	3	6
0.3 to 0.6		7		5	**9/0.075**
0.6 to 0.9		**4/0.190**		43	
0.9 to 1.2				**40/0.130**	
End of Test	**0.300**	**0.790**	**0.210**	**1.030**	**0.375**
~ RL top of test AHD	**54.700**	**54.360**	**53.100**	**52.800**	**52.500**
~ RL end of test AHD	**54.400**	**53.570**	**52.890**	**51.770**	**52.125**

DCP TESTING NOTES:

DCP#1	4 Blows for 0.300m then 8 blows for 0.003m. Strong Double Bounce. Refusal in rock or floater. Tip dry with damp shaft and clean.
DCP#2	4 Blows for 0.190m then 8 blows for 0.005m. Strong Double Bounce. Refusal in rock or floater. Tip damp with orange and red fragments on tip.
DCP#3	1 Blows for 0.210m then 8 blows for 0.003m. Strong Double Bounce. Refusal in rock or floater. Tip dry and clean.
DCP#4	40 Blows for 0.130m then 8 blows for 0.030m. Still going in weathered rock. Tip damp with orange and brown on tip.
DCP#5	9 Blows for 0.075m then 8 blows for 0.020m. Double Bounce. Refusal in rock or floater. Tip dry with white sandstone on very 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.

Due to the shallow or absent topsoils at many places across the block, natural ground waters will travel downslope along the rock. Evidence of this could be seen underneath the residence with water travelling across the rock interface.

6.2 SURROUNDING AREA.

Overland stormwater flow entering the site from the adjoining properties was not evident. Normal surface stormwater runoff will be managed by the street gutter drainage system for the road above though stormwater overflow could enter the site from above during intense or extended rainfall. Subsurface flows for the higher neighbouring site is possible.

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 subject property according Council's mapping maybe affected by slope instability. 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 at Level A will require a maximum depth of excavation to be approximately 2.0 to 2.5m 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 at Level A will require a maximum depth of excavation to be approximately 2.0 to 2.5m. 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.

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 top 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	0.3
	Risk $R_{(LoI)}$	0.0001 x 0.1 x 0.83 x 0.3 = 0.00000249, 2.49 x 10^{-6}/annum	**2.49 x 10^{-6}**
HAZARD TWO	The excavation for the proposed garage at Level A will require a maximum depth of excavation to be approximately 2.0 to 2.5m. 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	0.1
	$P_{(TS)}$	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	0.1
	Risk $R_{(LoI)}$	0.0001 x 0.1 x 0.36 x 0.1 = 0.00000036, 3.6 x 10^{-7}/annum	**3.6 x 10^{-7}**

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

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 as published by the Australian Geo-mechanics Society in March 2007, provided the recommendations given in **Section 10** are undertaken.

10. RISK MANAGEMENT.

10.1. TYPE OF STRUCTURE.

The proposed structures are considered suitable for the 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 January, 2020.

10.2.2 Temporary/permanent structural support and/or underpinning for the existing structures may be required during the excavation and construction phase of the project. This is to be designed, certified and supervised by the structural engineer. Any additional support that may be required is to be designed by the Structural Engineer

10.2.3 The cuts for the proposed garage at Level A will require a maximum depth of excavation to be approximately 2.0 to 2.5m. These are expected to be through the underlying competent Hawkesbury Sandstone. The requirements for permanent retaining structures are to be determined on site during construction as the sandstone may be left unsupported. Geotechnical engineer is to confirm.

10. RISK MANAGEMENT. (Continued)

10.2.4 Any minor excavations in soft soils are to be battered back and are to be kept dry to avoid collapse during the works. Temporary or permanent support is to be assessed and designed by the structural Engineer. All retaining walls are to be constructed as soon as possible.

10.2.5 Excavations required will be through what is expected to be through low to medium strength sandstone in some locations. Given the proximity to neighbouring occupied residential buildings it would be considered prudent to monitor and limit vibration effects on the adjacent structures.

Any excavation through rock must be carried out using equipment that results in minimal vibration so as not to impact on the existing structures or neighbouring properties. A Rock Saw is ideally suited for this purpose. If hydraulic picks are to be used the energy input per blow should not exceed 300 Joules. A 300kg Rock Breaker produces 250 to 600 Joules depending on the type (brand) of breaker. This should be confirmed with the manufacturer. Rock breaking should be carried out in short bursts to prevent amplification of vibration. If this cannot be carried out then the following should be implemented to monitor vibrations.

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.

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.

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

10. RISK MANAGEMENT. (Continued)

10.3. FILLS.

10.3.1 If minor 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.

10.4. FOUNDATION MATERIALS AND FOOTINGS.

It is recommended that all footings be supported and socketed 300mm into the underlying sandstone bedrock where piers as necessary. The design ultimate bearing pressures are 850 kPa for spread footings or shallow piers. All footings are to be founded on material of equal consistency to prevent differential settlement.

10.5. STORM WATER DRAINAGE.

Storm water generated from any new works is to be piped to the existing stormwater system for the block through any water tanks or onsite detention systems that may be required by the regulating authorities.

10.6. SUBSURFACE DRAINAGE.

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. Where possible nuisance subsurface flows are to be controlled and directed away from possible affected areas.

10.7. INSPECTIONS.

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 or stop the issuance of relevant certificates.

11. GEOTECHNICAL CONDITIONS FOR ISSUE OF CONSTRUCTION CERTIFICATE.

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

The work to be completed is to be carried out in accordance with the Risk Management Report QP 00309A dated 31st March, 2022.

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 to be completed was carried out in accordance with the Geotechnical Assessment Report QP 00309A dated 31st March, 2022.

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 subject property according Council's mapping maybe affected by slope instability. A failure of the slope across the property is considered to be a potential hazard.	The excavation for the proposed garage at Level A will require a maximum depth of excavation to be approximately 2.0 to 2.5m and is considered 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	2.49×10^{-6}/annum	3.6×10^{-7}/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.

Garth Hodgson MIE Aust
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Photo 1

Photo 2

Photo 3

Photo 4

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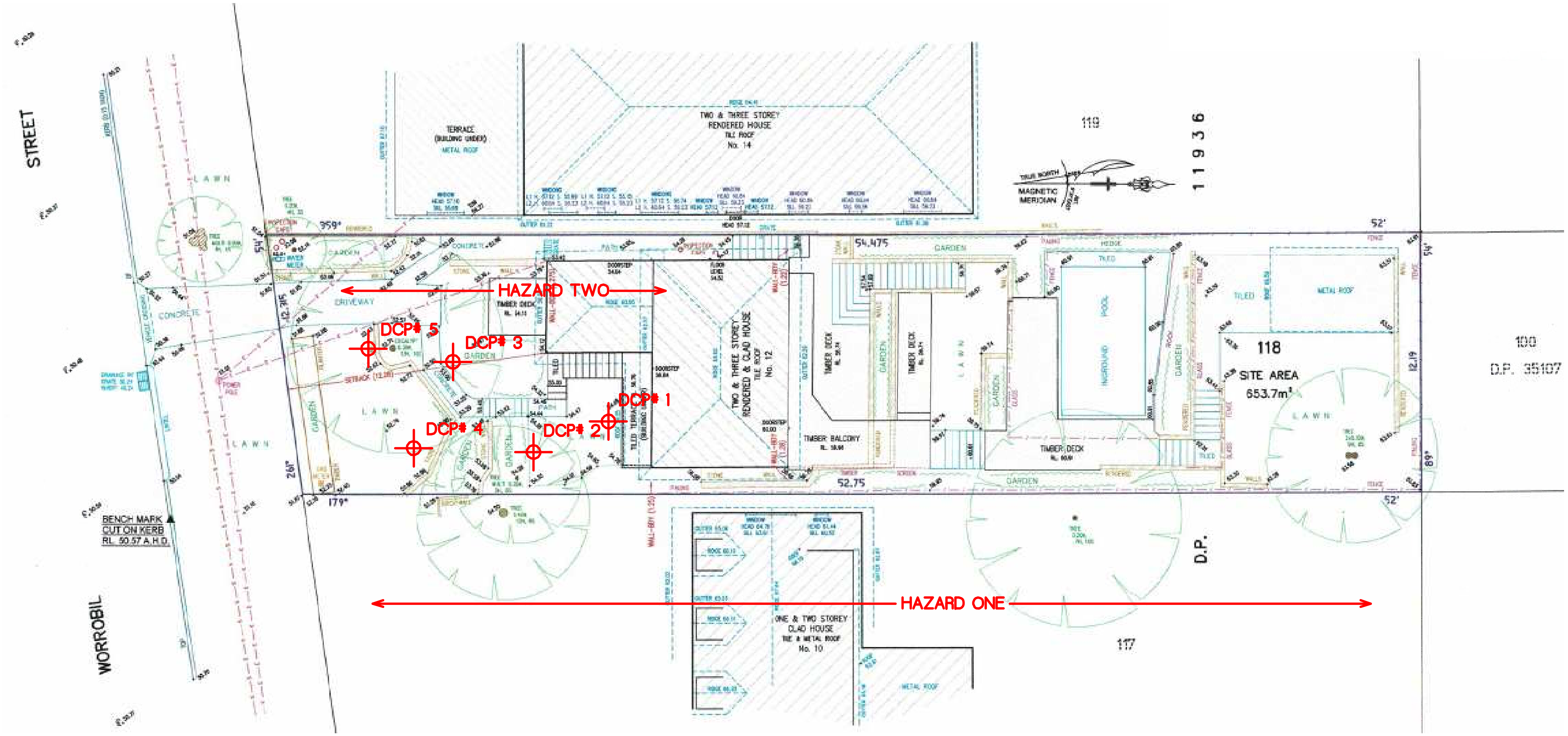
Photo 5

Photo 6

Photo 7

Photo 8



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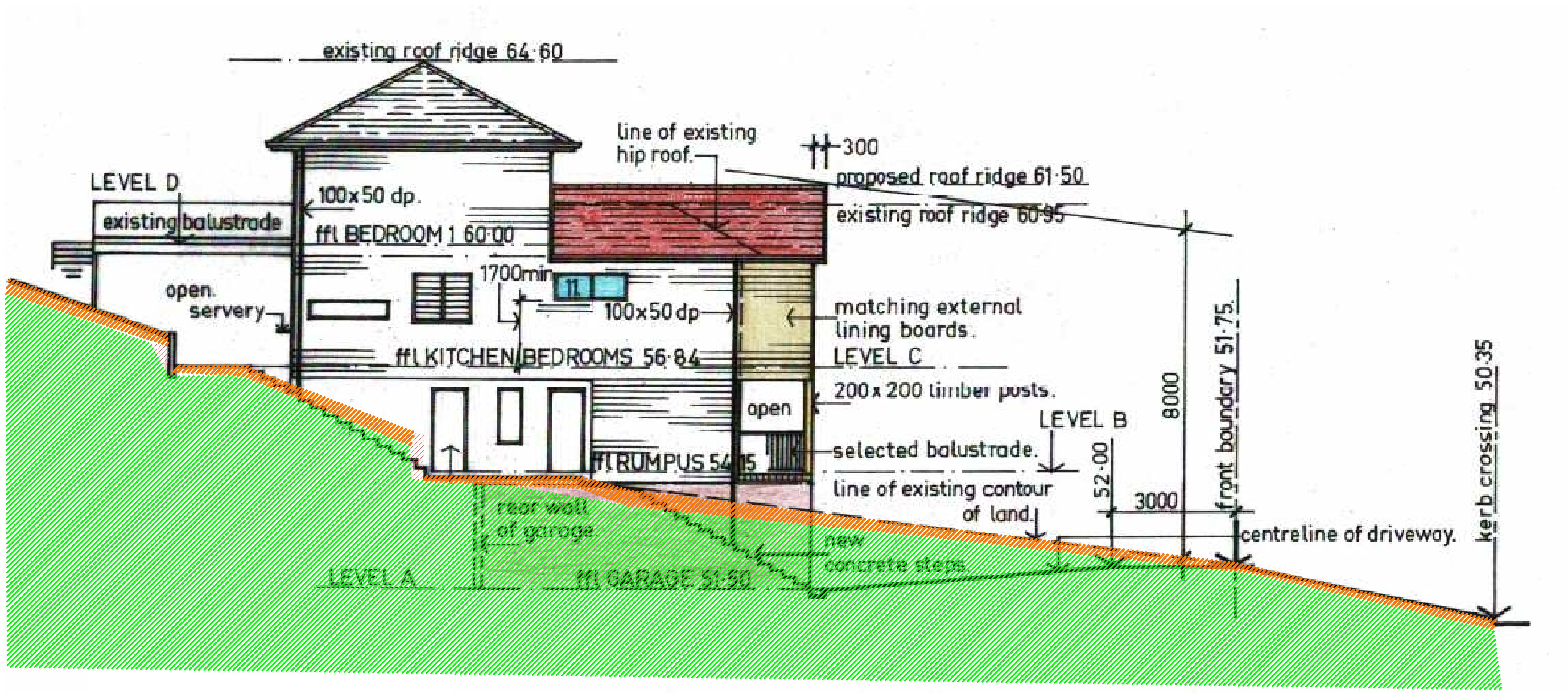
SITE PLAN - HAZARDS & DCP LOCATIONS

Job No	Address
QQ 00309	12 WORROBIL STREET NORTH BALGOWLAH NSW
Scale	
NTS	



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

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TYPE SECTION	
Job No: QQ 00309	Address: 12 WORROBIL STREET NORTH BALGOWLAH NSW
Scale: NTS	

STRATA PROFILE LEGEND

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

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 risk$1.0< \mathbf{P}_{(T:S)} >0$.

$\mathbf{V}_{(Prop:S)}$ 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’.