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

RISK ANALYSIS & MANAGEMENT FOR PROPOSED ALTERATIONS & ADDITIONS AT 10 TALGARA PLACE BEACON HILL

1. INTRODUCTION.

1.1 This assessment has been prepared to accompany an application for development approval.

1.2 By reference to Clause E10 of Warringah DCP and the WLEP Landslip Risk Map, the site is located in land that is subject to Area B classification. The methods used in this Assessment are based on those described in Landslide Risk Management March 2007, published by the Australian Geomechanics Society.

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

2. PROPOSED DEVELOPMENT.

2.1 Lower ground floor additions including new cantilevered entertainment deck, existing deck extension and rumpus room.

2.2 Ground floor additions and alterations including new deck, garage, bedrooms and various internal wall changes.

2.3 New First Floor level bedrooms.

2.4 New swimming pool and access stairs at the rear of the property.

2.5 Details of the proposed development are as per architectural drawings prepared by Zugai Strudwick Architects Project No: 1733 Dwg No: DA 01 to DA 41, Revision C and dated 11th October, 2018.

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3. DESCRIPTION OF SITE & SURROUNDING AREA.

3.1 The site was inspected on 3rd May 2018 for purpose of this assessment.

3.2 This property is located on a moderate to steep slope that falls from the road frontage towards the south and has a southerly aspect. At the rear of the existing residence is a stepped rock escarpment of total approximate height of 6.0 metres. The average slope above the rock escarpment is moderate averaging approximately 7.0 degrees with the average slope below the rock escarpment being steep at approximately 19.0 degrees.

3.3 Vehicle access to the property is via a strip concrete driveway that leads to a single car garage on the north western corner of the existing residence, Photo 1. Pedestrian access is also via the driveway and a pathway to the main entrance. Exposed sandstone bedrock was visible at the front to the property, Photo 2. Access to the rear of the property is via a pathway on the western side of the existing residence where sandstone bedrock was also visible, Photo 3. Access is also possible to the rear yard on the eastern side of the existing residence but is not a formalised pathway, Photo 4. An existing deck area is over a terrace created by a concrete blockwork wall near the top of the rock escarpment, Photo 5. No access to the area below the rock escarpment was available at the time of inspection with access via the neighbouring property to the north. The approximately 6.0 metre high stepped escarpment runs along the subject and neighbouring properties, Photo 6. A Council stormwater pipe runs along the subject properties western boundary with the exposed pipe visible in Photo 6. At the base of the rock escarpment the lower slope is littered with displaced joint blocks (Rock Floaters) of various sizes, Photo 7. A large Norfolk pine dominates the south western corner of the site directly next to the Council pipeline, Photo 8.

3.4 The multistorey timber and masonry house is in fair to good condition. The supporting brick walls and piers show no signs of movement. No evidence of significant cracking or movement was observed at the time of our inspection.

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. 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 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.

4. GEOLOGY OF THE SITE. (Continued)

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. Where not exposed at the surface, sandstone bedrock is expected to be encountered at depths of approximately 0.5 to 1.5 metres across the subject property or deeper where filling has been undertaken.

5. SUBSURFACE INVESTIGATION.

Due to the abundant outcropping sandstone visible across the site, no subsurface testing was deemed necessary.

6. DRAINAGE OF THE SITE.

6.1 ON THE SITE.

The site is naturally well drained.

6.2 SURROUNDING AREA.

Overland stormwater flow entering the site from the adjoining properties was not evident. During heavy prolonged rain fall water may enter from this property. Normal overland flow may enter the property from the slope above.

7. GEOTECHNICAL HAZARDS.

7.1 ABOVE THE SITE.

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

7.2 ON THE SITE.

The slope that rises across the site is considered a potential hazard (**HAZARD ONE**).

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7. GEOTECHNICAL HAZARDS. (Continued)

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 drops across the property at average angles up to 7.0 to 19.0 degrees on either side of the rock escarpment. The existing residence was found to display no evidence of significant cracking or movement. No evidence of significant slope instability was 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}).

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
No evidence of significant movement was observed on the site.
$\mathbf{P_{(H)}} = 0.0001$/annum

8. RISK ASSESSMENT. (Continued)

8.2.2.2 Probability of Spatial Impact
The existing residence is situated toward the upper half of the slope.
$\mathbf{P_{(SH)}} = 0.1$

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 hits the house, it is estimated that the vulnerability of a person to being killed in the house when a landslide hits is 0.01
$\mathbf{V_{(DT)}} = 0.01$

8.2.2.5 Risk Estimation
$\mathbf{R_{(LoI)}}$ = 0.0001 x 0.1 x 0.83 x 0.01
= 0.000000083
$\mathbf{R_{(LoI)}}$ = 8.3 x 10^{-8}/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. SUITABILITY OF DEVELOPMENT FOR SITE. (Continued)

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 Landslide Risk Management March 2007, published by the Australian Geomechanics Society, 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 March, 2015.

10.2.2 The foundations for the cantilevered entertainment deck are to be a minimum 1.0 metre away from the back of any undercut of the rock escarpment. All foundations are to be taken to the underlying rock.

10.2.3 The foundations of the proposed swimming pool will be complicated given the size and number of the rock floaters scattered over the lower slope. Piers will be required to be taken to the underlying bedrock. The swimming pool position has been recommended to provide that the disturbance and excavation is kept to minimum thus reducing the removal or the breaking of these rock floaters. We have

10. RISK MANAGEMENT. (Continued)

also recommended the swimming pool location is to be offset and clear of the rock escarpment so that the disturbance and excavation is kept to minimum. The position is also recommended to be adequately away from the Council stormwater pipeline and the Main Sewer pipeline. Advice to the detrimental effect of the pool foundations on the root system of the Norfolk Pine is to be obtained from suitably qualified arborist.

10.2.4 We recommend that any excavation through rock be carried out initially using a rock saw to minimise the vibration impact and disturbance on the adjoining residence. Any rock breaking must be carried out only after the rock has been sawed and in small bursts 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 energy input per blow of hydraulic picks should not exceed 600 Joules. A 300kg rock breaker produces ~600 Joules. It should be noted the input per blow varies between types of hammers so this is to be confirmed with the manufacturer.

10.2.5 All excavated material removed from site is to be removed from the site 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.

10.4. FOUNDATIONS, FOOTINGS AND SITE CLASSIFCATION

10.4.1 It is recommended that footings for the proposed works are to be taken to and where applicable potted into the underlying rock, using piers as necessary. The design allowable bearing pressures are 1000 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 where already not at the surface will be encountered at approximate depths of 0.5m, though may be deeper where fill has been placed. The swimming pool piers may be deeper given the

10. RISK MANAGEMENT. (Continued)

amount material lying over the existing slope. Further testing would be required to determine the depth to rock.

10.4.2 We would recommend the site be classified as 'Class A' as outlined in AS 2870. Class A is most sand and rock sites with little or no ground movement from moisture changes.

10.5. STORM WATER DRAINAGE.

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

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 The location of the entertainment deck and swimming pool foundations are to be inspected and approved by the geotechnical engineer before and/or during excavation after any necessary investigation excavation has been carried out.

10.7.2 The removal and/or breaking up of any rock floaters if required are to be inspected and approved by the geotechnical engineer before works are commenced.

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 MT 31477 dated 26th November, 2018.

The Geotechnical Engineer is to inspect and approve the location of the entertainment deck and swimming pool foundations before and/or during excavation after any necessary investigation excavation has been carried out.

The Geotechnical Engineer is to inspect and approve the removal and/or breaking up of any rock floaters if required before works are commenced.

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 31477 dated 26th November, 2018.

The Geotechnical Engineer inspected and approved the location of the entertainment deck and swimming pool foundations before and/or during excavation after any necessary investigation excavation has been carried out.

The Geotechnical Engineer inspected and approved the removal and/or breaking up of any rock floaters if required before works commenced.

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

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13. RISK ANALYSIS SUMMARY.

HAZARDS	HAZARD ONE
TYPE	The slope that rises across the property is considered a potential hazard
LIKELIHOOD	'Unlikely' (10^{-4})
CONSEQUENCES TO PROPERTY	'Minor' (5%)
RISK TO PROPERTY	'Low' (5×10^{-6})
RISK TO LIFE	8.3×10^{-8}/annum
COMMENTS	This level of risk is **'ACCEPTABLE'** provided the conditions in **Section 10** are followed.

JACK HODGSON CONSULTANTS PTY. LIMITED.

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

Photo 1

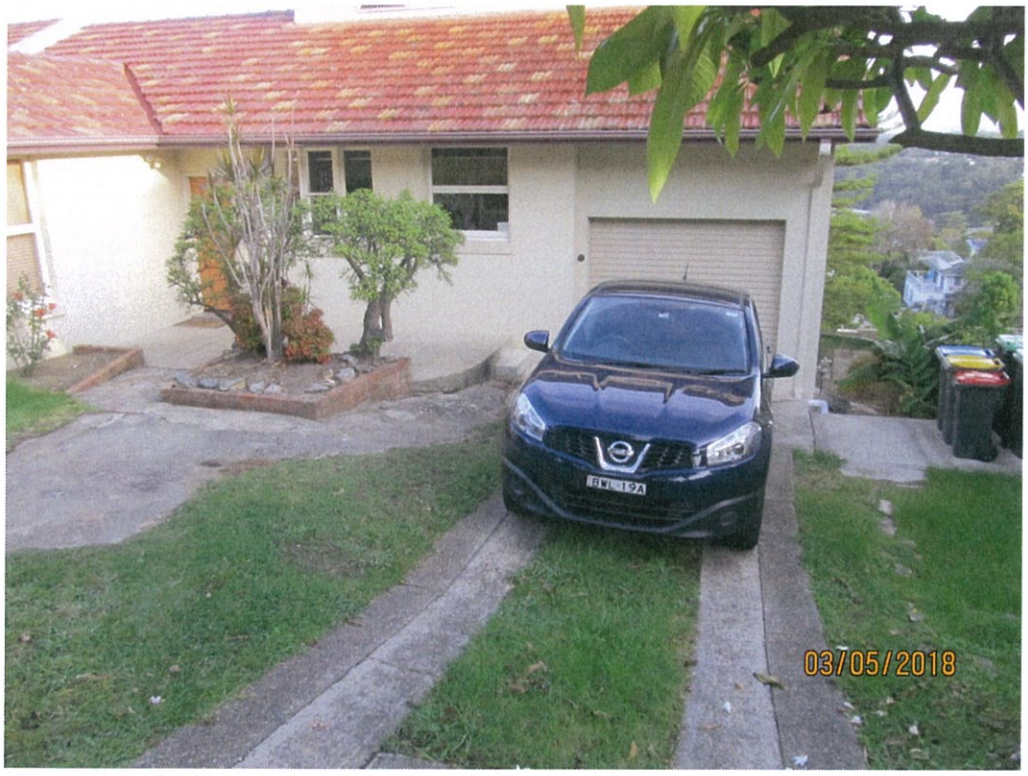


Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

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.

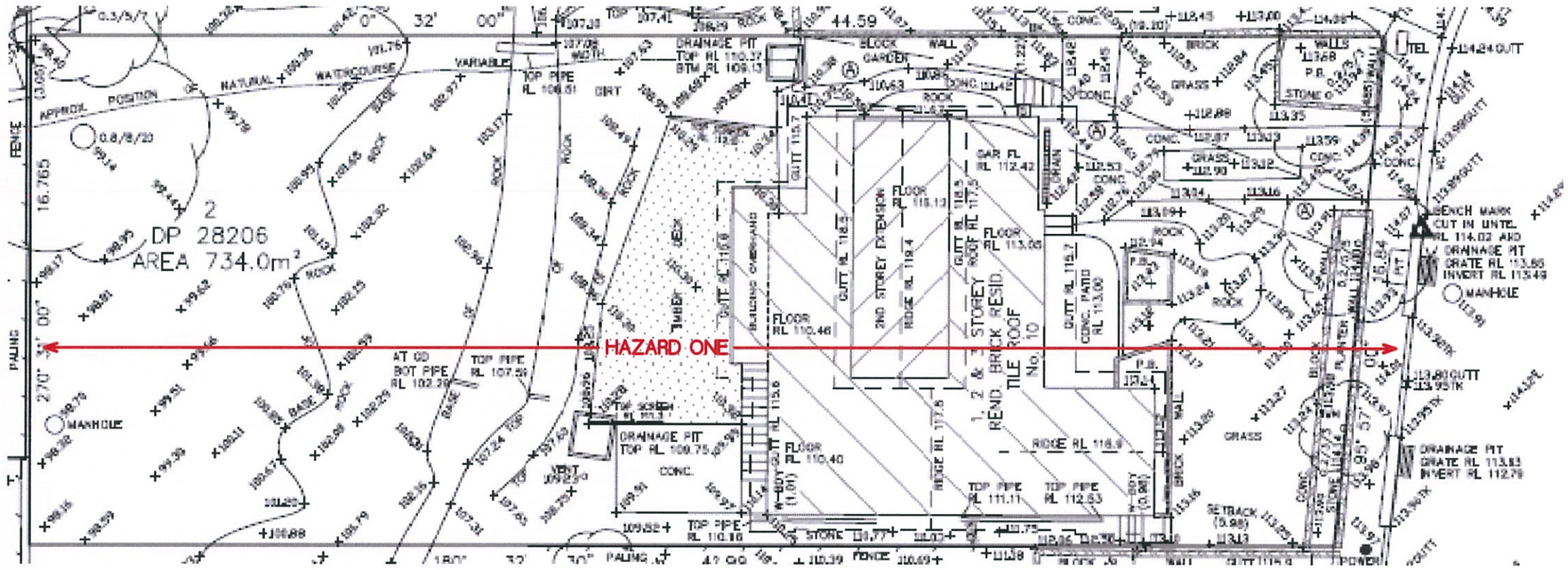
P(S:H) is the probability of spatial impact of the landslide impacting a building (location) taking into account
the travel distance and travel direction given the event.

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'.



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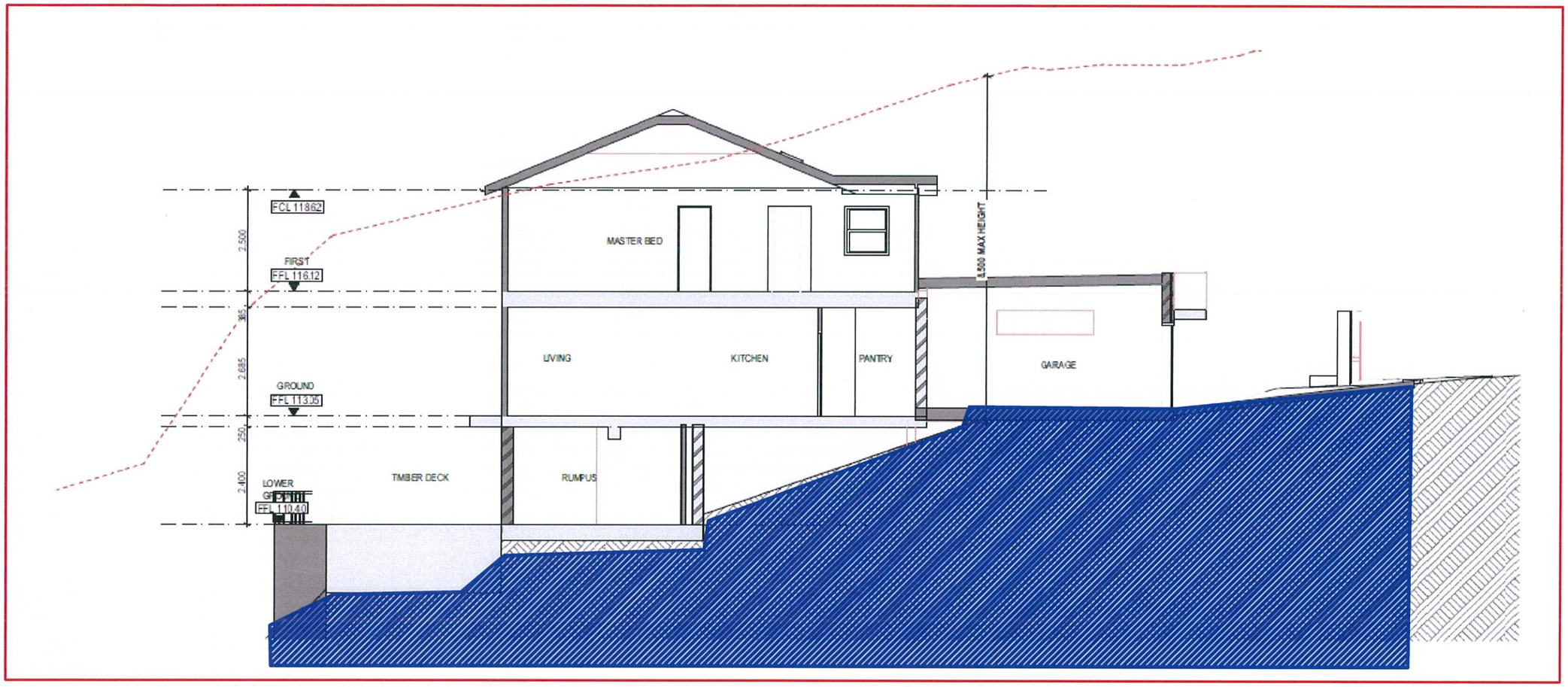
SITE PLAN - HAZARD ONE

Job No	Address
MT 31477	10 TALGARA PLACE
Scale	BEACON HILL
NTS	NSW



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

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TYPE SECTION

Job No	Address
MT 31477	10 TALGARA PLACE
Scale	BEACON HILL
NTS	NSW

STRATA PROFILE LEGEND

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