DAVIES GEOTECHNICAL
CONSULTING ENGINEERS

10 February 2016 15-062.A

Mr & Mrs A Toohey
14 Yeats Ave
KILLARNEY HEIGHTS NSW 2087

Attention: Andrew Toohey

Dear Andrew,

re: **GEOTECHNICAL ASSESSMENT / LANDSLIP RISK ISSUES**
PROPOSED RESIDENTIAL DEVELOPMENT– COMBINED SUBDIVISION & DA
NO.14 (LOTS 502 & 503 DP218045) YEATS AVE KILLARNEY HEIGHTS NSW

In response to a request from Robert Ursino Architecture & Design, Davies Geotechnical Pty Ltd has undertaken a geotechnical assessment for a proposed residential development at the above site. The assessment is required at the DA stage, as part of a combined subdivision and DA.

Method of Assessment

The assessment was undertaken in accordance with our scope of work advised on 4 November 2015. A site inspection was undertaken by the undersigned on 19 January 2016.

Architectural details for the currently proposed development were provided for the purposes of the assessment. Survey information for the property was available from the architectural drawings.

The following information was supplied to us in electronic format:

Document	Prepared by	Reference
Drawings – details of proposed subdivision and new development	Robert Ursino Architecture & Design	Project No. 15.04, set of 12 drawings Rev A dated 6 October 2015
Survey	Unknown	Provided on Drawing No.DA201-A

The assessment relies on our site inspection, geotechnical observations and mapping, and past experience in this locality. Sampling and testing of the site soils and bedrock was not intended and was not undertaken for the assessment.

Landslip Risk Issues

Warringah Council's Hazard Mapping (Landslide Risk) shows that the property lies within Landslip Risk Class B (refer map extract in Attachment A).

The Council's DCP/E10-Landslide Risk requires land in this category to be assessed under a Checklist to determine whether or not a geotechnical report is required addressing geotechnical risk in accordance with AGS 2007 Guidelines.

The site and slope features within and affecting the property were determined from a geotechnical site visit undertaken on 19 January 2016. The DCP Checklist has been completed and is attached.

Our assessment and opinions on slope instability risk for the site and proposed development are determined in accordance with the Australian Geomechanics Society's Landslide Risk Management Concepts and Guidelines (2007), as required by the DCP.

It should be noted that Warringah Council's DCP (*Objectives – to ensure development is* ***"geotechnically stable"***) does not define the level of "acceptable risk". In accordance with usual practice (refer Table 1 in AGS 2007), we have adopted Low Risk as the threshold for acceptable risk level for property damage/economic consequence, and 10^{-6} per annum for loss of life.

Site Conditions

A Locality Plan is provided in the attached Figure 1 and the Site Plan from the architectural details is provided as Figure 2. Site photographs are presented in Figures 3A & 3B.

The property at No.14 comprises Lots 502 & 503 DP218045 and is on the eastern upslope side of Yeats Ave just north from the intersection with Rathowen Pde. Lot 502 adjoins No.92 Rathowen Pde on the southern side.

The land is presently developed with a 1 and 2-storey, split level brick and clad dwelling, with a carport and in-ground pool. The development on No.14 spans across both allotments.

Yeats Ave is formed in a rock cutting across the frontage of No.14, which exposes sandstone bedrock. The cutting on the frontage is some 2m or so maximum height (refer photograph in Figure 3A). From the top of the road cutting, the land rises at a gentle to moderate grade (8^o – 10^o) to the east to the rear of the property, which borders on a public reserve.

Beyond the rear of No.14, the slope flattens and extends further east and south as a sandstone ridge/plateau. The northern side of the ridge/plateau steepens and falls to the north within the public reserve.

Sandstone bedrock is exposed at surface extensively over the site and adjacent land.

The existing development is partly benched into the slope at the south-eastern rear corner to about 1.4m depth and at the front carport to about 1.2m depth. Sandstone bedrock is exposed in the excavated faces.

Survey details for the property are available on the architectural drawing No.201-A (Figure 2 herewith).

The site is within the mapped extent of the Hawkesbury Sandstone (reference 1).

Proposed Development

Details of the proposed development are provided on the architectural drawings listed above.

The present boundary between Lots 502 and 503 will be adjusted to suit the footprint of the existing dwelling on No.14 and the proposed dwelling.

The development proposed on Lot 502 is for a two-level residence with basement garage and a pool. The garage level at RL103.8 will be approximately 2.7m maximum below present surface level. The garage excavation is 1.5m from the side boundary with the adjoining development on No.92.

The proposed development is illustrated by the plan and sections provided in Figure 4.

Discussion and Recommendations

Suitability for Development

The site is considered suitable for the proposed development from a geotechnical viewpoint.

In accordance with the DCP Checklist, it is our recommendation that a geotechnical report addressing landslide risk is not required in connection with the proposed development.

Reference should be made to ***Landslip Risk Issues*** above, and to the attached Checklist and Flowchart.

Recommendations are provided below for guidance at the DA-stage, relating to the geotechnical aspects of the development.

Footings and Excavation

The footings for the new development should be taken to a uniform bearing on or within sandstone bedrock. A serviceability design bearing pressure of 1000kPa is recommended (Pells et al, reference 2), for preliminary design.

Depending on the nature and conditions of the bedrock revealed in the site preparations, some areas of the building footings and pool may be supported directly on the bedrock if preferred for the design or construction. Class III Sandstone is recommended for this purpose. This will need to be verified by the structural engineer and by engineering inspection of the footings and bulk excavation.

Confirmation of the ground conditions in the excavation and the founding levels of future footings is recommended during construction by a geotechnical engineer's inspection. The rock levels and rock conditions should be determined in relation to the requirements and restrictions for excavation in accordance with Attachment B.

The engineering and building details should allow for relief of groundwater or seepage that could occur or accumulate behind the basement walls or below the basement floor slab.

Excavation Conditions/Support Requirements

We anticipate that sandstone bedrock in the strength range of Class III/Class II Sandstone (Pells et al, reference 2) would be encountered in the garage excavation. The rock conditions could be varied locally due to jointing and from the effects of weathering. Overburden materials are anticipated to comprise shallow intermittent sandy soil.

For the construction stage, the rock excavation is anticipated to be capable of self-support with vertical excavation faces. This will be subject to the actual rock conditions being verified progressively during the excavation, and assumes the excavation methods adopted by the builder will result in sound rock conditions.

Excavation in soil above the bedrock, and including any weak or weathered rock layers, should be trimmed to a temporary (short-term) batter of no steeper than 45^{o} (1H:1V) for limited depths (say 0.5m). Soil layers deeper than 0.5m should be benched back from the line of excavation.

Variations from this recommendation would need to be verified by a geotechnical engineer's inspection.

The detailed requirements will be governed by the soil depth and bedrock conditions, to be determined prior to commencement of the bulk excavation.

Where reliance is placed on vertical excavation faces in bedrock, any requirements for local treatment or additional support of the excavated rock faces if appropriate to the work (eg, dental concrete, shotcrete, rock bolts) which may be dictated by variations in the rock weathering, material strength or structural features (bedding and jointing), are to be determined by a geotechnical engineer during the progress of the excavation.

Rock Excavation

Recommended generic controls for rock excavation are provided in Attachment B for guidance in planning the proposed excavation work. Specific requirements noted elsewhere herein, or developed as part of the design following development consent, may supersede the general recommendations in Attachment B.

A dilapidation survey of the adjoining dwelling structure on No.92 is recommended prior to commencement of excavation, in accordance with anticipated requirements of Warringah Shire Council.

Excavation methods and equipment should be limited to rock sawing and small hydraulic rock hammer equipment, or pneumatically operated hand excavation tools. Use of rock hammer equipment closer than 3m to the adjoining development would only be permitted if:-

- the size of hammer is limited to a Krupp 300kg or equivalent, or smaller,
- vibration monitoring of adjoining properties is undertaken in accordance with recommendations determined by a geotechnical engineer, to verify that the use of the equipment does not result in vibrations at the adjoining structures exceeding a peak particle velocity (PPV) of 5mm/sec, and
- all recommendations provided in Attachment B and/or as otherwise developed from the engineering design are strictly followed.

Any variations proposed to the recommended procedures or equipment (as above), such that the risk of damage to the developments on adjoining properties might be increased, must be assessed by a geotechnical engineer prior to commencement, on the basis of potential for damage due to vibration effects.

Excavation Support Design

The excavation support requirements for temporary and permanent design situations are to be detailed by a suitably experienced consulting structural/civil engineer. Any temporary support walls should be capable of being installed prior to, or contemporaneously with the progress of the bulk excavation. Details are to be prepared by the structural/civil engineer and reviewed by a geotechnical engineer.

The temporary excavation batters as noted above in soil overburden can be adopted for design purposes and construction planning, subject to the batter slopes being achieved in the available space.

At all times, the excavation will be required to maintain stable conditions within the property and on the adjoining land. The design parameters and requirements for any temporary shoring proposed by the builder should be assessed and detailed at the time of construction, and approved by the structural engineer.

The ground conditions exposed in the excavation should be observed and assessed by a geotechnical engineer. The rock levels and rock conditions should be determined in relation to the requirements and restrictions for excavation in accordance with Attachment B, and the requirements of the engineering design for temporary and permanent excavation support.

Summary

The above report provides a geotechnical assessment of the site conditions and proposed development on Lot 502 (part of No.14) Yeats Ave Killarney Heights in response to the requirements of Warringah Shire Council's DCP.

Discussion and recommendations are provided for engineering controls for the building development and proposed garage/basement excavation anticipated to be within sandstone bedrock.

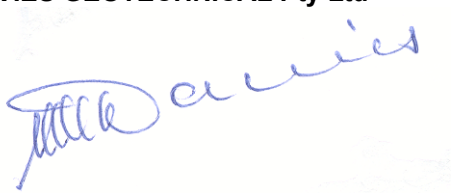
Geotechnical inspection, assessment of rock and general ground conditions, and confirmation of the advice provided above are required during the excavation for the proposed works.

Attachment C – Limitations of This Report – is provided for further understanding of the context of the investigation undertaken, and the limits of the recommendations provided in the report.

If any conditions are encountered during construction that vary significantly from those described or inferred in the above report, it is a condition of the report that we be advised so that those conditions, and the conclusions discussed in the report, can be reviewed and alternative recommendations assessed, if appropriate.

We trust the above is adequate for your needs at this time. Please contact the undersigned if you require further information or assistance.

Yours faithfully
DAVIES GEOTECHNICAL Pty Ltd



Warwick N Davies MIEAust CPEng NER (Civil)
Principal Geotechnical Engineer

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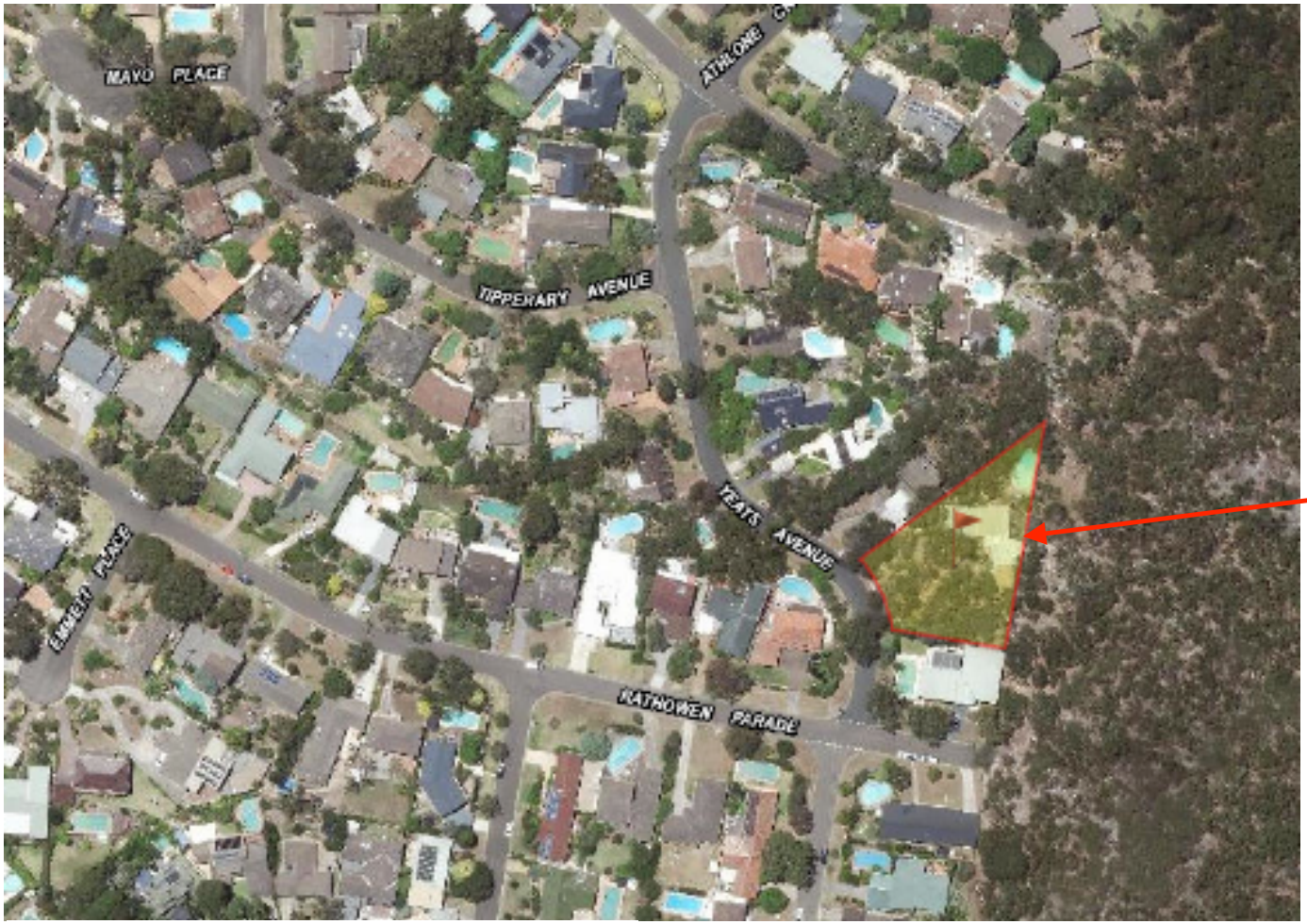
Encl:
Figure 1 – Locality Plan
Figure 2 – Site Plan
Figures 3A, 3B – Site Photographs
Figure 4 – Proposed Development

Attachment A – Warringah Council DCP E10 Landslip Risk Checklist
Attachment B – General Guidelines for Control of Rock Excavations
Attachment C – Limitations of this Report

REFERENCES

1. Geol. Sur. NSW, Dept Min Resources (1983). *Geological Series Sheet 9130 (Sydney) 1:100,000.*
2. Pells P.J.N., Mostyn G. and Walker B.F. (1998). "*Foundations on Sandstone and Shale in the Sydney Region*" Australian Geomechanics, Number 33 Part 3 Dec.1998.



NORTH

Image Source - NSW Land & Property Information SIX Maps

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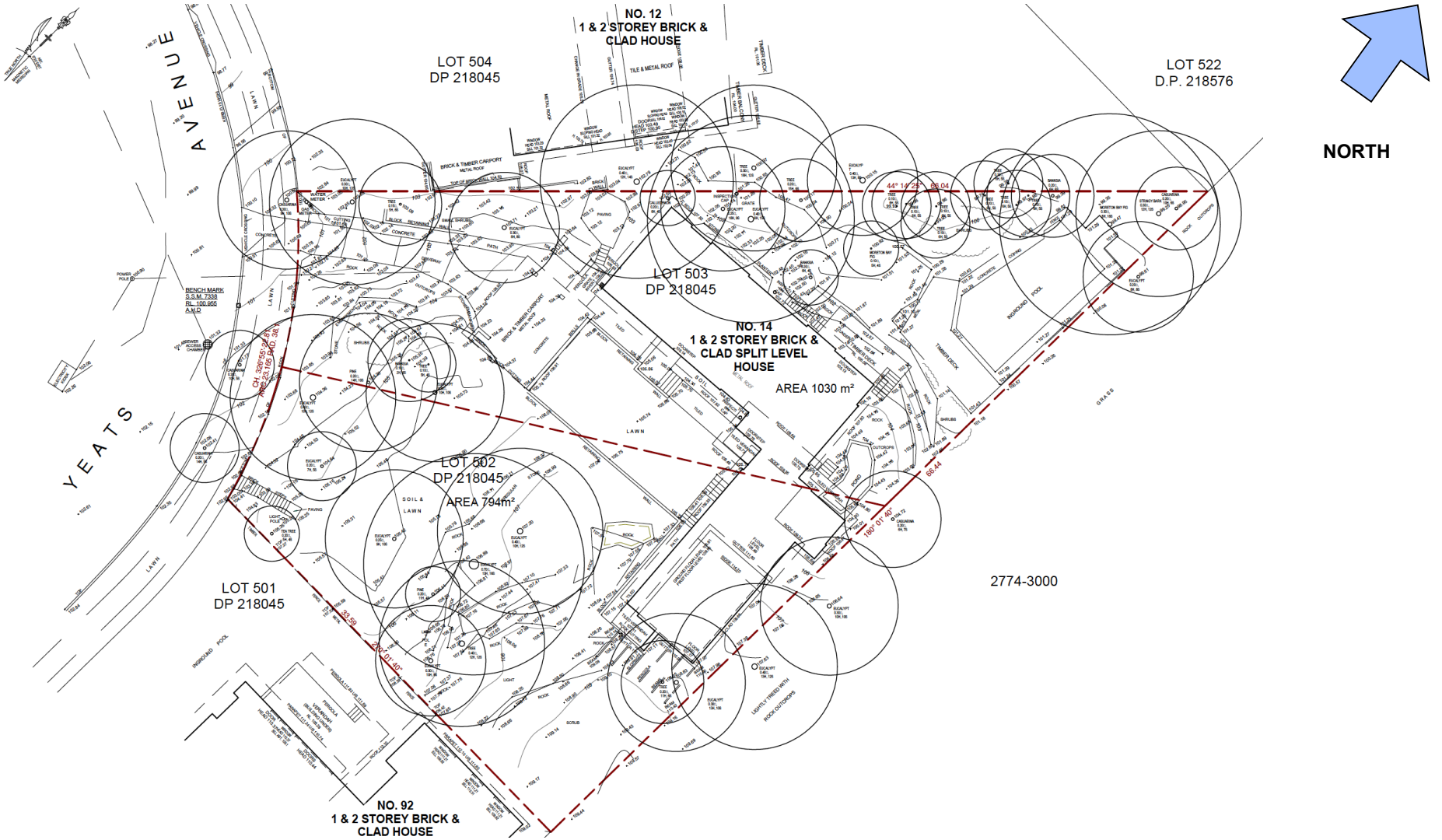
Project No:	15-062	**Scale:**	as shown	LOCALITY PLAN NO.14 YEATS AVE KILLARNEY HEIGHTS NSW (Mr & Mrs A Toohey)	**Figure 1**
Drawn:	wnd	**Date:**	10 Feb 16		



Survey plan from Drawing No.DA201-A (refer to report)

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Project No:	15-062	**Scale:**	as shown	SITE PLAN NO.14 YEATS AVE KILLARNEY HEIGHTS NSW (Mr & Mrs A Toohey)	**Figure 2**
Drawn:	wnd	**Date:**	10 Feb 16		

Frontage of Lot 502. Driveway to No.14 on left, brick wall on frontage of No.92 on right.

View east along proposed boundary between Lots 502 & 503. No.14 carport in left foreground.

View to SW across rear of Lot 502. Dwelling on No.92 in left background. Dwelling at rear corner of No.14 in right foreground.

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Project No:	15-062	**Scale:**	NTS	SITE PHOTOGRAPHS 19/1/16 NO.14 YEATS AVE KILLARNEY HEIGHTS NSW (Mr & Mrs A Toohey)	**Figure 3A**
Drawn:	wnd	**Date:**	10 Feb 16		

View from rear of Lot 502, looking towards front. No.14 carport on right.

Rear of dwelling on No.14 cut into sandstone bedrock. Lot 502 to the right.

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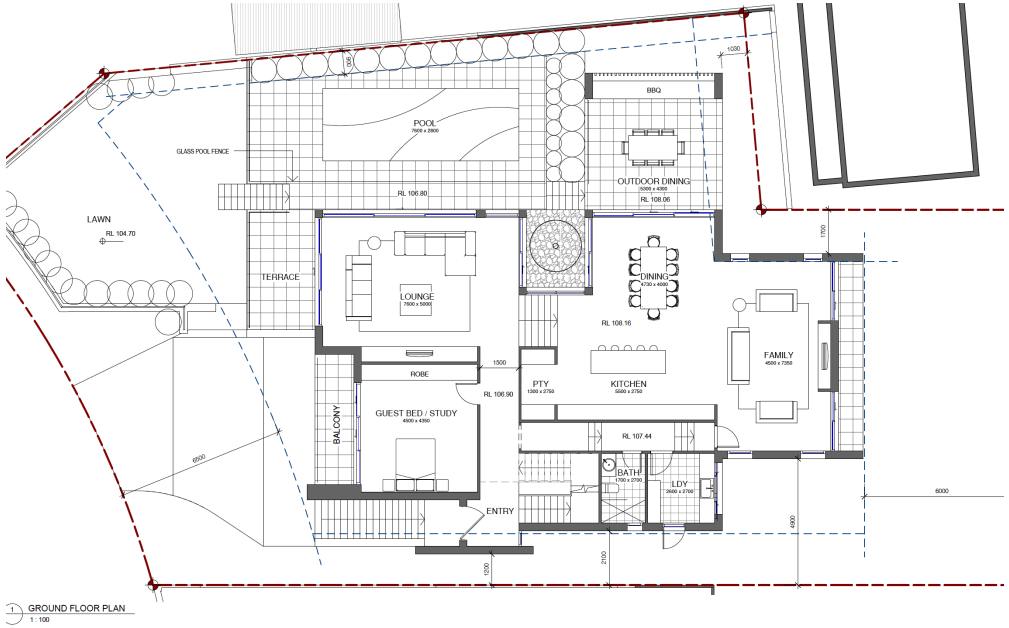
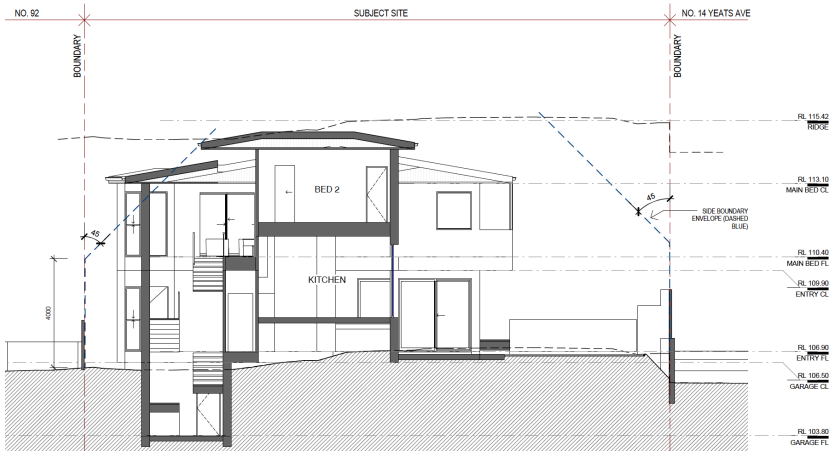
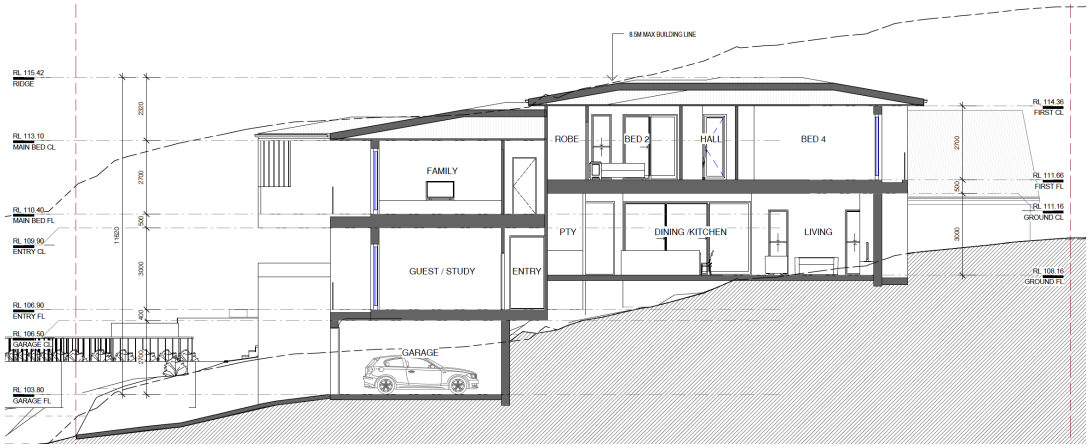
Project No:	15-062	**Scale:**	NTS	SITE PHOTOGRAPHS 19/1/16 NO.14 YEATS AVE KILLARNEY HEIGHTS NSW (Mr & Mrs A Toohey)	**Figure 3B**
Drawn:	wnd	**Date:**	10 Feb 16		





Drawings prepared by Robert Ursino Architecture & Design (refer to report)



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Project No:	15-062	**Scale:**	as shown	PROPOSED DEVELOPMENT NO.14 YEATS AVE KILLARNEY HEIGHTS NSW (Mr & Mrs A Toohey)	**Figure 4**
Drawn:	wnd	**Date:**	10 Feb 16		

ATTACHMENT A

Warringah Development Control Plan
Part E The Natural Environment
E10 Landslip Risk

CHECKLIST

1.0	LANDSLIP RISK CLASS (Landslip Risk Class in which site is located)
	A Geotechnical report not normally required
	B Council officers to decide if geotechnical report required
	C Geotechnical report required
	D Council officers to decide if geotechnical report required
	E Geotechnical report required

2.0	SITE LOCATION
No.14 (Lots 502 & 503 DP218045) Yeats Ave Killarney Heights. Located uphill side of street. Two truncated triangular blocks, 23m frontage x 33.6m depth.	

3.0	PROPOSED DEVELOPMENT
Two-storey house with basement garage at front, to be built on vacant part of site after boundary adjustment/re-subdivision. Excavation approx. 2.7m depth required for garage/stairway.	

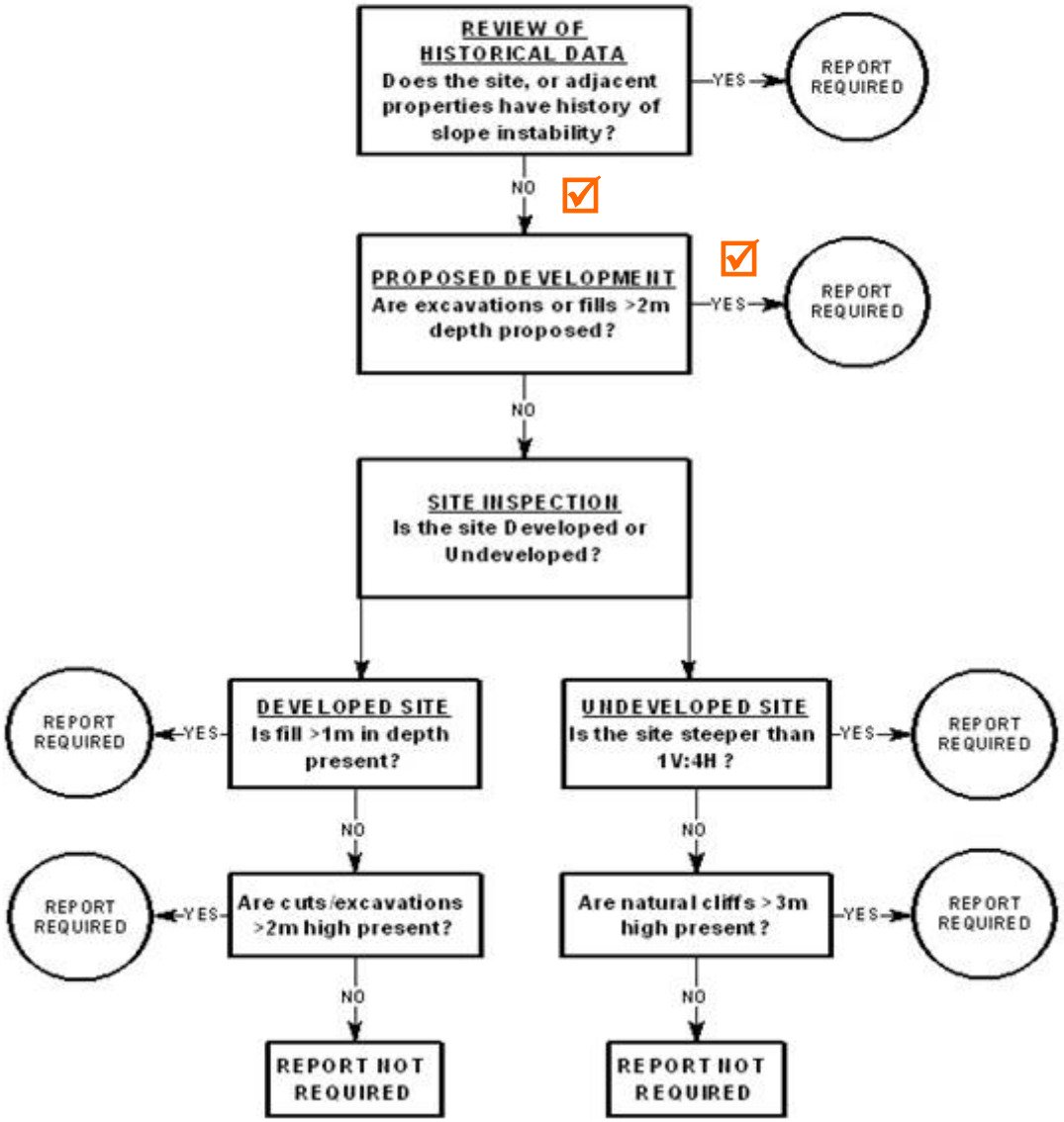
4.0	EXISTING SITE DESCRIPTION
Gentle to moderate slope gradient, 8^{o} – 10^{o} falling from rear to front (photographs attached). Current development built over both Lots 502 & 503. Sandstone ridge/plateau. No evidence of instability of natural slope.	

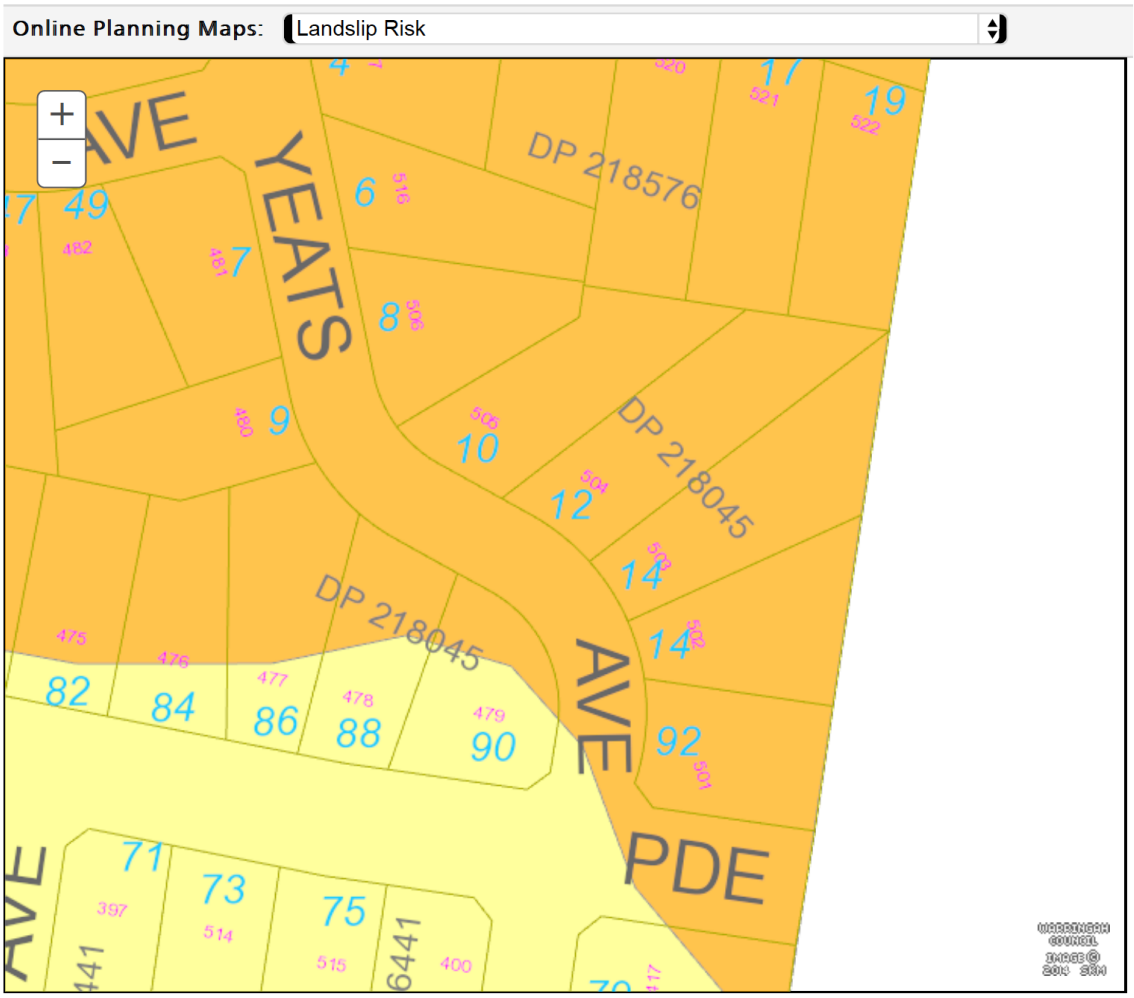
5.0	RECOMMENDATIONS
Geotechnical landslide risk assessment is not required. Engineering design required at CC stage for excavation and footings.	

6.0	DATE OF ASSESSMENT:	19 January 2016
7.0	ASSESSMENT BY:	Warwick Davies

(Refer Flowchart and Landslip Map Extract, below)

CHECKLIST FOR COUNCIL'S ASSESSMENT OF SITE CONDITIONS AND NEED FOR GEOTECHNICAL REPORT IN GEOTECHNICAL CLASS B AND D





LANDSLIP RISK MAP

Area A - Slope less than 5 degrees
Area B - Flanking Slopes from 5 to 25 degrees
Area C - Slopes more than 25 degrees
Area D - Collaroy Plateau Area Flanking Slopes 5 to 15 degrees
Area E - Collaroy Plateau Area Slopes more than 15 degrees

ATTACHMENT B

GENERAL GUIDELINES FOR CONTROL OF ROCK EXCAVATIONS

Where building constructions on adjacent properties are sensitive to ground vibrations, either in terms of proximity to the proposed excavation, or potential for cracking, controls by the excavation contractor over the rock excavation are necessary, and are recommended, so that excessive vibration effects are not generated.

We recommend that the following general practice be adopted for minimising potential vibration effects, subject to site-specific evaluation being carried out by a suitably experienced geotechnical engineer or engineering geologist.

- Bulk excavation should be commenced at the centre of the site, and progressed out towards the boundaries. Test excavations should be undertaken at the edges of the excavation outline, to assess the rock depths and rock conditions in advance of the bulk excavation extending to the boundary lines. A suitably experienced geotechnical engineer should confirm the rock conditions and support requirements at the boundaries during the initial excavation stage.

- The excavation activities must be controlled by the contractor, so that ground vibrations at the adjoining residential structures are limited to a level that would not cause damage to the structure(s). Unless otherwise determined by specific engineering assessment of the subject building or other structure, we recommend an upper limit of vibrations at the structure equivalent to a peak particle velocity (PPV) in the range of 5–10 mm/sec should be adopted. Although this is somewhat conservative, it is considered a reasonable basis for the assessment of suitable controls.

- The above, or other suitable limit, is expected to be achievable by reasonable controls over use of rock breaker equipment. For example, one or all of the following may be appropriate:-
  - the rock breaker or other equipment is restricted to an operating weight determined using established correlations between the distance from the source of vibrations and the level of vibration effects (expressed as PPV),
  - the use of the equipment is restricted to about one-half of full operating capacity,
  - smaller (rather than larger) rock breakers would be more suitable in maintaining vibration levels within required limits, and are less likely to be worked in excess of reasonable limits.

- At all times, the excavation equipment must be operated by experienced personnel, according to the manufacturer's instructions, and in a manner consistent with minimising vibration effects.

- Use of rock sawing, chemical rock splitting, or pneumatic hand equipment, although less productive, would reduce or possibly eliminate risks of damage to adjoining property through vibration effects transmitted via the ground. Such techniques may be considered for portion or all of the bulk excavations, if an alternative to rock breaking is necessary.

Monitoring of vibrations transmitted from the site excavation works may not be necessary, providing the limitations on the excavation equipment and its usage, as above, are adhered to.

Rock saw attachments can be employed to cut the perimeter walls of the excavations so as to minimise overbreak in the rock face and to reduce the transmission of vibrations to adjacent residential structures.

The initial selection of plant may be made to with reference to the recommendations provided herein. However it is recommended that a site specific monitoring trial be carried out at the commencement of excavation if vibration is likely to be a critical issue for the development.

To minimise further the effects of hydraulic rock hammer equipment, the work method should allow for the following:

- excavation of loose or rippable sandstone by bucket or single tyne attachments prior to commencement of rock hammering; care should be taken to ensure that loosening of sandstone blocks does not continue into the adjacent foundation areas;
- progressive breakage from open excavated faces;
- selective breakage along open joints where these are present;
- orientation of the rock hammer in a direction away from property boundaries and into the existing open excavation;
- use of rock hammers in short bursts to prevent generation of resonant frequencies;
- removal of large blocks away from the edge of the excavation and to a greater distance from adjacent structures prior to breaking up for transport from site.

It should be noted that vibrations that are below threshold levels for building damage are nevertheless discernable to persons, and may be experienced beyond the site boundaries. As such this would not necessarily be of concern for the integrity of the adjoining developments.

ATTACHMENT C

LIMITATIONS OF THIS REPORT

Soil and rock formations are variable. The logs or other information presented as part of this report indicate the approximate subsurface conditions only at the specific test locations. Boundaries between zones on the logs or stratigraphic sections are often not distinct, but rather are transitional and have been interpreted.

The precision with which subsurface conditions are indicated depends largely on the frequency and method of sampling, and on the uniformity of subsurface conditions. The spacing of test sites also usually reflects budget and schedule constraints.

Groundwater conditions described in this report refer only to those observed at the place and under circumstances noted in the report. The conditions may vary seasonally or as a consequence of construction activities on the site or adjacent sites.

Where ground conditions encountered at the site differ significantly from those anticipated in the report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Davies Geotechnical Pty Ltd be notified of any variations and be provided with an opportunity to review the recommendations of this report. Recognition of changed soil and rock conditions requires experience and it is recommended that a suitably experienced geotechnical engineer be engaged to visit the site with sufficient frequency to detect if conditions have changed significantly.

The comments given in this report are intended only for the guidance of the design engineer, or for other purposes specifically noted in the report. The number of boreholes or test excavations necessary to determine all relevant underground conditions which may affect construction costs, techniques and equipment choice, scheduling, and sequence of operations would normally be greater than has been carried out for design purposes. Contractors should therefore rely on their own additional investigations, as well as their own interpretations of the borehole data in this report, as to how subsurface conditions may affect their work.