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205400.00
9 July 2021
NB:jb
R.01.Rev1

Mr Patrick & Mrs Nicole Heller
c/o Utz Sanby Architects
Suite 103, 506 Miller Street
Cammeray, NSW 2062

Attention: Duncan Sanby

214 Hudson Parade, Clareville
Proposed Alterations and Additions to Residential Property

1. Introduction

This report presents the results of a geotechnical assessment carried out by Douglas Partners Pty Ltd (DP) for alterations and additions at 214 Hudson Parade, Clareville. The work was carried out at the request of Duncan Sanby of Utz Sanby Architects, acting on behalf of Mr Patrick & Mrs Nicole Heller, owners of the property.

It is understood that the project is to include a single multi-level residence split into an upper (roadside) and a lower wing with a courtyard in the middle. A pool will also be added along the western boundary between the two wings. The plans and section for the proposed development also indicate that excavations below the upper wing will be 2.7 m and between 1.2 m and 3.3 m below the lower wing.

Geotechnical assessment was carried out to provide information on subsurface conditions for preliminary design and costing and for Development Application purposes to address the requirements of Pittwater's Geotechnical Risk Management Policy (GRMP) of December 2009.

The assessment comprised detailed inspection and photography of the site and accessible adjacent areas, together with a series of Dynamic Cone Penetrometer tests (DCP's) at selected locations. Details of the field work are given in this report, together with comments relating to the inferred subsurface profile, identification, description and reporting of geotechnical hazards, as well as preliminary design parameters and construction practice.

Architectural plans for the project prepared by Utz Sanby Architects (Drawings 2102 Sk-1 to Sk-3) and a survey plan by C.M.S Surveyors (20064detail dated 17 February 2021) were provided for use in the assessment.

2. Site Description and Geology

The site is a rectangular residential lot located on the low, western side of Hudson Parade, Clareville. It has average plan dimensions of 49.5m by 15.2 m and a total area of approximately 752 m^2 (refer to Drawing 1, attached, for locality and selected site features). The site is bounded by residential lots to the east and west, Hudson Parade to the north and Pittwater to the south.

The site slopes from RL 18.5 (relative to Australian Height Datum – AHD) at the existing front boundary on Hudson Parade, to RL 1.5 at the lower, western boundary (concrete patio area) of the property. There is an overall difference in elevation of approximately 17 m, resulting in an average slope angle of 17°. The top two thirds of the site has been terraced to create areas for the residences and garden spaces. The lower third of the site comprises a steep slope (slope angle 38°) below the main residence down towards Pittwater.

The current site improvements include the main two story brick residence centrally located on the site, with a secondary residence, garage, carport and access driveway at the norther extremity of the site. A boat shed and jetty are located along the southern boundary. The pre-development levels of the site have been modified across most of the site with a series of brick garden walls/terraces between the current residences with some wooden and stone walls supporting landscaped areas and access to the foreshore area.

Reference to the Sydney 1:100 000 Geological Series Sheet 9130 indicates that the site is underlain by the Newport Formation, which is the upper unit of the Narrabeen Group and typically comprises interbedded siltstone, shale, laminite and lithic to quartz-lithic sandstone. This is consistent with the topography and the rock observed on, and adjacent to the site, as well as in the general area.

3. Site Observations and Field Work

The site was inspected by a engineering geologist on 4 July 2021 and the field assessment comprised detailed geological inspection and photography of the subject site and adjoining areas as well as three DCP tests.

The locations of the DCP tests, site photographs and features, as well as areas of rock outcrop are shown on Drawing 1. Additional information is provided on the photographic plates (Photos 1 to 6, Plate 1 attached).

The main site observations are:

- for descriptive purposes the site can be divided into two sections;
  - the upper section, which is occupied by the existing two residences (refer to Photo 1 to 5); and
  - the lower, southern steep slope leading down to a foreshore concrete pathway and sea wall. This area includes a few low height, timber post garden/landscaping walls which are in moderate condition (refer to Photo 6).

- the existing residences are of brick construction and appear externally, to be in reasonable condition with no major cracking noted (Photo 2);
- from a recent footing exposure by the client it appears that the main residence is founded on sandstone;
- the driveway at the top of the site appears to be in good condition with some minor cracking (Photo 1). Other areas of concrete pavement appear also to be in good condition with only minor cracking or settlement apparent;
- brick retaining walls located between the main and secondary residence appear to be in good condition. They are standing upright and show no signs of cracking or tilting (Photo 3 and 4);
- the access inclinator from the secondary to the main residence, running along the eastern boundary, appears in good condition with no apparent movement or settlement;
- a low height sandstone block wall is located below the main residence at the crest of the steep slope above Pittwater. There appears to be some cracking and movement of this block wall (Photo 5) ;
- the slope beyond the main residence is very steep with a timber retaining wall supporting garden beds. The wall has been creep-affected with some tilting of the wall observered (Photo 6); and
- sandstone outcrops are not present on site but can be seen at 216 Hudson Parade on the slope above Pittwater, as indicated on Drawing 1.

DCPs were carried out at three locations and are inferred to represent the level of the top of bedrock at the depths the DCP's achieved refusal.

4. Proposed Development

It is understood that a single multi-level residence split into upper and lower wings with a courtyard and pool in the middle is proposed. Reference should be made to the architectural drawings prepared by Utz Sanby Architects for the precise layout of the proposed development. The drawings indicate that the construction will require excavation for the ground and basement levels as well as for landscaping purposes. Excavations below the upper wing will be 2.7 m and between 1.2 m and 3.3 m below the lower wing.

5. Comments

5.1 Geotechnical Model and Inferred Section

The interpreted geotechnical model for the site comprises a moderate then steep slope with a surface mantle of colluvial soils and a relatively thin residual sandy clay soil profile (typically less than about 1.8 m deep) underlain by bedrock, shown in Drawing 2. Sandstone bedrock was not exposed on site but was observered along the lower slope above Pittwater at 216 Hudson Parade. Bedrock is likely to include some thinly bedded siltstone (strata thickness of 60 mm to 0.2 m). The rock profile could include some thickly to very thickly bedded sandstone (strata thickness greater than 2 m) with the bedrock profile likely to step down the slope in a series of buried cliff lines.

5.2 Stability and Slope Risk Assessment

Inspection of the general slope on the subject and adjoining lots indicated no evidence of gross, large scale slope instability in the recent past. However, there is evidence of minor settlement and creep movement affecting some areas of paving, pathways and landscaping walls, particularly in the lower southern slope where a small timber wall is tilting.

The lower site soils are subject to soil creep due to the steepness in the area and could also be susceptible to erosion if disturbed, hence care will be required to ensure concentrated surface flows are not created. Recommendations for stormwater disposal are presented in Section 5.5.

The hazards above, adjacent to and on the site have been assessed for risk to property and life using the general methodology outlined by the Australian Geomechanics Society - Landslide Risk Management Subcommittee, 2007.

For the purposes of this assessment, an acceptable level of geotechnical risk for the property is “Low” while an accepted annual probability of loss of life is 1×10^{-6}.

Identified hazards are summarised in Table 1, together with a qualitative assessment of likelihood, consequence and slope instability risk to property after completion of the proposed development (assuming appropriate engineering design and construction works are adopted).

Table 1: Slope Instability Risk to Property Assessment for Proposed Development (after Construction)

Hazard	Likelihood	Consequence	Risk
Collapse of excavation during construction of retaining walls	Unlikely - for appropriately designed, inspected and supported temporary excavations	Minor	Low
Rapid collapse of final retaining walls	Rare - for engineer designed, inspected and constructed wall.	Medium	Low
Slow, minor creep of colluvium and soils across upper and central sections of the site	Unlikely - for appropriately designed and constructed retaining/landscaping structures.	Minor	Low

Slow, minor creep of colluvium and soils across lower section of site	Possible - (subject to nature of landscaping works)	Insignificant	Very Low
Gross slope instability	Barely Credible - no evidence of past gross instability observed.	Major	Low

For loss of life, the individual risk can be calculated from:

$R_{(LoL)} = P_{(H)} \times P_{(S:H)} \times P_{(T:S)} \times V_{(D:T)}$

where:

- $R_{(LoL)}$ is the risk (annual probability of loss of life (death) of an individual)
- $P_{(H)}$ is the annual probability of the hazardous event (erosion/ wall failure)
- $P_{(S:H)}$ is the probability of spatial impact by the hazard (e.g. of the failure reaching the residence, taking into account the distance from a given event)
- $P_{(T:S)}$ is the temporal probability (e.g. of the adjacent area being occupied by the individual) given the spatial impact
- $V_{(D:T)}$ is the vulnerability of the individual (probability of loss of life of the individual given the impact).

The assessed individual risk to life (person most at risk) resulting from slope instability is summarised in Table 2.

Table 2: Slope Instability Risk to Life Assessment for Proposed Development (after Construction)

Hazard	$P_{(H)}$	$P_{(S:H)}$	$P_{(T:S)}$	$V_{(D:T)}$	Risk $R_{(LoL)}$
Collapse of excavation during construction of retaining walls	10^{-4}	1	0.1	0.1	1×10^{-6}
Rapid collapse of final retaining walls	10^{-5}	1	0.5	0.1	5×10^{-7}
Extremely slow, minor creep of colluvium and soils across upper and central sections of the site	10^{-4}	1	0.1	<0.01	$<1 \times 10^{-7}$
Extremely slow, minor creep of colluvium and soils across lower section of site	10^{-3}	<0.1	0.01	<0.01	$<1 \times 10^{-8}$
Gross slope instability	10^{-6}	1	0.5	1	5×10^{-7}

When compared to the requirements of the AGS, it is considered that the proposed development will meet 'Acceptable Risk Management' criteria with respect to both property and life under current and foreseeable conditions.

Provided the construction is undertaken in accordance with the recommendations contained in this report, is appropriately designed and incorporates sound engineering practice, it is considered that the project is technically feasible and that the construction would not be expected to adversely affect the overall stability of the site or negatively influence the geotechnical hazards identified in Tables 1 and 2.

5.3 Excavation and Retaining Structures

The architectural drawings indicate that excavation into the slope will be required for the proposed development. The excavations will be between 1.2 m and 3.3 m deep.

It is expected that excavation into colluvial and residual clay soils will be readily achieved using conventional hydraulically operated earthmoving equipment down to the level of low to medium (or stronger) rock. However, the upslope, eastern portion of the excavation may encounter medium strength rock (and possibly stronger) towards the lower parts of the excavation, which will require the use of appropriate sawing, ripping, rock milling and possibly rock breaking equipment.

To date the geotechnical assessment of the site has been limited to detailed site inspection and assessment using hand held equipment. Preliminary design, subject to onsite confirmation during construction (as needed as part of Pittwater Council Form 3 requirements) may be undertaken using the information and parameters detailed below and in the following sections of this report.

The existing clayey and sandy soils are currently subject to soil creep on the lower parts of the site, and will need to be appropriately supported. Any soil remaining exposed along the crest of any excavation cannot be relied upon to stand with batter slopes exceeding 1.5:1 (H:V) and support will be required where this batter slope cannot be achieved.

Engineer designed retaining walls should be used to retain all soils, filling or extremely weathered bedrock and particularly where the retained height is more than 1 m. Suggested retaining wall design parameters are given in Table 3.

Table 3: Retaining Wall Design Parameters

Material	Earth Pressure Coefficient		Bulk Density
	Short term	Long term	
Filling or sandy clay soils	0.3	0.4	20 kN/m^3
Sandstone/siltstone/shale - very low strength	0.1	0.15	22 kN/m^3

It should be noted that no provision has been made in the above design parameters for water pressure acting on the walls or other surcharges or sloping ground above a wall. Drainage measures such as free draining backfill and discharge points through all walls should be incorporated into all wall design

Within the proposed excavation, sandstone/siltstone/shale bedrock of at least medium strength is generally expected to be able to stand near-vertically without support. However, given the locally steep, foreshore location of the site, it is possible that there may be steeply inclined stress relief joints, sub-parallel to the slope which could give rise to localised instability requiring rock bolt or other support. Similarly, where there are intersecting joints, highly weathered zones within the rock mass or pockets of deeper soil cover, there could be a potential for local block or minor slip failures. Such features will require localised support such as rock bolts, underpinning or the application of shotcrete.

Regular inspections during the progress of all excavation work, by an experienced geotechnical professional, will be required and it is recommended that inspection be carried out at no greater than 1.5 m vertical intervals to delineate areas of potential instability for additional slope support works and stabilisation.

5.4 Foundations

The subsurface profile across the site is likely to be quite variable, comprising colluvial soils (sand and sandy clay), residual sandy clay and bedrock. The depth to bedrock, as well as the nature and strength of bedrock, will be variable which is considered typical of a stepped bedrock profile developed on the Newport Formation.

It is recommended that all foundations be taken down to and also be either socketed (or dowelled) into the underlying, in situ bedrock. Foundations are likely to comprise both pad and strip footings as well as short piles should there be deep soil or colluvial depths. A design allowable bearing pressure of up to 1000 kPa is considered appropriate for bedrock (sandstone and siltstone) of at least low strength together with pile bond strengths of at least 100 kPa . It is likely that higher bearing pressures may be possible, subject to inspection during construction.

Inspection of footing excavations for all retaining walls and the foundations for the residence, prior to pouring of concrete, will be required to enable completion of a Pittwater Council GRMP Form 3 (Final Geotechnical Certificate – Post Construction Geotechnical Certificate) to obtain a final occupation and Building Certificate upon completion of the works. It is anticipated that observation during the drilling of bored pier footings will also be necessary where such footings are required, potentially for the lower level retaining walls and the swimming pool footings.

5.5 Stormwater Disposal and Site Drainage

The soils on the site are potentially susceptible to erosion due to concentrated surface water flows and it is therefore recommended that appropriate surface runoff control measures are incorporated into the design of the works.

All roof water, any concentrated surface flows created by the proposed works and excess/overflow water from any water tanks must be discharged from site in a controlled manner using a piped stormwater system, potentially into the Council drainage system or to the western foreshore for discharge to Pittwater.

All drainage lines, including those behind retaining structures, should include inspection ports to permit periodic maintenance by the owners.

6. Conditions Relating to Design and Construction Monitoring

To comply with Pittwater Council conditions which are part of the design, construction, and post-construction certificate requirements of the GRMP, it will be necessary for DP to complete:

Form 2B this will comprise review of all structural drawings to confirm they address geotechnical issues of this report, and

Form 3 which requires the progressive inspection of all new footing excavations and bulk excavations into the slope to confirm compliance to design, with respect to allowable bearing pressure and stability.

7. Design Life and Requirement for Maintenance and Inspection

DP interprets the reference to design life requirements, as specified within the GRMP, to refer to structural elements designed to retain the subject slope and maintain the risk of instability within acceptable limits.

Specific structures that may affect the maintenance of site stability in relation to the proposed development on this site are considered to comprise:

- the proposed stormwater surface drains and buried pipes leading to the stormwater disposal system;
- proposed retaining walls on the site.

In order to attain a structural life of 100 years as required by the Council Policy, it will be necessary for the structural engineer to incorporate appropriate construction detailing and for the property owner to adopt and implement a maintenance and inspection programme.

A typical programme for developments on sloping sites is given in Table 4.

Table 4: Recommended Maintenance and Inspection Programme

Structure	Maintenance/Inspection Task	Frequency
Stormwater drains, subsoil drains, pipes and pits	Owner to inspect to ensure that the drains, pipes and pits are free of debris and sediment build-up. Clear surface grates of vegetation/litter build-up.	Every year or following each significant rainfall event.

Existing or proposed retaining walls	Owner to check walls for deviation from "as-constructed" condition.	Every two to three years or following each significant rainfall event.

Where changes to site conditions are identified during the maintenance and inspection programme, reference should be made to a relevant professional (e.g. structural engineer or geotechnical engineer).

8. Limitations

Douglas Partners (DP) has prepared this report for this project at 214 Hudson Parade, Clareville in accordance with DP's proposal P205400.00 dated 28 May 2021, and acceptance received from Mr Patrick & Mrs Nicole Heller dated 31 May 2021. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Mr Patrick & Mrs Nicole Heller and their agents for this project only and for the purposes as described in the report. It should not be used by or be relied upon for other projects or purposes on the same or another site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires a risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Yours faithfully
Douglas Partners Pty Ltd

Reviewed by

Nick Burrows
Engineering Geologist

John Braybrooke
Principal

Attachments: Notes About this Report
Drawing 1 & 2
Dynamic Cone Penetrating Tests Results
Photo Plates 1
Landslide Risk Management Concepts and Guidelines
Pittwater Forms 1 and 1a

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

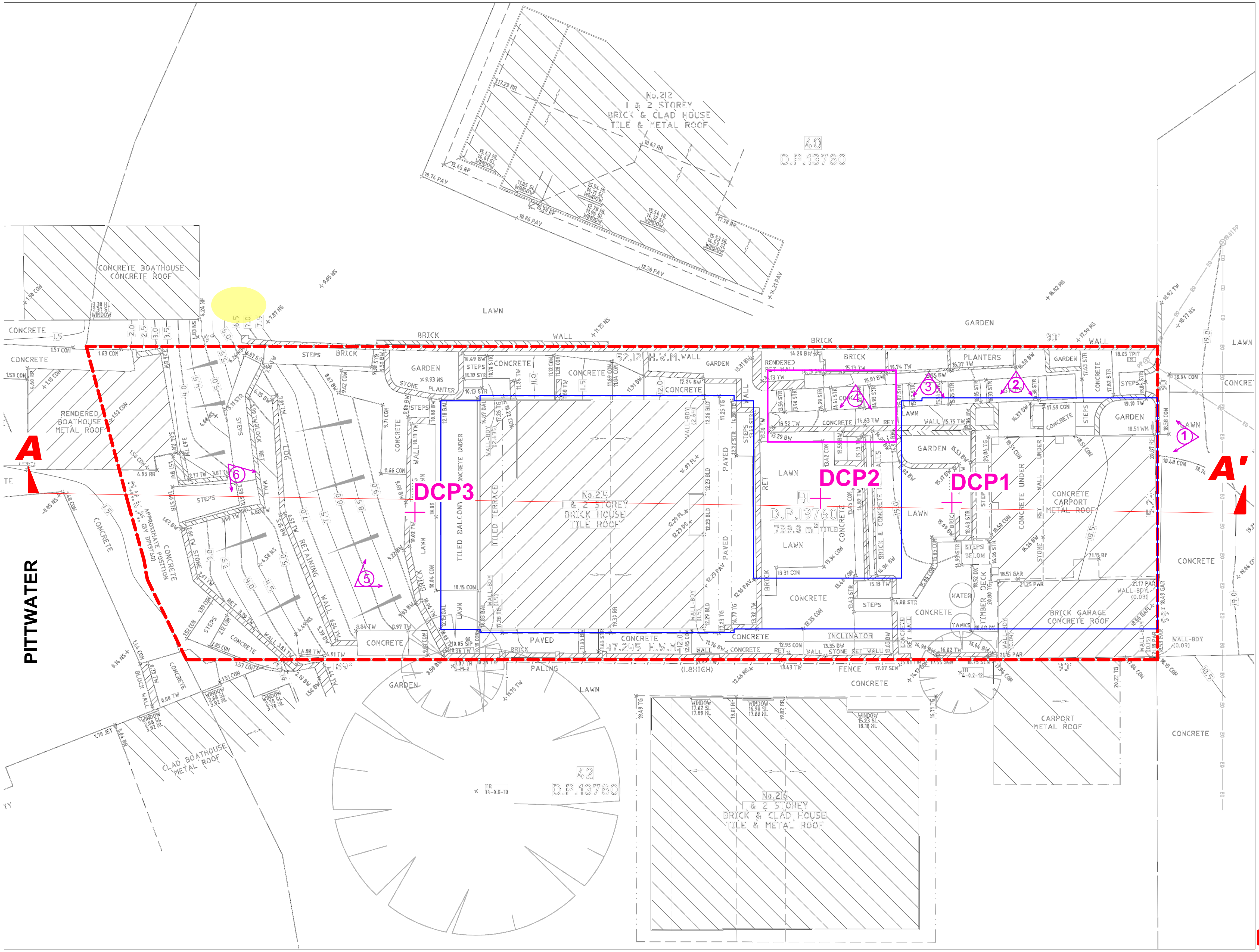
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.



Locality Plan

LEGEND

- Site Boundary
- Proposed Building Outline
- Proposed Pool Outline
- DCP Location and Number
- Cross Section
- Photograph number with direction of view
- Sandstone Outcrop

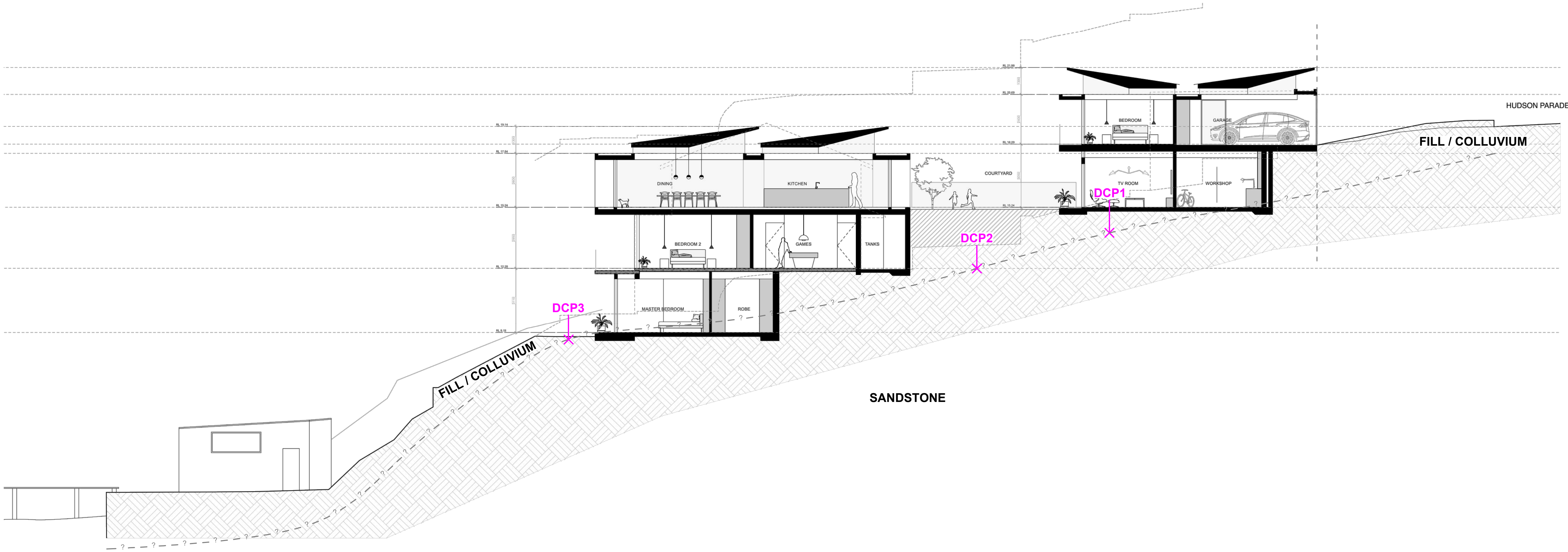
NOTE:
1: Plan adapted from Drawing No. 20064detail, Issue 2, prepared by C.M.S. Surveyors Pty Ltd (Dated 16.04.2021)

0 1 2 3 4 6 8 10 15 20m
1:200 @ A3

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: UTZ Sanby Architects		TITLE: **Test Location Plan**
OFFICE: Sydney	DRAWN BY: MG	**Proposed Alterations and Additions**
SCALE: 1:200 @ A3	DATE: 18.06.2021	**214 Hudson Parade, Clareville**

PROJECT No:	205400.00
DRAWING No:	1
REVISION:	0



NOTE:
1: Plan adapted from Drawing No. SK-2, prepared by UTZ Sanby Architects, Project No. 2101

0 1 2 3 4 6 8 10 15 20m
1:200 @ A3

LEGEND

— ? — — Interpreted geotechnical boundary

Douglas Partners *Geotechnics / Environment / Groundwater*	CLIENT: UTZ Sanby Architects	TITLE: **Cross Section A-A'**	PROJECT No: 205400.00
	OFFICE: Sydney — DRAWN BY: MG	**Proposed Alterations and Additions**	DRAWING No: 2
	SCALE: 1:200 @ A3 — DATE: 18.06.2021	**214 Hudson Parade, Clareville**	REVISION: 0

Photo 1: View of garage and carport area

Photo 2: View underneath seconday residence

Photo 3: View looking at upper patio area (view east)

Photo 4: View looking at lower patio area (view east)

Photo 5: View looking at main residence and retaining wall below (view north)

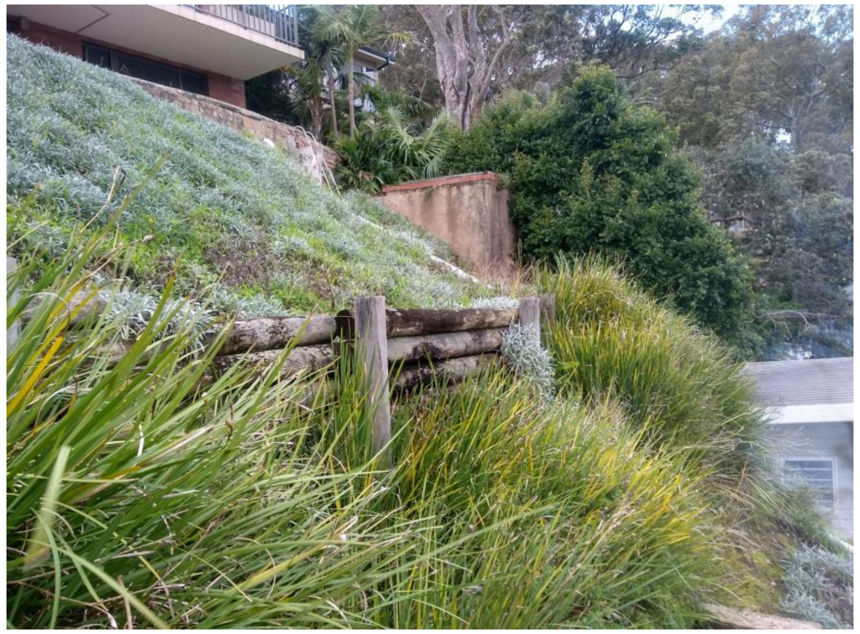


Photo 6: View of slope below main residence (view south)

Douglas Partners *Geotechnics / Environment / Groundwater*	CLIENT: Mr Patrick & Mrs Nicole Heller		TITLE: **Geotechnical Assessment**	PROJECT No: 205400.00
	OFFICE: Sydney	DRAWN BY: NB	**Proposed Additions & Alterations**	PLATE No: 1
	SCALE: NA	DATE: 1 Jul 2021	**214 Hudson Parade, Clareville**	REVISION: A

Douglas Partners
Geotechnics / Environment / Groundwater

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Results of Dynamic Penetrometer Tests

Client Mr Patrick & Mrs Nicole Heller — Project No. 205400.00

Project Proposed Additions and Alterations — Date 04-06-21

Location 214 Hudson Parade, Clareville — Page No. 1 of 1

Test Location	DCP1	DCP2	DCP3							
RL	15	13.3	10							
Depth (m)	**Penetration Resistance** Blows/150 mm									
0 - 0.15	1	1	1							
0.15 - 0.30	1	1	1							
0.30 - 0.45	1	2	1							
0.45 - 0.60	2	2	1							
0.60 - 0.75	4	4	3							
0.75 - 0.90	10/100	5	3							
0.90 - 1.05		10	2							
1.05 - 1.20		9	7							
1.20 - 1.35		3	10							
1.35 - 1.50		14	10/50							
1.50 - 1.65		25								
1.65 - 1.80		26								
1.80 - 1.95		26								
1.95 - 2.10										
2.10 - 2.25										
2.25 - 2.40										
2.40 - 2.55										
2.55 - 2.70										
2.70 - 2.85										
2.85 - 3.00										
3.00 - 3.15										
3.15 - 3.30										
3.30 - 3.45										
3.45 - 3.60										

Test Method AS 1289.6.3.2, Cone Penetrometer ☑ — **Tested By** NB

AS 1289.6.3.3, Flat End Penetrometer ☐ — **Checked By** DEM

Remarks R = Refusal, 24/110 indicates 25 blows for 110 mm penetration, B = Bouncing

AUSTRALIAN GEOGUIDE LR7 (LANDSLIDE RISK)

LANDSLIDE RISK

Concept of Risk

Risk is a familiar term, but what does it really mean? It can be defined as *"a measure of the probability and severity of an adverse effect to health, property, or the environment."* This definition may seem a bit complicated. In relation to landslides, geotechnical practitioners (GeoGuide LR1) are required to assess risk in terms of the likelihood that a particular landslide will occur and the possible consequences. This is called landslide risk assessment. The consequences of a landslide are many and varied, but our concerns normally focus on loss of, or damage to, property and loss of life.

Landslide Risk Assessment

Some local councils in Australia are aware of the potential for landslides within their jurisdiction and have responded by designating specific "landslide hazard zones". Development in these areas is often covered by special regulations. If you are contemplating building, or buying an existing house, particularly in a hilly area, or near cliffs, go first for information to your local council.

Landslide risk assessment must be undertaken by a geotechnical practitioner. It may involve visual inspection, geological mapping, geotechnical investigation and monitoring to identify:

- potential landslides (there may be more than one that could impact on your site)
- the likelihood that they will occur
- the damage that could result
- the cost of disruption and repairs and
- the extent to which lives could be lost.

Risk assessment is a predictive exercise, but since the ground and the processes involved are complex, prediction tends to lack precision. If you commission a landslide risk assessment for a particular site you should expect to receive a report prepared in accordance with current professional guidelines and in a form that is acceptable to your local council, or planning authority.

Risk to Property

Table 1 indicates the terms used to describe risk to property. Each risk level depends on an assessment of how likely a landslide is to occur and its consequences in dollar terms. "Likelihood" is the chance of it happening in any one year, as indicated in Table 2. "Consequences" are related to the cost of repairs and temporary loss of use if a landslide occurs. These two factors are combined by the geotechnical practitioner to determine the Qualitative Risk.

TABLE 2: LIKELIHOOD

Likelihood	Annual Probability
Almost Certain	1:10
Likely	1:100
Possible	1:1,000
Unlikely	1:10,000
Rare	1:100,000
Barely credible	1:1,000,000

The terms "unacceptable", "may be tolerated", etc. in Table 1 indicate how most people react to an assessed risk level. However, some people will always be more prepared, or better able, to tolerate a higher risk level than others.

Some local councils and planning authorities stipulate a maximum tolerable level of risk to property for developments within their jurisdictions. In these situations the risk must be assessed by a geotechnical practitioner. If stabilisation works are needed to meet the stipulated requirements these will normally have to be carried out as part of the development, or consent will be withheld.

TABLE 1: RISK TO PROPERTY

Qualitative Risk		Significance - Geotechnical engineering requirements
Very high	VH	**Unacceptable** without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low. May be too expensive and not practical. Work likely to cost more than the value of the property.
High	H	**Unacceptable** without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to acceptable level. Work would cost a substantial sum in relation to the value of the property.
Moderate	M	**May be tolerated** in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as possible.
Low	L	**Usually acceptable** to regulators. Where treatment has been needed to reduce the risk to this level, ongoing maintenance is required.
Very Low	VL	**Acceptable**. Manage by normal slope maintenance procedures.

Risk to Life

Most of us have some difficulty grappling with the concept of risk and deciding whether, or not, we are prepared to accept it. However, without doing any sort of analysis, or commissioning a report from an "expert", we all take risks every day. One of them is the risk of being killed in an accident. This is worth thinking about, because it tells us a lot about ourselves and can help to put an assessed risk into a meaningful context. By identifying activities that we either are, or are not, prepared to engage in we can get some indication of the maximum level of risk that we are prepared to take. This knowledge can help us to decide whether we really are able to accept a particular risk, or to tolerate a particular likelihood of loss, or damage, to our property (Table 2).

In Table 3, data from NSW for the years 1998 to 2002, and other sources, is presented. A risk of 1 in 100,000 means that, in any one year, 1 person is killed for every 100,000 people undertaking that particular activity. The NSW data assumes that the whole population undertakes the activity. That is, we are all at risk of being killed in a fire, or of choking on our food, but it is reasonable to assume that only people who go deep sea fishing run a risk of being killed while doing it.

It can be seen that the risks of dying as a result of falling, using a motor vehicle, or engaging in water-related activities (including bathing) are all greater than 1:100,000 and yet few people actively avoid situations where these risks are present. Some people are averse to flying and yet it represents a lower risk than choking to death on food. Importantly, the data also indicate that, even when the risk of dying as a consequence of a particular event is very small, it could still happen to any one of us any day. If this were not so, no one would ever be struck by lightning.

Most local councils and planning authorities that stipulate a tolerable risk to property also stipulate a tolerable risk to life. The AGS Practice Note Guideline recommends that 1:100,000 is tolerable in newly developed areas, where works can be carried out as part of the development to limit risk. The tolerable level is raised to 1:10,000 in established areas, where specific landslide hazards may have existed for many years. The distinction is deliberate and intended to prevent the concept of landslide risk management, for its own sake, becoming an unreasonable financial burden on existing communities. Acceptable risk is usually taken to be one tenth of the tolerable risk (1:1,000,000 for new developments and 1:100,000 for established areas) and efforts should be made to attain these where it is practicable and financially realistic to do so.

TABLE 3: RISK TO LIFE

Risk (deaths per participant per year)	**Activity/Event Leading to Death** (NSW data unless noted)
1:1,000	Deep sea fishing (UK)
1:1,000 to 1:10,000	Motor cycling, horse riding , ultra-light flying (Canada)
1:23,000	Motor vehicle use
1:30,000	Fall
1:70,000	Drowning
1:180,000	Fire/burn
1:660,000	Choking on food
1:1,000,000	Scheduled airlines (Canada)
1:2,300,000	Train travel
1:32,000,000	Lightning strike

More information relevant to your particular situation may be found in other AUSTRALIAN GEOGUIDES:

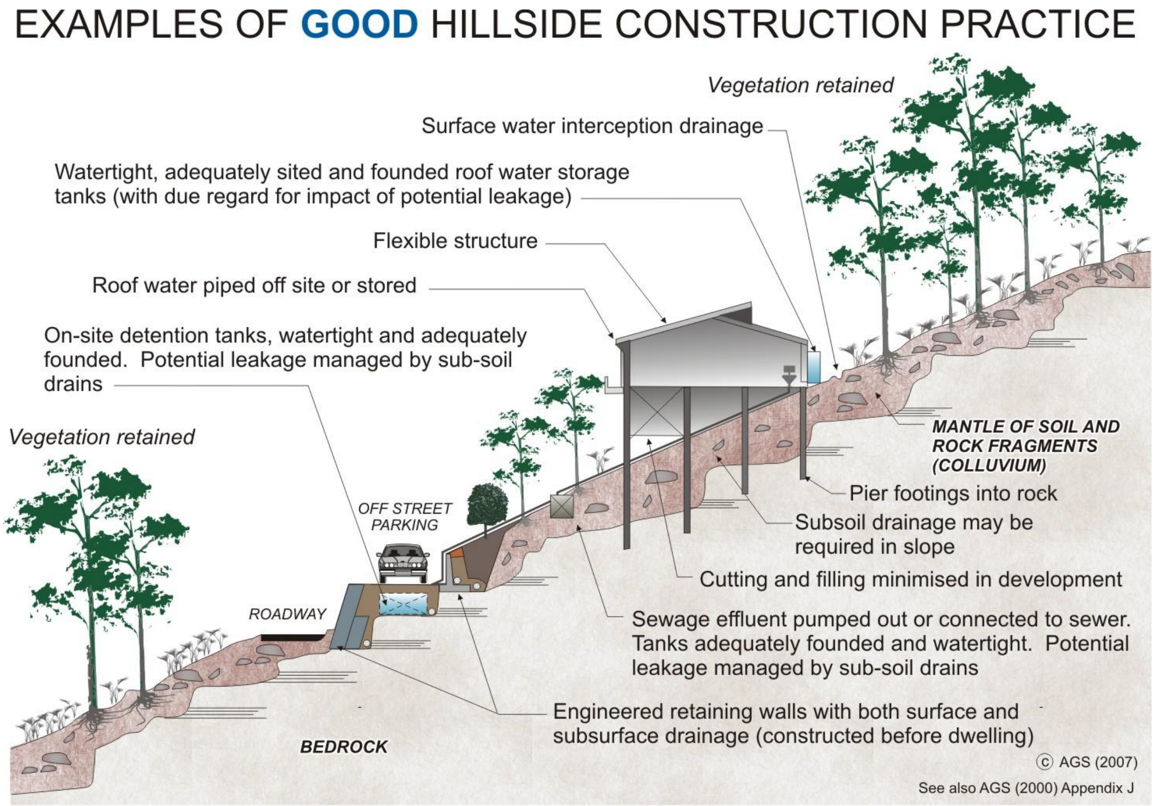
- GeoGuide LR1 - Introduction
- GeoGuide LR2 - Landslides
- GeoGuide LR3 - Landslides in Soil
- GeoGuide LR4 - Landslides in Rock
- GeoGuide LR5 - Water & Drainage
- GeoGuide LR6 - Retaining Walls
- GeoGuide LR8 - Hillside Construction
- GeoGuide LR9 - Effluent & Surface Water Disposal
  GeoGuide LR10 - Coastal Landslides
- GeoGuide LR11 - Record Keeping

The Australian GeoGuides (LR series) are a set of publications intended for property owners; local councils; planning authorities; developers; insurers; lawyers and, in fact, anyone who lives with, or has an interest in, a natural or engineered slope, a cutting, or an excavation. They are intended to help you understand why slopes and retaining structures can be a hazard and what can be done with appropriate professional advice and local council approval (if required) to remove, reduce, or minimise the risk they represent. The GeoGuides have been prepared by the Australian Geomechanics Society, a specialist technical society within Engineers Australia, the national peak body for all engineering disciplines in Australia, whose members are professional geotechnical engineers and engineering geologists with a particular interest in ground engineering. The GeoGuides have been funded under the Australian governments' National Disaster Mitigation Program.

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

HILLSIDE CONSTRUCTION PRACTICE

Sensible development practices are required when building on hillsides, particularly if the hillside has more than a low risk of instability (GeoGuide LR7). Only building techniques intended to maintain, or reduce, the overall level of landslide risk should be considered. Examples of good hillside construction practice are illustrated below.



WHY ARE THESE PRACTICES GOOD?

Roadways and parking areas - are paved and incorporate kerbs which prevent water discharging straight into the hillside (GeoGuide LR5).

Cuttings - are supported by retaining walls (GeoGuide LR6).

Retaining walls - are engineer designed to withstand the lateral earth pressures and surcharges expected, and include drains to prevent water pressures developing in the backfill. Where the ground slopes steeply down towards the high side of a retaining wall, the disturbing force (see GeoGuide LR6) can be two or more times that in level ground. Retaining walls must be designed taking these forces into account.

Sewage - whether treated or not is either taken away in pipes or contained in properly founded tanks so it cannot soak into the ground.

Surface water - from roofs and other hard surfaces is piped away to a suitable discharge point rather than being allowed to infiltrate into the ground. Preferably, the discharge point will be in a natural creek where ground water exits, rather than enters, the ground. Shallow, lined, drains on the surface can fulfil the same purpose (GeoGuide LR5).

Surface loads - are minimised. No fill embankments have been built. The house is a lightweight structure. Foundation loads have been taken down below the level at which a landslide is likely to occur and, preferably, to rock. This sort of construction is probably not applicable to soil slopes (GeoGuide LR3). If you are uncertain whether your site has rock near the surface, or is essentially a soil slope, you should engage a geotechnical practitioner to find out.

Flexible structures - have been used because they can tolerate a certain amount of movement with minimal signs of distress and maintain their functionality.

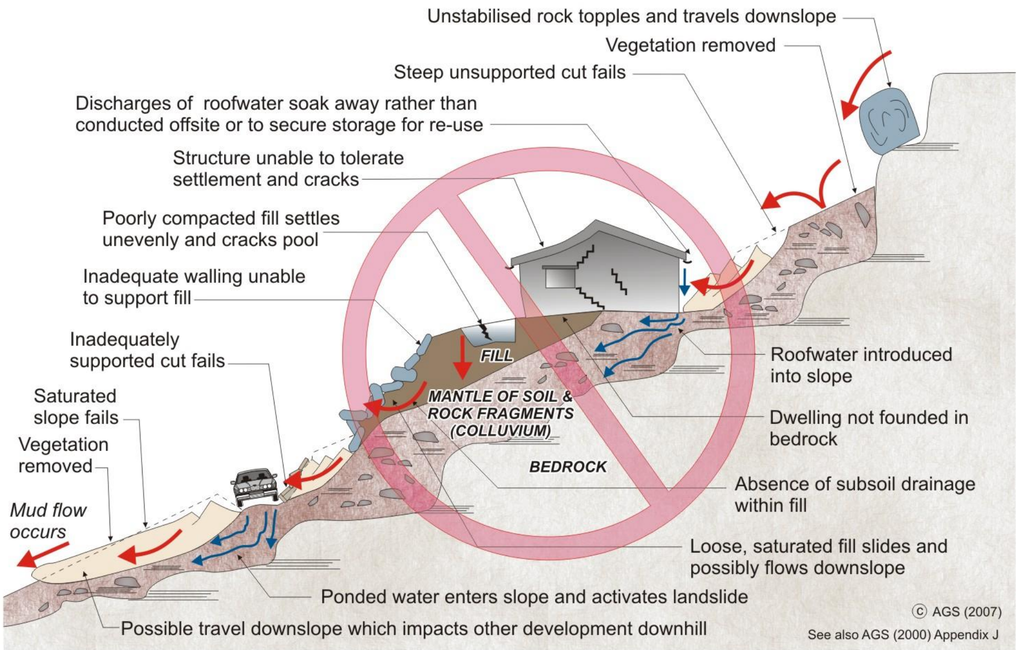
Vegetation clearance - on soil slopes has been kept to a reasonable minimum. Trees, and to a lesser extent smaller vegetation, take large quantities of water out of the ground every day. This lowers the ground water table, which in turn helps to maintain the stability of the slope. Large scale clearing can result in a rise in water table with a consequent increase in the likelihood of a landslide (GeoGuide LR5). An exception may have to be made to this rule on steep rock slopes where trees have little effect on the water table, but their roots pose a landslide hazard by dislodging boulders.

Possible effects of ignoring good construction practices are illustrated on page 2. Unfortunately, these poor construction practices are not as unusual as you might think and are often chosen because, on the face of it, they will save the developer, or owner, money. You should not lose sight of the fact that the cost and anguish associated with any one of the disasters illustrated, is likely to more than wipe out any apparent savings at the outset.

ADOPT GOOD PRACTICE ON HILLSIDE SITES

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

EXAMPLES OF POOR HILLSIDE CONSTRUCTION PRACTICE



WHY ARE THESE PRACTICES POOR?

Roadways and parking areas - are unsurfaced and lack proper table drains (gutters) causing surface water to pond and soak into the ground.

Cut and fill - has been used to balance earthworks quantities and level the site leaving unstable cut faces and added large surface loads to the ground. Failure to compact the fill properly has led to settlement, which will probably continue for several years after completion. The house and pool have been built on the fill and have settled with it and cracked. Leakage from the cracked pool and the applied surface loads from the fill have combined to cause landslides.

Retaining walls - have been avoided, to minimise cost, and hand placed rock walls used instead. Without applying engineering design principles, the walls have failed to provide the required support to the ground and have failed, creating a very dangerous situation.

A heavy, rigid, house - has been built on shallow, conventional, footings. Not only has the brickwork cracked because of the resulting ground movements, but it has also become involved in a man-made landslide.

Soak-away drainage - has been used for sewage and surface water run-off from roofs and pavements. This water soaks into the ground and raises the water table (GeoGuide LR5). Subsoil drains that run along the contours should be avoided for the same reason. If felt necessary, subsoil drains should run steeply downhill in a chevron, or herring bone, pattern. This may conflict with the requirements for effluent and surface water disposal (GeoGuide LR9) and if so, you will need to seek professional advice.

Rock debris - from landslides higher up on the slope seems likely to pass through the site. Such locations are often referred to by geotechnical practitioners as "debris flow paths". Rock is normally even denser than ordinary fill, so even quite modest boulders are likely to weigh many tonnes and do a lot of damage once they start to roll. Boulders have been known to travel hundreds of metres downhill leaving behind a trail of destruction.

Vegetation - has been completely cleared, leading to a possible rise in the water table and increased landslide risk (GeoGuide LR5).

DON'T CUT CORNERS ON HILLSIDE SITES - OBTAIN ADVICE FROM A GEOTECHNICAL PRACTITIONER

More information relevant to your particular situation may be found in other Australian GeoGuides:

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- GeoGuide LR3 - Landslides in Soil
- GeoGuide LR4 - Landslides in Rock
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- GeoGuide LR6 - Retaining Walls
- GeoGuide LR7 - Landslide Risk
- GeoGuide LR9 - Effluent & Surface Water Disposal
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GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER
FORM NO. 1 – To be submitted with Development Application

Development Application for Mr Patrick & Mrs Nicole Heller
Name of Applicant

Address of site 214 Hudson Parade, Clareville

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

I, Scott Easton on behalf of Douglas Partners Pty. Ltd.
(Insert Name) (Trading or Company Name)

on this the 9 July 2021 certify that I am a geotechnical engineer or engineering geologist or coastal engineer as defined by the Geotechnical Risk Management Policy for Pittwater 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.
Douglas Partners Pty Ltd:

Please mark appropriate box

☒ Prepared the detailed Geotechnical Report referenced below in accordance with the Australia Geomechanics Society's Geotechnical Risk Management Guidelines and the Pittwater Council Policy

☒ Am willing to technically verify that the detailed Geotechnical Report referenced below has been prepared in accordance with the Australian Geomechanics Society's Geotechnical Risk Management Guidelines and the Pittwater Council Policy

☒ 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 Policy requirements for Minor Development/Alterations.

☐ Provided the coastal process and coastal forces analysis for inclusion in the geotechnical report

Geotechnical Report Details:

Report Title: Proposed Alterations and Additions to Residential Property

Report Date: 9 July 2021

Author: Nick Burrows

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

Utz Sanby Architects (Drawings 2102 Sk-1 to Sk-3) and a survey plan by C.M.S Surveyors
(20064detail dated 17 February 2021).

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 ....

Name Scott Easton

Chartered Professional Status CPEng/NER

Membership No. 1371997

GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER
FORM NO. 1(a) - Checklist Of Requirements For Geotechnical Risk Management Report for Development Application or Part V assessment

Development Application for Mr Patrick & Mrs Nicole Heller
Name of Applicant
Address of site 214 Hudson Parade, Clareville

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: Proposed Alterations and Additions to Residential Property
Report Date: 9 July 2021
Author: Nick Burrows

Please mark appropriate box

[X] Comprehensive site mapping conducted 4 June 2021
(date)

[X] Mapping details presented on contoured site plan with geomorphic mapping to a minimum scale of 1:200 (as appropriate)

[X] Subsurface investigation required
- [ ] No Justification ……………………………………………………
- [X] Yes Date conducted ……………………………………………………

[X] Geotechnical model developed and reported as an inferred subsurface type-section

[X] Geotechnical hazards identified
- [ ] Above the site
- [X] On the site
- [ ] Below the site
- [ ] Beside the site

[X] Geotechnical hazards described and reported

[X] Risk assessment conducted in accordance with Council's Policy
- [X] Consequence analysis
- [X] Frequency analysis

[X] Risk calculation

[X] Risk assessment for property conducted in accordance with Council's Policy

[X] Risk assessment for loss of life conducted in accordance with Council's Policy

[X] Assessed risks have been compared to "Acceptable Risk Management" criteria as defined in the Geotechnical Risk Management Policy for Pittwater

[X] Opinion has been provided that the design can achieve the "Acceptable Risk Management" criteria provided that the specified conditions are achieved.

[X] Design Life Adopted:
- [X] 100 years
- [ ] Other ……………………………………………… specify

[X] Development Conditions to be applied to all four phases as described in Pittwater Geotechnical Risk Management Policy have been specified

[X] Additional action to remove risk where reasonable and practical have been identified and included in the report.

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 ……………………………………………………

Name Scott Easton

Chartered Professional Status CPEng/NER

Membership No. 1371997