GEOTECHNICAL INVESTIGATION:

New Garage and Alterations and Additions at **6 Hillcrest Place, North Manly**

1. Proposed Development

1.1 Construct a garage at the road frontage by excavating to a maximum depth of ~2.8m into the slope.

1.2 Construct an access way on the uphill side of the house by excavating to a maximum depth of ~3.0m into the slope.

1.3 Details of the proposed development are shown on 4 drawings prepared by Cadence and Co Design, project numbered ROB 0818, sheets 1 to dated June 2018.

2. Site Description

2.1 The site was inspected on the 18th March, 2019.

2.2 This residential property is on the low side of the road and has a W aspect. It is located on the gentle to moderately graded lower reaches of a hillslope. From the road frontage to the downhill side of the house, the slope falls at average angle of ~18° and continues at angles of ~8° to the downhill boundary. The slope below the property eases to the foot of the slope. The grade above the block continues at moderate angles.

2.3 At the road frontage, an excavation has been made in the slope to level an area for a lawn and deck on the uphill side of the house (Photo 1). The excavation is supported by a stable brick wall that will be rebuilt as part of the proposed works (Photo 2). Medium Strength Sandstone is exposed at the surface along Hillcrest Place and at the base of the brick retaining wall (Photo 3). An old brick garage on the N side

of the road frontage has been constructed on top of Medium Strength Sandstone and will be demolished as part of the proposed works (Photo 1). The part two-storey brick house is supported on brick walls and brick piers (Photo 4). No significant signs of movement were observed in the supporting brick walls and the supporting brick piers stand vertical (Photo 5). Competent Medium Strength Sandstone was observed outcropping in the foundation space (Photo 6). A well-vegetated slope falls from the downhill side of the house before easing to the lower boundary (Photo 7). The slope is broken up by a stack rock retaining wall reaching a maximum height of ~0.5m. The wall is old but, from what could be observed, is in a stable condition (Photo 8). Large dislodged sandstone joint blocks sit partially embedded in the slope directly below the house (Photos 9 & 10). They appear to be in a stable position and have been in place for some time. No significant signs of movement were observed on the property. No geotechnical hazards that could impact on the subject property were observed on the neighbouring properties as seen from the subject property and the road.

3. Geology

The Sydney 1:100 000 Geological sheet indicates the site is underlain by Holocene Sands with the contact of Hawksbury Sandstone along the uphill boundary. The map boundary is slightly out and Hawkesbury Sandstone rock outcrops across the uphill half of the property. It is described as a medium to coarse grained quartz sandstone with very minor shale and laminate lenses.

4. Subsurface Investigation

One Hand Auger Hole (AH) was put down to identify the ground materials. Five Dynamic Cone Penetrometer (DCP) tests were put down to determine the relative density of the overlying soil and the depth to bedrock. The locations of the tests are shown on the site plan. It should be noted that a level of caution should be applied when interpreting DCP test results. The tests will not pass through hard buried objects so in some instances it can be difficult to

determine whether refusal has occurred on an obstruction in the profile or on the natural rock surface. This is not expected to be an issue for the testing on this site and the results are as follows:

AUGER HOLE 1 (~RL15.4) **–** AH1 (Photo 11)

Depth (m)	**Material Encountered**
0.0 to 0.2	**SANDY SOIL**, brown, loose, soft, organic matter, fine to medium grained, dry.
0.2 to 0.7	**SILTY SAND,** weathered sandstone, yellowish brown, sugary texture, loose, rock fragments throughout, red mottling, clay inclusions, damp.

Refusal @ 0.7m in silty sand. No watertable encountered.

DCP TEST RESULTS – Dynamic Cone Penetrometer

Equipment: 9kg hammer, 510mm drop, conical tip. Standard: AS1289.6.3.2- 199

Depth(m) Blows/0.3m	**DCP 1** (~RL16.6)	**DCP 2** (~RL16.6)	**DCP 3** (~RL16.4)	**DCP 4** (~RL15.5)	**DCP 5** (~RL15.1)
0.0 to 0.3	11	5	4	3	Rock exposed @ surface
0.3 to 0.6	#	#	5	13	
0.6 to 0.9			#	#	
	Refusal on Rock @ 0.3m	Refusal on Rock @ 0.1m	Refusal on Rock @ 0.4m	End of Test @ 0.6m	Rock exposed @ Surface

#refusal/end of test. F=DCP fell after being struck showing little resistance through all or part of the interval.

DCP Notes:

DCP1 – Refusal on rock @ 0.3m, DCP bouncing off rock surface, white impact dust on dry tip.

DCP2 – Refusal on rock @ 0.1m, DCP bouncing off rock surface, white impact dust on dry tip.

DCP3 – Refusal on rock @ 0.4m, DCP bouncing off rock surface, white impact dust on dry tip.

DCP4 – End of test @ 0.6, DCP still very slowly going down, wet muddy tip.

DCP5 – Rock exposed @ surface.

5. Geological Observations /Interpretation

The surface features of the block are controlled by the outcropping and underlying sandstone bedrock that steps down the property forming sub horizontal benches between the steps. Where the grade is steeper, the steps are larger and the benches narrower. Where the slope eases, the opposite is true. Where the rock is not exposed, it is overlain by natural sandy soils over silty sands that cover the bench step formation. Where rock was not exposed, it was encountered between depths of ~0.3 to ~0.6m below the current ground surface. The outcropping sandstone on the property is estimated to be medium strength or better and similar strength rock is expected to underlie the proposed works. See the Type Section attached for a diagrammatical representation of the expected ground materials.

6. Groundwater

Normal ground water seepage is expected to move over the exposed rock and the buried surface of the rock and through the cracks. Due to the slope and elevation of the block, the water table is expected to be many metres below the base of the proposed excavation.

7. Surface Water

No evidence of surface flows were observed on the property during the inspection. It is expected that normal sheet wash will move onto the site from above the property during heavy down pours. Hillcrest Place above will provide only limited drainage diversion from surface flows as the road is not guttered above the subject property.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed below or beside the property. The moderate slope that falls across the property and continues above is a potential hazard (**Hazard One**). The vibrations from the proposed excavations are a potential hazard (**Hazard Two**). A loose

boulder, wedge, or similar geological defect toppling onto the work site during the excavation process for the garage and access way is a potential hazard (**Hazard Three**).

Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two	Hazard Three
TYPE	The moderately graded slope that falls across the property failing and impacting on the house and proposed works.	The vibrations produced during the proposed excavations impacting on the subject house, and neighbouring houses to the N and S.	A loose boulder, wedge, or similar geological defect toppling onto the work site during the excavation process for the access way.
LIKELIHOOD	'Unlikely' (10^{-4})	'Possible' (10^{-3})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (15%)	'Medium' (20%)	'Medium' (20%)
RISK TO PROPERTY	'Low' (2×10^{-5})	'Moderate' (2×10^{-4})	'Moderate' (2×10^{-4})
RISK TO LIFE	8.3×10^{-7}/annum	5.3×10^{-7}/annum	2.6×10^{-4}/annum
COMMENTS	This level of risk is 'ACCEPTABLE'.	This level of risk to life and property is 'UNACCEPTABLE'. To move risk to 'ACCEPTABLE' levels the recommendations in **Section 12** are to be followed.	This level of risk to life and property is 'UNACCEPTABLE'. To move risk to 'ACCEPTABLE' levels the recommendations in **Section 13** are to be followed.

(See Aust. Geomech. Jnl. Mar 2007 Vol. 42 No 1, for full explanation of terms)

9. Suitability of the Proposed Development for the Site

The proposed development is suitable for the site. No geotechnical hazards will be created by the completion of the proposed development provided it is carried out in accordance with the requirements of this report and good engineering and building practice.

10. Stormwater

Stormwater from the existing house is either discharged beside the house or is piped underground and the discharge location could not be visually identified. It is recommended a drainage easement be obtained from the downhill neighbouring property and all stormwater or drainage runoff from the proposed development be piped to the street below. If this option is not feasible, a spreader pipe system positioned clear of the downhill side of the house is suitable as a last resort provided flows are kept close to natural runoff for the site. All stormwater is to be piped through any tanks that may be required by the regulating authorities.

11. Excavations

An excavation to a maximum depth of ~2.8m is required to install the proposed garage and another excavation to a maximum depth of ~3.0m is required to install an access way on the uphill side of the house. Where rock is not exposed at the surface, both excavations are expected to be through ~0.3m sandy soil over Medium Strength Sandstone. It is envisaged that excavations through sandy soil can be carried out by a bucket only and excavations through rock will require grinding or rock sawing and breaking.

12. Vibrations

Possible vibrations generated during excavations through sandy soil will be below the threshold limit for building damage.

It is expected that the majority of the excavations will be through Medium Strength Sandstone. Excavations through rock should be carried out to minimise the potential to cause vibration damage to the supporting walls of the subject house, the supporting walls of the neighbouring garage to the S, and the neighbouring house to the N. The supporting brick walls of the subject house will be located immediately beside the proposed excavation for the retaining wall, and the neighbouring garage to the S will be ~1.6m. The subject house will come flush and the house to the N will be ~4.0m from the proposed excavation for the garage.

Close controls by the contractor over rock excavation are recommended so excessive vibrations are not generated.

Excavation methods are to be used that limit peak particle velocity to 5mm/sec at the perimeter of the excavation. Vibration monitoring will be required to verify this is achieved.

If a milling head is used to grind the rock vibration monitoring will not be required. Alternatively, if rock sawing is carried out around the perimeter of the excavation boundaries in not less than 1.0m lifts, a rock hammer up to 300kg could be used to break the rock without vibration monitoring. Peak particle velocity will be less than 5mm/sec at the supporting brick walls of the house and garage and common boundaries using this method provided the saw cuts are kept well below the rock to broken.

It is worth noting that vibrations that are below thresholds for building damage may be felt by the occupants in the subject and neighbouring houses.

13. Excavation Support Requirements

The proposed garage excavation will be as close as ~0.3m from the N common boundary and ~0.4m from the E common boundary. The excavation is expected to be almost entirely through Medium Strength Sandstone with a shallow ~0.3m portion of soil expected along the E side of the excavation. Thus, no structures or boundaries will lie within the zone of influence of the excavation. In this instance, the zone of influence is the area above a theoretical 30° line through soil from the base of the excavation, towards the surrounding structures and boundaries. As the excavation is progressed the shallow sandy soil portion of the excavation along the E boundary is to be scraped back from the line of the excavation.

The proposed excavation for the access way will be a maximum depth of ~3.0m and come flush with the uphill supporting wall of the subject house. The excavation is expected to be entirely through Medium Strength Sandstone. Thus, no structures or boundaries will be within the zone of influence of the excavation for the retaining wall.

In this instance, the zone of influence is the area above a theoretical 30° line through from the top of Medium Strength Sandstone, towards the surrounding structures and boundaries.

During the excavation process, the geotechnical consultant is to inspect the cuts in 1.5m intervals as they are lowered, while the machine/excavation equipment is on site, to ensure the ground materials are as expected and no wedges or other geological defects are present that could require additional support.

Upon completion of the excavations it is recommended all cut faces be supported with retaining walls to prevent any potential future movement of joint blocks in the cut face that can occur over time, when unfavourable jointing is obscured behind the excavation face. Additionally, retaining walls will help control seepage and to prevent minor erosion and sediment movement.

All excavation spoil is to be removed from site.

14. Retaining Walls

For cantilever or singly propped retaining walls it is suggested the design be based on a triangular distribution of lateral pressures using the parameters shown in Table 1.

Table 1 – Likely Earth Pressures for Retaining Walls

Unit	Earth Pressure Coefficients		
	Unit weight (kN/m^3)	'Active' K_a	'At Rest' K_0
Sandy Soil	20	0.40	0.55
Medium Strength Sandstone	24	0.00	0.10

For rock classes refer to Pells et al "Design Loadings for Foundations on Shale and Sandstone in the Sydney Region". Australian Geomechanics Journal 1978.

It is to be noted that the earth pressures in Table 1 assume a level surface above the wall, do not account for any surcharge loads and assume retaining walls are fully drained. Rock strength and relevant earth pressure coefficients are to be confirmed on site by the geotechnical consultant.

It is possible the starter bars for the retaining walls can be drilled and grouted directly into Medium Strength Rock at the base of the cut subject to an inspection and approval of the exposed rock by the geotechnical consultant.

All retaining walls are to have sufficient back-wall drainage and be backfilled immediately behind the wall with free-draining material (such as gravel). This material is to be wrapped in a non-woven Geotextile fabric (i.e. Bidim A34 or similar), to prevent the drainage from becoming clogged with silt and clay. If no back-wall drainage is installed in retaining walls, the likely hydrostatic pressures are to be accounted for in the retaining wall design.

15. Foundations

A concrete slab supported directly off Medium Strength Sandstone is a suitable footings for the proposed garage.

The proposed retaining wall for the lawn is to be supported directly off Medium Strength Sandstone.

A maximum allowable bearing pressure of 800KPa can be assumed for footings on Medium Strength Sandstone.

Naturally occurring vertical cracks known as joints commonly occur in sandstone. These are generally filled with soil, and are the natural seepage paths through the rock. They can extend to depths of several metres, and are usually relatively narrow but can range between 0.1 to 0.8m wide. If a pad footing falls over a joint in the rock, the construction process is simplified if with the approval of the structural engineer the joint can be spanned, or alternatively the footing can be repositioned so it does not fall over the joint.

NOTE: If the contractor is unsure of the footing material required, it is more cost effective to get the geotechnical consultant on site at the start of the footing excavation to advise on footing depth and material. This mostly prevents unnecessary over-excavation in clay-like shaly-rock but can be valuable in all types of geology.

16. Inspections

The client and builder are to familiarise themselves with the following required inspections as well as council geotechnical policy. We cannot provide geotechnical certification for the owner or the regulating authorities if the following inspections have not been carried out during the construction process.

- During the excavation process, the geotechnical consultant is to inspect the cuts in 1.5m intervals as it is lowered, while the machine/excavation equipment is on site, to ensure the ground materials are as expected and no wedges or other geological defects are present that could require additional support.

- All footings are to be inspected and approved by the geotechnical consultant while the excavation equipment is still onsite and before steel reinforcing is placed or concrete is poured.

White Geotechnical Group Pty Ltd.

Ben White M.Sc. Geol.,
AusIMM., CP GEOL.
No. 222757
Engineering Geologist

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9

Photo 10

Photo 11: Auger Hole 1, base of hole at base of image

Important Information about Your Report

It should be noted that Geotechnical Reports are documents that build a picture of the subsurface conditions from the observation of surface features and testing carried out at specific points on the site. The spacing and location of the test points can be limited by the location of existing structures on the site or by budget and time constraints of the client. Additionally the test themselves, although chosen for their suitability for the particular project, have their own limiting factors. The testing gives accurate information at the location of the test, within the confines of the tests capability. A geological interpretation or model is developed by joining these test points using all available data and drawing on previous experience of the geotechnical consultant. Even the most experienced practitioners cannot determine every possible feature or change that may lie below the earth. All of the subsurface features can only be known when they are revealed by excavation. As such a Geotechnical report can be considered an interpretive document. It is based on factual data but also on opinion and judgement that comes with a level of uncertainty. This information is provided to help explain the nature and limitations of your report.

With this in mind, the following points are to be noted:

- If upon the commencement of the works the subsurface ground or ground water conditions prove different from those described in this report it is advisable to contact White Geotechnical Group immediately, as problems relating to the ground works phase of construction are far easier and less costly to overcome if they are addressed early.

- If this report is used by other professionals during the design or construction process any questions should be directed to White Geotechnical Group as only we understand the full methodology behind the report's conclusions.

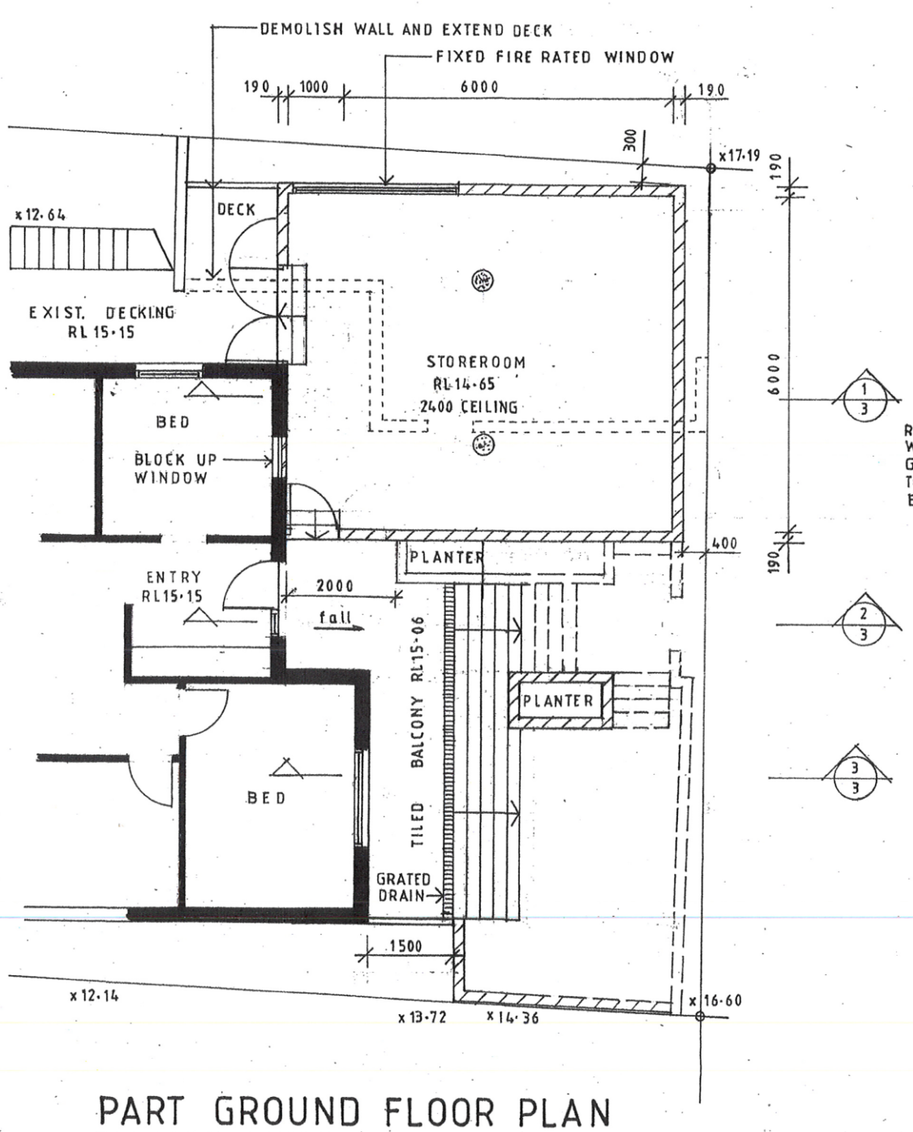
- The report addresses issues relating to your specific design and site. If the proposed project design changes, aspects of the report may no longer apply. Contact White Geotechnical if this occurs.

- This report should not be applied to any other project other than that outlined in section 1.0.

- This report is to be read in full and should not have sections removed or included in other documents as this can result in misinterpretation of the data by others.

- It is common for the design and construction process to be adapted as it progresses (sometimes to suit the previous experience of the contractors involved). If alternative design and construction processes are required to those described in this report contact White Geotechnical Group. We are familiar with a variety of techniques to reduce risk and can advise if your proposed methods are suitable for the site conditions.

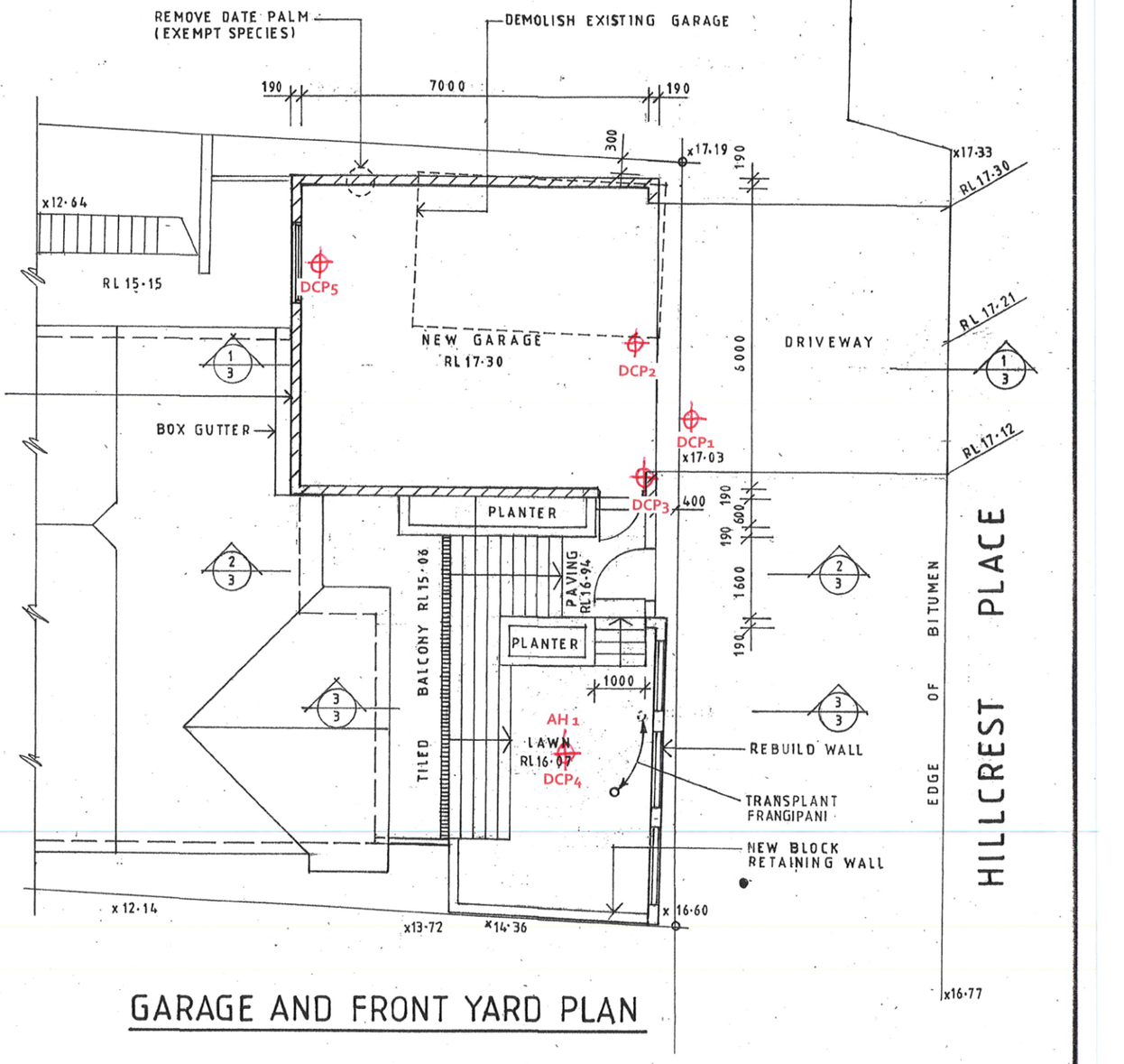
SITE PLAN – showing test locations



PART GROUND FLOOR PLAN

TN

REINFORCE BLOCKWORK WALLS TO 600 MIN. ABOVE GARAGE FLOOR LEVEL TO ACT AS VEHICLE BARRIER



GARAGE AND FRONT YARD PLAN

CADENCE & CO DESIGN PTY LTD
Suite 7, 287 Mona Vale Rd,
Terrey Hills, NSW, 2084,
P 84501950
E info@cadenceandco.com.au
ABN: 12 168 714 752

REVISION: DATE: REVISION NOTE:

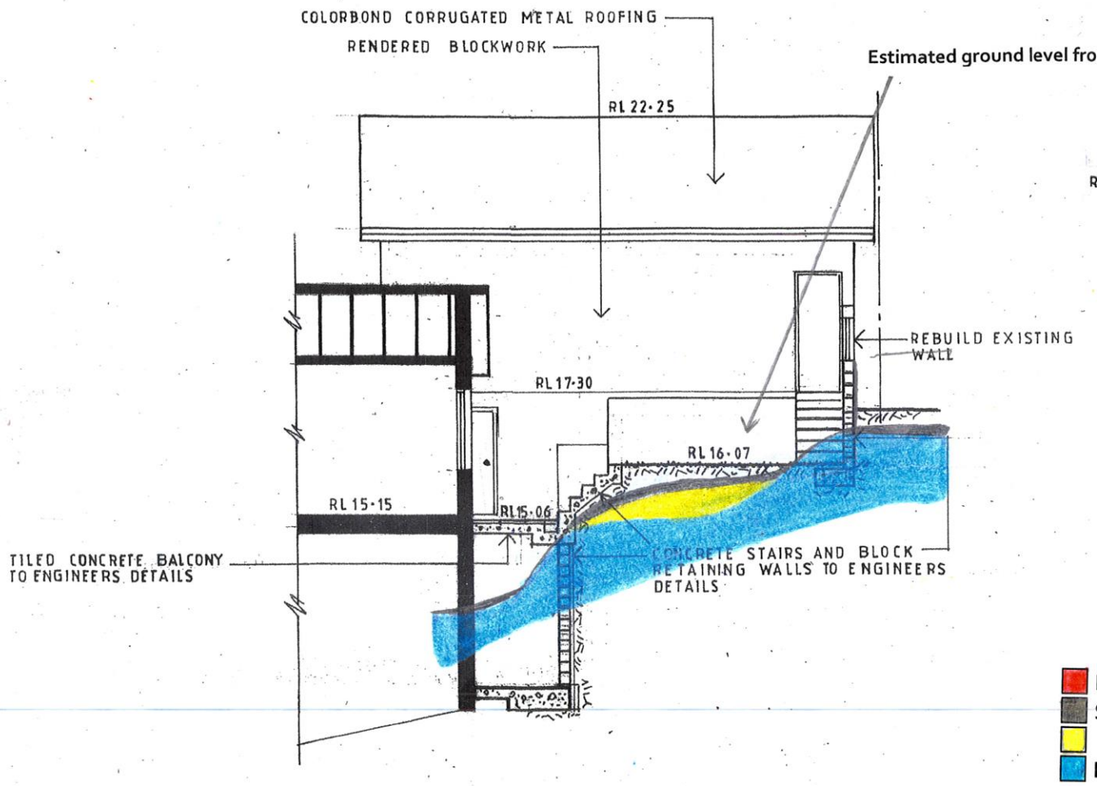
CLIENT: BLITHE AND ROCHELLE ROBINSON

ADDRESS: 6 HILLCREST PLACE
NORTH MANLY
LOT 52 DP22369

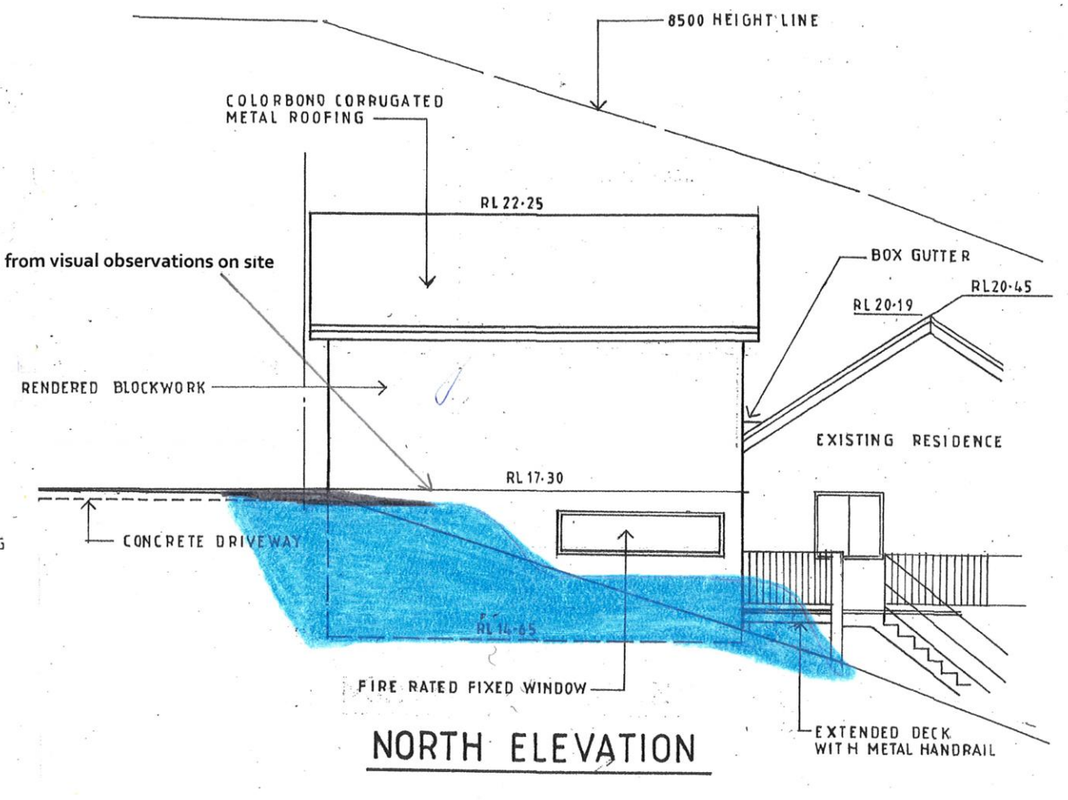
DRAWING: FLOOR PLANS
DRAWN: J.W.
SHEET NO: 1
PROJECT: NEW GARAGE AND STOREROOM
CHKD:
SCALE @ A3: 1:100
PROJECT NO: ROB 0818
ISSUE TYPE: DA
ISSUE DATE: 06/2018
REVISION:

GENERAL NOTES: ALL RL'S SHOWN ARE FINISHED LEVELS, BUILDER TO PROVIDE SET DOWNS & ALLOWANCES AS REQUIRED. ALL OPENING DIMENSIONS ARE NOMINAL, BUILDER TO CHECK SIZES ON-SITE BEFORE ORDERING WINDOW AND DOOR UNITS.

TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials



SECTION 3



NORTH ELEVATION

- Fill
- Sandy Soil
- Silty Sand – Medium Dense
- Hawkesbury Sandstone – Medium Strength

CADENCE & CO DESIGN PTY LTD
Suite 7, 267 Mona Vale Rd,
Terrey Hills, NSW, 2084,
P 94501950
E info@cadenceandco.com.au
ABN: 12 168 714 752

REVISION:	DATE:	REVISION NOTE:

CLIENT: BLITHE AND ROCHELLE ROBINSON

ADDRESS: 6 HILLCREST PLACE
NORTH MANLY
LOT 52 DP22369

DRAWING: ELEVATIONS
PROJECT: NEW GARAGE AND STOREROOM
PROJECT NO: ROB 0818
ISSUE TYPE: DA

DRAWN:	SHEET NO:
J.W.	2
CHKD:	SCALE @ A3: 1:100
ISSUE DATE: 06/2018	REVISION:

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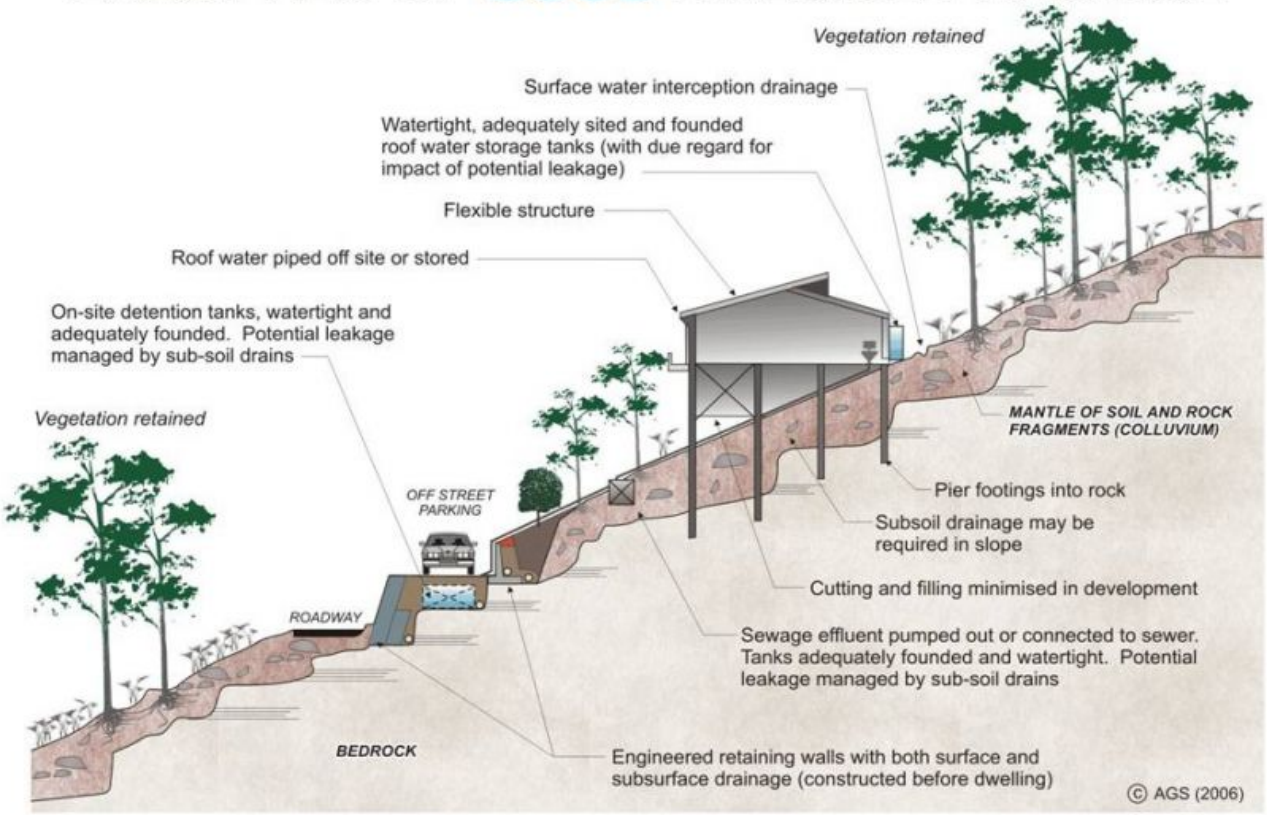
EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE