GEOTECHNICAL INVESTIGATION:

New House at **41 Marine Parade, Avalon**

1. Proposed Development

1.1 Demolish the existing house and construct a new dwelling.

1.2 Details of the proposed development are shown on 7 drawings prepared by Casey Brown Architecture, drawings numbered A1.1, A2.1 & 2.2 are labelled Revision B, dated 14/04/16 and drawings numbered A1.2 to 1.4, A2.3 are labelled Revision C, dated 14/04/16.

2. Site Description

2.1 The site was inspected on the 28th April, 2016.

2.2 This battle axe shaped residential property is on the higher side of the road and has a W aspect. The block runs longways to the S so the slope is a cross fall. It is located on the moderately graded upper middle reaches of a hillslope. The natural slope rises from the lower boundary at average angle of ~10° to the upper boundary. The slope below the S boundary of the property falls at gradually increasing angles for ~40m before reaching a coastal scarp that falls some ~20m to a rock platform below.

2.3 At the road frontage a long concrete driveway runs up the slope to a stable, brick garage and a car parking area beside the house (Photo 1 & 2). A cut that increases in height to the S has been made into the slope for the parking area and the uphill side of the house. The N portion of the cut is supported by a low elevation, rough, stack rock retaining wall that currently appears stable (Photo 3). The majority of the S side of the cut is through competent, medium strength sandstone. The very shallow soil and clay portions are slightly battered uphill and appear stable (Photo 4). The two storey rendered brick and timber framed house is in good condition for its age. No significant signs of movement or cracking were observed in its external supporting walls. Under the W corner of the house a cut through competent, medium strength sandstone has been made into the slope for a storage area (Photo 5). On the downhill side the house medium strength sandstone beds outcrop (Photo 6 & 7). Some areas of the beds are undercut however the cantilever arms are thick is thick in relation to the overhang length and the rock faces are considered stable. No other significant geological defects were observed on the exposed rock faces that could affect their stability. Dislodged boulders are either sitting on top of the beds or partly embedded in the slope and are considered to be in stable positions. Approximately 40m below the lower boundary a coastal scarp falls some ~20m to a rock platform and the ocean. From below the cliff face it can be seen to be made up of thinly bedded shale and thicker bedded sandstone (Photo 8). The base of the cliff is armoured from the undercutting action of the waves by the rock platform and a build-up of some slope debris (boulders) at the base of the cliff. The weathering process of the cliff face occurs when the harder beds are undercut by the softer beds. Because the beds are relatively thin and jointed the resulting failures are small in scale. This weathering process is extremely slow, measured from the geological record to be in the order of 5-10mm year. Given the elevation of the rock platform and boulders armouring the base of the cliff the current accepted predicted sea level rise for the next century is not expected to lead to significant undercutting from wave action.

3. Geology

The Sydney 1:100 000 Geological sheet indicates the site is underlain by the Newport Formation of the Narrabeen Group. This is described as interbedded laminite, shale and quartz to lithic quartz sandstone.

4. Subsurface Investigation

Seven Dynamic Cone Penetrometer (DCP) tests were put down to determine the relative density of the overlying soil and the depth to rock. The location of the tests are shown on the site plan. It should be noted that a level of caution should be applied to interpreting DCP test results. The test 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. With this in mind the results are as follows:

SEE THE DCP RESULTS OVER THE PAGE

DCP TEST RESULTS – Dynamic Cone Penetrometer							
Equipment: 9kg hammer, 510mm drop, conical tip.					Standard: AS1289.6.3.2- 1997		
Depth(m) Blows/0.3m	**DCP 1**	**DCP 2**	**DCP 3**	**DCP 4**	**DCP 5**	**DCP 6**	**DCP 7**
0.0 to 0.3	1F	1F	1F	1F	4	5	7
0.3 to 0.6	5	6	17	40	24	45	15
0.6 to 0.9	11	#	#	#	40	#	
0.9 to 1.2	14				#		
1.2 to 1.5	#						
1.5 to 1.8							
1.8 to 2.1							
	Refusal on Rock @ 1.1m	Refusal on Rock @ 0.4m	Refusal on Rock @ 0.5m	Refusal on Rock @ 0.6m	End of Test @ 0.9m	End of Test @ 0.6m	Refusal on Rock @ 0.4m

#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 @ 1.1m, DCP bouncing off rock surface, clean dry tip.
DCP2 – Refusal on rock @ 0.4m, DCP bouncing off rock surface, clean dry tip.
DCP3 – Refusal on rock @ 0.5m, DCP bouncing off rock surface, clean dry tip.
DCP4 – Refusal on rock @ 0.6m, DCP bouncing off rock surface, clean dry tip.
DCP5 – End of test @ 0.9m, DCP still very slowly going down, clean dry tip with a small amount of yellow rock fragments.
DCP6 – End of test @ 0.6m, DCP still very slowly going down, clean dry tip.
DCP7 – Refusal on rock @ 0.4m, DCP bouncing off rock surface, clean dry tip.

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 sandy clays that cover the bench step formation. In the test locations the depth to rock ranged between 0.4 to 1.1m below the current surface, being slightly variable due to the stepped structure of the rock. The outcropping sandstone above and under the house is estimated to be medium strength or better and similar strength rock is expected to underlie the entire site. 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. Normal sheet wash from the slope above will move onto the property during heavy downpours.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed above, below or beside the property. The sandstone beds that line the lower common boundary are a potential hazard (**Hazard One**). The vibrations from the proposed excavations are a potential hazard (**Hazard Two**). The proposed excavations are a potential hazard until retaining walls are in place (**Hazard Three**).

Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two	Hazard Three
TYPE	The undercut sandstone beds that line the lower boundary toppling and impacting the existing house or the proposed works.	The vibrations produced during the proposed excavations causing failure of the undercut sandstone beds along the lower boundary of the subject property (Photo 6 & 7).	The proposed excavation collapsing onto the work site before retaining walls are in place.
LIKELIHOOD	'Rare' (10^{-5})	'Unlikely' (10^{-4})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (12%)	'Medium' (12%)	'Medium' (20%)
RISK TO PROPERTY	'Low' (2×10^{-6})	'Low' (2×10^{-5})	'Moderate' (2×10^{-4})
RISK TO LIFE	5.3×10^{-8}/annum	1.2×10^{-7}/annum	6.8×10^{-4}/annum
COMMENTS	This level of risk is 'ACCEPTABLE'.	This level of risk is 'ACCEPTABLE'. Provided the recommendations in **Section 12** are 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.

Where there is fall to the street below all stormwater or drainage runoff from the proposed development is to be piped to it. Where this is not possible a spreader pipe system 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 ~3.0m is required to install the lower ground floor level of the proposed house. Medium strength sandstone is exposed under NW corner of the existing house. A portion of the proposed excavation could not be accessed through the foundation space of the existing house but the surrounding ground tests indicate that where rock is not exposed it is overlain by a shallow sandy soil over a firm to stiff sandy clay with medium strength sandstone expected at depths between 0.4 to 1.1m below the current surface. It is envisaged that excavations through sandy soil and sandy clays can be carried out by an excavator and bucket only and excavations through medium strength sandstone or better will require grinding or rock sawing and breaking.

12. Vibrations.

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

It is expected that the majority of the excavations will be through medium strength sandstone or better. Excavations through rock should be carried out to minimise the potential to cause vibration damage to the undercut sandstone beds along the lower boundary of the subject property (Photo 6 & 7). The closest neighbouring house is at least ~20m from the edge of the proposed excavation. 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 10mm/sec at the common boundaries of the subject property. 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 600kg could be used to break the rock without vibration monitoring. Peak particle velocity will be less than 10mm/sec at the 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 of the house and garage.

13. Excavation Support Requirements

The existing house will be demolished as part of the proposed works and the closest common boundary is at least ~1.8m from the edge of the proposed excavations. No structures or boundaries will be inside the excavations zone of influence. In this instance the zone of influence is the area above a theoretical 45° line from the top of medium strength sandstone towards the surrounding structures and boundaries.

The sandy soil and sandy clay portions of the cut face are to be temporarily battered at 1.0 Vertical: 1.7 Horizontal (30°) until permanent retaining walls are in place. Excavations through medium strength sandstone will stand at vertical angles unsupported subject to approval by the geotechnical professional.

Cut batters through sandy soil and sandy clay are to be covered to prevent access of water in wet weather and loss of moisture in dry weather. The covers are to be tied down with metal pegs or other suitable fixtures so they can't blow off in a storm. Upslope runoff is to be diverted from the cut faces by sandbag mounds or other diversion works. The materials and labour to construct the retaining walls are to be organised so on completion of the excavations they can be constructed as soon as possible. The excavations are to be carried out during a dry period. No excavations are to commence if heavy or prolonged rainfall is forecast.

During the excavation process for the lower ground floor level the geotechnical professional is to inspect the cut while the machine 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 this excavation 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 or be supported by engineered retaining walls.

14. Retaining Walls

Retaining walls supporting sandy soil and sandy clays can be designed for a lateral earth pressure coefficient K_a of 0.35 and assume a bulk density of $20kN/m^3$. Cuts through medium strength sandstone will exert no earth pressure subject to the inspection of the cut face by the geotechnical professional to ensure no wedges or other defects are present.

It is likely the starter bars for the retaining walls can be drilled and grouted directly into the sandstone at the base of the cut subject to an inspection and approval of the exposed rock by the geotechnical professional.

Any surcharge loads that may act on the proposed retaining structures are to be accounted for in the design.

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 likely hydrostatic pressures are to be accounted for in the retaining structure design.

15. Site Classification

The site classification in accordance with AS2870-2011 for footings supported on sandstone bedrock is Class A.

16. Foundations

A concrete slab, shallow piers, strip or pad footings supported directly off medium strength sandstone are suitable footings for the proposed house. Where this material is not exposed at the base of the excavation it is expected at a depths between 0.4 to 1.1m below the current surface. A maximum allowable bearing pressure of 1.2MPa 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 professional 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.

17. 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 Occupation Certificate if the following inspections have not been carried out during the construction process.

- During the excavation process for the lower ground floor level the geotechnical professional is to inspect the cut face while the machine 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 professional before concrete is placed.

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

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 professional. 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.

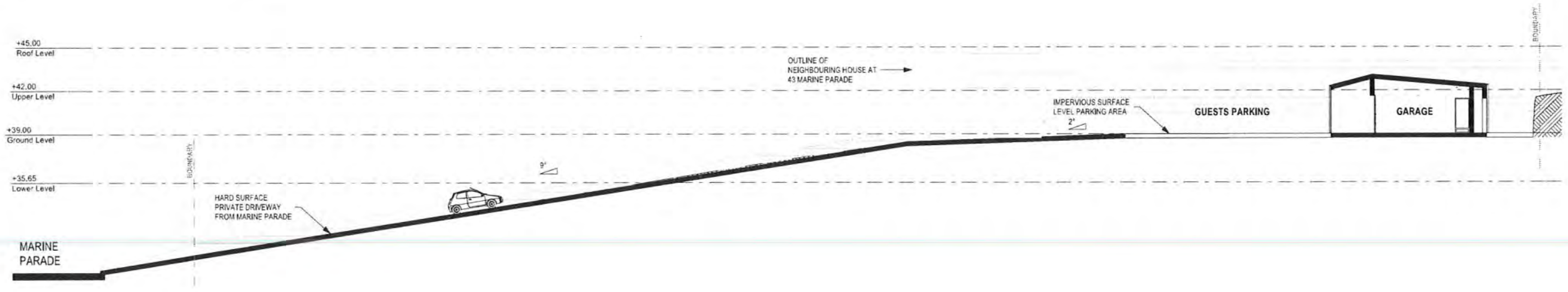
- This report should not be applied to any other project other than that outlined in section 1.0.

- 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

1 Roof / Site / Demolition Plan 1:200



2 DW Section 1:200

AREA CALCULATIONS

SITE AREA : 1515 m²

SITE COVERAGE :

	HARD SURFACE	LANDSCAPED - IMPERVIOUS
PERMISSIBLE	40% (606 m²)	60% (909 m²) - 6% (90.9 m²) = 54%
EXISTING	46% (700 m²)	54% (815 m²) - 3% (51 m²) = 51%
PROPOSED	34% (521 m²)	66% (994 m²) - 10% (148 m²) = 56%

BASIX COMMITMENT

- SOLAR / INSTANTANEOUS GAS HOT WATER SYSTEM
- TIMBER FRAMED DOUBLE GLAZED DOORS AND WINDOWS
- OUTDOOR CLOTHES LINES
- HYDROLIC FLOOR HEATING
- WOOD BURNING FIRE PLACE
- PHOTOVOLTAIC ELECTRICITY
- INSULATION REQUIREMENT

TIMBER FRAME PITCHED ROOF	TBC
CONCRETE FLAT ROOF	TBC
CAVITY BRICK WALL	TBC
SUSPENDED CONCRETE FLOOR	TBC
CONCRETE SLAB ON GROUND	TBC

THE PROPOSED WORKS HAVE BEEN DESIGNED TO COMPLY WITH :

- NATIONAL CONSTRUCTION CODE
- STATEMENT OF ENVIRONMENTAL EFFECTS PREPARED BY DENIS FISH
- BUSHFIRE HAZARD ASSESSMENT REPORT PREPARED BY BUILDING CODE & BUSHFIRE HAZARD SOLUTIONS
- BASIX REPORT PREPARED BY VICTOR LIN & ASSOCIATES
- GEOTECHNICAL REPORT PREPARED BY WHITE GEOTECHNICAL GROUP
- ARBORIST REPORT PREPARED BY GROWING MY WAY TREE SERVICES
- LANDSCAPE DESIGN PREPARED BY SELENA HANNAN LANDSCAPE DESIGN

ABBREVIATIONS

BR	MASONERY CONSTRUCTION (BRICK/NATURAL STONE)
CR	CONCRETE ROOF
DP	DOWN PIPE
MB	METAL BALUSTRADE
MR	METAL ROOF
OFC	OFF FORM CONCRETE
TW	TIMBER FRAME WINDOW
TD	TIMBER FRAME DOOR
TV	TIMBER FRAME VENT

Rev.	Notes	Date	Reviewed
A	Preliminary pricing	17.02.2016	RB / TO
B	Coordination	14.04.2016	RB / TO

BUILDERS/ CONCTRACTORS ARE TO VERIFY ALL DIMENSIONS PRIOR TO COMMENCEMENT OF SITE WORK OR OFF-SITE FABRICATION. ALL SHOP DRAWINGS ARE TO BE SUBMITTED TO THE PROJECT MANAGER, AND MANUFACTURE SHALL NOT COMMENCE UNTIL RETURN OF UNAMENDED SHOP DRAWINGS. FIGURED DIMENSIONS ARE TO BE READ IN PREFERENCE TO SCALED.

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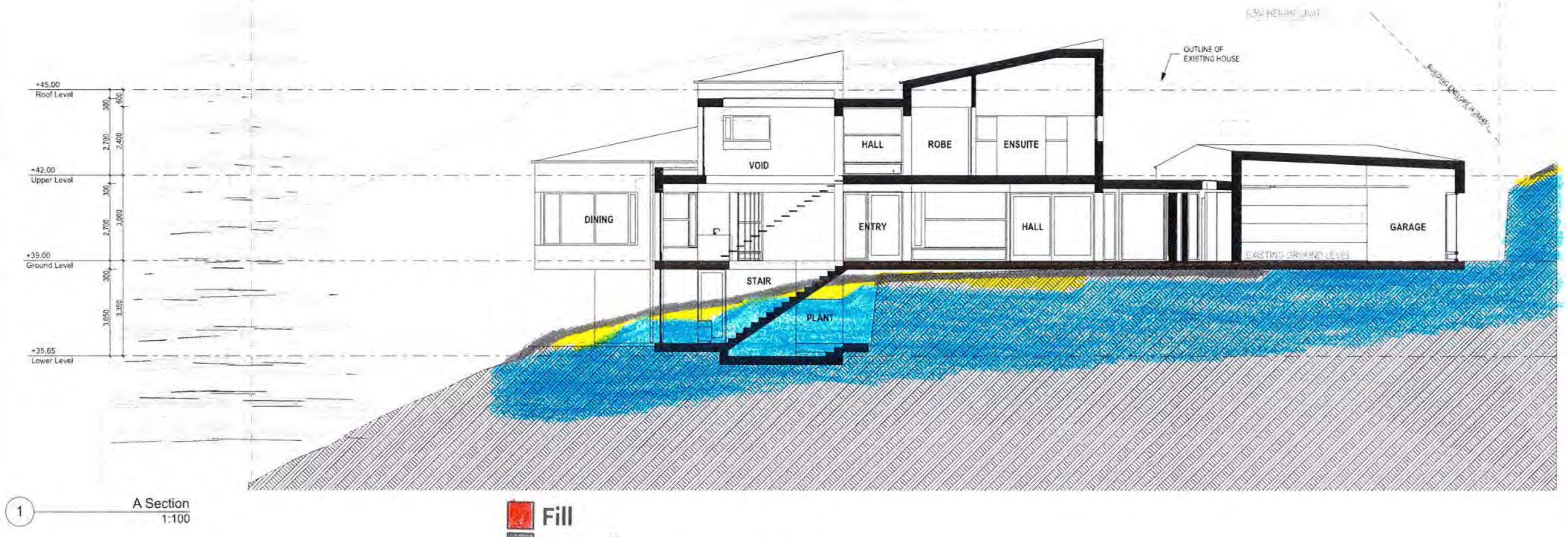
Project
41 MARINE PARADE, AVALON

Drawing Title
SITE PLAN / DRIVEWAY SECTION

Drawing No.	Scale
A1.1	1:200 (A1)

Casey Brown Architecture Pty Ltd ABN 38004010575
Nominated Architect Robert Brown 5425

TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials



- Fill
- Topsoil
- Sandy Clay – Firm to Stiff
- Narrabeen Group Rocks – Medium Strength Sandstone

ABBREVIATIONS

BR	MASONERY CONSTRUCTION (BRICK/NATURAL STONE)
CR	CONCRETE ROOF
DP	DOWN PIPE
MB	METAL BALUSTRADE
MR	METAL ROOF
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TW	TIMBER FRAME WINDOW
TD	TIMBER FRAME DOOR
TV	TIMBER FRAME VENT

0 1 2 5 10M

Rev.	Notes	Date	Reviewed
A	Preliminary pricing	17.02.2016	RB / TO
B	Coordination	18.03.2016	RB / TO
C	Coordination	14.04.2016	RB / TO

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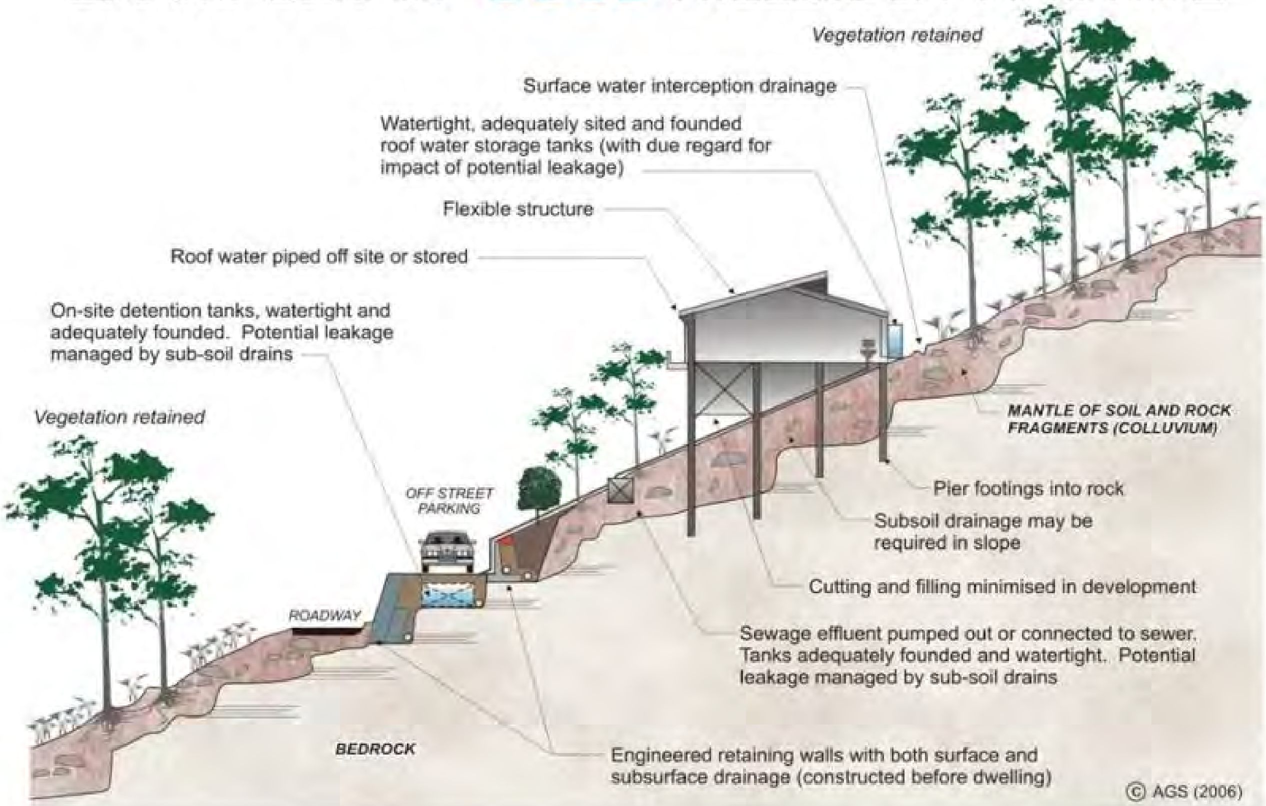
Project
41 MARINE PARADE, AVALON

Drawing Title
SECTIONS

Drawing No.: A2.3
Scale: 1:100 (A1)

Casey Brown Architecture Pty Ltd ABN 38004010575
Nominated Architect Robert Brown 5425

EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE