GEOTECHNICAL INVESTIGATION:

New House and Pool at **5A Hilltop Crescent, Fairlight**

1. Proposed Development

1.1 Demolish the existing house.

1.2 Construct a new part-three-storey house by excavating to a maximum depth of ~2.0m into the slope.

1.3 Install a pool on the downhill side of the house by excavating to a maximum depth of ~1.5m into the slope.

1.4 Details of the proposed development are shown on 9 drawings prepared by Watershed Design, project numbered 18021, Issue I, drawings numbered DA01 to 13, drawings dated 15.3.19.

2. Site Description

2.1 The site was inspected on the 24th January, 2019.

2.2 This residential property is on the low side of Hilltop Crescent. The block is located on the moderate to gently graded upper reaches of a hill slope. From the road frontage to the uphill side of the house the slope falls at an average angle of <5° and continues at average angles of ~17° to the downhill boundary. The slope above and below the property continues at similar angles.

2.3 At the road frontage, a concrete driveway runs to a carport attached to the E side of the house (Photos 1 & 2). Between the road frontage and the house is a level lawn area surrounded by gardens (Photo 3). The part two storey brick house will be demolished as part of the proposed works (Photo 4). A gently sloping artificial turfed lawn extends from the downhill side of the house to the downhill boundary (Photo 5). A timber clad shed on the downhill side of the house will be demolished as part of the proposed works (Photo 6). 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 Hawkesbury Sandstone. 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 soil materials. Six 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 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. This is not expected to be an issue for the testing on this site and the results are as follows:

AUGER HOLE 1 (~RL52.3) **–** AH1 (Photo 7)

Depth (m)	Material Encountered
0.0 to 0.4	**FILL**, disturbed sandy soil, light brown to brown orange, loose, fine to medium grained, rock fragments throughout, pebbles, dry.
0.4 to 0.6	**SANDY SOIL**, brown, loose, fine to medium grained, minor rock fragments, dry.

End of hole @ 0.6m in sandy soil. No watertable encountered.

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** (~RL56.2)	**DCP 2** (~RL56.1)	**DCP 3** (~RL56.4)	**DCP 4** (~RL52.4)	**DCP 5** (~RL53.1)	**DCP 6** (~RL52.4)
0.0 to 0.3	12	11	6	8	16	5
0.3 to 0.6	6	#	12	6	23	3
0.6 to 0.9	#		16	4	#	8
0.9 to 1.2			#	#		#
1.2 to 1.5						
	Refusal on Rock @ 0.4m	Refusal on Rock @ 0.1m	Refusal on Rock @ 0.7m	Refusal on Rock @ 0.8m	Refusal on Rock @ 0.4m	Refusal on Rock @ 0.9m

#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 @ 0.4m, DCP bouncing off rock surface, red 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 @ 0.7m, DCP bouncing off rock surface, red impact dust on dry tip.
DCP4 – Refusal on rock @ 0.8m, DCP bouncing off rock surface, red impact dust and sandy soil on dry tip.
DCP5 – Refusal on rock @ 0.4m, DCP bouncing off rock surface, wet sandy clay tip.
DCP6 – Refusal on rock @ 0.9m, DCP bouncing off rock surface, red clay on wet tip.

5. Geological Observations /Interpretation

The surface features of the block are controlled by the 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 fill over sandy soils and firm to stiff sandy clays that fill the bench step formation. In the test locations, the depth to rock ranged between ~0.1 to ~0.9m below the current ground surface, being deeper where a shallow fill has been placed on the downhill side of the house. As the DCP bounced at the end of every test, Medium Strength Sandstone 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 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 excavations.

7. Surface Water

No evidence of surface flows were observed on the property during the inspection. As the property encompasses the crest of the hill, the property will not be impacted by upslope runoff. Flows generated on the block will flow away from the property.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed above, below or beside the property. The moderate slope that falls across the lower portion of the property is a potential hazard (**Hazard One**). The vibrations from the proposed house excavation are a potential hazard (**Hazard Two**). The proposed excavations are a potential hazard until retaining walls are in place (**Hazard Three**).

SEE THE RISK ANALYSIS SUMMARY OVER THE PAGE

Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two	Hazard Three
TYPE	The moderate slope that falls across the lower portion of the property impacting on the proposed works (Photo 6)	The vibrations produced during the proposed excavations impacting on the supporting brick walls of the neighbouring houses to the E and W.	The proposed excavation for the lower ground floor and pool collapsing onto the worksite before retaining walls are in place.
LIKELIHOOD	'Unlikely' (10^{-4})	'Possible' (10^{-3})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Minor' (8%)	'Medium' (20%)	'Medium' (15%)
RISK TO PROPERTY	'Low' (x 10^{-6})	'Moderate' (2 x 10^{-4})	'Moderate' (2 x 10^{-4})
RISK TO LIFE	7.3 x 10^{-7}/annum	5.8 x 10^{-6}/annum	2.9 x 10^{-4}/annum
COMMENTS	This level of risk is 'ACCEPTABLE'.	This level of risk to life and property is '**UNACCEPTABLE**'. To move the risk levels 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

The current stormwater disposal system is unknown. If it is not currently piped below through an easement to Fairlight Street a drainage easement is to be obtained from the downhill neighbouring property and all stormwater or drainage runoff from the proposed new development be piped to the street below. If this option is not feasible, 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 ~2.0m is required to install the proposed new house. The excavation is expected to be through sandy soil over firm to stiff sandy clays with Medium Strength Sandstone expected at an average depth of ~0.6m below the current ground surface.

Another excavation to ~1.5m will be required to install the proposed pool. The excavation is expected to be through a shallow fill over sandy soil and firm to stiff sandy clay.

It is envisaged that excavations through fill, sandy soil and sandy clays can be carried with a bucket and excavations through rock will require grinding or rock sawing and breaking.

12. Vibrations

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

Excavations through rock should be carried out to minimise the potential to cause vibration damage to the neighbouring house to the E and W. The supporting walls of the neighbouring house to the E will be as close as ~4.8m and the W neighbouring house ~3.6m from the proposed excavations. 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 property boundaries. Vibration monitoring will be required to verify this is achieved.

If a milling head is used to grind the rock or hand tools are used such a jack hammers or similar, 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 10mm/sec at the supporting brick walls and piers of the house or 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

Excavation for the Proposed House

An excavation to a maximum depth of ~2.0m is required to install the lower ground floor of the proposed house. The excavation will decrease in depth downslope to the natural ground line with the fill, soil, and clay portions of the cut not exceeding a depth of ~0.5m. Accounting for back-wall drainage, the excavation will be as close as ~0.5m from the E and W common boundaries. Thus, the E and W common boundaries will be within the zone of influence of the excavation in places. No adjoining structures will be 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 and the area above a theoretical 45° line through clay from the base of the excavation towards the surrounding structures.

The fill, soil, and clay portions of the cut are to be battered at 1.0 Horizontal to 1.7 Vertical (30°) until the retaining walls are installed. Where room is limited along the E and W sides of the excavation, the cut batters may be steepened accordingly provided any boundary fences are propped where necessary. Excavations through Medium Strength Sandstone or better will stand at vertical angles unsupported, subject to approval by the geotechnical consultant.

The geotechnical consultant is to inspect the excavation as it is lowered to a depth of 1.5m, while the machine is on site to ensure the ground materials are as expected and that no additional support is required.

Excavation for the proposed pool

The proposed pool excavation will be a maximum depth of ~1.5 with rock expected at a maximum depth of ~0.9m below the current ground surface. Thus, no structures or boundaries will lie within the zone of influence of the excavation. The excavation is expected to be through fill over sandy soil and clay with Medium Strength Sandstone expected to be exposed at the base of the excavation. Provided the cut batters are kept from becoming saturated they will stand at vertical angles for short periods until the pool structure is in place. If the cut faces for the pool will be left for more than a few days without pool construction commencing it is recommended that standard pool shoring such as sacrificial sheet iron be used to support the cut batters. Excavations through Medium Strength Sandstone or better will stand at vertical angles unsupported, subject to approval by the geotechnical consultant.

The following applies to both excavations

Cut batters through fill, soil, and 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.

14. Retaining Structures

For cantilever or singly propped retaining structures 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 Structures

Unit	Earth Pressure Coefficients		
	Unit weight (kN/m³)	'Active' K_a	'At Rest' K_0
Fill, Sandy Soil and Residual Clays	20	0.4	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 structures, do not account for any surcharge loads and assume retaining structures are fully drained. Rock strength and relevant earth pressure coefficients are to be confirmed on site by the geotechnical consultant.

All retaining structures are to have sufficient back-wall drainage and be backfilled immediately behind the structure 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 structures, the likely hydrostatic pressures are to be accounted for in the retaining structures design.

15. Foundations

A concrete slab supported on Medium Strength Sandstone is a suitable footing for the proposed house. This ground material is expected to be exposed across most of the base of the excavation for the house. Where the house is not excavated and where excavation depth is shallow, piers taken to Medium Strength Sandstone will be required to maintain a uniform bearing material across the structure.

Medium Strength Sandstone is expected to be exposed across most of the base of the excavation for the pool. This is a suitable bearing material. Where rock is not exposed the pool can be supported on shallow piers taken to the underlying Medium Strength Sandstone. As the area will become saturated during pool use it is recommended any paving around the pool be supported on a concrete slab supported on Medium Strength Sandstone with piers as necessary. This will reduce the risk of settlement around the pool that can result from ongoing saturation of the soil.

A maximum allowable 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.

SEE OVER THE PAGE FOR REQUIRED INSPECTIONS

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 cut face as it is lowered to 1.5m to ensure ground materials are as expected and that there are geological defects present in the profile that may 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.

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Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7: Auger Hole 1. Top of Image is top of hole.

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.

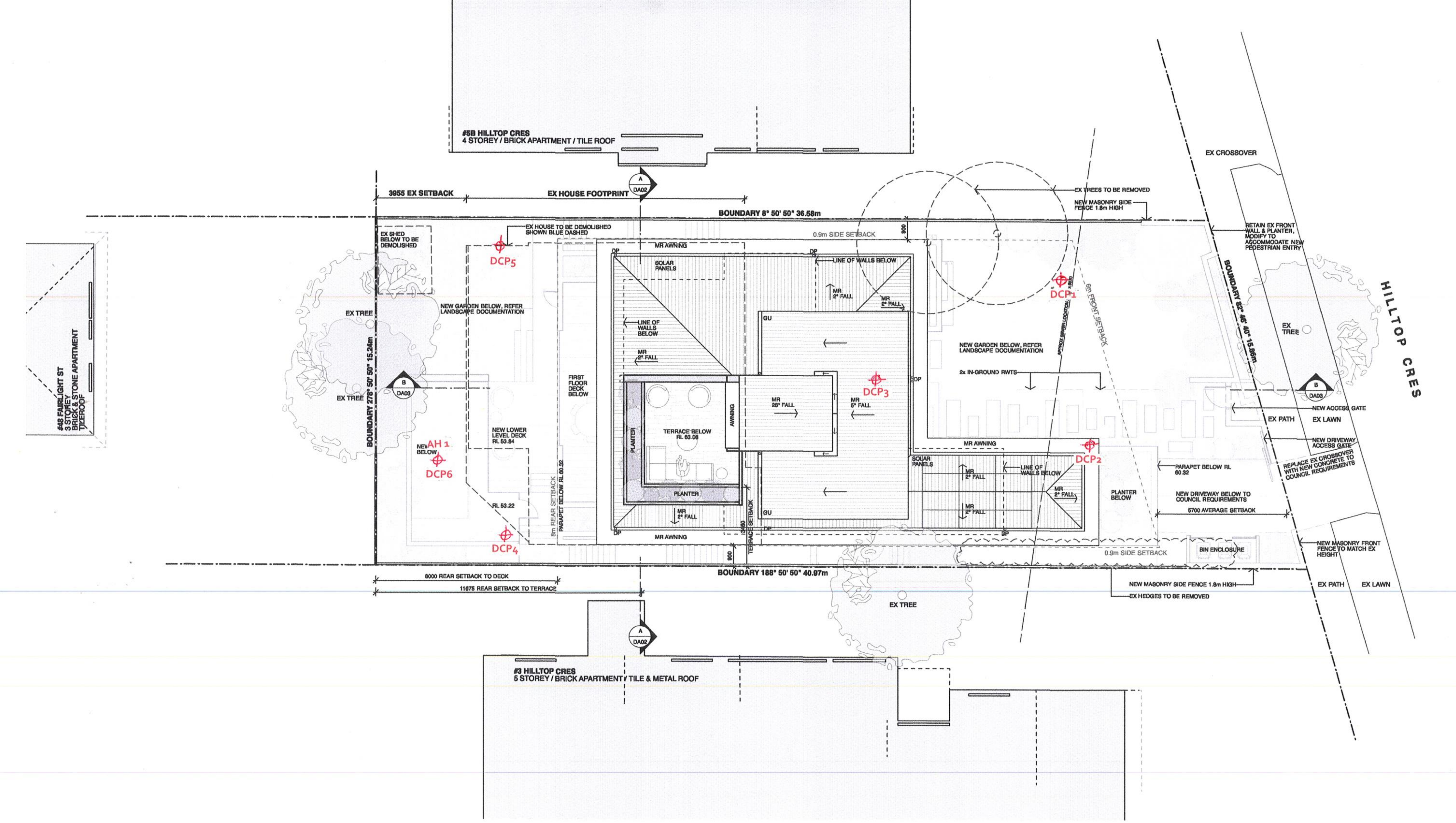
- The report addresses issues relating to your specific design and site. If the proposed project design changes, aspects of the report may no longer apply. Contact White Geotechnical if this occurs.

- 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



NOTES

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REVISIONS

NO	AMENDMENT	DATE
E	ISSUE TO CLIENTS	05.03.19
F	ISSUE TO PLANNER	06.03.19
G	ISSUE TO PLANNER	14.03.19
H	ISSUE TO PLANNER	14.03.19
I	PRELIM DA ISSUE	15.03.19

WATERSHED DESIGN architecture interiors landscapes

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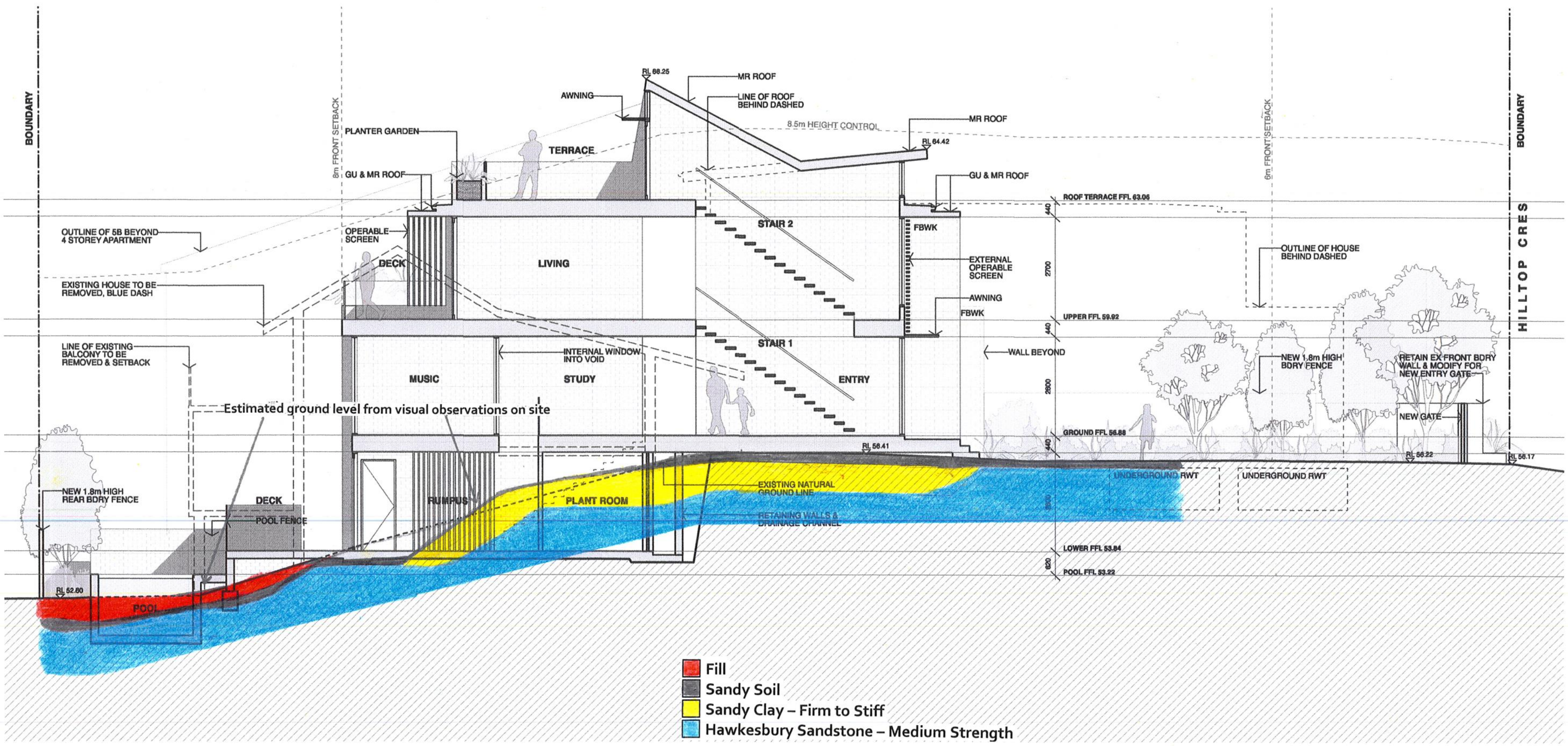
true north

CLIENT	Monique & Andrew Tompson	ADDRESS	5A Hilltop Crescent, Fairlight	JOB NO	18021
PROJECT	New Residence	TITLE	Site & Roof Plan	DRAWN	NT
				CHECKED	MK
				SCALE	1:150 @ A3

DRAWING NO **DA02**

ISSUE **I**

TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials



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G	ISSUE TO PLANNER	14.03.19
H	ISSUE TO PLANNER	14.03.19
I	PRELIM DA ISSUE	15.03.19

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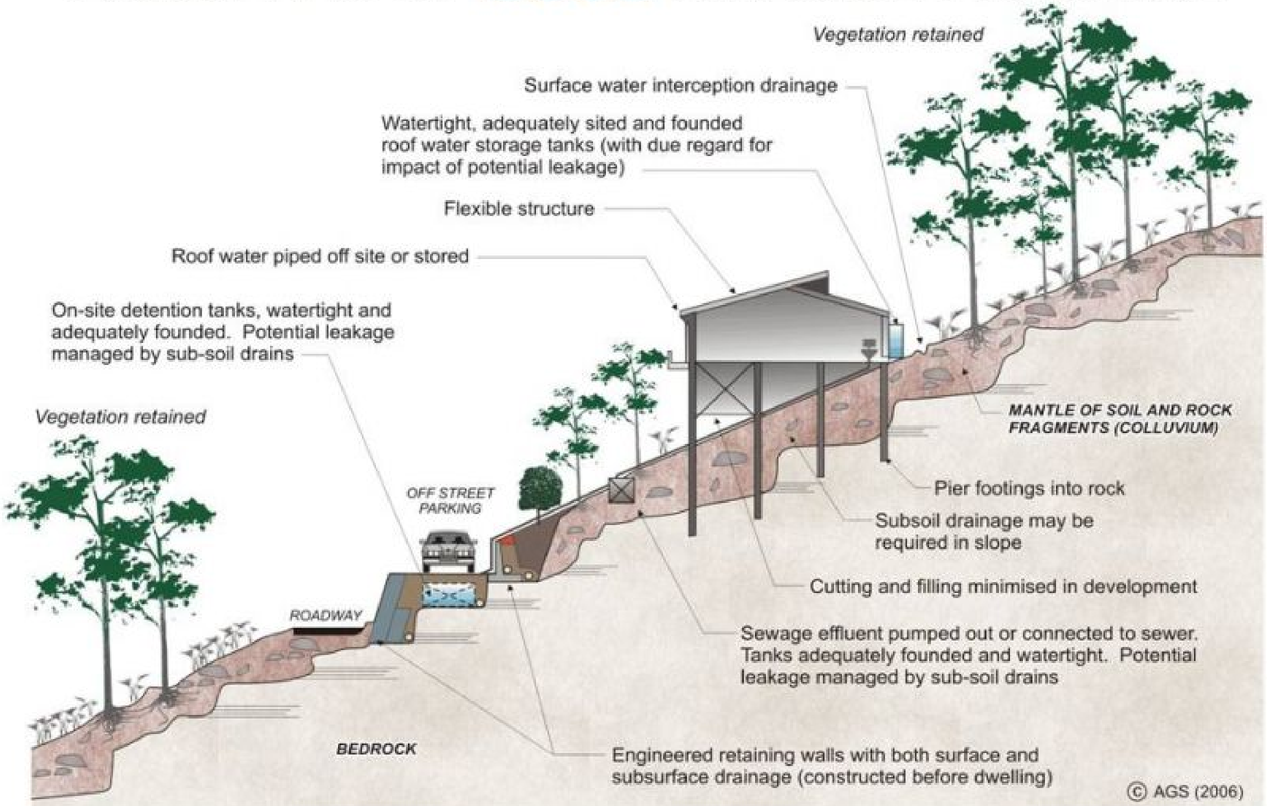
CLIENT	Monique & Andrew Tompson	ADDRESS	5A Hilltop Crescent, Fairlight	JOB NO	18021	DRAWING NO
				DRAWN	NT	DA09
PROJECT	New Residence	TITLE	Section B-B	CHECKED	MK	ISSUE
				SCALE	1:100 @ A3	I

EXAMPLES OF GOOD HILLSIDE PRACTICE



EXAMPLES OF POOR HILLSIDE PRACTICE