GEOTECHNICAL INVESTIGATION:

Subdivision and Two New Houses at **50 Condover Street, North Balgowlah**

1. Proposed Development

1.1 Demolish the existing house and subdivide the property into 2 lots.

1.2 Construct a new house on each lot by excavating to a maximum depth of ~3.0m for the upper house and ~3.4m for the lower house.

1.3 Details of the proposed development are shown on 16 drawings prepared by McGregor Coxall, Project number DA001, Revision A, drawings numbered DA-01 and DA-04 are not dated and drawings numbered DA-02, DA-03, and DA-05 to DA-16 are dated 12/7/21.

2. Site Description

2.1 The site was inspected on the 22nd June, 2021, and previously on the 23rd September, 2019, and 28th August, 2019.

2.2 This residential property has dual access. It is on the uphill side of Condover Street and on the downhill side of Kimo Street. The property has a NE aspect. It is located on the moderately graded lower middle reaches of a hillslope. The natural surface falls across the property at an average angle of ~16°. The slope above the property continues at similar angles. The slope below eases to the toe of the slope.

2.3 At the road frontage, a brick-paved driveway runs up the slope to a carport on the downhill side of the property (Photo 1). The driveway and carport will both be demolished as part of the proposed works. Competent Medium Strength Sandstone outcrops at the road frontage and on the downhill side of the carport (Photo 2). The single-storey brick house was observed to be supported directly off outcropping sandstone and will also be demolished as part of the proposed works (Photo 3). The cut for the uphill side of the house is supported by a stable stack rock retaining wall

~1.0m high (Photo 4). Medium Strength Sandstone bedrock outcrops and steps up the slope above the cut (Photo 5). The outcropping rock is slightly undercut but has been underpinned in the past by the owner using concrete block and brick blade walls and piers mortared with non-shrink grout (Photo 6). A gentle to moderately sloping lawn rises above the outcrop to the road frontage with Kimo Street (Photo 7). Medium Strength Sandstone outcrops and steps up the slope through this lawn (Photo 8). No significant geological defects were observed in the outcrop and it is considered stable.

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 laminite lenses.

4. Subsurface Investigation

Sixteen 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 attached. 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. However, excavation and foundation budgets should always allow for the possibility that the interpreted ground conditions in this report vary from those encountered during excavations. See the appended "Important information about your report" for a more comprehensive explanation. The results are as follows:

DCP TEST RESULTS ON THE NEXT 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 (~RL45.4)	DCP 2 (~RL43.5)	DCP 3 (~RL42.6)	DCP 4 (~RL41.3)	DCP 5 (~RL41.8)	DCP 6 (~RL42.9)	DCP 7 (~RL45.3)	DCP 8 (~RL48.5)
0.0 to 0.3	Rock Exposed at Surface	4	3	4	Rock Exposed at Surface	11	4	3
0.3 to 0.6		12	3	28		#	8	4
0.6 to 0.9		30	5	16			9	2
0.9 to 1.2		#	25	#			13	8
1.2 to 1.5			#				14	30
1.5 to 1.8							#	16
1.8 to 2.1								#
		End of Test @ 0.7m	Refusal on Rock @ 1.1m	Refusal on Rock @ 1.0m		Refusal on Rock @ 0.3m	Refusal on Rock @ 1.4m	Refusal on Rock @ 1.6m

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

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 9 (~RL47.1)	DCP 10 (~RL50.2)	DCP 11 (~RL51.5)	DCP 12 (~RL50.9)	DCP 13 (~RL52.8)	DCP 14 (~RL53.5)	DCP 15 (~RL55.7)	DCP 16 (~RL53.5)
0.0 to 0.3	Rock Exposed at Surface	Rock Exposed at Surface	Rock Exposed at Surface	3	Rock Exposed at Surface	Rock Exposed at Surface	Rock Exposed at Surface	Rock Immediately Below Surface
0.3 to 0.6				5				
0.6 to 0.9				10				
0.9 to 1.2				4				
1.2 to 1.5				#				
				Refusal on Rock @ 1.2m				

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

DCP Notes:

DCP1 – Rock exposed at the surface – Medium Strength Sandstone.
DCP2 – End of test @ 0.7m, DCP still very slowly going down, orange sandstone fragments on wet muddy tip.
DCP3 – Refusal on rock @ 1.1m, DCP bouncing off rock surface, white and maroon sandstone on dry tip.
DCP4 – Refusal on rock @ 1.0m, DCP bouncing off rock surface, white impact dust on damp tip.
DCP5 – Rock exposed at the surface – Medium Strength Sandstone.
DCP6 – Refusal on rock @ 0.3m, DCP bouncing off rock surface, orange and maroon sandstone on dry tip.
DCP7 – Refusal on rock @ 1.4m, DCP bouncing off rock surface, orange sandstone fragments on dry tip.
DCP8 – Refusal on rock @ 1.6m, DCP bouncing off rock surface, maroon sandstone fragments on wet tip.
DCP9 – Rock exposed at surface – Medium Strength Sandstone.
DCP10 – Rock exposed at surface – Medium Strength Sandstone.
DCP11 – Rock exposed at surface – Medium Strength Sandstone.
DCP12 – Refusal on rock @ 1.0m, DCP bouncing off rock surface, brown and maroon sandstone fragments on wet tip.
DCP13 – Rock exposed at surface – Medium Strength Sandstone.
DCP14 – Rock exposed at surface – Medium Strength Sandstone.
DCP15 – Rock exposed at surface – Medium Strength Sandstone.
DCP16 – Rock immediately below surface (<50mm) – Medium Strength Sandstone.

5. Geological Observations/Interpretation

The surface features of the block are controlled by the outcropping and underlying sandstone bedrock that steps up 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 sandy soils and sandy clays that fill the bench step formation. In the test locations where rock was not exposed, the depth to rock ranged between 0.3 to 1.6m below the current surface, being slightly deeper due to the stepped nature of the underlying bedrock. The outcropping sandstone on the property 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 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 significant surface flows were observed on the property during the inspection. Normal sheet wash from the slope above will be intercepted by the street drainage system for Kimo Street above.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed above or beside the property. The moderately graded 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 is a potential hazard (**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 property and continues above failing and impacting on the property.	The vibrations produced during the proposed excavations impacting on the supporting walls of the neighbouring houses.	A loose boulder, wedge, or similar geological defect toppling onto the work site during the excavation process.
LIKELIHOOD	'Unlikely' (10^{-4})	'Possible' (10^{-3})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (20%)	'Medium' (15%)	'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	6.3×10^{-5}/annum
COMMENTS	This level of risk is 'ACCEPTABLE'.	This level of risk to 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

The fall is to Condover Street. Roof water from the development is to be piped to the street drainage system through any tanks that may be required by the regulating authorities.

11. Excavations

A stepped excavation is required to construct the upper house. The step for Level 1 of the house is to be a maximum depth of ~3.0m and the step for Level 2 of the house is to also be a maximum depth of ~3.0m with a distance of ~2.6m between the steps. The excavation is expected to be through shallow sandy soils and firm to stiff sandy clays with Medium Strength Sandstone expected at a maximum depth of ~1.0m below the surface.

An excavation to a maximum depth of ~3.4m is required to construct the proposed lower house. This excavation is expected to be through sandy soils and firm to stiff sandy clays with Medium Strength Sandstone expected at a maximum depth of ~1.6m below the surface.

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

12. Vibrations

Possible vibrations generated during excavations through soil and clay will be below the threshold limit for building damage. The majority of the proposed excavations are expected to be through Medium Strength Sandstone.

Excavations through Medium Strength Sandstone or better should be carried out to minimise the potential to cause vibration damage to the S neighbouring boundary retaining wall, and N, SE, and S neighbouring houses. Allowing for back-wall drainage, the S neighbouring boundary retaining wall will come close to flush with the proposed excavation for the upper house, the supporting walls of the neighbouring house to the N will be as close as ~7.0m, the supporting walls of the neighbouring house to the SE will be as close as ~5.0m, and the supporting walls of the neighbouring house to the S will be as close as ~2.3m from the edges of the proposed excavations. Close controls by the contractor over rock excavation are recommended so excessive vibrations are not generated.

Dilapidation reporting carried out on the SE and S neighbouring properties is recommended prior to the excavation works commencing

Excavation methods are to be used that limit peak particle velocity to 8mm/sec at the property boundaries. Vibration monitoring will be required to verify this is achieved. The Vibration monitoring equipment must include a light/alarm so the operator knows if vibration limits have been exceeded. It also must log and record vibrations throughout the excavation works.

In Medium Strength Rock or better, techniques to minimise vibration transmission will be required. These include:

- Rock sawing the excavation perimeter to at least 1.0m deep prior to any rock breaking with hammers, keeping the saw cuts below the rock to be broken throughout the excavation process.
- Limiting rock hammer size.
- Rock hammering in short bursts so vibrations do not amplify.
- Rock breaking with the hammer angled away from the nearby sensitive structures.
- Creating additional saw breaks in the rock where vibration limits are exceeded.

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

13. Excavation Support Requirements

No structures or boundaries will be within the zone of influence of any excavations. In this instance, the zone of influence is the area above a theoretical 30° line through soil, and a 45° line through clay from the top of Medium Strength Sandstone towards the surrounding structures and boundaries.

The soil and clay portions of the cut batters are to be battered temporarily at 1.0 Vertical to 2.0 Horizontal (30°) until the retaining walls are in place. We note due to the depth of the excavations, the soil and clay is to be scraped back from the footprint of the excavations at least 0.5m and then battered. Medium Strength Sandstone or better will stand at vertical angles unsupported subject to approval by the geotechnical consultant.

Upslope runoff is to be diverted from the cut faces by sandbag mounds or other diversion works. Unsupported cut batters through 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. 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, the geotechnical consultant is to inspect the excavations as they are lowered in 1.5m intervals to ensure the ground materials are as expected and no wedges or other geological defects are present that could require additional support. Should additional ground support be required, this will likely involve the use of mesh, sprayed concrete, and rock bolts.

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 faces that can occur over time, when unfavourable jointing is obscured behind the excavation faces. Additionally, retaining walls will help control seepage and to prevent minor erosion and sediment movement.

All excavation spoil is to be removed from site following the current Environmental Protection Agency (EPA) waste classification guidelines.

14. Retaining Walls

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

TABLE 1 IS ON THE NEXT PAGE

Table 1 – Likely Earth Pressures for Retaining Walls

Unit	Earth Pressure Coefficients		
	Unit weight (kN/m³)	‘Active’ K_a	‘At Rest’ K_0
Sandy Soil and Residual Clay	20	0.4	0.55
Medium Strength Sandstone	24	0.00	0.01

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, does 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.

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 structural design.

15. Foundations

Concrete slabs supported directly off Medium Strength Sandstone are suitable footings for the proposed houses. This material is expected to be exposed across most of the base of the excavations. Where it is not exposed, and where the footprints of the proposed houses do not fall over the excavation, piers will be required to maintain a uniform bearing material. A maximum allowable bearing pressure of 1000kPa 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 cut faces as they are lowered in 1.5m intervals to ensure ground materials are as expected and that there are no wedges or other defects present in the rock that may require additional support.

- All footings are to be inspected and approved by the geotechnical consultant while the excavation equipment and contractors are 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

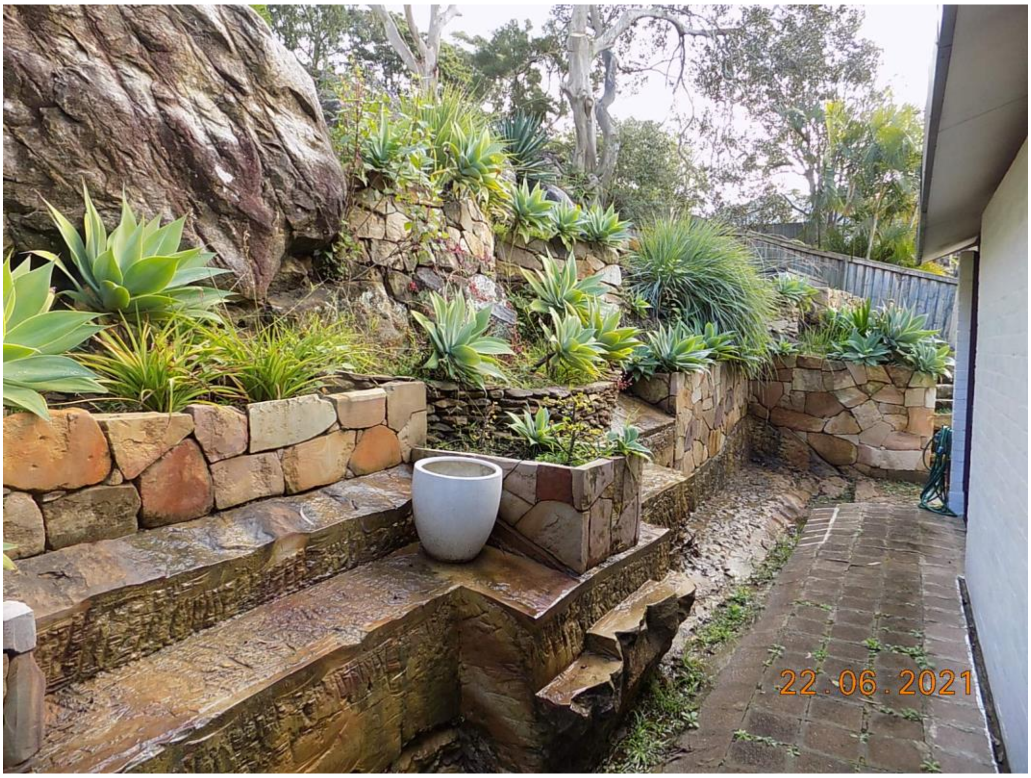


Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

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 test's 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.

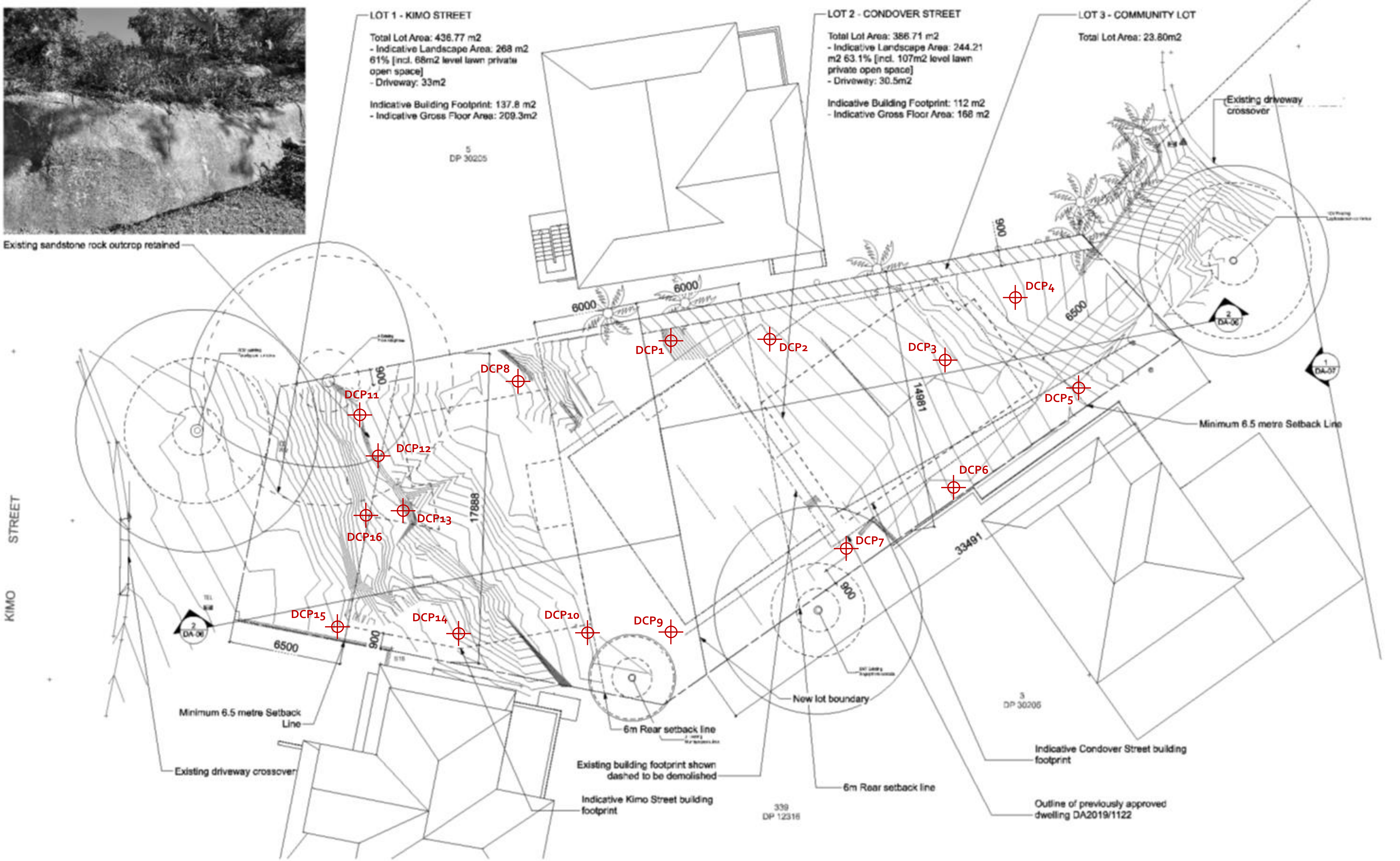
- The report addresses issues relating to your specific design and site. If the proposed project design changes, aspects of the report may no longer apply. Contact White Geotechnical if this occurs.

- 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



MCGREGOR COXALL

© Copyright McGregor Coxall
AUS ACN 087 334 790
UK 10199863

Sydney Melbourne Shenzhen Bristol
www.mcgregorcoxall.com

Client
Adrian McGregor

Project Team

Project Name
50 Condover Street Subdivision

Project No.
Project No. DA001

Address
50 Condover Street North Balgowlah

Key Plan

Issue Log

Rev	Revision Description	By / Checked	Date
A	DA Issue	AMC	12/7/21

Scale
1: 100 @ A1

All dimensions are in millimetres unless otherwise noted.
Do not scale from this drawing.

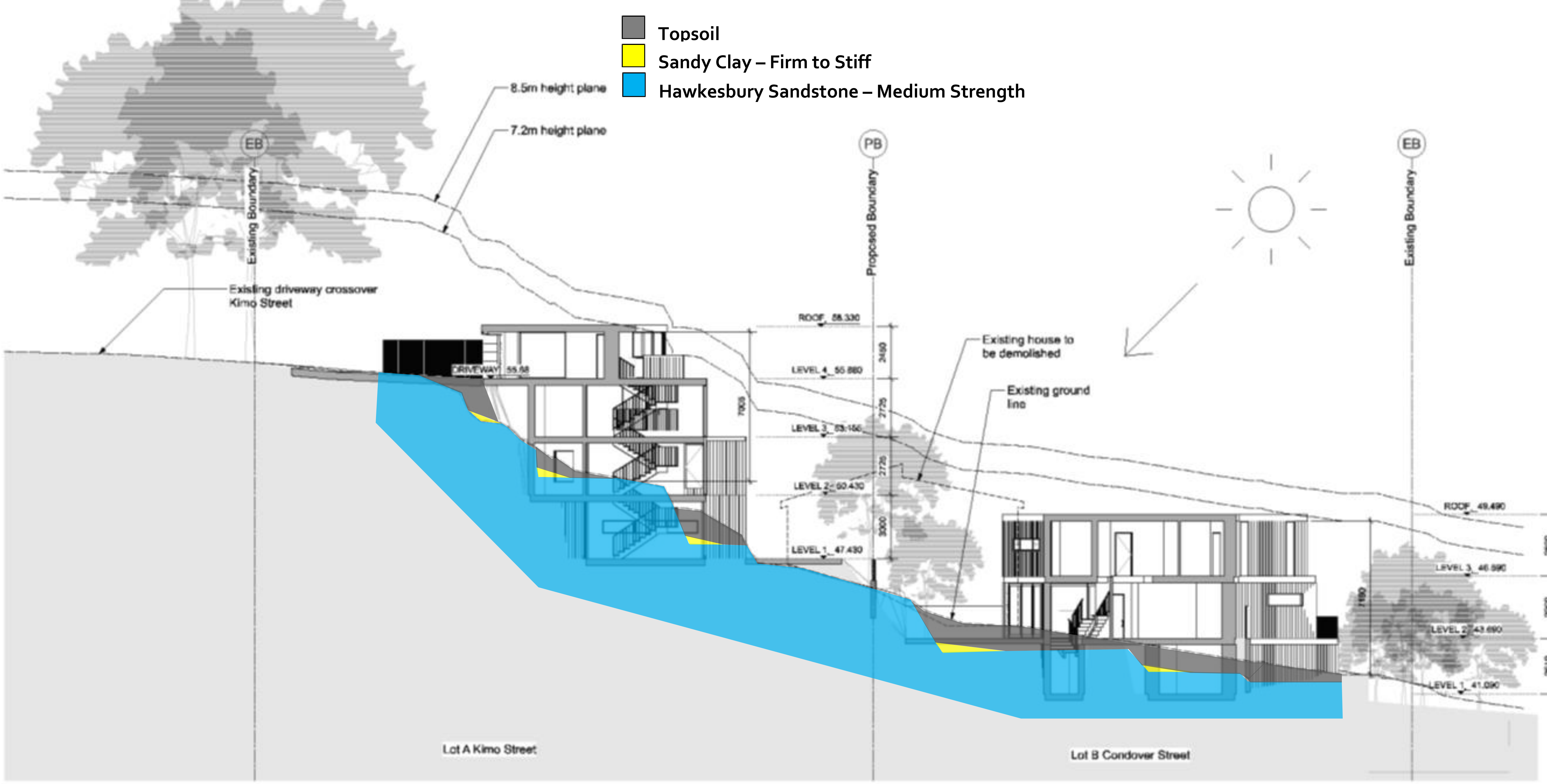
North

Phase
Schematic Design

Sheet Title
Indicative Dwelling Compliance Plan

Sheet No. DA-05
Rev A

TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials



2 Subdivision Section
Scale: 1:100

MCGREGOR COXALL

Sydney Melbourne Shenzhen Bristol
www.mcgregorcoxall.com

Client
Adrian McGregor

Project Team

Project Name
50 Condover Street Subdivision
Project No. DA001

Address
50 Condover Street North Balgowlah

Key Plan

Issue Log

Rev	Revision Description	By / Checked	Date
A	DA Issue	AMC	12/7/21

Scale
1: 100 @ A1

North

All dimensions are in millimetres unless otherwise noted. Do not scale from this drawing.

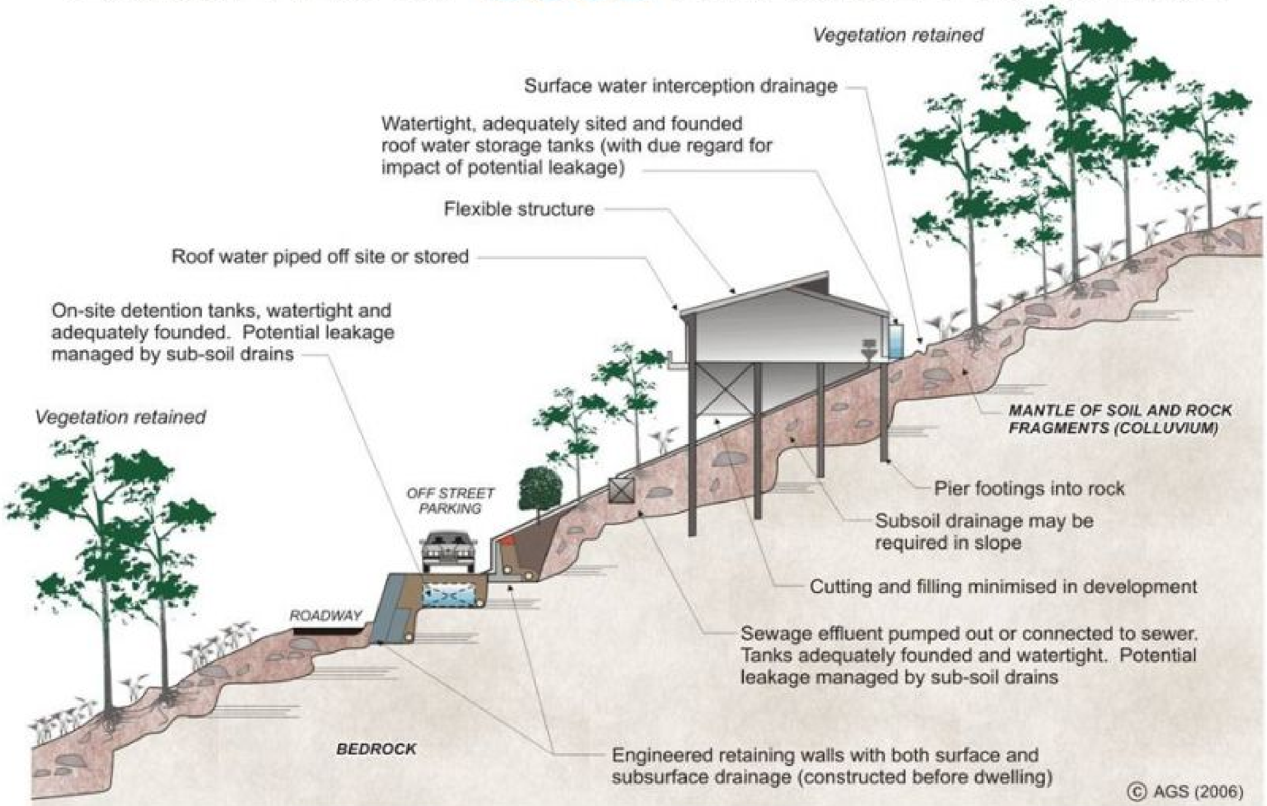
Phase
Schematic Design

Sheet Title
Dwellings Site Section

Sheet No. DA-06

Rev A

EXAMPLES OF GOOD HILLSIDE PRACTICE



EXAMPLES OF POOR HILLSIDE PRACTICE