GEOTECHNICAL INVESTIGATION:

New House and Pool at **28 Bangaroo Street, North Balgowlah**

1. Proposed Development

1.1 Demolish the majority of the existing commercial space and attached dwelling and construct a new two-storey secondary dwelling and renovated commercial space in the same location.

1.2 Demolish the existing garage on the W side of the property and construct a new two-storey house across the W side of the property with a new garage and driveway.

1.3 Construct a new pool between the proposed secondary dwelling and proposed house by excavating to a maximum depth of ~2.0m.

1.4 Details of the proposed development are shown on 3 drawings prepared by Break Spear Architects that are not numbered or dated.

2. Site Description

2.1 The site was inspected on the 14th July, 2022.

2.2 This residential property is on the corner of Bangaroo Street and St Pauls Road. It is on the uphill side of both roads. The property has a SE aspect. The slope rises across the property at angles of <5°. The slopes above and below the property continue at gentle angles.

2.3 Extending off the road frontage to Bangaroo Street is a single-storey brick commercial space and attached timber framed and clad dwelling (Photos 1 & 2). The commercial space will be mostly demolished and the dwelling will be entirely demolished as part of the proposed works. A gently sloping lawn and garden area extends from the dwelling to and around a timber framed and clad garage on the W side of the property (Photos 3 & 4). The garage will also be demolished as part of the proposed works.

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

One hand Auger Hole (AH) was put down to identify the soil materials. Six DCP (Dynamic Cone Penetrometer) 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:

AUGER HOLE 1 (~RL67.1) **–** AH1 (Photo 5)

Depth (m)	**Material Encountered**
0.0 to 0.2	**CLAYEY SOIL**, dark brown, medium dense, damp, fine to medium grained with fine trace organic matter.
0.2 to 0.6	**SANDY CLAY**, brown, dense, damp, fine to medium grained.
0.6 to 0.9	**CLAY**, derived from weathered sandstone, orange, stiff, damp, fine to medium grained with sugary texture.

End of test @ 0.9m in clay derived from weathered sandstone. No water table 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** (~RL66.9)	**DCP 2** (~RL67.1)	**DCP 3** (~RL66.9)	**DCP 4** (~RL67.1)	**DCP 5** (~RL67.6)	**DCP 6** (~RL67.9)
0.0 to 0.3	3	3	5	4	3	5
0.3 to 0.6	5	12	12	5	44	10
0.6 to 0.9	#	13	36	18	45	30
0.9 to 1.2		33	#	47	#	#
1.2 to 1.5		#		#		
	Refusal on Rock @ 0.4m	Refusal on Rock @ 1.1m	Refusal on Rock @ 0.9m	End of Test @ 1.1m	End of Test @ 0.7m	Refusal on Rock @ 0.7m

#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, wet muddy tip.

DCP2 – Refusal on rock @ 1.1m, DCP bouncing off rock surface, orange sandstone fragments on wet tip.

DCP3 – Refusal on rock @ 0.9m, DCP bouncing off rock surface, maroon sandstone fragments on wet tip.

DCP4 – End of test @ 1.1m, DCP still very slowly going down, maroon sandstone fragments on wet tip.

DCP5 – End of test @ 0.7m, DCP still very slowly going down, wet muddy tip, orange weathered sandstone in collar above tip.

DCP6 – Refusal on rock @ 0.7m, DCP bouncing off rock surface, wet muddy tip.

5. Geological Observations/Interpretation

The surface features of the block are controlled by the 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. The rock is overlain by a thin clayey topsoil over sandy clays and clays that fill 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 deeper due to the stepped nature of the underlying bedrock. The sandstone underlying the property is estimated to be medium strength or better as the DCP bounced at the end of most tests. Similar strength rock is expected to underlie the entire site. See 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 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.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed above, below, or beside the property. The gently graded slope that rises across the property is a potential hazard (**Hazard One**). The vibrations from the proposed excavation are a potential hazard (**Hazard Two**). The excavation is a potential hazard until the pool structure is in place (**Hazard Three**).

RISK ANALYSIS SUMMARY ON NEXT PAGE

Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two	Hazard Three
TYPE	The gentle slope that rises across the site failing and impacting on the proposed works.	The vibrations produced during the proposed excavation impacting on the surrounding structures.	The excavation for the proposed pool collapsing onto the work site before the pool structure is in place.
LIKELIHOOD	'Unlikely' (10^{-4})	'Possible' (10^{-3})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (12%)	'Medium' (15%)	'Medium' (15%)
RISK TO PROPERTY	'Low' (2×10^{-5})	'Moderate' (2×10^{-4})	'Moderate' (2×10^{-4})
RISK TO LIFE	5.5×10^{-7}/annum	5.3×10^{-7}/annum	5.3×10^{-5}/annum
COMMENTS	This level of risk is 'ACCEPTABLE'.	UNACCEPTABLE' level of risk to life and property. To move risk to 'ACCEPTABLE' levels, the recommendations in **Section 12** are to be followed.	UNACCEPTABLE' level of risk to life and property. 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

There is fall to both Bangaroo Street and St Pauls Road. Roof water from the proposed development is to be piped to either street drainage system 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 construct the proposed pool. The excavation is expected to be through a thin clayey soil over sandy clays and clays with Medium Strength Sandstone expected at depths of between 0.9 to 1.1m below the current surface.

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

12. Vibrations

Possible vibrations generated during excavations through clayey soil, sandy clays, and clays will be below the threshold limit for building damage. The majority of the proposed excavation is expected to be taken 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 portion of the commercial space to remain and to the N neighbouring house. Allowing for back-wall drainage, the portion of the commercial space to remain will be as close as ~9.5m and the supporting walls of the N neighbouring house will be as close as ~5.0m 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 N neighbouring property is recommended prior to the excavation works commencing to minimise the possibility of spurious building damage claims.

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.
- Use of rock grinders (milling head).

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 the excavation. In this instance, the zone of influence is the area above a theoretical 45° line through from the top of Medium Strength Sandstone towards the surrounding structures and boundaries. In the location of the proposed pool, rock is expected at shallow depths of ~1.1m or less.

The soil and clay portions of the cut for the pool are expected to stand at near-vertical angles for short periods of time until the pool structure is installed, provided the cut batters are kept from becoming saturated. If the cut batters remain unsupported for more than a day before the pool construction commences, they are to be supported with typical pool shoring such as sacrificial form ply, until the pool structure is in place. Excavations through 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 pool structure are to be organised so on completion of the excavation it can be constructed as soon as possible. The excavation is to be carried out during a dry period. No excavations are to commence if heavy or prolonged rainfall is forecast.

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

14. Retaining Structures

For cantilever or singly-propped retaining structures, it is suggested the design be based on a triangular pressure 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/m^3)	'Active' K_a	'At Rest' K_0
Clayey Soil, Sandy Clay, and Residual Clay	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 structure, 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 structural design.

15. Foundations

The proposed house, secondary dwelling, and the works to the commercial space are to be supported on piers taken to the underlying Medium Strength Sandstone. This material is expected at variable depths of between 0.4 to 1.1m below the current surface.

The proposed pool is expected to be seated on the Medium Strength Sandstone. This is a suitable foundation material.

As the area around the pool will periodically become saturated with pool use, to prevent excessive settlement it is recommended the proposed pavilion be supported on piers and any paving be laid on a concrete slab supported on Medium Strength Sandstone.

A maximum allowable bearing pressure of 1000kPa can be assumed for footings on Medium Strength Sandstone.

It is difficult to predict the foundation material of the portion of the commercial space to remain. Ideally, footings should be founded on the same footing material across the old and new structures. Where the footing material changes across the structure, construction joints or similar are to be installed to prevent differential settlement, where the structure cannot tolerate such movement.

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 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. Inspection

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

- 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.

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Photo 1

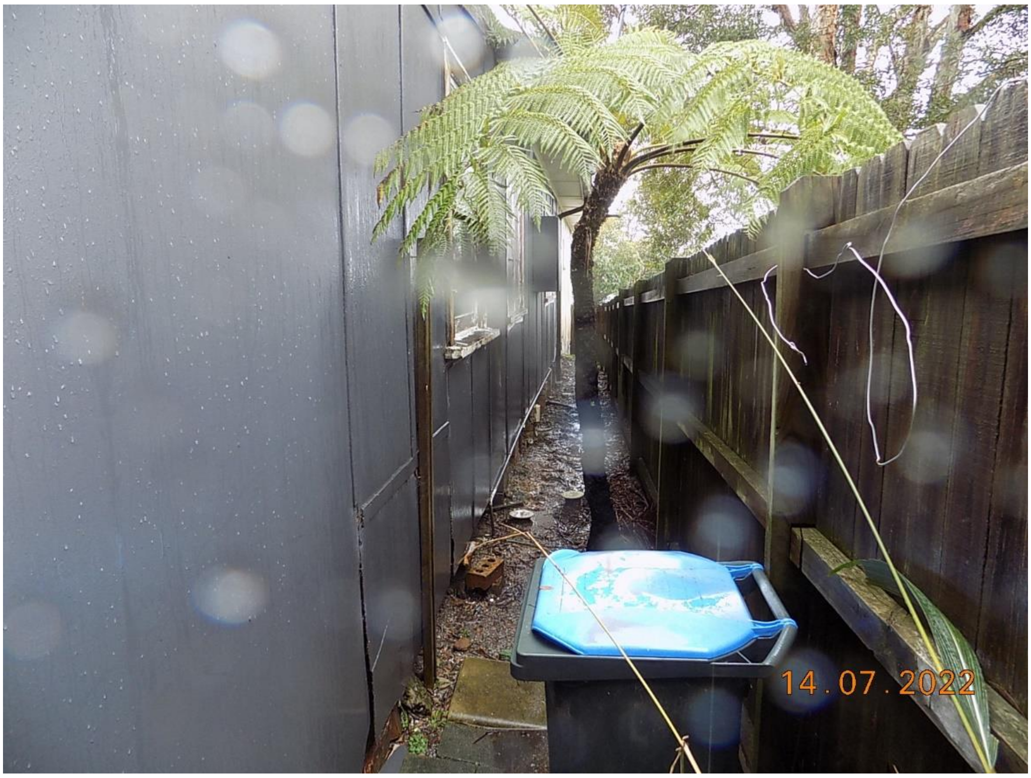


Photo 2

Photo 3

Photo 4

Photo 5: AH1 – Downhole is from top to bottom

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.

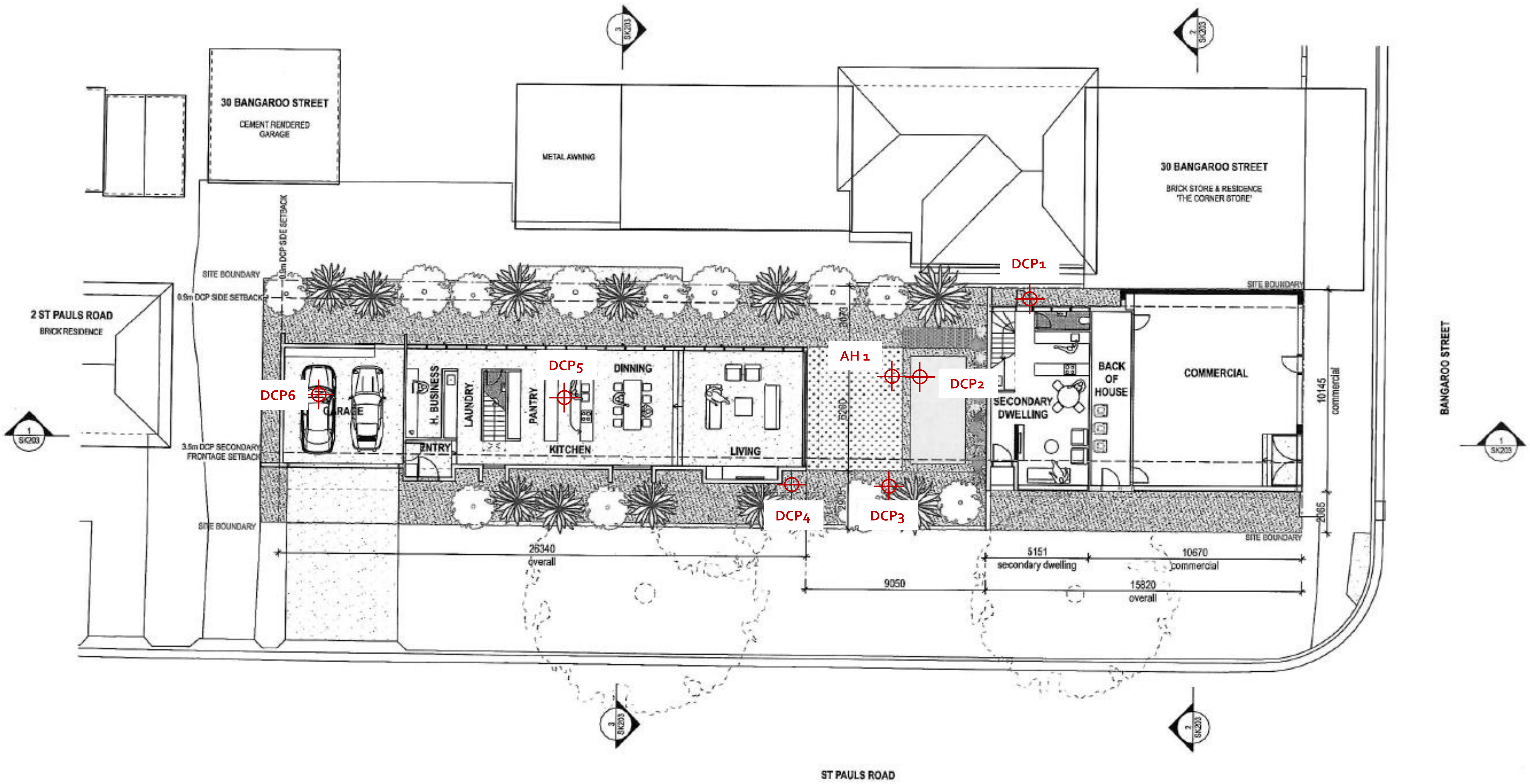
- The report addresses issues relating to your specific design and site. If the proposed project design changes, aspects of the report may no longer apply. Contact White Geotechnical if this occurs.

- 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



1 PROPOSED GROUND FLOOR PLAN
Scale: 1:200

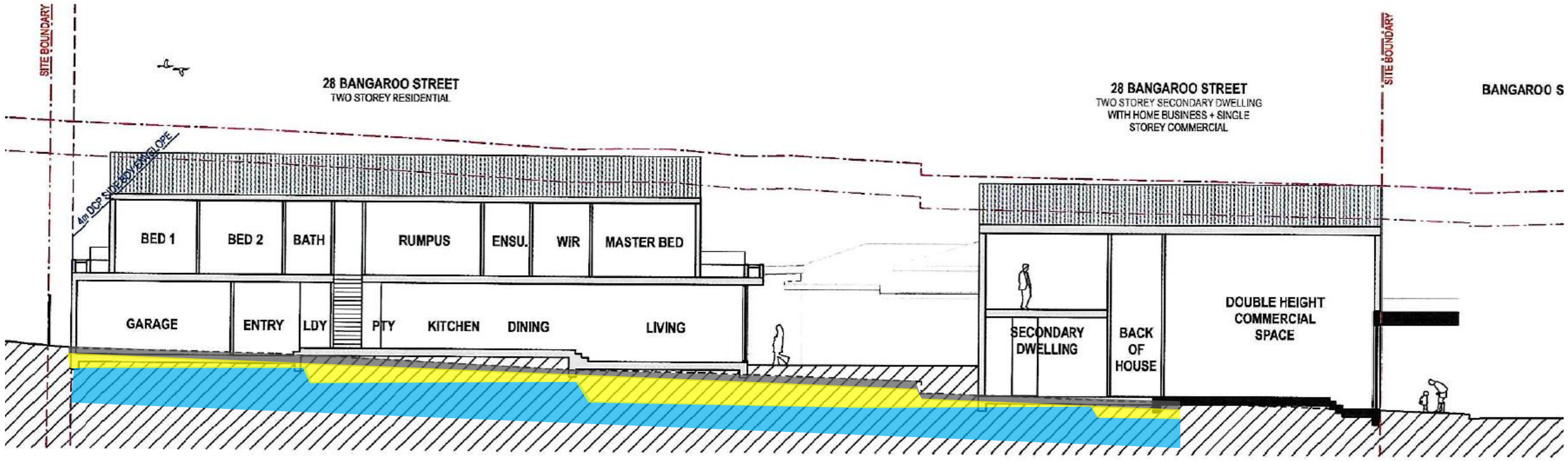
BANGAROO MIX
28 BANGAROO STREET, NORTH BALGOWLAH
FOR: John Cimino and Hayden Zullo
PROPOSED GROUND PLAN

1:200 0 1 2 5 10

BREAK SPEAR ARCHI TECTS

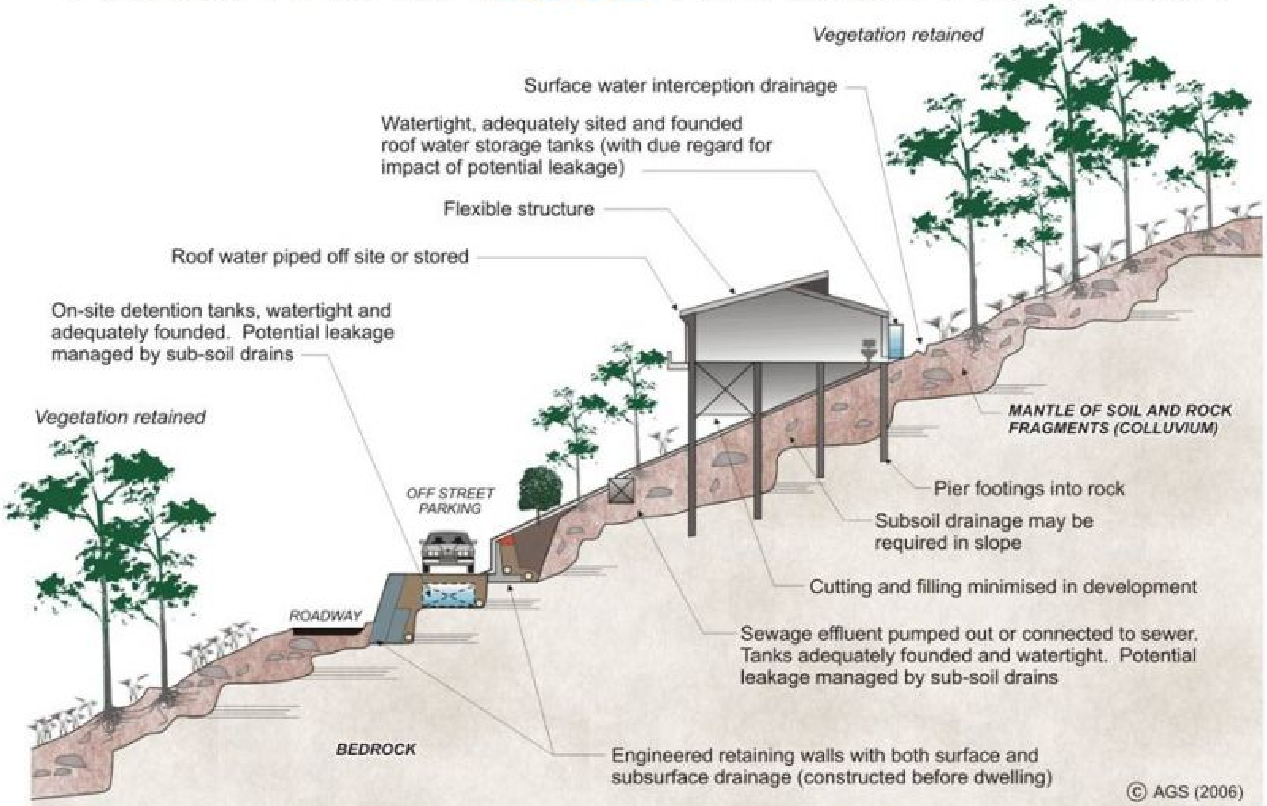
TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials

Clayey Topsoil
Sandy Clay and Clay
Hawkesbury Sandstone – Medium Strength



1 PROPOSED LONG SECTION
Scale: 1:200

EXAMPLES OF GOOD HILLSIDE PRACTICE



EXAMPLES OF POOR HILLSIDE PRACTICE