GEOTECHNICAL INVESTIGATION:

New Unit Block at **18 Alexander Street, Collaroy**

1. Proposed Development

1.1 Demolish the existing structures on the property and construct a new part four-storey unit block by excavating to a maximum depth of ~5.7m.

1.2 Details of the proposed development are shown on 22 drawings prepared by Walsh Architects, drawings numbered DA000, 010, 101, 102, 110 to 114, 200, 201, 300, 400, 401, 500, 502, 503, 511 to 513, and 901, Revision A, dated 3/9/2021.

2. Site Description

2.1 The site was inspected on the 5th March, 2019 and previously on the 7th August, 2015.

2.2 This residential property is on the high side of the road and has a north easterly aspect. The block is positioned on the gently graded lower reaches of a hill slope that rises to Collaroy Plateau. The natural slope rises evenly across the property at gentle angles that do not exceed ~7°. The slope below the property eases towards the foot of the slope. The slope above the property continues at similar angles.

2.3 At the road frontage, a concrete driveway runs to a garage beneath the house (Photo 1). A free-standing studio is located beside the driveway (Photo 2). This will be demolished as part of the proposed works. A gravel driveway runs up the slope to a car parking space on the E side of the studio (Photo 3). The area between the road frontage and the house is otherwise densely vegetated (Photo 4). The house will also be demolished as part of the proposed works (Photo 5). A stable timber retaining wall reaching a maximum height of ~1.0m terraces the slope on the E side of the house and

will be demolished as part of the proposed works (Photo 6). A near level lawn area rises from the uphill side of the house to a stable ~0.5m high sandstone block retaining wall along the uphill boundary (Photo 7). A recently constructed pool in the SW corner of the property will also be demolished as part of the proposed works (Photo 8). No signs of movement were observed on the grounds. The adjoining neighbouring properties were observed to be in good order as seen from the road and the subject property. No geotechnical hazards were observed on these properties that could impact on the subject property.

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

One hand Auger Hole (AH) was put down to identify the ground materials. Six Dynamic Cone Penetrometer (DCP) tests were put down to determine the relative density of the overlying soil and the depth to weathered rock. 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 (~RL12.4) **–** AH1 (Photo 11)

Depth (m)	Material Encountered
0.0 to 0.1	**FILL**, disturbed sandy soil, light brown, loose, fine to medium grained, organic matter, dry.
0.1 to 0.6	**SANDY SOIL**, dark brown, rock fragments, fine to medium grained, loose, dry.
0.6 to 0.8	**SAND**, light grey, loose, fine to medium grained, dry.
0.8 to 0.9	**SAND**, light tan, loose, fine to medium grained, dry.
0.9 to 1.3	**SANDY CLAY**, orange with yellow and grey mottling, firm to stiff, fine to medium grained, dry.
1.3 to 1.4	**SANDY CLAY**, orange with yellow and grey mottling, stiff, fine to medium grained, dry.

End of test @ 1.4m in sandy clay. 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 (~RL10.2)	DCP 2 (~RL9.8)	DCP 3 (~RL10.2)	DCP 4 (~RL11.4)	DCP 5 (~RL12.4)	DCP 6 (~RL11.6)
0.0 to 0.3	13	7	4	5	2	4
0.3 to 0.6	30	10	10	5	6	6
0.6 to 0.9	27	10	15	18	15	5
0.9 to 1.2	17	9	15	13	7	11
1.2 to 1.5	28	15	20	20	12	13
1.5 to 1.8	48	18	16	40	15	18
1.8 to 2.1	#	17	23	#	22	22
2.1 to 2.4		16	19		28	35
2.4 to 2.7		24	28		51	#
2.7 to 3.0		28	35		#	
3.0 to 3.3		48	#			
3.3 to 3.6		#				
	End of Test @ 1.8m	End of Test @ 3.3m	End of Test @ 3.0m	End of Test @ 1.8m	End of Test @ 2.7m	End of Test @ 2.4m

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

DCP Notes:

DCP1 – End of test @ 1.8m, DCP bouncing off rock surface, brown and white sandstone fragments on dry tip.
DCP2 – End of test @ 3.3m, DCP bouncing off rock surface, white impact dust on dry tip, brown clay in collar above tip.
DCP3 – End of test @ 3.0m, DCP bouncing off rock surface, white sandstone fragments on dry tip.
DCP4 – End of test @ 1.8m, DCP bouncing off rock surface, yellow sand on wet tip.
DCP5 – End of test @ 2.7m, DCP bouncing off rock surface, clean dry tip, brown clay in collar above tip.
DCP6 – End of test @ 2.4m, DCP bouncing off rock surface, white impact dust on dry tip.

5. Geological Observations/Interpretation

The slope materials are colluvial at the near surface and residual at depth. In the test locations, the ground materials consist of a thin fill over sandy topsoil and sand to a depth of ~0.9m before encountering firm to stiff sandy clays. The sandy clays merge into the underlying weathered rock at depths of between 1.5 to 3.0m below the current ground surface. The weathered zone is interpreted to be Extremely Low Strength Shale that becomes progressively stronger with depth. This ground material is clay like when cut up by excavation equipment. Fill was encountered to a maximum depth of ~0.6m on the E side of the house. See Type Section attached for a diagrammatical representation of the expected ground materials.

6. Groundwater

As the site is located at the toe of the long slope that rises to Collaroy Plateau, ground water seepage is expected to be higher than average, especially after rainfall when the slope is draining. Ground water seepage is expected to move over the buried surface of the rock and through the cracks. See **Sections 13 and 14** for recommendations regarding groundwater.

Due to the elevation of the proposed basement at ~RL7.0, the true water table is expected to be a several metres below the base of the proposed works.

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 proposed excavation collapsing onto the worksite before retaining walls are in place is a potential hazard (**Hazard One**). The proposed excavation undercutting the E neighbouring house is a potential hazard (**Hazard Two**).

Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two
TYPE	The proposed excavation collapsing onto the worksite and impacting on the E neighbouring property before retaining walls are in place.	The proposed excavation undercutting the neighbouring house to the E, causing failure in the supporting walls of the neighbouring house (Photos 9 & 10).
LIKELIHOOD	'Likely' (10^{-2})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (30%)	'Medium' (15%)
RISK TO PROPERTY	'Moderate' (2×10^{-4})	'Moderate' (2×10^{-4})
RISK TO LIFE	6.5×10^{-4}/annum	8.3×10^{-5}/annum
COMMENTS	This level of risk to life and property is '**UNACCEPTABLE'**. To move the risk levels to acceptable levels, the recommendations in **Section 13** are to be followed.	This level of risk to life and property is '**UNACCEPTABLE'**. To move the risk levels 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 Alexander Street. Roof water from the proposed development is to be piped to the street drainage system through any tanks that may be required by the regulating authorities.

11. Excavations

An excavation to a maximum depth of ~5.7m is required to construct the proposed unit block. The excavation is expected to be through a shallow fill and soil, over sand and clay with Extremely Low Strength Shale expected to be encountered at depths of between 1.5 to 3.0m below the current surface. It is envisaged that excavations through fill, sandy soil, sand, clays, and Extremely Low Strength Shale can be carried out with an excavator and bucket.

12. Vibrations

No excessive vibrations will be generated by excavation through soil, sand, clay, or Extremely Low Strength Shale. Any vibrations generated by a domestic machine and bucket up to 20 ton will be below the threshold limit for infrastructure or building damage.

13. Excavation Support Requirements

It is recommended, before the structural design commences for the project, exploration core drilling is to be carried out on the site to confirm the rock quality and strength. This is to be arranged and supervised by the geotechnical consultant and should consist of a minimum of two cored bore holes taken to a depth of ~9.0m each. The following ground support advice can be considered preliminary and will be reviewed on recovery of the drill core. It may change as a result of the assessment of the drill core.

Due to the depth of the excavation, we recommend it be carried out by builders and contractors who are well experienced in similar work and can provide a proven history of completed work. We recommend a pre-construction meeting between the structural engineer, the builder, and the geotechnical consultant to discuss and confirm the excavation plan and to ensure suitable excavation equipment will be on site.

On steep sites such as this one, to help maintain excavation stability, it is critical upslope runoff be diverted from the proposed excavations with temporary or permanent drainage measures. Temporary measures may be trenches and sandbag mounds and permanent measures could be a wide diameter dish drain or similar. These are to be installed before any excavation work commences.

The excavation for the proposed unit block will reach a maximum depth of ~5.7m and, allowing for back-wall drainage, will be set back ~2.1m from the E and W common boundaries. The E neighbouring house will be set back a minimum of ~2.7m and the W neighbouring house will be set back ~4.4m from the edges of the excavation. As such, the E and W neighbouring houses and properties will be within the zone of influence of the proposed excavation.

Due to the depth of the excavation and its proximity to the neighbouring houses and common boundaries, we recommend heavy ground support be installed along all sides prior to the commencement of the excavation to ensure the safety of any workers below the cut and integrity of the neighbouring houses and properties. See the basement plan attached for the minimum extent of the required heavy ground support.

As there is relatively thick surface sand over the site, a Secant or Contiguous Pile Wall is one of the suitable methods of support around the perimeter of the excavation. Secant piles are the preferred option but if contiguous piles are used, the gaps between the piles are to be grouted closed as the excavation is lowered so no sand/sediment moves through the wall. The piers can be supported by embedment or propping, temporarily.

To drill the pier holes for the walls, a pilling rig that can excavate through Medium to High Strength Rock will be required. We recommend the excavation contractor assess the drill core to ensure the equipment is capable of reaching the required depths. The walls are to be tied into the concrete floor and ceiling slabs of the unit block after which any temporary bracing can be released.

The geotechnical consultant is to inspect the drilling process of the entire first pile and the ground materials at the base of all pier holes/excavations for ground support purposes.

As the basement is to be embedded up to 5.7m below the current surface, it is recommended the basement be tanked to minimise the otherwise ongoing use of pumps over the life of the building. Tanking the basement will also reduce the soil drying effects that can occur around large excavations, that over time, can result in cracking in surrounding structures. The ground support advice above is the minimum shoring support required for the excavation. This method of shoring alone will not result in tanked basement. As such the structural engineer may nominate a similar shoring system more suitable for tanking (i.e., secant piles), provided it is installed before the excavation commences.

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/m^3)	'Active' K_a	'At Rest' K_0	Passive
Fill, Soil, Sand, and Residual Clays	20	0.40	0.55	N/A
Extremely Low Strength Shale	22	0.25	0.35	Kp 2.5 ultimate

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. It should be noted that passive pressure is an ultimate value and should have an appropriate safety factor applied. No passive resistance should be assumed for the top 0.4m to account for any disturbance from the excavation. Rock strength and relevant earth pressure coefficients are to be confirmed on site by the geotechnical consultant.

It should be noted normal seepage may still move into the bulk excavation for the proposed basement. We expect this seepage can be removed with a conventional sump and pump system. The bulk excavation is to be periodically inspected by the Geotechnical Consultant to monitor ground water movements into the bulk excavation.

As discussed above it is recommended the basement be tanked to minimise the use of pumps over the life of the building and to reduce the impact on soil moisture levels around the development.

15. Foundations

A thickened edge concrete slab and pad footings supported directly off Extremely Low Strength Shale are suitable footings over the footprint of the proposed basement. This ground material is expected to be exposed across the entire base of the proposed excavation. Where

it is not exposed, or where the footprint of the proposed unit block does not fall over the footprint of the proposed excavation, foundations can be piered. Suitable Extremely Low Strength Shale it is expected at depths of between 1.5 to 3.0m below the current ground surface. A maximum allowable bearing pressure of 600kPa can be assumed for footings on Extremely Low Strength Shale. A shaft adhesion of 60kPa can be assumed for piered foundations through weathered shale.

As the bearing capacity of clay and shale reduces when it is wet, we recommend the footings be dug, inspected, and poured in quick succession (ideally the same day if possible). If the footings get wet, they will have to be drained and the soft layer of wet clay or shale on the footing surface will have to be removed before concrete is poured.

If a rapid turnaround from footing excavation to the concrete pour is not possible, a sealing layer of concrete may be added to the footing surface after it has been cleaned.

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.

REQUIRED INSPECTIONS ARE ON THE NEXT PAGE

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 owners or the regulating authorities if the following inspections have not been carried out during the construction process.

- The geotechnical consultant is to inspect the drilling process of the entire first pile of the retaining walls, and the ground materials at the base of all the piers before any concrete is placed.

- 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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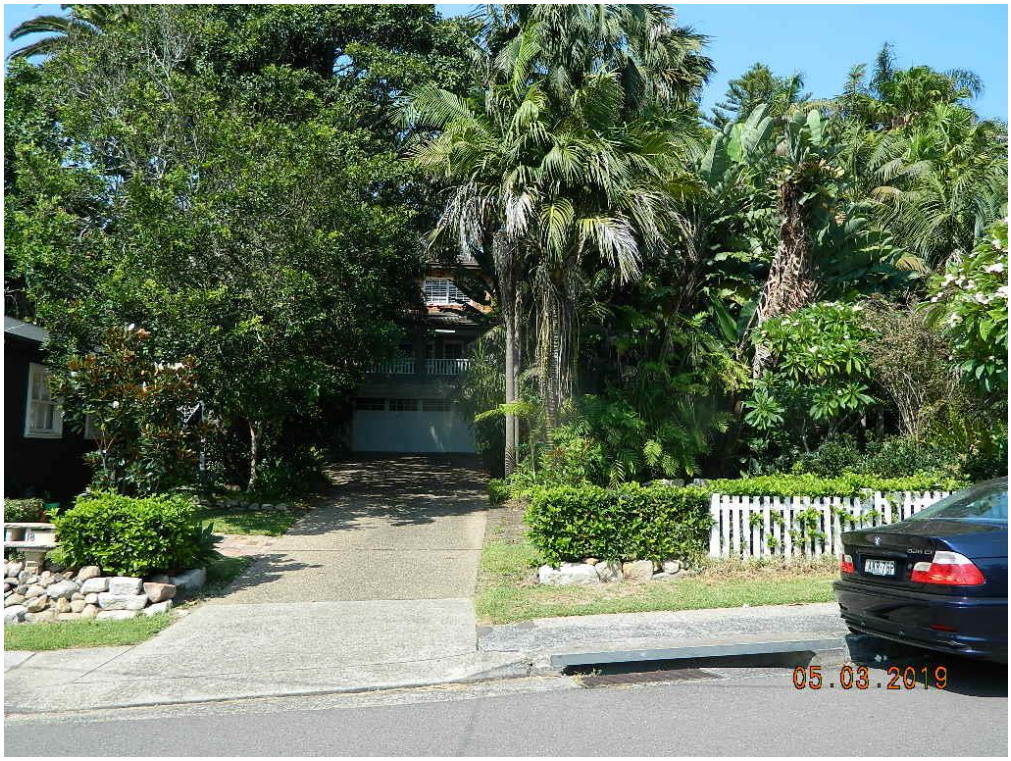

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9

Photo 10

Photo 11: Auger Hole 1: The base of auger hole is at the base of the 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 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

COMPLIANCE TABLE

ADG	OBJECTIVE	COMPLIES?
3B-1(1)	DEEP SOIL	YES
3F-1(1)	BUILDING SEPARATION	YES
4A-1(1)	2 HOUR SOLAR ACCESS	YES
4A-1(3)	NO SUN	YES
4B-3(1)	CROSS VENTILATION	YES
4C-1(1)	CEILING HEIGHTS	YES
4D-1(1)	APARTMENT AREAS	YES
4D-3(1-4)	ROOM SIZES	YES
4E-1(1)	POS SIZES	YES
4G-1(1)	STORAGE	YES

LEP	CLAUSE	COMPLIES?
4.3	HEIGHT OF BUILDINGS	YES
6.1	ACID SULFATE SOILS	YES
6.2	EARTHWORKS	YES
6.4	DEVELOPMENT ON SLOPING LAND	YES

DCP	CLAUSE	COMPLIES?
B1	WALL HEIGHTS	YES
B2	NUMBER OF STORIES	YES
B5	SIDE BOUNDARY SETBACKS - BASEMENT	YES
B5	SIDE BOUNDARY SETBACKS - GROUND - 2	YES
B7	FRONT BOUNDARY SETBACKS	YES
B9	REAR BOUNDARY SETBACKS	YES
D1	LANDSCAPED OPEN SPACE	YES

SITE INFORMATION				
ADDRESS	18 ALEXANDER STREET COLLAROY			
SITE AREA	1156.117 m²			
LOT	LOTS B-9 OF DP 6684			
ZONING	R2 - LOW DENSITY RESIDENTIAL			
YIELD	SENIORS HOUSING DEVELOPMENT 5 UNITS			
	LOCATION OF CONTROL	CONTROL	ACTUAL	COMPLIANCE
SITE AREA	SEPP SENIORS LIVING	1000m² MINIMUM	1156.117 m²	COMPLIES
SITE FRONTAGE	SEPP SENIORS LIVING	20m MINIMUM	24.39 m	COMPLIES
IF THE DEVELOPMENT COMPLIES WITH THE BELOW STANDARDS, THEY CANNOT BE USED AS MEANS TO REFUSE				
	LOCATION OF CONTROL	CONTROL	PROPOSED	
HEIGHT	SEPP SENIORS LIVING	8.0m TO CEILING	7.9m TO CEILING	COMPLIES
DENSITY AND SCALE	SEPP SENIORS LIVING	FSR 0.5:1	FSR 0.5:1	COMPLIES
LANDSCAPED AREA	SEPP SENIORS LIVING	30% OF THE SITE AREA IS TO BE LANDSCAPED	43.3%	COMPLIES
DEEP SOIL ZONES	SEPP SENIORS LIVING	15% OF THE SITE AREA, MINIMUM DIMENSION OF 3M	26.8%	COMPLIES
SOLAR ACCESS	SEPP SENIORS LIVING	70% OF LIVING ROOMS & POS RECEIVE 3 HRS 9AM-3PM	80% OF LIVING ROOMS & POS RECEIVE 3 HRS 9AM-3PM	COMPLIES
PRIVATE OPEN SPACE	SEPP SENIORS LIVING	15m² PER DWELLING, NOT LESS THAN 3 METRES WIDE AND 3 METRES LONG	ALL ARE GREATER THAN 15m²	COMPLIES
PARKING	SEPP SENIORS LIVING	0.5 CARS PER ROOM (NO REQUIREMENT FOR VISITORS)	0.5 X 15 ROOMS = 7.5 IS REQUIRED (15 IS PROVIDED)	COMPLIES

WALSH ARCHITECTS
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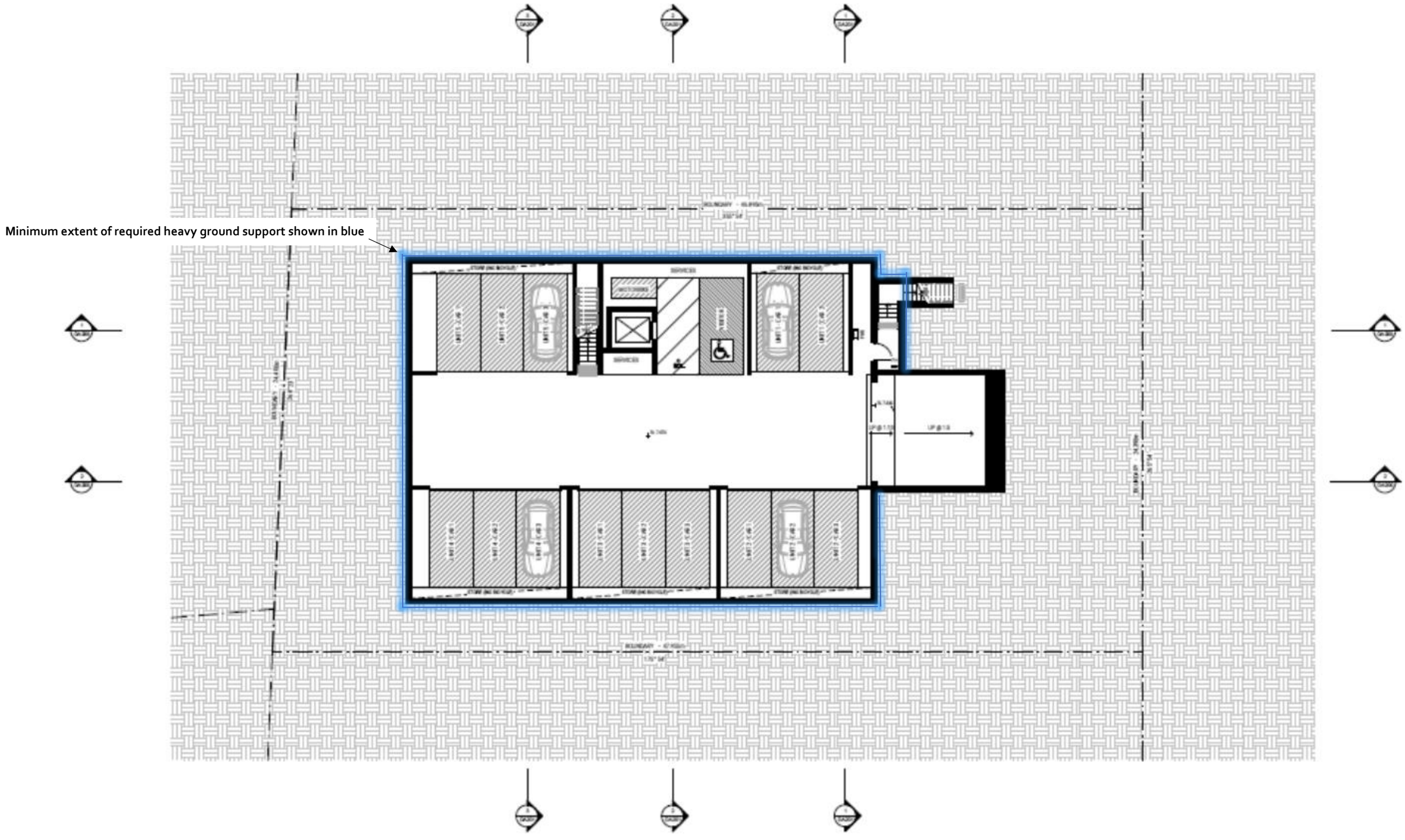
P: 0466 049 880
Nominated Architect : Scott Walsh
ACT 2624 | NSW 10366

REV NO.	DESCRIPTION	REV DATE
A	ISSUE FOR DA APPROVAL	03.09.21

PROPOSED SITE PLAN
SHEET NUMBER DA101
REVISION A
SCALE @ A1 1 : 200
18 ALEXANDER ST COLLAROY NSW

BASEMENT PLAN – showing minimum required extent of heavy ground support



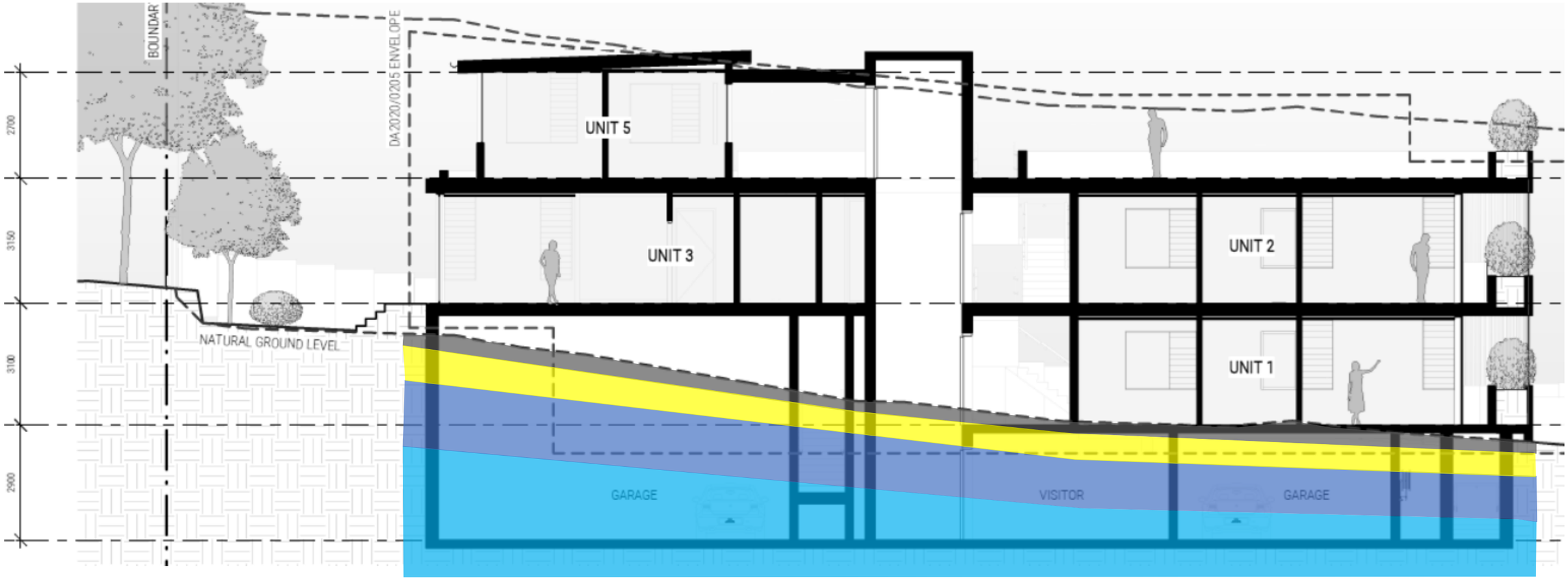
WALSH ARCHITECTS

REV NO.	DESCRIPTION	REV DATE
A	ISSUE FOR DA APPROVAL	03.09.21

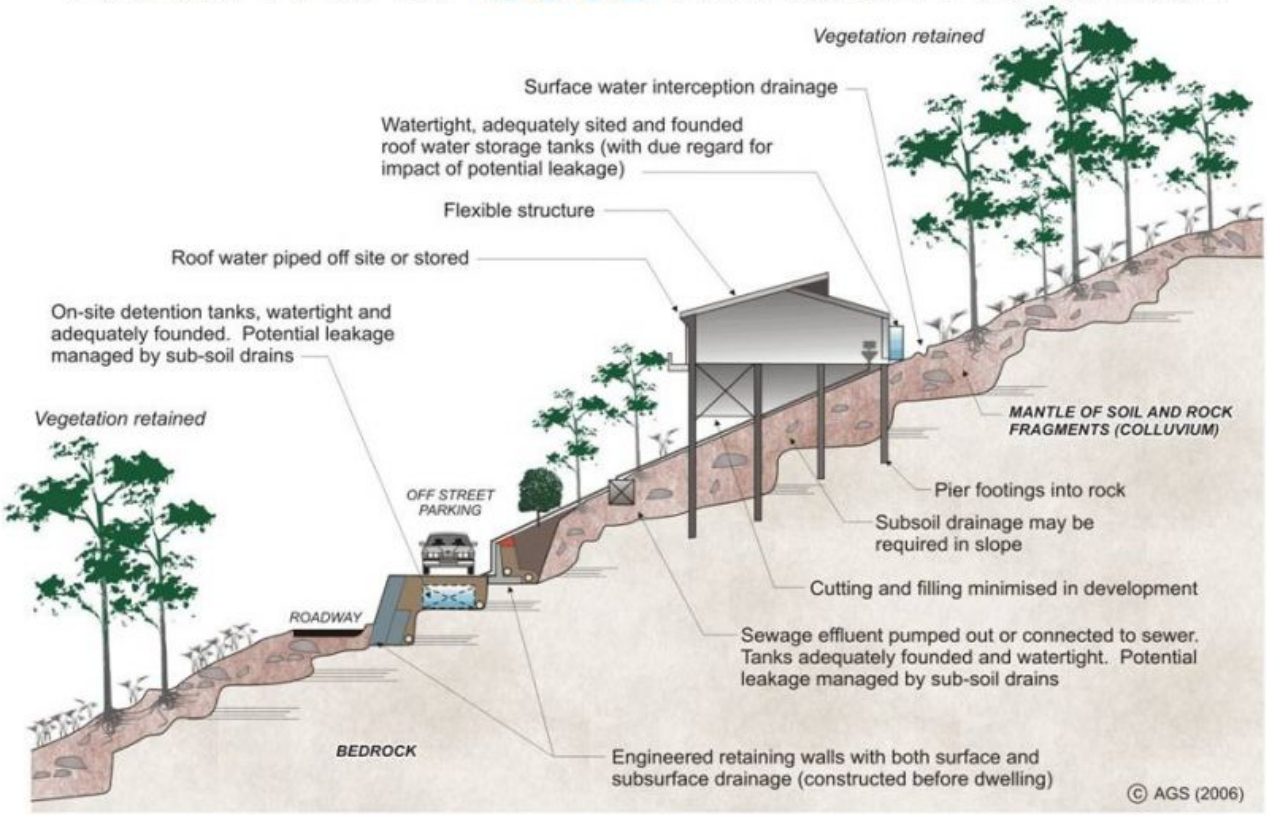
BASEMENT PLAN
SHEET NUMBER DA110
REVISION A
SCALE @ A1 1 : 100
10 ALEXANDER ST COLLAROY NSW

TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials

- Sandy Soil
- Silty Sand
- Sandy Clay – Firm to Stiff
- Narrabeen Group Rocks – Extremely Low Strength Shale - after being cut up by excavation equipment can resemble a stiff to hard clay.



EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE