GEOTECHNICAL INVESTIGATION:

New Pool at **19 West Street, Balgowlah**

1. Proposed Development

1.1 Install a new pool with deck, paving and landscaping works requiring a stepped excavation. The upper and lower steps reach maximum depths of ~2.7m and ~2.0m respectively. The bench between the two steps is ~1.9m. The maximum combined stepped excavation depth is ~3.7m. The landscaping portion of the excavation has upper and lower steps of ~2.0m and ~0.7m deep respectively with a bench ~0.8m wide. The maximum combined excavation depth of the landscaping works is ~2.5m.

1.2 Minor Landscaping works on the downhill side of the house requiring minor filling. Construct a new pathway beside the existing driveway by excavating to a maximum depth of ~0.9m.

1.3 Details of the proposed development are shown on 9 drawings prepared by Jamie King Landscape Architect, project number 22035, drawings numbered Sht-101 to Sht-108 and Sht-201, Issue D, dated 25/10/21.

2. Site Description

2.1 The site was inspected on the 6th of July, 2021.

2.2 This residential property is on the high side of the road and has an E aspect. It is located on the gentle to moderately graded middle reaches of a hillslope. The natural slope rises across the property at an average angle of ~12°. The slope below the property gradually increases in grade. The slope above the property decreases in grade.

2.3 At the road frontage, a concrete driveway runs up the slope to a garage attached to the house (Photos 1 & 2). Between the road frontage and the house is a

gently sloping lawn area. The fill for the lawn is supported by a low sandstone flagging retaining wall and a stable rendered masonry retaining wall up to ~1.5m high (Photo 1). The part two storey rendered masonry house with garage below is supported by rendered masonry walls (Photos 2 & 3). The external supporting walls show no significant signs of movement. A paved area extends off the uphill side of the house (Photo 4). Low rendered masonry and timber retaining walls support cuts and fills on the uphill side of the pavement. A near level lawn area is located uphill of the paved area (Photo 5). No signs of slope instability were observed on the property. The adjoining neighbouring properties were observed to be in good order as seen from the street and subject property.

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 auger hole was put down to identify the soil materials. Five 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. 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 have been an issue for this site. But due to the possibility that the actual ground conditions vary from our interpretation there should be allowances in the excavation and foundation budget to account for this. We refer to the appended “Important Information about Your Report” to further clarify. The results are as follows:

AUGER HOLE 1 (~RL71.4) **–** AH1 (Photo 6)

Depth (m)	Material Encountered
0.0 to 0.3	**TOPSOIL**, sandy soil, dark brown, moist, fine to medium grained.
0.3 to 0.5	**CLAYEY SAND**, light brown, moist, fine to medium grained.
0.5 to 0.7	**SANDY CLAY**, light orange, moist, firm.

End of Hole @ 0.7m in firm sandy clay. 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 (~RL72.3)	DCP 2 (~RL72.3)	DCP 3 (~RL71.6)	DCP 4 (~RL71.4)	DCP 5 (~RL70.7)
0.0 to 0.3	12	5	2	4	3
0.3 to 0.6	48	14	10	6	3
0.6 to 0.9	#	#	6	7	3
0.9 to 1.2			15	8	15
1.2 to 1.5			#	#	#
	Refusal on rock @ 0.6m	Refusal on rock @ 0.6m	Refusal on rock @ 1.2m	Refusal on rock @ 1.0m	Refusal on rock @ 1.1m

#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 @ 0.6m, DCP bouncing off rock surface, orange and white sandstone fragments on dry tip.

DCP2 – Refusal on rock @ 0.6m, DCP bouncing off rock surface, red/orange sandstone fragments on dry tip.

DCP3 – Refusal on rock @ 1.2m, DCP bouncing off rock surface, white sandstone fragments on dry tip.

DCP4 – Refusal on rock @ 1.0m, DCP bouncing off rock surface, white sandstone fragments and dark brown soil on moist tip.

DCP5 – Refusal on rock @ 1.1m, DCP bouncing off rock surface, white sandstone fragments and dark brown soil on moist 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. The rock is overlain by topsoil, clayey sand and sandy clay that fills the bench step formation. Fill to a maximum depth of ~1.5m provides lawn and garden areas above the natural profile. In the test locations, the depth to rock ranged from between ~0.6m to ~1.2m below the current surface. The sandstone underlying the property is estimated to be Medium Strength or better. 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 in the rock.

Due to the slope and elevation of the block, the water table in the location is expected to be many metres below 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 or beside the property. The gentle to moderate slope that falls across the property and continues below is a potential hazard (**Hazard One**). The proposed excavation for the pool and landscaping works is a potential hazard until retaining structures are in place (**Hazard Two**). The vibrations from the proposed excavation are a potential hazard (**Hazard Three**).

Geotechnical Hazards and Risk Analysis - Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two	Hazard Three
TYPE	The gentle to moderate slope that falls across the property and continues below failing and impacting on the property.	The proposed excavation for the pool and landscaping works collapsing onto the worksite and impacting the neighbouring properties before retaining structures are in place.	The vibrations produced during the proposed excavation for the pool and landscaping works impacting on the surrounding structures.
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	8.3×10^{-7}/annum	8.3×10^{-6}/annum	5.3×10^{-7}/annum
COMMENTS	This level of risk is 'ACCEPTABLE'.	This level of risk to life and property is 'UNACCEPTABLE'. To move the risk to 'ACCEPTABLE' levels, the recommendations in **Section 13** are to be followed.	This level of risk to property is 'UNACCEPTABLE'. To move risk to 'ACCEPTABLE' levels the recommendations in **Sections 11 & 12** 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

No significant stormwater runoff will be created by the proposed development.

11. Excavations

A stepped excavation to a maximum combined depth of ~3.7m will be required to install the proposed pool with deck, paving and landscaping works. The upper and lower steps reach maximum depths of ~2.7m and ~2.0m respectively. The bench between the two steps is ~1.9m. The landscaping portion of the excavation has upper and lower steps of ~2.0m and ~0.7m deep respectively with a bench ~0.8m wide. The maximum combined excavation depth of the landscaping works is ~2.5m. The excavation is expected to be through fill, topsoil, clayey sand and sandy clay with Medium Strength Sandstone expected at depths from between ~0.6m to ~1.2m below the current surface.

Another excavation to a maximum depth of ~0.9m is required to construct the proposed new pathway. The excavation is expected to be through fill and topsoil.

It is envisaged that excavations through fill, soil, sand and clay can be carried out with a machine and bucket and excavations through Medium Strength Sandstone or better will require grinding or rock sawing and breaking.

12. Vibrations

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

Excavations through Medium Strength Rock or better should be carried out to minimise the potential to cause vibration damage to the subject house and neighbouring properties to the N, S and W. Allowing for backwall drainage, the excavation for the pool and landscaping works is set back ~4.0m from the subject house, ~4.0m from the N neighbouring house, ~2.3m from the S neighbouring house and ~2.0m from the W neighbouring pool.

Dilapidation reporting carried out on the N, S and W neighbouring properties is recommended prior to the excavation works commencing.

Excavation methods are to be used that limit peak particle velocity to 5mm/sec at the subject house and property boundaries. Vibration monitoring will be required to verify this is achieved. Vibration monitoring must include a light/alarm so the operator knows if vibration limits have been exceeded. The equipment is to 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).

13. Excavations Support Requirements

Bulk Excavation for Pool and Landscaping Works

A stepped excavation to a maximum combined depth of ~3.7m will be required to install the proposed pool with deck, paving and landscaping works. Allowing for backwall drainage, the excavation is set back ~0.5m from the N, S and W common boundaries. The common boundaries 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 fill/soil/sand and a 45° line through clay from the base of the excavation or the top of Medium Strength Rock, whichever comes first, towards the surrounding structures and boundaries.

The N, S and W common boundary fences are to be braced, prior to the excavation commencing.

The cut batters through fill, soil, sand and clay are to be permanently or temporarily supported before the excavation through rock commences. The support is to be installed either before the excavation commences, or systematically in a staged retaining wall/shoring construction as the excavation progresses to ensure the integrity of the neighbouring property. If the support is temporary, it is to remain in place until the retaining wall is built as a sacrificial-type system. See the Site Plan attached for the minimum required extent of the shoring shown in blue.

Medium Strength Sandstone or better will stand at vertical angles unsupported subject to approval by the geotechnical consultant.

During the excavation process, the geotechnical consultant is to inspect the cut face in 1.5m intervals as it is lowered to ensure ground materials are as expected and that additional support is not required.

Upon completion of the excavations, it is recommended the 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.

Excavation for Pathway

An excavation to a maximum depth of ~0.9m is required to construct the proposed new pathway. Allowing for backwall drainage, the excavation comes flush with the N common boundary.

The cut batter through fill and soil is to be permanently or temporarily supported as per the recommendations for the pool and landscaping works excavation.

Advice Applying to Both Excavations

Upslope runoff is to be diverted from the cut faces by sandbag mounds or other diversion works. 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 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
Fill, Topsoil and Clayey Sand	20	0.40	0.55
Residual Clays	20	0.35	0.45
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 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 full hydrostatic pressures are to be accounted for in the retaining structure design.

15. Foundations

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

REQUIRED INSPECTIONS ON 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.

- During the excavation process, the geotechnical consultant is to inspect the cut face in 1.5m intervals as it is lowered to ensure ground materials are as expected and that additional support is not required.
- 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

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.

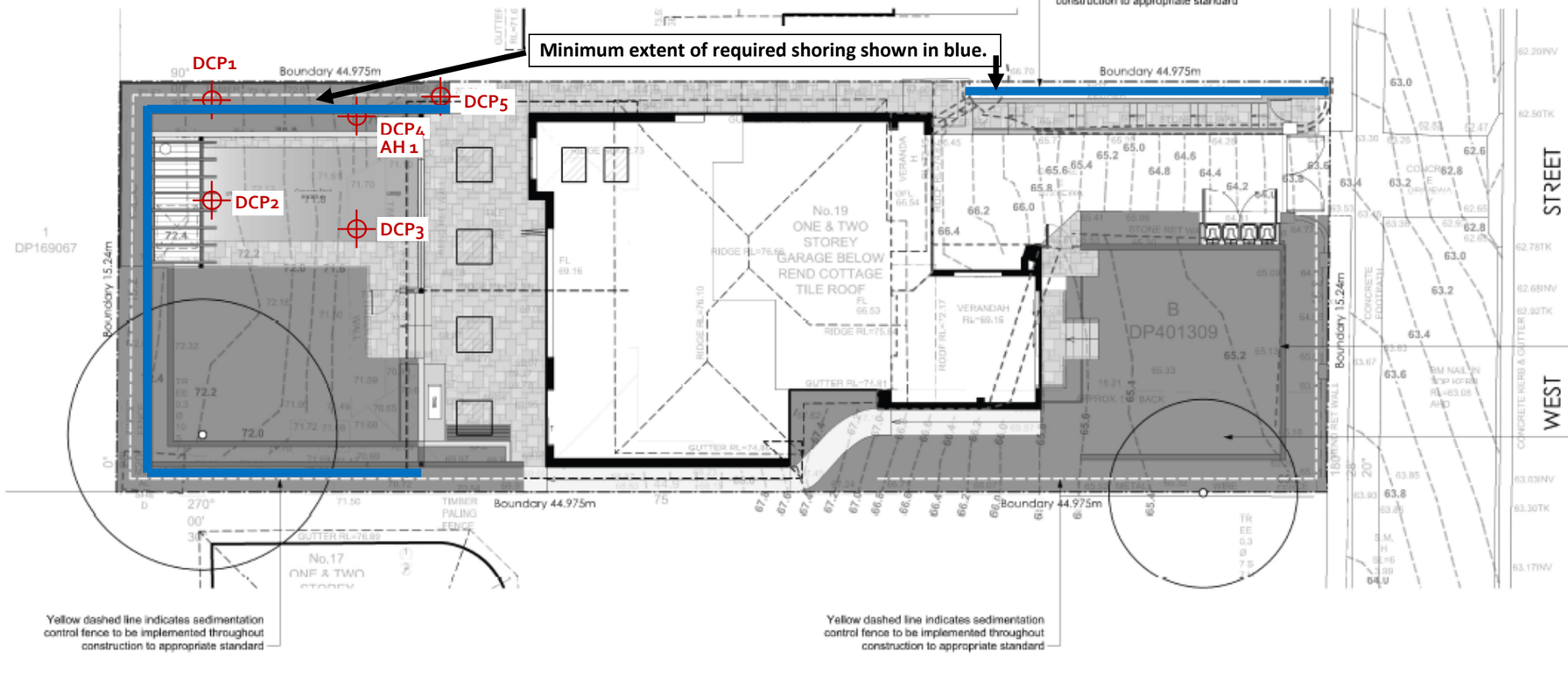
- This report should not be applied to any other project other than that outlined in section 1.0.

- 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.

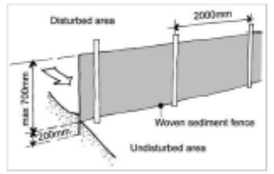
- It is common for the design and construction process to be adapted as it progresses (sometimes to suit the previous experience of the contractors involved). If alternative design and construction processes are required to those described in this report, contact White Geotechnical Group. We are familiar with a variety of techniques to reduce risk and can advise if your proposed methods are suitable for the site conditions.

Master Landscape Plan
1:100@A1 1:200@A3. Do not scale off plan

SITE PLAN – showing test locations



AREA CALCULATION		
	AREA (m2)	PERCENTAGE
Site	682,9	
Landscape total as per DCP	240,24	35,18%



Sedimentation Control Fence
Not to scale.
Source: www.yourhome.gov.au

Legend
- MULCH AREA
- TURF AREA
- TIMBER DECKING
- CONCRETE PAVING
- UNIT PAVING
- STAIRS
- PEBBLE
- GRAVEL
- COBBLESTONE
- TIMBER
- WATER
- MASONRY RETAINING WALL
- STONE RETAINING WALL
- TIMBER RETAINING WALL
- BOULDER RETAINING WALL
- SITE OR WORKS BOUNDARY
- PROPOSED LEVEL
- TOP OF WALL LEVEL
- MATERIAL NAME
- SURFACE FALL DIRECTION
- SURFACE DRAINS
- EXISTING TREE TO RETAIN
- EXISTING TREE TO REMOVE
- EXISTING ROCK OUTCROP

Notes:
>Do not scale off plan.
>Contractors to check all measurements onsite before quoting or commencing work.
>If discrepancies arise, contact the Landscape Architect.

>POOL TO BE INSTALLED TO MEET THE REQUIREMENTS OF AS1839:2021. POOL LEVEL SHOWN IS INDICATIVE ONLY AND TO BE CONFIRMED UNDER BY BUILDER TO ENSURE COMPLIANCE WITH AS1839:2021

ISSUE	DATE	REVISION
D	25/10/21	Issue D.
C	19/10/21	Issue C.
B	11/10/21	Issue B.
A	05/10/21	DRAFT issue for review.

JAMIE KING
LANDSCAPE ARCHITECT
DESIGN • APPROVE • MANAGE

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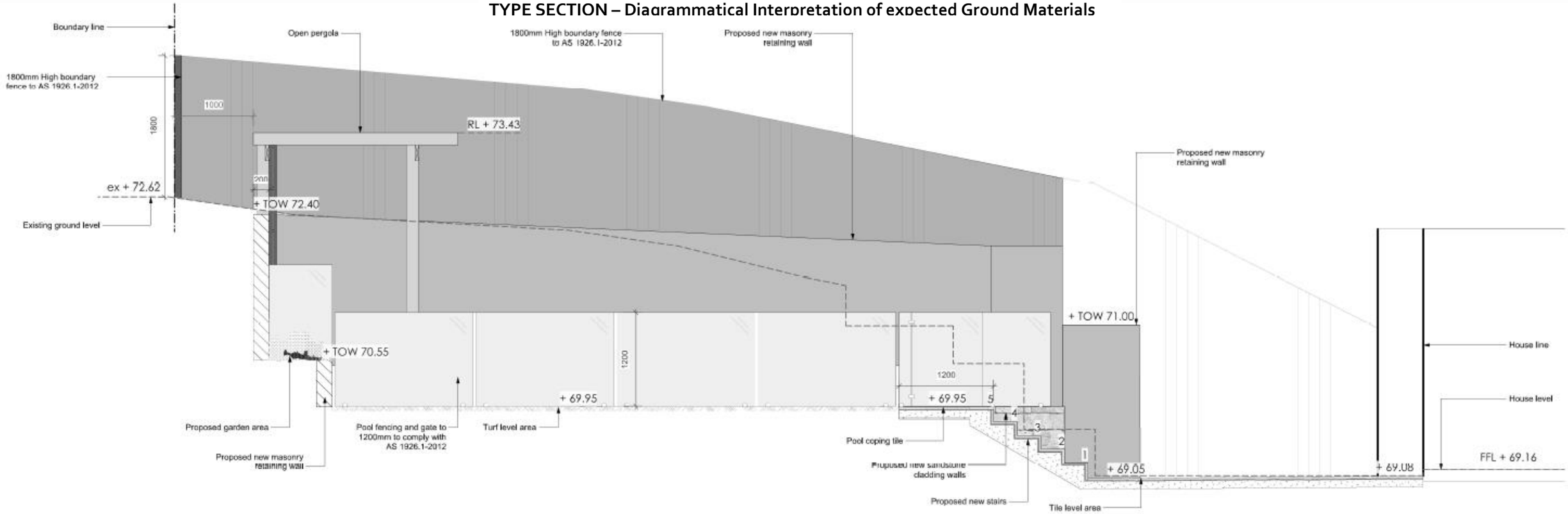
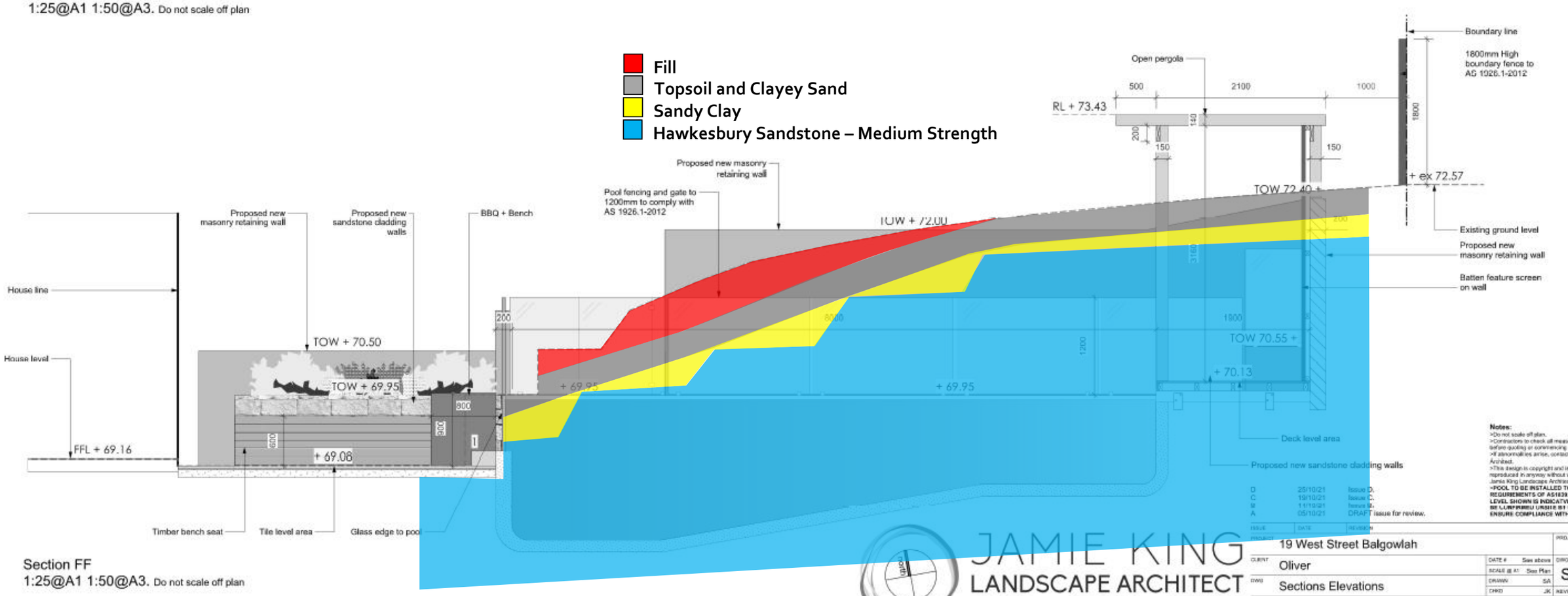
PROJECT	19 West Street Balgowlah
PROJECT #	22035
CLIENT	Oliver
DATE #	See above
SCALE @ A1	See Plan
DWG #	Sht-101
DWG	Master Landscape Plan
DRAWN	SA
CHKD	JK
REVISION	

TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials



Section EE
1:25@A1 1:50@A3. Do not scale off plan

Fill
Topsoil and Clayey Sand
Sandy Clay
Hawkesbury Sandstone – Medium Strength



Section FF
1:25@A1 1:50@A3. Do not scale off plan

Notes:
>Do not scale off plan.
>Contractors to check all measurements onsite before quoting or commencing work.
>If abnormalities arise, contact the Landscape Architect.

>POOL TO BE INSTALLED TO MEET THE REQUIREMENTS OF AS1926:2021. POOL LEVEL SHOWN IS INDICATIVE ONLY AND TO BE CONFIRMED ONSITE BY BUILDER TO ENSURE COMPLIANCE WITH AS1926:2021

ISSUE	DATE	REVISION
D	25/10/21	Issue D.
C	19/10/21	Issue C.
B	11/10/21	Issue B.
A	05/10/21	DRAFT issue for review.

JAMIE KING
LANDSCAPE ARCHITECT
DESIGN • APPROVE • MANAGE

PROJECT	19 West Street Balgowlah	PROJECT #	22035
CLIENT	Oliver	DATE @ A1	See above
DWG	Sections Elevations	SCALE @ A1	See Plan
		DRAWN	SA
		CHKD	JK
		DWG #	Sht-107
		REVISION	

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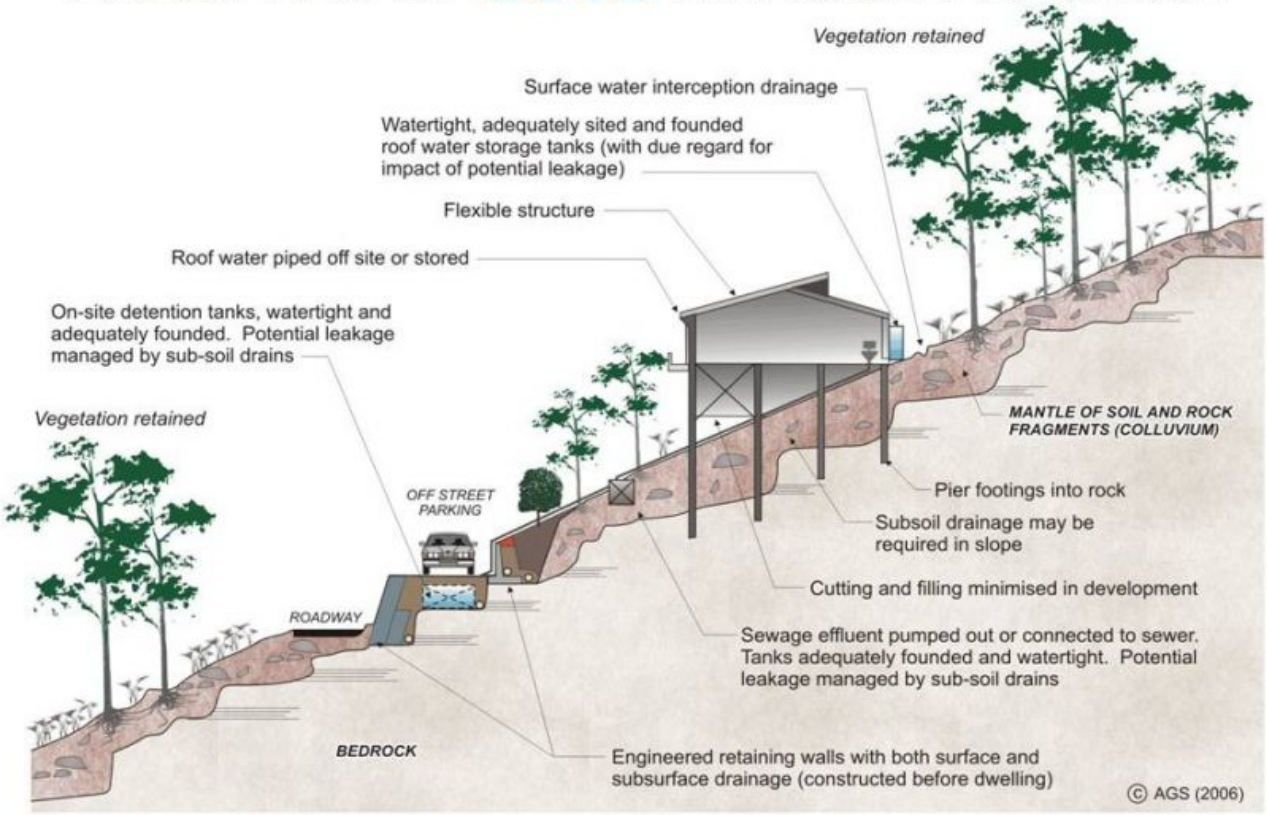
EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE