GEOTECHNICAL INVESTIGATION:

New Courtyard, Landscaping, and New Spa at **9 Salisbury Square, Seaforth**

1. Proposed Development

1.1 Construct a sunken courtyard off the downhill side of the house by excavating to a maximum depth of ~2.7m.

1.2 Install a spa on the downhill side of the property by excavating to a maximum depth of ~0.9m.

1.3 Level the lawn area by filling to a maximum height of ~1.0m.

1.4 Other minor internal and external additions and alterations.

1.5 Details of the proposed development are shown on 7 drawings prepared by Scope Architects, Project number 02203, drawings numbered A01 to A04 and A06 to A08, dated 27.4.22.

2. Site Description

2.1 The site was inspected on the 5th May, 2022.

2.2 This residential property is on the low side of the street and has a W aspect. It is located on the gentle to moderately graded middle reaches of a hillslope. The slope falls across the property at an average angle of ~6°. The slope above the property continues at similar angles and the slope below the property increases in grade.

2.3 At the road frontage, a concrete driveway runs down the slope to a parking garage attached to the uphill side of the house (Photo 1). Between the road frontage and the house is a level paved and garden area (Photo 2). The cut for the level lawn area is supported by a ~0.7m high stable rendered masonry retaining wall that lines the upper boundary (Photos 3). The part three-storey brick house is supported on

brick walls (Photo 4). The brick walls show no significant signs of movement. Access to the foundation space was not available at the time of this inspection. The cut for the lower level of the house is supported by a stable rendered masonry retaining wall that rises up to ~1.2m high (Photo 5). A gently sloping lawn area extends off the downhill side of the house to a pool at the downhill common boundary (Photo 6). The concrete shell of the pool shows no significant signs of movement as indicated by the water level against the tiles. The fill for the lawn area is supported by a stable ~0.8m high keystone block retaining wall (Photo 7).

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 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:

GROUND TEST RESULTS ON THE NEXT PAGE

AUGER HOLE 1 (~RL49.0) **–** AH1 (Photo 8)

Depth (m)	Material Encountered
0.0 to 0.1	**TOPSOIL**, dark brown, medium grained, loose to medium dense, dry.
0.1 to 0.2	**FILL**, sand derived from Very Low Strength Sandstone, sugary, white, coarse grained, dry.
0.2 to 0.6	**FILL**, brown, clayey sand, fine, coarse, damp.

Refusal @ 0.6m on rock. Auger grinding. 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 (~RL49.0)	DCP 2 (~RL48.0)	DCP 3 (~RL49.0)	DCP 4 (~RL48.1)	DCP 5 (~RL48.3)	DCP 6 (~RL48.3)
0.0 to 0.3	2	3	4	5	3	3
0.3 to 0.6	4	5	8	10	7	3
0.6 to 0.9	#	17	#	12	10	7
0.9 to 1.2		10		15	15	12
1.2 to 1.5		#		8	12	9
1.5 to 1.8				#	#	7
1.8 to 2.1						#
	Refusal on Rock @ 0.4m	Refusal on Rock @ 1.0m	Refusal on Rock @ 0.5m	Refusal on Rock @ 1.4m	Refusal on Rock @ 1.5m	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 Notes:

DCP1 – Refusal on rock @ 0.4m, DCP bouncing off rock surface, white impact dust dry tip.
DCP2 – Refusal on rock @ 1.0m, DCP bouncing off rock surface, white impact dust on dry tip.
DCP3 – Refusal on rock @ 0.5m, DCP bouncing off rock surface, white impact dust on dry tip.
DCP4 – Refusal on rock @ 1.4m, DCP bouncing off rock surface, white sand on wet tip.
DCP5 – Refusal on rock @ 1.5m, DCP bouncing off rock surface, white sand on wet tip.
DCP6 – Refusal on rock @ 1.6m, DCP bouncing off rock surface, white sand on wet tip.

5. Geological Observations/Interpretation

The surface features of the block are controlled by the underlying sandstone bedrock that steps down the property forming sub-horizontal benches between the steps. Where the grade is steeper, the steps are larger and the benches, narrower. Where the slope eases, the opposite is true. Filling has been placed around the site for garden beds and levelling of the existing lawn area. The rock is overlain by a thin topsoil over clays that fill the bench step formation. In the test locations, the depth to rock ranged between 0.4 to 1.6m below the current surface, being slightly deeper due to the presence of fill and 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 every test. 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 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 Salisbury Square above.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed beside the property. The gently to moderately graded slope that falls across the property and continues above and below is a potential hazard (**Hazard One**). The proposed fill for the lawn area is a potential hazard until retaining walls are in place (**Hazard Two**). The vibrations from the proposed excavation are a potential hazard

(**Hazard Three**). The proposed excavation is a potential hazard until retaining walls are in place (**Hazard Four**).

Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two
TYPE	The gentle to moderate slope that falls across the property and continues above and below failing and impacting on the proposed works.	The proposed fill (up to a maximum height of ~1.0m) failing and impacting the proposed works.
LIKELIHOOD	'Unlikely' (10^{-4})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (12%)	'Medium' (15%)
RISK TO PROPERTY	'Low' (2×10^{-5})	'Moderate' (2×10^{-4})
RISK TO LIFE	8.3×10^{-7}/annum	6.0×10^{-5}/annum
COMMENTS	This level of risk is 'ACCEPTABLE'.	This level of risk to life and property is 'UNACCEPTABLE'. To move risk to 'ACCEPTABLE' levels the recommendations in **Section 11** are to be followed.

RISK ANALYSIS SUMMARY ON THE NEXT PAGE

HAZARDS	Hazard Three	Hazard Four
TYPE	The vibrations produced during the proposed excavation impacting on the surrounding structures.	The excavation (up to a maximum depth of 2.7m) collapsing onto the work site before retaining structures are in place.
LIKELIHOOD	'Possible' (10^{-3})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (15%)	'Medium' (15%)
RISK TO PROPERTY	'Moderate' (2×10^{-4})	'Moderate' (2×10^{-4})
RISK TO LIFE	5.3×10^{-7}/annum	8.3×10^{-6}/annum
COMMENTS	This level of risk to property is 'UNACCEPTABLE'. To move 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 **Section 14 and 15** 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 additional stormwater runoff will be created by the proposed development.

11. Fill

A fill will be placed on the downhill side of the property for landscaping. No fills are to be laid until retaining walls are in place. The fill will reach a maximum depth of ~1.0m. The surface is to be prepared before any fills are laid by removing any organic matter and topsoil. Fills are to be laid in a loose thickness not exceeding 0.3m before being moderately compacted. Tracking the machine over the loose fill in 1 to 2 passes should be sufficient. Immediately behind the retaining walls (say to 1.5m), the fills are to be compacted with light weight

equipment such as a hand-held plate compactor so as not to damage the retaining walls. Where light weight equipment is used, fills are to be laid in a loose thickness not exceeding 0.2m before being compacted. No structures are to be supported on fill.

12. Excavations

An excavation up to a maximum depth of ~2.7m is required to construct the sunken courtyard off the downhill side of the house. Another excavation to a maximum depth of ~0.9m is required to install the spa on the downhill side of the property. The excavation is expected to be through fill, sandy soil, and clay with Medium Strength Rock expected at depths of between ~0.4m and ~1.6m below the current surface in the area of the proposed works.

It is envisaged that excavations through fill, sandy soils, and clay can be carried out with an excavator and bucket, and excavations through rock will require grinding or rock sawing and breaking.

13. Vibrations

Possible vibrations generated during excavations through fill, soil, and clay will be below the threshold limit for building damage. It is expected that the majority of the excavation will be through Medium Strength Sandstone or better.

Excavations through rock should be carried out to minimise the potential to cause vibration damage to the subject house and neighbouring property to the E and W. Allowing ~0.5m for backwall drainage, the setbacks are as follows:

- Flush with the existing walls of the subject house.
- ~1.0m from the N common boundary.
- ~1.0m from the concrete shell of the existing pool.

Close controls by the contractor over rock excavation are recommended so excessive vibrations are not generated.

Excavation methods are to be used that limit peak particle velocity to 8mm/sec at the subject walls. 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.

14. Excavation Support Requirements

Bulk Excavation for the Sunken Courtyard

The excavation for the sunken courtyard will reach a maximum depth of ~2.7m. Allowing ~0.5m for backwall drainage, the setbacks are as follows:

- Flush with the existing walls of the subject house.
- ~1.0m from the N common boundary.

As the depth to rock in the area of the proposed courtyard reaches a maximum depth of between ~0.4m and ~1.0m, being shallower near the N common boundary, no structures or boundaries will lie within the zone of influence of the proposed excavation for the courtyard.

Where the soil is deepest on the W side of the excavation face, the fill and soil portions of the are to be battered temporarily at 1.0 Vertical to 1.7 Horizontal (30°) until the retaining walls are in place. Excavations through natural clay are expected to stand unsupported for a short

period of time at near vertical angles until the retaining walls are in place, provided they are kept from becoming saturated. Medium Strength Sandstone or better will stand at vertical angles unsupported subject to approval by the geotechnical consultant.

The remaining sides of the courtyard excavation are expected to stand at near-vertical angles for a short period of time until the retaining structures are in place, provided they are kept from becoming saturated.

During the excavation process for the courtyard, the geotechnical consultant is to inspect the cut in 1.5m intervals as it is lowered 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.

Bulk Excavation for the Spa

The excavation for the proposed spa will reach a maximum depth of ~0.9m. The setbacks are as follows:

- ~1.0m from the concrete shell of the existing pool.

As the base of the existing pool is founded below the base of the excavation for the Spa no structures or boundaries will lie within the zone of influence of the proposed spa.

The fill, soil, and clay portions of the proposed spa excavation are expected to stand at near-vertical angles for short periods of time until the spa structure is installed, provided the cut batters are kept from becoming saturated. If the cut batters through fill, soil, and clay remain unsupported for more than a few days before pool construction commences, they are to be supported with typical pool shoring until the pool structure is in place. Excavations through Medium Strength Rock or better are expected to stand at vertical angles unsupported subject to approval by the geotechnical consultant.

Advice regarding all Excavations

Upslope runoff is to be diverted from the cut faces by sandbag mounds or other diversion works. Unsupported cut batters through fill, soil, and clay are to be covered to prevent access of water in wet weather and loss of moisture in dry weather. The covers are to be tied down with metal pegs or other suitable fixtures so they can't blow off in a storm. The materials and labour to construct the pool structure/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.

Upon completion of the courtyard excavation, it is recommended all 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 spoil may be used for landscaping on site.

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

15. 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 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
Fill and Sandy Soil	20	0.40	0.55
Clay	20	0.30	0.40
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 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 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 walls, the likely hydrostatic pressures are to be accounted for in the structural design.

16. Foundations

The proposed sunken courtyard is expected to be entirely seated in Medium Strength Sandstone. This is a suitable foundation material.

To prevent surcharge loads on the pool structure from the Spa, the proposed Spa on the downhill side of the property is to be supported on piers taken to Medium Strength

Sandstone. This material is expected at depths of between ~1.4m and ~1.5m below the current surface in the area of the proposed spa.

As the lawn area has been previously filled, footings for the retaining wall supporting the fill for the lawn and proposed deck around the spa are to also be supported on piers taken to the underlying Medium Strength Sandstone.

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.

17. 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.

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Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8 (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.

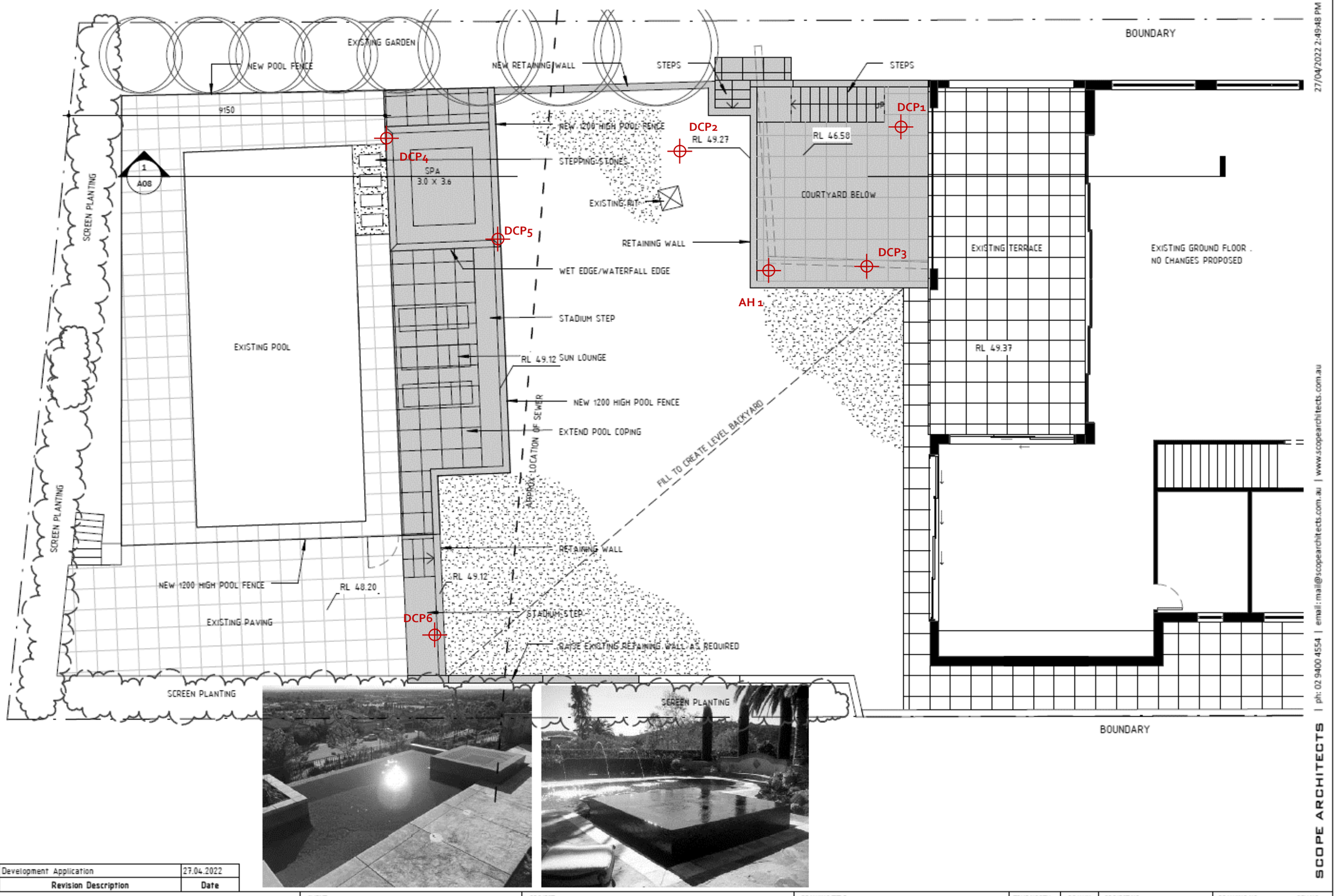
- The report addresses issues relating to your specific design and site. If the proposed project design changes, aspects of the report may no longer apply. Contact White Geotechnical if this occurs.

- 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



No	Revision Description	Date
1	Development Application	27.04.2022

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CLIENT: SAMUEL ALLEN

PROJECT: Alterations & Additions
9 SALISBURY SQ SEAFORTH
LOT: 110 DP: 4889

DRAWING TITLE: GROUND FLOOR PLAN

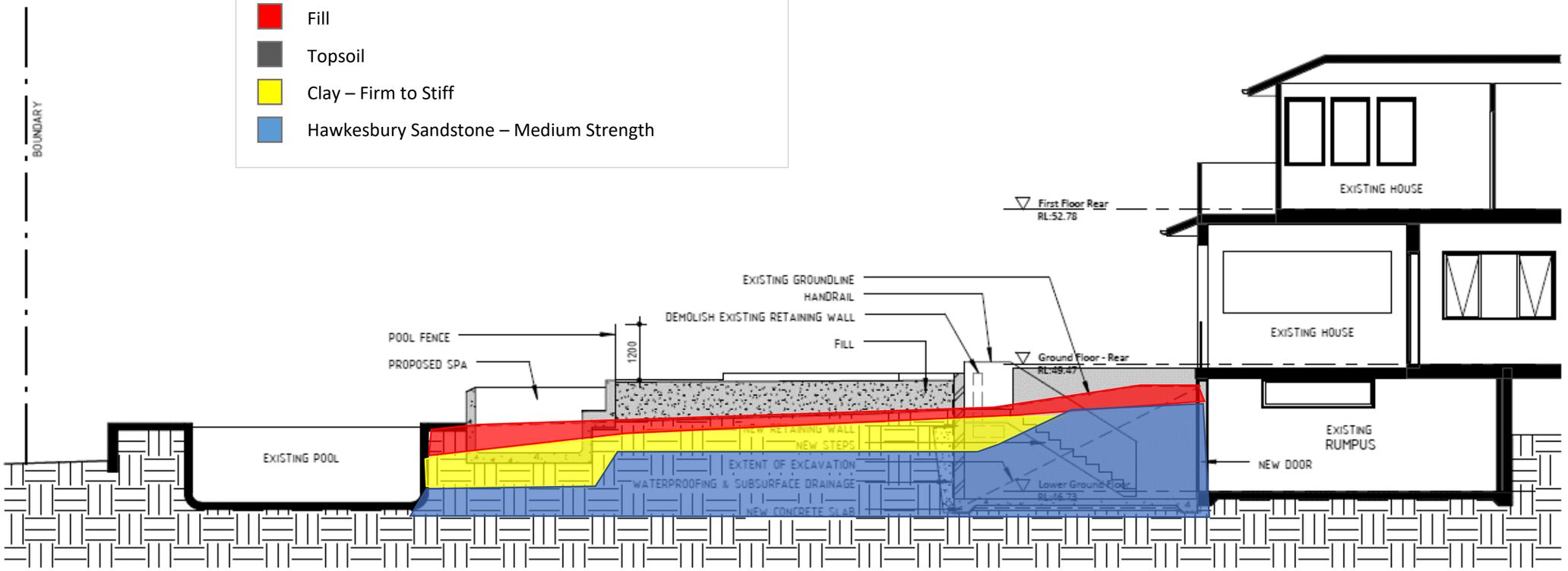
TRUE NORTH

DRAWN	PROJECT NO.	DRAWING NO	REV NO
Xu	02203	A03	1
SIZE: A3	SCALE: 1 : 100		

TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials

Expected Ground Materials

- Fill
- Topsoil
- Clay – Firm to Stiff
- Hawkesbury Sandstone – Medium Strength



LEGEND

- EXISTING WALL
- NEW TIMBER WALL
- NEW BRICK WALL
- DEMOLISH
- PROPOSED WORKS

No	Revision Description	Date
1	Development Application	27.04.2022

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PROJECT: Alterations & Additions
9 SALISBURY SQ SEAFORTH
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DRAWING TITLE: SECTION

TRUE NORTH

DRAWN: XK

PROJECT NO.: 02203

SIZE: A3

SCALE: 1 : 100

DRAWING NO: A08

REV NO: 1

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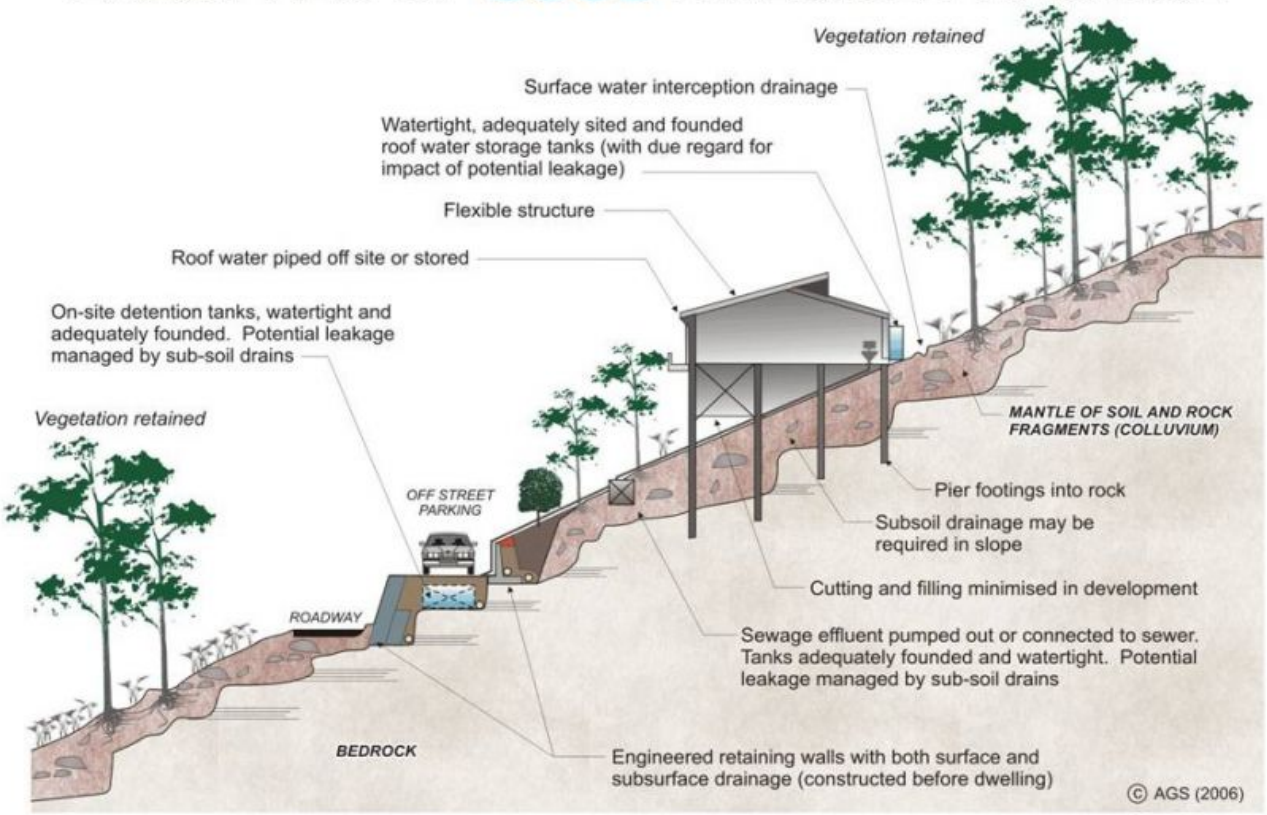
27/04/2022 2:49:51 PM

EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE