GEOTECHNICAL INVESTIGATION:

New Garage and Alterations and Additions at **22 Loch Street, Freshwater**

1. Proposed Development

1.1 Construct a new garage on downhill side of the house by excavating to a maximum depth of ~2.2m.

1.2 Various other internal and external alterations and additions.

1.4 Details of the proposed development are shown on architectural drawings prepared by Castlepeake Architecture, 23 drawings numbered DA00, DA03 to DA12, EF01, SD01 to SD03, EX01 to EX04, CF01, D01 and D02, revision DA, and DA01 and DA02, revision P2, all dated 12/2022

2. Site Description

2.1 The site was inspected on the 12th January, 2023.

2.2 This residential property is on the high side of Loch Street. The property encompasses the gently graded E and W flanks and crest of a N-S trending ridge. The slope rises from the road frontage at an angle of ~7° which eases to the crest of the ridge. The slopes on both flanks continues at gradually increasing angles.

2.3 At the road frontage, a concrete driveway runs up the slope to a garage on the W side of the house (Photo 1). Medium Strength Sandstone was observed to be outcropping at the road frontage and steps up the slope (Photo 2). The two-storey brick house is supported on brick walls. Access to the foundation space of the house was not available at the time of inspection. However, the external walls of the house show no signs of significant cracking. A gently sloping lawn extends from the E side of the house to the E common boundary (Photo 3).

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. Four 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 (~RL49.4) **–** AH1 (Photo 4)

Depth (m)	Material Encountered
0.0 to 0.5	**TOPSOIL**, sandy soil, dark brown, medium dense, damp, fine to medium grained with fine trace organic matter.
0.1 to 0.4	**SAND**, grey-white & grey-brown, dense, dry, medium grained with fine trace organic matter.

Refusal @ 0.4m. Auger grinding on the rock surface. No water table encountered.

DCP TEST RESULTS ON NEXT PAGE

DCP TEST RESULTS – Dynamic Cone Penetrometer				
Equipment: 9kg hammer, 510mm drop, conical tip.			Standard: AS1289.6.3.2 - 1997	
Depth(m) Blows/0.3m	**DCP 1** (~RL49.0)	**DCP 2** (~RL49.4)	**DCP 3** (~RL49.2)	**DCP 4** (~RL49.4)
0.0 to 0.3	1	Rock exposed at surface	Rock exposed at surface	12
0.3 to 0.6	3			20
0.6 to 0.9	#			#
	Refusal on Rock @ 0.4m			Refusal on Rock @ 0.4m

#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 on dry tip.
DCP2 – Medium Strength Sandstone exposed at surface.
DCP3 – Medium Strength Sandstone exposed at surface.
DCP4 – Refusal on rock @ 0.4m, DCP bouncing off rock surface, white impact dust on dry tip.

5. Geological Observations/Interpretation

The surface features of the block are controlled by the outcropping and underlying sandstone bedrock that steps up the property forming sub-horizontal benches between the steps. Where the grade is steeper, the steps are larger and the benches narrower. Where the slope eases, the opposite is true. Where the rock is not exposed, it is overlain by sandy soils, clayey sands and sandy clays which fill the bench step formation. In the test locations, where the rock is not exposed, it was encountered at a depth of ~0.4m below the current surface. The outcropping sandstone on the property is estimated to be Medium Strength or better and similar strength rock is expected to underlie the entire site as all the DCP tests bounced at refusal. 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. As the property encompasses the crest of the hill, any surface flows will be generated on the property and will flow away from the property.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed above or beside the property. The gentle to moderately graded slope that rises across the property and continues below at similar angles 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 retaining walls are in place (**Hazard Three**). The proposed excavation undercutting the footings for the house is a potential hazard (**Hazard Four**).

RISK ANALYSIS SUMMARY ON NEXT PAGE

Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two
TYPE	The gentle slope that rises across the property and continues below failing and impacting on the proposed works.	The vibrations produced during the proposed excavation impacting on the surrounding structures.
LIKELIHOOD	'Unlikely' (10^{-4})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Minor' (5%)	'Medium' (15%)
RISK TO PROPERTY	'Low' (5×10^{-6})	'Moderate' (2×10^{-4})
RISK TO LIFE	8.3×10^{-7}/annum	8.3×10^{-7}/annum
COMMENTS	This level of risk is 'ACCEPTABLE'.	This level of risk to property is 'UNACCEPTABLE'. To move risk to 'ACCEPTABLE' levels, the recommendations in **Section 12** are to be followed.

HAZARDS	Hazard Three	Hazard Four
TYPE	The excavation collapsing onto the work site before retaining walls are in place.	The proposed excavation undercutting the footings of the house causing failure.
LIKELIHOOD	'Possible' (10^{-3})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (15%)	'Medium' (35%)
RISK TO PROPERTY	'Moderate' (2×10^{-4})	'Moderate' (2×10^{-4})
RISK TO LIFE	8.6×10^{-5}/annum	5.0×10^{-5}/annum
COMMENTS	This level of risk to life and property is 'UNACCEPTABLE'. To move risk to 'ACCEPTABLE' levels, the recommendations in **Section 13 and 14** are to be followed.	This level of risk to life and property is 'UNACCEPTABLE'. To move risk to 'ACCEPTABLE' levels, the recommendations in **Section 13** are to be followed.

(See Aust. Geomech. Jnl. Mar 2007 Vol. 42 No 1, for full explanation of terms)

9. Suitability of the Proposed Development for the Site

The proposed development is suitable for the site. No geotechnical hazards will be created by the completion of the proposed development provided it is carried out in accordance with the requirements of this report and good engineering and building practice.

10. Stormwater

The roofing of the proposed works adds less than ~50m^2 to the current roof area so it is possible the existing stormwater system can be used with the approval of the stormwater engineer.

11. Excavations

An excavation to a maximum depth of ~2.2m is required for the proposed garage.

The excavations are expected to be through soil and sand, with Medium Strength Sandstone expected at a maximum depth of ~0.4m below the surface where it is not exposed in the area of the proposed excavations.

It is envisaged that excavations through shallow soil, sand and clay can be carried out with an excavator and toothed bucket. Rock sawing through Medium Strength Sandstone will be required to minimise the potential to cause vibration damage to the nearby sewer main that cuts across the property.

12. Vibrations

Possible vibrations generated during excavations through soil and sand will be below the threshold limit for building damage. It is expected that the majority of the excavations 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 existing subject house, and neighbouring structures to the N and S. Allowing for ~0.5m of back wall drainage, the setbacks are as follows:

- Flush with the subject house.
- ~1.3m from the S neighbouring house.
- ~2.0m from the N neighbouring house.

To reduce the likelihood of spurious building damage claims, dilapidation reporting carried out on the N and S neighbouring properties is recommended prior to the excavation works commencing.

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 5 mm/sec at the subject house and N and S neighbouring house 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.
- Use of rock grinders (milling head).

Should excavation induced vibrations exceed vibration limits after the recommendations above have been implemented, excavation works are to cease immediately and our office is to be contacted.

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

13. Excavation Support Requirements

The excavation will reach a maximum depth of ~2.2m. Allowing for 0.5m of back wall drainage, the setbacks are as follows:

- Flush with the subject house.
- ~0.6m from the S common boundary concrete wall.
- ~1.5m from the N common boundary.

Medium Strength Sandstone was encountered at shallow depths of ~0.4m or less. As such, only the subject house and the S common boundary is expected to be within the zone of influence of the proposed excavation. In this instance, the zone of influence is the area above a theoretical 30° line from the base of the excavation or top of Medium Strength Rock, whichever is encountered first, towards the surrounding structures and boundaries.

Given the shallow depth to rock, we think it is likely the subject house and the S boundary wall is supported on rock. However, to be sure, where the subject house and the S common boundary wall falls within the zone of influence of the excavation, exploration pits along the walls will need to be put down by the builder to determine the foundation depth and material. These are to be inspected by the geotechnical consultant.

If the foundations are confirmed to be supported on rock or extend below the zone of influence of the proposed excavation, the excavation may commence. If they are not, the supporting walls will need to be underpinned to rock or to below the zone of influence of the

cut prior to the excavation commencing. See the site plan attached for the minimum extent of the required exploration pits/underpinning.

Underpinning is to follow the underpinning sequence 'hit one miss two'. Under no circumstances is the bulk excavation to be taken to the edges of the walls and then underpinned. Underpins are to be constructed from drives that should be proportioned according to footing type and size. Allowances are to be made for drainage through the underpinning to prevent a build-up of hydrostatic pressure. Underpins that are not designed as retaining walls are to be supported by retaining walls. The void between the retaining walls and the underpinning is to be filled with free-draining material such as gravel.

During the excavation process, the geotechnical consultant is to inspect the excavations as they approach no less than 0.8m horizontally from the foundations of the house to confirm the stability of the cut to go close to flush with the footings.

The soil and sand portions of the remaining excavation faces are to be battered temporarily at 1.0 Vertical to 1.7 Horizontal (30°) until the retaining walls are in place. Medium Strength Sandstone or better is expected to stand at vertical angles unsupported subject to approval by the geotechnical consultant.

During the excavation process, 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.

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 cannot blow off in a storm. The materials and labour to construct the retaining walls are to be organised so on completion of the

excavations they can be constructed as soon as possible. The excavations are to be carried out during a dry period. No excavations are to commence if heavy or prolonged rainfall is forecast.

Upon completion of the 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.

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
Soil and Sand	20	0.40	0.55
Medium Strength Sandstone	24	0.00	0.01

For rock classes refer to Pells et al "Design Loadings for Foundations on Shale and Sandstone in the Sydney Region". Australian Geomechanics Journal 1978.

It is to be noted that the earth pressures in Table 1 assume a level surface above the 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 garage 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.

16. Inspections

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

- The exploration pits to determine the foundation material along the downhill wall of the house and the S boundary wall are to be inspected by the geotechnical consultant to determine if underpinning is necessary. This is to occur before the bulk excavation for the garage commences.
- During the excavation process, the geotechnical consultant is to inspect the excavations as they approach no less than 0.8m horizontally from the foundations of the house to confirm the stability of the cut to go close to flush with the footings.
- During the excavation process, the geotechnical consultant is to inspect the cut face as it is 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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Engineering Geologist

Photo 1

Photo 2

Photo 3

Photo 4 (AH1 - Downhole from Left to Right)

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.

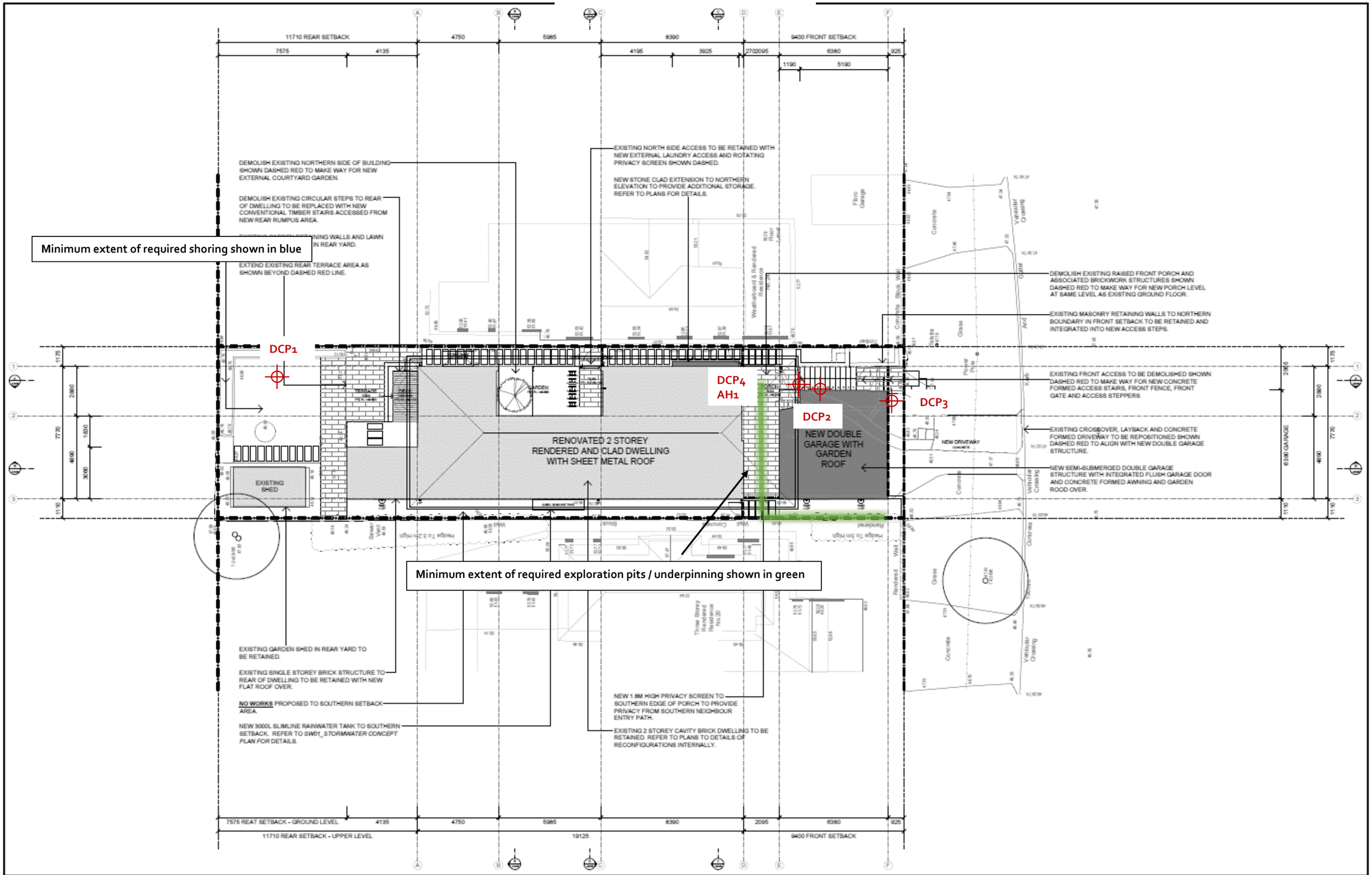
- The report addresses issues relating to your specific design and site. If the proposed project design changes, aspects of the report may no longer apply. Contact White Geotechnical if this occurs.

- 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



DA	ISSUE TO NORTHERN BEACHES COUNCIL FOR DEVELOPMENT APPLICATION	DEC '22	KW	KW					
REVISION	AMENDMENT OR REASON FOR ISSUE	ISSUE DATE	DRAWN	CHECKED	REVISION	AMENDMENT OR REASON FOR ISSUE	ISSUE DATE	DRAWN	CHECKED

NORTH

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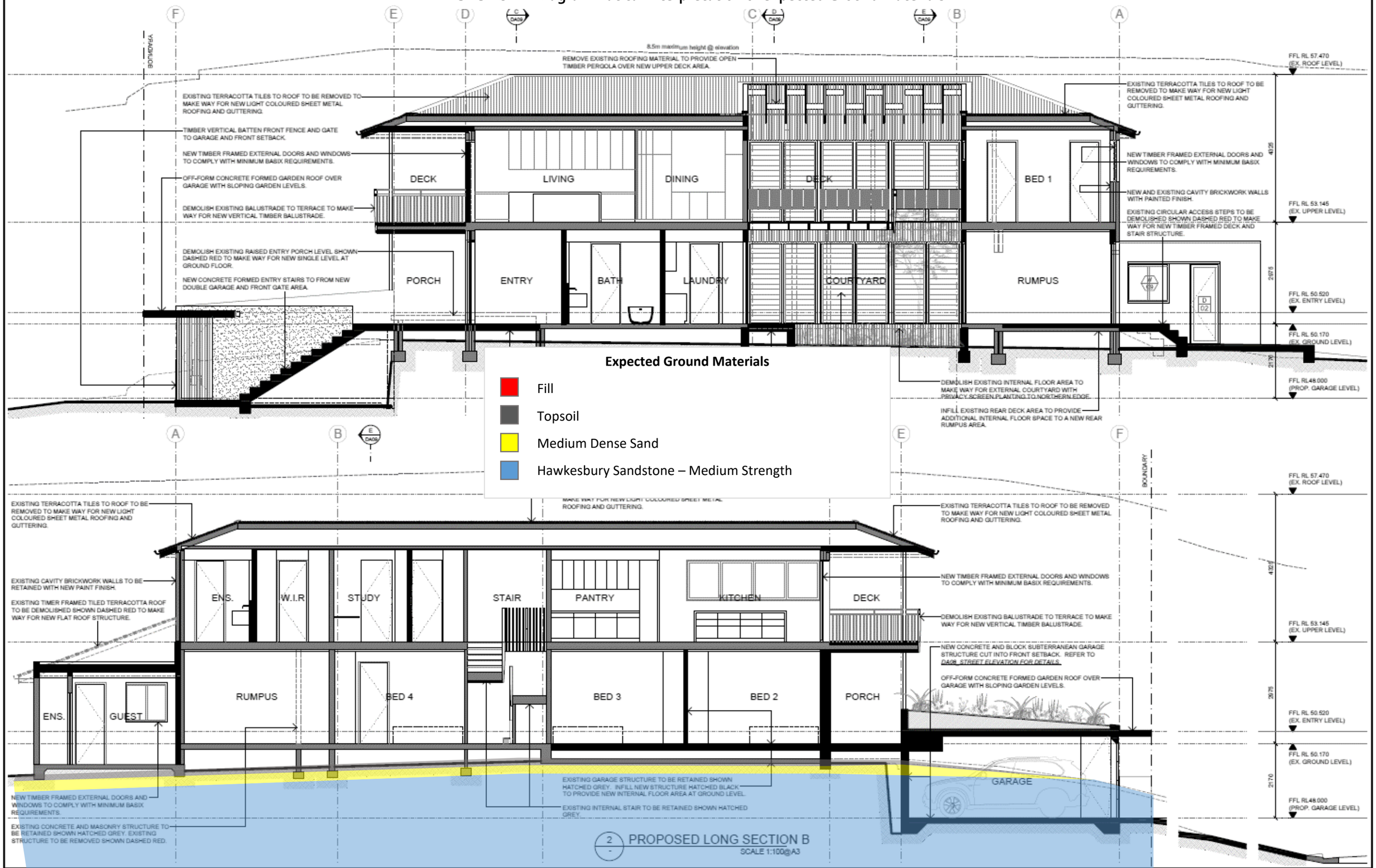
Drawing Title: SITE PLAN

Project: PARKER RESIDENCE - 22 LOCH STREET, FRESHWATER

Nominated Registered Architects: Mark Crutchett - Reg No. 7190; Kelly Wilson - Reg No. 11312; Martin Hall - Reg No. 9854

Scale	Job No.	Drawing No.	Revision
1:200@A3		DA01	P2

TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials



2 PROPOSED LONG SECTION B
SCALE 1:100@A3

DA	ISSUE TO NORTHERN BEACHES COUNCIL FOR DEVELOPMENT APPLICATION	DEC '22	KW	KW					
REVISION	AMENDMENT OR REASON FOR ISSUE	ISSUE DATE	DRAWN	CHECKED	REVISION	AMENDMENT OR REASON FOR ISSUE	ISSUE DATE	DRAWN	CHECKED

NORTH

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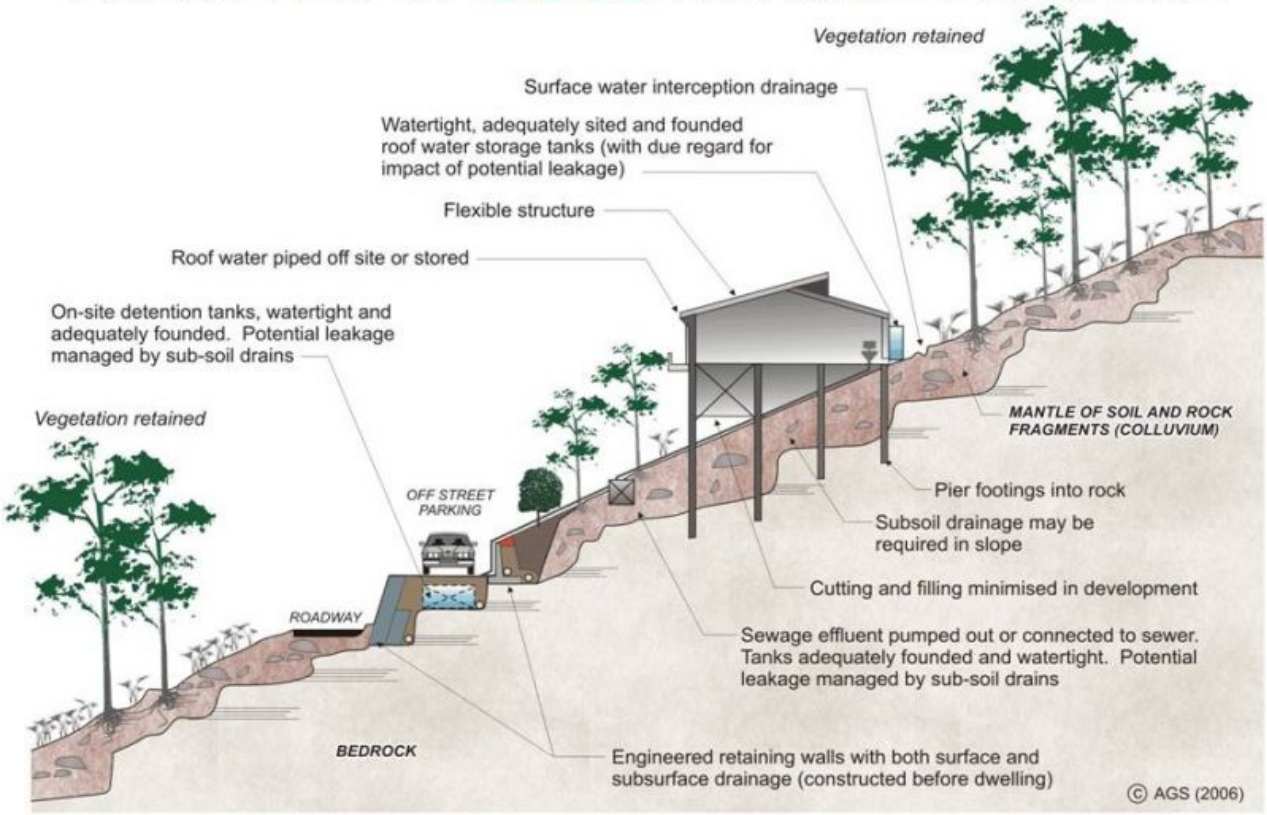
Drawing Title: PROPSOED LONG SECTIONS A & B
Project: PARKER RESIDENCE - 22 LOCH STREET, FRESHWATER

Nominated Registered Architects: Mark Donellan - Reg No. 7150; Kelly Wilson - Reg No. 11012; Martin Hall - Reg No. 9854

Scales	Job No.	Drawing No.	Revision
1:100@A3		DA09	DA

EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE