GREEN

GEOTECHNICS

GEOTECHNICAL INVESTIGATION

FOR

YOUNG ASSETS HOLDINGS PTY LTD

116-120 FRENCHS FOREST ROAD & 11 GLADYS AVENUE, FRENCHS FOREST

REPORT GG11138.001A

21 MARCH 2024

Geotechnical Investigation for a proposed residential unit development at 116-120 Frenchs Forest Road & 11 Gladys Avenue, Frenchs Forest

Prepared for

Young Assets Holding Pty Limited
Shop 1, 63 Archer Street
Chatswood NSW 2067

Prepared by

Green Geotechnics Pty Limited
PO Box 3244
Rouse Hill, NSW, 2155
ABN: 786 438 493 89
www.greengeo.com.au
matt@greengeo.com.au

21 March 2024

Document Authorisation

Our Ref: GG11138.001A

For and on behalf of Green Geotechnics

Matthew Green
Principal Engineering Geologist
RPGeo (10276)

Document Control

Revision	Description	Format	Date	Author	Distributed to
A	Final	PDF	21/03/2024	MG	Young Assets Holding Pty Limited (Client)

Table of Contents

FIGURES

APPENDICIES

1. INTRODUCTION

This report presents the results of a Geotechnical Investigation undertaken by Green Geotechnics Pty Limited for a proposed residential unit development to be constructed at 116-120 Frenchs Forest Road and 11 Gladys Avenue, Frenchs Forest, NSW. The assessment was commissioned by Young Assets Holding Pty Limited by acceptance of Proposal PROP-2023-0073A, dated 10 July 2023.

Based on the provided architectural design documentation, we understand that the development will comprise demolition of existing structures prior to the construction of three residential unit buildings with between six (6) and eight (8) above ground levels overlying communal basement car parking. The lowest basement car parking level, Basement 1, has a finished floor level of Reduced Level (RL) 148.15 metres Australian Height Datum (AHD). Construction of the basement will therefore require excavating up to eleven (11) metres below the existing ground surface, with the depth of excavation decreasing towards Gladys Avenue.

Structural loads have not been advised but we have assumed column loads in the moderate to high range will apply for this type of development.

The purpose of the investigation was to:

- assess the subsurface conditions over the site including ground water levels,
- classify the site in accordance with AS2870,
- classify the site in accordance with AS1170.4.
- provide recommendations regarding the appropriate foundation system for the site including design parameters,
- comment on excavation conditions,
- provide recommendations regarding vibration control during rock excavation, and
- provide parameters for the temporary and permanent support of the excavation including design parameters and recommendations for temporary batter slopes, and
- provide an exposure classification in accordance with AS2870 & AS2159.

2. INVESTIGATION PROCEDURE

2.1 Fieldwork Details

The fieldwork was carried out on the 27 & 28 July 2023 and comprised the drilling of four (4) cored and four (4) non cored boreholes numbered BH1 to BH8, to depths of 0.8 metres to 11.4 metres below existing ground surface levels.

The boreholes were drilled using a combination of Christie MDR track mounted drilling rig (BH1, BH2, BH4 and BH7), supplied and operated by BG Drilling, Christie Utility mounted drilling rig (BH3 and BH5), supplied and operated by Green Geotechnics, and hand auger (BH6 and BH8). All machine drilled boreholes were commenced using rotary solid flight augers. BH1, BH2, BH4 and BH7 were advanced using augers until at least low strength bedrock was encountered. These boreholes were then advanced into the underlying bedrock to the target depths using NMLC sized diamond coring equipment. BH3, BH5, BH6 and BH8 were drilled to auger refusal.

Soil strengths in the cored boreholes were assessed by undertaking Standard Penetration Tests (SPT's) at regular depth intervals in the boreholes. The SPT N values were then augmented by undertaking pocket penetrometer readings on cohesive soil samples recovered from the SPT split spoon sampler. Soil strengths in BH3, BH5, BH6 and BH8 were assessed by undertaking Dynamic Cone Penetrometer (DCP) tests adjacent to each borehole.

The recovered rock core from BH1, BH2, BH4 and BH7 was logged, boxed and photographed. To assist in assessing rock strengths the recovered rock core was Point Load Index tested, with tests undertaken at a nominal depth interval of 1 metre.

Groundwater observations were made in all boreholes during auger drilling. To further assess groundwater levels, PVC standpipe piezometers were installed in BH2 and BH5 shortly after drilling. The piezometer installed in BH2 was bailed of drill water shortly after installation.

The surface reduced levels of the boreholes were determined by interpolation between spot levels shown on the provided site survey plan, and so should be considered to be approximate. The datum of the levels is Australian Height Datum (AHD).

The site location is shown in the attached Figure A. The borehole locations, as shown on Figure B, were determined by taped measurements from existing surface features shown on the survey plan provided by the client. Photographs of the site indicating the borehole locations are provided in Figure C.

The fieldwork was completed in the full-time presence of our Senior Field Geologist who set out the boreholes, nominated the sampling and testing, and prepared the borehole logs. The logs which include the approximate surface reduced levels and groundwater observations together with photos of the rock core and Point Load Index test results, are attached to this report, together with a glossary of the terms and symbols used in the logs.

For further details of the investigation techniques adopted, reference should be made to the attached explanation notes.

Environmental and contamination testing of the soils was beyond the agreed scope of the works.

2.2 Laboratory Testing

In order to assess the soils for their aggressiveness in accordance with AS2159 and AS2870, selected representative soil samples were tested to determine the following:

- pH,
- Sulphate Content (SO4),
- Chloride Content (CL), and
- Electrical Conductivity (EC).

The detailed test reports are provided in Appendix B and are further discussed in Section 4.9 of this report.

3. RESULTS OF INVESTIGATION

3.1 Site Description

The site is identified as Lot 14 in DP 25713, Lots 1 and 2 in DP 213608 and Lot 24 25713 and comprises an irregular shaped parcel of land with a combined area of approximately 5,740m^2.

At the time of our investigation No.11 Gladys Avenue was occupied by a single storey weatherboard clad residential dwelling with tile roof and separate garage, No.116 Frenchs Forest Road was occupied by a one and two storey weatherboard clad residence with tile roof and separate one storey structure and garage, No.118 Frenchs Forest Road was occupied by a two storey brick residential dwelling with tile roof, attached garage and pool in the rear garden area, and No.120 Frenchs Forest Road was occupied by a double storey brick dwelling with tile roof.

The dwellings include brick and paved driveways, small sheds and retained garden beds. Site vegetation comprises grassed garden areas, garden beds and numerous mature trees. The ground surface on the site falls approximately 8 metres to the north - north west, from approximately RL 160 metres AHD at the kerb level of No.120 Frenchs Forest Road, to RL152 metres AHD at the kerb level of Gladys Avenue.

To the south of the site is Frenchs Forest Road and to the north is Gladys Avenue. To the east of the site is No. 114 Frenchs Forest Road, a single storey clad and brick residential dwelling with tile roof set back around 1.5 metres from the site boundary. To the west of the site is No.122 Frenchs Forest Road, a single storey brick residential dwelling with tile roof set back around 2.0 metres from the site boundary.

3.2 Regional Geology & Subsurface Conditions

The 1:100,000 series geological map of Sydney (Geological Survey of NSW, Geological Series Sheet 9030) indicates that the site is underlain by Triassic Age bedrock belonging to a subgroup of the Hawkesbury Sandstone formation. The subgroup comprises a shale and laminite cap rock overlying medium to coarse grained sandstone bedrock belonging to the Hawkesbury Sandstone formation. Bedrock within the subgroup formation typically weathers to form residual clayey soils of medium to high plasticity.

For the development of a site-specific geotechnical model, the observed subsurface conditions from the boreholes have been grouped into five (5) geotechnical units which are summarised below in Table 3.1.

TABLE 3.1 – Summary of Subsurface Conditions

Unit	Material Type	Depth to top of Layer (m)*	Depth to base of Layer (m)*	Material Description
1	Topsoil / Fill	Surface	0.2 – 0.6m	Low and medium plasticity silty clays, silty sandy clays dark brown in colour, moist. Traces of organics in topsoil materials. Fill contains some gravels and traces of brick.
2	Residual Soil – Firm to Stiff, Stiff and to Very Stiff Clay	0.3 – 2.0m	1.1 – 1.8m	Gravelly silty clays, silty sandy clays and silty clays of medium and high plasticity with traces of ironstone, shale and sandstone gravel. Generally firm to stiff becoming stiff and very stiff with depth, and moist becoming dry to moist. Unable to be penetrated in BH6 and BH8.
3	Class 5 Shale & Sandstone Bedrock	1.1 – 1.8m	2.6 – 7.5m	Extremely weathered extremely low to very low strength shale and sandstone bedrock, orange to brown and grey brown in colour with frequent clay seams and iron indurated lenses. Sandstone generally encountered over northern portion of the site and shale encountered over the southern portion. Not core drilled.
4	Class 4 Shale & Sandstone	2.6 – 7.5m	2.7 – >9.0m	Highly weathered to slightly weathered dark grey to grey shale bedrock and red grey to grey sandstone bedrock with frequent clay seams, iron stained bedding partings and inclined to sub-horizonal joints. Sandstone lenses encountered in BH4
5	Class 3 & 2 Sandstone	2.7 – 8.4m	-	Slightly weathered to fresh pale grey sandstone bedrock with iron stained lenses, shallow over the northern portion of the site and deep adjacent to Frenches Forest Road. Mostly high strength.

TABLE 3.2 – Summary of Bedrock Classification

Borehole ID	Depth of Rock Classification (m)		
	Class 5	Class 4	Class 3
1	1.2 – 1.8m	1.8 – 4.2m	4.2 – 8.7m
2	1.8 – 2.6m	2.6 – 2.7m	2.7 – 7.5m
3	1.7 – 1.9m	>1.9m	Not Encountered
4	1.1 – 6.5m	6.5 – 9.0m	Not Encountered
5	1.6 – 7.2m	7.2 – 8.4m	Not Encountered
6	Not Encountered	Not Encountered	Not Encountered
7	1.2 – 7.5m	7.5 – 8.4m	8.4 – 11.4
8	Not Encountered	Not Encountered	Not Encountered

Groundwater seepage was observed during auger drilling of BH1 at a depth 1.8 metres. All other boreholes remained dry during drilling.

The piezometers installed in BH2 and BH5 were re-measured after a period of 5 days, with groundwater recorded at a depth of 2.0 metres in BH2 and 3.0 metres in BH5, which is within the upper residual soils or soil/rock interface.

4. GEOTECHNICAL RECOMMENDATIONS

4.1 Primary Geotechnical Considerations

Based on the results of the assessment, we consider the following to be the primary geotechnical considerations for the development:

- Basement excavation and retention to limit lateral deflections and ground loss as a result of excavations, resulting in damage to nearby structures,
- Rock excavation and the generation of ground borne vibrations, and
- Foundation design for structural loads.

4.2 Site Classification to AS2870

The classification has been prepared in accordance with the guidelines set out in the "Residential Slabs and Footings" Code, AS2870 – 2011.

Because there are trees and structures/pavements present on the site, abnormal moisture conditions (AMC) prevail at the subject site (Refer to Section 1.3.3 of AS2870).

Because of the AMC and fill present, the site is classified a ***Problem Site (P).*** However, provided the recommendations given in Section 4.8 are adopted and the footings bear in the underlying shale or sandstone bedrock, the site may be reclassified ***Moderately Reactive (M).***

4.3 Site Classification to AS1170.4 (Earthquake)

The site sub-soil classification has been determined using AS1170.4-2007. The classification is based on the results of the borehole drilling. The depth of soil recorded in the subsurface profile less than 3 metres, therefore the site is classified as a Rock Site (B_e). An earthquake hazard factor (Z) of 0.08 applies to sites within the Sydney region.

4.4 Excavation Conditions and Vibration Control

All excavation recommendations should be complemented with reference to the NSW Government Code of Practice for Excavation work, dated January 2020.

It would be appropriate before commencing excavation to undertake a dilapidation survey of any adjacent structures that may potentially be damaged. This will provide a reasonable basis for assessing any future claims of damage.

Based on the subsurface conditions observed in boreholes, bulk excavations on the subject site are expected to encounter topsoil, fill residual soils and weathered to fresh shale and sandstone bedrock. The bedrock was assessed to be extremely low strength becoming medium and high strength with depth. Based on the results of the point load index testing, the fresh sandstone has correlated Unconfined Compressive Strengths up to 50 MPa, with majority of the fresh bedrock having correlated Unconfined Compressive Strengths around 20-30 MPa.

Excavation of the soils and the upper extremely low strength shale and sandstone will be achievable using conventional excavation equipment, such as the buckets of hydraulic excavators. Excavators alone without assistance will not be able to remove any significant amount of the fresh sandstone bedrock. Hydraulic breakers mounted on an excavator or jack hammers will be required to break up the majority of the rock before it can be removed using an excavator.

During the use of hydraulic impact hammers, precautions must be made to reduce the risk of vibrational damage to adjoining structures. At the commencement of the use of hydraulic impact hammers we recommend that full time quantitative vibration monitoring be carried out on the adjoining residences or at the boundaries by an experienced vibration consultant or geotechnical engineer to check that vibrations are within acceptable limits.

Australian Standard AS 2187: Part 2-2006 recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2" as they "are applicable to Australian conditions". The standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where the minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration that are considered in the standard include demolition, blasting (carried out during mineral extraction or construction excavation), piling, ground treatments (e.g. compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery. For residential structures, BS 7385 recommends vibration criteria of 7.5 mm/s to 10 mm/s for frequencies between 4 Hz and 15 Hz, and 10 mm/s to 25 mm/s for frequencies between 15 Hz to 40 Hz and above. These values would normally be applicable for new residential structures or residential structures in good condition.

Higher values would normally apply to commercial structures, and more conservative criteria would normally apply to heritage structures. However, structures can withstand vibration levels significantly higher than those required to maintain comfort for their occupants. Human comfort is therefore likely to be the critical factor in vibration management.

Excavation methods should be adopted which limit ground vibrations at the adjoining developments to not more than 10mm/sec. Vibration monitoring is recommended to verify that this is achieved. The limits of 5mm/sec and 10mm/sec are expected to be achievable if rock breaker equipment or other excavation methods are restricted as indicated in Table 4.1.

Table 4.1 – Recommendations for rock breaking equipment

Distance from adjoining structure (m)	Maximum Peak Particle Velocity 5mm/sec		Maximum Peak Particle Velocity 10mm/sec	
	Equipment	Operating Limit (% of maximum capacity)	Equipment	Operating Limit (% of maximum capacity)
1.5 to 2.5	Hand operated hack hammer only	100	300 kg rock hammer	50
2.5 to 5.0	300 kg rock hammer	50	300 kg rock hammer	100
			600 kg rock hammer	50
5.0 to 1.00	300 kg rock hammer	100	600 kg rock hammer	100
	600 kg rock hammer	50	900 kg rock hammer	50

At all times, the excavation equipment must be operated by experienced personnel, per the manufacturer's instructions, and in a manner, consistent with minimising vibration effects.

If during excavation with the hydraulic impact hammers, vibrations are found to be excessive or there is concern, then alternative lower vibration emitting equipment, such as rock saws, rock grinders or smaller hammers may need to be used. The use of a rotary grinder or rock sawing in conjunction with ripping presents an alternative low vibration excavation technique, however, productivity is likely to be slower. When using a rock saw or rotary grinder, the resulting dust must be suppressed by spraying with water.

It is pointed out that the rock classification system used in Table 3.2 is intended primarily for use in the design of foundations, and is not intended to be used to directly assess rock excavation characteristics.

Excavation contractors should refer to the detailed engineering logs and where available, core photographs, laboratory strength tests, and inspection of rock core samples, and should not rely solely on the rock classifications presented in geotechnical engineering reports when assessing the suitability of their excavation equipment for the proposed development. Further geotechnical advice must be sought if rock excavation characteristics are critical to the proposed development.

It should be noted that vibrations that are below threshold levels for building damage may be experienced at adjoining developments. Rock excavation methodology should also consider acceptable noise limits as per the “Interim Construction Noise Guideline” (NSW EPA).

The excavated material will also need to be classified for disposal purposes, which will require environmental testing of the various materials.

4.5 Groundwater Considerations

Groundwater or significant seepage was not observed during drilling of the boreholes. Some groundwater seepage may be expected following rainfall within defects of the underlying bedrock (such as jointing, and bedding planes, etc.) and along the soil/rock interface, however an unconfined groundwater aquifer is not expected to be encountered.

Due to the low permeability of the bedrock profile any groundwater inflows into the excavation should not have an adverse impact on the proposed development or on the neighbouring sites and should be manageable. The initial flows into the excavation may be locally high but would be expected to decrease considerably with time as the bedding seams/joints are drained. We recommend that monitoring of seepage be implemented during the excavation works to confirm the capacity of the drainage system.

We expect that any seepage that does occur will be able to be controlled by a conventional sump and pump system. We recommend that a sump-and-pump system be used both during construction and for permanent groundwater control below the basement floor slab.

In the long term, drainage should be provided behind all basement retaining walls, around the perimeter of the basement and below the basement slab. The completed excavation should be inspected by the hydraulic engineer to confirm that adequate drainage has been allowed for. Drainage should be connected to the sump-and-pump system and discharging into the stormwater system. The permanent groundwater control system should take into account any possible soluble substances in the groundwater which may dictate whether or not groundwater can be pumped into the stormwater system.

Pump-out tests within the installed monitoring wells are recommended to estimate the permeability of the bedrock and the rate of water seepage expected into the excavation.

The design of drainage and pump systems should take the above issues into account along with careful ongoing inspections and maintenance programs.

4.6 Excavation Retention & Support Design

From a geotechnical perspective, it is critical to maintain the stability of all adjacent structures and infrastructures during demolition, excavation and construction works.

Give the likely depth of any proposed excavations, unsupported vertical cuts of the soil are not recommended for this site as these carry the risk of potential slumping especially after a period of wet weather. Slumping of the material may result in injury to personnel and/or damage to nearby structures/infrastructures and equipment.

A suitable retention system will be required for the support of the soil and weathered bedrock within the excavation. For this site, we consider that an anchored and/or propped soldier pile wall with mass concrete in between the piles to be the most suitable. Anchors/props and mass concrete must be installed progressively as excavation proceeds. The piles should be founded in shale bedrock.

The existence of significant horizontal in-situ stresses in bedrock, particularly in the Sydney basin, is well established. The release of such stresses during the basement excavation may cause adverse impact on the stability of the excavation faces and thus increase the movements. Monitoring of several deep excavations within sandstone and shale in the Sydney region indicates that the lateral displacement at the top of the excavation is generally between 0.5mm to 2mm per meter depth of excavation, and therefore monitoring of the lateral movement as the excavation progresses is recommended.

Bored piles are considered to be the most suitable for this site. However, relatively large capacity piling rigs will be required for drilling through the shale and sandstone bedrock. The proposed pile locations should take into account the presence of buried services. Further advice should be sought from prospective piling contractors who should be provided with a copy of this report.

When considering the design of the support system, it will be necessary to allow for the loading from structures in adjoining properties, any ground surface slope and the water table present.

For the design of temporary structures where some ground movement is acceptable, an active earth pressure coefficient (K_a) may be adopted. However, where adjoining structures are within the zone of influence of the excavation, or it is necessary to limit lateral deflections, it will be necessary to adopt at rest (K_o) conditions. K_o conditions should also be used to design the permanent support system.

A triangular lateral earth pressure distribution should be adopted for cantilevered walls, and a rectangular or trapezoidal lateral earth pressure distribution should be adopted for walls that are progressively propped at their top and base, and/or where two or more rows of anchors are used. A triangular earth pressure distribution should be adopted when determining the load on shotcrete infill panels.

As previously discussed, anchors or internal props can also be considered. Where anchors are used and they extend into the adjoining property, it will be necessary to obtain the permission of the property owners.

Anchor designs should be based on bonding to be developed behind an 'active zone' determined by drawing a line from the base of the retained height at 45° from horizontal.

Anchors should be proof loaded as follows:

- 1.5 times working load for permanent anchors;
- 1.3 times working load for temporary anchors.

Anchors should be installed into the weathered rock.

Retaining walls may be designed using the parameters provided below in Table 4.2.

TABLE 4.2 – Retaining Wall Design Parameters

Material Unit	Bulk Unit Weight (kN/m³)	Effective Cohesion C' (kPa)	Effective Angle of Friction, ϕ (Deg)	Poisson's Ratio	Elastic Modulus E' (MPa)	Earth Pressure Co-efficients			Allowable Bond Stress for Anchors (kPa)
						At Rest (K_o)	Active (K_a)	Allowable Toe Resistance (kPa)	
1	18	0	24	0.3	8	0.6	0.4	-	-
2	19	2	27	0.3	25	0.55	0.36	-	-
3	21	30	28	0.25	80	0.53	0.36	70	35
4	22	50	31	0.25	150	0.47	0.31	150	70
5	23	100	34	0.20	350	0.44	0.28	350	250

The embedment of retaining walls can be used to achieve passive support. A triangular passive earth pressure distribution (increasing linearly with depth) may be assumed, starting from 0.5 m below excavation toe/base level.

4.7 Drainage and Basement Floor Slab Construction

Following bulk excavations for the proposed basement, a combination of shale/sandstone bedrock and very stiff residual clays are expected to be exposed at the basement floor BEL.

Following the removal of all loose and softened materials, we recommend that underfloor drainage be provided and should comprise a strong, durable, single sized washed aggregate such as 'blue metal gravel'. Joints in the concrete floor slab should be designed to accommodate shear forces but not bending moments by using dowelled and keyed joints. The basement floor slab should be isolated from columns. The completed excavation should be inspected by the hydraulic engineer to confirm the extent of the drainage required.

In addition, a system of sub-soil drains comprising a durable single sized aggregate with perforated drains/pipes leading to sumps should be provided. The basement floor slab should be isolated from columns.

Permission may need to be obtained from the NSW Department of Primary Industries (DPI) and possibly Council for any permanent discharge of seepage into the drainage system. Given the subsurface conditions, we expect that seepage volumes would be low and within the DPI limits. However, if permission for discharge is not obtained, the basement may need to be designed as a tanked basement.

4.8 Foundation Design

On completion of bulk excavation, stiff to very stiff residual clays or sandstone bedrock will be encountered over the northern portion of the site where excavation depths are expected to be limited, and a combination of shale and sandstone bedrock will likely be encountered over the southern and central sections of the site, depending on the final excavation depths.

To limit risks associated with differential settlement we recommend that the proposed building be uniformly supported on footings founded in the underlying bedrock.

Foundation design parameters for the various units are provided in Table 4.3 below:

TABLE 4.3 – Foundation Design Parameters

(Unit) Material	Maximum Allowable (Working Stress) Values (kPa)			Ultimate Strength Limit State Values (kPa)		
	End Bearing Pressure	Shaft Friction in compression#	Shaft Friction in tension*	End Bearing Pressure	Shaft Friction in compression#	Shaft Friction in tension*
(1) Fill and Topsoil	-	-	-	-	-	-
(2) Residual Claysy	150	20	10	450	60	30
(3) Class 5 Shale and Sandstone	700	70	35	3,000	100	50
(4) Class 4 Shale and Sandstone	1000	100	50	4,500	150	75
(5) Class 3 & 2 Sandstone	3500	350	175	10,000	600	300

Note: Parameters for Class 3 shale bedrock are provided for bored piles only – these should not be used for CFA piles.

* Uplift capacity of piles in tension loading should also be checked for inverted cone pull out mechanism.

clean socket of roughness category R2 or better is assumed

In accordance with AS2159-2009 "Piling–Design and Installation", for limit state design, the ultimate geotechnical pile capacity shall be multiplied by a geotechnical reduction factor (Φg). This factor is derived from an Average Risk Rating (ARR) which considers geotechnical uncertainties, redundancy of the foundation system, construction supervision, and the quantity and type of pile testing (if any). Where testing is undertaken, or more comprehensive ground investigation is carried out, it may be possible to adopt a larger Φ_g value that results in a more economical pile design. Further geotechnical advice will be required in consultation with the pile designer and piling contractor, to develop an appropriate Φ_g value.

Settlements for footings on rock are anticipated to be about 1% of the minimum footing dimension, based on serviceability parameters as per Table 4.3. Settlements for pad footings in clayey soils are anticipated to be up to about 15mm where loading does not exceed the maximum allowable values.

All shallow footings should be poured with minimal delay (i.e. preferably on the same day of excavation) or the base of the footing should be protected by a concrete blinding layer after cleaning of loose spoil and inspection.

Drilling of rock sockets into the low to medium strength or better sandstone will require the use of large piling rigs equipped with rock augers. Some limited groundwater inflow should be anticipated into the bored pile excavations. We expect any minor seepage to be controllable by conventional pumping methods. However, some contingency for pouring concrete by tremie methods should be allowed.

Bored pile footings should be drilled, cleaned, inspected and poured with minimal delay, on the same day. Water should be prevented from ponding in the base of footings as this will tend to soften the foundation material, resulting in further excavation and cleaning being required.

The initial stages of footing excavation/drilling should be inspected by a geotechnical engineer/engineering geologist to ascertain that the recommended foundation material has been reached and to check initial assumptions about foundation conditions and possible variations that may occur between borehole locations. The need for further inspections can be assessed following the initial visit.

4.9 Exposure Classification to AS2870 & AS2159

The aggressiveness or erosion potential of an environment in building materials, particularly concrete and steel is dependent on the levels of soil pH and the types of salts present, generally sulphates and chlorides. In order to determine the degree of aggressiveness, the test values obtained are compared to Tables 6.4.2 (C) and 6.5.2 (C) in AS2159 – 2009 Piling – Design and Installation and Tables 5.1 and 5.2 of AS2870-2011. In regard to the electrical conductivity, the laboratory test results have been multiplied by the appropriate factor to convert the results to EC_e.

The soils on the site consist of low permeability clays and shale/sandstone bedrock above a regional groundwater table. Therefore, the soil conditions B are considered appropriate. The test results are summarised in Table 4.4 below.

Table 4.4 – Exposure Classification Summary Table

Sample ID	Location	Depth (m)	pH	EC_e (dS/m)	Sulfate (ppm)	Chloride (ppm)	Exposure Classification AS2159		Exposure Classification AS2870
							Steel Piles	Concrete Piles	
S1	BH3	0.6	5.7	0.3	30	20	Non Aggressive	Non Aggressive	A1
S2	BH3	1.3	4.8	0.5	60	20	Non Aggressive	Mild	A2
S3	BH5	1.1	5.7	0.9	90	130	Non Aggressive	Non Aggressive	A1
S4	BH5	3.1	4.9	1.9	130	350	Non Aggressive	Mild	A2

5. FURTHER GEOTECHNICAL INPUT

The following summarises the scope of further geotechnical work recommended within this report. For specific details reference should be made to the relevant sections of this report.

- Complete dilapidation surveys of the adjoining buildings and structures.
- Inspection of shoring piles during installation,
- Regular routine inspections of excavation faces during bulk excavation,

- Inspection of footing excavations to ascertain that the recommended foundation has been reached and to check initial assumptions regarding foundation conditions and possible variations that may occur.

- We also recommend that Green Geotechnics view the proposed earthworks and structural drawings in order to confirm they are within the guidelines of this report.

Nevertheless, it will be essential during excavation and construction works that progressive geotechnical inspections be commissioned to check initial assumptions about excavation and foundation conditions and possible variations that may occur between inspected and tested locations and to provide further relevant geotechnical advice.

6. GENERAL RECOMMENDATIONS

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. In the event that any of the construction phase recommendations presented in this report are not implemented, the general recommendations may become inapplicable and Green Geotechnics accept no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

Occasionally, the subsurface conditions may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. If there is any change in the proposed development described in this report then all recommendations should be reviewed. Copyright in this report is the property of Green Geotechnics. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.

REPORT INFORMATION

Introduction

These notes have been provided to amplify Green Geotechnics report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

Green Geotechnics reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several limitations, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. The borehole must be flushed, and any water must be extracted from the hole if further water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, Green Geotechnics will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, Green Geotechnics cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, Green Geotechnics will be pleased to assist with investigations or advice to resolve the matter.

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, Green Geotechnics requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Copyright

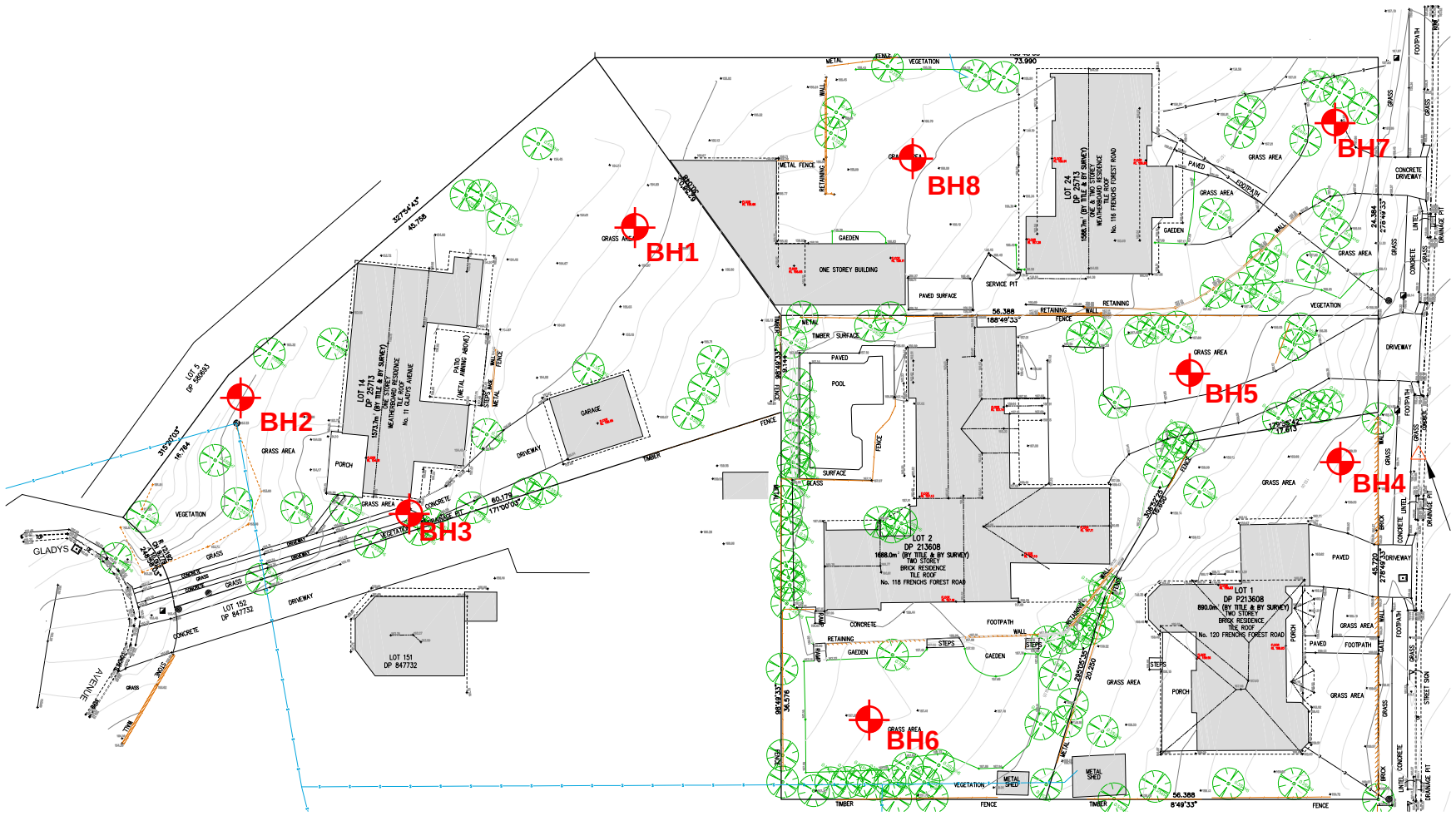
FIGURES

GREEN GEOTECHNICS	Project No: GG11138.001	Geotechnical Investigation 116-120 Frenchs Forest Road, Frenchs Forest **SITE LOCATION PLAN**	Figure No: GG11138.001A
	Client: Young Assets Holdings PTY LTD		Drawn By: MG
	Date: 21 March 2024		Scale: Unknown

Legend:

= Borehole = DCP

= Test Pit



GREEN GEOTECHNICS	Project No: GG11138.001	Geotechnical Investigation 116-120 Frenchs Forest Road, Frenchs Forest **TEST LOCATION PLAN**	Figure No: GG11138.001B
	Client: Young Assets Holdings PTY LTD		Drawn By: MG
	Date: 21 March 2024		Scale: Unknown

Position of BH1

Position of BH2

GREEN GEOTECHNICS	Project No: GG11138.001	Geotechnical Investigation 116-120 Frenchs Forest Road, Frenchs Forest **SITE PHOTOGRAPHS**	Page: 1 of 4
	Client: Young Assets Holdings PTY LTD		
	Date: 21 March 2024		

Position of BH3

Position of BH4

GREEN GEOTECHNICS	Project No: GG11138.001	Geotechnical Investigation 116-120 Frenchs Forest Road, Frenchs Forest **SITE PHOTOGRAPHS**	Page: 2 of 4
	Client: Young Assets Holdings PTY LTD		
	Date: 21 March 2024		

Position of BH5

Position of BH6

GREEN GEOTECHNICS	Project No: GG11138.001	Geotechnical Investigation 116-120 Frenchs Forest Road, Frenchs Forest **SITE PHOTOGRAPHS**	Page: 3 of 4
	Client: Young Assets Holdings PTY LTD		
	Date: 21 March 2024		

Position of BH7

Position of BH8

GREEN GEOTECHNICS	Project No: GG11138.001	Geotechnical Investigation 116-120 Frenchs Forest Road, Frenchs Forest **SITE PHOTOGRAPHS**	Page: 4 of 4
	Client: Young Assets Holdings PTY LTD		
	Date: 21 March 2024		

APPENDIX A – BOREHOLE LOGS , CORE PHOTOS AND POINT LOAD TEST RESULTS

GREEN GEOTECHNICS

Borehole No.
BH1
Page 1 of 3

Engineering Log - Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	27/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	27/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	MG
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	154.80 m		
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:	AF

Drilling Information							***Soil Description***			***Observations***
Method	Support	Penetration	Groundwater Levels	Samples & Field Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	Structure and Additional Observations
AD/T						153.8	1		CI	TOPSOIL Sandy Silty CLAY: medium plasticity, brown, trace of gravel; with rootlets. 0.30m	M		TOPSOIL
									CI /CH	Gravelly Silty CLAY: medium to high plasticity, pale brown to orange brown, with ironstone gravel. 1.20m	M	F to St	RESIDUAL SOIL
				1.50m SPT 25/100mm N=R 1.60m		152.8	2			SANDSTONE: fine to medium grained, red brown to orange brown, iron indurated, estimated highly weathered, very low to low strength (Class 5). 1.80m	D to M		ROCK
				3.00m SPT 25/120mm N=R 3.12m		151.8	3			SANDSTONE: red brown to orange brown, estimated extremely weathered, very low to low strength (Class 4). 3.30m	D		
						150.8	4			SANDSTONE: pale red to grey orange, estmated moderately weathered, low to medium strength (Class 4). 4.20m	D		
						149.8	5			Continued on cored borehole sheet			

Method
AS - Auger Screwing
ADV Auger V Bit
ADT Auger Tungsten Carbide Bit
RR - Rock Roller
WB- Washbore

Support
C - Casing

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
PP - Pocket Penetrometer

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet
w - Moisture Content
PL - Plastic Limit
LL - Liquid Limit

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
Fr - Friable
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Engineering Log - Cored Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	27/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	27/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	MG
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	154.80 m
Barrel Type and Length:	Stepped Face 3 m	Bearing:		Datum:	AHD Operator: AF

Drilling Information							***Rock Substance***			***Rock Mass Defects***	
Method	Support	Water	TCR (%)	RQD (%)	RL (m)	Depth (m)	Graphic Log	Material Description rock type: grain characteristics, colour, structure, minor components	Weathering	Strength UCS=$I_{(50)}$ ● - Axial ○ - Diametral ■ - UCS VL L M H VH EH	Average Defect Spacing (mm) 10 30 100 300 1000	Defect Description thickness, type, inclination, planarity, roughness, coating/infilling
					153.8	1						
					152.8	2						
					151.8	3						
					150.8	4		4.20m Continued from non-cored borehole sheet				
NMLC		80% Return	100	100	149.8	5		SANDSTONE: fine to medium grained, red brown.	SW			DB DB DB DB
			100	98				5.84m 6.00m SANDSTONE: fine to medium grained, pale grey	FR			EW, =10 mm

Method
AS - Auger Screwing
WB - Washbore
HQ3 - HQ3 Core Barrel
NQ3 - NQ3 Core Barrel
NMLC - NMLC Core Barrel

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Support
T - Timbering

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Weathering
FR - Fresh
SW - Slightly Weathered
MW - Moderately Weathered
DW - Distinctly Weathered
HW - Highly Weathered
XW - Extremely Weathered
RS - Residual Soil

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Engineering Log - Cored Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	27/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	27/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	MG
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	154.80 m
Barrel Type and Length:	Stepped Face 3 m	Bearing:		Datum:	AHD Operator: AF

Drilling Information							Rock Substance				Rock Mass Defects	
Method	Support	Water	TCR (%)	RQD (%)	RL (m)	Depth (m)	Graphic Log	Material Description rock type: grain characteristics, colour, structure, minor components	Weathering	Strength UCS=$I_{(50)}$ ● - Axial ○ - Diametral ■ - UCS VL L M H VH EH	Average Defect Spacing (mm) 10 30 100 300 1000	Defect Description thickness, type, inclination, planarity, roughness, coating/infilling
NMLC		80% Return	100	98	147.8	7		with dark grey, bedding at 0-15°. SANDSTONE: fine to medium grained, pale grey with grey, bedding at 0-15°.	FR			HB EW, =5 mm IS, clay, =20 mm IS, clay, =10 mm HB DB HB P, 10°
			100	100	146.8	8		8.70m				
					145.8	9		Hole Terminated at 8.70 m Target depth				
					144.8	10						
					143.8	11						

Method
AS - Auger Screwing
WB - Washbore
HQ3 - HQ3 Core Barrel
NQ3 - NQ3 Core Barrel
NMLC - NMLC Core Barrel

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Support
T - Timbering

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Weathering
FR - Fresh
SW - Slightly Weathered
MW - Moderately Weathered
DW - Distinctly Weathered
HW - Highly Weathered
XW - Extremely Weathered
RS - Residual Soil

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

GREEN GEOTECHNICS	Project No: GG11138	Geotechnical Investigation 116-120 Frenchs Forest Road, Frenchs Forest **CORE PHOTO - BH1**	Box : 1 of 1
	Client: Young Assets Holdings PTY LTD		
	Date Cored: 27/07/2023		

GREEN GEOTECHNICS

Borehole No.
BH2
Page 1 of 3

Engineering Log - Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	27/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	27/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	MG
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	153.10 m		
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:	AF

Drilling Information								***Soil Description***			***Observations***
Method	Support	Penetration	Groundwater Levels	Samples & Field Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	Structure and Additional Observations
AD/T			4/8/2023	1.50m SPT 14,25,22/50mm N=R 1.85m		152.1	1		CL	FILL / TOPSOIL Silty Sandy CLAY: low plasticity, dark brown to grey brown, trace of gravel. 0.40m	D to M		FILL / TOPSOIL
									CI	Sandy Silty CLAY: medium plasticity, red brown to pale grey, with ironstone gravel bands and lenses of sandstone. 1.80m	D to M	St to VSt VSt	RESIDUAL SOIL
						151.1	2			SANDSTONE: red brown to grey brown, estimated highly weathered to extremely weathered, very low to low strength (Class 5). 2.60m	D		ROCK
										Continued on cored borehole sheet			
						150.1	3						
						149.1	4						
						148.1	5						

Method
AS - Auger Screwing
ADV Auger V Bit
ADT Auger Tungsten Carbide Bit
RR - Rock Roller
WB- Washbore

Support
C - Casing

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
PP - Pocket Penetrometer

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet
w - Moisture Content
PL - Plastic Limit
LL - Liquid Limit

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
Fr - Friable
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Engineering Log - Cored Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	27/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	27/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	MG
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	153.10 m	
Barrel Type and Length:	Stepped Face 3 m	Bearing:		Datum:	AHD	Operator: AF

Drilling Information							Rock Substance				Rock Mass Defects	
Method	Support	Water	TCR (%)	RQD (%)	RL (m)	Depth (m)	Graphic Log	Material Description rock type: grain characteristics, colour, structure, minor components	Weathering	Strength UCS=$I_{(50)}$ ● - Axial ○ - Diametral ■ - UCS (VL L M H VH EH)	Average Defect Spacing (mm) (10 30 100 300 1000)	Defect Description thickness, type, inclination, planarity, roughness, coating/infilling
					152.1	1						
					151.1	2						
						2.60m		Continued from non-cored borehole sheet				
NMLC		100% Return	89	94	150.1	3		SANDSTONE: fine to medium grained, red to brown purple, bedded at 20°.	SW			EW, =10 mm IS, clay, =10 mm IS, clay, =10 mm DB P, 20°
						3.05m		SANDSTONE: pale grey with grey, bedding at 0-15°. Occasional ironstone stain from 5.40m to 5.60m.				
					149.1	4						DB DB HB DB EW, =5 mm
			100	100	148.1	5			FR			DB EW, <5 mm EW, =15 mm EW, <5 mm EW, <5 mm

Method
AS - Auger Screwing
WB - Washbore
HQ3 - HQ3 Core Barrel
NQ3 - NQ3 Core Barrel
NMLC - NMLC Core Barrel

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Support
T - Timbering

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Weathering
FR - Fresh
SW - Slightly Weathered
MW - Moderately Weathered
DW - Distinctly Weathered
HW - Highly Weathered
XW - Extremely Weathered
RS - Residual Soil

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Engineering Log - Cored Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	27/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	27/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	MG
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	153.10 m		
Barrel Type and Length:	Stepped Face 3 m	Bearing:		Datum:	AHD	Operator:	AF

Drilling Information							***Rock Substance***			***Rock Mass Defects***	
Method	Support	Water	TCR (%)	RQD (%)	RL (m)	Depth (m)	Graphic Log	Material Description rock type: grain characteristics, colour, structure, minor components	Weathering	Strength UCS=$I_{(50)}$ ● - Axial ○ - Diametral ■ - UCS (VL L M H VH EH)	Average Defect Spacing (mm) (10 30 100 300 1000)	Defect Description thickness, type, inclination, planarity, roughness, coating/infilling
NMLC		100% Return	100	100	146.1	7		SANDSTONE: pale grey with grey, bedding at 0-15°. Occasional ironstone stain from 5.40m to 5.60m.*(continued)*	FR	H		DB EW, <5 mm EW, <5 mm
							7.50m					
					145.1	8		Hole Terminated at 7.50 m Target depth				
					144.1	9						
					143.1	10						
					142.1	11						

Method
AS - Auger Screwing
WB - Washbore
HQ3 - HQ3 Core Barrel
NQ3 - NQ3 Core Barrel
NMLC - NMLC Core Barrel

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Support
T - Timbering

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Weathering
FR - Fresh
SW - Slightly Weathered
MW - Moderately Weathered
DW - Distinctly Weathered
HW - Highly Weathered
XW - Extremely Weathered
RS - Residual Soil

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

GREEN GEOTECHNICS	Project No: GG11138	Geotechnical Investigation 116-120 Frenchs Forest Road, Frenchs Forest **CORE PHOTO - BH2**	Box : 1 of 1
	Client: Young Assets Holdings PTY LTD		
	Date Cored: 27/07/2023		

GREEN GEOTECHNICS

Borehole No.
BH3
Page 1 of 1

Engineering Log - Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	28/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	28/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie Utility	Inclination:	-90°	RL Surface:	154.60 m		
Hole Diameter:	105 mm	Bearing:		Datum:	AHD	Operator:	JK

Drilling Information								Soil Description				Observations
Method	Support	Penetration	Groundwater Levels	Samples & Field Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	Structure and Additional Observations
AD/T						153.6	1		CL	TOPSOIL Silty CLAY: low plasticity, dark brown.	D		TOPSOIL
				0.50m D-S1 0.60m						0.30m			
									CI /CH	Silty Sandy CLAY: medium to high plasticity, yellow brown with pale grey and orange brown, trace of sandstone/ ironstone gravel.	D	F to St	RESIDUAL SOIL
										0.81m			
									CI /CH	Silty CLAY: medium to high plasticity, pale grey with orange brown and red brown, trace of sandstone/ ironstone geotextile.	D	VSt	
				1.20m D-S2 1.30m						1.70m			
										SANDSTONE: fine to medium grained, pale grey with orange brown and red brown. estimate very low to low strength (Class 5).	D		ROCK
										1.90m			
						152.6	2			Hole Terminated at 1.90 m Refusal on weathered sandstone (Class 4)			
						151.6	3						
						150.6	4						
						149.6	5						

Method
AS - Auger Screwing
ADV Auger V Bit
ADT Auger Tungsten Carbide Bit
RR - Rock Roller
WB- Washbore

Support
C - Casing

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
PP - Pocket Penetrometer

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet
w - Moisture Content
PL - Plastic Limit
LL - Liquid Limit

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
Fr - Friable
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

GREEN GEOTECHNICS

Borehole No.
BH4
Page 1 of 3

Engineering Log - Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	28/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	28/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	159.20 m		
Hole Diameter:	105 mm	Bearing:		Datum:	AHD	Operator:	AF

Drilling Information							***Soil Description***				***Observations***
Method	Support	Penetration	Groundwater Levels	Samples & Field Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	Structure and Additional Observations
AD/T						158.2	1		CL	FILL Silty CLAY: low plasticity, dark brown, trace of fine grained sand; with a trace of gravel / brick.	D to M		FILL
										0.50m			
									CI /CH	Silty CLAY: medium to high plasticity, pale grey with orange brown.	D to M	St	RESIDUAL SOIL
										1.10m			
										SHALE: dark grey with pale grey, with clay seams. estimate very low to low strength (Class 5).	D		ROCK
										1.80m			
										Continued on cored borehole sheet			
						157.2	2						
						156.2	3						
						155.2	4						
						154.2	5						

Method
AS - Auger Screwing
ADV Auger V Bit
ADT Auger Tungsten Carbide Bit
RR - Rock Roller
WB- Washbore

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
PP - Pocket Penetrometer

Moisture Condition
D - Dry
M - Moist
W - Wet
w - Moisture Content
PL - Plastic Limit
LL - Liquid Limit

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
Fr - Friable
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Support
C - Casing

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Engineering Log - Cored Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	28/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	28/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	159.20 m	
Barrel Type and Length:	Stepped Face 3 m	Bearing:		Datum:	AHD	Operator: AF

Drilling Information							Rock Substance				Rock Mass Defects	
Method	Support	Water	TCR (%)	RQD (%)	RL (m)	Depth (m)	Graphic Log	Material Description rock type: grain characteristics, colour, structure, minor components	Weathering	Strength UCS=$I_{(50)}$ ● - Axial ○ - Diametral ■ - UCS VL L M H VH EH	Average Defect Spacing (mm) 10 30 100 300 1000	Defect Description thickness, type, inclination, planarity, roughness, coating/infilling
NMLC		100% Return			158.2	1						
								1.80m Continued from non-cored borehole sheet				
			62.5	0	157.2	2		NO CORE 0.45m (1.80-2.25)				
								2.25m SHALE: dark grey with pale grey.	XW			EW ROCK
					156.2	3		3.00m NO CORE 1.42m (3.00-4.42)				
					155.2	4		4.42m SHALE: pale grey with dark grey.				
			52	0	154.2	5			XW			EW ROCK

Method
AS - Auger Screwing
WB - Washbore
HQ3 - HQ3 Core Barrel
NQ3 - NQ3 Core Barrel
NMLC - NMLC Core Barrel

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Support
T - Timbering

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Weathering
FR - Fresh
SW - Slightly Weathered
MW - Moderately Weathered
DW - Distinctly Weathered
HW - Highly Weathered
XW - Extremely Weathered
RS - Residual Soil

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Engineering Log - Cored Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	28/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	28/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	159.20 m	
Barrel Type and Length:	Stepped Face 3 m	Bearing:		Datum:	AHD	Operator: AF

Drilling Information | ***Rock Substance*** | ***Rock Mass Defects***

Method	Support	Water	TCR (%)	RQD (%)	RL (m)	Depth (m)	Graphic Log	Material Description rock type: grain characteristics, colour, structure, minor components	Weathering	Strength UCS=·$I_{(50)}$ ● - Axial ○ - Diametral ■ - UCS VL L M H VH EH	Average Defect Spacing (mm) 10 30 100 300 1000	Defect Description thickness, type, inclination, planarity, roughness, coating/infilling
NMLC		100% Return	86	58	152.2	7		6.10m NO CORE 0.42m (6.10-6.52) 6.52m SHALE: dark grey with pale grey.	XW HW			EW, =80 mm P, 5° HB HB EW, =10 mm EW, =110 mm DB
					151.2	8		8.18m SANDSTONE: fine to medium grained, pale grey. 8.61m SHALE: dark grey with pale grey.	FR to SW HW			HB HB P, 0° EW, =10 mm P, 0° DB DB DB DB DB J, 70°, SN, PR, RF DB DB P, 0° P, 15° HB
					150.2	9		9.00m Hole Terminated at 9.00 m Target depth				
					149.2	10						
					148.2	11						

Method
AS - Auger Screwing
WB - Washbore
HQ3 - HQ3 Core Barrel
NQ3 - NQ3 Core Barrel
NMLC - NMLC Core Barrel

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Support
T - Timbering

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Weathering
FR - Fresh
SW - Slightly Weathered
MW - Moderately Weathered
DW - Distinctly Weathered
HW - Highly Weathered
XW - Extremely Weathered
RS - Residual Soil

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

GREEN GEOTECHNICS	Project No: GG11138	Geotechnical Investigation 116-120 Frenchs Forest Road, Frenchs Forest **CORE PHOTO - BH4**	Box : 1 of 1
	Client: Young Assets Holdings PTY LTD		
	Date Cored: 28/07/2023		

GREEN GEOTECHNICS

Borehole No.
BH5
Page 1 of 2

Engineering Log - Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	28/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	28/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie Utility	Inclination:	-90°	RL Surface:	157.60 m		
Hole Diameter:	105 mm	Bearing:		Datum:	AHD	Operator:	JK

Drilling Information								Soil Description				Observations
Method	Support	Penetration	Groundwater Levels	Samples & Field Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	Structure and Additional Observations
AD/T			4/8/2023 3.00m	1.00m D-S3 1.10m 3.00m D-S4 3.10m		156.6 155.6 154.6 153.6 152.6	1 2 3 4 5		CL	FILL Silty Sandy CLAY: low plasticity, dark brown, trace of gravel. 0.20m	D		FILL
									CI /CH	Silty CLAY: medium to high plasticity, pale grey with orange brown.	D to M	F to St St to VSt	
										1.60m SHALE: dark grey with pale grey, with clay seams. estimate very low strength (Class 5).	D M to D		ROCK

Method
AS - Auger Screwing
ADV Auger V Bit
ADT Auger Tungsten Carbide Bit
RR - Rock Roller
WB- Washbore

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
PP - Pocket Penetrometer

Moisture Condition
D - Dry
M - Moist
W - Wet
w - Moisture Content
PL - Plastic Limit
LL - Liquid Limit

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
Fr - Friable
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Support
C - Casing

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Engineering Log - Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	28/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	28/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie Utility	Inclination:	-90°	RL Surface:	157.60 m		
Hole Diameter:	105 mm	Bearing:		Datum:	AHD	Operator:	JK

Drilling Information								Soil Description				Observations
Method	Support	Penetration	Groundwater Levels	Samples & Field Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	Structure and Additional Observations
AD/T						150.6	7			SHALE: dark grey with pale grey, with clay seams. estimate very low strength (Class 5).*(continued)*	M		ROCK
										7.20m	W		
						149.6	8			SANDSTONE: fine to medium grained, pale grey with dark grey. estimate low to medium strength (Class 4).	D		
										8.40m			
						148.6	9			Hole Terminated at 8.40 m Refusal on weathered sandstone (Class 4)			
						147.6	10						
						146.6	11						

Method
AS - Auger Screwing
ADV Auger V Bit
ADT Auger Tungsten Carbide Bit
RR - Rock Roller
WB- Washbore

Support
C - Casing

Penetration
No resistance ranging to refusal

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
PP - Pocket Penetrometer

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet
w - Moisture Content
PL - Plastic Limit
LL - Liquid Limit

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
Fr - Friable
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

GREEN GEOTECHNICS

Borehole No.
BH6
Page 1 of 1

Engineering Log - Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	28/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	28/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Hand Auger	Inclination:	-90°	RL Surface:	157.30 m		
Hole Diameter:	65 mm	Bearing:		Datum:	AHD	Operator:	JK

Drilling Information								Soil Description				Observations
Method	Support	Penetration	Groundwater Levels	Samples & Field Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	Structure and Additional Observations
HA									CL	TOPSOIL Silty CLAY: low plasticity, dark brown.	D		TOPSOIL
										0.30m			
									CI /CH	Silty CLAY: high plasticity, pale grey with orange brown.	M	St to VSt	RESIDUAL SOIL
										0.80m	D to M		
										Hole Terminated at 0.80 m Refusal on silty clay			
						156.3	1						
						155.3	2						
						154.3	3						
						153.3	4						
						152.3	5						

Method
AS - Auger Screwing
ADV Auger V Bit
ADT Auger Tungsten Carbide Bit
RR - Rock Roller
WB- Washbore

Support
C - Casing

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
PP - Pocket Penetrometer

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet
w - Moisture Content
PL - Plastic Limit
LL - Liquid Limit

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
Fr - Friable
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

GREEN GEOTECHNICS

Borehole No.
BH7
Page 1 of 3

Engineering Log - Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	28/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	28/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	157.50 m		
Hole Diameter:	105 mm	Bearing:		Datum:	AHD	Operator:	AF

Drilling Information								Soil Description				Observations
Method	Support	Penetration	Groundwater Levels	Samples & Field Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	Structure and Additional Observations
AD/T						156.5	1			0.11m CONCRETE: 110mm Thick.			
									CI	Silty CLAY: medium plasticity, dark brown and orange brown.	D		RESIDUAL SOIL
										0.60m			
									CL	Silty CLAY: low plasticity, pale grey with orange brown, trace of shale/ gravel.	D		
										1.20m			
						155.5	2			SHALE: pale grey with dark grey, with clay seams. At 4.20m, becoming dark grey. estimate very low strength (Class 5).			ROCK
						154.5	3				D		
						153.5	4						
						152.5	5				M to D		

Method
AS - Auger Screwing
ADV Auger V Bit
ADT Auger Tungsten Carbide Bit
RR - Rock Roller
WB- Washbore

Support
C - Casing

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
PP - Pocket Penetrometer

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet
w - Moisture Content
PL - Plastic Limit
LL - Liquid Limit

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
Fr - Friable
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Engineering Log - Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	28/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	28/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	157.50 m
Hole Diameter:	105 mm	Bearing:		Datum:	AHD

Operator: AF

Drilling Information									Soil Description			Observations
Method	Support	Penetration	Groundwater Levels	Samples & Field Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	Structure and Additional Observations
AD/T						150.5	7			SHALE: pale grey with dark grey, with clay seams. At 4.20m, becoming dark grey. estimate very low strength (Class 5). *(continued)*	M		ROCK
						149.5	8			7.50m SHALE: dark grey. estimate low to medium strength (Class 4). 8.40m			
						148.5	9			Continued on cored borehole sheet			
						147.5	10						
						146.5	11						

Method
AS - Auger Screwing
ADV Auger V Bit
ADT Auger Tungsten Carbide Bit
RR - Rock Roller
WB- Washbore

Support
C - Casing

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
PP - Pocket Penetrometer

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet
w - Moisture Content
PL - Plastic Limit
LL - Liquid Limit

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
Fr - Friable
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Engineering Log - Cored Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	28/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	28/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	157.50 m
Barrel Type and Length:		Bearing:		Datum: AHD	Operator: AF

Drilling Information							Rock Substance				Rock Mass Defects	
Method	Support	Water	TCR (%)	RQD (%)	RL (m)	Depth (m)	Graphic Log	Material Description rock type: grain characteristics, colour, structure, minor components	Weathering	Strength UCS=$I_{(50)}$ ● - Axial ○ - Diametral ■ - UCS VL L M H VH EH	Average Defect Spacing (mm) 10 30 100 300 1000	Defect Description thickness, type, inclination, planarity, roughness, coating/infilling
					150.5	7						
					149.5	8						
								8.40m Continued from non-cored borehole sheet				
NMLC		100% Return	100	87	148.5	9		SANDSTONE: fine to medium grained, pale grey with occasional dark grey bands.	FR			P, 0°, PR, RF P, 0°, PR, RF J, 40°, IR, RF P, 10°, PR, SM P, 0°, PR, RF P, 5°, PR, RF P, 10°, PR, SM P, 10°, PR, SM J, 80°, PR, RF P, 0°, PR, SM HB P, 5°, PR, RF P, 0°, RF clay, SM P, 0°, PR, SM P, 5°, PR, SM
					147.5	10						
					146.5	11		11.40m				
								Hole Terminated at 11.40 m Target depth				

Method
AS - Auger Screwing
WB - Washbore
HQ3 - HQ3 Core Barrel
NQ3 - NQ3 Core Barrel
NMLC - NMLC Core Barrel

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Support
T - Timbering

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Weathering
FR - Fresh
SW - Slightly Weathered
MW - Moderately Weathered
DW - Distinctly Weathered
HW - Highly Weathered
XW - Extremely Weathered
RS - Residual Soil

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

GREEN GEOTECHNICS	Project No: GG11138	Geotechnical Investigation 116-120 Frenchs Forest Road, Frenchs Forest **CORE PHOTO - BH7**	Box : 1 of 1
	Client: Young Assets Holdings PTY LTD		
	Date Cored: 28/07/2023		

GREEN GEOTECHNICS

Borehole No.
BH8
Page 1 of 1

Engineering Log - Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	28/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	28/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Hand Auger	Inclination:	-90°	RL Surface:	155.80 m		
Hole Diameter:	65 mm	Bearing:		Datum:	AHD	Operator:	JK

Drilling Information							Soil Description				Observations
Method	Support	Penetration	Groundwater Levels	Samples & Field Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	Structure and Additional Observations
HA						154.8	1		CL	FILL Silty CLAY: low plasticity, dark brown with dark grey, trace of gravel.	M		FILL
										0.60m			
									CH	Silty CLAY: high plasticity, pale grey with yellow brown.	M to W	F to St	RESIDUAL SOIL
										1.00m			
									CI /CH	Silty CLAY: medium to high plasticity, pale grey with orange brown and yellow brown.	M	St	
										1.40m			
						153.8	2			Hole Terminated at 1.40 m Refusal on silty clay			
						152.8	3						
						151.8	4						
						150.8	5						

Method
AS - Auger Screwing
ADV Auger V Bit
ADT Auger Tungsten Carbide Bit
RR - Rock Roller
WB- Washbore

Support
C - Casing

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
PP - Pocket Penetrometer

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet
w - Moisture Content
PL - Plastic Limit
LL - Liquid Limit

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
Fr - Friable
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

GREEN GEOTECHNICS

Borehole No.
BH2
Page 1 of 2

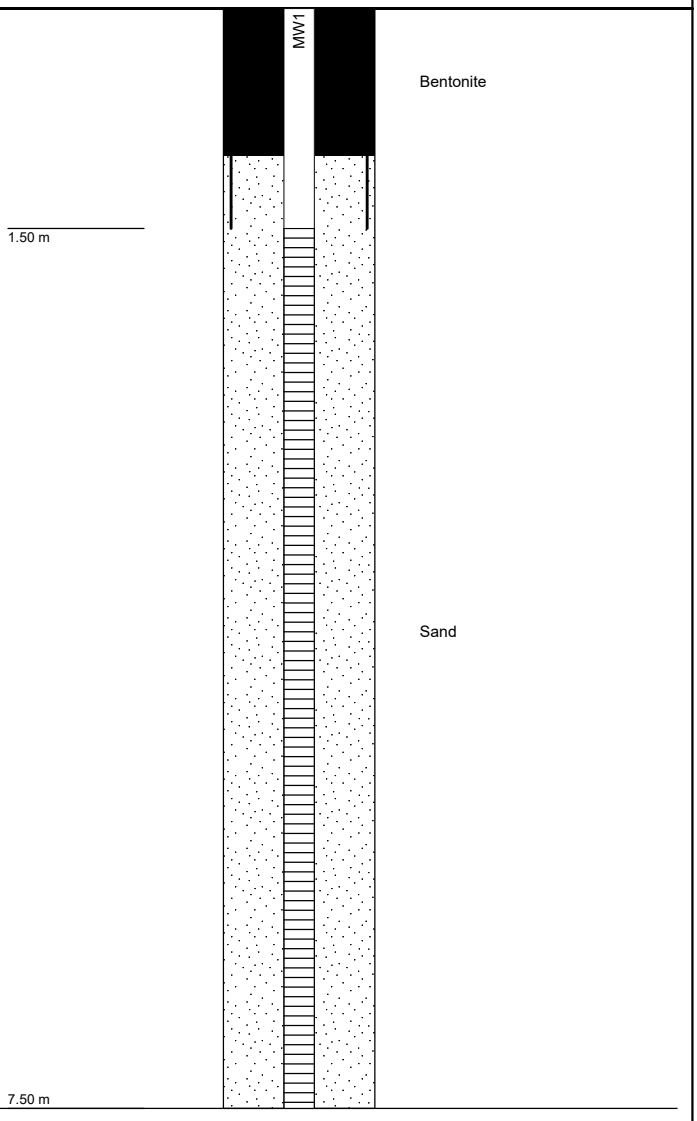
Engineering Log - Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	27/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	27/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	MG
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	153.10 m	Permit Number :	
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:	AF

Drilling Information					Soil Description			Piezometer Construction Details
Method	Support	Water	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	ID / Type / Stick Up & RL / Tip Depth & RL / Installation Date / Static Water Level: MW1 Standpipe Piezometer — 7.50 m 145.60 m AHD — 27/8/2023
AD/T		4/8/2023	152.1	1		CL	FILL / TOPSOIL Silty Sandy CLAY: low plasticity, dark brown to grey brown, trace of gravel.	
						CI	Sandy Silty CLAY: medium plasticity, red brown to pale grey, with ironstone gravel bands and lenses of sandstone.	
			151.1	2			SANDSTONE: red brown to grey brown, estimated highly weathered to extremely weathered, very low to low strength (Class 5).	
NMLC			150.1	3			SANDSTONE: fine to medium grained, red to brown purple, bedded at 20°. high strength; slightly weathered.	
			149.1	4			SANDSTONE: pale grey with grey, bedding at 0-15°. Occasional ironstone stain from 5.40m to 5.60m. medium to high strength; fresh.	
			148.1	5				
			147.1	6				
			146.1	7				
			145.1	8			Hole Terminated at 7.50 m Target depth	



Method
AS - Auger Screwing
ADV Auger V Bit
ADT Auger Tungsten Carbide Bit
RR - Rock Roller
WB- Washbore

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Support
C - Casing

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

GREEN GEOTECHNICS

Borehole No.
BH5
Page 1 of 1

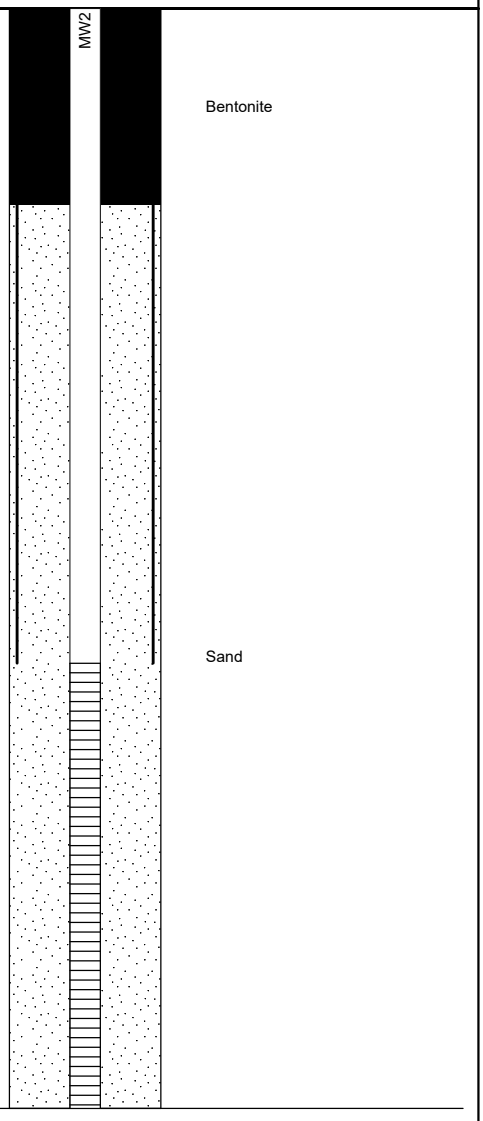
Engineering Log - Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	28/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	28/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie Utility	Inclination:	-90°	RL Surface:	157.60 m	Permit Number :	
Hole Diameter:	105 mm	Bearing:		Datum:	AHD	Operator:	JK

Drilling Information					Soil Description			Piezometer Construction Details
Method	Support	Water	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	ID / Type / Stick Up & RL / Tip Depth & RL / Installation Date / Static Water Level
AD/T		4/8/2023	156.6	1		CL	FILL Silty Sandy CLAY: low plasticity, dark brown, trace of gravel.	MW2 Standpipe Piezometer 8.40 m 149.20 m AHD
						CI /CH	Silty CLAY: medium to high plasticity, pale grey with orange brown.	
			155.6	2			SHALE: dark grey with pale grey, with clay seams. estimate very low strength (Class 5).	
			154.6	3				
			153.6	4				
			152.6	5				5.00 m
			151.6	6				
			150.6	7				
			149.6	8			SANDSTONE: fine to medium grained, pale grey with dark grey. estimate low to medium strength (Class 4).	8.40 m
			148.6	9			Hole Terminated at 8.40 m Refusal on weathered sandstone (Class 4)	



Method
AS - Auger Screwing
ADV Auger V Bit
ADT Auger Tungsten Carbide Bit
RR - Rock Roller
WB- Washbore

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Support
C - Casing

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

GREEN GEOTECHNICS

Borehole No.
BH2
Page 1 of 2

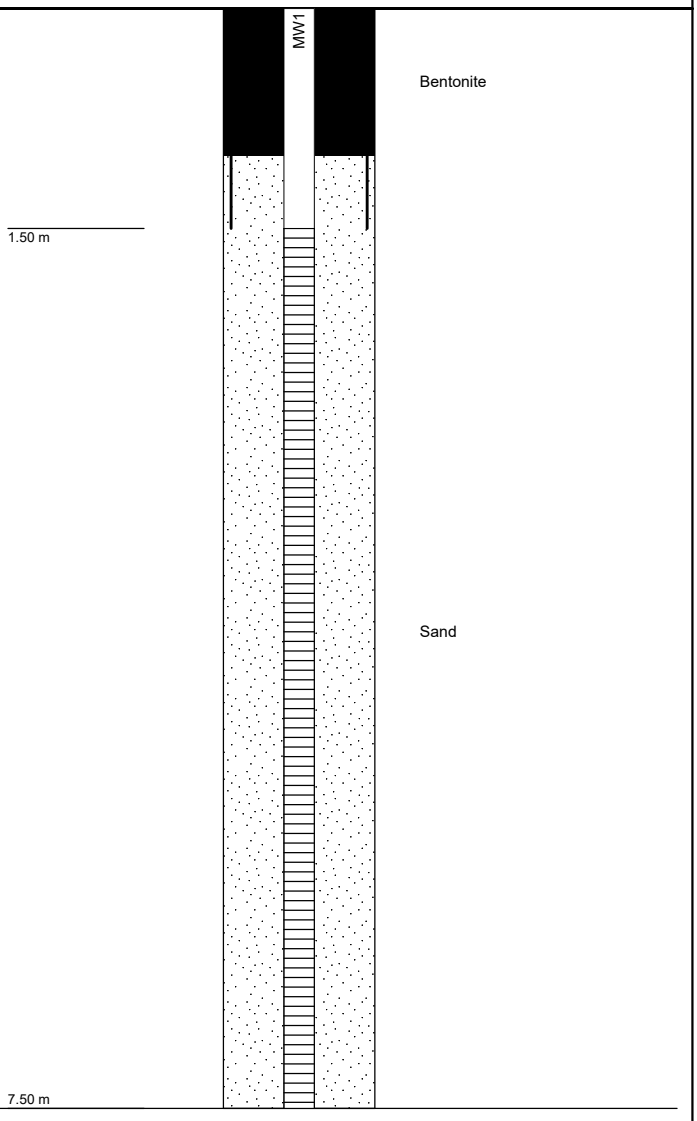
Engineering Log - Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	27/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	27/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	MG
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	153.10 m	Permit Number :	
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:	AF

Drilling Information					Soil Description			Piezometer Construction Details
Method	Support	Water	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	ID / Type / Stick Up & RL / Tip Depth & RL / Installation Date / Static Water Level: MW1 Standpipe Piezometer — 7.50 m 145.60 m AHD — 27/8/2023
AD/T		4/8/2023	152.1	1		CL	FILL / TOPSOIL Silty Sandy CLAY: low plasticity, dark brown to grey brown, trace of gravel.	
						CI	Sandy Silty CLAY: medium plasticity, red brown to pale grey, with ironstone gravel bands and lenses of sandstone.	
			151.1	2			SANDSTONE: red brown to grey brown, estimated highly weathered to extremely weathered, very low to low strength (Class 5).	
NMLC			150.1	3			SANDSTONE: fine to medium grained, red to brown purple, bedded at 20°. high strength; slightly weathered.	
			149.1	4			SANDSTONE: pale grey with grey, bedding at 0-15°. Occasional ironstone stain from 5.40m to 5.60m. medium to high strength; fresh.	
			148.1	5				
			147.1	6				
			146.1	7				
			145.1	8			Hole Terminated at 7.50 m Target depth	



Method
AS - Auger Screwing
ADV Auger V Bit
ADT Auger Tungsten Carbide Bit
RR - Rock Roller
WB- Washbore

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Support
C - Casing

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

GREEN GEOTECHNICS

Borehole No.
BH5
Page 1 of 1

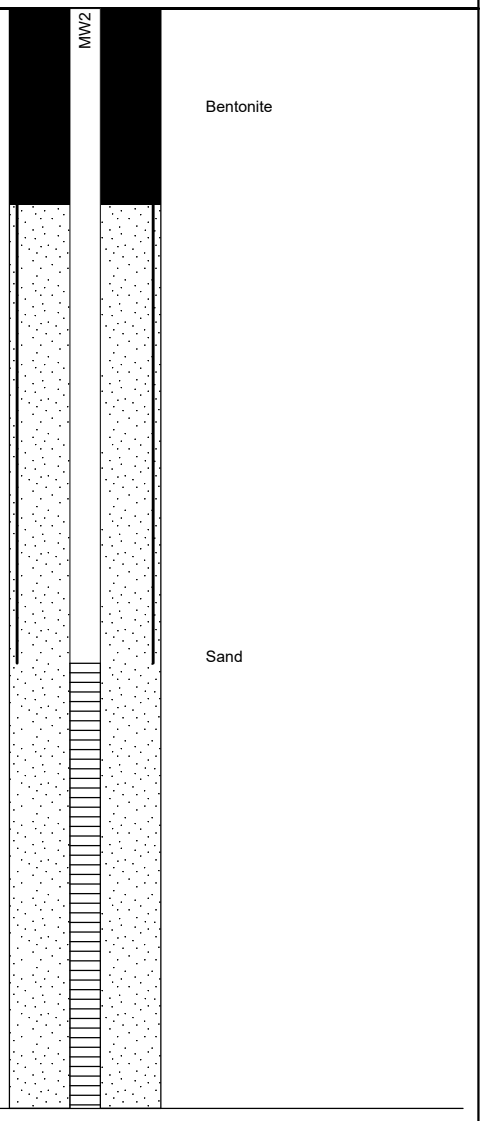
Engineering Log - Borehole

Project No.: GG11138

Client:	Young Assets Holdings PTY LTD	Commenced:	28/7/2023
Project Name:	Geotechnical Investigation: 116-120 Frenchs Forest Road	Completed:	28/7/2023
Hole Location:	116-120 Frenchs Forest Road, Frenchs Forest	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie Utility	Inclination:	-90°	RL Surface:	157.60 m	Permit Number :	
Hole Diameter:	105 mm	Bearing:		Datum:	AHD	Operator:	JK

Drilling Information					Soil Description			Piezometer Construction Details
Method	Support	Water	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	ID / Type / Stick Up & RL / Tip Depth & RL / Installation Date / Static Water Level
AD/T		4/8/2023	156.6	1		CL	FILL Silty Sandy CLAY: low plasticity, dark brown, trace of gravel.	MW2 Standpipe Piezometer 8.40 m 149.20 m AHD
						CI /CH	Silty CLAY: medium to high plasticity, pale grey with orange brown.	
			155.6	2			SHALE: dark grey with pale grey, with clay seams. estimate very low strength (Class 5).	
			154.6	3				
			153.6	4				
			152.6	5				5.00 m
			151.6	6				
			150.6	7				
			149.6	8			SANDSTONE: fine to medium grained, pale grey with dark grey. estimate low to medium strength (Class 4).	8.40 m
			148.6	9			Hole Terminated at 8.40 m Refusal on weathered sandstone (Class 4)	



Method
AS - Auger Screwing
ADV Auger V Bit
ADT Auger Tungsten Carbide Bit
RR - Rock Roller
WB- Washbore

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Support
C - Casing

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Green Geotechnics Pty Ltd
PO Box 3244, Rouse Hill NSW 2155
Phone: 0477 779 684 | Email: matt@greengeo.com.au

POINT LOAD STRENGTH INDEX

Project No: GG11138
Project Address: 116-120 Frenchs Forest Road, Frenchs Forest
Client: Young Assets Holdings PTY LTD

Test Method: AS 4133.4.1
Test Date: 30/07/2023
Tested By: MG

Borehole No: BH1

Date Drilled: 27/07/2023

Depth	Test Type	**Is(50) (Mpa)**	Rock Type	Rock Structure	Moisture
4.50	D	**0.73**	SS	MA	D
	A	**1.47**	SS	MA	D
5.95	D	**1.39**	SS	MA	D
	A	**1.07**	SS	MA	D
6.88	D	**0.98**	SS	BE	D
	A	**1.06**	SS	BE	D
7.38	D	**1.30**	SS	BE	D
	A	**1.17**	SS	BE	D
8.43	D	**1.97**	SS	BE	D
	A	**2.39**	SS	BE	D

Borehole No:

Date Drilled:

Depth	Test Type	**Is(50) (Mpa)**	Rock Type	Rock Structure	Moisture

STRUCTURE
MA= MASSIVE
BE= BEDDED
LA= LAMINATED
CR= CRYSTALLINE

TEST TYPE
A= AXIAL
D= DIAMETRAL
I= IRREGULAR
C= CUBE

MOISTURE CONDITION
W= WET
M= MOIST
D= DRY

ROCK TYPE
SS= SANDSTONE
ST= SILTSTONE
SH= SHALE
YS= CLAYSTONE
IG= IGNEOUS

Green Geotechnics Pty Ltd
PO Box 3244, Rouse Hill NSW 2155
Phone: 0477 779 684 | Email: matt@greengeo.com.au

POINT LOAD STRENGTH INDEX

Project No: GG11138
Project Address: 116-120 Frenchs Forest Road, Frenchs Forest
Client: Young Assets Holdings PTY LTD

Test Method: AS 4133.4.1
Test Date: 30/07/2023
Tested By: MG

Borehole No: BH2

Date Drilled: 27/07/2023

Depth	Test Type	**Is(50) (Mpa)**	Rock Type	Rock Structure	Moisture
2.75	D	**2.22**	SS	MA	D
	A	**2.47**	SS	MA	D
3.78	D	**1.05**	SS	MA	D
	A	**0.98**	SS	MA	D
4.30	D	**0.39**	SS	MA	D
	A	**0.52**	SS	MA	D
5.67	D	**0.38**	SS	MA	D
	A	**0.54**	SS	MA	D
6.10	D	**0.96**	SS	BE	D
	A	**1.30**	SS	BE	D
7.14	D	**0.98**	SS	BE	D
	A	**1.16**	SS	BE	D

Borehole No:

Date Drilled:

Depth	Test Type	**Is(50) (Mpa)**	Rock Type	Rock Structure	Moisture

STRUCTURE
MA= MASSIVE
BE= BEDDED
LA= LAMINATED
CR= CRYSTALLINE

TEST TYPE
A= AXIAL
D= DIAMETRAL
I= IRREGULAR
C= CUBE

MOISTURE CONDITION
W= WET
M= MOIST
D= DRY

ROCK TYPE
SS= SANDSTONE
ST= SILTSTONE
SH= SHALE
YS= CLAYSTONE
IG= IGNEOUS

Green Geotechnics Pty Ltd
PO Box 3244, Rouse Hill NSW 2155
Phone: 0477 779 684 | Email: matt@greengeo.com.au

POINT LOAD STRENGTH INDEX

Project No: GG11138
Project Address: 116-120 Frenchs Forest Road, Frenchs Forest
Client: Young Assets Holdings PTY LTD

Test Method: AS 4133.4.1
Test Date: 30/07/2023
Tested By: MG

Borehole No: BH4

Date Drilled: 28/07/2023

Depth	Test Type	**Is(50) (Mpa)**	Rock Type	Rock Structure	Moisture
6.94	D	**0.05**	SH	LA	M
	A	**0.03**	SH	LA	M
7.68	D	**0.02**	SH	LA	M
	A	**0.03**	SH	LA	M
8.28	A	**0.67**	SS	MA	D

Borehole No:

Date Drilled:

Depth	Test Type	**Is(50) (Mpa)**	Rock Type	Rock Structure	Moisture

STRUCTURE
MA= MASSIVE
BE= BEDDED
LA= LAMINATED
CR= CRYSTALLINE

TEST TYPE
A= AXIAL
D= DIAMETRAL
I= IRREGULAR
C= CUBE

MOISTURE CONDITION
W= WET
M= MOIST
D= DRY

ROCK TYPE
SS= SANDSTONE
ST= SILTSTONE
SH= SHALE
YS= CLAYSTONE
IG= IGNEOUS

Green Geotechnics Pty Ltd
PO Box 3244, Rouse Hill NSW 2155
Phone: 0477 779 684 | Email: matt@greengeo.com.au

POINT LOAD STRENGTH INDEX

Project No: GG11138
Project Address: 116-120 Frenchs Forest Road, Frenchs Forest
Client: Young Assets Holdings PTY LTD

Test Method: AS 4133.4.1
Test Date: 30/07/2023
Tested By: MG

Borehole No: BH7

Date Drilled: 28/07/2023

Depth	Test Type	**Is(50) (Mpa)**	Rock Type	Rock Structure	Moisture
8.84	D	**1.52**	SS	MA	D
	A	**1.49**	SS	MA	D
9.83	D	**1.33**	SS	MA	D
	A	**1.4**	SS	MA	D
10.51	D	**0.59**	SS	BE	D
	A	**0.55**	SS	BE	D
11.30	D	**0.73**	SS	BE	D
	A	**0.78**	SS	BE	D

Borehole No:

Date Drilled:

Depth	Test Type	**Is(50) (Mpa)**	Rock Type	Rock Structure	Moisture

STRUCTURE
MA= MASSIVE
BE= BEDDED
LA= LAMINATED
CR= CRYSTALLINE

TEST TYPE
A= AXIAL
D= DIAMETRAL
I= IRREGULAR
C= CUBE

MOISTURE CONDITION
W= WET
M= MOIST
D= DRY

ROCK TYPE
SS= SANDSTONE
ST= SILTSTONE
SH= SHALE
YS= CLAYSTONE
IG= IGNEOUS

Dynamic Cone Penetrometer Test Report

Project Number: GG11138

Site Address: 116-120 Frenchs Forest Road, Frenchs Forest

Test Date: 28/07/2023

Test Method: **AS1289.6.3.2**

Technician: JK

Test No	BH3	BH8	BH7	BH6		
Starting Level	Surface Level	Surface Level	Surface Level	Surface Level		
Depth (m)	Penetration Resistance (blows / 150mm)					
0.00 - 0.15	*	1	*	2		
0.15 - 0.30	2	2	*	5		
0.30 - 0.45	3	2	8	9		
0.45 - 0.60	3	3	12	10		
0.60 - 0.75	4	4	22	14		
0.75 - 0.90	12	3	Refusal	19		
0.90 - 1.05	22	8		22		
1.05 - 1.20	Refusal	9		Refusal		
1.20 - 1.35		9				
1.35 - 1.50		9				
1.50 - 1.65		15				
1.65 - 1.80		22				
1.80 - 1.95		Refusal				
1.95 - 2.10						
2.10 - 2.25						
2.25 - 2.40						
2.40 - 2.55						
2.55 - 2.70						
2.70 - 2.85						
2.85 - 3.00						

Remarks: * Pre drilled prior to testing

SAMPLING & IN-SITU TESTING

GREEN GEOTECHNICS

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock. Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure. Undisturbed samples are taken by pushing a thin walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength and are necessary for laboratory determination of shear strength and compressibility.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator.

Large Diameter Augers

Boreholes can be drilled using a large diameter auger, typically up to 300 mm or larger in diameter mounted on a standard drilling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration.

Diamond Core Rock Drilling

A continuous core sample of can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter (NMLC). The borehole is advanced using a water or mud flush to lubricate the bit and removed cuttings.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1. The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable, and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as: 15, 30/40 mm.

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.

- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

SOIL DESCRIPTIONS

GREEN GEOTECHNICS

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle Size (mm)
Boulder >200	Boulder >200
Cobble 63 - 200	Cobble 63 - 200
Gravel 2.36 - 63	Gravel 2.36 - 63
Sand 0.075 - 2.36	Sand 0.075 - 2.36
Silt 0.002 - 0.075	Silt 0.002 - 0.075
Clay <0.002	Clay <0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle Size (mm)
Coarse Gravel	20 – 63
Medium Gravel	6 – 20
Fine Sand	2.36 – 6
Coarse Sand	0.6 – 2.36
Medium Sand	0.2 – 0.6
Fine Sand	0.075 – 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion
And	Specify
Adjective	20 - 35%
Slightly	12 - 20%
With some	5 - 12%
With a trace of	0 - 5%

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained Shear Strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	ST	50 - 100
Very stiff	VST	100 - 200
Hard	H	200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (DCP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N Value	CPT qc value (MPa)
Very loose	VL	<4	<2
Loose	L	4 - 10	2 -5
Medium Dense	MD	10-30	5-15
Dense	D	30-50	15-25
Very Dense	VD	>50	>25

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Fill - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

ROCK DESCRIPTIONS

GREEN GEOTECHNICS

Rock Strength

The Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 1993. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $IS_{(50)}$ MPa	Approximate Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200

* Assumes a ration of 20:1 for UCS to $IS_{(50)}$

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Residual Soil	RS	Soil developed on extremely weathered rock, the mass structure and substance fabric are no longer evident.
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable.
Distinctly Weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured usually by iron staining.
Moderately weathered	MW	Staining and discolouration of rock substance has taken place.
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.

Degree of Fracturing

The following classification applies to the spacing of natural fractures in core samples (bedding plane partings, joints and other defects, excluding drilling breaks

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured Core	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and loner sections
Unbroken	Unbroken Core lengths mostly > 1000 mm

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	2 m

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$RQD\ \% = \frac{\text{cumulative length of 'sound' core sections} \geq 100\text{ mm long}}{\text{total drilled length of section being assessed}}$$

'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling/handling, then the broken pieces are fitted back together and are not included in the calculation of RQD.

ABBREVIATIONS

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
ADT	Auger Drill TC Bit
ADV	Auger Drill V Brit
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

Z	Water seep
V	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
S	Chemical sample
U50	Undisturbed tube sample (50mm)
W	Water sample
PP	Pocket Penetrometer (kPa)
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

C	Crushed Seam
DB	Drilling Break
DL	Drilling Lift
EW	Extremely Weathered Seam
HB	Handling Break
IS	Infilled Seam
J	Joint
MB	Mechanical Break
P	Parting
S	Sheared Surface
SS	Sheared Seam
SZ	Sheared Zone

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cn	clean
ct	coating
sn	stained
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pr	planar
st	stepped
un	undulating

Roughness

po	polished
rf	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

SYMBOLS

Graphic Symbols for Soil and Rock

General

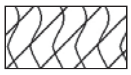

Asphalt


Road base

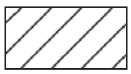

Concrete

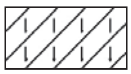

Filling

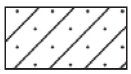
Soils


Topsoil

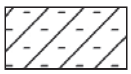

Peat


Clay

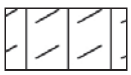

Silty clay

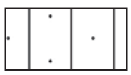

Sandy clay

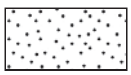

Gravelly clay

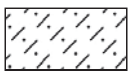

Shaly clay

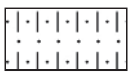

Silt


Clayey silt


Sandy silt

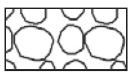

Sand

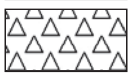

Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

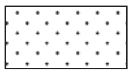

Talus

Sedimentary Rocks

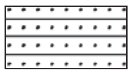

Boulder conglomerate

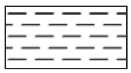

Conglomerate


Conglomeratic sandstone

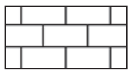

Sandstone


Siltstone

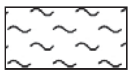

Laminite

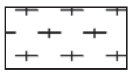

Mudstone, claystone, shale

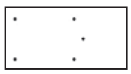

Coal


Limestone

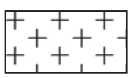
Metamorphic Rocks

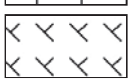

Slate, phyllite, schist

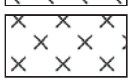

Gneiss

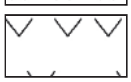

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote

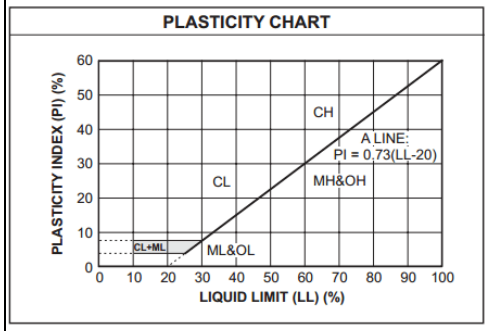

Tuff, breccia


Porphyry

UNIFIED SOIL CLASSIFICATION TABLE

GREEN GEOTECHNICS

Field Identification Procedures (Excluding particles larger than 75um and basing fractions on estimated weights)				Group Symbols	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria
Coarse-grained soils More than half of the material is large that 75um sieve size[b] — The 75um sieve size is about the particle visible to the naked eye	Gravels More than half of the coarse fraction is larger than a 4mm sieve	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name: indicative approximate percentages of sand and gravel; maximum size; angularity; surface condition, and hardness of the coarse grains; local of geologic name and other pertinent descriptive information; and symbols in parentheses For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics Example: *Silty Sand*, gravelly; about 20% hard, angular gravel particles 12mm maximum size; rounded and subangular sand grains, coarse to fine, about 15% non-plastic fines low dry strength; well compacted and moist in place; alluvial sand; *(SM)*	Use grain size curve in identifying the fractions as given under field identification Determine percentages of gravel and sand from grain size curve Depending on percentage of fines (fraction smaller than 75um sieve size) coarse grained soils are classified as follows Less than 5% GW, GP, SW, SP More than 12% GM, GC, SM, SC 5 to 12% Borderline cases requiring use of dual symbol $C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all graduation requirements for *GW* Atterberg limits below "A" line or *PI* less than 4 — Above "A" line with *PI* between 4 and 7 are borderline cases of requiring use of dual symbols Atterberg limits above "A" line with *PI* greater than 7
		Gravels with fines (appreciable amount of fines)	Predominantly one size or range of sizes with some intermediate sizes missing	*GP*	Poorly graded gravels, grave-sand mixtures, little or no fines		
			Nonplastic fines (for identification procedures see *ML* below)	*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures		
			Plastic fines (for identification procedures see *CL* below)	*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures		
	Sands More than half of the coarse fraction is smaller than a 4mm sieve	Clean sands (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	*SW*	Well graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all graduation requirements for *SW* Atterberg limits below "A" line or *PI* less than 5 — Above "A" line with *PI* between 4 and 7 are borderline cases of requiring use of dual symbols Atterberg limits above "A" line with *PI* greater than 7
			Predominantly one size or range of sizes with some intermediate sizes missing	*SP*	Poorly graded sands, gravelly sands, little or no fines		
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)	*SM*	Silty sands, poorly graded sand-silt mixtures		
			Plastic fines (for identification procedures see *CL* below)	*SC*	Clayey sands, poorly graded sand-clay mixtures		
Find-grained soils More than half of the material is smaller than 75um sieve size	Identification Procedures of Fractions Smaller than 380 um Sieve Size						
	Silts and clays liquid limit less than 50	Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)			
		None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slit plasticity	Give typical name: indicative degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions Example: *Clayey Silt,* brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; *(ML)*
		Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
		Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity	
	Silts and clays liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, clastic silts	
		High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays	
		Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity	
Highly Organic Soils		Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils	



Plasticity Chart
For laboratory classification of fine-grained soils

Note: 1 Soils possessing characteristics of two groups are designated by combinations of group symbols (eg. GW-GC, well graded gravel-sand mixture with clay fines

2 Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity

APPENDIX B

LABORATORY TEST RESULTS

CERTIFICATE OF ANALYSIS

Work Order	: **ES2325507**	Page	: 1 of 4
Client	: **GREEN GEOTECHNICS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR MATTHEW GREEN	Contact	: Customer Services ES
Address	: PO BOX 3244 ROUSE HILL 2155	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: GG11125/11138	Date Samples Received	: 01-Aug-2023 08:15
Order number	: GG11125/11138	Date Analysis Commenced	: 02-Aug-2023
C-O-C number	: ----	Issue Date	: 07-Aug-2023 13:57
Sampler	: JK		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 10		
No. of samples analysed	: 10		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Evie Sidarta	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	GG11125/S1	GG11125/S2	GG11125/S3	GG11125/S4	GG11125/S5
			Sampling date / time	27-Jul-2023 00:00	27-Jul-2023 00:00	27-Jul-2023 00:00	27-Jul-2023 00:00	27-Jul-2023 00:00
Compound	CAS Number	LOR	Unit	ES2325507-001	ES2325507-002	ES2325507-003	ES2325507-004	ES2325507-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.0**	**5.9**	**8.0**	**6.6**	**6.2**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**730**	**446**	**157**	**684**	**357**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**12.2**	**13.1**	**14.5**	**18.8**	**12.4**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**160**	**150**	**90**	**230**	**260**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	**1250**	**730**	**190**	**1170**	**400**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	GG11125/S6	GG11138/S1	GG11138/S2	GG11138/S3	GG11138/S4
			Sampling date / time	27-Jul-2023 00:00	28-Jul-2023 00:00	28-Jul-2023 00:00	28-Jul-2023 00:00	28-Jul-2023 00:00
Compound	CAS Number	LOR	Unit	ES2325507-006	ES2325507-007	ES2325507-008	ES2325507-009	ES2325507-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	7.9	5.7	4.8	5.7	4.9
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	383	39	56	133	238
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	8.8	17.3	16.7	11.9	13.1
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	130	30	60	90	130
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	450	20	20	130	350