MACQUARIE GEOTECH

Mudgee 5MW Solar Farm – Geotechnical Investigation

Geotechnical Investigation Report

Job No.: B20354

Submitted to: Engie Electrical & Communications

171 Grange Road

Fairfield, VIC 3078

Attn: Brett Ferris

Report No.: B20354

Engie Electrical & Communications – Mudgee 5MW Solar Farm

REVISION CONTROL

Revision	Date	Details	Prepared By	Reviewed By
00	08/09/2020	Draft	A. Drösemeyer	D. Clarkson

MACQUARIE GEOTECH

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1 INTRODUCTION

At the request of Brett Ferris from Engie Electrical & Communications, Macquarie Geotechnical (MG) has carried out a Geotechnical Investigation for the proposed 5MW Solar Farm project near Mudgee, NSW.

The objective of the investigation is to provide a Geotechnical Interpretation Investigation Report for a proposed solar farm.

The comments and opinions expressed in this report are based on the ground conditions encountered during the site work including the results of tests carried out in the field and in the laboratory. However, there may be special conditions prevailing on the site which have not been disclosed by this investigation and which have not been taken into account by this report.

2 SCOPE OF INVESTIGATION

Undertake a desk study of the site to confirm the likely geological conditions of the site and to develop a geological model for the site.

Undertake Dial Before You Dig (DBYD) Search.

Mobilisation of a drill rig for drilling, logging and sampling of five (5) boreholes as per Table 1 below. In-situ testing comprised of Standard Penetration Testing (SPT) at selected intervals.

Table 1: Borehole Scope

Hole ID	Eastings	Northings	Depth (m)	Termination Remark
BH-01	738986.66	6392571.80	2.70	Refusal
BH-02	738925.71	6392702.55	5.00	Target depth
BH-03	738839.76	6392551.16	4.84	Refusal
BH-04	738689.55	6392533.20	5.00	Target depth
BH-05	738646.59	6392831.43	1.65	Refusal

Samples were taken at selected intervals and at every change of strata to allow for laboratory testing at our NATA accredited laboratory in Bathurst. Testing comprised of the following:

- Six (6) Moisture Content Tests
- Three (3) Atterberg Limit Tests
- Three (3) Linear Shrink Tests
- Three (3) Shrink Swell Tests
- Three (3) Particle Size Distribution (Wash) Tests
- Four (4) Maximum Dry Density – MDD Tests
- Four (4) California Bearing Ratio – CBR Tests
- Three (3) Soil Chemical Properties Suite Tests

2.1 Site Description

The project areas are located at Caerleon, approximately 9km North West of Mudgee, NSW.

The proposed site is situated within council land south of the sewerage treatment plant.

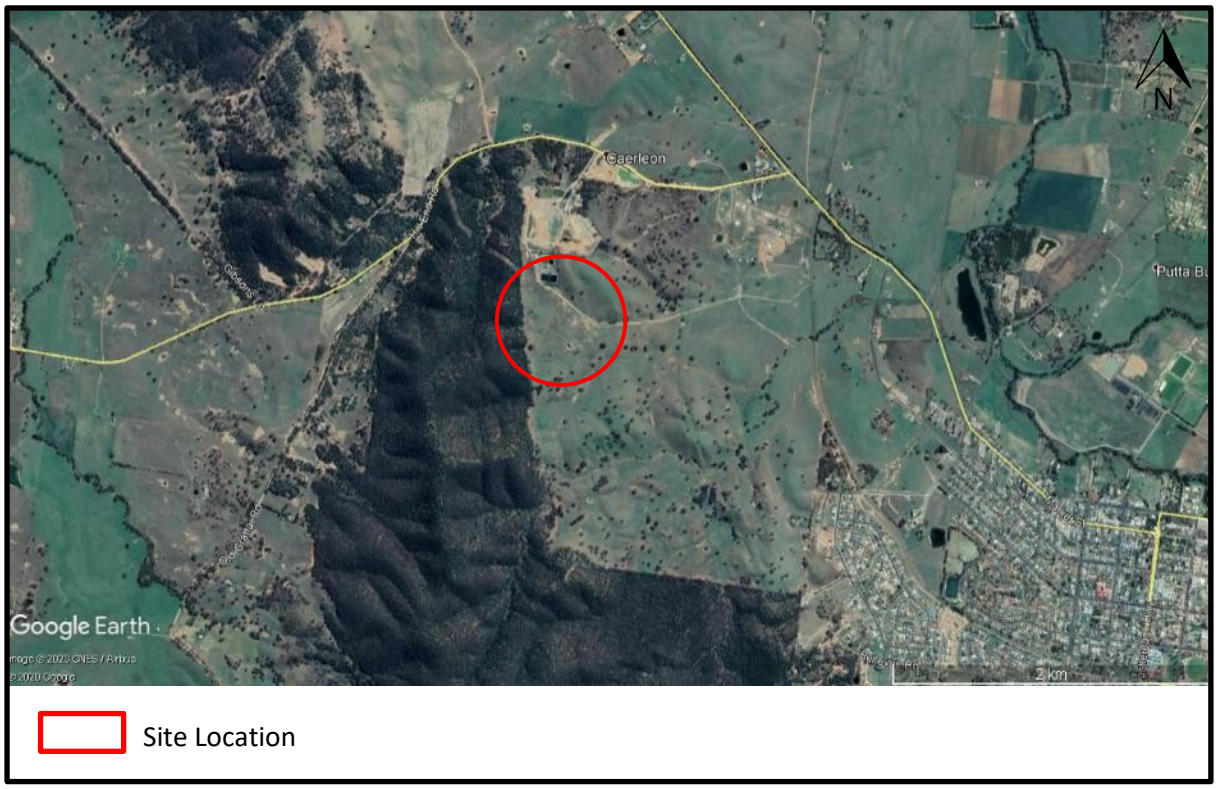

Figure 1: Site Location

2.2 Desk Study

A desk study was undertaken using readily available geological and geotechnical information and included the following:

- Dubbo 1:250,000
- Previous Geotechnical Investigations undertaken within the study area
- NSW Department of Primary Industries – Groundwater Bore Data
- ASRIS/CSIRO
- Google Earth

2.3 Regional Geology

The 1:250,000 Geological map sheet extract Dubbo is shown in Figure 2 below:

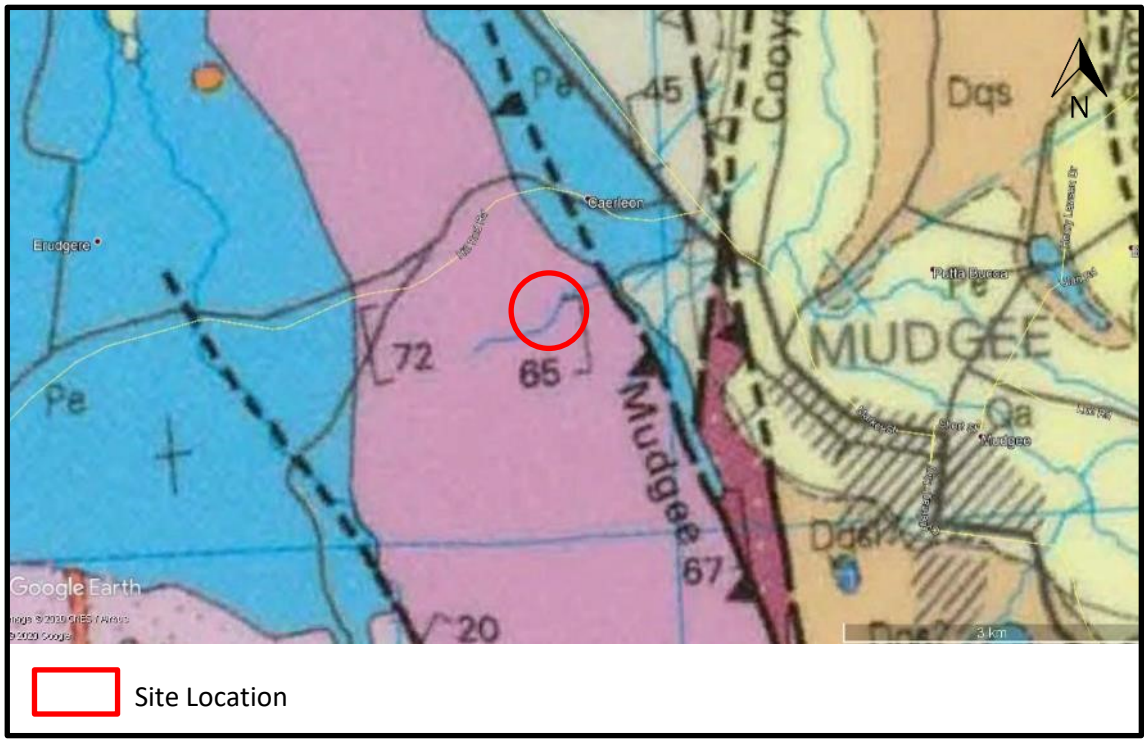

Figure 2: Geology Map Extract Overlay – Dubbo 1:250,000 Sheet

With reference to the 1:250,000 Geological map sheet extract Dubbo, the site is underlain by the following:

Table 2: Summary of Geology

Geological Symbol	Group	Lithology
Ssb	Chesleigh Group	Biraganbil Formation: Quartz-lithic sandstone, slate, mudstone.

2.3.1 Acid Sulphate Maps

Reference is made to the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Atlas of Australian Acid Sulphate Soils and presented in Figure 3 below:

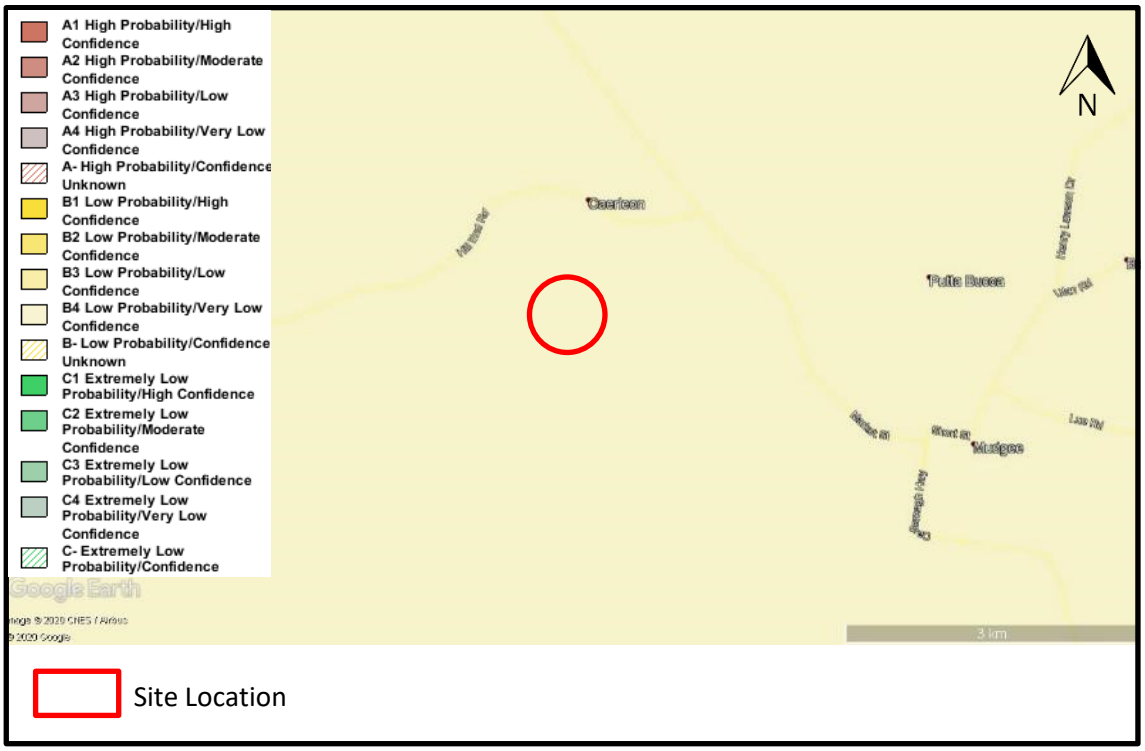

Figure 3: Acid Sulphate Risk Map

The acid sulphate map indicates a low probability of acid sulphate soils within the site.

2.3.2 Groundwater Bores

Table 3: Groundwater Data

Bore ID	Depth (m)	Geological Strata
GW804773 (Approx. 250m from site)	0.00 – 2.00	Clay
	2.00 – 28.00	Sandstone

2.3.3 Topography

The site topography of the investigated area is slightly undulating with elevation ranging from approximately 495 to 525m AHD.

2.4 Fieldwork

Fieldwork was undertaken on the 20th and 21st August 2020 by a Driller and an Engineering Geologist from our Bathurst office. The fieldwork was undertaken in accordance with our proposal and AS1726 Geotechnical Site Investigation.

2.4.1 Service Location

Macquarie Geotechnical obtained underground services and utility plans through 'Dial Before You Dig (DBYD) services.

2.4.2 GPS

Test locations were surveyed using a handheld GPS with co-ordinates recorded. The GPS co-ordinates were recorded in MGA Zone 55H format and elevations in Australian Height Datum (AHD).

2.4.3 Boreholes

The borehole was drilled at a location nominated by Engie Electrical & Communications and is summarised in Table 1.

A truck mounted Christie drill rig was used to drill five (5) boreholes up to depths of 5.00m. Drilling comprised of a 114mm diameter solid flight auger and 250mm diameter bulk auger up to depths of 1.00m. In situ testing comprised of Standard Penetration Tests (SPT) at 1.50m intervals.

The boreholes were reinstated with arising's upon completion.

The borehole logs are presented in Appendix C.

2.5 Sampling

Sampling was undertaken in accordance with AS1289 1.2.1 and as defined in the proposal and considered the engineering requirements of the investigation and the nature of the materials encountered. Samples were returned to our NATA accredited laboratory in Bathurst for testing.

2.6 In-Situ Testing

In-situ testing as specified by our proposal was carried out in selected exploratory holes in accordance with the techniques outlined in the relevant Australian Standards and Macquarie Geotech's Quality procedures. The results are presented on the relevant exploratory hole log in Appendix C.

2.6.1 Standard Penetration Testing

Standard Penetration Tests (SPT) was carried out in the boreholes with techniques outlined in AS1289 6.3.1 in order to determine the relative density and consistency of the strata encountered. The "N" value (number of blows per 300mm penetration) or the blow count/penetration was recorded for each test.

2.6.2 Electrical Resistivity Testing

Earth resistivity testing was undertaken using a DET4TC2 Megger Earth Tester in accordance with the four (4) pin Wenner method. Electrodes were inserted into the ground along an orthogonal traverse (R1 to R2) with an E-W direction and N-S direction. The electrode spacing ranged between 0.5m and 16m.

The testing was undertaken in accordance with ASTM G57-06 Wenner Electrical Sounding Method.

A summary of the results is included in Section 4.

2.7 Laboratory Testing

The samples were returned to Macquarie Geotechnical NATA accredited laboratory at Bathurst for further assessment and testing. The laboratory tests were carried out as per the proposal.

Table 4: Summary of Laboratory Tests

Hole ID	Depth (m)	Laboratory Tests
BH-01	0.10 – 0.50	AS1289 2.1.1 Moisture Content
		AS1289 3.1.1 Atterberg Limits
		AS1289 3.4.1 Linear Shrink
		AS1289 3.6.1 Particle Size Distribution (Wash)
		AS1289 5.1.1 Maximum Dry Density - MDD
		AS1289 6.1.1 California Bearing Ratio - CBR
	0.50 – 0.95	AS1289 4.2.1 Sulphate Content
		AS1289 4.3.1 pH Value
		EC Electrical Conductivity
		T1010 Chloride Content
	1.00 – 1.50	AS1289 7.1.1 Shrink Swell
BH-02	0.50 – 1.00	AS1289 2.1.1 Moisture Content
		AS1289 5.1.1 Maximum Dry Density - MDD
		AS1289 6.1.1 California Bearing Ratio - CBR
	1.00 – 1.50	AS1289 7.1.1 Shrink Swell
	2.50 – 3.00	AS1289 2.1.1 Moisture Content
		AS1289 3.1.1 Atterberg Limits
		AS1289 3.4.1 Linear Shrink
		AS1289 3.6.1 Particle Size Distribution (Wash)
BH-03	0.10 – 0.50	AS1289 2.1.1 Moisture Content
		AS1289 5.1.1 Maximum Dry Density - MDD
		AS1289 6.1.1 California Bearing Ratio - CBR
	1.50 – 1.95	AS1289 2.1.1 Moisture Content
		AS1289 3.1.1 Atterberg Limits
		AS1289 3.4.1 Linear Shrink
		AS1289 4.2.1 Sulphate Content
		AS1289 4.3.1 pH Value
		EC Electrical Conductivity
		T1010 Chloride Content
BH-04	1.00 – 1.50	AS1289 7.1.1 Shrink Swell

Hole ID	Depth (m)	Laboratory Tests
BH-04	1.00 – 1.95	AS1289 3.6.1 Particle Size Distribution (Wash)
	3.00 – 3.45	AS1289 4.2.1 Sulphate Content
		AS1289 4.3.1 pH Value
		EC Electrical Conductivity
		T1010 Chloride Content
BH-05	0.50 – 1.00	AS1289 2.1.1 Moisture Content
		AS1289 5.1.1 Maximum Dry Density - MDD
		AS1289 6.1.1 California Bearing Ratio - CBR

3 EXISTING SUBSURFACE CONDITIONS

The subsurface conditions encountered in the borehole is presented in detail in the attached borehole log (refer Appendix C). The subsurface conditions encountered in the borehole is broadly summarised in Table 5 below.

3.1 Exploratory Hole Summary

Table 5: Summary of Boreholes

-	BH-01	BH-02	BH-03	BH-04	BH-05
Material Description	**Depth (m)**				
Silty CLAY (Topsoil)	0.00 – 0.10	0.00 – 0.10	0.00 – 0.10	0.00 – 0.10	0.00 – 0.10
Sandy CLAY trace gravel (residual Soil)	0.10 – 0.50	–	–	–	–
Silty CLAY (Residual Soil)	0.50 – 1.70	0.10 – 2.50	0.10 – 2.40	–	0.10 – 0.50
Silty Sandy CLAY (Residual Soil)	–	–	2.40 – 4.84	0.10 – 5.00	–
Clayey Sandy GRAVEL (Residual Soil)	–	–	–	–	0.50 – 1.20
Sandy CLAY with gravel (Residual soil)	–	2.50 – 3.00	–	–	–
Silty Gravelly CLAY (XW Material)	1.70 – 2.70	3.00 – 5.00	–	–	–
Silty Clayey GRAVEL (XW Material)	–	–	–	–	1.20 – 1.65
Total Depth (m)	2.70 (R)	5.00 (LOI)	4.84 (R)	5.00 (LOI)	1.65 (R)
Groundwater Observation (m)	NFGWO	NFGWO	NFGWO	NFGWO	NFGWO

Note: Please refer to borehole logs in Appendix C for detailed descriptions.
LOI – Limit of Investigation, R – Refusal;
NFGWO – No Free Ground Water Observed.

3.2 Groundwater

The comments on groundwater are based on the observations made at the time of the investigation. Groundwater was not observed in the borehole at the time of investigation. It is possible that elevated groundwater levels during wet periods may occur.

Seasonal variation in ground water may be encountered and shall be considered as part of design process.

4 FIELD TEST RESULTS

The summary of electrical resistivity test results is shown in tables 6 and 7 below.

Table 6: Summary of Electrical Resistivity Test Results – North Array

Electrode Spacing (m)	Apparent Resistivity (Ohm)	
	E/W	N/S
1.0	-	50.3
2.0	-	25.1
4.0	-	25.1
8.0	-	50.3
12.0	-	75.4
16.0	-	100.5

Notes: 1. Apparent Resistivity 2pπaR; where a = meters and R = ohms

2. The calculated earth and thermal resistivity values are based on the assumption of homogeneous ground conditions from the surface to a depth approximately equal to the electrode spacing. Non-homogeneous ground conditions may affect the calculated earth resistivity values. The electrical resistivity of the ground can be affected by moisture; therefore resistivity of the upper soil profile may change in accordance with the prevailing moisture conditions.

Table 7: Summary of Electrical Resistivity Test Results – South Array

Electrode Spacing (m)	Apparent Resistivity (Ohm)	
	E/W	N/S
1.0	238.8	-
2.0	62.8	-
4.0	25.1	-
8.0	50.3	-
12.0	75.4	-

Notes: 1. Apparent Resistivity 2pπaR; where a = meters and R = ohms

2. The calculated earth and thermal resistivity values are based on the assumption of homogeneous ground conditions from the surface to a depth approximately equal to the electrode spacing. Non-homogeneous ground conditions may affect the calculated earth resistivity values. The electrical resistivity of the ground can be affected by moisture; therefore resistivity of the upper soil profile may change in accordance with the prevailing moisture conditions.

5 LABORATORY TEST RESULTS

The Laboratory tests were carried out on the samples nominated by Macquarie Geotech. The test results are summarised in Tables 8 to 10 below.

Table 8: Laboratory Test Results – Classification

Hole ID	Depth (m)	Sample Description (USCS)	Moisture Content (%)	Atterberg Limits			Linear Shrinkage (%)	Shrink Swell Index (ISS)
				LL (%)	PL (%)	PI (%)		
BH-01	0.10 – 0.50	Sandy CLAY trace gravel	15.8	31	14	17	9.0	-
	1.00 – 1.50	Silty CLAY*	-	-	-	-	-	0.3
BH-02	0.50 – 1.00	Silty CLAY*	14.5	-	-	-	-	-
	1.00 – 1.50	Silty CLAY*	-	-	-	-	-	0.5
	2.50 – 3.00	Sandy CLAY with gravel	13.3	29	16	13	7.5	-
BH-03	0.10 – 0.50	Sandy CLAY*	15.5	-	-	-	-	-
	1.50 – 1.95	Sandy CLAY*	9.8	27	17	10	4.0	-
BH-04	1.00 – 1.50	Silty sandy CLAY*	-	-	-	-	-	0.5
BH-05	0.50 – 1.00	Sandy GRAVEL*	10.5	-	-	-	-	-

Note: USCS – Unified Soil Classification System; LL – Liquid Limit; PL – Plastic Limit; PI – Plasticity Index; * Visual description

Table 9: Laboratory Test Results – Compaction & CBR

Hole ID	Depth (m)	Sample Description (USCS)	Field Moisture Content (%)	California Bearing Ratio (CBR)			
				MDD (t/m^3)	OMC (%)	CBR (%)	CBR Swell (%)
BH-01	0.10 – 0.50	Sandy CLAY trace gravel	15.3	1.87	15.8	3.5	0.0
BH-02	0.50 – 1.00	Silty CLAY*	15.0	1.87	14.4	5.0	0.7
BH-03	0.10 – 0.50	Sandy GRAVEL*	16.7	1.82	15.3	5.0	0.4
BH-05	0.50 – 1.00	Sandy GRAVEL*	9.8	2.02	11.8	15.0	0.2

Note: USCS – Unified Soil Classification System; MDD – Maximum Dry Density; OMC – Optimum Moisture Content; * Visual description

Table 10: Laboratory Test Results – Soil Chemical Properties

Hole ID	Depth (m)	Sample Description*	Soil Chemical Properties (SCP)			
			pH	SO_4 (ppm)	Cl (ppm)	Electrical Conductivity (uS/cm)
BH-01	0.50 – 0.95	Sandy silty CLAY*	10.1	40.9	170.6	640.0
BH-03	1.50 – 1.95	Sandy silty CLAY*	9.1	31.7	93.1	70.4
BH-04	3.00 – 3.45	Sandy silty CLAY*	9.4	26.6	59.9	121.0

Note: * Visual description; SO_4 – Sulphate, Cl – Chloride.

6 GEOTECHNICAL ASSESSMENT

6.1 Site Classification

The classification of a site involves a number of geotechnical factors such as depth of bedrock, the nature and extent of subsurface soils and any specific problems (slope stability, soft soils, filling, reactivity, etc).

In accordance with AS2870 2011 the proposed development site will have an anticipated surface movement (Ys) of **20-30mm** and is classified as "**Class M**".

An appropriate footing system should be designed in accordance with the above code to accommodate these anticipated movements. The possibility of additional movements, due to abnormal moisture variations, should be minimised by proper "site management" procedures.

It should be noted that this assessment is based on site conditions being represented by the natural soil profile. Any change in conditions noted during development, including cut or fill should be referred to Macquarie Geotechnical for appropriate inspection and assessment.

The above classifications, based on AS2870 which relates to construction of residential dwellings, is not technically correct for the type of industrial structures proposed and therefore it is given as a guide only with respect to soil reactivity.

Soil reactivity is expected to govern the serviceability of shallow footings at this site, which will be subject to seasonal shrink/swell movement of the reactive founding soils. Based on a classification of **M**, shallow spread footings founded in residual clay soils may experience seasonal movement of up to **30 mm**.

6.2 Foundations

The investigation indicates that the ground conditions generally comprised of residual soils overlying weathered sedimentary sequences.

6.2.1 Geotechnical Design Parameters

Based on our investigation, and our experience in this region, we recommend the following geotechnical design parameters:

Table 11: Estimated Soil Geotechnical Engineering Parameters

Depth (m)	Soil Description	Unit Weight (kN/m³)	Angle of Friction (degrees)		Cohesion (kPa)		Concrete to Soil Friction Angle δ (degrees)
			Drained ϕ'	Undrained ϕ	Drained c'	Undrained Cu	
0.10 – 2.50	Sandy CLAY/ Silty CLAY – Stiff	19	26	-	0	50	20
1.00 – 4.00	Sandy CLAY/ Silty CLAY – Very Stiff	19	29	-	0	100	22
1.50 – 5.00	Sandy CLAY / Silty Gravelly CLAY – Hard (XW Claystone)	20	32	-	0	200	25
BH05 0.50 – 1.20	Clayey Sandy GRAVEL – Medium Dense	20	32	32	0	-	25
BH05 1.20 – 1.65	Silty Clayey GRAVEL (XW material)	21	40	40	0	-	32

Table 12: Shallow Footing Bearing Pressures

Depth (m)	Soil Description	Allowable Bearing Pressure (kPa)	Ultimate Bearing Pressure (kPa)	Modulus of Subgrade Reaction (MN/m³)
0.10 – 2.50	Sandy CLAY/ Silty CLAY – Stiff	85	255	3
1.00 – 4.00	Sandy CLAY/ Silty CLAY – Very Stiff	170	510	7
1.50 – 5.00	Sandy CLAY / Silty Gravelly CLAY – Hard (XW Claystone)	340	1020	14
BH05 0.50 – 1.20	Clayey Sandy GRAVEL – Medium Dense	200	600	8
BH05 1.20 – 1.65	Silty Clayey GRAVEL (XW material)	500	1500	20

Note: Preliminary design parameters to be confirmed by a detailed design analysis.

Table 13: Pile Design Parameters

Depth (m)	Soil Description	Ultimate End Bearing Capacity (kPa)	Ultimate Shaft Adhesion (kPa)	Modulus of Subgrade Reaction (MN/m³) Ks	
				Vertical	Horizontal
1.00 – 4.00	Sandy CLAY/ Silty CLAY – Very Stiff	-	30	12	9
1.50 – 5.00	Sandy CLAY / Silty Gravelly CLAY – Hard (XW Claystone)	1800	60	24	18

Note: Preliminary design parameters to be confirmed by a detailed design analysis.
Pile design parameters based on bored piles.
A bearing capacity factor Nc equal to 9 for clay can be used provided that the pile has been embedded at least to a depth of five diameters into the bearing stratum.

Additional investigation should be undertaken for provision of deeper soil parameters.

For foundations bearing on soil or rock, weaker soil layers or weaker / fractured zones of rock present below the base of the foundation should be taken into account in the design of the foundation.

6.2.2 Geotechnical Strength Reduction Factor (AS2159)

The geotechnical strength reduction factor for pile design is defined in the Piling Code. Selection of the geotechnical strength reduction factor (ϕ_g) is based on a series of individual risk ratings (IRR) which are weighted and lead to an average risk rating (ARR). The individual risk ratings and final value of (ϕ_g) depend on the following factors:

- Site: the type, quantity and quality of testing.
- Design: design methods and parameter selection.
- Installation: construction control and monitoring.
- Pile testing regime
- Redundancy.

Without clear details about the pile type, design method, testing regime and other construction factors it is not possible to calculate the appropriate (ϕ_g) value. Assuming no pile testing, limited specialist geotechnical supervision during construction, and the limited/basic investigation and testing, an ϕ_g value of 0.45 is considered appropriate.

Nevertheless, with geotechnical supervision and pile integrity testing ϕ_g value can be increase to 0.52.

6.2.3 Foundation Settlements

For shallow or deep foundations bearing on the residual or extremely weathered soils the total and differential settlements are expected to be within 25mm provided that the allowable bearing capacities are not exceeded.

6.2.4 Aggressive Soils

We refer to Table 6.4.2 (c) Exposure Classification for Concrete Piles AS2159 – 2009 ‘Piling – Design and Installation’.

The soil condition is classified as 'Condition – B'. The test results indicate low levels of Sulfates (26.6-40.9 ppm), Chlorides (59.9-170.6 ppm) and a pH (9.1-10.1). Therefore the soil at this site is non-aggressive.

7 EXCAVATION AND STABILITY

7.1 Soil

The soils at the site comprised predominately residual and extremely weathered materials and should present no excavation difficulty. For temporary work conditions, benching or slope angles of 1V:1H is considered appropriate for the cohesive residual and extremely weathered materials (Boreholes BH01 to BH04). For temporary work conditions, slope angles of 1V:1H is considered appropriate for the granular residual and extremely weathered materials (Borehole BH05). For permanent conditions, slope angles of 1V:2H is considered appropriate.

7.2 Rock

Bedrock was not encountered in the boreholes. However, auger refusal was encountered at boreholes BH01, BH03 and BH05 at depths ranging from 1.65m to 2.70m below ground level.

8 EARTHWORKS

8.1 Re-use of Site Material

The majority of the site won material from the soil cuttings is considered to be suitable for use as general fill material. If the material is proposed to be used as structural fill within the permanent works then some blending of the material with coarser particle sizes may be required to comply with earthwork specification requirements.

9 CONCLUSION

The findings of our report were based on our fieldwork, in-situ testing, laboratory testing, technical assessment and local knowledge for this site.

We trust the foregoing is sufficient for your present purposes, and if you have any questions please contact the undersigned.

Yours sincerely,

Aloésio Drösemeyer
Geotechnical Engineer
MSc (Geotechnical)

David Clarkson
Senior Geotechnical Engineer
BEng MSc MIEAust

Attached: Limitations of Geotechnical Site Investigation
References: Australian Standard 1726 – 2017 Geotechnical Site Investigations

LIMITATIONS OF GEOTECHNICAL SITE INVESTIGATION

Scope of Services

This report has been prepared for the Client in accordance with the Services Engagement Form (SEF), between the Client and Macquarie Geotechnical.

Reliance on Data

Macquarie Geotechnical has relied upon data and other information provided by the Client and other individuals. Macquarie Geotechnical has not verified the accuracy or completeness of the data, except as otherwise stated in the report. Recommendations in the report are based on the data.

Macquarie Geotechnical will not be liable in relation to incorrect recommendations should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed.

Geotechnical Investigation

Findings of Geotechnical Investigations are based extensively on judgment and experience. Geotechnical reports are prepared to meet the specific needs of individual clients. This report was prepared expressly for the Client and expressly for the Clients purposes.

This report is based on a subsurface investigation, which was designed for project-specific factors. Unless further geotechnical advice is obtained this report cannot be applied to an adjacent site nor can it be used when the nature of any proposed development is changed.

Limitations of Site investigation

As a result of the limited number of sub-surface excavations or boreholes there is the possibility that variations may occur between test locations. The investigation undertaken is an estimate of the general profile of the subsurface conditions. The data derived from the investigation and laboratory testing are extrapolated across the site to form a geological model. This geological model infers the subsurface conditions and their likely behavior with regard to the proposed development.

The actual conditions at the site might differ from those inferred to exist.

No subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies.

Time Dependence

This report is based on conditions, which existed at the time of subsurface exploration. Construction operations at or adjacent to the site, and natural events such as floods, or groundwater fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report.

Macquarie Geotechnical should be kept appraised of any such events, and should be consulted for further geotechnical advice if any changes are noted.

Avoid Misinterpretation

A geotechnical engineer or engineering geologist should be retained to work with other design professionals explaining relevant geotechnical findings and in reviewing the adequacy of their plans and specifications relative to geotechnical issues.

No part of this report should be separated from the Final Report.

Sub-surface Logs

Sub-surface logs are developed by geoscientific professionals based upon their interpretation of field logs and laboratory evaluation of field samples. These logs should not under any circumstances be redrawn for inclusion in any drawings.

Geotechnical Involvement During Construction

During construction, excavation frequently exposes subsurface conditions. Geotechnical consultants should be retained through the construction stage, to identify variations if they are exposed.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and no other party. Other parties should not rely upon the report or the accuracy or completeness of any recommendations and should make their own enquiries and obtain independent advice in relation to such matters

Macquarie Geotechnical assumes no responsibility and will not be liable to any other person or organisations for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisations arising from matters dealt with or conclusions expressed in the report.

Other limitations

Macquarie Geotechnical will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

Other Information

For further information reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by the Institution of Engineers Australia, 1987.

Appendix A – Geotechnical Explanatory Notes

MACQUARIE GEOTECH

Geotechnical Explanatory Notes

Soil Description

In engineering terms soil includes every type of uncemented or partially cemented inorganic material found in the ground. In practice, if the material can be remoulded by hand in its field condition or in water it is described as a soil. The dominant soil constituent is given in capital letters, with secondary textures in lower case. The dominant feature is assessed from the Unified Soil Classification system and a soil symbol is used to define a soil layer as follows:

UNIFIED SOIL CLASSIFICATION

The appropriate symbols are selected on the result of visual examination, field tests and available laboratory tests, such as, sieve analysis, liquid limit and plasticity index.

USC Symbol	Description
GW	Well graded gravel
GP	Poorly graded gravel
GM	Silty gravel
GC	Clayey gravel
SW	Well graded sand
SP	Poorly graded sand
SM	Silty sand
SC	Clayey sand
ML	Silt of low plasticity
CL	Clay of low plasticity
OL	Organic soil of low plasticity
MH	Silt of high plasticity
CH	Clay of high plasticity
OH	Organic soil of high plasticity
Pt	Peaty Soil

MOISTURE CONDITION

Dry – Cohesive soils are friable or powdery
Cohesionless soil grains are free-running

Moist – Soil feels cool, darkened in colour
Cohesive soils can be moulded
Cohesionless soil grains tend to adhere

Wet – Cohesive soils usually weakened
Free water forms on hands when handling

For cohesive soils the following codes may also be used:

MC>PL Moisture Content greater than the Plastic Limit.
MC~PL Moisture Content near the Plastic Limit.
MC<PL Moisture Content less than the Plastic Limit.

PLASTICITY

The potential for soil to undergo change in volume with moisture change is assessed from its degree of plasticity. The classification of the degree of plasticity in terms of the Liquid Limit (LL) is as follows:

Description of Plasticity	LL (%)
Low	<35
Medium	35 to 50
High	>50

COHESIVE SOILS – CONSISTENCY

The consistency of a cohesive soil is defined by descriptive terminology such as very soft, soft, firm, stiff, very stiff and hard. These terms are assessed by the shear strength of the soil as observed visually, by the pocket penetrometer values and by resistance to deformation to hand moulding.

A Pocket Penetrometer may be used in the field or the laboratory to provide approximate assessment of unconfined compressive strength of cohesive soils. The values are recorded in kPa, as follows:

Strength	Symbol	Pocket Penetrometer Reading (kPa)
Very Soft	VS	< 25
Soft	S	20 to 50
Firm	F	50 to 100
Stiff	St	100 to 200
Very Stiff	VSt	200 to 400
Hard	H	> 400

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COHESIONLESS SOILS – RELATIVE DENSITY

Relative density terms such as very loose, loose, medium, dense and very dense are used to describe silty and sandy material, and these are usually based on resistance to drilling penetration or the Standard Penetration Test (SPT) 'N' values. Other condition terms, such as friable, powdery or crumbly may also be used.

The Standard Penetration Test (SPT) is carried out in accordance with AS 1289, 6.3.1. For completed tests the number of blows required to drive the split spoon sampler 300 mm are recorded as the N value. For incomplete tests the number of blows and the penetration beyond the seating depth of 150 mm are recorded. If the 150 mm seating penetration is not achieved the number of blows to achieve the measured penetration is recorded. SPT correlations may be subject to corrections for overburden pressure and equipment type.

Term	Symbol	Density Index	N Value (blows/0.3 m)
Very Loose	VL	0 to 15	0 to 4
Loose	L	15 to 35	4 to 10
Medium Dense	MD	35 to 65	10 to 30
Dense	D	65 to 85	30 to 50
Very Dense	VD	>85	>50

COHESIONLESS SOILS PARTICLE SIZE DESCRIPTIVE TERMS

Name	Subdivision	Size
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 μm to 2.36 mm
	medium	200 μm to 600 μm
	fine	75 μm to 200 μm

Rock Description

The rock is described with strength and weathering symbols as shown below. Other features such as bedding and dip angle are given.

ROCK QUALITY

The fracture spacing is shown where applicable and the Rock Quality Designation (RQD) or Total Core Recovery (TCR) is given where:

$$\text{RQD (\%)} = \frac{\text{Sum of Axial lengths of core > 100mm long}}{\text{total length considered}}$$

$$\text{TCR (\%)} = \frac{\text{length of core recovered}}{\text{length of core run}}$$

ROCK STRENGTH

Rock strength is described using AS1726 and ISRM – Commission on Standardisation of Laboratory and Field Tests, "Suggested method of determining the Uniaxial Compressive Strength of Rock materials and the Point Load Index", as follows:

Term	Symbol	Point Load Index $Is_{(50)}$ (MPa)
Very Low	VL	0.03 to 0.1
Low	L	0.1 to 0.3
Medium	M	0.3 to 1
High	H	1 to 3
Very High	VH	3 to 10
Extremely High	EH	>10

ROCK MATERIAL WEATHERING

Rock weathering is described using the following abbreviation and definitions used in AS1726:

Abbreviation	Term
RS	Residual soil
XW	Extremely weathered
DW	Distinctly weathered
HW	Highly weathered
MW	Moderately weathered
SW	Slightly weathered
FR	Fresh

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DEFECT SPACING/BEDDING THICKNESS

Measured at right angles to defects of same set or bedding.

Term	Defect Spacing	Bedding
Extremely closely spaced	<6 mm	Thinly Laminated
	6 to 20 mm	Laminated
Very closely spaced	20 to 60 mm	Very Thin
Closely spaced	0.06 to 0.2 m	Thin
Moderately widely spaced	0.2 to 0.6 m	Medium
Widely spaced	0.6 to 2 m	Thick
Very widely spaced	>2 m	Very Thick

DEFECT DESCRIPTION

Type:	Description
B	Bedding
F	Fault
C	Cleavage
J	Joint
S	Shear Zone
D	Drill break

Planarity/Roughness:

Class	Description
I	rough or irregular, stepped
II	smooth, stepped
III	slickensided, stepped
IV	rough or irregular, undulating
V	smooth, undulating
VI	slickensided, undulating
VII	rough or irregular, planar
VIII	smooth, planar
IX	slickensided, planar

The inclination if defects are measured from perpendicular to the core axis.

WATER


Water level at date shown


Partial water loss


Water inflow


Complete water loss

Groundwater not observed: The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.

Groundwater not encountered: The borehole/test pit was dry soon after excavation, however groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

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Graphic Symbols for Soils and Rocks

Typical symbols for soils and rocks are as follows. Combinations of these symbols may be used to indicated mixed materials such as clayey sand.

Soil Symbols

Main components


CLAY - CL


CLAY - CH


SAND


GRAVEL


BOULDERS / COBBLES


TOPSOIL


SILT

Minor Components


Clayey


Silty


Sandy


Gravelly

Other


FILL


BITUMEN


CONCRETE

Rock Symbols

Sedimentary Rocks


SANDSTONE


SILTSTONE


CLAYSTONE, MUDSTONE


SHALE


LAMINITE


ASPHALT


LIMESTONE


CONGLOMERATE

Igneous Rocks


GRANITE


BASALT


UNDIFFERENTIATED IGNEOUS

Metamorphic Rocks


SLATE, PHYLLITE, SCHIST


GNEISS

QUARTZITE

MACQUARIE GEOTECH

Engineering Classification of Shales and Sandstones in the Sydney Region – A Summary Guide

The Sydney Rock Class classification system is based on rock strength, defect spacing and allowable seams as set out below. All three factors must be satisfied.

CLASSIFICATION FOR SANDSTONE

Class	Uniaxial Compressive Strength (MPa)	Defect Spacing (mm)	Allowable Seams (%)
I	>24	>600	<1.5
II	>12	>600	<3
III	>7	>200	<5
IV	>2	>60	<10
V	>1	N.A.	N.A.

CLASSIFICATION FOR SHALE

Class	Uniaxial Compressive Strength (MPa)	Defect Spacing (mm)	Allowable Seams (%)
I	>16	>600	<2
II	>7	>200	<4
III	>2	>60	<8
IV	>1	>20	<25
V	>1	N.A.	N.A.

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UNIAXIAL COMPRESSIVE STRENGTH (UCS)

For expedience in field/construction situations the uniaxial (unconfined) compressive strength of the rock is often inferred, or assessed using the point load strength index (Is_{50}) test (AS 4133.4.1 – 1993). For Sydney Basin sedimentary rocks the uniaxial compressive strength is typically about 20 x (Is_{50}) but the multiplier may range from about 10 to 30 depending on the rock type and characteristics. In the absence of UCS tests, the assigned Sydney Rock Class classification may therefore include rock strengths outside the nominated UCS range.

DEFECT SPACING

The terms relate to spacing of natural fractures in NMLC, NQ and HQ diamond drill cores and have the following definitions:

Defect Spacing (mm)	Terms Used to Describe Defect Spacing[1]
>2000	Very widely spaced
600 – 2000	Widely spaced
200 – 600	Moderately spaced
60 – 200	Closely spaced
20 – 60	Very closely spaced
<20	Extremely closely spaced

[1]After ISO/CD14689 and ISRM.

ALLOWABLE SEAMS

Seams include clay, fragmented, highly weathered or similar zones, usually sub-parallel to the loaded surface. The limits suggested in the tables relate to a defined zone of influence. For pad footings, the zone of influence is defined as 1.5 times the least footing dimension. For socketed footings, the zone includes the length of the socket plus a further depth equal to the width of the footing. For tunnel or excavation assessment purposes the defects are assessed over a length of core of similar characteristics.

Source: Based on Pells et al (1978), as revised by Pells et al (1998).
Pells, P.J.N, Mostyn, G. and Walker, B.F. – Foundations on Sandstone and Shale in the Sydney Region. Australian Geomechanics Journal, No 33 Part 3, December 1998.

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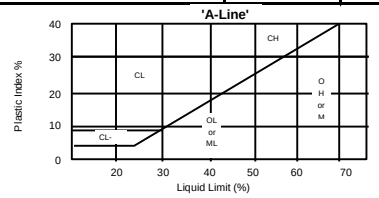
Summary of Soil Logging Procedures

Coarse Material: grain size - colour - particle shape - secondary components - minor constituents - moisture condition - relative density - origin - additional observations.

Fine Material: plasticity - colour - secondary components - minor constituents - moisture w.r.t. plasticity - consistency - origin - additional observations.

Guide to the Description, Identification and Classification of Soils

Major Divisions				SYMBOL	Typical Names
> 200mm	BOULDERS				
60 to 200mm	COBBLES				
COARSE GRAINED SOILS	More than 65% by dry mass less than 63mm is greater that 0.075mm	GRAVEL	More than 50% of coarse fraction > 2.36mm	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
				GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels.
		Gravelly Soils		GM	Silty gravels, gravel-sand-silt mixtures.
				GC	Clayey gravels, gravel-sand-clay mixtures
		SANDS	More than 50% of coarse fraction < 2.36mm	SW	Well-graded sands, gravelly sands, little or no fines.
				SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands.
		Sandy Soils		SM	Silty sands, sand-silt mixtures.
				SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	More than 35% by dry mass less than 60mm is less than 0.076mm	Liquid Limit < 50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts
				CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays.
				OL	Organic silts and organic silty clays of low plasticity.
		Liquid Limit > 50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
				CH	Inorganic clays of high plasticity, fat clays.
				OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS				Pt	Peat and other highly organic soils.



Grain sizes			
Gravel		Sand	
Coarse -	63 to 20mm	Coarse -	2.36 to 0.6mm
Medium -	20 to 6 mm	Medium -	0.6 to 0.2mm
Fine -	6 to 2.36mm	Fine -	0.2 to 0.075mm

GEOLOGICAL ORIGIN:-

Fill - artificial soils / deposits
Alluvial - soils deposited by the action of water
Aeolian - soils deposited by the action of wind
Topsoil - soils supporting plant life containing significant organic content
Residual - soils derived from insitu weathering of parent rock.
Colluvial - transported debris usually unsorted, loose and deposited

Field Identification of Fine Grained Soils - Silt or Clay?

Dry Strength - Allow the soil to dry completely and then test its strength by breaking and crumbling between the fingers.
High dry strength - Clays; Very slight dry strength - Silts.

Toughness Test - the soil is rolled by hand into a thread about 3mm in diameter. The thread is then folded and re-rolled repeatedly until it has dried sufficiently to break into lumps. In this condition inorganic clays are fairly stiff and tough while inorganic silts produce a weak and often soft thread which may be difficult to form and readily breaks and crumbles.

Dilatancy Test - Add sufficient water to the soil, held in the palm of the hand, to make it soft but not sticky. Shake horizontally, striking vigorously against the other hand several times. Dilatancy is indicated by the appearance of a shiny film on the surface of the soil. If the soil is then squeezed or pressed with the fingers, the surface becomes dull as the soil stiffens and eventually crumbles. These reactions are pronounced only for predominantly silt size material. Plastic clays give no reaction.

Descriptive Terms for Material Portions

COARSE GRAINED SOILS		FINE GRAINED SOILS	
% Fines	*Term/Modifier*	*% Coarse*	*Term/Modifier*
≤ 5	Omit, or use "trace"	≤ 15	Omit, or use "trace"
> 5, ≤ 12	"with clay/silt" as applicable	> 15, ≤ 30	"with sand/gravel" as applicable
> 12	Prefix soil as "silty/clayey"	> 30	Prefix as "sandy/gravelly"

Moisture Condition

for non-cohesive soils:

Dry -	runs freely through fingers.
Moist -	does not run freely but no free water visible on soil surface.
Wet -	free water visible on soil surface.

for cohesive soils:

MC > PL	Moisture content estimated to be greater than the plastic limit.
MC ~ PL	Moisture content estimated to be approximately equal to the plastic limit. The soil can be moulded
MC < PL	Moisture content estimated to be less than the plastic limit. The soil is hard and friable, or powdery.

The plastic limit (PL) is defined as the moisture content (percentage) at which the soil crumbles when rolled into threads of 3mm dia.

Consistency - For Clays & Silts

Description	*UCS(kPa)*	*Field guide to consistency*
Very soft	< 25	Exudes between the fingers when squeezed in hand
Soft	25 - 50	Can be moulded by light finger pressure
Firm	50 - 100	Can be moulded by strong finger pressure
Stiff	100 - 200	Cannot be moulded by fingers. Can be indented by thumb.
Very stiff	200 - 400	Can be indented by thumb nail
Hard	> 400	Can be indented with difficulty by thumb nail
Friable	-	Crumbles or powders when scraped by thumbnail

Relative Density for Gravels and Sands

Description	*SPT "N" Value*	*Density Index (ID) Range %*
Very loose	0 - 4	< 15
Loose	4 - 10	15 - 35
Medium dense	10 - 30	35 - 65
Dense	30 - 50	65 - 85
Very dense	> 50	> 85

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Summary of Rock Logging Procedures

Description order: constituents - rock name - grain size - colour - weathering - strength - minor constituents - additional observations.
- minor constituents - moisture w.r.t. plasticity - consistency - origin - additional observations.

Definition - Sedimentary Rock

Conglomerate	more than 50% of the rock consists of gravel (>2mm) sized fragments
Sandstone	more than 50% of the rock consists of sand (0.06 to 2mm) sized grains
Siltstone	more than 50% of the rock consists of silt sized granular particles and the rock is not laminated
Claystone	more than 50% of the rock consists of clay or mica material and the rock is not laminated
Shale	more than 50% of the rock consists of clay or silt sized particles and the rock is laminated

Weathering

Residual Soil	RS	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a change in volume but the soil has not significantly transported.
Extremely Weathered	EW	Rock is weathered to such an extent that it has 'soil' properties; ie. it either disintegrates or can be remoulded, in water.
Distinctly Weathered	DW	**Highly Weathered (HW)** - Rock is wholly discoloured and rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals **Moderately Weathered (MW)** - The whole of the rock is discoloured, usually by iron staining and bleaching. Shows little or no change in rock strength.
Slightly Weathered	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh	FR	Rock shows no sign of decomposition or staining.

Stratification

thinly laminated	<6mm	medium bedded	0.2 - 0.6m
laminated	6 - 20mm	thickly bedded	0.6 - 2m
very thinly bedded	20 - 60mm	very thickly bedded	>2m
thinly bedded	60mm - 0.2m		

Discontinuities

order of description: depth - type - orientation - spacing - roughness / planarity - thickness - coating

	Type	Class	Roughness/Planarity	Class	Roughness/Planarity
B	Bedding	I	rough or irregular, stepped	VI	slickensided, undulating
F	Fault	II	smooth, stepped	VII	rough or irregular, planar
C	Cleavage	III	slickensided, stepped	VIII	smooth, planar
J	Joint	IV	rough or irregular, undulating	IX	slickensided, planar
S	Shear Zone	V	smooth, undulating		
D	Drill break				

Rock Strength

Term		Is (50)	Field Guide
		0.03	
Very low	VL		Material crumbles under firm blows with sharp end of pick; can be peeled with knive. Pieces up to 30mm thick can be broken by finger pressure.
		0.1	
Low	L		A piece of core 150 mm long x 50 mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
		0.3	
Medium	M		A piece of core 150 mm long x 50 mm dia. can be broken by hand with considerable difficulty. Readily scored with knife.
		1	
High	H		A piece of core 150 mm long x 50 mm dia. core cannot be broken by unaided hands, can be slightly scratched or scored with knife.
		3	
Very High	VH		A piece of core 150 mm long x 50 mm dia. May be broken readily with hand held hammer. Cannot be scratched with pen knife.
		10	
Extremely High	EH		A piece of core 150 mm long x 50 mm dia. Is difficult to break with hand held hammer. Rings when struck with a hammer.

* - rock strength defined by point load strength (Is 50) in direction normal to bedding

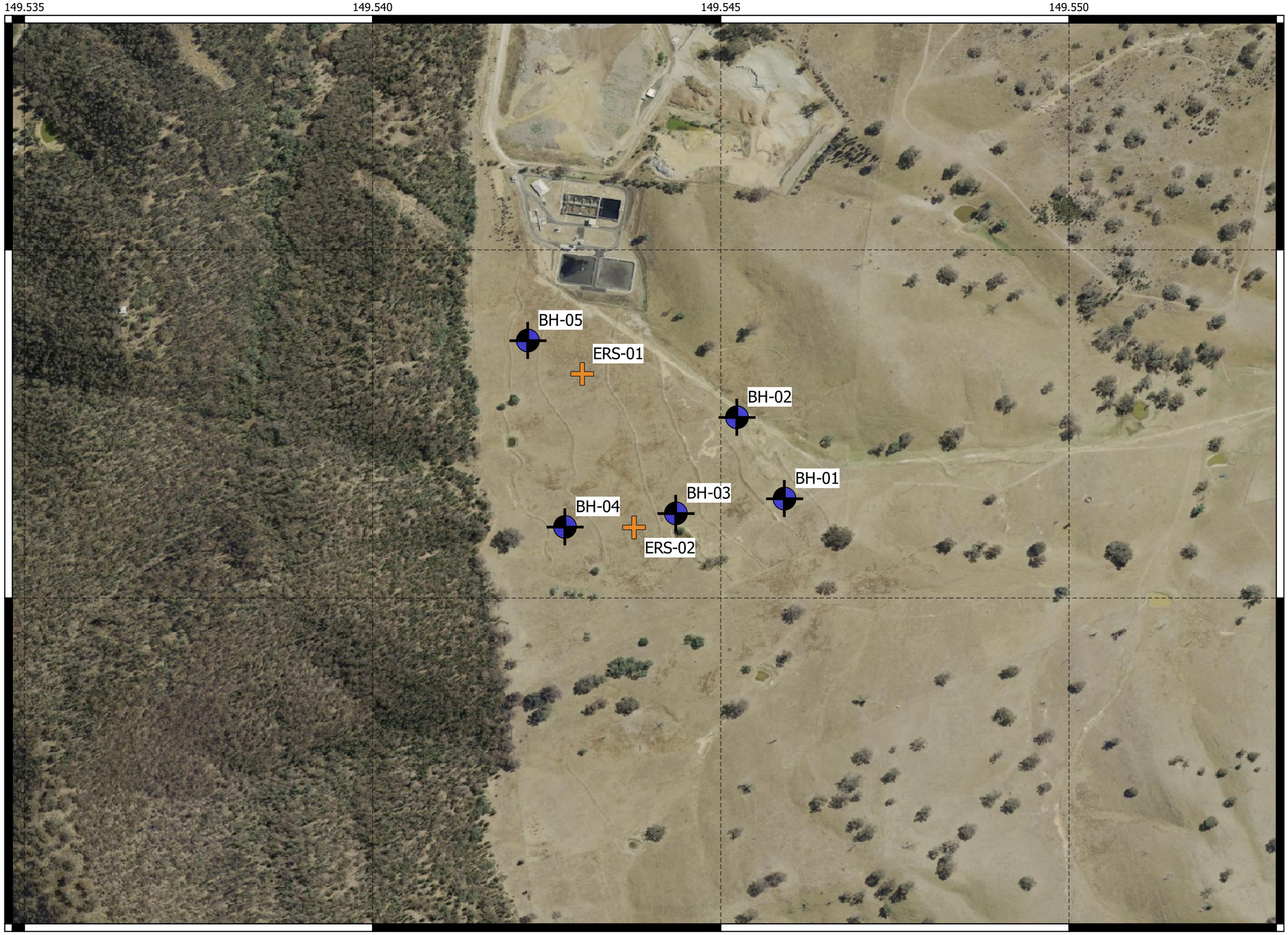
Degree of fracturing

fragmented	The core is comprised primarily of fragments of length less than 20mm, and mostly of width less than the core diameter
highly fractured	Core lengths are generally less than 20mm - 40mm with occasional fragments.
fractured	Core lengths are mainly 30mm - 100mm with occasional shorter and longer lengths
slightly fractured	Core lengths are generally 300mm - 1000mm with occasional longer sections and shorter sections of 100mm -- 300mm.
unbroken	The core does not contain any fracture.

- spacing of all types of natural fractures, but not artificial breaks, in cored bores.

The fracture spacing is shown where applicable and the Rock Quality Designation is given by: RQD (%) = sum of unbroken core pieces 100 mm or longer

Appendix B – Site Plan & Borehole Locations



MACQUARIE GEOTECH
3 Watt Drive, Bathurst NSW 2795
P: 02 6332 2011 F: 02 6334 4213 E: macgeo@macgeo.com.au

Client: Engie Electrical & Communications

Project: Mudgee 5MW Solar Farm

Location: Mudgee NSW

Drawn: A. Drösemeyer | Checked: J. Boyle | 08-09-2020

0 100 200 300 400 500

Metres - Scale 1:4000

Vertical to Horizontal Scale 1 : 1
Co-ordinate Reference System - EPSG: 4326 WGS: 84

JOB NO B20354

Macquarie Geotechnical Ltd
Geotechnical Investigation Locality Map

Drawing Number: B30354 - Rev0

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Appendix C – Borehole Logs

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Borehole No.
BH-01
Page 1 of 2

Engineering Log - Borehole

Project No.: B20354

Client:	Engie Electrical & Communications	Commenced:	20/08/2020
Project Name:	Mudgee 5MW Solar Farm	Completed:	20/08/2020
Hole Location:		Logged By:	L. Brindle
Hole Coordinates:	738986.7 m E 6392571.8 m N MGA94 Zone 55	Checked By:	J.Boyle

Drill Model and Mounting:	Christie Drill Rig	Inclination:	-90°	RL Surface:	495.62 m		
Hole Diameter:	114 - 250 mm	Bearing:		Datum:	AHD	Operator:	L. Brindle

Drilling Information									Soil Description			Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density / Pocket Penetrometer UCS (kPa)	Structure and Additional Observations
AD/T		Not Observed		1 B 0.10-0.50 m 1 D 0.10-0.50 m 1 2 B 0.50-1.00 m SPT 0.50-0.95 m 4,5,7 N=12 PP 0.50 m =200 kPa 2 D 1.00-1.50 m 2 SPT 1.50-1.79 m 5,11/140mm HB N=11/140mm PP 1.50 m =250 kPa		494.6	1		CL-CI	TOPSOIL Silty CLAY: medium plasticity, brown.			TOPSOIL
									CL-CI	Silty Sandy CLAY trace gravel: low to medium plasticity, orange-brown; sand fine to coarse grained; gravel fine sub-angular.	M (>PL)	St	RESIDUAL SOIL
									CI	Silty CLAY: medium plasticity, yellow-brown.		St to VSt	
						493.6	2		CL-CI	XW CLAYSTONE recovered as Silty Gravelly CLAY: low to medium plasticity, yellow-brown, with fine to medium angular gravel.	M (<PL)	H	EXTREMELY WEATHERED MATERIAL
						492.6	3			Hole Terminated at 2.70 m Refusal			
						491.6	4						
						490.6	5						

Method
AS - Auger Screwing
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

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
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

Plastic Limit
< PL
= PL
< PL

Engineering Log - Borehole

Project No.: B20354

Client:	Engie Electrical & Communications	Commenced:	20/08/2020
Project Name:	Mudgee 5MW Solar Farm	Completed:	20/08/2020
Hole Location:		Logged By:	L. Brindle
Hole Coordinates:	738986.7 m E 6392571.8 m N MGA94 Zone 55	Checked By:	J.Boyle

Drill Model and Mounting:	Christie Drill Rig	Inclination:	-90°	RL Surface:	495.62 m		
Hole Diameter:	114 - 250 mm	Bearing:		Datum:	AHD	Operator:	L. Brindle

BH-01 Depth Range: 0.50 - 0.95 m

BH-01 Depth Range: 1.50 - 1.79 m

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Borehole No.
BH-02
Page 1 of 3

Engineering Log - Borehole

Project No.: B20354

Client:	Engie Electrical & Communications	Commenced:	20/08/2020
Project Name:	Mudgee 5MW Solar Farm	Completed:	20/08/2020
Hole Location:		Logged By:	L. Brindle
Hole Coordinates:	738925.7 m E 6392702.6 m N MGA94 Zone 55	Checked By:	J.Boyle

Drill Model and Mounting:	Christie Drill Rig	Inclination:	-90°	RL Surface:	495.70 m		
Hole Diameter:	114 - 250 mm	Bearing:		Datum:	AHD	Operator:	L. Brindle

Drilling Information									Soil Description			Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density / Pocket Penetrometer UCS (kPa)	Structure and Additional Observations
AD/T		Not Observed		1 B 0.10-0.50 m 1 D 0.10-0.50 m 1 SPT 0.50-0.95 m 3,4,7 N=11 PP 0.50 m =200 kPa 2 D 1.00-1.50 m 2 SPT 1.50-1.95 m 6,6,7 N=13 PP 1.50 m =200 kPa 3 D 2.50-3.00 m 3 SPT 3.00-3.45 m 5,7,19 N=26 4 D 4.00-4.50 m 4 SPT 4.50-4.55 m 11/50mm HB		494.7 493.7 492.7 491.7 490.7	1 2 3 4 5		CI CL CL-CI	TOPSOIL Silty CLAY: medium plasticity, brown. Silty CLAY: medium plasticity, orange-brown. Silty Sandy CLAY with gravel: low plasticity, yellow-brown; sand fine to coarse grained; gravel fine to medium sub-angular to angular. XW CLAYSTONE recovered as Silty Gravelly CLAY: low to medium plasticity, yellow-brown, with fine to medium angular gravel. Hole Terminated at 5.00 m Target depth	M (>PL) M (~PL) M (<PL)	St VSt to H H	TOPSOIL RESIDUAL SOIL EXTREMELY WEATHERED MATERIAL

Method
AS - Auger Screwing
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

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
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

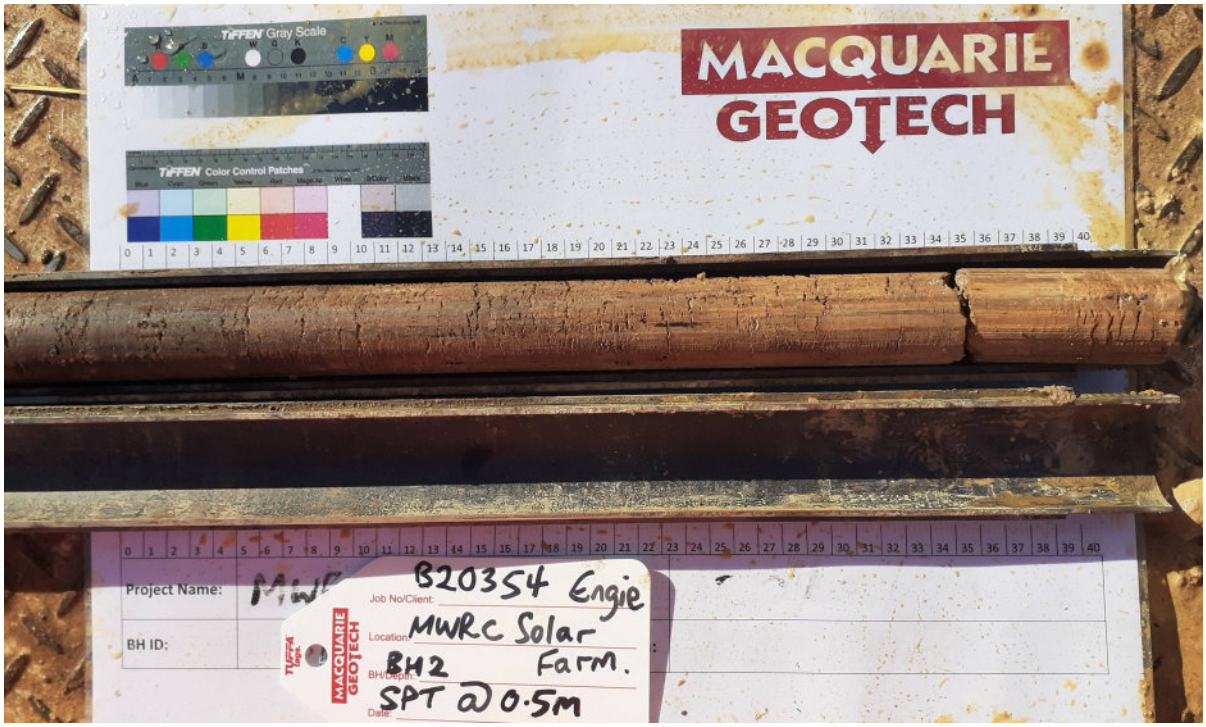
Plastic Limit
< PL
= PL
< PL

Engineering Log - Borehole

Project No.: B20354

Client:	Engie Electrical & Communications	Commenced:	20/08/2020
Project Name:	Mudgee 5MW Solar Farm	Completed:	20/08/2020
Hole Location:		Logged By:	L. Brindle
Hole Coordinates:	738925.7 m E 6392702.6 m N MGA94 Zone 55	Checked By:	J.Boyle

Drill Model and Mounting:	Christie Drill Rig	Inclination:	-90°	RL Surface:	495.70 m		
Hole Diameter:	114 - 250 mm	Bearing:		Datum:	AHD	Operator:	L. Brindle



BH-02 Depth Range: 0.50 - 0.95 m

BH-02 Depth Range: 1.50 - 1.95 m

Engineering Log - Borehole

Project No.: B20354

Client:	Engie Electrical & Communications	Commenced:	20/08/2020
Project Name:	Mudgee 5MW Solar Farm	Completed:	20/08/2020
Hole Location:		Logged By:	L. Brindle
Hole Coordinates:	738925.7 m E 6392702.6 m N MGA94 Zone 55	Checked By:	J.Boyle

Drill Model and Mounting:	Christie Drill Rig	Inclination:	-90°	RL Surface:	495.70 m		
Hole Diameter:	114 - 250 mm	Bearing:		Datum:	AHD	Operator:	L. Brindle

BH-02 Depth Range: 3.00 - 3.45 m

MACQUARIE GEOTECH

Borehole No.
BH-03
Page 1 of 3

Engineering Log - Borehole

Project No.: B20354

Client:	Engie Electrical & Communications	Commenced:	21/08/2020
Project Name:	Mudgee 5MW Solar Farm	Completed:	21/08/2020
Hole Location:		Logged By:	L. Brindle
Hole Coordinates:	738839.8 m E 6392551.2 m N MGA94 Zone 55	Checked By:	J.Boyle

Drill Model and Mounting:	Christie Drill Rig	Inclination:	-90°	RL Surface:	503.97 m		
Hole Diameter:	114 - 250 mm	Bearing:		Datum:	AHD	Operator:	L. Brindle

Drilling Information										Soil Description			Observations	
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	Pocket Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T			Not Observed	1 B 0.10-0.50 m 1 D 0.10-0.50 m 1 2 B 0.50-1.00 m SPT 0.50-0.95 m 2,4,8 N=12 PP 0.50 m =300 kPa 2 D 1.00-1.50 m 2 SPT 1.50-1.95 m 9,9,12 N=21 PP 1.50 m =300 kPa 3 D 2.50-3.00 m 3 SPT 3.00-3.45 m 13,14,18 N=32 PP 3.00 m =250 kPa 4 D 4.00-4.50 m 4 SPT 4.50-4.84 m 15,25,6/40mm N=31/190mm		503.0 502.0 501.0 500.0 499.0	1 2 3 4 5		CL CL-Cl	TOPSOIL Silty CLAY: medium plasticity, brown. Silty CLAY: low plasticity, orange-brown. Silty Sandy CLAY: low to medium plasticity, orange-brown; sand fine grained. Hole Terminated at 4.84 m Refusal	M (>PL) M (<PL)	St VSt VSt to H	×	TOPSOIL RESIDUAL SOIL

Method
AS - Auger Screwing
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

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
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

Plastic Limit
< PL
= PL
< PL

Engineering Log - Borehole

Project No.: B20354

Client:	Engie Electrical & Communications	Commenced:	21/08/2020
Project Name:	Mudgee 5MW Solar Farm	Completed:	21/08/2020
Hole Location:		Logged By:	L. Brindle
Hole Coordinates:	738839.8 m E 6392551.2 m N MGA94 Zone 55	Checked By:	J.Boyle

Drill Model and Mounting:	Christie Drill Rig	Inclination:	-90°	RL Surface:	503.97 m		
Hole Diameter:	114 - 250 mm	Bearing:		Datum:	AHD	Operator:	L. Brindle

BH-03 Depth Range: 0.50 - 0.95 m

BH-03 Depth Range: 1.50 - 1.95 m

Engineering Log - Borehole

Project No.: B20354

Client:	Engie Electrical & Communications	Commenced:	21/08/2020
Project Name:	Mudgee 5MW Solar Farm	Completed:	21/08/2020
Hole Location:		Logged By:	L. Brindle
Hole Coordinates:	738839.8 m E 6392551.2 m N MGA94 Zone 55	Checked By:	J.Boyle

Drill Model and Mounting:	Christie Drill Rig	Inclination:	-90°	RL Surface:	503.97 m		
Hole Diameter:	114 - 250 mm	Bearing:		Datum:	AHD	Operator:	L. Brindle

BH-03 Depth Range: 3.00 - 3.45 m

BH-03 Depth Range: 4.50 - 4.84 m

MACQUARIE GEOTECH

Borehole No.
BH-04
Page 1 of 3

Engineering Log - Borehole

Project No.: B20354

Client:	Engie Electrical & Communications	Commenced:	21/08/2020
Project Name:	Mudgee 5MW Solar Farm	Completed:	21/08/2020
Hole Location:		Logged By:	L. Brindle
Hole Coordinates:	738689.6 m E 6392533.2 m N MGA94 Zone 55	Checked By:	J.Boyle

Drill Model and Mounting:	Christie Drill Rig	Inclination:	-90°	RL Surface:	515.77 m		
Hole Diameter:	114 mm	Bearing:		Datum:	AHD	Operator:	L. Brindle

Drilling Information									Soil Description				Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	Pocket Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T			Not Observed	1 D 0.10-0.50 m					CI	TOPSOIL Silty CLAY: medium plasticity, brown.				TOPSOIL
				1 SPT 0.50-0.95 m 3,6,14 N=20 PP 0.50 m =400 kPa		514.8	1			Silty Sandy CLAY: medium plasticity, dark orange-brown; sand fine grained.	M (>PL)	St to VSt	×	RESIDUAL SOIL
				2 D 1.00-1.50 m					CL-CI	Silty Sandy CLAY: low to medium plasticity, pale orange-brown; sand fine to coarse grained.		VSt to H		
				2 SPT 1.50-1.65 m 30 HB		513.8	2							1.50: Material fissile
				3 D 2.50-3.00 m							M (<PL)			
				3 SPT 3.00-3.09 m 30/90mm HB		512.8	3					H		3.00: Material fissile
				4 D 4.00-4.50 m		511.8	4							
				4 SPT 4.50-4.55 m 30/50mm HB		510.8	5			Hole Terminated at 5.00 m Target depth				

Method
AS - Auger Screwing
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

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
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

Plastic Limit
< PL
= PL
< PL

Engineering Log - Borehole

Project No.: B20354

Client:	Engie Electrical & Communications	Commenced:	21/08/2020
Project Name:	Mudgee 5MW Solar Farm	Completed:	21/08/2020
Hole Location:		Logged By:	L. Brindle
Hole Coordinates:	738689.6 m E 6392533.2 m N MGA94 Zone 55	Checked By:	J.Boyle

Drill Model and Mounting:	Christie Drill Rig	Inclination:	-90°	RL Surface:	515.77 m		
Hole Diameter:	114 mm	Bearing:		Datum:	AHD	Operator:	L. Brindle

BH-04 Depth Range: 0.50 - 0.95 m

BH-04 Depth Range: 1.50 - 1.65 m

Engineering Log - Borehole

Project No.: B20354

Client:	Engie Electrical & Communications	Commenced:	21/08/2020
Project Name:	Mudgee 5MW Solar Farm	Completed:	21/08/2020
Hole Location:		Logged By:	L. Brindle
Hole Coordinates:	738689.6 m E 6392533.2 m N MGA94 Zone 55	Checked By:	J.Boyle

Drill Model and Mounting:	Christie Drill Rig	Inclination:	-90°	RL Surface:	515.77 m		
Hole Diameter:	114 mm	Bearing:		Datum:	AHD	Operator:	L. Brindle

BH-04 Depth Range: 3.00 - 3.09 m

MACQUARIE GEOTECH

Borehole No.
BH-05
Page 1 of 2

Engineering Log - Borehole

Project No.: B20354

Client:	Engie Electrical & Communications	Commenced:	21/08/2020
Project Name:	Mudgee 5MW Solar Farm	Completed:	21/08/2020
Hole Location:		Logged By:	L. Brindle
Hole Coordinates:	738646.6 m E 6392831.4 m N MGA94 Zone 55	Checked By:	J.Boyle

Drill Model and Mounting:	Christie Drill Rig	Inclination:	-90°	RL Surface:	514.13 m		
Hole Diameter:	114 - 250 mm	Bearing:		Datum:	AHD	Operator:	L. Brindle

Drilling Information									Soil Description			Observations	
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	Pocket Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T			Not Observed	1 B 0.10-0.50 m 1 D 0.10-0.50 m 1 2 B 0.50-1.00 m 2 D 0.50-1.50 m SPT 0.50-0.95 m 7,7,10 N=17 PP 0.50 m =300 kPa 3 D 1.00-1.20 m SPT 1.50-1.55 m 30/50mm		513.1	1		CI	TOPSOIL Silty CLAY: medium plasticity, brown.				TOPSOIL
									CI	Silty CLAY: medium plasticity, orange-brown.	M (>PL)			RESIDUAL SOIL
									GP	Clayey Sandy GRAVEL with silt: fine to medium grained, angular, brown; sand fine to coarse grained; clay low to medium plasticity.	M (<PL)	St to VSt	×	
									GC	XW rock recovered as Silty Clayey GRAVEL with sand: fine to medium angular, brown, low to medium plasticity clay, fine to coarse grained sand.		H		EXTREMELY WEATHERED MATERIAL
						512.1	2			Hole Terminated at 1.65 m Refusal				
						511.1	3							
						510.1	4							
						509.1	5							

Method
AS - Auger Screwing
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

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
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

Plastic Limit
< PL
= PL
< PL

Engineering Log - Borehole

Project No.: B20354

Client:	Engie Electrical & Communications	Commenced:	21/08/2020
Project Name:	Mudgee 5MW Solar Farm	Completed:	21/08/2020
Hole Location:		Logged By:	L. Brindle
Hole Coordinates:	738646.6 m E 6392831.4 m N MGA94 Zone 55	Checked By:	J.Boyle

Drill Model and Mounting:	Christie Drill Rig	Inclination:	-90°	RL Surface:	514.13 m		
Hole Diameter:	114 - 250 mm	Bearing:		Datum:	AHD	Operator:	L. Brindle

BH-05 Depth Range: 0.50 - 0.95 m

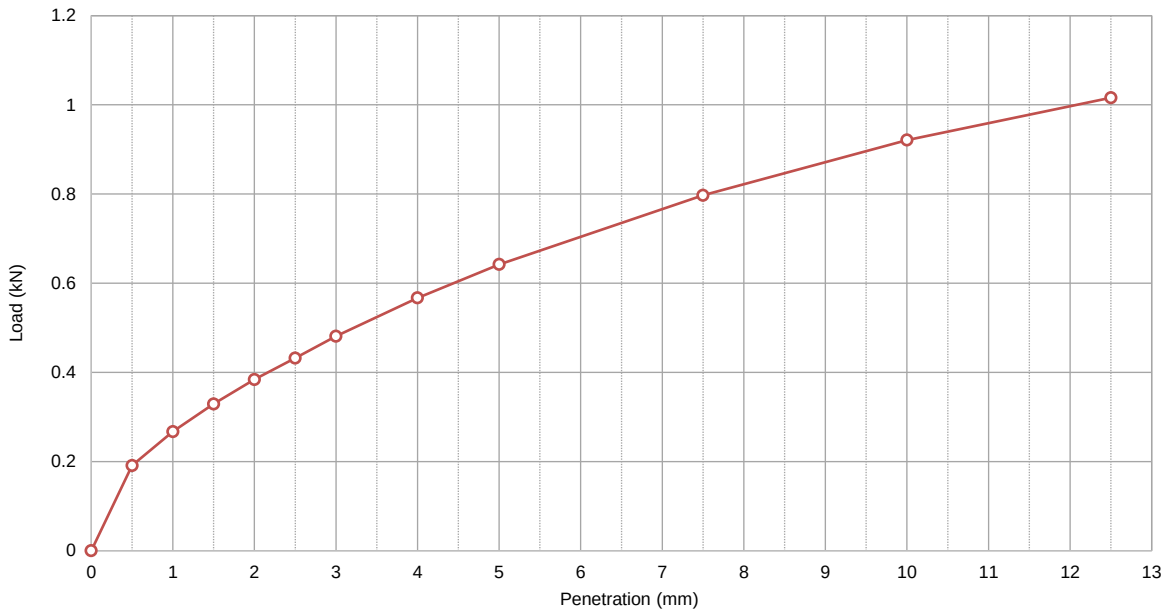
Appendix D – Laboratoty Test Results

CALIFORNIA BEARING RATIO REPORT

Client	Engie Electrical & Communications	**Source**	BH1 0.1-0.5m
Address	171 Grange Road Fairfield, VIC 3078	**Sample Description**	Sandy CLAY trace gravel
Project	Mudgee 5MW Solar Farm	**Report No.**	B63718-CBR
Job No.	B20354	**Sample No.**	B63718

Test Procedure:				
☑	AS 1289.6.1.1	☐	RMS T117	California Bearing Ratio
☑	AS 1289.5.1.1	☐	RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
☐	AS 1289.5.2.1	☐	RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
☑	AS 1289.2.1.1	☐	RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling:	AS 1289.1.2.1 - 6.5.3 (Power auger drilling)	**Date Sampled:**	20/08/2020
Preparation:	AS1289 1.1		



Preparation & Specification		Density & Moisture	Achieved	Target
Retained on 19.0mm Sieve (%)	1	Lab Moisture Ratio - LMR (%)	101.5	100.0
Method of Establishing Plasticity Level	Technician Assessment	Lab Density Ratio - LDR (%)	99.0	100.0
Sample Curing Time (hrs)	74 hrs	Dry Density - At Compaction (t/m³)	1.85	1.87
Compaction Hammer Used	Standard	Dry Density - After Soaking (t/m³)	1.85	
Surcharge Mass Applied (kg)	4.5	Specimen Swell (%)	0.4	
Period of Soaking (Days)	4	Moisture Content - At Compaction (%)	16.0	
Maximum Dry Density - MDD (t/m³)	1.87	Moisture Content - Top 30mm (%)	18.9	
Optimum Moisture Content - OMC (%)	15.8	Moisture Content - Remainder (%)	18.0	

Material CBR Value (%): **3.5** **at a penetration of** **2.5** **mm**

Notes:

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9/09/2020

John Boyle Date:

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Bathurst NSW 2795

SOIL CLASSIFICATION REPORT

Client	Engie Electrical & Communications	**Source**	BH1 0.1-0.5m
Address	171 Grange Road Fairfield, VIC 3078	**Sample Description**	Sandy CLAY trace gravel
Project	Mudgee 5MW Solar Farm	**Report No.**	B63718-PI
Job No.	B20354	**Sample No.**	B63718

Test Procedure:

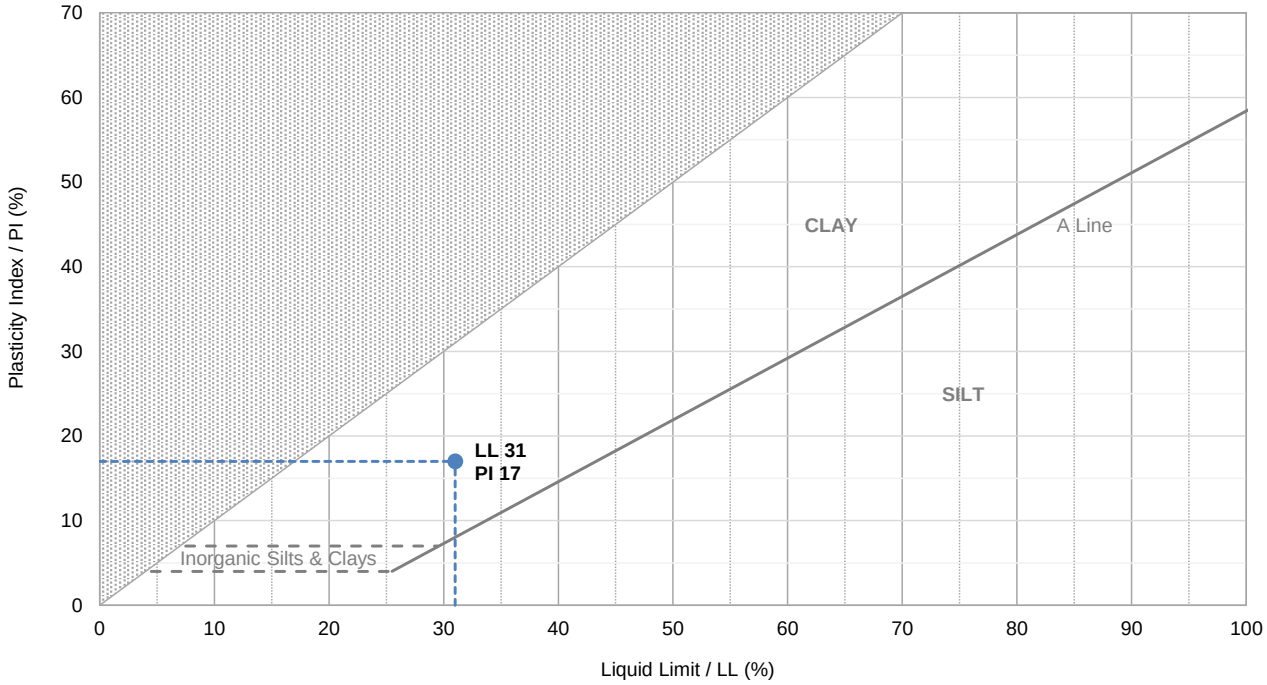
☐	AS 1289.2.1.1	Moisture Content - Oven drying method (Standard method)
☑	AS 1289.3.1.1	Liquid Limit - Four point Casagrande method
☐	AS 1289.3.1.2	Liquid Limit - One point Casagrande method
☑	AS 1289.3.2.1	Plastic Limit - Standard method
☑	AS 1289.3.3.1	Calculation of the Plasticity Index
☑	AS 1289.3.4.1	Linear Shrinkage - Standard method

Sampling: AS 1289.1.2.1 - 6.5.3 (Power auger drilling) **Date Sampled:** 20/08/2020

Preparation: AS1289 1.1

Plasticity Chart for Classification of Fine-Grained Soils

AS 1726:2017 Clause 6.1.6 (Figure 5)



Preparation		Results	
Field Moisture Content (%)	-	Liquid Limit / LL (%)	**31**
Method of Preparation	**Dry Sieved**	Plastic Limit (%)	**14**
History of the Sample	**Oven Dried**	Plasticity Index / PI (%)	**17**
		Linear Shrinkage (%)	**9.0**
		Condition upon Drying	**Linear**

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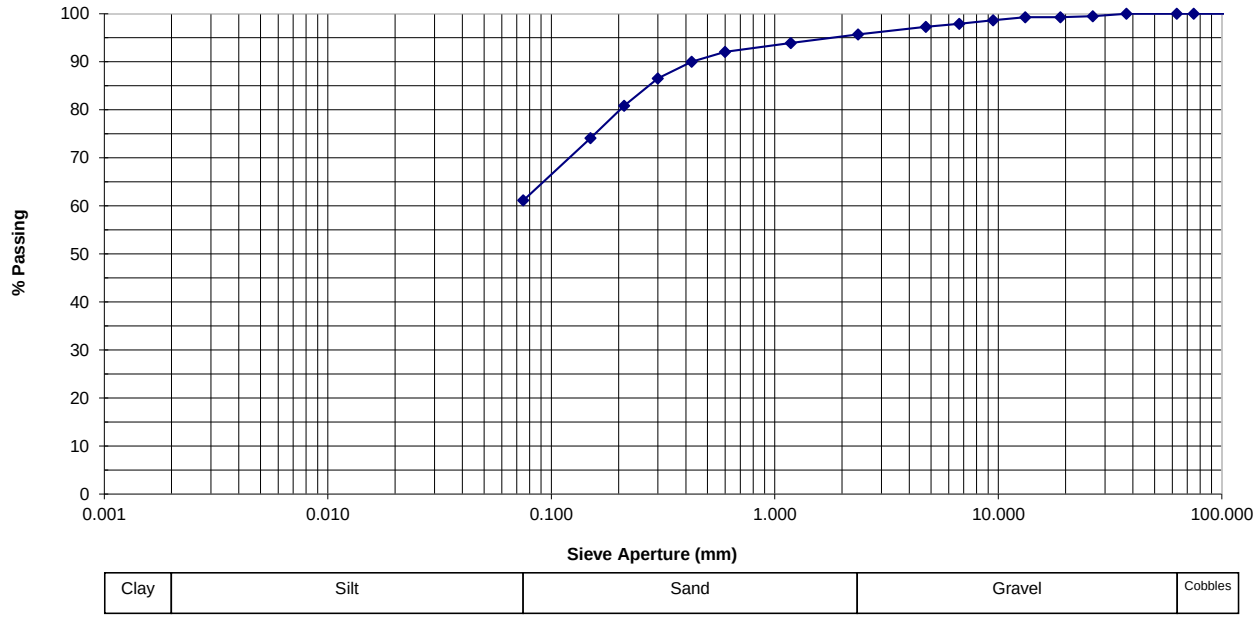
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Engie Electrical & Communications	**Source:**	BH1 0.1-0.5m
Address:	171 Grange Road Fairfield, VIC 3078	**Sample Description:**	Sandy CLAY trace gravel
Project:	Mudgee 5MW Solar Farm	**Report No:**	B63718-PSD
Job No:	B20354	**Lab No:**	B63718

Test Procedure: ☑ AS1289 3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving

Sampling:	AS 1289.1.2.1 - 6.5.3 (Power auger drilling)	**Date Sampled:**	20/08/2020
Preparation:	AS1289 1.1		



Sieve Apperture: (mm)	% Passing	Specification N/A Envelope	Sieve Aperture: (mm)	% Passing	Specification N/A Envelope
200	100		4.75	97	
75	100		2.36	96	
63	100		1.18	94	
37.5	100		0.600	92	
26.5	100		0.425	90	
19	99		0.300	87	
13.2	99		0.212	81	
9.5	99		0.150	74	
6.7	98		0.075	61	

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Date:

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SOIL CHEMICAL PROPERTIES REPORT

Client	Engie Electrical & Communications	**Source**	BH1 0.5-0.95m
Address	171 Grange Road Fairfield, VIC 3078	**Sample Description**	Sandy silty CLAY trace gravel
Project	Mudgee 5MW Solar Farm	**Report No.**	B63719-SCP
Job No	B20354	**Lab No.**	B63719

Test Procedure:

☑	AS1289 4.2.1	Soil Chemical Tests - Determination of a sulfate content of a natural soil and the sulfate content of the groundwater - Normal Method
☑	AS1289 4.3.1	Soil Chemical Tests - Determination of the pH value of a soil - Electrometric method
☐	AS 1289 4.4.1	Soil Chemical Tests - Determination of the electrical resistivity of a soil - Method for sands and granular material
☐	AS 1012.20	Chloride and sulphate
☐	RMS T123	pH value of a soil (electrometric method)
☐	RMS T185	Resistivity of sands and granular road construction materials
☐	RMS T200	Chloride content of roadbase
☑	RMS T1010	Quantitative determination of chlorides in soil
☐	RMS T1011	Quantitative determination of sulphates in soil
☐	BS1377(1990 pt.3)	Water soluble sulphate content
☐	APHA 4500 H+B	pH
☐	APHA 4500 SO4 2-B	Sulphate
☐	APHA 4500 Cl-B	Chloride
☑	APHA 2510 & 2520-B	Electrical Conductivity
☐	TAI B117	Sulphides Present (This service Not Covered by NATA Accreditation)

Sampling:	AS 1289.1.2.1 - 6.5.3 (Power auger drilling)	**Date Sampled:**	20/08/2020
Preparation:	Prepared in accordance with the test method		

Sulphides Present	-
Sulphur Peroxide (% w/w)	-
Sulphate content (ppm)	40.9
Sulphate content (% w/w)	0.00
Chloride ion content (ppm)	170.6
Chloride ion content (% w/w)	0.02
pH	10.1
Electrical Conductivity (uS/cm)	640.0
Mean Resistivity Ω.m	-
(Resisitivity) Density ratio (R_D)	-
(Resisitivity) Density index (I_D)	-

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

[redacted]

Brad Morris

2/09/2020

Date:

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Bathurst NSW 2795

SOIL CLASSIFICATION REPORT

Client	Engie Electrical & Communications	**Source**	BH03 1.5-1.95m
Address	171 Grange Road Fairfield, VIC 3078	**Sample Description**	Silty CLAY
Project	Mudgee 5MW Solar Farm	**Report No.**	B63738-PI
Job No.	B20354	**Sample No.**	B63738

Test Procedure:

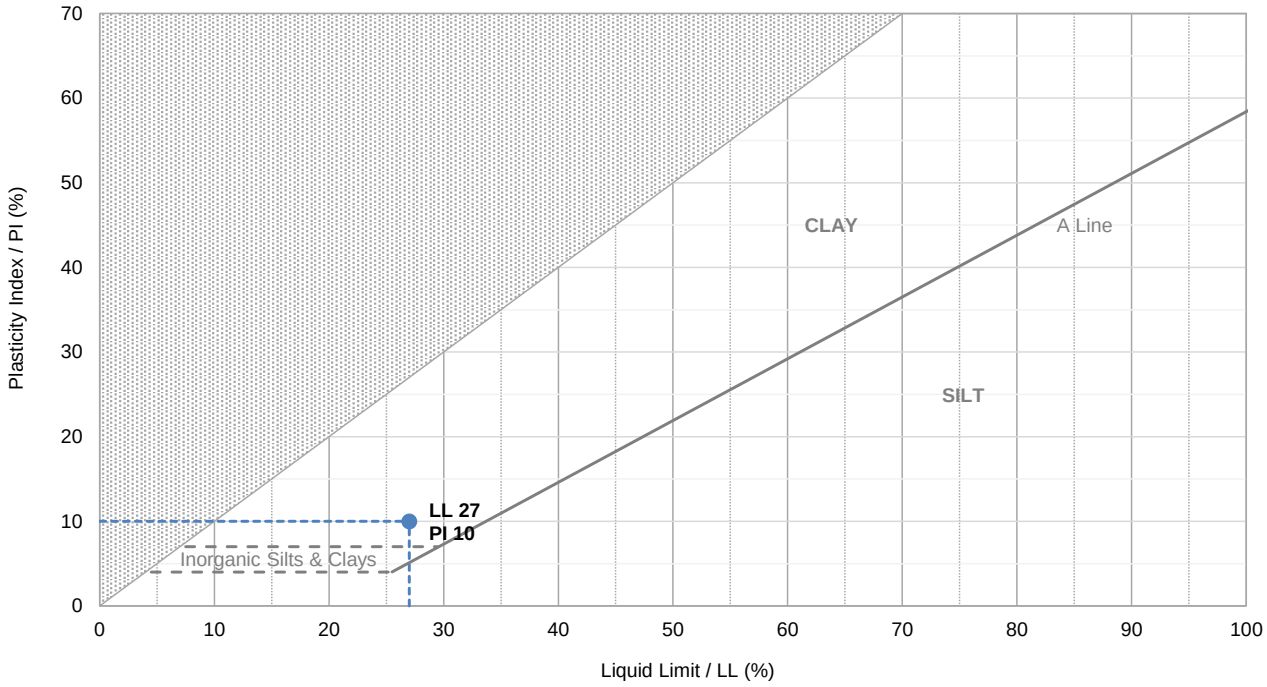
☐	AS 1289.2.1.1	Moisture Content - Oven drying method (Standard method)
☑	AS 1289.3.1.1	Liquid Limit - Four point Casagrande method
☐	AS 1289.3.1.2	Liquid Limit - One point Casagrande method
☑	AS 1289.3.2.1	Plastic Limit - Standard method
☑	AS 1289.3.3.1	Calculation of the Plasticity Index
☑	AS 1289.3.4.1	Linear Shrinkage - Standard method

Sampling: AS 1289.1.2.1 - 6.5.3 (Power auger drilling) **Date Sampled:** 21/08/2020

Preparation: AS1289 1.1

Plasticity Chart for Classification of Fine-Grained Soils

AS 1726:2017 Clause 6.1.6 (Figure 5)



Preparation		Results	
Field Moisture Content (%)	-	Liquid Limit / LL (%)	**27**
Method of Preparation	**Dry Sieved**	Plastic Limit (%)	**17**
History of the Sample	**Oven Dried**	Plasticity Index / PI (%)	**10**
		Linear Shrinkage (%)	**4.0**
		Condition upon Drying	**Linear**

Notes:

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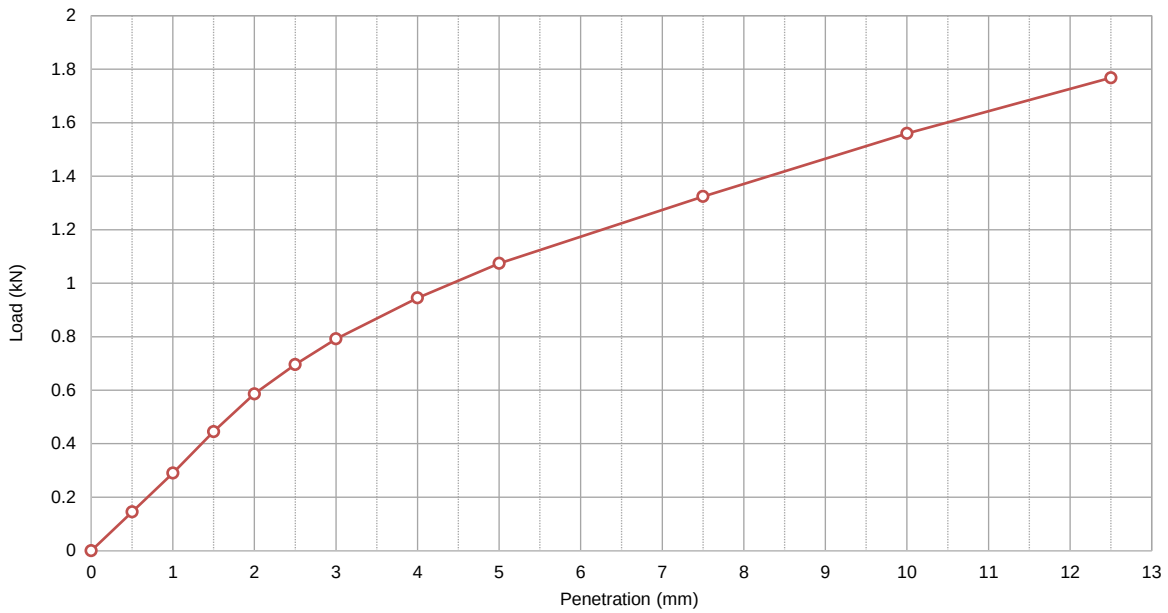
CALIFORNIA BEARING RATIO REPORT

Client	Engie Electrical & Communications	**Source**	BH02 0.5-1.0m
Address	171 Grange Road Fairfield, VIC 3078	**Sample Description**	Silty CLAY
Project	Mudgee 5MW Solar Farm	**Report No.**	B63728-CBR
Job No.	B20354	**Sample No.**	B63728

Test Procedure:				
☑	AS 1289.6.1.1	☐	RMS T117	California Bearing Ratio
☑	AS 1289.5.1.1	☐	RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
☐	AS 1289.5.2.1	☐	RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
☑	AS 1289.2.1.1	☐	RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling:	RMS T100 - AS 1289.1.2.1 - 6.5.3 (Power auger drilling)	**Date Sampled:**	20/08/2020
Preparation:	AS1289 1.1		



Preparation & Specification		**Density & Moisture**	**Achieved**	**Target**
Retained on 19.0mm Sieve (%)	0	Lab Moisture Ratio - LMR (%)	100.5	100.0
Method of Establishing Plasticity Level	Technician Assessment	Lab Density Ratio - LDR (%)	99.5	100.0
Sample Curing Time (hrs)	74 hrs	Dry Density - At Compaction (t/m³)	1.86	1.87
Compaction Hammer Used	Standard	Dry Density - After Soaking (t/m³)	1.85	
Surcharge Mass Applied (kg)	4.5	Specimen Swell (%)	0.7	
Period of Soaking (Days)	4	Moisture Content - At Compaction (%)	14.5	
Maximum Dry Density - MDD (t/m³)	1.87	Moisture Content - Top 30mm (%)	18.5	
Optimum Moisture Content - OMC (%)	14.4	Moisture Content - Remainder (%)	17.5	

Material CBR Value (%): **5** **at a penetration of** **2.5** **mm**

Notes:

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NATA Accredited Laboratory Number: 14874

Authorised Signatory: [redacted]

9/09/2020

John Boyle Date:

MACQUARIE GEOTECH

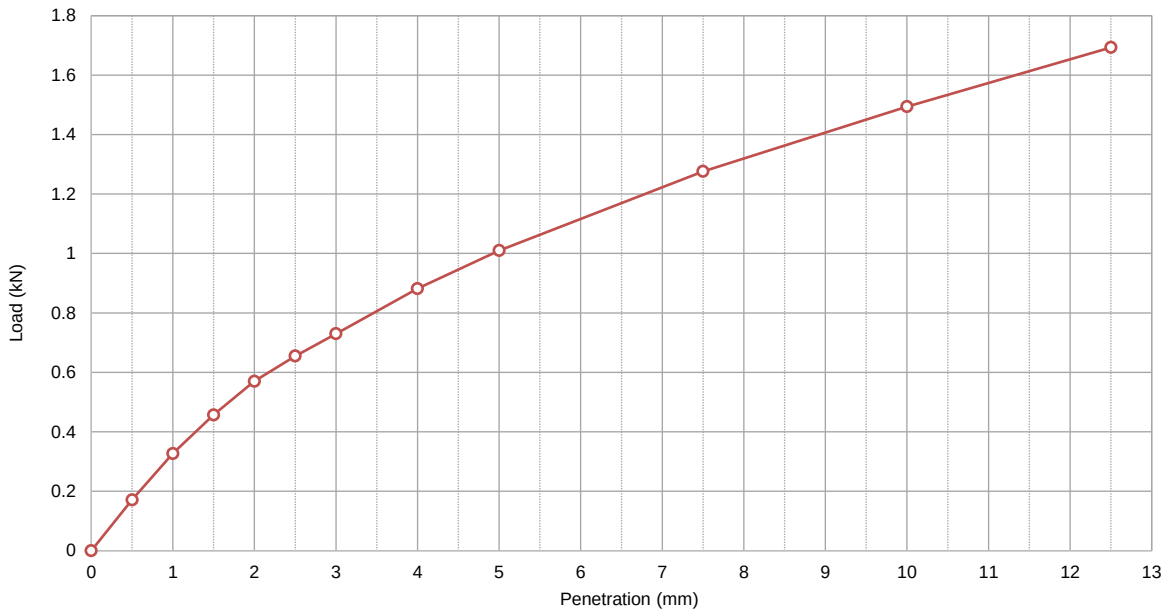
Macquarie Geotechnical
3 Watt Drive
Bathurst NSW 2795

CALIFORNIA BEARING RATIO REPORT

Client	Engie Electrical & Communications	**Source**	BH03 0.1-0.5m
Address	171 Grange Road Fairfield, VIC 3078	**Sample Description**	Silty CLAY
Project	Mudgee 5MW Solar Farm	**Report No.**	B63729-CBR
Job No.	B20354	**Sample No.**	B63729

Test Procedure:				
☑	AS 1289.6.1.1	☐	RMS T117	California Bearing Ratio
☑	AS 1289.5.1.1	☐	RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
☐	AS 1289.5.2.1	☐	RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
☑	AS 1289.2.1.1	☐	RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling:	AS 1289.1.2.1 - 6.5.3 (Power auger drilling)	**Date Sampled:**	21/08/2020
Preparation:	AS1289 1.1		



Preparation & Specification		Density & Moisture	Achieved	Target
Retained on 19.0mm Sieve (%)	0	Lab Moisture Ratio - LMR (%)	99.5	100.0
Method of Establishing Plasticity Level	Technician Assessment	Lab Density Ratio - LDR (%)	100.0	100.0
Sample Curing Time (hrs)	74 hrs	Dry Density - At Compaction (t/m³)	1.82	1.82
Compaction Hammer Used	Standard	Dry Density - After Soaking (t/m³)	1.81	
Surcharge Mass Applied (kg)	4.5	Specimen Swell (%)	0.4	
Period of Soaking (Days)	4	Moisture Content - At Compaction (%)	15.3	
Maximum Dry Density - MDD (t/m³)	1.82	Moisture Content - Top 30mm (%)	20.4	
Optimum Moisture Content - OMC (%)	15.3	Moisture Content - Remainder (%)	18.9	

Material CBR Value (%): **5** **at a penetration of** **2.5** **mm**

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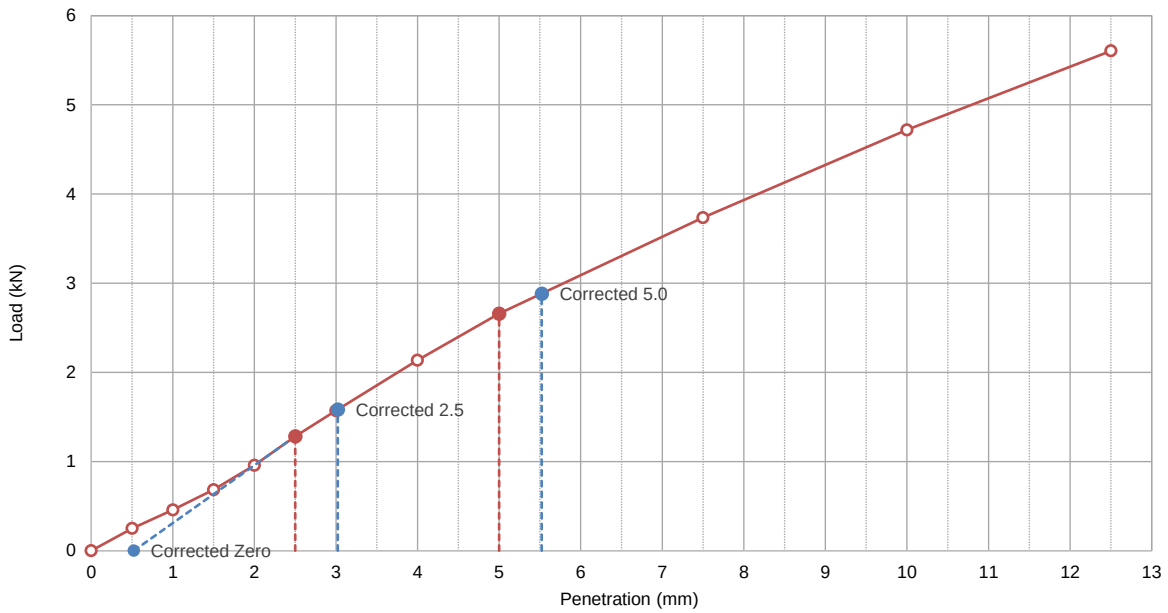
CALIFORNIA BEARING RATIO REPORT

Client	Engie Electrical & Communications	**Source**	BH05 0.5-1.0m
Address	171 Grange Road Fairfield, VIC 3078	**Sample Description**	Clayey sandy GRAVEL
Project	Mudgee 5MW Solar Farm	**Report No.**	B63730-CBR
Job No.	B20354	**Sample No.**	B63730

Test Procedure:				
☑	AS 1289.6.1.1	☐	RMS T117	California Bearing Ratio
☑	AS 1289.5.1.1	☐	RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
☐	AS 1289.5.2.1	☐	RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
☑	AS 1289.2.1.1	☐	RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling:	AS 1289.1.2.1 - 6.5.3 (Power auger drilling)	**Date Sampled:**	21/08/2020
Preparation:	AS1289 1.1		



Preparation & Specification		Density & Moisture	Achieved	Target
Retained on 19.0mm Sieve (%)	0	Lab Moisture Ratio - LMR (%)	99.0	100.0
Method of Establishing Plasticity Level	Technician Assessment	Lab Density Ratio - LDR (%)	99.5	100.0
Sample Curing Time (hrs)	74 hrs	Dry Density - At Compaction (t/m³)	2.01	2.02
Compaction Hammer Used	Standard	Dry Density - After Soaking (t/m³)	2.00	
Surcharge Mass Applied (kg)	4.5	Specimen Swell (%)	0.2	
Period of Soaking (Days)	4	Moisture Content - At Compaction (%)	11.7	
Maximum Dry Density - MDD (t/m³)	2.02	Moisture Content - Top 30mm (%)	13.4	
Optimum Moisture Content - OMC (%)	11.8	Moisture Content - Remainder (%)	13.0	

Material CBR Value (%): **15** **at a penetration of** **5.0** **mm**

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SOIL CHEMICAL PROPERTIES REPORT

Client	Engie Electrical & Communications	**Source**	BH03 1.5-1.95m
Address	171 Grange Road Fairfield, VIC 3078	**Sample Description**	Silty CLAY
Project	Mudgee 5MW Solar Farm	**Report No.**	B63731-SCP
Job No	B20354	**Lab No.**	B63731

Test Procedure:

☑	AS1289 4.2.1	Soil Chemical Tests - Determination of a sulfate content of a natural soil and the sulfate content of the groundwater - Normal Method
☑	AS1289 4.3.1	Soil Chemical Tests - Determination of the pH value of a soil - Electrometric method
☐	AS 1289 4.4.1	Soil Chemical Tests - Determination of the electrical resistivity of a soil - Method for sands and granular material
☐	AS 1012.20	Chloride and sulphate
☐	RMS T123	pH value of a soil (electrometric method)
☐	RMS T185	Resistivity of sands and granular road construction materials
☐	RMS T200	Chloride content of roadbase
☑	RMS T1010	Quantitative determination of chlorides in soil
☐	RMS T1011	Quantitative determination of sulphates in soil
☐	BS1377(1990 pt.3)	Water soluble sulphate content
☐	APHA 4500 H+B	pH
☐	APHA 4500 SO4 2-B	Sulphate
☐	APHA 4500 Cl-B	Chloride
☑	APHA 2510 & 2520-B	Electrical Conductivity
☐	TAI B117	Sulphides Present (This service Not Covered by NATA Accreditation)

Sampling:	AS 1289.1.2.1 - 6.5.3 (Power auger drilling)	**Date Sampled:**	21/08/2020
Preparation:	Prepared in accordance with the test method		

Sulphides Present	-
Sulphur Peroxide (% w/w)	-
Sulphate content (ppm)	31.7
Sulphate content (% w/w)	0.00
Chloride ion content (ppm)	93.1
Chloride ion content (% w/w)	0.01
pH	9.1
Electrical Conductivity (uS/cm)	70.4
Mean Resistivity Ω.m	-
(Resisitivity) Density ratio (R_D)	-
(Resisitivity) Density index (I_D)	-

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Authorised Signatory:

[redacted]

Brad Morris

8/09/2020

Date:

Macquarie Geotechnical
3 Watt Drive
Bathurst NSW 2795

SOIL CHEMICAL PROPERTIES REPORT

Client	Engie Electrical & Communications	**Source**	BH04 3.00-3.45m
Address	171 Grange Road Fairfield, VIC 3078	**Sample Description**	Sandy silty CLAY trace gravel
Project	Mudgee 5MW Solar Farm	**Report No.**	B63732-SCP
Job No	B20354	**Lab No.**	B63732

Test Procedure:

☑	AS1289 4.2.1	Soil Chemical Tests - Determination of a sulfate content of a natural soil and the sulfate content of the groundwater - Normal Method
☑	AS1289 4.3.1	Soil Chemical Tests - Determination of the pH value of a soil - Electrometric method
☐	AS 1289 4.4.1	Soil Chemical Tests - Determination of the electrical resistivity of a soil - Method for sands and granular material
☐	AS 1012.20	Chloride and sulphate
☐	RMS T123	pH value of a soil (electrometric method)
☐	RMS T185	Resistivity of sands and granular road construction materials
☐	RMS T200	Chloride content of roadbase
☑	RMS T1010	Quantitative determination of chlorides in soil
☐	RMS T1011	Quantitative determination of sulphates in soil
☐	BS1377(1990 pt.3)	Water soluble sulphate content
☐	APHA 4500 H+B	pH
☐	APHA 4500 SO4 2-B	Sulphate
☐	APHA 4500 Cl-B	Chloride
☑	APHA 2510 & 2520-B	Electrical Conductivity
☐	TAI B117	Sulphides Present (This service Not Covered by NATA Accreditation)

Sampling:	AS 1289.1.2.1 - 6.5.3 (Power auger drilling)	**Date Sampled:**	21/08/2020
Preparation:	Prepared in accordance with the test method		

Sulphides Present	-
Sulphur Peroxide (% w/w)	-
Sulphate content (ppm)	26.6
Sulphate content (% w/w)	0.00
Chloride ion content (ppm)	59.9
Chloride ion content (% w/w)	0.01
pH	9.4
Electrical Conductivity (uS/cm)	121.0
Mean Resistivity Ω.m	-
(Resisitivity) Density ratio (R_D)	-
(Resisitivity) Density index (I_D)	-

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Authorised Signatory:

[redacted]

Brad Morris

2/09/2020

Date:

Macquarie Geotechnical
3 Watt Drive
Bathurst NSW 2795

SHRINK SWELL INDEX REPORT

Client	Engie Electrical & Communications	**Source**	BH2 1.0-1.5m
Address	171 Grange Road Fairfield, VIC 3078	**Sample Description**	Silty CLAY
Project	Mudgee 5MW Solar Farm	**Report No**	B63733-SS
Job No	B20354	**Lab No**	B63733

Test Procedure: ☑ AS1289 7.1.1 Soil reactivity tests- Determination of the shrinkage index of a soil - Shrink-swell index

Sampling: AS 1289.1.2.1 - 6.5.3 (Power auger drilling) **Date Sampled:** 20/08/2020

Preparation: Prepared in accordance with the test method

Swell Test:

Swell on Saturation(E_{SW}):	0.0
Moisture Content Before Test (%):	14.0
Moisture Content After Test (%):	15.8

Shrink Test:

Shrinkage on Drying (E_{SH}%):	0.9
Estimated Inert Material Present (%):	0.0
Extent of Crumbling During Shrinkage:	MINOR
Extent of Cracking During Shrinkage:	MINOR
Moisture Content (%)	13.7

Shrink Swell Preparation: Remoulded

Shrink Swell Index:

Iss: **0.5**

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John Boyle

9/09/2020

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SHRINK SWELL INDEX REPORT

Client	Engie Electrical & Communications	**Source**	BH04 1.0-1.5m
Address	171 Grange Road Fairfield, VIC 3078	**Sample Description**	Silty sandy CLAY
Project	Mudgee 5MW Solar Farm	**Report No**	B63734-SS
Job No	B20354	**Lab No**	B63734

Test Procedure: ☑ AS1289 7.1.1 Soil reactivity tests- Determination of the shrinkage index of a soil - Shrink-swell index

Sampling: AS 1289.1.2.1 - 6.5.3 (Power auger drilling) **Date Sampled:** 21/08/2020

Preparation: Prepared in accordance with the test method

Swell Test:

Swell on Saturation(E_{SW}):	0.0
Moisture Content Before Test (%):	13.9
Moisture Content After Test (%):	14.3

Shrink Test:

Shrinkage on Drying (E_{SH}%):	1.0
Estimated Inert Material Present (%):	0.0
Extent of Crumbling During Shrinkage:	MINOR
Extent of Cracking During Shrinkage:	MINOR
Moisture Content (%)	14.0

Shrink Swell Preparation: Remoulded

Shrink Swell Index:

Iss: **0.5**

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Bathurst NSW 2795

SHRINK SWELL INDEX REPORT

Client	Engie Electrical & Communications	**Source**	BH01 1.0-1.5m
Address	171 Grange Road Fairfield, VIC 3078	**Sample Description**	Silty CLAY
Project	Mudgee 5MW Solar Farm	**Report No**	B63735-SS
Job No	B20354	**Lab No**	B63735

Test Procedure: ☑ AS1289 7.1.1 Soil reactivity tests- Determination of the shrinkage index of a soil - Shrink-swell index

Sampling: AS 1289.1.2.1 - 6.5.3 (Power auger drilling) **Date Sampled:** 20/08/2020

Preparation: Prepared in accordance with the test method

Swell Test:

Swell on Saturation(E_{SW}):	0.0
Moisture Content Before Test (%):	11.9
Moisture Content After Test (%):	14.3

Shrink Test:

Shrinkage on Drying (E_{SH}%):	0.5
Estimated Inert Material Present (%):	0.0
Extent of Crumbling During Shrinkage:	NONE
Extent of Cracking During Shrinkage:	NONE
Moisture Content (%)	11.5

Shrink Swell Preparation: Remoulded

Shrink Swell Index:

Iss: **0.3**

Notes

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Authorised Signatory:

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John Boyle

9/09/2020

Date:

MACQUARIE GEOTECH

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3 Watt Drive
Bathurst NSW 2795

SOIL CLASSIFICATION REPORT

Client	Engie Electrical & Communications	**Source**	BH02 2.5-3.0m
Address	171 Grange Road Fairfield, VIC 3078	**Sample Description**	Sandy CLAY with gravel
Project	Mudgee 5MW Solar Farm	**Report No.**	B63736-PI
Job No.	B20354	**Sample No.**	B63736

Test Procedure:

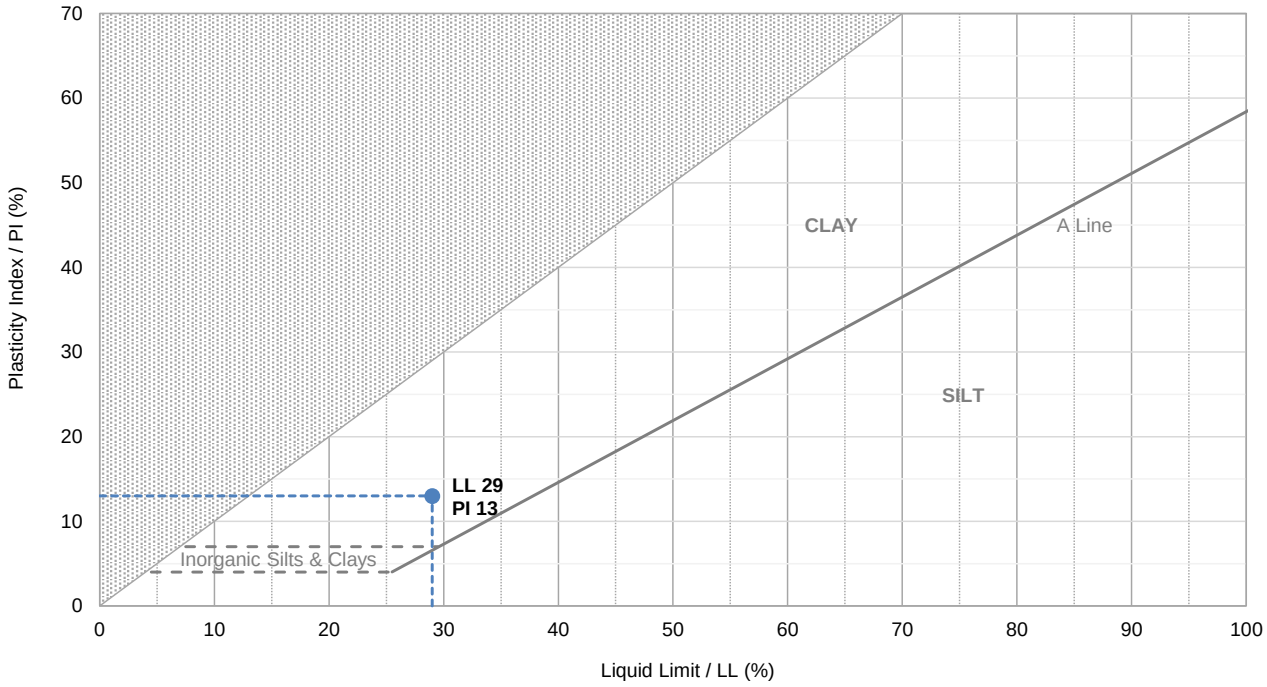
☐	AS 1289.2.1.1	Moisture Content - Oven drying method (Standard method)
☑	AS 1289.3.1.1	Liquid Limit - Four point Casagrande method
☐	AS 1289.3.1.2	Liquid Limit - One point Casagrande method
☑	AS 1289.3.2.1	Plastic Limit - Standard method
☑	AS 1289.3.3.1	Calculation of the Plasticity Index
☑	AS 1289.3.4.1	Linear Shrinkage - Standard method

Sampling: AS 1289.1.2.1 - 6.5.3 (Power auger drilling) **Date Sampled:** 20/08/2020

Preparation: AS1289 1.1

Plasticity Chart for Classification of Fine-Grained Soils

AS 1726:2017 Clause 6.1.6 (Figure 5)



Preparation		Results	
Field Moisture Content (%)	-	Liquid Limit / LL (%)	**29**
Method of Preparation	**Dry Sieved**	Plastic Limit (%)	**16**
History of the Sample	**Oven Dried**	Plasticity Index / PI (%)	**13**
		Linear Shrinkage (%)	**7.5**
		Condition upon Drying	**Linear**

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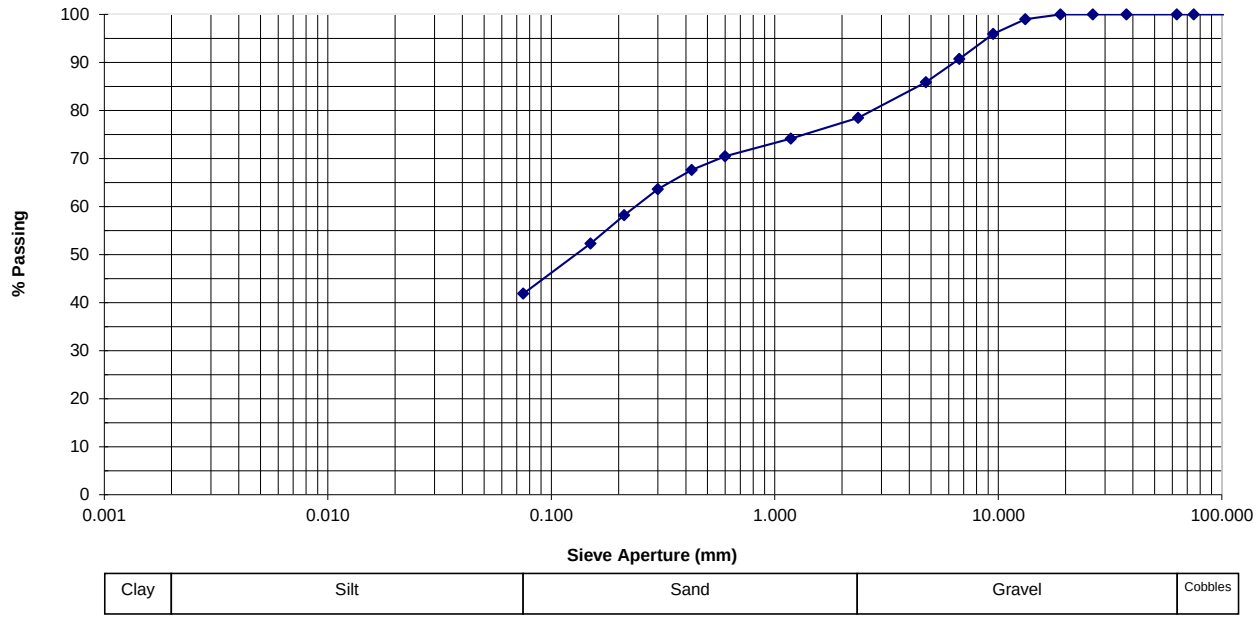
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Engie Electrical & Communications	**Source:**	BH02 2.5-3.0m
Address:	171 Grange Road Fairfield, VIC 3078	**Sample Description:**	Sandy CLAY with gravel
Project:	Mudgee 5MW Solar Farm	**Report No:**	B63736-PSD
Job No:	B20354	**Lab No:**	B63736

Test Procedure: ☑ AS1289 3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving

Sampling:	AS 1289.1.2.1 - 6.5.3 (Power auger drilling)	**Date Sampled:**	20/08/2020
Preparation:	AS1289 1.1		



Sieve Apperture: (mm)	% Passing	Specification N/A Envelope	Sieve Aperture: (mm)	% Passing	Specification N/A Envelope
200	100		4.75	86	
75	100		2.36	78	
63	100		1.18	74	
37.5	100		0.600	70	
26.5	100		0.425	68	
19	100		0.300	64	
13.2	99		0.212	58	
9.5	96		0.150	52	
6.7	91		0.075	42	

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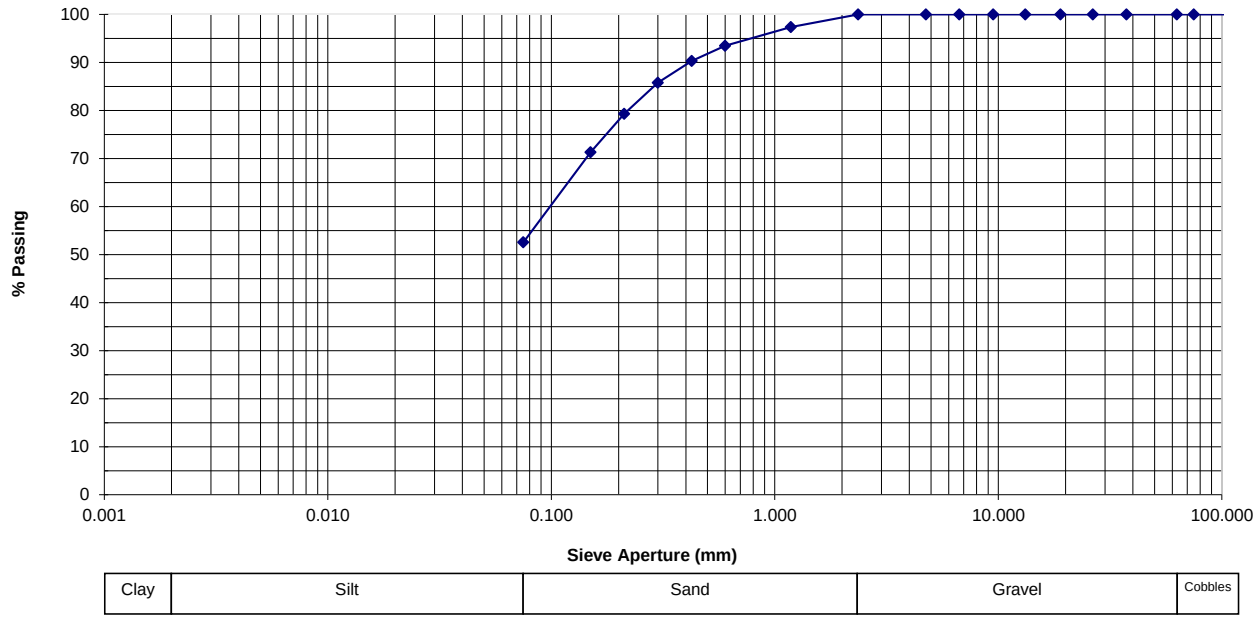
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Engie Electrical & Communications	**Source:**	BH04 1.5-1.95m
Address:	171 Grange Road Fairfield, VIC 3078	**Sample Description:**	Sandy CLAY
Project:	Mudgee 5MW Solar Farm	**Report No:**	B63737-PSD
Job No:	B20354	**Lab No:**	B63737

Test Procedure: ☑ AS1289 3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving

Sampling:	AS 1289.1.2.1 - 6.5.3 (Power auger drilling)	**Date Sampled:**	21/08/2020
Preparation:	AS1289 1.1		



Sieve Apperture: (mm)	% Passing	Specification N/A Envelope	Sieve Aperture: (mm)	% Passing	Specification N/A Envelope
200	100		4.75	100	
75	100		2.36	100	
63	100		1.18	97	
37.5	100		0.600	93	
26.5	100		0.425	90	
19	100		0.300	86	
13.2	100		0.212	79	
9.5	100		0.150	71	
6.7	100		0.075	53	

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