

March 6, 2025
Project No. 30055/10042
Report No. 25/0545
MM/js

SUMMARY SHEET

Client: McDonald Jones Homes
Address: Lot 15, 15 Raven Circuit, Warriewood
Reference: 607463/016/01



SITE CLASSIFICATION	P/M	AS2870-2011
WIND CLASSIFICATION	N1-Exposed	AS4055-2021
EXPOSURE CLASSIFICATION	A1	AS2870-2011

This summary sheet must be read in conjunction with the full report.

March 6, 2025

Project No. 30055/10042

Report No. 25/0545

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SITE INVESTIGATION REPORT

Client: McDonald Jones Homes

Address: Lot 15, 15 Raven Circuit, Warriewood

Proposed Development: Residential dwelling

Site Description

Approx. area (m²): 243

Approx. fall: 0.5 metres to the east, poor to reasonable site drainage

Vegetation: Grass

Improvements: Vacant

Geology, Fieldwork Details and Subsurface Conditions

The Sydney geological series sheet at a scale of 1:100,000 shows the site is underlain by Triassic Age Hawkesbury Sandstone. Rocks within this formation comprise mainly medium to coarse grained quartz sandstone.

Two boreholes were drilled and two Dynamic Cone penetrometer (DCP) tests were carried out on February 14, 2025 at the locations shown on Drawing No. 25/0545. The subsurface conditions encountered are shown on the attached borehole logs. Explanation sheets and notes relating to geotechnical reports are also attached.

When assessing the subsurface conditions across a site from a limited number of boreholes, there is the possibility that variations may occur between test locations. The data derived from the site investigation programme are extrapolated across the site to form a geological model and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour regarding the proposed development. The actual condition at the site may differ from those inferred, since no subsurface exploration programme, no matter how comprehensive, can reveal all subsurface details and anomalies.

The subsurface conditions consist of fill overlying silty sandy clay. The fill is present to depths of 3.8 and 4.0 metres. Soft silty sandy clays underlie the fill to the depth of drilling, 4.5 metres.

No groundwater was observed in the boreholes during the fieldwork.

Wind Classification

The classification given below has been prepared to assist the designer in accordance with the guidelines set out in AS4055-2021 “Wind loads for housing”. This assessment has been undertaken and verified using a commercially available software CHECKWINDv7.3.7 by Revolutio. Final designs should be verified by an experienced qualified structural engineer to accurately determine the appropriate Wind Classifications in accordance with the Building Code of Australia.

Region	A
Terrain Category	TC3
Topographic Classification	T0
Shielding	NS
Rating	N1-Exposed

Laboratory Testing

The sample collected for shrink swell testing was unsuitable. Experience has shown that at times, the shrink swell index can be estimated by dividing the soil Plasticity Index (PI) by a factor of 10. The soil tested at this site has a PI of 16% which implies the shrink swell index is 1.6% per ΔpF .

Site Classification

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

Due to the presence of greater than 400mm of fill, the site is classified a *Problem Site (P)*. However, provided the recommendations given below are adopted and the fill has written certification that it was placed as controlled engineering fill, the site may be re-classified as *Moderately Reactive (M)*. After cutting and filling the classification remains unchanged provided the fill is placed in a controlled manner and is non-reactive.

Foundation design and construction consistent with this classification shall be adopted as specified in the above referenced standard and in accordance with the following design details.

Foundation Design and Construction

Pad and/or strip footings founded in compacted fill materials certified in writing as having been placed as controlled engineered fill, may be proportioned using an allowable bearing

pressure of 100 kPa. The minimum depth of founding must comply with the requirements of AS2870.

Piers founded in controlled engineered fill, may be proportioned using an allowable end bearing pressure of 200 kPa, provided their depth to diameter ratio exceeds a value of 4. An allowable adhesion value of 20 kPa may be adopted for the portion of the shaft below a depth of 0.5 metres.

The site is considered suitable for slab on ground construction provided due regard is given to the ground surface slope and the fill is certified in writing as having been placed as controlled engineered fill. Otherwise, piers will be required to suspend the slab.

In order to ensure the bearing values given can be achieved, care should be taken to ensure the base of the excavations is free of all loose material prior to concreting. To this end, it is recommended that all excavations be concreted as soon as possible, preferably immediately after excavating, cleaning, inspecting and approval. Pier excavations should not be left open overnight. The possibility of groundwater inflow needs to be considered when drilling the piers and pouring concrete.

The site is considered suitable for slab on ground construction provided due regard is given to the ground surface slope.

During foundation construction, should the subsurface conditions vary to those inferred in this report, a suitably experienced geotechnical engineer should review the design and recommendations given above to determine if any alterations are required.

Soil Aggressiveness

The exposure classification for the concrete has been determined for the onsite soils. The exposure classification is obtained from Tables 5.1 and 5.2 of AS2870-2011. In regards to the electrical conductivity, the laboratory test results have been multiplied by the appropriate factor to convert the results to EC_e .

Detailed test reports are attached and summarised below, together with the exposure classification.

Sample No.	Electrical Conductivity (dS/m)		pH	Sulfate (ppm)	Exposure Classification
	$EC_{1:5}$	EC_e			
S1/10042	0.091	0.9	5.7	130	A1

The minimum concrete strength and reinforcement cover required for the various exposure classifications are given in Tables 5.3 and 5.4 of AS2870-2011 (see attached).

Additional Comments

Attention is drawn to Appendix B of AS2870 - 2011 regarding the need to properly maintain the foundations. Surface drainage should be provided to avoid the possibility of water ponding near the building and the finished ground surface should fall at least 50 mm over a distance of one metre away from the building.

The above classification has been made assuming that all footings will bear in either natural ground or in controlled filling. Prior to the placement of any filling the existing surface should be stripped of all vegetation and topsoil.

If excavations for rainwater or detention tanks are to be made within 6 metres of the building foundations, advice should be sought regarding their effect on the foundations.

Placing absorption trenches on the high side of the property may create abnormal moisture conditions for the foundations (Refer to Section 1.3.3 of AS2870). This could have a negative effect on the foundation performance and more than likely alter the site classification provided above.

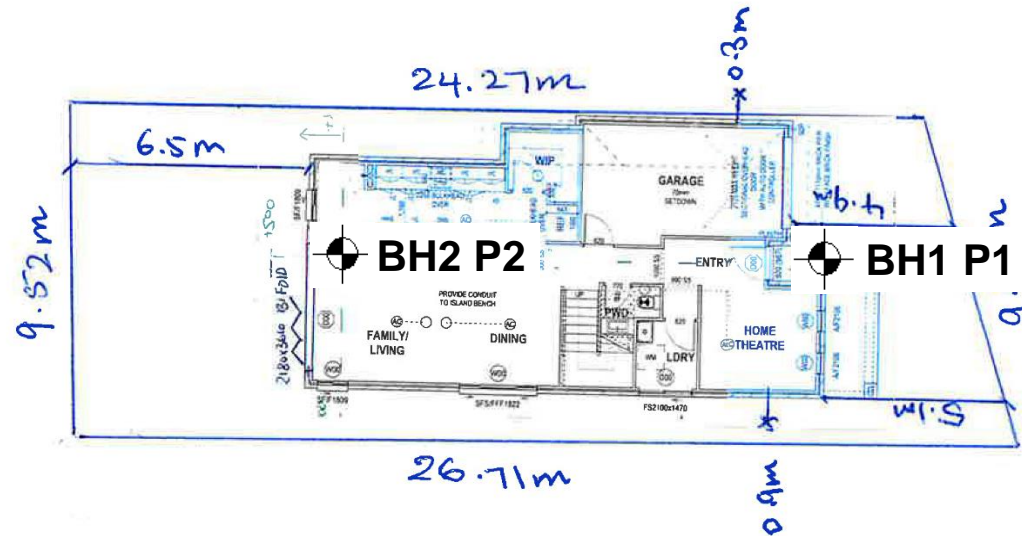
This report has been prepared assuming that no trees other than those noted will be present on the site. If future tree planting is planned, eg. there is a landscaping plan, their effect on the foundation performance must be considered.

This report has been prepared assuming the site development will be limited to one or two storey residential buildings. The information and interpretation may not be relevant if the design proposal changes (e.g. to a five-storey building involving major cuts during the site preparation). If changes occur, we would be pleased to review the report and advise on the adequacy of the investigation.

Yours faithfully,



*Masoud Haghparast
Senior Geotechnical Engineer
PhD, MEng, BE
STS Geotechnics Pty Limited*



Raven Circuit



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Borehole and Penetrometer Locations

Client: McDonald Jones Homes	Project NO. 30055/10042	Date: February 14, 2025
Site Address: Lot 15, 15 Raven Circuit, Warriewood	Drawing NO. 25/0544	Scale: Unknown
Work: Site Investigation	Revision NO. 0	

INTRODUCTION

These notes have been provided to outline the methodology and limitations inherent in geotechnical reporting. The issues discussed are not relevant to all reports and further advice should be sought if there are any queries regarding any advice or report. When copies of reports are made, they should be reproduced in full.

GEOTECHNICAL REPORTS

Geotechnical reports are prepared by qualified personnel on the information supplied or obtained and are based on current engineering standards of interpretation and analysis.

Information may be gained from limited subsurface testing, surface observations, previous work and is supplemented by knowledge of the local geology and experience of the range of properties that may be exhibited by the materials present. For this reason, geotechnical reports should be regarded as interpretative rather than factual documents, limited to some extent by the scope of information on which they rely.

Where the report has been prepared for a specific purpose (eg. design of a three-storey building), the information and interpretation may not be appropriate if the design is changed (eg. a twenty storey building). In such cases, the report and the sufficiency of the existing work should be reviewed by STS Geotechnics Pty Limited in the light of the new proposal.

Every care is taken with the report content, however, it is not always possible to anticipate or assume responsibility for the following conditions:

- Unexpected variations in ground conditions. The potential for this depends on the amount of investigative work undertaken.
- Changes in policy or interpretation by statutory authorities.
- The actions of contractors responding to commercial pressures.

If these occur, STS Geotechnics Pty Limited would be pleased to resolve the matter through further investigation, analysis or advice.

UNFORSEEN CONDITIONS

Should conditions encountered on site differ markedly from those anticipated from the information contained in the report, STS Geotechnics Pty Limited should be notified immediately. Early identification of site anomalies generally results in any problems being more readily resolved and allows re-interpretation and assessment of the implications for future work.

SUBSURFACE CONDITIONS

Logs of a borehole, recovered core, test pit, excavated face or cone penetration test are an engineering and/or geological interpretation of the subsurface conditions. The reliability of the logged information depends on the drilling/testing method, sampling and/or observation spacings and the ground conditions. It is not always possible or economic to obtain continuous high quality data. It should also be recognised that the volume or material observed or tested is only a fraction of the total subsurface profile.

Interpretation of subsurface information and application to design and construction must take into consideration the spacing of the test locations, the frequency of observations and testing, and the possibility that geological boundaries may vary between observation points.

Groundwater observations and measurements outside of specially designed and constructed piezometers should be treated with care for the following reasons:

- In low permeability soils groundwater may not seep into an excavation or bore in the short time it is left open.
- A localised perched water table may not represent the true water table.
- Groundwater levels vary according to rainfall events or season.
- Some drilling and testing procedures mask or prevent groundwater inflow.

The installation of piezometers and long term monitoring of groundwater levels may be required to adequately identify groundwater conditions.

SUPPLY OF GEOTECHNICAL INFORMATION OR TENDERING PURPOSES

It is recommended tenderers are provided with as much geological and geotechnical information that is available and that where there are uncertainties regarding the ground conditions, prospective tenders should be provided with comments discussing the range of likely conditions in addition to the investigation data.

Exposure Classification and Concrete Requirements

TABLE 5.1 FROM AS2870-2011

EXPOSURE CLASSIFICATION FOR CONCRETE IN SALINE SOILS

Saturated Extract Electrical Conductivity (EC_e), dS/m	Exposure Classification
<4	A1
4-8	A2
8-16	B1
>16	B2

NOTES:

- Guidance on concrete in saline environments can be found in CCAA T56.
- Exposure classifications are from AS3600.
- The currently accepted method of determining the salinity level of the soil is by measuring the extract electrical conductivity (EC) of a soil and water mixture in deciSiemens per metre (dS/m) and using conversion factors that allow for the soil texture to determine the saturated extract electrical conductivity (EC_e).
- The division between a non-saline and saline soil is generally regarded as an EC_e value of 4 dS/m, therefore no increase in the minimum concrete strength is required below this value.

TABLE 5.2 FROM AS2870-2011

EXPOSURE CLASSIFICATION FOR CONCRETE IN SULFATE SOILS

Exposure Conditions			Exposure Classification	
Sulfates (expressed as SO_4)*			Soil Conditions A†	Soil Conditions B‡
In Soil ppm	In Groundwater ppm	pH		
<5000	<1000	>5.5	A2	A1
5000-10 000	1000-3000	4.5-5.5	B1	A2
10 000-20 000	3000-10 000	4-4.5	B2	B1
>20 000	>10 000	<4	C2	B2

* Approximately 100 ppm SO_4 = 80 ppm SO_3 .

† Soil conditions A – high permeability soils (eg. Sands and gravels) that are in groundwater.

‡ Soil conditions B – low permeability soils (eg. Silts and clays) or all soils have groundwater.

TABLE 5.3 FROM AS2870-2011

**MINIMUM DESIGN CHARACTERISTIC STRENGTH (f'_c)
AND CURING REQUIREMENTS FOR CONCRETE**

Exposure Classification	Minimum f'_c MPa	Minimum Initial Curing Requirement
A1	20	Cure continuously for at least 3 days
A2	25	
B1	32	Cure continuously for at least 7 days
B2	40	
C1	≥50	
C2	≥50	

TABLE 5.4 – FROM AS2870-2011

MINIMUM REINFORCEMENT COVER FOR CONCRETE


Exposure Classification	Minimum Cover in Saline Soils* (mm)	Minimum Cover in Sulfate Soils† (mm)
A1	See Clause 5.3.2	40
A2	45	50
B1	50	60
B2	55	65
C1	‡	70
C2	‡	85

* Where a damp-proofing membrane is installed, the minimum reinforcement cover in saline soils may be reduced to 30 mm.


† Where a damp-proofing membrane is installed, the minimum reinforcement cover in sulfate soils may be reduced by 10 mm.

‡ Saline soils have a maximum exposure classification of B2 as per Table 5.1.

GEOTECHNICAL LOG - NON CORE BOREHOLE

		Client: McDonald Jones Homes Project: Lot 15, 15 Raven Circuit, Warriewood Location: Refer to Drawing No. 25/0544		Project Number: 30055/10042 Date : February 14, 2025 Logged: MB Checked By: MT		BOREHOLE NO.: BH1	
		Sheet 1 of 1					
W A T E R L E	S A M P L E S	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	S Y M B O L	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	M O I S T U R E	
			FILL: SILTY CLAY: low plasticity, brown, trace of gravel	CL	APPEARS COMPACTED	<PL	
	S1						
	U50	1.0					
		2.0					
		3.0					
		4.0	SILTY SANDY CLAY: low plasticity, dark grey (saturated)	CL	SOFT	>PL	
		5.0	BOREHOLE DISCONTINUED AT 4.5 M				
		6					
D - disturbed sample U - undisturbed tube sample B - bulk sample WT - level of water table or free water N - Standard Penetration Test (SPT) S - jar sample				Contractor: STS Equipment: Christie Hole Diameter (mm): 100 Angle from Vertical (o): 0 Drill Bit: Spiral			
NOTES: See explanation sheets for meaning of all descriptive terms and symbols							

GEOTECHNICAL LOG - NON CORE BOREHOLE

		Client: McDonald Jones Homes Project: Lot 15, 15 Raven Circuit, Warriewood Location: Refer to Drawing No. 25/0544		Project Number: 30055/10042 Date : February 14, 2025 Logged: MB Checked By: MT		BOREHOLE NO.: BH2	
		Sheet 1 of 1					
W A T E R L E	S A M P L E S	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	S Y M B O L	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	M O I S T U R E	
		1.0	FILL: SILTY CLAY: low plasticity, brown, trace of gravel	CL	APPEARS COMPACTED	<PL	
		2.0					
		3.0					
		4.0	SILTY SANDY CLAY: low plasticity, dark grey (saturated)	CL	SOFT	>PL	
		5.0	BOREHOLE DISCONTINUED AT 4.5 M				
		6					
D - disturbed sample U - undisturbed tube sample B - bulk sample WT - level of water table or free water N - Standard Penetration Test (SPT) S - jar sample				Contractor: STS Equipment: Christie Hole Diameter (mm): 100 Angle from Vertical (o): 0 Drill Bit: Spiral			
NOTES: See explanation sheets for meaning of all descriptive terms and symbols							

Dynamic Cone Penetrometer Test Report

Project: LOT 15, 15 RAVEN CIRCUIT, WARRIEWOOD

Client: McDONALD JONES HOMES

Address: 62 Norwest Boulevard, Baulkham Hills

Test Method: AS 1289.6.3.2

Project No.: 30055/10042

Report No.: 25/0544

Report Date: 24/02/2025

Page: 1 of 1

Site No.	P1	P2				P1	P2		
Location	Refer to Drawing No. 25/0544	Refer to Drawing No. 25/0544							
Date Tested	14/2/2025	14/2/2025							
Starting Level	Surface Level	Surface Level							
Depth (m)	Penetration Resistance (blows / 150mm)				Depth (m)	Penetration Resistance (blows / 150mm)			
0.00 - 0.15	3	8			3.00 - 3.15	*	*		
0.15 - 0.30	10	16			3.15 - 3.30	23+	*		
0.30 - 0.45	11	23+			3.30 - 3.45	*	*		
0.45 - 0.60	16	*			3.45 - 3.60	*	*		
0.60 - 0.75	20	*			3.60 - 3.75	23+	*		
0.75 - 0.90	15	*			3.75 - 3.90	*	*		
0.90 - 1.05	23+	23+			3.90 - 4.05	3	*		
1.05 - 1.20	*	*			4.05 - 4.20	3	1		
1.20 - 1.35	*	*			4.20 - 4.35	2	2		
1.35 - 1.50	*	23+			4.35 - 4.50	1	2		
1.50 - 1.65	*	*			4.50 - 4.65	1	2		
1.65 - 1.80	23+	*			4.65 - 4.80	1	2		
1.80 - 1.95	*	23+			4.80 - 4.95	1	2		
1.95 - 2.10	*	*			4.95 - 5.10	3	2		
2.10 - 2.25	*	*			5.10 - 5.25	2	2		
2.25 - 2.40	23+	*			5.25 - 5.40	2	1		
2.40 - 2.55	*	*			5.40 - 5.55	2	3		
2.55 - 2.70	*	23			5.55 - 5.70	1	3		
2.70 - 2.85	*	*			5.70 - 5.85	2	3		
2.85 - 3.00	*	*			5.85 - 6.00	3	2		

Remarks: * = Pre-drilled hole prior to testing



Accredited for compliance with ISO/IEC
17025 - Testing
The results of the tests, calibrations and/or
measurements included in this document are
traceable to Australian/national standards
NATA Accreditation Number 2750

Approved Signatory.....

Mrigesh Tamang, Manager

Technician: MB

Quality of Materials Report

Report No: SAR-W-SY-25-00037-1 | Issue No: 1

Client:	McDonald Jones Homes	Project Number:	30055
Address:	PO BOX 7994, BAULKHAM HILLS, 2153	Report Date:	28/02/2025
Project Name:	30055 - Geotechnical Investigation	Order Number:	
Project Location:	10042 Raven Circuit, Lot 15, 15, Warriewood, 2102	Job Description:	

Sample Details		SAMPLE LOCATION
Sample ID:	S-SY-25-00038	
Sampling Method:	AS 1289.1.3.1 Clause-3.1.3.2 - Open-drive samplers - Thin-walled sampler	
Sampled By:	Micheal Brown	
Date/Time Sampled:	14/02/2025 / 08:30	
Sample Preparation	AS 1289.1.1	Lot Number: Field Sample Id: 1 TRN: Specification:
Material Type:		
Rock Type:		
Material Source:	Onsite Material	
Soil Description:	Silty Clay, brown	

Test Method Name	Result	Limits
AS 1289.3.1.2 3.2.1 3.3.1 3.4.1 One Point Atterberg Limits		
Date Tested	25-02-2025	S-SY-25-00038
Liquid Limit (%)	31	
Plastic Limit (%)	15	
Plastic Index (%)	16	
Linear Shrinkage (%)	7.0	
Sample History	Oven Dried	
Preparation Method	Dry Sieved	
Nature Of Shrinkage	, ,	

COMMENTS

Page 1 of 1



APPROVED SIGNATORY

Name: Lucky Ly
Date Of Issue: 28/02/2025 | Issue#: 1
NATA Accredited Laboratory Number: 2750



CERTIFICATE OF ANALYSIS

Work Order	: ES2504486	Page	: 1 of 4
Client	: STS Geotechnics	Laboratory	: Environmental Division Sydney
Contact	: ENQUIRES STS	Contact	: Customer Services ES
Address	: Unit 14/1 Cowpasture Place Wetherill Park 2164	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 30055, 30060, 32983, 32987, 32971	Date Samples Received	: 17-Feb-2025 11:45
Order number	: 2025-056	Date Analysis Commenced	: 19-Feb-2025
C-O-C number	: ----	Issue Date	: 20-Feb-2025 14:17
Sampler	: AF, JV, MB, TB		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 8		
No. of samples analysed	: 8		



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



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	30055/10038	30055/10039	30055/10042	30060/2034	32983/S1
Sampling date / time					14-Feb-2025 00:00	14-Feb-2025 00:00	14-Feb-2025 00:00	14-Feb-2025 00:00	14-Feb-2025 00:00
Compound	CAS Number	LOR	Unit		ES2504486-001	ES2504486-002	ES2504486-003	ES2504486-004	ES2504486-005
				Result	Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		6.3	5.0	5.7	7.2	7.8
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		26	12	91	145	113
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		19.1	8.2	6.5	14.4	7.9
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		<10	<10	130	220	40
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg		----	----	----	----	<10



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	32987/S1	32971/S1	32971/S2	----	----
Sampling date / time					14-Feb-2025 00:00	14-Feb-2025 00:00	14-Feb-2025 00:00	----	----
Compound	CAS Number	LOR	Unit		ES2504486-006	ES2504486-007	ES2504486-008	-----	-----
					Result	Result	Result	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		7.2	7.0	5.6	----	----
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		100	42	40	----	----
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		14.8	18.9	18.4	----	----
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		50	30	20	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg		50	180	90	----	----

EXPLANATION OF NOTES, ABBREVIATIONS & TERMS USED ON BOREHOLE AND TEST PIT LOGS

DRILLING/EXCAVATION METHOD





HA	Hand Auger	ADH	Hollow Auger	NQ	Diamond Core - 47 mm
DT	Diatube Coring	RT	Rotary Tricone bit	NMLC	Diamond Core - 52 mm
NDD	Non-destructive digging	RAB	Rotary Air Blast	HQ	Diamond Core - 63 mm
AD*	Auger Drilling	RC	Reverse Circulation	HMLC	Diamond Core - 63 mm
*V	V-Bit	PT	Push Tube	EX	Tracked Hydraulic Excavator
*T	TC-Bit, e.g. AD/T	WB	Washbore	HAND	Excavated by Hand Methods

PENETRATION RESISTANCE

L	Low Resistance	Rapid penetration/ excavation possible with little effort from equipment used.
M	Medium Resistance	Penetration/ excavation possible at an acceptable rate with moderate effort from equipment used.
H	High Resistance	Penetration/ excavation is possible but at a slow rate and requires significant effort from equipment used.
R	Refusal/Practical Refusal	No further progress possible without risk of damage or unacceptable wear to equipment used.

These assessments are subjective and are dependent on many factors, including equipment power and weight, condition of excavation or drilling tools and experience of the operator.

WATER

	 Standing Water Level	 Partial water loss
	 Water Seepage	 Complete Water Loss
GWNO	GROUNDWATER NOT OBSERVED - Observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave-in of the borehole/ test pit.	
GWNE	GROUNDWATER NOT ENCOUNTERED - 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.	

SAMPLING AND TESTING

SPT	Standard Penetration Testing to AS1289.6.3.3 2004
4,7,11 N=18	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following a 150mm seating drive
30/80mm	Where practical refusal occurs, the blows and penetration for that interval are reported, N is not reported
RW	Penetration occurred under the rod weight only, N<1
HW	Penetration occurred under the hammer and rod weight only, N<1
HB	Hammer double bouncing on anvil, N is not reported
Sampling	
S1	Jar sample – number indicates sample number
D	Disturbed Sample
B	Bulk disturbed Sample
U50	Thin walled tube sample - number indicates nominal sample diameter in millimetres
Testing	
PP	Pocket Penetrometer test expressed as instrument reading in kPa
DCP	Dynamic Cone Penetrometer (AS1289.6.3.1 1997)
PSP	Perth Sand Penetrometer (AS1289.6.3.2 1997)

GEOLOGICAL BOUNDARIES

————— = Observed Boundary (Position known)	- - - - - = Observed Boundary (Position approximate)	- -? - -? - -? - = Boundary (Interpreted or inferred)
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ROCK CORE RECOVERY

TCR = Total Core Recovery (%)

$$= \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100$$

RQD = Rock Quality Designation (%)

$$= \frac{\sum \text{Axial lengths of core} > 100\text{mm}}{\text{Length of core run}} \times 100$$

METHOD OF SOIL DESCRIPTION USED ON BOREHOLE AND TEST PIT LOGS



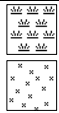
FILL



COUBLES or
BOULDERS



GRAVEL (GP or GW)



ORGANIC SOILS
(OL, OH or Pt)



SILT (ML or MH)

Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay



CLAY (CL, CI or CH)



SAND (SP or SW)

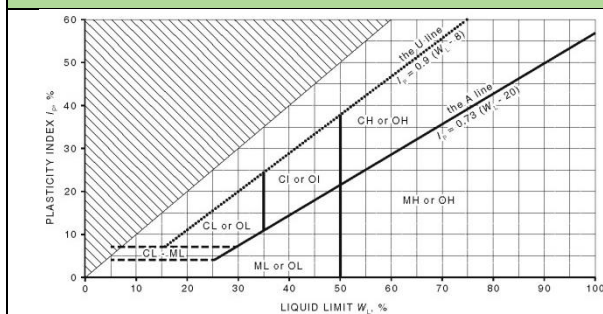
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS 1726:2017, Section 6.1 – Soil description and classification.

PARTICLE SIZE CHARACTERISTICS

Fraction	Components	Sub Division	Size mm
Oversize	BOULDERS		>200
	COBBLES		63 to 200
Coarse grained soil	GRAVEL	Coarse	19 to 63
		Medium	6.7 to 19
		Fine	2.36 to 6.7
	SAND	Coarse	0.6 to 2.36
		Medium	0.21 to 0.6
		Fine	0.075 to 0.21
Fine grained soil	SILT		0.002 to 0.075
	CLAY		<0.002

PLASTICITY PROPERTIES



GROUP SYMBOLS

Major Divisions	Symbol	Description
COARSE GRAINED SOILS More than 65% of soil excluding oversize fraction is greater than 0.075mm	GRAVEL More than 50% of coarse fraction is >2.36mm	GW Well graded gravel and gravel-sand mixtures, little or no fines, no dry strength.
		GP Poorly graded gravel and gravel-sand mixtures, little or no fines, no dry strength.
		GM Silty gravel, gravel-sand-silt mixtures, zero to medium dry strength.
		GC Clayey gravel, gravel-sand-clay mixtures, medium to high dry strength.
	SAND More than 50% of coarse fraction is <2.36 mm	SW Well graded sand and gravelly sand, little or no fines, no dry strength.
		SP Poorly graded sand and gravelly sand, little or no fines, no dry strength.
		SM Silty sand, sand-silt mixtures, zero to medium dry strength.
		SC Clayey sand, sandy-clay mixtures, medium to high dry strength.
	FINE GRAINED SOILS More than 35% of soil excluding oversized fraction is less than 0.075mm	ML Inorganic silts of low plasticity, very fine sands, rock flour, silty or clayey fine sands, zero to medium dry strength.
		CL, CI Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, medium to high dry strength.
		OL Organic silts and organic silty clays of low plasticity, low to medium dry strength.
		MH Inorganic silts of high plasticity, high to very high dry strength.
Highly Organic soil	CH	Inorganic clays of high plasticity, high to very high dry strength.
	OH	Organic clays of medium to high plasticity, medium to high dry strength.
	PT	Peat muck and other highly organic soils.

MOISTURE CONDITION

Symbol	Term	Description
D	Dry	Non- cohesive and free running.
M	Moist	Soils feel cool, darkened in colour. Soil tends to stick together.
W	Wet	Soils feel cool, darkened in colour. Soil tends to stick together, free water forms when handling.

Moisture content of cohesive soils shall be described in relation to plastic limit (PL) or liquid limit (LL) for soils with higher moisture content as follows: Moist, dry of plastic limit ($w < PL$); Moist, near plastic limit ($w \approx PL$); Moist, wet of plastic limit ($w > PL$); Wet, near liquid limit ($w \approx LL$); Wet, wet of liquid limit ($w > LL$).

CONSISTENCY

Symbol	Term	Undrained Shear Strength (kPa)	SPT "N" #
VS	Very Soft	≤ 12	≤ 2
S	Soft	>12 to ≤ 25	>2 to ≤ 4
F	Firm	>25 to ≤ 50	>4 to ≤ 8
St	Stiff	>50 to ≤ 100	>8 to ≤ 15
VSt	Very Stiff	>100 to ≤ 200	>15 to ≤ 30
H	Hard	>200	>30
Fr	Friable	-	-

DENSITY

Symbol	Term	Density Index %	SPT "N" #
VL	Very Loose	≤ 15	0 to 4
L	Loose	>15 to ≤ 35	4 to 10
MD	Medium Dense	>35 to ≤ 65	10 to 30
D	Dense	>65 to ≤ 85	30 to 50
VD	Very Dense	>85	Above 50

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material.

SPT correlations are not stated in AS1726:2017, and may be subject to corrections for overburden pressure, moisture content of the soil, and equipment type.

MINOR COMPONENTS

Term	Assessment Guide	Proportion by Mass
Add 'Trace'	Presence just detectable by feel or eye but soil properties little or no different to general properties of primary component	Coarse grained soils: $\leq 5\%$ Fine grained soil: $\leq 15\%$
Add 'With'	Presence easily detectable by feel or eye but soil properties little or no different to general properties of primary component	Coarse grained soils: 5 - 12% Fine grained soil: 15 - 30%
Prefix soil name	Presence easily detectable by feel or eye in conjunction with the general properties of primary component	Coarse grained soils: $>12\%$ Fine grained soil: $>30\%$

CLASSIFICATION AND INFERRED STRATIGRAPHY

Rock is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS1726 – 2017, Section 6.2 – Rock identification, description and classification.

ROCK MATERIAL STRENGTH CLASSIFICATION

Symbol	Term	Point Load Index, $Is_{(50)}$ (MPa) #	Field Guide
VL	Very Low	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30 mm can be broken by finger pressure.
L	Low	0.1 to 0.3	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
M	Medium	0.3 to 1	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.
H	High	1 to 3	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken with pick with a single firm blow; rock rings under hammer.
VH	Very High	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
EH	Extremely High	>10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Rock Strength Test Results



Point Load Strength Index, $Is_{(50)}$, Axial test (MPa)



Point Load Strength Index, $Is_{(50)}$, Diametral test (MPa)

Relationship between rock strength test result ($Is_{(50)}$) and unconfined compressive strength (UCS) will vary with rock type and strength, and should be determined on a site-specific basis. However UCS is typically $20 \times Is_{(50)}$.

ROCK MATERIAL WEATHERING CLASSIFICATION

Symbol	Term	Field Guide
RS	Residual Soil	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
XW	Extremely Weathered	Rock is weathered to such an extent that it has soil properties - i.e. it either disintegrates or can be remoulded, in water.
DW	HW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores. In some environments it is convenient to subdivide into Highly Weathered and Moderately Weathered, with the degree of alteration typically less for MW.
	MW	
SW	Slightly Weathered	Rock slightly discoloured but shows little or no change of strength relative to fresh rock.
FR	Fresh	Rock shows no sign of decomposition or staining.

ABBREVIATIONS AND DESCRIPTIONS FOR ROCK MATERIAL AND DEFECTS

CLASSIFICATION AND INFERRED STRATIGRAPHY

Rock is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS1726 – 2017, Section 6.2 – Rock identification, description and classification.

DETAILED ROCK DEFECT SPACING

Bedding Thickness* (Spacing between bedding partings)

Term	Spacing (mm)
Thinly laminated	<6
Laminated	6 – 20
Very thinly bedded	20 – 60
Thinly bedded	60 – 200
Medium bedded	200 – 600
Thickly bedded	600 – 2,000
Very thickly bedded	> 2,000

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT TYPES

Defect Type	Abbr.	Description
Joint	JT	Surface of a fracture or parting, formed without displacement, across which the rock has little or no tensile strength. May be closed or filled by air, water or soil or rock substance, which acts as cement.
Bedding Parting	BP	Surface of fracture or parting, across which the rock has little or no tensile strength, parallel or sub-parallel to layering/ bedding. Bedding refers to the layering or stratification of a rock, indicating orientation during deposition, resulting in planar anisotropy in the rock material.
Contact	CO	The surface between two types or ages of rock.
Sheared Surface	SSU	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.
Sheared Seam/ Zone (Fault)	SS/SZ	Seam or zone with roughly parallel almost planar boundaries of rock substance cut by closely spaced (often <50 mm) parallel and usually smooth or slickensided joints or cleavage planes.
Crushed Seam/ Zone (Fault)	CS/CZ	Seam or zone composed of disoriented usually angular fragments of the host rock substance, with roughly parallel near-planar boundaries. The brecciated fragments may be of clay, silt, sand or gravel sizes or mixtures of these.
Extremely Weathered Seam/ Zone	XWS/XWZ	Seam of soil substance, often with gradational boundaries, formed by weathering of the rock material in places.
Infilled Seam	IS	Seam of soil substance, usually clay or clayey, with very distinct roughly parallel boundaries, formed by soil migrating into joint or open cavity.
Vein	VN	Distinct sheet-like body of minerals crystallised within rock through typically open-space filling or crack-seal growth.

NOTE: Defects size of <100mm SS, CS and XWS. Defects size of >100mm SZ, CZ and XWZ.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT SHAPE AND ROUGHNESS

Shape	Abbr.	Description	Roughness	Abbr.	Description
Planar	PR	Consistent orientation	Polished	POL	Shiny smooth surface
Curved	CU	Gradual change in orientation	Slickensided	SL	Grooved or striated surface, usually polished
Undulating	UN	Wavy surface	Smooth	SM	Smooth to touch. Few or no surface irregularities
Stepped	ST	One or more well defined steps	Rough	RO	Many small surface irregularities (amplitude generally <1mm). Feels like fine to coarse sandpaper
Irregular	IR	Many sharp changes in orientation	Very Rough	VR	Many large surface irregularities, amplitude generally >1mm. Feels like very coarse sandpaper

Orientation:

Vertical Boreholes – The dip (inclination from horizontal) of the defect.

Inclined Boreholes – The inclination is measured as the acute angle to the core axis.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT COATING

DEFECT APERTURE

Coating	Abbr.	Description	Aperture	Abbr.	Description
Clean	CN	No visible coating or infilling	Closed	CL	Closed.
Stain	SN	No visible coating but surfaces are discoloured by staining, often limonite (orange-brown)	Open	OP	Without any infill material.
Veneer	VNR	A visible coating of soil or mineral substance, usually too thin to measure (< 1 mm); may be patchy	Infilled	-	Soil or rock i.e. clay, silt, talc, pyrite, quartz, etc.