Geotechnical Investigation Report

PRELIMINARY GEOTECHNICAL REPORT

8-16 WATT STREET, GOSFORD NSW

Prepared for:

JARRE PTY LTD

Reference: P1865_ 01

12 March 2020

Morrow Geotechnics Pty Ltd | ABN 42 605 892 126
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1 PROJECT BACKGROUND

Morrow Geotechnics Pty Ltd has undertaken a Preliminary Geotechnical Investigation to provide geotechnical advice and recommendations for the proposed development at 8-16 Watt Street, Gosford NSW (the site).

Previous geotechnical investigations were carried out by Jeffery and Katauskas Consulting Geotechnical Engineers. The first, ref. 2289 is dated 24 August 1982, and a second, ref. 2289X is dated 3 August 1983. Their findings have been considered in the following report.

Morrow Geotechnics has been provided with the following geotechnical reports, prepared for previous development on the site:

- Jeffery and Katauskas Pty Ltd, *Foundation Investigations for Proposed Development, Watt Street, Gosford NSW* referenced 2289 and dated 24 August 1982 (JK 1982).
- Jeffery and Katauskas Pty Ltd, *Additional Foundation Investigations for Proposed Shopping Centre, Mann Street, Gosford NSW* referenced 2289X and dated 3 August 1983 (JK 1983).

1.1 Proposed Development

A pre-DA Masterplan for the proposed development have been prepared by ADG Architects December 2019. Based on the drawings provided, Morrow Geotechnics understands that the proposed development involves construction of three mixed-use towers. Based on concept drawings, basement carpark levels appear to require excavation to a depth of approximately 9 meters below ground level (mBGL).

1.2 Investigation Intent

The purpose of the investigation is to provide preliminary geotechnical advice and recommendations specific to the ground conditions observed at site for the proposed development. These recommendations include:

- Foundation advice along with relevant preliminary geotechnical design parameters;
- Excavation and shoring advice along with relevant preliminary geotechnical design parameters;
- Approaches to minimise the impact of the proposed development through vibration, ground movement or groundwater drawdown;
- Other relevant geotechnical issues which may impact construction; and
- Recommendations for further geotechnical input.

1.3 Published Geological Mapping

Information on regional sub-surface conditions, referenced from the Department of Mineral Resources Geological Map Gosford 1:100,000 Geological Series Sheet 9131 (DMR 2015), indicates that the site overlies the Terrigal Formation, which typically comprises interbedded laminite, shale and fine to coarse grained quartz to quartz lithic sandstone, and minor red claystone.

1.4 Published Soil Landscapes

The Soil Conservation Service of NSW Gosford 1:100,000 Soil Landscapes Series Sheet 9131 (1st Edition) indicates that the erosional landscape at the site likely comprises the Erina landscape. This landscape type typically includes undulating to rolling low hills on the Terrigal formation. Soils are moderately deep to deep (> 2.0 m) yellow podzolic soils. These soils are noted to present high soil erosion hazard, mass movement hazard and seasonal waterlogging.

2 OBSERVATIONS

2.1 Investigation Methods

Fieldwork was undertaken by Morrow Geotechnics on 19 & 20 February 2020. Work carried out as part of this investigation includes:

- Review of publicly available information from previous reports in the project area, published geological and soil mapping and government agency websites;
- Site walkover inspection by a Geotechnical Engineer to assess topographical features, condition of surrounding structures and site conditions;
- Dial Before You Dig (DBYD) services search of proposed borehole locations;
- Drilling of two boreholes in total. The boreholes (BH1 & BH2) were drilled by a track mounted drill rig using solid flight augers equipped with a tungsten-carbide bit (TC bit). The boreholes were extended beyond TC bit refusal by NMLC coring techniques to depths of 24.9 and 20.22 m below ground level (mBGL) respectively. Rock core was boxed and photographed and point load tests were undertaken on selected core samples to assess rock strength. Borehole locations are shown on **Figure 1** and borehole logs are presented in **Appendix A**.

2.2 Subsurface Conditions

The stratigraphy at the site is characterised by fill and residual soil overlying interbedded siltstone and sandstone bedrock. Observations taken during the investigation have been used to produce a stratigraphic model of the site. The observed stratigraphy has been divided into six geotechnical units.

A summary of the subsurface conditions across the site, interpreted from the investigation results, is presented in **Table 1**. More detailed descriptions of subsurface conditions at the test locations are available in the borehole logs presented in **Appendix A**. The details of the method of soil and rock classification, explanatory notes and abbreviations adopted in the borehole logs are also presented in **Appendix A**.

Strength descriptions and material origins have not been provided on JK borehole logs and classification of the material encountered in JK boreholes has been inferred from TC bit resistance. The results of the JK boreholes have been provided for preliminary understanding of site conditions. Further borehole drilling including strength testing of rock core will be required prior to finalisation of structural designs for the project.

TABLE 1 SUMMARY OF INFERRED SUBSURFACE CONDITIONS

Unit	Material	Comments
1	Topsoil / Fill	Generally mixed fill comprising, silt, clay, sand and gravel. Unit 1 fill is inferred to be uncontrolled and poorly compacted.
2	Alluvial Soil	Generally medium plasticity silty sandy clay with some ironstone gravel. Unit 2 is generally of soft to firm consistency over the upper 4 m and generally stiff consistency below 4 m depth.
3	Residual Soil	Generally medium to high plasticity silty clay and sandy clay with some ironstone gravel. Unit 3 is generally of stiff to hard consistency.
4	Extremely Low to Very Low Strength Bedrock	Generally sandstone with siltstone interbeds, grading from extremely weathered to fresh, extremely low strength to high strength. Defects within Units 4 to 6 are generally horizontally oriented bedding partings and joints inclined to 80°.
5	Low Strength Bedrock	
6	Medium to High Strength Bedrock	

TABLE 2 ENCOUNTERED GEOTECHNICAL CONDITIONS

	Material	Unit 1 Fill	Unit 2 Alluvial Soil	Unit 3 Residual Soil	Unit 4 EL-VL Strength Bedrock	Unit 5 L Strength Bedrock	Unit 6 M-H Strength Bedrock
Approx. Depth Range of Unit [1] mBGL	Morrow – BH1						
	Morrow – BH2						
	JK – BH1	0.0 to 0.25	-	0.25 to 3.6	-	3.6 to 6.0	-
	JK – BH2a	0.0 to 1.8	-	1.8 to 5.9	5.9 to 8.0	8.0 to 13.0	-
	JK – BH3	0.0 to 1.0	1.0 to 4.6	4.6 to 10.0	10.0 to 13.6	-	-
	JK – BH4	0.0 to 1.0	-	1.0 to 3.7	-	-	-
	JK – BH5	0.0 to 1.0	-	1.0 to 6.0	-	-	-
	JK – BH6	0.0 to 0.2	0.2 to 10.6	10.6 to 12.5		12.5 to 13.6	13.6 to 15.05
	JK – BH7	0.0 to 0.3	0.3 to 12.0	12.0 to 13.0	13.0 to 15.1	15.1 to 15.3	-
	JK – BH8	0.0 to 0.5	-	0.5 to 4.8	4.8 to 9.0	-	-
	JK – BH9	0.0 to 0.05	0.05 to 9.5	9.5 to 12.2	12.2 to 15.1	-	-
	JK – BH10	0.0 to 0.1	0.1 to 7.5	7.5 to 9.5	9.5 to 12.1	-	-

Notes:

1 Depths shown are based on material observed within test locations and will vary across the site.

2.3 Groundwater Observations

A standing watertable was noted within BH1, drilled on the western side of the site, at 2.6 mBGL. This is inferred to represent a regional watertable present within alluvial soils on the lower portion of the site. Seepage water is expected to present intermittent flow from joints in the sandstone and siltstone bedrock on the upper portion of the site in response to rainfall events.

3 RECOMMENDATIONS

3.1 Excavation Retention

Temporary batters up to 4 m height may be adopted for all units provided that batter angles do not exceed 45^o above the horizontal and surcharge loading is not present within a zone designed by a line drawn at 2H:1V from the base of the excavation. Where excavations extend beneath the zone of influence of nearby structures, services or pavements, or where site constraints do not allow the construction of temporary batters, basement retention will be required. Given the proposed basement profile and the ground conditions encountered an anchored soldier pile wall is likely to prove economical.

For design of flexible shoring systems a triangular pressure distribution may be employed using the parameters provided in **Table 3**. For design of rigid anchored or braced walls, a trapezoidal earth pressure distribution should be used with a maximum pressure of $0.65.K_a.\gamma.H$ (kPa), where 'H' is the effective vertical height of the wall in metres.

TABLE 3 RETENTION DESIGN PARAMETERS

Material		Unit 1 Fill	Unit 2 Alluvial Soil	Unit 3 Residual Soil	Unit 4 ELS-VLS Bedrock	Unit 5 LS Bedrock	Unit 6 MS-HS Bedrock
Earth Pressure Coefficients	At rest, K_o	0.55	0.50	0.44	0.30	0.20	0
	Passive, K_p	2.66	3.00	3.54	4.00	4.50	750 kPa ultimate stress block
	Active, K_a	0.38	0.33	0.28	0.20	0.10	0
Bulk Unit Weight (kN/m^3)		16	18	19	22	23	24

Earth pressure coefficients with **Table 3** are provided on the assumption that the ground behind the retaining wall is flat and drained. For cases where the ground profile rises at more than 5^o behind the retaining system detailed design input should be sought from a geotechnical engineer.

In addition, design of retaining walls should consider the following:

- Appropriate surcharge loading from construction equipment, vehicular traffic and neighbouring structures at finished surface level should be taken into account in the retention design. Surcharge loads on retention structures may be calculated using a rectangular stress block with an earth pressure coefficient of 0.5 applied to surcharge loads at ground surface level.

- Anchor design should ignore the contribution of any bonded length within a wedge which extends upwards at 45^{o} from the base of the excavation to account for a failure wedge forming behind the shoring system.

3.1.1 Soil and Rock Excavatability

The expected ability of equipment to excavate the soil and rock encountered at the site is summarised in **Table 4**. This assessment is based on available site investigation data and guidance on the assessment of excavatability of rock by Pettifer and Fookes (1994). The presence of medium to high strength bands in lower strength rock and the discontinuity spacing may influence the excavatability of the rock mass.

TABLE 4 SOIL AND ROCK EXCAVATABILITY

Unit	Material	Excavatability
1	**Topsoil / Fill**	Easy digging by 20t Excavator
2	**Alluvial Soil**	Easy digging by 20t Excavator
3	**Residual Soil**	Easy digging by 20t Excavator
4	**Extremely Low to Very Low Strength Bedrock**	Moderate to hard ripping by 20t Excavator
5	**Low Strength Bedrock**	Hydraulic hammering may be required where medium to high strength ironstone bands are encountered within Unit 4
6	**Medium to High Strength Bedrock**	Hydraulic hammering will be required

The excavation methodology may also be affected by the following factors:

- Scale and geometry of the excavation;
- Availability of suitable construction equipment;
- Potential reuse of material on site; and
- Acceptable excavation methods, noise, ground vibration and other environmental criteria.

3.2 Excavation Vibration Considerations

As a guide, safe working distances for typical items of vibration intensive plant are listed in **Table 5**. The safe working distances are quoted for both “cosmetic” damage (refer British Standard BS 7385:1993) and human comfort (refer NSW Environmental Protection Agency Vibration Guideline).The safe working distances should be complied with at all times, unless otherwise mitigated to the satisfaction of the relevant stakeholders.

TABLE 5 RECOMMENDED SAFE WORKING DISTANCES FOR VIBRATION INTENSIVE PLANT

Plant Item	Rating/Description	Safe Working Distance	
		Cosmetic Damage (BS 7385:1993) [1]	Human Response (EPA Vibration Guideline)
Vibratory Roller	< 50 kN (typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (typically 2-4 tonnes)	6 m	20 m
	< 200 kN (typically 4-6 tonnes)	12 m	40 m
	< 300 kN (typically 7-13 tonnes)	15 m	100 m
	< 300 kN (typically 13-18 tonnes)	20 m	100 m
	< 300 kN (typically >18 tonnes)	25 m	100 m
Small Hydraulic Hammer	300 kg – 5 to 12 t excavator	2 m	7 m
Medium Hydraulic Hammer	900 kg – 12 to 18 t excavator	7 m	23 m
Large Hydraulic Hammer	1600 kg – 18 to 34 t excavator	22 m	73 m
Vibratory Pile Driver	Sheet Piles	2 m to 20 m	20 m
Pile Boring	≤ 800 mm	2m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

Notes:

1 More stringent conditions may apply to heritage buildings or other sensitive structures.

In relation to human comfort (response), the safe working distances in **Table 5** relate to continuous vibration and apply to residential receivers. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are permitted, as discussed in British Standard BS 6472-1:2008.

Where vibration intensive works such as hydraulic hammering of competent rock or driven piles are proposed contractors should make an assessment of the potential impact of their works on the basis of the borehole logs, core photographs and point load data. Monitoring of construction induced vibration should be undertaken at the commencement of such activities at the nearest vibration receptor in consultation with the project superintendent and geotechnical engineer. On the basis of trials at the commencement of works a construction methodology may be proposed to limit peak particle velocities (ppv) to acceptable levels. In the absence of ppv guidelines from affected asset owners, Morrow Geotechnics recommends the following limits be placed on vibrations:

- 20 mm/s for commercial or industrial structures;
- 10 mm/s for residential structures;
- 3 mm/s for structures which are particularly susceptible to vibration such as heritage buildings.

If vibration levels are found to be unacceptable during the trial, it may be necessary to adopt vibration mitigation measures such as:

- The use of smaller excavation plant and hydraulic hammers;
- Saw cutting of the perimeter of the excavation;
- Hammering at 50% capacity in short bursts to prevent the buildup of resonant frequencies;
- The use of low vibration techniques such as rotary grinders or chemical rock splitting.

3.3 Foundation Design

The parameters given in **Table 6** may be used for the design of pad footings and bored piles. Morrow Geotechnics recommends that a Preliminary Geotechnical Strength Reduction Factor (GSRF) of 0.4 is used for the design of piles in accordance with AS 2159:2009 if no allowance is made for pile testing during construction. Should pile testing be nominated, the GSRF may be reviewed and a value of 0.55 to 0.65 may be expected.

Ultimate geotechnical strengths are provided for use in limit state design. Allowable bearing pressures are provide for serviceability checks. These values have been determined to limit settlements to an acceptable level for conventional building structures, typically less than 1% of the minimum footing dimension.

TABLE 6 PAD FOOTING AND PILE DESIGN PARAMETERS

Material		Unit 1 Fill	Unit 2 Alluvial Soil	Unit 3 Residual Soil	Unit 4 ELS-VLS Bedrock	Unit 5 LS Bedrock	Unit 6 MS-HS Bedrock
Allowable Bearing Pressure (kPa)		-	100	250	700	1250	3000
Ultimate Vertical End Bearing Pressure (kPa)		-	300	750	2100	3750	9000
Elastic Modulus (MPa)		4	15	40	75	120	300
Allowable Shaft Adhesion (kPa)	In Compression	0	15	25	70	120	250
	In Tension	0	7.5	12.5	35	60	125
Susceptibility to Liquefaction during an Earthquake		Medium	Medium	Low	Low	Low	Low

Notes:

1 Side adhesion values given assume there is intimate contact between the pile and foundation material. Design engineer to check both 'piston' pull-out and 'cone' pull-out mechanics in accordance with AS4678-2002 Earth Retaining Structures.

2 Susceptibility to liquefaction during an earthquake is based on the following definition:
- Low - Medium to very dense sands, stiff to hard clays, and rock
- Medium - Loose to medium dense sands, soft to firm clays, or uncontrolled fill below the water table
- High - Very loose sands or very soft clays below the water table

To adopt these parameters we have assumed that the bases of all pile excavations are cleaned of loose debris and water and inspected by a suitably qualified Geotechnical Engineer prior to pile construction to verify that ground conditions meet design assumptions. Where groundwater ingress is encountered during pile excavation, concrete is to be placed as soon as possible upon completion of pile excavation. Pile excavations should be pumped dry of water prior to pouring concrete, or alternatively a tremmie system could be used.

Selection of footing types and founding depth will need to consider the risk of adverse differential ground movements within the foundation footprint and between high level and deeper footings. Unless an

allowance for such movement is included in the design of the proposed development we recommend that all new structures found on natural materials with comparable end bearing capacities and elastic moduli.

3.4 AS1170 Earthquake Site Risk Classification

Assessment of the material encountered during the investigation in accordance with the guidelines provided in AS1170.4-2007 indicates an earthquake subsoil class of Class C_e – Shallow Soil for the site.

3.5 Groundwater Management

A standing groundwater level was encountered within the proposed depth of excavation at approximately 2.6 mBGL within alluvial soils. Sandy clay alluvial soils generally yield moderate seepage volumes below the groundwater table. NSW DPI Office of Water licensing of the excavation will be required as the proposed excavation intersects the groundwater table. Consideration should be given to groundwater management within design and construction to prevent ongoing groundwater flows.

Design of excavation retention systems will need to consider both the soil and groundwater conditions encountered within the investigation. Given the relatively high water level observed at site it will be necessary to design the basement shoring as a tanked system. Watertight shoring walls are usually achieved through either secant piles, cutter soil mix walls or sheet piling. If the basement shoring is designed as a watertight wall it will be necessary to design walls to withstand hydrostatic pressures and anchoring or internal bracing will be required.

4 RECOMMENDATIONS FOR FURTHER GEOTECHNICAL SERVICES

Further geotechnical inspections should be carried out during construction to confirm the geotechnical and hydrogeological model. These should include:

- Additional cored boreholes must be undertaken prior to detailed structural design in order to provide an assessment of the rock quality for shoring and foundation design.
- Geotechnical design input during structural design including Finite Element Analysis of ground movements for the protection of adjacent structures and properties.
- All excavated material transported off site should be classified in accordance with NSW EPA 2014 - Waste Classification Guideline Part 1; Classifying Waste.
- Observation of the material within pile excavations should be undertaken at the start of piling works to confirm that material across the site is in accordance with the geotechnical model presented in this report.
- A suitably qualified geotechnical engineer is to assess the condition of exposed material at foundation or subgrade level to assess the ability of the prepared surface to act as a foundation or as a subgrade.
- Regular inspections of battered and unsupported excavations, where proposed, to confirm geotechnical conditions and to assess the suitability of design assumptions and to provide further advice with regards to excavation retention/ support and proposed construction methodologies, if required.

5 STATEMENT OF LIMITATIONS

The adopted investigation scope was limited by the investigation intent. Further geotechnical investigations should be carried out prior to finalisation of design and during construction to confirm both the geotechnical model and the design parameters provided in this report.

Your attention is drawn to the document "Important Information", which is included in **Appendix B** of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by Morrow Geotechnics, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

6 REFERENCES

AS1726:1993, *Geotechnical Site Investigations*, Standards Australia.

AS2159:2009, *Piling – Design and Installation*, Standards Australia.

AS2870:2011, *Residential Slabs and Footings*, Standards Australia.

AS3798:2007, *Guidelines on Earthworks for Commercial and Residential Developments*, Standards Australia.

NSW Department of Finance and Service, Spatial Information Viewer, maps.six.nsw.gov.au.

Pells (2004) Substance and Mass Properties for the Design of Engineering Structures in the Hawkesbury Sandstone, Australian Geomechanics Journal, Vol 39 No 3

7 CLOSURE

Please do not hesitate to contact Morrow Geotechnics if you have any questions about the contents of this report.

For and on behalf of Morrow Geotechnics Pty Ltd,

Alan Morrow
Senior Geotechnical Engineer

morrow
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Drawn	ZS
Approved	AM
Date	26/02/2020
Scale	NTS

ADG Architects
8-16 Watt Street, Gosford NSW
Geotechnical Investigation
Borehole Location Plan

Figure: **1**

Project: P1865

Appendix A

BOREHOLE LOGS AND EXPLANATORY NOTES

Borehole Log Report

Morrow Geotechnics Pty Ltd
PO Box 4069
Carlton NSW 2218
M 0405 843 933

Hole ID. **BH1**
Hole Depth: **24.90 m**
Sheet: **1 of 4**

Project Name: **Geotechnical Assessment** Project Number: **P1865**
Location / Site: **8 - 16 Watt Street, Gosford** Client: **ADG Architects**

Drilling Company: **Geosense Pty Ltd** Date Started: **19-FEB-20** Ground Level: ----------
Drill Method: **SFA/NLMC** Date Completed: **19-FEB-20** Easting: ----------
Equipment: **Track mounted D&B Hanjin** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Consistency / Density	Moisture	Samples / Tests (SPT)	Observations / Comments
							Surface: Aspahalt				
SFA	2.6m 20-Feb-20	1.0			GP		**ASPHALT**- dark grey.	medium dense	m		
							FILL: Sandy Gravel- grey brown, fine to coarse grained, fine Gravel (DGB).		m to w		
					CL		**FILL: Silty Sandy CLAY**- brown grey brown, low plasticity, fine to medium grained.	soft		0 0 0 N=0 HW	
		2.0			SP		**COLLUVIAL: SAND trace Silt and Clay**- brown, fine to medium grained.	very loose	m to w		
							Clayey Silty SAND- grey some red, low plasticity, fine to medium grained.		m	0 0 1 N=1	
		3.0						loose		2 4 5 N=9	
		4.0			SC	Residual Soil					
		5.0								5 5 6 N=11	
		6.0									

GEE DAVIES BH LOG DRAFT LOGS GOSFORD.GPJ GEE.GDT 25-2-20 10:16:19 PM

Moisture

D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet
Sd	Saturated

Additional Comments

Logged By: **Matthew Kilham** Date: **19-Feb-20** Checked By: **Alan Morrow** Date: **22-FEB-20**

Borehole Log Report

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Sheet: **2 of 4**

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Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Consistency / Density	Moisture	Samples / Tests (SPT)	Observations / Comments
SFA		7.0			SC	Residual Soil	**Clayey Silty SAND**- grey some red, low plasticity, fine to medium grained.*(continued)* becoming light grey some red and orange.	loose	m	3 5 6 N=11	
		8.0								2 3 5 N=8	
		9.0			CH		**Silty CLAY**- dark grey some red, high plasticity.	very stiff	m	8 10 15 N=25	
		10.0			SP		**SAND trace Silt and Clay**- orange brown red, fine to coarse grained.	medium dense	m	6 10 18 N=28	
		11.0			SC		**SAND, Sandy Clay and Clayey SAND**- orange brown red, low plasticity, fine to coarse grained.	stiff and medium dense	m		
		12.0									

Moisture

D	Dry
Dp	Damp
SM	Slightly Moist
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Equipment: **Track mounted D&B Hanjin** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Consistency / Density	Moisture	Samples / Tests: SPT	Observations / Comments
SFA		13.0			SC	Residual Soil	**SAND, Sandy Clay and Clayey SAND**- orange brown red, low plasticity, fine to coarse grained.*(continued)*	stiff and medium dense	m	5 8 8 N=16	
		16.0				Bedrock	**SANDSTONE**- orange brown red, fine to coarse grained, extremely weathered, estimated very low strength.				16.1m drilling firm to hard, bands weathered rock
		17.0					*BH1 continued as cored hole from 17m*				
		18.0									

Moisture	
D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
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Additional Comments

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Sheet: **4 of 6**

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Equipment: **Track mounted D&B Hanjin** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa) EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	$Is_{(50)}$ MPa D=diametral A=axial	U.C.S. (Mpa)	Rock Mass Defects: RQD %	Core Photo	Defect Spacing (mm) 20 60 200 600 2000	Defect Description type, inclination, thickness, shape, roughness, coating Specific / General	Depth (m)	Casing & Core Lifts
		12.5													12.5	
		13.0													13.0	
		13.5													13.5	
		14.0													14.0	
		14.5													14.5	
		15.0													15.0	
		15.5													15.5	
		16.0													16.0	
		16.5													16.5	
		17.0													17.0	
NLMC		17.5			Bedrock	**SANDSTONE** - grey white pink, fine to medium grained, weak to moderate iron staining, moderate to strong iron staining on some joints and bedding planes.	DW-SW		A=1.64 D=1.12		79			SM, 0, clay, 100mm BD, 5, RG, FE BD, 3, RG, FE BD, 3, RG, FE	17.5	
		18.0													18.0	

Additional Comments

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Drill Method: **SFA/NLMC** Date Completed: **19-FEB-20** Easting: ----------
Equipment: **Track mounted D&B Hanjin** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa) EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	$Is_{(50)}$ MPa D=diametral A=axial	U.C.S. (Mpa)	Rock Mass Defects: RQD %	Core Photo	Defect Spacing (mm) 20 60 200 600 2000	Defect Description type, inclination, thickness, shape, roughness, coating: Specific / General	Depth (m)	Casing & Core Lifts
NLMC		18.5			Bedrock	**SANDSTONE** - grey white pink, fine to medium grained, weak to moderate iron staining, moderate to strong iron staining on some joints and bedding planes.	DW-SW		A=3.01 D=3.09		79			SM, 3, clay, 30mm BD, 0, RG, FE BD, 3, RG, FE BD, 10, RG, FE BD, 10, RG BD, 3mm ironstone band BD, 3, RG, FE BD, 2, RG, FE JT*2, 80, RG, FE	18.5	
		19.0													19.0	
		19.5												BD, 3, RG, FE BD, 2, RG, FE JT, 60, RG, FE JT, 60, RG, FE ironstone band 15mm ironstone band 15mm BD, 2, RG, FE	19.5	
		20.0				**SANDSTONE** - white orange, fine to coarse grained, weak to moderate iron staining, moderate to strong iron staining on some joints and bedding planes.			A=1.74 D=1.8					DB	20.0	20.18
		20.5													20.5	
		21.0							A=1.61 D=1.39		77			JT, 70, RG	21.0	
		21.5							A=1.15 D=1.18					JT, 55, RG, FE JT, 55, RG, FE BD, 0, RG, FE BD, 0, RG, FE JT, 70, RG, FE	21.5	
		22.0												SM, 0, clay, 3mm SM, 0, clay, 20mm DB BD, 2, RG, FE BD, 0, RG, FE BD, 0, RG, FE JT, 35, RG, FE BD, 0, RG, FE	22.0	21.86
		22.5				**Silty SANDSTONE bands SANDSTONE** - grey and light grey, fine to coarse grained.	FR		A=0.42 D=0.32					SM, 0, clay, 2mm BD, 2, RG, FE BD, 2, RG, FE SM, 0, clay, 3mm SM, 0, clay, 60mm SM, 5, clay, 4mm	22.5	
		23.0							A=1.09 D=1.21		82			SM, clay, 0, 10mm	23.0	
		23.5													23.5	
		24.0													24.0	

Additional Comments

Logged By: **Matthew Kilham** Date: **19-Feb-20** Checked By: **Alan Morrow** Date: **22-FEB-20**

Borehole Log Report

Morrow Geotechnics Pty Ltd
PO Box 4069
Carlton NSW 2218
M 0405 843 933

Hole ID. **BH1**
Hole Depth: **24.90 m**
Sheet: **6 of 6**

Project Name: **Geotechnical Assessment** Project Number: **P1865**
Location / Site: **8 - 16 Watt Street, Gosford** Client: **ADG Architects**

Drilling Company: **Geosense Pty Ltd** Date Started: **19-FEB-20** Ground Level: ----------
Drill Method: **SFA/NLMC** Date Completed: **19-FEB-20** Easting: ----------
Equipment: **Track mounted D&B Hanjin** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa) EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	$Is_{(50)}$ MPa D=diametral A=axial	U.C.S. (Mpa)	Rock Mass Defects: RQD %	Core Photo	Defect Spacing (mm) 20 60 200 600 2000	Defect Description type, inclination, thickness, shape, roughness, coating: Specific / General	Depth (m)	Casing & Core Lifts
NLMC		24.5			Bedrock	**Silty SANDSTONE bands SANDSTONE** - grey and light grey, fine to coarse grained.	FR		A=1.09 D=0.66		82				24.5	
						SANDSTONE - light grey, fine to coarse grained.			A=0.97 D=1.33					SM, clay, 0, 10mm SM, 0, clay, 20mm		24.9
		25.0				**Hole Terminated at 24.90 m** Target depth achieved									25.0	
		25.5													25.5	
		26.0													26.0	
		26.5													26.5	
		27.0													27.0	
		27.5													27.5	
		28.0													28.0	
		28.5													28.5	
		29.0													29.0	
		29.5													29.5	
		30.0													30.0	

Additional Comments

Logged By: **Matthew Kilham** Date: **19-Feb-20** Checked By: **Alan Morrow** Date: **22-FEB-20**

Borehole Log Report

Morrow Geotechnics Pty Ltd
PO Box 4069
Carlton NSW 2218
M 0405 843 933

morrow

Hole ID. **BH2**
Hole Depth: **20.22 m**
Sheet: **1 of 4**

Project Name: **Geotechnical Assessment** Project Number: **P1865**
Location / Site: **8 - 16 Watt Street, Gosford** Client: **ADG Architects**

Drilling Company: **Geosense Pty Ltd** Date Started: **20-FEB-19** Ground Level: ----------
Drill Method: **SFA/NLMC** Date Completed: **20-FEB-19** Easting: ----------
Equipment: **Track mounted D&B Hanjin** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Consistency / Density	Moisture	Samples / Tests (SPT)	Observations / Comments
							Surface: Concrete				
SFA							**CONCRETE**.				
					SP		**FILL: SAND**- yellow orange, fine to coarse grained, trace fine to coarse Gravel and cobbles (concrete).	loose	m		
		1.0			SP		**COLLUVIAL: SAND trace Silt**- brown, fine to medium grained.	loose	m		
					CL	Residual Soil	**Sandy CLAY**- brown mottled red and grey, fine to medium grained.	firm	m	1 3 3 N=6	
		2.0			SC		**Clayey SAND**- grey some red and orange, fine to medium grained.	medium dense	m	5 6 7 N=13	
		3.0			CL		**Sandy CLAY**- grey red and orange, fine to coarse grained.	stiff to very stiff	m	6 8 10 N=18	
		4.0									
		5.0					*BH2 continued as cored hole from 4.5m*				
		6.0									

Moisture	
D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet
Sd	Saturated

Additional Comments

Logged By: **Matthew Kilham** Date: **20-Feb-19** Checked By: **Alan Morrow** Date: **22-FEB-20**

Borehole Log Report

Morrow Geotechnics Pty Ltd
PO Box 4069
Carlton NSW 2218
M 0405 843 933

Hole ID. **BH2**
Hole Depth: **20.22 m**
Sheet: **2 of 5**

Project Name: **Geotechnical Assessment** Project Number: **P1865**
Location / Site: **8 - 16 Watt Street, Gosford** Client: **ADG Architects**

Drilling Company: **Geosense Pty Ltd** Date Started: **20-FEB-19** Ground Level: ----------
Drill Method: **SFA/NLMC** Date Completed: **20-FEB-19** Easting: ----------
Equipment: **Track mounted D&B Hanjin** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa) EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	$Is_{(50)}$ MPa D=diametral A=axial	U.C.S. (Mpa)	Rock Mass Defects: RQD %	Core Photo	Defect Spacing (mm) 20 60 200 600 2000	Defect Description type, inclination, thickness, shape, roughness, coating: Specific / General	Depth (m)	Casing & Core Lifts
NLMC		0.5 … 4.5													0.5 … 4.5	
NLMC		5.0			Bedrock	**SANDSTONE** - red brown orange white, fine to coarse grained.	DW		A=1.08 D=0.74		82			BD, 0, RG, FE	5.0	
														BD, 0, RG, FE SM, 0, clay, 110mm		
														BD, 0, RG, FE		
		5.5							A=0.48 D=0.42		84			DB SM, 0, clay, 10mm SM, 0, clay, 40mm BD, 0, RG, FE	5.5	5.45
		6.0													6.0	

Additional Comments

Logged By: **Matthew Kilham** Date: **20-Feb-19** Checked By: **Alan Morrow** Date: **22-FEB-20**

Borehole Log Report

Morrow Geotechnics Pty Ltd
PO Box 4069
Carlton NSW 2218
M 0405 843 933

morrow

Hole ID. **BH2**
Hole Depth: **20.22 m**
Sheet: **3 of 5**

Project Name: **Geotechnical Assessment** Project Number: **P1865**
Location / Site: **8 - 16 Watt Street, Gosford** Client: **ADG Architects**

Drilling Company: **Geosense Pty Ltd** Date Started: **20-FEB-19** Ground Level: ----------
Drill Method: **SFA/NLMC** Date Completed: **20-FEB-19** Easting: ----------
Equipment: **Track mounted D&B Hanjin** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa) EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	$Is_{(50)}$ MPa D=diametral A=axial	U.C.S. (Mpa)	Rock Mass Defects: RQD %	Core Photo	Defect Spacing (mm) 20 60 200 600 2000	Defect Description type, inclination, thickness, shape, roughness, coating: Specific / General	Depth (m)	Casing & Core Lifts
NLMC		6.5			Bedrock	**SANDSTONE** - orange white grey, fine to medium grained.	DW-SW		A=0.28 D=0.03		84			JT, 45, RG; DB	6.5	6.67
		7.0							A=0.67 D=0.09						7.0	
		7.5									88				7.5	
		8.0												BD, 0, RG, FE; BD, 0, RG, FE; BD, 0, RG, FE; BD, 0, RG, FE; BD, 0, RG, FE; JT, 45, clay veneer; DB	8.0	
		8.5							A=1.29 D=0.46						8.5	8.44
		9.0				**SANDSTONE** - grey, fine to medium grained, trace carbonaceous laminations.	SW-FR		A=0.62 D=0.17					BD, 0, RG, FE	9.0	
		9.5												BD, 0, RG, FE; BD, 0, RG, FE; BD, 0, RG, FE; BD, 0, RG, FE	9.5	
		10.0							A=0.99 D=0.32		96			BD, 5, RG, FE	10.0	
		10.5												ironstone band 10mm; BD, 2, RG, FE; BD, 2, RG, FE	10.5	
		11.0							A=0.73 D=0.37						11.0	
		11.5												DB	11.5	11.48
		12.0									98			SM, 0, clay	12.0	

Additional Comments

Logged By: **Matthew Kilham** Date: **20-Feb-19** Checked By: **Alan Morrow** Date: **22-FEB-20**

Borehole Log Report

Morrow Geotechnics Pty Ltd
PO Box 4069
Carlton NSW 2218
M 0405 843 933

Hole ID. **BH2**
Hole Depth: **20.22 m**
Sheet: **4 of 5**

Project Name: **Geotechnical Assessment** Project Number: **P1865**
Location / Site: **8 - 16 Watt Street, Gosford** Client: **ADG Architects**

Drilling Company: **Geosense Pty Ltd** Date Started: **20-FEB-19** Ground Level: ----------
Drill Method: **SFA/NLMC** Date Completed: **20-FEB-19** Easting: ----------
Equipment: **Track mounted D&B Hanjin** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa) EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	$Is_{(50)}$ MPa D=diametral A=axial	U.C.S. (Mpa)	Rock Mass Defects: RQD %	Core Photo	Defect Spacing (mm) 20 60 200 600 2000	Defect Description type, inclination, thickness, shape, roughness, coating: Specific / General	Depth (m)	Casing & Core Lifts
NLMC		12.5–18.0			Bedrock	**SANDSTONE** - grey, fine to medium grained, trace carbonaceous laminations.	SW-FR		A=0.93 D=0.93 A=0.88 D=0.75 A=0.77 D=0.6 A=0.8 D=0.46 A=0.78 D=0.62		98 97 99			JT, 45, RG, FE DB JT, 70, RG, FE SM, 0, clay ironstone band 10mm DB		14.53 17.68
						Silty SANDSTONE bands SANDSTONE - dark grey, fine to medium grained.	SW		A=0.35 D=0.17							

Additional Comments

Logged By: **Matthew Kilham** Date: **20-Feb-19** Checked By: **Alan Morrow** Date: **22-FEB-20**

Borehole Log Report

Morrow Geotechnics Pty Ltd
PO Box 4069
Carlton NSW 2218
M 0405 843 933

morrow

Hole ID. **BH2**
Hole Depth: **20.22 m**
Sheet: **5 of 5**

Project Name: **Geotechnical Assessment** Project Number: **P1865**
Location / Site: **8 - 16 Watt Street, Gosford** Client: **ADG Architects**

Drilling Company: **Geosense Pty Ltd** Date Started: **20-FEB-19** Ground Level: ----------
Drill Method: **SFA/NLMC** Date Completed: **20-FEB-19** Easting: ----------
Equipment: **Track mounted D&B Hanjin** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa) EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	$Is_{(50)}$ MPa D=diametral A=axial	U.C.S. (Mpa)	Rock Mass Defects: RQD %	Core Photo	Defect Spacing (mm) 20 60 200 600 2000	Defect Description type, inclination, thickness, shape, roughness, coating: Specific / General	Depth (m)	Casing & Core Lifts
NLMC		18.5			Bedrock	**Silty SANDSTONE bands SANDSTONE** - dark grey, fine to medium grained.	FR		A=0.98 D=0.12		99				18.5	
		19.0							A=0.8 D=0.24					JT, 10, RG	19.0	
		19.5					DW		A=0.93 D=0.44					BD, 0, RG	19.5	
		20.0					FR		A=2.64 D=5.19						20.0	20.22
						Hole Terminated at 20.22 m Target depth achieved										
		20.5													20.5	
		21.0													21.0	
		21.5													21.5	
		22.0													22.0	
		22.5													22.5	
		23.0													23.0	
		23.5													23.5	
		24.0													24.0	

Additional Comments

Logged By: **Matthew Kilham** Date: **20-Feb-19** Checked By: **Alan Morrow** Date: **22-FEB-20**

Soil and Rock Logging Explanatory Notes

GENERAL

Information obtained from site investigations is recorded on log sheets. The "Cored Drill Hole Log" presents data from an operation where a core barrel has been used to recover material - commonly rock. The "Non-Core Drill Hole - Geological Log" presents data from an operation where coring has not been used and information is based on a combination of regular sampling and insitu testing. The material penetrated in non-core drilling is commonly soil but may include rock. The "Excavation - Geological Log" presents data and drawings from exposures of soil and rock resulting from excavation of pits, trenches, etc.

The heading of the log sheets contains information on Project Identification, Hole or Pit Identification, Location and Elevation. The main section of the logs contains information on methods and conditions, material substance description and structure presented as a series of columns in relation to depth below the ground surface which is plotted on the left side of the log sheet. The common depth scale is 8m per drill log sheet and about 3-5m for excavation logs sheets.

As far as is practicable the data contained on the log sheets is factual. Some interpretation is inevitable in the identification of material boundaries in areas of partial sampling, the location of areas of core loss, description and classification of material, estimation of strength and identification of drilling induced fractures. Material description and classifications are based on SAA Site Investigation Code AS 1726 - 1993 with some modifications as defined below.

These notes contain an explanation of the terms and abbreviations commonly used on the log sheets.

DRILLING

Drilling & Casing

ADV	Auger Drilling with V-Bit
ADT	Auger Drilling with TC Bit
WB	Wash-bore drilling
RR	Rock Roller
NMLC	NMLC core barrel
NQ	NQ core barrel
HMLC	HMLC core barrel
HQ	HQ core barrel

Drilling Fluid/Water

The drilling fluid used is identified and loss of return to the surface estimated as a percentage.

Drilling Penetration/Drill Depth

Core lifts are identified by a line and depth with core loss per run as a percentage. Ease of penetration in non-core drilling is abbreviated as follows:

VE	Very Easy
E	Easy
M	Medium
H	High
VH	Very High

Groundwater Levels

Date of measurement is shown.

Standing water level measured in completed borehole

Level taken during or immediately after drilling

D	Disturbed
B	Bulk
U	Undisturbed
SPT	Standard Penetration Test
N	Result of SPT (sample taken)
PBT	Plate Bearing Test
PZ	Piezometer Installation
HP	Hand Penetrometer Test

EXCAVATION LOGS

Explanatory notes are provided at the bottom of drill log sheets. Information about the origin, geology and pedology may be entered in the "Structure and other Observations" column. The depth of the base of excavation (for the logged section) at the appropriate depth in the "Material Description" column. Refusal of excavation plant is noted should it occur. A sketch of the exposure may be added.

MATERIAL DESCRIPTION - SOIL

Classification Symbol - In accordance with the Unified Classification System (AS 1726-1993, Appendix A, Table A1)

Material Description - In accordance with AS 1726-1993, Appendix A2.3

Moisture Condition

D	Dry, looks and feels dry
M	Moist, No free water on remoulding
W	Wet, free water on remoulding

Consistency - In accordance with AS 1726-1993, Appendix A2.5

VS	Very Soft	< 12.5 kPa
S	Soft	12.5 – 25 kPa
F	Firm	25 – 50 kPa
St	Stiff	50 – 100 kPa
VSt	Very Stiff	100 – 200 kPa
H	Hard	> 200 kPa

Strength figures quoted are the approximate range of undrained shear strength for each class.

Density Index. (%) is estimated or is based on SPT results.

VL	Very Loose	< 15 %
L	Loose	15 – 35 %
MD	Medium Dense	35 – 65 %
D	Dense	65 – 85 %
VD	Very Dense	> 85 %

MATERIAL DESCRIPTION -ROCK

Material Description

Identification of rock type, composition and texture based on visual features in accordance with AS 1726-1993, Appendix A3.1-A3.3 and Tables A6a, A6b and A7.

Core Loss

Is shown at the bottom of the run unless otherwise indicated.

Bedding

Thinly Laminated	< 6 mm
Laminated	6 - 20
Very Thinly Bedded	20 - 60
Thinly Bedded	60 - 200
Medium Bedded	200 – 600
Thickly Bedded	600 – 2000
Very Thickly Bedded	> 2000

Weathering - No distinction is made between weathering and alteration. Weathering classification assists in identification but does not imply engineering properties.

Fresh (F)	Rock substance unaffected by weathering
Slightly Weathered (SW)	Rock substance partly stained or discoloured. Colour and texture of fresh rock recognisable.
Moderately Weathered (MW)	Staining or discolouration extends throughout rock substance. Fresh rock colour not recognisable.
Highly Weathered (HW)	Stained or discoloured throughout. Signs of chemical or physical alteration. Rock texture retained.
Extremely Weathered (EW)	Rock texture evident but material has soil properties and can be remoulded.

Strength - The following terms are used to described rock strength:

Rock Strength Class	Abbreviation	Point Load Strength Index, Is(50) (MPa)
Extremely Low	EL	< 0.03
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

Strengths are estimated and where possible supported by Point Load Index Testing of representative samples. Test results are plotted on the graphical estimated strength by using:

° Diametral Point Load Test

Axial Point Load Test

Where the estimated strength log covers more than one range it indicates the rock strength varies between the limits shown.

MATERIALS STRUCTURE/FRACTURES

ROCK

Natural Fracture Spacing - A plot of average fracture spacing excluding defects known or suspected to be due to drilling, core boxing or testing. Closed or cemented joints, drilling breaks and handling breaks are not included in the Natural Fracture Spacing.

Visual Log - A diagrammatic plot of defects showing type, spacing and orientation in relation to core axis.

Defects	———	Defects open in-situu or clay sealed
	– – – – –	Defects closed in-situ
	.....	Breaks through rock substance

Additional Data - Description of individual defects by type, orientation, in-filling, shape and roughness in accordance with AS 1726-1993, Appendix A Table A10, notes and Figure A2.

Orientation - angle relative to the plane normal to the core axis.

Type	BP	Bedding Parting
	JT	Joint
	SM	Seam
	FZ	Fracture Zone
	SZ	Shear Zone
	VN	Vein
	FL	Foliation
	CL	Cleavage
	DL	Drill Lift
	HB	Handling Break
	DB	Drilling Break
Infilling	CN	Clean
	X	Carbonaceous
	Clay	Clay
	KT	Chlorite
	CA	Calcite
	Fe	Iron Oxide
	Qz	Quartz
	MS	Secondary Mineral
	MU	Unidentified Mineral
Shape	PR	Planar
	CU	Curved
	UN	Undulose
	ST	Stepped
	IR	Irregular
	DIS	Discontinuous
Rougness	POL	Polished
	SL	Slickensided
	S	Smooth
	RF	Rough
	VR	Very Rough

SOIL

Structures - Fissuring and other defects are described in accordance with AS 1726-1993, Appendix A2.6, using the terminology for rock defects.

Origin - Where practicable an assessment is provided of the probable origin of the soil, eg fill, topsoil, alluvium, colluvium, residual soil.

Appendix B

Borehole Logs and Explanatory Notes from JK 1982 & JK 1983 Investigations

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 1

Client: WOOLACOTT, HALE, CORBETT & JUMIKIS PTY. LTD.
Project: PROPOSED DEVELOPMENT
Location: WATT STREET, GOSFORD.

Job No. 2289
Date: 4-8-82
Method: SPIRAL AUGER
R.L. Surface: —
Datum: —

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
DRY ON COMPLETION						BITUMEN over FILL: Gravel sand & ash.				
					CL	SILTY, SANDY CLAY: low to medium plasticity, light brown mottled red.	MC<PL	V. St.		
	DS	N = 14 4, 6, 8	1						200 350 350	
			2		CH	CLAY: high plasticity, light grey mottled red with some ironstone gravel.	MC≒PL	V. St. - H		
	DS	N > 20 7, 12, 8/70mm.							470 350 300	
			3							"V" BIT REFUSAL
	DS					SANDSTONE: medium to coarse grained, reddish brown, highly to moderately weathered, medium strong to strong.				
▼ W.L. AFTER 4 HRS.			4							HARD "TC" BIT DRILLING
	DS		5			becoming medium grained, light grey & reddish brown, moderately weathered, weak to medium strong.				MODERATE "TC" BIT DRILLING
	DS		6			END OF BOREHOLE AT 6.0m				

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 2 1/2

Client: WOOLACOTT, HALE, CORBETT & JUMIKIS PTY. LTD.
Project: PROPOSED DEVELOPMENT
Location: WATT STREET, GOSFORD.

Job No. 2289
Date: 4-8-82
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
DRY ON COMPLETION						BITUMEN SURFACE				
						FILL: Silty, clayey sand with some fine gravel.	M			
	DS	N = 7 2, 3, 4	1							
	DS	N = 18 4, 8, 10	2		CL	SILTY, SANDY CLAY: low to medium plasticity, light brown mottled red.	MC<PL	V. St. - H		
			3		CL - CH	becoming medium plasticity, reddish brown & grey slightly sandy with some ironstone.				
	DS	N>>5 12, 5/30mm BOUNCING	4						350 400+	
	DS		5							"V" BIT REFUSAL
W. L. AFTER 1½ HRS.			6			SANDSTONE: medium grained, brown, reddish brown & grey, highly to moderately weathered, weak to medium strong.				EASY TO MODERATELY EASY "TC" BIT DRILLING

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 2 2/2

Client: WOOLACOTT, HALE, CORBETT & JUMIKIS PTY. LTD.
Project: PROPOSED DEVELOPMENT
Location: WATT STREET, GOSFORD.

Job No. 2289
Date: 4-8-82
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
			7			SANDSTONE : as above				EASY TO MODERATELY EASY "TC" BIT DRILLING
			8			END OF BOREHOLE AT 7.6m				
			9							
			10							

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 3 1/2

Client: WOOLACOTT, HALE, CORBETT & JUMIKIS PTY. LTD.
Project: PROPOSED DEVELOPMENT
Location: WATT STREET, GOSFORD.

Job No. 2289
Date: 4-8-82
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
	DS					FILL: Silty, sandy clay with some gravel & ash.	MC ≈ PL	St.		
	DS	N=4 5, 1, 3	1		CL	SILTY, SANDY CLAY: low to medium plasticity, light brown & greyish brown with some red mottling and fine gravel.	MC >> PL	S - F		
	DS	RODS SANK UNDER WEIGHT OF HAMMER	2							
	DS		3							AUGERS PUSHED WITHOUT ROTATION FOR 1500mm
	DS	N = 13 5, 6, 7	4		CL - CH	SILTY CLAY: medium plasticity, light grey mottled red & brown, sandy in places.	MC > PL	St. - V. St.	200 170 230	
W.L. : 5·5m AFTER 2½ HRS	DS	N > 15 11, 15/150mm	5			as above, but sandy with some ironstone.	MC < PL	H	420 >500	
			6							

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 3 2/2

Client: WOOLACOTT, HALE, CORBETT & JUMIKIS PTY. LTD.
Project: PROPOSED DEVELOPMENT
Location: WATT STREET, GOSFORD.

Job No. 2289
Date: 4-8-82
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
			8			as above				
	DS		9		CH	CLAY: medium to high plasticity, light grey mottled red.	MC<PL	H		
	DS		10			grading into SILTSTONE: light grey and red, highly weathered, very weak with ironstone layers.				"V" BIT REFUSAL
	DS		11							VERY EASY "TC" BIT DRILLING
			12			becoming greyish brown, very weak to weak.				
	DS		13							
						END OF BOREHOLE AT 13.6m				

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 4

Client: WOOLACOTT, HALE, CORBETT & JUMIKIS PTY. LTD.
Project: PROPOSED DEVELOPMENT
Location: WATT STREET, GOSFORD.

Job No. 2289
Date: 4-8-82
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
DRY ON COMPLETION	DS					FILL: Silty sand, fine grained, greyish brown.	M			
	DS		1		CL	SILTY, SANDY CLAY: low to medium plasticity, light brown.	MC>PL	St.		
	DS		2		CL-CH	becoming medium plasticity, reddish brown.	MC ≈ PL			
	DS		3							"V" BIT REFUSAL
						END OF BOREHOLE AT 3.7m				
			4							
			5							
			6							

JEFFERY AND KATAUSKAS PTY. LTD.

Borehole No. 5

BOREHOLE LOG

Client: WOOLACOTT, HALE, CORBETT & JUMIKIS PTY. LTD.
Project: PROPOSED DEVELOPMENT
Location: WATT STREET, GOSFORD.

Job No. 2289
Date: 4-8-82
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
DRY ON COMPLETION			0			FILL: Silty sand, dark brownish grey.	M			
			1		CL	SILTY CLAY: low to medium plasticity, light brown.	MC ≈ PL	St.		
			2							
			3			as above, but reddish brown.		V. St.		
			4							
			5			becoming reddish brown & grey, slightly sandy.	MC < PL	V. St. - H		RIG LIFTING
			6			END OF BOREHOLE AT 6.0m				

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 2A 1/2

Client: WOOLACOTT HALE CORLETT & JUMIKIS PTY. LTD.
Project: PROPOSED SHOPPING CENTRE
Location: MANN STREET, GOSFORD

Job No. 2289 X
Date: 27.7.83
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
						BITUMEN SURFACE				
			1			FILL: SILTY CLAYEY SAND with some fine gravel	M			
			2		CL	SILTY SANDY CLAY, low to medium plasticity, light brown mottled red	MC< PL	V.St-H		
			3							
			4							
			5							
			6			SANDSTONE, highly to moderately weathered weak to medium strong (REFER TO CORED BH LOG)				'V' bit refusal; rock roller drilling

JEFFERY AND KATAUSKAS PTY. LTD.

Borehole No. 2A 2/2

CORED BOREHOLE LOG

Client: WOOLACOTT HALE CORLETT & JUMIKIS PTY. LTD.
Project: PROPOSED SHOPPING CENTRE
Location: MANN STREET, GOSFORD

Job No: 2289 X
Date Drilled: 27.7.83
Drill Type: ROTARY
Core Size: NMLC
Inclination: VERT
Bearing:
R.L. Surface
Datum:

Water Loss	Water Record	Barrel Lift	Core Loss	Depth (m)	Graphic Log	CORE DESCRIPTION	Weathering	Strength	DEFECT DETAILS: DEFECT SPACING (m) .5 .3 .1 .05 .03 .01	DEFECT DETAILS: Description
						START CORING @ 7.25 m				
				8		SANDSTONE, fine to medium grained, reddish brown, brown and grey	EW-HW	VW		150 mm sugary seam 200 mm clay seam
								MS-S		joints. 2 No. clean
										joints. 2 No., clean
										5 mm sugary seam joint. clean
				9			MW	MS		
				10			MW-HW	S VW		joint. clean. 45° 100 mm sugary seam 60 mm clay seam 100 mm fragmented zone
						SILTSTONE, dark grey and brown laminated				
				11			HW	VW		
				12						100 mm clay seam 50 mm fragmented zone
						——as above but light grey mottled brown and red with some black shaley bands		W		subvertical joint, ironstained
							HW-MW	MS W		50 mm fragmented zone 50 mm clay seam
				13				VW		
						END OF BH @ 13.0 m				

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 6 1/3

Client: WOOLACOTT HALE CORLETT & JUMIKIS PTY. LTD.
Project: PROPOSED SHOPPING CENTRE
Location: MANN STREET, GOSFORD

Job No. 2289 X
Date: 26.7.83
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
						FILL: ASH, SAND & GRAVEL				
			1		SM-SC	SILTY CLAYEY SAND, light brown & grey, fine grained	M	MD		
	DS	N=11 2,4,7								
			2			——— grading into SILTY SANDY CLAY, medium plasticity brown and grey				
▼ AFTER 28 HRS	DS	N=13 3,7,6			CL-CH		MC > PL	St-V.St	170 180 280	
			3							
	DS	N=12 5,6,6	4		CL-CH-SC	SANDY CLAY - CLAYEY SAND, medium plasticity, light grey with some silty fine grained sand bands	MC > PL	St-V.St	140 200 240	
			5							penetration of augers without rotation (mm)
	DS	N>20 20/230 mm			CL-SC	——— as above but low plasticity mottled red and brown	MC < PL	H	420 500 500	— 0
			6							T 100
										T 20

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 6 2/3

Client: WOOLACOTT HALE CORLETT & JUMIKIS PTY. LTD.
Project: PROPOSED SHOPPING CENTRE
Location: MANN STREET, GOSFORD

Job No. 2289 X
Date: 26.7.83
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
			8		CL-SC	——— as above			30	
			9						30	
									10	
			10						10	
									10	
									0	
									0	
										rig lifting
			11		CH	SILTY CLAY, medium to high plasticity, reddish brown and grey with some ironstone layers	MC< PL	H		
			12							'V' bit refusal
						REFER TO CORED BH LOG				

JEFFERY AND KATAUSKAS PTY. LTD.

Borehole No. 6 3/3

CORED BOREHOLE LOG

Client: WOOLACOTT HALE CORLETT & JUMIKIS PTY. LTD.
Project: PROPOSED SHOPPING CENTRE
Location: MANN STREET . GOSFORD

Job No: 2289 X
Date Drilled: 26.7.83
Drill Type: ROTARY

Core Size: NMLC
Inclination: VERT
Bearing:

R.L. Surface
Datum:

Water Loss	Water Record	Barrel Lift	Core Loss	Depth (m)	Graphic Log	CORE DESCRIPTION	Weathering	Strength	DEFECT DETAILS: DEFECT SPACING (m) .5 .3 .1 .05 .03 .01	DEFECT DETAILS: Description
						START CORING @ 12.47 m				
				13		CORE LOSS 6 cm SILTSTONE, light grey mottled red and brown with some thin fine grained sandstone bands	HW	VW S VN-W		= 50 mm clay seam = 20 mm clay seam = joints, 2No, ironstained, 0° — joint, subvertical, ironstained } joints, 0°, ironstained
				14		— — as above but dark grey with brown ironstone bands and laminations	W-SW	MS MS		= 40mm clay seam = joints, 3No, ironstained, 0° = joints, 2No, ironstained, 20° = joints, 2No, ironstained, 0° — joint, flakey infill, 10° — joint, flakey infill, 30° — joint, flakey infill, 10° — joint, flakey infill, 10°
				15		END OF BH @ 15.05 m				

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 7 1/3

Client: WOOLACOTT HALE CORLETT & JUMIKIS PTY. LTD.
Project: PROPOSED SHOPPING CENTRE
Location: MANN STREET, GOSFORD

Job No. 2289 X
Date: 26.7.83
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
						FILL: ASH & GRAVEL	M			
					SM	SILTY SAND, fine grained, dark grey	M			
▼ AFTER 24 HRS	DS	SPT fell 0.5 m self weight	1		CL-SC	SANDY CLAY - CLAYEY SAND, medium plasticity, light grey with layers of fine sand	MC>> PL	S		
							MC > PL	F	60 60	
			2					St		
	DS	N=21 4,8,13					W	MD		Sand layer
			3				MC≈ PL	St-V.St	150*	* on partially remoulded auger sample
	DS	N=18 10,9,9	4							
							MC< PL	V.St-H	370 400	
			5							penetration of augers without rotation (mm)
	DS	N>20 20/150 mm					W	D		Sand layer — 0
			6							— 0 — 0

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 7 2/3

Client: WOOLACOTT HALE CORLETT & JUMIKIS PTY. LTD.
Project: PROPOSED SHOPPING CENTRE
Location: MANN STREET, GOSFORD

Job No. 2289 X
Date: 26.7.83
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
			8							40
										0
										20
			9		CL-SC	as above				
										100
			10							40
										30
			11							20
										20
			12		CH	SILTY CLAY, medium to high plasticity, reddish brown & grey with some ironstone layers	MC< PL	H		0
										0
			13			SILTSTONE, brown & grey, highly weathered very weak to weak with some thin strong bands				'V' bit refusal; easy T.C drilling with some hard bands

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 7 3/3

Client: WOOLACOTT HALE CORLETT & JUMIKIS PTY. LTD.
Project: PROPOSED SHOPPING CENTRE
Location: MANN STREET, GOSFORD

Job No. 2289 X
Date: 26.7.83
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
			15			—— —— as above				easy hard easy hard
						END OF BH @ 15.3 m				'T.C' bit refusal

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 8 1/2

Client: WOOLACOTT HALE CORLETT & JUMIKIS PTY. LTD.
Project: PROPOSED SHOPPING CENTRE
Location: MANN STREET, GOSFORD

Job No. 2289 X
Date: 26.7.83
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
Dry on completion						BITUMEN SURFACE				
					SM	SILTY SAND, fine grained, brown - grey	M			
						SANDY CLAY - CLAYEY SAND, low to medium plasticity, brown and red				
	DS	N=12 4,5,7	1		CL-SC		MC> PL	V.St-H	370 370 500	
			2							
	DS	N=18 7,9,9				—— —— as above but mottled grey, clay content increasing	MC< PL	H	470 500	
			3							
	DS	N>20 29/250 mm	4			—— —— grading into SANDY CLAY, medium plasticity, grey brown and red with some ironstone				
					CL-CH		MC< PL	H	>500	'V' bit refusal
	DS		5			SANDSTONE, medium grained, reddish brown, highly weathered very weak to weak with occasional medium strong bands and frequent clay seams				easy to very easy 'T.C' drilling with some moderate bands
			6							

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 8 2/2

Client: WOOLACOTT HALE CORLETT & JUMIKIS PTY. LTD.
Project: PROPOSED SHOPPING CENTRE
Location: MANN STREET, GOSFORD

Job No. 2289 X
Date: 26.7.83
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
			8			—— —— as above but fine to medium grained, weak with some medium strong bands				easy-V. easy; easy T.C with some moderate bands
	DS		9							
						END OF BH @ 9.0m				

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 9 1/3

Client: WOOLACOTT HALE CORLETT & JUMIKIS PTY. LTD.
Project: PROPOSED SHOPPING CENTRE
Location: MANN STREET, GOSFORD

Job No. 2289 X
Date: 27.7.83
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
						CONCRETE : 50mm				
			1		SP	SAND, fine grained, dark grey, slightly silty				
	DS	N=3 1,2,1				—— —— becoming light grey	M	VL		
			2		CL-CH-SC	SILTY SANDY CLAY, medium plasticity, brown and grey mottled red with some CLAYEY SAND layers	Mc > PL	F-St		
	DS	N=13 4,6,7					Mc < PL	V.St	240 270 370	
▼ AFTER 3 HRS			3							
	DS	N=15 6,7,8	4		SC-CL	CLAYEY SAND - SANDY CLAY, low to medium plasticity light grey	Mc < PL	V.St	310 320 340	
			5							
	DS	N>20 7,12,8/70mm					Mc < PL	H	410 420 500	penetration of augers without rotation
			6							10 30

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 9 2/3

Client: WOOLACOTT HALE CORLETT & JUMIKIS PTY. LTD.
Project: PROPOSED SHOPPING CENTRE
Location: MANN STREET, GOSFORD

Job No. 2289 X
Date: 27.7.83
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
▶			8		SC-CL	as above				0
										10
			9							10
										0
						grading into SILTY CLAY, medium to high plasticity, reddish brown and grey with some ironstone layers				10
			10							10
										20
			11							20
										20
										0
			12							Virtual 'V' bit refusal
						SILTSTONE, brown and grey, highly weathered, very weak to weak with some strong bands				easy T.C drilling with some hard bands
			13							

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 9 3/3

Client: WOOLACOTT HALE CORLETT & JUMIKIS PTY. LTD.
Project: PROPOSED SHOPPING CENTRE
Location: MANN STREET, GOSFORD

Job No. 2289 X
Date: 27.7.83
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
			15			—— —— as above				easy 'T.C' with some thin hard bands
						END OF BH @ 15.1m				

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 10 1/2

Client: WOOLACOTT HALE CORLETT & JUMIKIS PTY. LTD.
Project: PROPOSED SHOPPING CENTRE
Location: MANN STREET, GOSFORD

Job No. 2289 X
Date: 27.7.83
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
						BITUMEN SURFACE				
DRY ON COMPLETION					SP	SAND. fine grained. brown. slightly silty	M	L		
	DS	N=12	1							
	DS	4.4.8			CL-CH	SILTY SANDY CLAY. medium plasticity. grey - brown mottled red	MC ≈ PL	V.St	190 250 260	
			2							
	DS	N=15 4.7.8					MC ≈ PL	V.St	200 250 260	
			3							
	DS	N=18 6.8.10	4				MC ≈ PL	St-V.St	170 290 380	
			5							
	DS	N>20 20/250mm					MC ≈ PL	V.St	370 380 390	
			6							

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 10 2/2

Client: WOOLACOTT HALE CORLETT & JUMIKIS PTY. LTD.
Project: PROPOSED SHOPPING CENTRE
Location: MANN STREET, GOSFORD

Job No. 2289 X
Date: 27.7.83
Method: SPIRAL AUGER
R.L. Surface:
Datum:

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
						—— as above				
▼ AFTER ½ hr.			8		CH	SILTY CLAY, medium to high plasticity, light grey mottled red with some ironstone layers	MC < PL	H		
			9							Virtual 'V' bit refusal
			10			SILTSTONE, brown and grey speckled red, highly weathered very weak to weak with some strong bands				easy to very easy 'T.C' bit drilling with some hard bands
			11							
			12							
						END OF BH @ 12.1 m				

Appendix C

IMPORTANT INFORMATION

Important Information

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