Geotechnical Investigation Report

RESIDENTIAL DEVELOPMENT

69 MELWOOD AVE, FORESTVILLE NSW

Prepared for:

DILCARA CONSTRUCTION PTY LTD

Reference: P2778_01

16 December 2022

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

Morrow Geotechnics Pty Ltd has undertaken a Geotechnical Investigation to provide geotechnical advice and recommendations for the proposed development at 69 Melwood Avenue, Forestville NSW (the site).

Architectural drawings for the proposed development have been prepared by CD Architects for Project J22558D dated 5 December 2022. Morrow Geotechnics understands that the proposed development involves demolition of existing structures at the site and construction of a senior housing development, consisting of a four storey multi dwelling structure requiring excavation of approximately 3 m below existing ground level (mBGL).

1.1 Investigation Intent

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

- Foundation advice along with relevant geotechnical design parameters;
- Excavation and shoring advice along with relevant 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.

1.2 Investigation Methods

Fieldwork was undertaken by Morrow Geotechnics on 12 December 2022. 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 (DBYG) services search of proposed borehole locations;
- Drilling of two boreholes (BH1 and BH2) drilled by a track mounted drill rig using solid flight augers equipped with a tungsten-carbide bit (TC bit). BH1 and BH2 were extended beyond TC bit refusal by NMLC coring techniques to depths of 8.0 m and 7.95 below ground level (mBGL) respectively. Rock core was boxed and photographed and point load tests were undertaken on selected core sample to assess rock strength. Borehole locations are shown on **Figure 1** and borehole logs are presented in **Appendix A**;
- Groundwater observations within boreholes during drilling.

2 DESKTOP REVIEW OF SITE CONDITIONS

2.1 Published Geological Mapping

Information on regional sub-surface conditions, referenced from the Department of Mineral Resources Geological Map Sydney 1:100,000 Geological Series Sheet 9130 (DMR 1983), indicates that the site overlies Hawkesbury Sandstone, which typically comprises medium to coarse grained quartz sandstone with very minor siltstone and laminite lenses.

2.2 Published Soil Landscapes

The Soil Conservation Service of NSW Sydney 1:100,000 Soil Landscapes Series Sheet 9130 (2nd Edition) indicates that the erosional landscape at the site likely comprises the Gymea Landscape. This landscape type typically includes undulating to rolling rises on Hawkesbury Sandstone. Soils are generally shallow to moderately deep (< 1.0 m) yellow earths and earthy sands. These soils are noted present high soil erosion hazards with shallow highly permeable soil.

3 Observations

3.1 Subsurface Conditions

The stratigraphy at the site is characterised by fill and residual soil overlying 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 four 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**.

TABLE 1 SUMMARY OF INFERRED SUBSURFACE CONDITIONS

Unit	Material	Approx. Depth Range of Unit [1] mBGL (RL mAHD)		Comments
		BH1	BH2	
1	**Fill**	0.0 to 0.6 (109.37 to 108.77)	0.0 to 0.4 (106.81 to 106.41)	Mixed fill comprising sand, silt and clay with trace gravel. Fill material encountered is uncontrolled and poorly compacted.
2	**Residual Soil**	0.6 to 1.6 (108.77 to 107.77)	-	Generally stiff consistency sandy silty clay.
3	**Class IV Sandstone**	1.6 to 2.0 (107.77 to 107.33)	0.4 to 8.0 (sub 106.41)	Generally distinctly to highly weathered, low to medium strength sandstone.
4	**Class III Sandstone**	2.0 to 7.95 (sub 107.33)	-	Generally highly to moderately weathered, medium strength sandstone. Defects within Unit 4 are generally widely spaced, horizontally oriented bedding partings. No signs of mass movement were observed on the surface of joints within Unit 4.

Notes:

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

3.2 Groundwater Observations

A groundwater table was not encountered during drilling to below the proposed depth of excavation. Minor seepage should be expected at the soil rock interface in response to surface water infiltration following rainfall events.

4 RECOMMENDATIONS

4.1 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. Unit 4 and 5 bedrock may be cut vertically provided that allowances are made for geotechnical inspections of the unsupported rock face at no greater than 1.5 m depth intervals. If unfavourable jointing within Unit 4 and 5 material is encountered in the excavation face there is the potential for minor block or wedge failures to form which must be treated by spot bolting or shotcreting where encountered.

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. For design of flexible shoring systems a triangular pressure distribution may be employed using the parameters provided in **Table 2**. 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 2 EARTH PRESSURE PARAMETERS

Material		Unit 1 Fill	Unit 2 Residual Soil	Unit 3 Class IV Sandstone	Unit 4 Class III Sandstone
Bulk Unit Weight (kN/m^3)		17	18	23	24
Earth Pressure Coefficients	At rest, K_o	0.55	0.50	-	-
	Passive, K_p	2.66	3.00	400 kPa ultimate stress block	1500 kPa ultimate stress block
	Active, K_a	0.38	0.33	-	-

Notes:

1 Unit Weight is based on visual assessment only, order of accuracy is approximately ±10%.
2 Earth pressures are provided on the assumption that the ground behind the retaining wall is flat and drained.

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.

4.2 Soil and Rock Excavatability

The expected ability of equipment to excavate the soil and rock encountered at the site is summarised in **Table 3**. 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 3 SOIL AND ROCK EXCAVATABILITY

Unit	Material	Excavatability
1	**Fill**	Easy digging by 20t Excavator
2	**Residual Soil**	Easy ripping by 20t Excavator
3	**Class IV Sandstone**	Hydraulic hammering will be required within Unit 3 for medium strength bands.
4	**Class III Sandstone**	Hydraulic hammering and saw cutting 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.

4.3 Excavation Vibration Considerations

As a guide, safe working distances for typical items of vibration intensive plant are listed in **Table 4**. 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 4 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 4** 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.

The safe working distances provided in **Table 4** are given for guidance only. Monitoring of vibration levels may be required to ensure vibrations levels remain below threshold values during the construction period. Where vibration monitoring is implemented due to inability to maintain the safe working distances outlined above it is recommended that the monitoring threshold is set at a peak particle velocity (ppv) of 5 mm/sec on the nearest residential receiver.

4.4 Foundation Design

The parameters given in **Table 5** 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 5 PAD FOOTING AND PILE DESIGN PARAMETERS

Material		Unit 1 Fill	Unit 2 Residual Soil	Unit 3 Class IV Sandstone	Unit 4 Class III Sandstone
Allowable Bearing Pressure (kPa)		N/A	150	2000	3500
Ultimate Vertical End Bearing Pressure (kPa)		N/A	450	6000	10500
Elastic Modulus (MPa)		3	10	200	500
Ultimate Shaft Adhesion (kPa)	In Compression	0	50	300	600
	In Tension	0	25	150	300
Susceptibility to Liquefaction during an Earthquake		Medium	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.

4.5 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 B_e – Rock for the site.

5 RECOMMENDATIONS FOR FURTHER GEOTECHNICAL SERVICES

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

- All excavated material transported off site should be classified in accordance with NSW EPA 2014 - Waste Classification Guideline Part 1; Classifying Waste.
- 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.

6 STATEMENT OF LIMITATIONS

The adopted investigation scope was limited by site access restrictions due to presence of structures at the site at the time of our investigation and by the investigation intent. Further geotechnical inspections should be carried out 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.

7 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.

Chapman, G.A. and Murphy, C.L. (1989), Soil Landscapes of the Penrith 1:100000 sheet. Soil Conservation Services of NSW, Sydney.

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

NSW Department of Mineral Resources (1985) Penrith 1:100,000 Geological Series Sheet 9129 (Edition 1). Geological Survey of New South Wales, Department of Mineral Resources.

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

8 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,

Jordan Andonoski
Geotechnical Engineer

Alan Morrow
Principal Geotechnical Engineer

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Map description	Borehole Location Plan		
Site location	69 Melwood Avenue, Forestville NSW		
Client	Melwood Avenue, Dilcara Construction Pty Ltd		
Project name	Forestville		
Project No	P2778	**Scale**	Not to scale

Appendix A

Borehole Logs and Explanatory Notes

Morrow Geotechnics
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Engineering Log - Borehole

Borehole No: BH1

UTM	: 56H	**Driller Rig**	: Geo 205	**Job Number**	: P2778
Easting	: 334277.8	**Driller Supplier**	: GEOSENSE	**Client**	: Melwood Avenue, Dilcara Construction Pty Ltd
Northing	: 6262272.2	**Logged By**	: Jordan Andonoski	**Project**	: Forestville
RL	: 109.33	**Reviewed By**	: Rhiannon McKeon	**Location**	: 69 Melwood Avenue, Forestville NSW
Total Depth	: 8m	**Date**	: 12/12/2022		

Drilling Method	Water	Testing: SPT	Soil Origin	Graphic Log	Classification Code	Depth (m)	Elevation (m)	Material Description	Consistency	Moisture	Observations
							109.33				
ADT			Topsoil		SM			Silty SAND (SM) : loose, brown, fine grained, moist (low resistance)	L	M	
						0.5	108.83				
		2, 1, 2 (N = 3)				0.6					
			Residual		CI-CH			Sandy CLAY (CI-CH) : firm, medium to high plasticity, yellow white orange, fine to medium grained sand, w > pl (low reistance)	F	w > PL	
						1	108.33				
						1.5	107.83	**1.5m : Commenced NMLC Coring;**			
						2	107.33				
						2.5	106.83				
						3	106.33				
						3.5	105.83				
						4					

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Engineering Log - Borehole

Borehole No: BH1

UTM	: 56H	Driller Rig	: Geo 205	Job Number	: P2778
Easting	: 334277.8	Driller Supplier	: GEOSENSE	Client	: Melwood Avenue, Dilcara Construction Pty Ltd
Northing	: 6262272.2	Logged By	: Jordan Andonoski	Project	: Forestville
RL	: 109.33	Reviewed By	: Rhiannon McKeon	Location	: 69 Melwood Avenue, Forestville NSW
Total Depth	: 8m	Date	: 12/12/2022		

Drilling Method	Water	RQD% and TCR%	Is(50)	Estimated Strength	Weathering	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Defect Spacing (mm)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
NMLC Coring	10% Water Loss	RQD = 88% TCR = 100%	D - 0.13, A - 0.15	VLS LS MS HS VHS EHS	DW	2	107.33		SST	As Above SANDSTONE: distinctly weathered, low strength, red light grey brown orange, medium grained, (heavily iron stained, some clay bands) .	30 100 300 1000 3000	2	1.6-1.7, CS, 1.75, J, 10°, RO, PL, CN, OP 1.8-1.81, J, 15°, RO, PL, STN, OP
					HW				SST	SANDSTONE: highly weathered, medium strength, red-purple and light grey, fine to medium grained, (generally massive, heavily iron stained) .			1.99-2.02, IS, clay seam, CN, 2.09-2.1, J, clay, RO, PL, CN, OP 2.26, J, 10°, RO, PL, CN, OP
			D - 1.60, A - 1.89			3	106.33					3	2.51-2.55, IS, clay seam, 2.62-2.65, 10°, RO, PL, STN, OP 2.78-2.81, 15°, RO, PL, STN, OP 2.99-3, J, 20°, RO, PL, STN, OP 3.02-3.9, 20°, RO, PL, STN, OP
		RQD = 93% TCR = 100%	D - 1.06, A - 1.01			4	105.33					4	4, J, 10°, RO, PL, STN, OP 4.06, J, 5°, RO, PL, STN, OP 4.36-4.43, XWS, RO, 4.56-4.58, J, 10°, RO, PL, STN, OP 4.67, J, 10°, RO, PL, STN, OP
						5	104.33					5	4.95, J, 15°, RO, PL, CN, OP 5-5.08, J, 50°, RO, PL, STN, OP 5.1-5.12, J, 20°, RO, PL, STN, OP
					HW-MW	6	103.33		SST	AS ABOVE:highly to moderately , orange and very light grey, (bedding at 2-3mm at 2 degrees, moderately iron stained) .		6	6-6.14, 15°, RO, PL, STN, OP 6.14-6.4, 15°, RO, PL, STN, OP 6.4-6.55, 15°, RO, PL, STN, OP 6.55-6.7, 15°, RO, PL, STN, OP 6.7-7.02, 15°, RO, PL, STN, OP
		RQD = 99% TCR = 100%	D - 0.44, A - 1.18			7	102.33					7	7.15-7.3, 15°, RO, PL, STN, OP 7.3-7.35, 10°, RO, PL, STN, OP 7.35-7.45, 10°, VR, PL, CN, OP
						8	101.33			**BH1 Terminated at 8m (Target Depth Reached)**		8	
						9	100.33					9	

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Photo description	BH1 Tray 1 of 2		
Client	Melwood Avenue, Dilcara Construction Pty Ltd		
Location	69 Melwood Avenue, Forestville NSW		
Project name	Forestville		
Project No	P2778	**Scale**	Not to Scale
BH No	BH1	**BH Depth**	1.5 to 6.0m

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Photo description	BH1 Tray 2 of 2		
Client	Melwood Avenue, Dilcara Construction Pty Ltd		
Location	69 Melwood Avenue, Forestville NSW		
Project name	Forestville		
Project No	P2778	**Scale**	Not to Scale
BH No	BH1	**BH Depth**	6.0 to 7.95m

Morrow Geotechnics
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Engineering Log - Borehole

Borehole No: BH2

UTM	: 56H	Driller Rig	: Geo 205	Job Number	: P2778
Easting	: 334333.8	Driller Supplier	: GEOSENSE	Client	: Melwood Avenue, Dilcara Construction Pty Ltd
Northing	: 6262292.2	Logged By	: Jordan Andonoski	Project	: Forestville
RL	: 106.81	Reviewed By	: Rhiannon McKeon	Location	: 69 Melwood Avenue, Forestville NSW
Total Depth	: 7.95m	Date	: 12/12/2022		

Drilling Method	Water	DCP	Soil Origin	Graphic Log	Classification Code	Depth (m)	Material Description	Consistency	Moisture	Observations
ADT	GWNE		Topsoil		SM	0.2	Silty SAND (SM) : loose, brown, fine grained, trace fine to medium sized gravel, moist, (sandstone gravels , low resistance) .	L	M	
			Fill		SM	0.4	Silty to gravelly SAND (SM) : loose, red brown, fine grained, fine to coarse sized gravel, moist, (sandstone gravels . low resistance) .	L	M	
			Rock		SST	0.5	SANDSTONE: distinctly weathered, low strength, brown grey red, fine grained, (medium to high resistance) .	LS		
							0.5m : Commenced NMLC Coring;			
						1				
						1.5				
						2				
						2.5				
						3				
						3.5				
						4				

Morrow Geotechnics
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Engineering Log - Borehole

Borehole No: BH2

UTM	: 56H	Driller Rig	: Geo 205	Job Number	: P2778
Easting	: 334333.8	Driller Supplier	: GEOSENSE	Client	: Melwood Avenue, Dilcara Construction Pty Ltd
Northing	: 6262292.2	Logged By	: Jordan Andonoski	Project	: Forestville
RL	: 106.81	Reviewed By	: Rhiannon McKeon	Location	: 69 Melwood Avenue, Forestville NSW
Total Depth	: 7.95m	Date	: 12/12/2022		

Drilling Method	Water	RQD% and TCR%	Is(50)	Estimated Strength	Weathering	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Defect Spacing (mm)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
NMLC Coring	10% Water Loss	RQD = 100% TCR = 100%	D - 0.33, A - 0.32	VLS LS MS HS VHS EHS	DW	1	106.31		SST	SANDSTONE: distinctly weathered, low strength, brown grey red, fine grained, (generally massive, heavily iron stained) .	30 100 300 1000 3000	1	0.56-0.57, J, 25°, , PL, STN, OP
					HW	1.5	105.81		SST	SANDSTONE: highly weathered, low strength, brown grey red, fine to medium grained, (generally massive, heavily iron stained) .		1.5	1.3-1.31, J, 20°, RO, PL, STN, OP
			D - 0.32, A - 0.46			2	105.31					2	2.19-2.2, J, 20°, RO, PL, STN, OP
					MW	2.4	104.81		SST	SANDSTONE: moderately weathered, medium strength, light yellow mottled red, fine to medium grained, (generally massive, slight iron staining) .		2.5	
			D - 0.46, A - 0.49			3	104.31					3	
		RQD = 80% TCR = 100%				3.5	103.81					3.5	3.84-3.86, J, 20°, RO, PL, STN, OP
					HW	4	103.31		SST	SANDSTONE: highly weathered, low strength, orange yellow red, fine to medium grained, (generally massive, moderate iron staining) .		4	4-4.05, CS,
						4.5	102.81					4.5	4.2-4.6, 20°, RO, PL, STN, OP
			D - 0.31, A - 0.34			5	102.31					5	4.7-4.75, 10°, RO, PL, STN, OP
						5.5	101.81					5.5	5-5.12, 15°, RO, PL, STN,
			D - 0.24, A - 0.30			6	101.31					6	5.55-5.9, 20°, RO, PL, STN, OP
		RQD = 70% TCR = 100%				6.5	100.81					6.5	6-6.4, J x 8, 20°, RO, PL, STN, OP
						7	100.31					7	6.5-6.9, 5°, RO, PL, STN, OP
						7.5	99.81					7.5	7-7.25, J x 5, 5°, RO, PL, STN, OP
			D - 0.24, A - 0.48			8	99.31					8	7.42-7.6, 10°, RO, PL, STN, OP
						8.5	98.81			**BH2 Terminated at 7.95m (Target Depth Reached)**		8.5	7.68-7.95, 15°, RO, PL, STN, OP

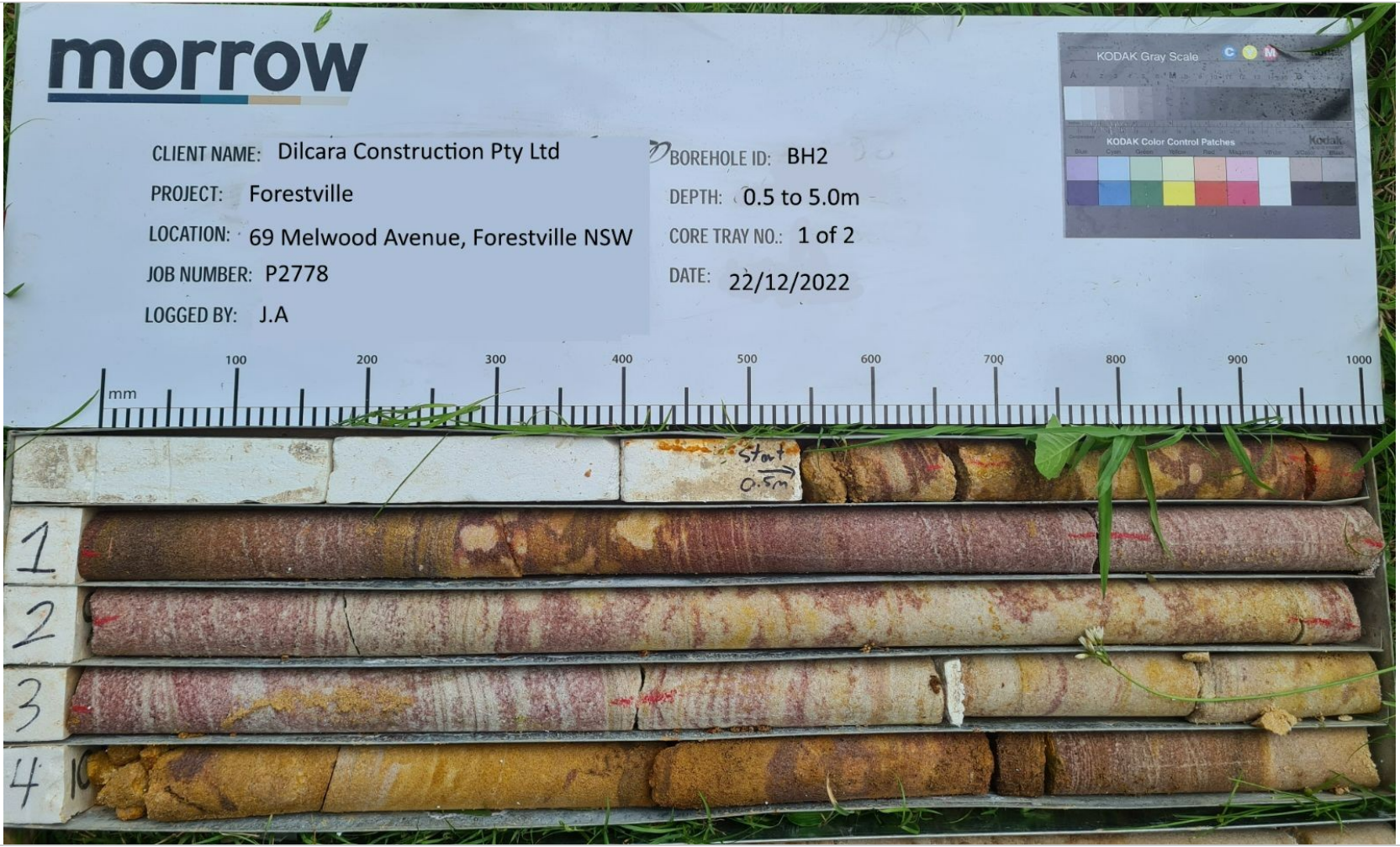

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Photo description	BH2 Tray 1 of 2		
Client	Melwood Avenue, Dilcara Construction Pty Ltd		
Location	69 Melwood Avenue, Forestville NSW		
Project name	Forestville		
Project No	P2778	**Scale**	Not to Scale
BH No	BH2	**BH Depth**	0.5 to 5.0m

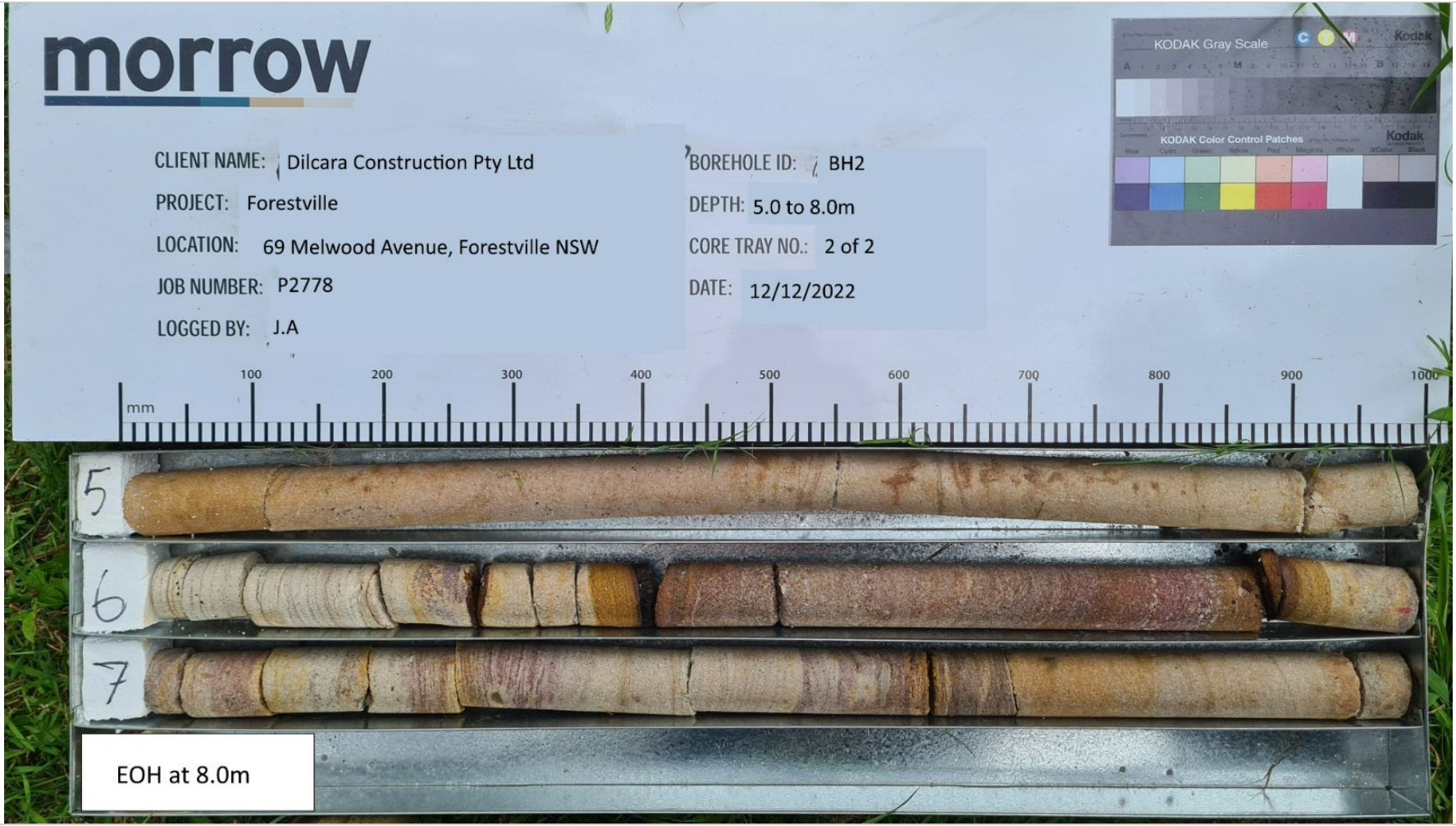

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Photo description	BH1 Tray 2 of 2		
Client	Melwood Avenue, Dilcara Construction Pty Ltd		
Location	69 Melwood Avenue, Forestville NSW		
Project name	Forestville		
Project No	P2778	**Scale**	Not to Scale
BH No	BH1	**BH Depth**	5.0 to 8.0m

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

IMPORTANT INFORMATION

Important Information

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