JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. 4 2 / 5

BOREHOLE LOG

Client: HELM PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 177 RUSSELL AVENUE, DOLLS POINT, NSW

Job No.: 29353S
Method: SPIRAL AUGER & CASING ADVANCER
R.L. Surface: ~1.6 m
Date: 2/5/16
Datum: AHD
Plant Type: JK308
Logged/Checked By: A.B./P.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	■			■	N = 13 3,7,6	-6	8			SAND: fine to medium grained, grey.	W	MD		SLIGHT ORGANIC ODOUR
	■			■	N = 18 4,8,10	-7	9							
	■			■	N = 22 6,8,14	-8	10			as above, but light grey.				
	■			■	N = 36 7,15,21	-9	11					D		
	■			■	N = 6 4,4,2	-10	12							
						-11	13			SAND: fine to medium grained, dark grey, trace of silt.		L		
						-12								

JK_LIB_CURRENT - V8.00.GLB Log J & K AUGERHOLE - MASTER 29353S DOLLS POINT.GPJ <<DrawingFile>> 25/05/2016 11:11 Produced by gINT Professional, Developed by Datgel

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Borehole No. 4 3 / 5

BOREHOLE LOG

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						-13				SAND: fine to medium grained, dark grey, trace of silt. *(continued)*	W	L		SLIGHT ORGANIC ODOUR
	■			■	N = 40 15,28,12		15			SAND: fine to medium grained, light grey and grey.		D		
						-14								
							16		SC	CLAYEY SAND/SANDY CLAY: fine to medium grained, light grey and yellow brown.				
						-15								
							17							PUSH - NO MOVEMENT
						-16						(L)		ASSESSMENT BASED ON PENETRATION RATE
							18							
						-17								
							19							
						-18								
							20							
						-19						(D)		PENENTRATION RATE SLOWED AND CHAIN TIGHTENED

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Borehole No. 4 4 / 5

BOREHOLE LOG

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Location: 177 RUSSELL AVENUE, DOLLS POINT, NSW

Job No.: 29353S
Date: 2/5/16
Plant Type: JK308
Method: SPIRAL AUGER & CASING ADVANCER
Logged/Checked By: A.B./P.S.
R.L. Surface: ~1.6 m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
						-20			SC	CLAYEY SAND/SANDY CLAY: fine to medium grained, light grey and yellow brown. *(continued)*	W	(D)		PENENTRATION RATE SLOWED AND CHAIN TIGHTENED
							22		-	SANDSTONE: fine to medium grained, light grey.	DW	M		
						-21	23			REFER TO CORED BOREHOLE LOG				
						-22	24							
						-23	25							
						-24	26							
						-25	27							
						-26								

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. 4 5 / 5

CORED BOREHOLE LOG

Client: HELM PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 177 RUSSELL AVENUE, DOLLS POINT, NSW

Job No.: 0 **Core Size:** NMLC **R.L. Surface:** ~1.6 m
Date: 2/5/16 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK308 **Bearing:** N/A **Logged/Checked By:** A.B./P.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT SPACING (mm) (500, 300, 100, 50, 30, 10)	DEFECT DETAILS: DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
		-20	22		START CORING AT 22.49m					
100% RETURN		-21	23		SANDSTONE: fine to coarse grained, light grey, bedded at 0-5°.	FR	M			(22.60m) Be, 5°, P, R, CLAY INFILL
		-22	24		SANDSTONE: fine to medium grained, light grey, orange brown and red brown, cross bedded at 15°-20°.	SW	H			
		-23	25							(24.63m) CS, 0°, 25 mm.t
										(25.18m) Be, 2°, P, R, CLAY INFILL
		-24	26		END OF BOREHOLE AT 25.50 m					MONITORING WELL INSTALLED TO 6m, BENTONITE FROM 0.1m TO 0.5m. FINISHED WITH CONCRETE ENCASED GATIC COVER
		-25	27							
		-26								

JK_LIB_CURRENT - V7.3.GLB Log J & K CORED BOREHOLE - MASTER 29353S DOLLS POINT.GPJ <<DrawingFile>> 25/05/2016 14:57 Produced by gINT Professional, Developed by Datgel

EXPLANATORY NOTES – ENVIRONMENTAL LOGS

INTRODUCTION

These notes have been provided to supplement the environmental report with regards to drilling and field logging. Not all notes are necessarily relevant to all reports. Where geotechnical borehole logs are utilised for environmental purpose, reference should also be made to the explanatory notes included in the geotechnical report. Environmental logs are not suitable for geotechnical purposes.

The ground is a product of continuing natural and manmade processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Environmental studies involve gathering and assimilating limited facts about these characteristics and properties in order to understand the ground on a particular site under certain conditions. These conditions are directly relevant only to the ground at the place where, and time when, the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, the SAA Site Investigation Code. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the grading of other particles present (e.g. sandy clay) as set out below (note that unless stated in the report, the soil classification is based on a qualitative field assessment, not laboratory testing):

Soil Classification	Particle Size
Clay	less than 0.002mm
Silt	0.002 to 0.075mm
Sand	0.075 to 2mm
Gravel	2 to 60mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose	less than 4
Loose	4 – 10
Medium dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, laboratory testing or engineering examination. The strength terms are defined as shown in the following table:

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 – 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 – 400
Hard	Greater than 400
Friable	Strength not attainable – soil crumbles

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'Shale' is used to describe thinly bedded to laminated siltstone.

DRILLING OR EXCAVATION METHODS

The following is a brief summary of drilling and excavation methods currently adopted by the Company, and some comments on their use and application. All except test pits and hand auger drilling require the use of a mechanical drilling rig.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils if it is safe to descend into the pit. The depth of penetration is limited to approximately 3m for a backhoe and up to 6m for an excavator. Limitations of test pits include problems associated with disturbance and difficulty of reinstatement; and the consequent effects on nearby structures. Care must be taken if construction is to be carried out near test pit locations to either properly re-compact the backfill during construction, or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Premature refusal of the hand augers can occur on a variety of materials such as fill, hard clay, gravel or ironstone, and does not necessarily indicate rock level.

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and in-situ testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock fragments. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from "feel" and rate of penetration.

Mud Stabilised Drilling: Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (e.g. from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel, which gives a core of about 50mm diameter, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The locations of losses are determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the top end of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" – Test F3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

- In the case where full penetration is obtained with successive blow counts for each 150mm of, say, 4, 6 and 7 blows, as: N = 13 (4, 6, 7)
- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm, as: N>30 (15, 30/40mm)

The results of the test can be related empirically to the engineering properties of the soil. Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, the test results are shown on the borehole logs in brackets.

A modification to the SPT test is where the same driving system is used with a solid 60 tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as "Nc" on the borehole logs, together with the number of blows per 150mm penetration.

LOGS

The borehole or test pit logs presented herein are an interpretation of the subsurface conditions, and their reliability will depend to some extent on the frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will enable the most reliable assessment, but is not always practicable or possible to justify on economic grounds. In any case, the boreholes or test pits represent only a very small sample of the total subsurface conditions.

The attached explanatory notes define the terms and symbols used in preparation of the logs.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than "straight line"