Malbec Properties Pty Ltd

Preliminary Geotechnical and Constraints Assessment:

Lot 3 DP 568613
& Lot 384 DP 755952
Mundamia
NSW.

ENVIRONMENTAL

WATER

WASTEWATER

GEOTECHNICAL

CIVIL

PROJECT MANAGEMENT

P0802193JR01_v2
November 2008

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2	Final	27/11/08	1E,1H,1P	1H	1P			

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All enquiries regarding this project are to be directed to the Project Manager.

Contents

1 Overview

1.1 Study Overview

The purpose of this report was to assess the geotechnical constraints through preliminary field investigations at the site, being Lot 3 DP 568613 and Lot 384 DP755952, Jonsson Rd, Mundamia. The report is designed to support a development application for the sub-division of the 2 lots for residential purposes.

1.2 Development Proposal

At the time of reporting, the following details regarding components of the development proposal were available:

- Proposed sub-division into approximately 360 residential allotments.
- Internal road network with associated stormwater drainage.
- Sewerage, water, power and gas infrastructure to service the development.

1.3 Project Scope

Geotechnical investigations outlined in this report assess general sub-surface conditions across the site with particular emphasis on:

- Site classification(s) in accordance with AS2870 (1996).
- Hazard risk assessment including review of slope stability, hazard identification, viability of the proposed development and recommended provisions of treatment measures.
- Drainage and subsequent sub-surface moisture conditions.
- Recommendations for further investigation to more accurately determine any identified development constraints.

2 Site Description

2.1 Field Investigations

Site inspection was undertaken on the 9th of September for geotechnical assessment of the site. Geotechnical investigation works conducted include:

- General walkover inspection of the site and nearby areas to review local geology, topography, hydrology and vegetation.
- Completion of 13 boreholes using 4WD mounted drill rig to determine the nature of sub-surface materials. Approximate borehole locations are shown on the site plan in Attachment A and full log sheets provided in Attachment B.
- Collection of three (3) bulk soil samples for future CBR testing and forty eight (48) other samples for future reference / laboratory testing.

2.2 Location and Existing Land-use

The site is located on the eastern side of Jonsson and George Evans Roads, Mundamia. It is approximately 3km due west of Nowra city centre, in the SCC LGA. The site's northern boundary is located 300m to the south east of the bank of the Shoalhaven River.

A single dwelling with a number of corrugated iron sheds resides in the south eastern corner of Lot 3. Lot 384 contains a single dwelling with a number of sheds and other dilapidated buildings, located in close proximity in the southern portion of the site. Both lots are rural in nature, and are currently used for livestock grazing.

A site aerial photo with approximate site boundaries is provided as Figure 1.

Figure 1: Aerial photograph (2008) showing the site in its environmental context.

2.3 Topography & Drainage

In terms of the wider regional topography, the site comprises the north east facing upper/middle slope units of a broad ridge/crest unit. Lots are described below:

- Lot 384: Elevations on Lot 384 range from 70 to 50 mAHD with the upper elevations of the site dominated by cleared pasture and slopes <5°. This portion of the site drains to the north (through a number of small dams) onto Lot 3. The eastern portion of the lot contains steeper slopes (up to 15°), with vegetation dominated by dry schlerophyll forest. The slope increases to the east of the site, down to benched sandstone outcrops and ultimately a scarp which is located off the site. This portion of the site also drains to the east, into an unnamed creek and ultimately the Shoalhaven River.

- Lot 3: Elevations on Lot 3 range from 52 to 36 mAHD. A broad drainage depression drains the majority of the site towards the north east. The depression forms into an intermittent creek (bedrock controlled) in the middle-north portion of the site, which directs overland flow to the unnamed creek located to the east of the lot (as described above). Lot 3 is dominated by

dry schlerophyll forest in the eastern portion, with slopes ranging from 5 -10° before increasing down to the scarp as described above. Cleared pasture dominates the western portion of the lot, with slopes ranging from 2 - 5°.

2.4 Groundwater

During the investigation, groundwater was observed in four boreholes and seepage observed in area's of the site. Site groundwater conditions are described as follows:

- Groundwater was observed in four boreholes (BH4, BH5, BH9 & BH10), there was no indication of groundwater in other holes prior to termination depth and for duration of exposure.
- All other boreholes provided no indication of groundwater prior to termination depth.
- Groundwater seepage was observed in the eastern portion of Lot 384 (see Figure 2 and Sheet 2 Attachment A). The area of seepage had vegetation indicating the seepage is a permanent feature and not limited to periods immediately following rainfall.
- Waterlogged soils were observed in the southern portion of Lot 3 in an area up to 100m downslope of the dam located on the northern boundary of Lot 384 (see Sheet 2, Attachment A).
- Further investigations to fully characterise shallow groundwater conditions on the site are recommended prior to detailed design of civil infrastructure.

2.5 Acid Sulfate Soils

The site is at an elevation of 36 – 70 mAHD with an underlying geology of sedimentary rock. Soil profiles observed on site are residual or colluvial in character and are not recent (Holocene or Pleistocene) deposits. As such, there is considered to be a negligible risk of acid sulfate soils on the site.

3 Geotechnical Assessment

3.1 Standards & Guidelines

The geotechnical assessment was conducted in general accordance with AS1796 (1993) and AS2870 (1996) and AGS (2007) guidelines.

3.2 Sub-Surface Conditions

3.2.1 Geology

Geological survey of NSW geology sheet (Wollongong 5609) map the site being underlain by Nowra Sandstone, a subgroup of the Megalong Conglomerate Group geology.

Examination of the exposed bedrock and sub-soil investigations (see Figure 2) reveals the site is generally underlain by various grades of weathered sandstone. Further to this, site inspection revealed area's in the southern portion of the site are underlain by Limonite or Geothite concretions (this rock is commonly referred to as 'Ironstone' by farmers / landowners in the area). Due to limited testing, the extent of the concretions is unknown.

Field investigations indicate depth to weathered rock ranges from 0.5 m b.g.l. in the southern portion of the site (Lot 384) to > 2.5 m b.g.l. in the lower elevations (drainage depressions) in the north western portion of the site. Rock outcropping was observed along the entire eastern portion of the site.

3.2.2 Soil Landscape Mapping

Soil Landscape's of the 1:100,000 Kiama Sheet map the site soil as the Nowra Landscape. Soil conditions are described as moderately deep (50 – 100cm) brown podzolic soils on crests/upper slopes, with yellow earths or yellow podzolic soils on mid slopes, lower slopes and drainage depressions.

The landscape is described as having a moderate to high erosion hazard, with limitations to development posed from shallow soil profiles, localised rock outcropping, low wet bearing strength and run-on.

Sub-surface conditions (soil type / depth) differ across the site, associated with topography. In general, the soil profile is described as organic silty sand, overlying clayey sand, overlying residual soils

(silty/sandy clays) which grade into extremely weathered rock at various depths.

Three broad sub-surface condition categories have been distinguished for landuse planning purposes. Considering the limited testing undertaken, the distribution of these categories is approximate only, and should be used with discretion (+/- 100m). Categories are described as:

- Category One - generally found along the upper elevations and eastern portion of the site (dominated by very shallow soil profiles <1m / exposed sandstone bedrock).
- Category Two - located on the upper elevations in the south western portion of the site (soil profiles 1 - <2m)
- Category Three - located along the drainage depression in the north western area of the site (deeper soil profiles > 2m).

Soil categories mapping is provided in Attachment A, with detailed borehole logs in Attachment B.

Figure 2: Photo of sandstone outcropping and seepage. View looking south west towards existing buildings on Lot 384.

3.3 Foundation Class

Based on preliminary field investigations, Category 1 is generally considered "A", Category 2 is generally considered "S" and Category 3 is generally considered "M or H" in accordance with AS 2870 (1996) and AS 2870 Supp1 (1996). More detailed investigation (e.g. linear shrinkage / shrink-swell index, Atterberg limits) and a greater testing frequency is required to confirm these preliminary classifications.

The presence of minor fill in some areas of the site may change the above classification, however, observed fill is expected to be minor in nature and not considered to be a significant geotechnical issue for site development. A number of irregular small grassed mounds on the southern portion of the site indicated that some minor stockpiling of soil / fill had occurred in the past. These areas are classified as "P". If any other uncontrolled fill is encountered during excavations, foundation design should either take this in to account or the material be removed and replaced with engineered fill. Fill areas are further considered in Martens preliminary (Stage 1) contamination assessment (report P0802193JR01_v1).

3.4 Geotechnical Risk and Constraints Assessment

3.4.1 Risk and Constraint Classification

The site risk assessment has been conducted in accordance with the Australian Geomechanics Society (2007) guidelines. Hazard (mass movement) identification has been undertaken on the basis of our understanding of the slope processes and the relationship of those processes to geomorphology, geology, hydrogeology, climate and vegetation at the time of our site inspection.

Based on our investigation we consider that the primary form of slope instability on the site is rock fall, based on the presence of steep gradients coupled with rock outcropping and boulders in the eastern portion of the site. A review of preliminary development plans provided by the Client, identifies this area as being utilised as an environmental buffer zone, with no residential development. Rockfall is expected to be away from the site, and subsequently it is not considered to be a constraint to development. No other obvious signs of recent or relic mass movements were noted on the allotment at the time of inspection.

Based on the limited testing conducted to date, the proposed development areas of the site contain minor geotechnical constraints,

such as a shallow groundwater table; poor drainage conditions; deep sub-surface soil profiles that are of low bearing strength and erodibility.

A summary of further investigation recommendations to more accurately identify and characterise the extent of the constraints outlined above is provided in Table 1.

Table 1: Additional testing to fully characterise geotechnical risks / constraints.

Constraint	Recommended Further Investigation
Shallow Groundwater	Installation of piezometers in lower portions of the site to fully characterise extents.
Groundwater Seepage	None
Low Bearing Strength Soils	Sub-surface investigations including penetration testing (DCP, SPT), and laboratory analysis of CBR, linear shrinkage, shrink-swell and atterberg limits.
Soil Erosion	Emerson aggregate testing conducted on topsoils and shallow subsoils.

3.5 General Recommendations

3.5.1 Placement of Fill

If fill from off-site is utilised, it should be suitable in accordance with AS 3798 (2007), be well graded, have a maximum particle size of 75mm and be certified as free of harmful material. Site sub-soils are likely to be suitable for use as engineered fill, subject to laboratory compaction / CBR test results.

All earthworks are to be undertaken in accordance with AS 3798 (2007). Proof rolling of sub-grades should be conducted before placement of any fill, and this should be closely monitored by the site supervisor to identify sub-surface moisture issues and soft / unstable layers. Fill should be free of organics, deleterious substances such as wood, metal, boulders and plastic. Fill should be placed in 150 – 200mm layers. Compaction criteria and frequencies of compaction testing for different types of placed fill are outlined below:

1. Building pads: minimum dry density (MDD) of 95% (for clay soils), or minimum density index (I_D) of 70 % for cohesionless soils, with moisture variation not to exceed +/- 2% of optimum moisture content (OMC).

2. Site pavements: MDD of 98%, I_D of 75%, with moisture not to exceed 2% of OMC.

3. Other controlled fill: MDD of 95%, I_D of 70%, with moisture not to exceed 2% of OMC.

3.5.2 Excavations

Following the proposed sub-division of the site, future works will require soil and rock excavation at various locations. Site investigations indicate that excavation works (for say services, road boxing and shallow foundations) in Category 2 and 3 areas will involve soil overburden. Shallow excavation in Category 1 area is likely to encounter bedrock / outcropping.

It is recommended that where possible:

- Temporary batters of 1V:1H should be used when excavating soil materials.

- Weathered sandstone can have a batter slope of up to 4V:1H without shoring or support to a depth of 1.5 m. Deeper cuts are to be designed following a geotechnical engineer or engineering geologist's inspection of excavated rock.

- Where the abovementioned batter slopes are not feasible, suitably designed and constructed shoring walls and supports should be implemented during construction works.

Organic topsoils or silty soils should be stockpiled separately from clay subsoils. Stripping of these soils is expected to be required to depths of 0.1 - 0.2 m b.g.l., however may be deeper in areas of Category 3 soils. Topsoils can be re-used on the site for landscaping purposes, while clayey subsoils can be reused for areas of compacted fill requirement subject to future testing and appropriate control. Any soil taken off-site is to be assessed in accordance with EPA 1999 waste classification guidelines.

3.5.3 Footings and Foundations

Given the relatively shallow bedrock depth underlying parts of the site (soil Category 1 & 2), we recommend that footings for all permanent buildings on the site be taken to weathered sandstone where possible. Depending on the final structural loads and tolerance to differential settlements, shallow pad, strip or stiffened slab footings may also be appropriate on the site.

Foundations of all proposed buildings are to be designed by a suitably qualified and experienced structural or geotechnical engineer. Provision of preliminary safe bearing pressures and other geotechnical parameters for structural design will require further investigation and/or site specific analysis.

3.5.4 Retaining Structures

No specific comment can be made regarding retaining structures on the site as the detailed development proposal has not been completed at the time of writing this report. It is recommended that retaining structures greater than 1.0 m in height or those located in Category 3 are to be individually assessed and designed by an appropriate engineer. The following general comments are made with regards to minor retaining structures:

- All smaller retaining structures (<1.0 m) are to be backfilled with free-draining aggregate and suitable drainage measures included.
- A geotextile fabric is to be placed between *in-situ* and fill soils and aggregate to prevent the access of fine materials into the aggregate.
- A minimum 100 mm diameter agricultural drainage pipe(s) installed within the aggregate is considered to be sufficient to collect sub-surface seepage that may occur behind minor retaining structures.
- Drainage water should be disposed of to site stormwater discharge structures where possible.

3.5.5 Adequacy

From a geotechnical perspective, we consider the site suitable for the proposed development, subject to the recommendations and preliminary treatment measures as outlined in this report.

4 References

Australian Standard 1796 (1993) *Geotechnical Site Investigations.*

Australian Standard 2870 (1996) *Residential Slabs and Footings*

Australian Standard 2870 Supplement 1 (1996) *Residential Slabs and Footings – Construction - Commentary*

Australian Standard 3798 (2007) *Guidelines on earthworks for commercial and residential developments.*

Australian Standard 4678 (2002) *Earth Retaining Structures.*

Australian Geomechanics Society (AGS, 2007), Sub-Committee on Landslide Risk Management - *Landslide Risk Management Geoguide*.

Das, B.M., (1995) *Principles of Foundation Engineering.*

Geologic Survey of NSW, Department of Minerals and Energy (1991), Geological Series 1:100,000, Wollongong Sheet.

Hazleton, P.A. (1992). *Soil Landscapes of the Kiama 1:100,000 Sheet*. Department of Conservation and Land Management (incorporating the Soil Conservation Service of NSW), Sydney.

Landcom (2004) *Managing Urban Stormwater: Soils and Construction,* Vol 1, 4th edition.

5 Attachment A – Site Plans

0 80 160 240 320 400

UNITS - METRES

N

W E

S

LOT 3 DP 568613

LOT 384 DP 755952

Lot 32

Existing Cottage

Existing Cottage

BH-P0802193-13

BH-P0802193-12

BH-P0802193-11

BH-P0802193-10

BH-P0802193-8

BH-P0802193-7

BH-P0802193-9

BH-P0802193-6

BH-P0802193-5

BH-P0802193-4

BH-P0802193-3

BH-P0802193-2

BH-P0802193-1

EXTENT OF SOIL DEPTH ZONES
ARE APPROXIMATE ONLY

EXTENT OF SOIL DEPTH ZONES
ARE APPROXIMATE ONLY

APPROXIMATE LOCATION OF DAMS

EXTENT OF SOIL DEPTH ZONES
ARE APPROXIMATE ONLY

KEY:
APPROXIMATE SOIL DEPTH
1 - SOIL <1M
2 - SOIL 1-<2M
3 - SOIL > 2M

BH-P0802193-12 BOREHOLE LOCATIONS AND IDENTITIES

NOTE:
- SITE PLAN PROVIDED BY ALLEN PRICE P/L, SEPTEMBER 2008
- ALL CONSTRAINTS BOUNDARIES ARE APPROXIMATE ONLY

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CLIENT/PROJECT
MALBEC PROPERTIES
MUNDAMIA

TITLE
TESTING LOCATIONS AND APPROXIMATE SOIL DEPTH ZONES

THIS PLAN MUST NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED BY PRINCIPAL CERTIFYING AUTHORITY
All measurements in m unless otherwise specified.

PROJECT MANAGER: MR ANDREW NORRIS

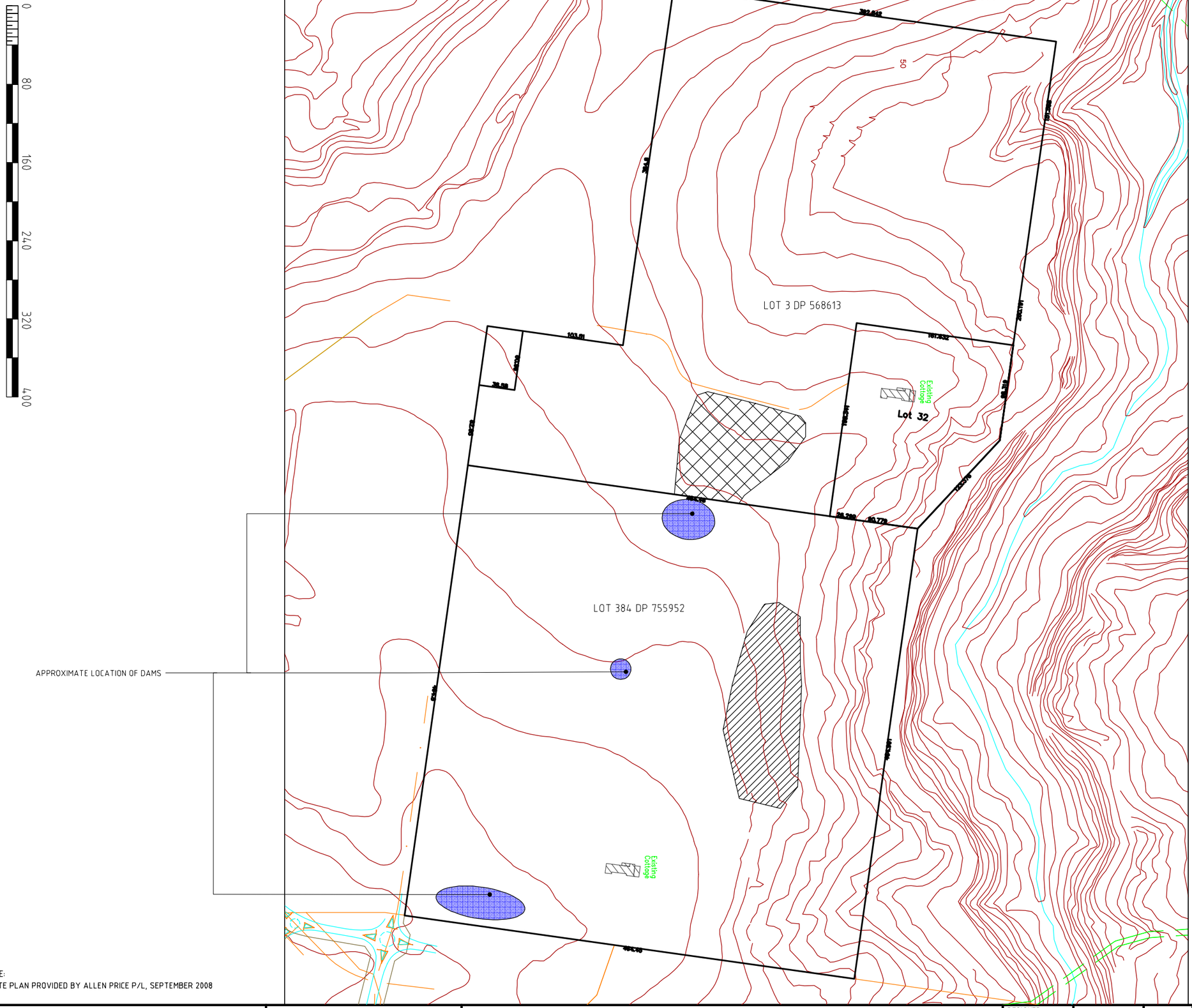
DRAWING NUMBER: P0802193JD02_V1

DESIGNED: JSF
DRAWN: JSF
REVIEWED: ASN

DATUM: mAHD
HORIZONTAL RATIO: 1:2000 @ A1, 1:4000 @ A3
VERTICAL RATIO: 1:2000 @ A1, 1:4000 @ A3

SHEET 1 OF 2 SHEETS
PAPER SIZE: A1 / A3

REV.	DESCRIPTION	DATE	ISSUED
1	PRELIMINARY GEOTECHNICAL ASSESSMENT	29/9/2008	JSF



NOTE:
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CLIENT/PROJECT
MALBEC PROPERTIES
MUNDAMIA

TITLE
WATERLOGGED SOILS AND SEEPAGE LOCATIONS

THIS PLAN MUST NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED BY PRINCIPAL CERTIFYING AUTHORITY
All measurements in m unless otherwise specified.

PROJECT MANAGER: MR ANDREW NORRIS

DRAWING NUMBER: P0802193JD02__V1

DESIGNED:	JSF
DRAWN:	JSF
REVIEWED:	ASN
DATUM:	mAHD
HORIZONTAL RATIO:	1:2000 @ A1 1:4000 @ A3
VERTICAL RATIO:	1:2000 @ A1 1:4000 @ A3
SHEET	2 OF 2 SHEETS
PAPER SIZE:	A1 / A3

REV.	DESCRIPTION	DATE	ISSUED
1	PRELIMINARY GEOTECHNICAL ASSESSMENT	26/9/2008	JSF

6 Attachment B – Soil Test Pit Logs

CLIENT	MALBEC PROPERTIES PTY LTD	**COMMENCED**	9/9/08	**COMPLETED**	9/9/08	**REF**	**BH1**
PROJECT	PRELIMINARY GEOTECHNICAL ASSESSMENT	**LOGGED**	JSF	**CHECKED**	ASN	**Sheet**	1 of 1
SITE	JONSSON ROAD, MUNDAMIA	**GEOLOGY**	SANDSTONE	**VEGETATION**	GRASS	**PROJECT NO.**	2193
EQUIPMENT	4WD MOUNTED PUSH TUBE	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	Ø 50mm x 1400mm depth	**NORTHING**	NA	**ASPECT**	NE	**SLOPE**	< 2 °

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS	
PT	Nil	N	M	0.1			SM	ORGANIC SILTY SAND - Brown, moist, soft, rootlets.			PT	0.05	2193/1/0.05	
PT	Nil	N	M	0.5			SC	CLAYEY SAND - Light brown/ yellow, moist, loose, with clay content increasing with depth.			PT	0.4	2193/1/0.4	
PT	Nil	N	M	1.0			EW	EXTREMELY WEATHERED SANDSTONE Grey, clay with sandstone (ironstone) gravels (orange/ red), stiff, moist.			PT	0.8	2193/1/0.8	1.0
				1.4							PT	1.3	2193/1/1.3	
				2.0				Borehole terminated at 1.4m on extremely weathered sandstone.						2.0
				3.0										3.0
				4.0										4.0

EQUIPMENT / METHOD
- N Natural exposure
- X Existing excavation
- BH Backhoe bucket
- E Excavator
- HA Hand auger
- S Hand spade
- PT Push tube
- A Auger
- CC Concrete Corer

SUPPORT
- SH Shoring
- SC Shotcrete
- RB Rock Bolts
- Nil No support

WATER
- N None observed
- X Not measured
- Water level
- Water outflow
- Water inflow

MOISTURE
- D Dry
- M Moist
- W Wet
- Wp Plastic limit
- Wl Liquid limit

PENETRATION
- L Low
- M Moderate
- H High
- R Refusal

CONSISTENCY
- VS Very Soft
- S Soft
- F Firm
- St Stiff
- VSt Very Stiff
- H Hard
- F Friable

DENSITY
- VL Very Loose
- L Loose
- MD Medium Dense
- D Dense
- VD Very Dense

SAMPLING & TESTING
- A Auger sample
- B Bulk sample
- U Undisturbed sample
- D Disturbed sample
- M Moisture content
- Ux Tube sample (x mm)
- pp Pocket penetrometer
- S Standard penetration test
- VS Vane shear
- DCP Dynamic cone penetrometer
- FD Field density
- WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
- Y USCS
- N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

Quality Sheet No. 4

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Engineering Log - Borehole

CLIENT	MALBEC PROPERTIES PTY LTD	COMMENCED	9/9/08	COMPLETED	9/9/08	**REF**	**BH2**
PROJECT	PRELIMINARY GEOTECHNICAL ASSESSMENT	LOGGED	JSF	CHECKED	ASN	Sheet	1 of 1
SITE	JONSSON ROAD, MUNDAMIA	GEOLOGY	SANDSTONE	VEGETATION	GRASS	PROJECT NO.	2193
EQUIPMENT	4WD MOUNTED PUSH TUBE	EASTING	NA	RL SURFACE	NA		
EXCAVATION DIMENSIONS	Ø 50mm x 700mm depth	NORTHING	NA	ASPECT	NE	SLOPE	< 2 °

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
PT	Nil	N	M	0.1			SM	ORGANIC SILTY SAND - Brown, moist, soft, rootlets.			PT	0.05	2193/21/0.05
PT	Nil	N	M	0.3			SC	CLAYEY SAND - Light brown/ yellow, moist, loose clay content increasing with depth.			PT	0.2	2193/2/0.2
PT	Nil	N	M	0.55			EW	EXTREMELY WEATHERED SANDSTONE - Wet with slightly weathered gravels.			PT	0.5	2193/2/0.5
PT	Nil	N	M	0.7			EW	EXTREMELY WEATHERED SANDSTONE					
				1.0				Borehole terminated at 0.7m on moderately weathered sandstone.					
				2.0									
				3.0									
				4.0									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	MALBEC PROPERTIES PTY LTD	COMMENCED	9/9/08	COMPLETED	9/9/08	**REF**	**BH3**
PROJECT	PRELIMINARY GEOTECHNICAL ASSESSMENT	LOGGED	JSF	CHECKED	ASN	Sheet	1 of 1
SITE	JONSSON ROAD, MUNDAMIA	GEOLOGY	SANDSTONE	VEGETATION	GRASS	PROJECT NO.	2193
EQUIPMENT	4WD MOUNTED PUSH TUBE	EASTING	NA	RL SURFACE	NA		
EXCAVATION DIMENSIONS	Ø 50mm x 1350mm depth	NORTHING	NA	ASPECT	NE	SLOPE	< 2 °

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS	
PT	Nil	N	M	0.15			SM	ORGANIC SILTY SAND - Brown, moist, soft, rootlets.			PT	0.1	2193/3/0.1	
PT	Nil	N	M	0.8			SC	CLAYEY SAND - Light brown/ yellow, moist, loose clay content increasing with depth.			PT PT	0.4 0.7	2193/3/0.4 2193/3/0.7	
PT	Nil	N	M	1.0 1.1			CL	SANDY CLAY - Light brown, with sandstone gravels moist, soft.			PT	1.0	2193/3/1.0	1.0
PT	Nil	N	M	1.35			EW	EXTREMELY WEATHERED SANDSTONE Grey, clay with sandstone gravels (orange/ red), stiff, moist.						
								Borehole terminated at 1.35m on extremely weathered sandstone.						
				2.0										2.0
				3.0										3.0
				4.0										4.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	MALBEC PROPERTIES PTY LTD	COMMENCED	9/9/08	COMPLETED	9/9/08	**REF**	**BH4**
PROJECT	PRELIMINARY GEOTECHNICAL ASSESSMENT	LOGGED	JSF	CHECKED	ASN	Sheet	1 of 1
SITE	JONSSON ROAD, MUNDAMIA	GEOLOGY	SANDSTONE	VEGETATION	GRASS	PROJECT NO.	2193
EQUIPMENT	4WD MOUNTED PUSH TUBE	EASTING	NA	RL SURFACE	NA		
EXCAVATION DIMENSIONS	Ø 50mm x 1300mm depth	NORTHING	NA	ASPECT	NE	SLOPE	< 2 °

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
PT	Nil	N	M	0.15			SM	ORGANIC SILTY SAND - Brown, moist, soft, rootlets.			PT	0.1	2193/4/0.1
PT	Nil	N	M	0.45			SC	CLAYEY SAND - Light brown/ yellow, moist, loose clay content increasing with depth.			PT	0.4	2193/4/0.4
PT	Nil	0.6 ▽ Y	W	1.0 1.3			CL	SANDY CLAY - Grey, wet, soft, some sandstone gravels at 0.9 - 1.1m.			PT	0.9	Ground water at 0.6m. 2193/4/0.9
								Borehole terminated at 1.3m on sandy clay.					
				2.0									2.0
				3.0									3.0
				4.0									4.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
▽ Water level
◁ Water outflow
▷ Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	MALBEC PROPERTIES PTY LTD	**COMMENCED**	9/9/08	**COMPLETED**	9/9/08	**REF**	**BH5**
PROJECT	PRELIMINARY GEOTECHNICAL ASSESSMENT	**LOGGED**	JSF	**CHECKED**	ASN	**Sheet**	1 of 1
SITE	JONSSON ROAD, MUNDAMIA	**GEOLOGY**	SANDSTONE	**VEGETATION**	GRASS	**PROJECT NO.**	2193
EQUIPMENT	4WD MOUNTED PUSH TUBE	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	Ø 50mm x 1400mm depth	**NORTHING**	NA	**ASPECT**	NE	**SLOPE**	< 2 °

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS	
PT	Nil	N	M	0.15			SM	ORGANIC SILTY SAND - Brown, moist, soft, rootlets.			PT	0.1	2193/5/0.1	
PT	Nil	0.3 ▽ Y	M	0.55			SC	CLAYEY SAND - Orange, moist(wet at 0.3m), loose with minor sandstone gravels.			PT	0.4	Ground water at 0.3m. 2193/5/0.4	
PT	Nil	Y	W	0.8			HW	HIGHLY WEATHERED SANDSTONE						
PT	Nil	Y	W	1.0 1.4			SC	CLAYEY SAND - Grey,wet, loose, with minor sandstone gravels at 1.2m.			PT	1.2	2193/5/1.2	1.0
				2.0 3.0 4.0				Borehole terminated at 1.4m on clayey sand.						2.0 3.0 4.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
▽ Water level
◁ Water outflow
▷ Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	MALBEC PROPERTIES PTY LTD	COMMENCED	9/9/08	COMPLETED	9/9/08	**REF**	**BH6**
PROJECT	PRELIMINARY GEOTECHNICAL ASSESSMENT	LOGGED	JSF	CHECKED	ASN	Sheet	1 of 1
SITE	JONSSON ROAD, MUNDAMIA	GEOLOGY	SANDSTONE	VEGETATION	GRASS	PROJECT NO.	2193
EQUIPMENT	4WD MOUNTED PUSH TUBE	EASTING	NA	RL SURFACE	NA		
EXCAVATION DIMENSIONS	Ø 50mm x 1200mm depth	NORTHING	NA	ASPECT	NE	SLOPE	< 2 °

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS	
PT	Nil	N	M	0.1			SM	ORGANIC SILTY SAND - Brown, moist, soft, rootlets.			PT	0.05	2193/6/0.05	
PT	Nil	N	M	0.7			CS	CLAYEY / SILTY SAND - Light brown, soft, moist.			PT	0.5	2193/6/0.5	
PT	Nil	N	M	1.0 1.2			CL	SANDY CLAY - Grey, wet, soft, some sandstone gravels at 0.9 - 1.1m.						1.0
				2.0				Borehole terminated at 1.2m on sandy clay.						2.0
				3.0										3.0
				4.0										4.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	MALBEC PROPERTIES PTY LTD	**COMMENCED**	9/9/08	**COMPLETED**	9/9/08	**REF**	**BH7**
PROJECT	PRELIMINARY GEOTECHNICAL ASSESSMENT	**LOGGED**	JSF	**CHECKED**	ASN	**Sheet**	1 of 1
SITE	JONSSON ROAD, MUNDAMIA	**GEOLOGY**	SANDSTONE	**VEGETATION**	GRASS	**PROJECT NO.**	2193
EQUIPMENT	4WD MOUNTED PUSH TUBE	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	Ø 50mm x 1200mm depth	**NORTHING**	NA	**ASPECT**	NE	**SLOPE**	< 2 °

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS	
PT	Nil	N	M	0.1			SM	ORGANIC SILTY SAND - Brown, moist, soft, rootlets.			PT	0.05	2193/7/0.05	
PT	Nil	N	M	0.6			SC	CLAYEY SAND - Light brown/ yellow, moist, loose clay content increasing with depth.			PT	0.4	2193/7/0.4	
PT	Nil	N	M	1.0 1.2			RS - EW	EXTREMELY WEATHERED SANDSTONE Grey, clay like properties with sandstone gravels (orange/ red), stiff, moist.			PT	1.0	2193/7/1.0	1.0
				2.0				Borehole terminated at 1.2m on extremely to moderately weathered sandstone.						2.0
				3.0										3.0
				4.0										4.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	MALBEC PROPERTIES PTY LTD	COMMENCED	9/9/08	COMPLETED	9/9/08
PROJECT	PRELIMINARY GEOTECHNICAL ASSESSMENT	LOGGED	JSF	CHECKED	ASN
SITE	JONSSON ROAD, MUNDAMIA	GEOLOGY	SANDSTONE	VEGETATION	GRASS
EQUIPMENT	4WD MOUNTED PUSH TUBE	EASTING	NA	RL SURFACE	NA
EXCAVATION DIMENSIONS	Ø 50mm x 1200mm depth	NORTHING	NA	ASPECT	NE

REF BH8
Sheet 1 of 1
PROJECT NO. 2193
SLOPE < 2 °

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS	
PT	Nil	N	M	0.15			SP	ORGANIC SILTY SAND - Brown, grey, moist, soft.			PT	0.1	2193/8/0.1	
PT	Nil	N	M	0.5			ML	CLAYEY SILT - Orange/ brown, moist, soft.			PT	0.3	2193/8/0.3	
PT	Nil	N	M	1.0			CL	CLAY - Grey, moist, firm, plastic.			PT	0.7	2193/8/0.7	1.0
				1.2							PT	1.1	2193/8/1.1	
				2.0				Borehole terminated at 1.2m on clay.						2.0
				3.0										3.0
				4.0										4.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	MALBEC PROPERTIES PTY LTD	**COMMENCED**	9/9/08	**COMPLETED**	9/9/08	**REF**	**BH9**
PROJECT	PRELIMINARY GEOTECHNICAL ASSESSMENT	**LOGGED**	JSF	**CHECKED**	ASN	**Sheet**	1 of 1
SITE	JONSSON ROAD, MUNDAMIA	**GEOLOGY**	SANDSTONE	**VEGETATION**	GRASS	**PROJECT NO.**	2193
EQUIPMENT	4WD MOUNTED PUSH TUBE	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	Ø 50mm x 1100mm depth	**NORTHING**	NA	**ASPECT**	NE	**SLOPE**	< 2 °

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS	
PT	Nil	N	M	0.1			SM	ORGANIC SILTY SAND - Brown, moist, soft, rootlets.			PT	0.05	2193/9/0.05	
PT	Nil	0.3 ▽ Y	M	0.7			SC	CLAYEY SAND - Orange, moist(wet at 0.3m), loose with minor sandstone gravels.			PT	0.4	Ground water at 0.3m. 2193/9/0.4	
PT	Nil	Y	W	0.9			MW	MODERATELY WEATHERED SANDSTONE						
PT	Nil	Y	W	1.0 1.1			EW	EXTREMELY WEATHERED SANDSTONE - White coarse grained.			PT	1.0	2193/9/1.0	1.0
				2.0				Borehole terminated at 1.1m on moderately weathered sandstone .						2.0
				3.0										3.0
				4.0										4.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
▽ Water level
◁ Water outflow
▷ Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	MALBEC PROPERTIES PTY LTD	COMMENCED	9/9/08	COMPLETED	9/9/08	**REF**	**BH10**
PROJECT	PRELIMINARY GEOTECHNICAL ASSESSMENT	LOGGED	JSF	CHECKED	ASN	Sheet	1 of 1
SITE	JONSSON ROAD, MUNDAMIA	GEOLOGY	SANDSTONE	VEGETATION	GRASS	PROJECT NO.	2193
EQUIPMENT	4WD MOUNTED AUGER	EASTING	NA	RL SURFACE	NA		
EXCAVATION DIMENSIONS	Ø 95mm x 2800mm depth	NORTHING	NA	ASPECT	NE	SLOPE	< 3 °

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	M	0.3			SM	SILTY SAND - Brown, moist, soft.			A	0.1	2193/10/0.1
A	Nil	N	M	0.7			CS	CLAYEY SAND - Orange, moist.			A	0.4	2193/10/0.4
A	Nil	N	M	1.0			CL	SANDY/ SILTY CLAY - Orange,with red mottles, some sandstone floaters, firm, moist.			A	0.9	2193/10/0.9 1.0
A	Nil	1.7 ▽ Y	W	2.0			CL-EW	SANDY CLAY - With extremely weathered sandstone/ gravels, white and red mottled moist (wet below 1.7m).			A	1.5	2193/10/1.5 Ground water at 1.7m. 2.0
				2.8							A	2.5	2193/10/2.5
				3.0				Borehole terminated at 2.8m on extremely weathered sandstone.					3.0
				4.0									4.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
▽ Water level
◁ Water outflow
▷ Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	**MALBEC PROPERTIES PTY LTD**	**COMMENCED**	9/9/08	**COMPLETED**	9/9/08	**REF**	**BH11**
PROJECT	**PRELIMINARY GEOTECHNICAL ASSESSMENT**	**LOGGED**	JSF	**CHECKED**	ASN	**Sheet**	**1 of 1**
SITE	**JONSSON ROAD, MUNDAMIA**	**GEOLOGY**	SANDSTONE	**VEGETATION**	GRASS	**PROJECT NO.**	2193
EQUIPMENT	4WD MOUNTED AUGER	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	Ø 95mm x 1500mm depth	**NORTHING**	NA	**ASPECT**	NE	**SLOPE**	< 3 °

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	M	0.1			SP	ORGANIC SILTY SAND - Brown, grey, moist, soft.			A	0.1	2193/11/0.1
A	Nil	N	M	0.6			CS	CLAYEY SAND - Orange, moist.			A	0.5	2193/11/0.5
A	Nil	N	M	1.0 1.5			CL-EW	SANDY CLAY - With extremely weathered sandstone gravels, white and red mottled, moist.			A	1.2	2193/11/1.2
				2.0 3.0 4.0				Borehole terminated at 1.5m on sandy clay / extremely weathered sandstone.					

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
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N Agricultural

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Engineering Log - Borehole

CLIENT	**MALBEC PROPERTIES PTY LTD**	**COMMENCED**	9/9/08	**COMPLETED**	9/9/08	**REF**	**BH12**
PROJECT	**PRELIMINARY GEOTECHNICAL ASSESSMENT**	**LOGGED**	JSF	**CHECKED**	ASN	**Sheet**	**1 of 1**
SITE	**JONSSON ROAD, MUNDAMIA**	**GEOLOGY**	SANDSTONE	**VEGETATION**	GRASS	**PROJECT NO.**	2193
EQUIPMENT	4WD MOUNTED AUGER	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	Ø 95mm x 1500mm depth	**NORTHING**	NA	**ASPECT**	NE	**SLOPE**	< 3 °

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS	
A	Nil	N	M	0.15			SP	ORGANIC SILTY SAND - Brown, grey, moist, soft.			A	0.1	2193/12/0.1	
A	Nil	N	M	1.0			CL	SANDY/ SILTY CLAY - Orange,with red mottles, some sandstone floaters, firm, moist.			A A	0.3 0.8	2193/12/0.3 2193/12/0.8	1.0
A	Nil	N	M	1.5			CL-EW	SANDY CLAY - With extremely weathered sandstone / gravels, white and red mottled, moist.			A	1.4	2193/12/1.4	
				2.0				Borehole terminated at 1.5m on sandy clay / extremely weathered sandstone.						2.0
				3.0										3.0
				4.0										4.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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Engineering Log - Borehole

CLIENT	MALBEC PROPERTIES PTY LTD	COMMENCED	9/9/08	COMPLETED	9/9/08	**REF**	**BH13**
PROJECT	PRELIMINARY GEOTECHNICAL ASSESSMENT	LOGGED	JSF	CHECKED	ASN	Sheet	1 of 1
SITE	JONSSON ROAD, MUNDAMIA	GEOLOGY	SANDSTONE	VEGETATION	GRASS	PROJECT NO.	2193
EQUIPMENT	4WD MOUNTED AUGER	EASTING	NA	RL SURFACE	NA		
EXCAVATION DIMENSIONS	Ø 95mm x 1500mm depth	NORTHING	NA	ASPECT	NE	SLOPE	< 3 °

EXCAVATION DATA						MATERIAL DATA						SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	M	0.3			SP	ORGANIC SILTY SAND - Brown, grey, moist, soft.			A	0.2	2193/13/0.2
A	Nil	N	M	1.0			CS	CLAYEY SAND - Orange, moist.			A	0.5	2193/13/0.5
A	Nil	N	M	1.5			CL	SANDY/ SILTY CLAY - Orange,with red mottles, some sandstone floaters, firm, moist.			A	1.4	2193/13/1.4
				2.0				Borehole terminated at 1.5m on sandy / silty clay.					
				3.0									
				4.0									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
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VSt Very Stiff
H Hard
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DENSITY
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U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

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S Standard penetration test
VS Vane shear
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FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
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EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

7 Attachment C – Notes About This Report

Information

Important Information About Your Report

Subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Martens to help you interpret and understand the limitations of your report. Not all of course, are necessarily relevant to all reports, but are included as general reference.

Engineering Reports - Limitations

Geotechnical reports are based on information gained from limited sub-surface site testing and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretative rather than factual documents, limited to some extent by the scope of information on which they rely.

Engineering Reports – Project Specific Criteria

Engineering reports are prepared by qualified personnel and are based on the information obtained, on current engineering standards of interpretation and analysis, and on the basis of your unique project specific requirements as understood by Martens. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the Client.

Where the report has been prepared for a specific design proposal (eg. a three storey building), the information and interpretation may not be relative if the design proposal is changed (eg. to a twenty storey building). Your report should not be relied upon if there are changes to the project without first asking Martens to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Martens will not accept responsibility for problems that may occur due to design changes if they are not consulted.

Engineering Reports – Recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption often cannot be substantiated until project implementation has commenced and therefore your site investigation report recommendations should only be regarded as preliminary.

Only Martens, who prepared the report, are fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Martens cannot be held responsible for such misinterpretation.

Engineering Reports – Use For Tendering Purposes

Where information obtained from this investigation is provided for tendering purposes, Martens recommend that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. Attention is drawn to the document 'Guidelines for the Provision of Geotechnical Information in Tender Documents', published by the Institution of Engineers, Australia.

The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Engineering Reports – Data

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings *etc* are customarily included in a Martens report and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These data should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Engineering Reports – Other Projects

To avoid misuse of the information contained in your report it is recommended that you confer with Martens before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Subsurface Conditions - General

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical aspects, relevant standards and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions - the potential for will depend partly on test point (eg. excavation or borehole) spacing and sampling frequency which are often limited by project imposed budgetary constraints.

- Changes in guidelines, standards and policy or interpretation of guidelines, standards and

policy by statutory authorities.

- The actions of contractors responding to commercial pressures.

- Actual conditions differing somewhat from those inferred to exist, because no professional, no matter how qualified, can reveal precisely what is hidden by earth, rock and time.

  The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions

If these conditions occur, the Company will be pleased to assist with investigation or advice to resolve the matter.

Subsurface Conditions - Changes

Natural processes and the activity of man create subsurface conditions. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Reports are based on conditions which existed at the time of the subsurface exploration.

Decisions should not be based on a report whose adequacy may have been affected by time. If an extended period of time has elapsed since the report was prepared, consult Martens to be advised how time may have impacted on the project.

Subsurface Conditions - Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those that were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved at the time when conditions are exposed, rather than at some later stage well after the event.

Report Use By Other Design Professionals

To avoid potentially costly misinterpretations when other design professionals develop their plans based on a report, retain Martens to work with other project professionals who are affected by the report. This may involve Martens explaining the report design implications and then reviewing plans and specifications produced to see how they have incorporated the report findings.

Subsurface Conditions - Geoenvironmental Issues

Your report generally does not relate to any findings, conclusions, or recommendations about the potential for hazardous or contaminated materials existing at the site unless specifically required to do so as part of the Company's proposal for works.

Specific sampling guidelines and specialist equipment, techniques and personnel are typically used to perform geoenvironmental or site contamination assessments. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Martens for information relating to such matters.

Responsibility

Geotechnical reporting relies on interpretation of factual information based on professional judgment and opinion and has an inherent level of uncertainty attached to it and is typically far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded.

To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Martens to other parties but are included to identify where Martens' responsibilities begin and end. Their use is intended to help all parties involved to recognize their individual responsibilities. Read all documents from Martens closely and do not hesitate to ask any questions you may have.

Site Inspections

Martens will always be pleased to provide engineering inspection services for aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site. Martens is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction.

Soil Data

Explanation of Terms (1 of 3)

Definitions

In engineering terms, soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material does not exhibit any visible rock properties and can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726 and the S.A.A Site Investigation Code. In general, descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions.

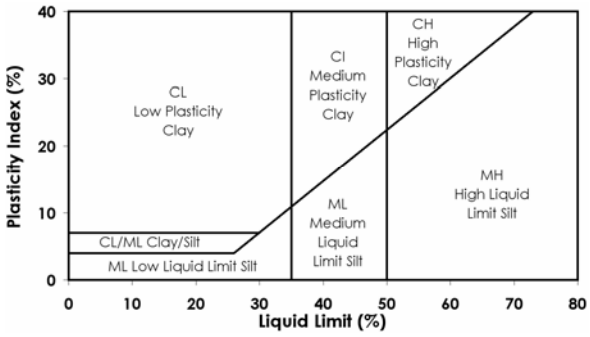
Particle Size

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (eg. sandy clay). Unless otherwise stated, particle size is described in accordance with the following table.

Division	Subdivision	Size
BOULDERS		>200 mm
COBBLES		60 to 200 mm
GRAVEL	Coarse	20 to 60 mm
	Medium	6 to 20 mm
	Fine	2 to 6 mm
SAND	Coarse	0.6 to 2.0 mm
	Medium	0.2 to 0.6 mm
	Fine	0.075 to 0.2 mm
SILT		0.002 to 0.075 mm
CLAY		< 0.002 mm

Plasticity Properties

Plasticity properties can be assessed either in the field by tactile properties, or by laboratory procedures.



Moisture Condition

Dry — Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.

Moist — Soil feels cool and damp and is darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.

Wet — As for moist but with free water forming on hands when handled.

Consistency of Cohesive Soils

Cohesive soils refer to predominantly clay materials.

Term	C_u (kPa)	Approx SPT "N"	Field Guide
Very Soft	<12	2	A finger can be pushed well into the soil with little effort.
Soft	12 - 25	2 to 4	A finger can be pushed into the soil to about 25mm depth.
Firm	25 - 50	4 – 8	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 - 100	8 – 15	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 - 200	15 – 30	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	> 200	> 30	The surface of the soil can be marked only with the thumbnail.
Friable	-		Crumbles or powders when scraped by thumbnail

Density of Granular Soils

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration test (SPT) or Dutch cone penetrometer tests (CPT) as below:

Relative Density	%	SPT 'N' Value (blows/300mm)	CPT Cone Value (q_c Mpa)
Very loose	< 15	< 5	< 2
Loose	15 – 35	5 - 10	2 -5
Medium dense	35 – 65	10 - 30	5 - 15
Dense	65- 85	30 - 50	15 - 25
Very dense	> 85	> 50	> 25

Minor Components

Minor components in soils may be present and readily detectable, but have little bearing on general geotechnical classification. Terms include:

Term	Assessment	Proportion of Minor component In:
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: < 5 % Fine grained soils: < 15 %
With some	Presence easily detectable by feel or eye, soil properties little different to general properties of primary component.	Coarse grained soils: 5 – 12 % Fine grained soils: 15 – 30 %

Soil Data

Explanation of Terms (2 of 3)

Soil Agricultural Classification Scheme

In some situations, such as where soils are to be used for effluent disposal purposes, soils are often more appropriately classified in terms of traditional agricultural classification schemes. Where a Martens report provides agricultural classifications, these are undertaken in accordance with descriptions by Northcote, K.H. (1979) *The factual key for the recognition of Australian Soils*, Rellim Technical Publications, NSW, p 26 - 28.

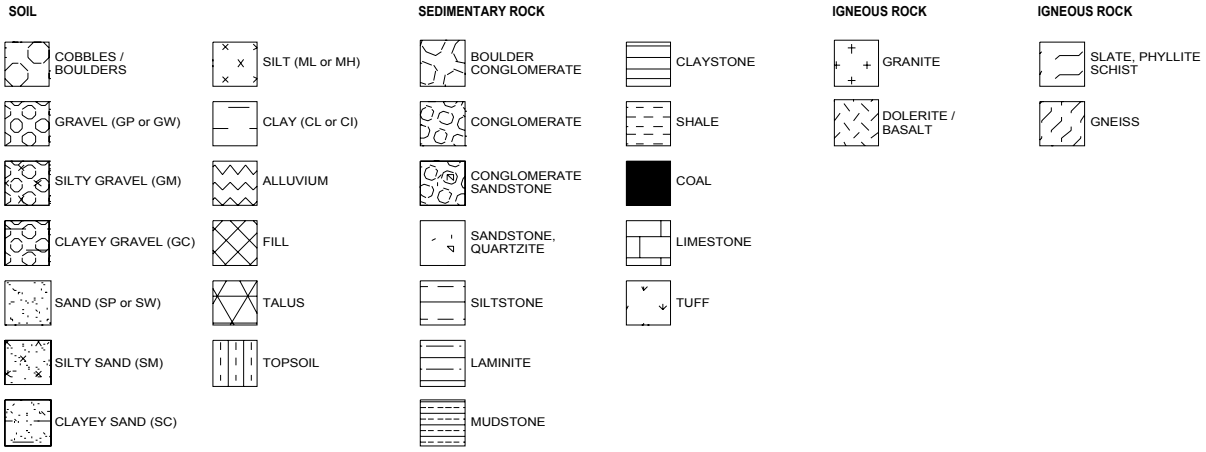
Symbol	Field Texture Grade	Behaviour of moist bolus	Ribbon length	Clay content (%)
S	Sand	Coherence nil to very slight; cannot be moulded; single grains adhere to fingers	0 mm	< 5
LS	Loamy sand	Slight coherence; discolours fingers with dark organic stain	6.35 mm	5
CLS	Clayey sand	Slight coherence; sticky when wet; many sand grains stick to fingers; discolours fingers with clay stain	6.35mm - 1.3cm	5 - 10
SL	Sandy loam	Bolus just coherent but very sandy to touch; dominant sand grains are of medium size and are readily visible	1.3 - 2.5	10 - 15
FSL	Fine sandy loam	Bolus coherent; fine sand can be felt and heard	1.3 - 2.5	10 - 20
SCL-	Light sandy clay loam	Bolus strongly coherent but sandy to touch, sand grains dominantly medium size and easily visible	2.0	15 - 20
L	Loam	Bolus coherent and rather spongy; smooth feel when manipulated but no obvious sandiness or silkiness; may be somewhat greasy to the touch if much organic matter present	2.5	25
Lfsy	Loam, fine sandy	Bolus coherent and slightly spongy; fine sand can be felt and heard when manipulated	2.5	25
SiL	Silt loam	Coherent bolus, very smooth to silky when manipulated	2.5	25 + > 25 silt
SCL	Sandy clay loam	Strongly coherent bolus sandy to touch; medium size sand grains visible in a finer matrix	2.5 - 3.8	20 - 30
CL	Clay loam	Coherent plastic bolus; smooth to manipulate	3.8 - 5.0	30 - 35
SiCL	Silty clay loam	Coherent smooth bolus; plastic and silky to touch	3.8 - 5.0	30- 35 + > 25 silt
FSCL	Fine sandy clay loam	Coherent bolus; fine sand can be felt and heard	3.8 - 5.0	30 - 35
SC	Sandy clay	Plastic bolus; fine to medium sized sands can be seen, felt or heard in a clayey matrix	5.0 - 7.5	35 - 40
SiC	Silty clay	Plastic bolus; smooth and silky	5.0 - 7.5	35 - 40 + > 25 silt
LC	Light clay	Plastic bolus; smooth to touch; slight resistance to shearing	5.0 - 7.5	35 - 40
LMC	Light medium clay	Plastic bolus; smooth to touch, slightly greater resistance to shearing than LC	7.5	40 - 45
MC	Medium clay	Smooth plastic bolus, handles like plasticine and can be moulded into rods without fracture, some resistance to shearing	> 7.5	45 - 55
HC	Heavy clay	Smooth plastic bolus; handles like stiff plasticine; can be moulded into rods without fracture; firm resistance to shearing	> 7.5	> 50

Soil Data

Explanation of Terms (3 of 3)

martens consulting engineers

Symbols for Soil and Rock



Unified Soil Classification Scheme (USCS)

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 63 mm and basing fractions on estimated mass)					USCS	Primary Name
COARSE GRAINED SOILS More than 50 % of material less than 63 mm is larger than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.0 mm.	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	GW	Gravel
				Predominantly one size or a range of sizes with more intermediate sizes missing	GP	Gravel
			GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)	GM	Silty Gravel
				Plastic fines (for identification procedures see CL below)	GC	Clayey Gravel
		SANDS More than half of coarse fraction is smaller than 2.0 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of intermediate sizes missing.	SW	Sand
				Predominantly one size or a range of sizes with some intermediate sizes missing	SP	Sand
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)	SM	Silty Sand
				Plastic fines (for identification procedures see CL below)	SC	Clayey Sand

FINE GRAINED SOILS More than 50 % of material less than 63 mm is smaller than 0.075 mm	IDENTIFICATION PROCEDURES ON FRACTIONS < 0.2 MM					
	DRY STRENGTH (Crushing Characteristics)	DILATANCY	TOUGHNESS	DESCRIPTION	USCS	Primary Name
	None to Low	Quick to Slow	None	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	ML	Silt
	Medium to High	None	Medium	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays	CL	Clay
	Low to Medium	Slow to Very Slow	Low	Organic slits and organic silty clays of low plasticity	OL	Organic Silt
	Low to Medium	Slow to Very Slow	Low to Medium	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	MH	Silt
	High	None	High	Inorganic clays of high plasticity, fat clays	CH	Clay
	Medium to High	None	Low to Medium	Organic clays of medium to high plasticity	OH	Organic Silt
HIGHLY ORGANIC SOILS	Readily identified by colour, odour, spongy feel and frequently by fibrous texture				Pt	Peat

Low Plasticity – Liquid Limit W_L < 35 % Medium Plasticity – Liquid limit W_L 35 to 60 % High Plasticity - Liquid limit W_L > 60 %

Rock Data

Explanation of Terms (1 of 2)

Definitions

Descriptive terms used for Rock by Martens are given below and include rock substance, rock defects and rock mass.

Rock Substance — In geotechnical engineering terms, rock substance is any naturally occurring aggregate of minerals and organic matter which cannot, unless extremely weathered, be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Rock substance is effectively homogeneous and may be isotropic or anisotropic.

Rock Defect — Discontinuity or break in the continuity of a substance or substances.

Rock Mass — Any body of material which is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects.

Degree of Weathering

Rock weathering is defined as the degree in rock structure and grain property decline and can be readily determined in the field.

Term	Symbol	Definition
Residual Soil	Rs	Soil derived from the weathering of rock. The mass structure and substance fabric are no longer evident. There is a large change in volume but the soil has not been significantly transported.
Extremely weathered	EW	Rock substance affected by weathering to the extent that the rock exhibits soil properties - ie. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.
Highly weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decrease compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original rock substance is no longer recognisable.
Moderately weathered	MW	Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock substance and the original colour of the fresh rock is no longer recognisable.
Slightly weathered	SW	Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable.
Fresh	Fr	Rock substance unaffected by weathering

Rock Strength

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance is the direction normal to the bedding. The test procedure is described by the International Society of Rock Mechanics.

Term	Is (50) MPa	Field Guide	Symbol
Extremely weak	< 0.03	Easily remoulded by hand to a material with soil properties.	EW
Very weak	0.03 - 0.1	May be crumbled in the hand. Sandstone is 'sugary' and friable.	VW
Weak	0.1 - 0.3	A piece of core 150mm long x 50mm diameter may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.	W
Medium strong	0.3 - 1	A piece of core 150mm long x 50mm diameter can be broken by hand with considerable difficulty. Readily scored with a knife.	MS
Strong	1 - 3	A piece of core 150mm long x 50mm diameter cannot be broken by unaided hands, can be slightly scratched or scored with a knife.	S
Very Strong	3 - 10	A piece of core 150mm long x 50mm diameter may be broken readily with hand held hammer. Cannot be scratched with pen knife.	VS
Extremely strong	> 10	A piece of core 150mm long x 50mm diameter is difficult to break with hand held hammer. Rings when struck with a hammer.	ES

Rock Data

Explanation of Terms (2 of 2)

Degree of Fracturing

This classification applies to diamond drill cores and refers to the spacing of all types of natural fractures along which the core is discontinuous. These include bedding plane partings, joints and other rock defects, but excludes fractures such as drilling breaks.

Term	Description
Fragmented	The core is comprised primarily of fragments of length less than 20mm, and mostly of width less than core diameter.
Highly fractured	Core lengths are generally less than 20mm-40mm with occasional fragments.
Fractured	Core lengths are mainly 30mm-100mm with occasional shorter and longer sections.
Slightly fractured	Core lengths are generally 300mm-1000mm with occasional longer sections and occasional sections of 100mm-300mm.
Unbroken	The core does not contain any fractures.

Rock Core Recovery

TCR = Total Core Recovery

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

SCR = Solid Core Recovery

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

RQD = Rock Quality Designation

$$= \frac{\Sigma \text{Axial lengths of core} > 100\,\text{mm long}}{\text{Length of core run}} \times 100\%$$

Rock Strength Tests

▼ Point load strength Index (Is50) - axial test (MPa)

▶ Point load strength Index (Is50) - diametrall test (MPa)

● Unconfined compressive strength (UCS) (MPa)

Defect Type Abbreviations and Descriptions

Defect Type (with inclination given)

BP	Bedding plane parting
X	Foliation
L	Cleavage
JT	Joint
F	Fracture
SZ	Sheared zone (Fault)
CS	Crushed seam
DS	Decomposed seam
IS	Infilled seam
V	Vein

Coating or Filling

Cn	Clean
Sn	Stain
Ct	Coating
Fe	Iron Oxide

Planarity

Cu	Curved
Ir	Irregular
Pl	Planar
St	Stepped
Un	Undulating

Roughness

Po	Polished
Ro	Rough
Sl	Slickensided
Sm	Smooth
Vr	Very rough

Inclination

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

Test Methods

Explanation of Terms (1 of 2)

Sampling

Sampling is carried out during drilling or excavation to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples may be taken by pushing a thin-walled sample tube into the soils and withdrawing a soil sample in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils. Other sampling methods may be used. Details of the type and method of sampling are given in the report.

Drilling Methods

The following is a brief summary of drilling methods currently adopted by the Company and some comments on their use and application.

Hand Excavation – in some situations, excavation using hand tools such as mattock and spade may be required due to limited site access or shallow soil profiles.

Hand Auger - the hole is advanced by pushing and rotating either a sand or clay auger generally 75-100mm in diameter into the ground. The depth of penetration is usually limited to the length of the auger pole, however extender pieces can be added to lengthen this.

Test Pits - these are 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 about 3m for a backhoe and up to 6m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (eg. Pengo) - the hole is advanced by a rotating plate or short spiral auger, generally 300mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

Continuous Sample Drilling - the hole is advanced by pushing a 100mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength *etc.* is only marginally affected.

Continuous Spiral Flight Augers - the hole is advanced using 90 - 115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or *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 or, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling - the hole is 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.

Rotary Mud Drilling - similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

Continuous Core Drilling - a continuous core sample is obtained using a diamond tipped core barrel, usually 50mm internal diameter. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

Standard Penetration Tests

Standard penetration tests are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in AS 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 under the impact of a 63 kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150 mm 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:

(i) In the case where full penetration is obtained with successive blow counts for each 150mm of say 4, 6 and 7 blows:

as 4, 6, 7
N = 13

(ii) 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 15, 30/40 mm.

The results of the tests can be related empirically to the engineering properties of the soil. Occasionally, the test method is used to obtain samples in 50mm diameter thin walled sample tubes in clays. In such circumstances, the test results are shown on the borelogs in brackets.

CONE PENETROMETER TESTING AND INTERPRETATION

Cone penetrometer testing (sometimes referred to as Dutch Cone - abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in AS 1289 - Test F4.1.

In the test, a 35mm diameter rod with a cone tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on separate 130mm long sleeve, immediately behind the cone. Tranducers in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output on continuous chart

Test Methods

Explanation of Terms (2 of 2)

recorders. The plotted results given in this report have been traced from the original records.

The information provided on the charts comprises:
Cone resistance - the actual end bearing force divided by the cross sectional area of the cone - expressed in MPA.
Sleeve friction - the frictional force of the sleeve divided by the surface area - expressed in kPa.
Friction ratio - the ratio of sleeve friction to cone resistance - expressed in percent.

There are two scales available for measurement of cone resistance. The lower (A) scale (0 - 5 Mpa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main (B) scale (0 - 50 Mpa) is less sensitive and is shown as a full line.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1%-2% are commonly encountered in sands and very soft clays rising to 4%-10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:

q_c (Mpa) = (0.4 to 0.6) N (blows/300mm)

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range:

q_c = (12 to 18) c_u

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes *etc.* This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

DYNAMIC CONE (HAND) PENETROMETERS
Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150mm increments of penetration. Normally, there is a depth limitation of 1.2m but this may be extended in certain conditions by the use of extension rods. Two relatively similar tests are used.

Perth sand penetrometer - a 16 mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS 1289 - Test F 3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
Cone penetrometer (sometimes known as the Scala Penetrometer) - a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS 1289 - Test F 3.2). The test was developed initially for pavement sub-grade investigations, with correlations of the test results with California bearing ratio published by various Road Authorities.

LABORATORY TESTING
Laboratory testing is carried out in accordance with AS 1289 Methods of Testing Soil for Engineering Purposes. Details of the test procedure used are given on the individual report forms.

TEST PIT / BORE LOGS
The test pit / bore log(s) presented herein are an engineering and/or geological interpretation of the sub-surface conditions and their reliability will depend to some extent on frequency of sampling and the method of excavation / drilling. Ideally, continuous undisturbed sampling or excavation / core drilling will provide the most reliable assessment, but this is not always practicable, or possible to justify on economic grounds. In any case, the boreholes represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes, the frequency of sampling and the possibility of other than 'straight line' variation between the boreholes.

GROUND WATER
Where ground water levels are measured in boreholes, there are several potential problems:

In low permeability soils, ground water although present, may enter the hole slowly, or perhaps not at all during the time it is left open.
A localised perched water table may lead to an erroneous indication of the true water table.
Water table levels will vary from time to time with seasons or recent prior weather changes. They may not be the same at the time of construction as are indicated in the report.
The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.