Appendix 4

Geotechnical Investigations February and December 2012

(Total No. of pages including blank pages = 92)

(Note: A copy of this Appendix is only available on the Project CD)

BOGAN SHIRE COUNCIL

ENVIRONMENTAL IMPACT STATEMENT

Appendix 4

Nyngan Waste and Resource Management Facility Report No. 800/02

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Geotechnical Engineers & Engineering Geologists NATA Accredited Laboratories for Asphalt, Aggregate, Coal, Concrete, Environmental, Soil & Rock Geotechnical & Environmental Drilling

Geotechnical Investigation for Proposed Waste Management Facility, Nyngan

Bogan Shire Council

15th February 2012

Ref: 12/047



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1 INTRODUCTION

At the request of Dean Woods from Bogan Shire Council, Macquarie Geotechnical has carried out a Geotechnical investigation for permeability assessment of material at the proposed waste management facility, Nyngan.

The objectives of this investigation were to determine the sub-surface conditions and provide permeability parameters.

2 METHOD OF INVESTIGATION

Fieldwork was undertaken on 6th February 2012 by an Engineering Geologist from our Bathurst office.

The fieldwork was undertaken in accordance with AS1726 - "Geotechnical Site Investigations" and our proposal dated 9th January 2012.

The fieldwork comprised six test pits up to 1.2m depth.

The test pits were excavated using a backhoe fitted with a 450mm toothed bucket. The test pits were identified as TP1 to TP6 inclusive. The test pit locations are shown in Appendix B and the test pit logs are located in Appendix C.

The soil samples were returned to Macquarie Geotechnical NATA accredited laboratory in Bathurst for further assessment and testing.

Laboratory testing was carried out on selected samples and included the following:

• Six (6) Falling Head Permeability tests for soil permeability characteristics

Subsequently, the results of the field investigation and laboratory testing were assessed and this report prepared.

2.1 Testing Methods

Falling Head Permeability Testing:

Falling Head Permeability testing was carried out as per AS1289 6.7.2.

Moisture Contents:

The moisture contents of the samples were determined in accordance with AS1289 2.1.1.

Maximum Dry Density:

The maximum dry density of the samples was determined in accordance with AS1289 5.1.1



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3 SITE DESCRIPTION

The site is located off the Nyngan – Mundaroo Road, behind the existing Nyngan Waste Facility, approximately 5km North of Nyngan.

At the time of the investigation the test pits were located in relatively flat lying scrubland with an elevation of 170m.

The site plan and test pit locations are attached within Appendix B.

3.1 Regional Geology

Reference to the Nyngan Geological map (1 250:000) sheet SH/55-15 and indicates that the geology underlying the site consists of the following:

"Unconsolidated dark yellow brown clay, slightly silty with rare carbonate nodules and quartz sand. Common desiccation cracks. Laminated and contains rootlets."

4 RESULTS OF INVESTIGATION

4.1 Sub-surface conditions

The existing ground conditions have been summarised as follows:

Table 1: Subsurface Conditions TP-1 to TP-5

Depth (m)	Log	Descriptions
0.0 - 0.60		Sandy CLAY with roots: red brown, medium to high plasticity clay, fine to coarse sand, firm, moist, moisture content ~ plastic limit (TOPSOIL) (ALLUVIAL)
0.60 - 1.20		Sandy CLAY trace gravel: red brown, medium to high plasticity clay, fine to coarse sand, fine subangular to subrounded gravel, stiff, dry, moisture content < plastic limit (ALLUVIAL).

Note: Please refer to logs for detailed descriptions.

Groundwater was not encountered in the test pits.

4.2 Laboratory Test Results

Laboratory testing in this area is summarised as follows;

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Table 2: Results of Falling Head Permeability

Test Pit Number	Depth (m)	Permeability
TP-1	0.8 – 1.0	3.48 x 10 ⁻⁹
TP-2	0.8 – 1.0	9.17 x 10 ⁻⁸
TP-3	0.8 – 1.0	3.90 x 10 ⁻⁹
TP-4	0.8 – 1.0	7.44 x 10 ⁻¹¹
TP-5	0.8 – 1.0	7.13 x 10 ⁻⁹
TP-6	0.8 – 1.0	2.05 x 10 ⁻¹¹

5 CONCLUSION

The findings of our report were based on our fieldwork, in-situ testing, laboratory testing, technical assessment and local knowledge for this site. We trust the foregoing is sufficient for your present purposes, and if you have any questions please contact either of the undersigned.

Yours sincerely

Reviewed by

Karl Addison

Engineering Geologist

BSc (Hons) Environmental Management

Jason P Lewis

Principal Geotechnical Engineer B.E. (Civil) MIE Aust CP Eng

References: Australian Standard 1726 – 2007 Geotechnical Site Investigations

LIMITATIONS OF GEOTECHNICAL SITE INVESTIGATION

Scope of Services

This report has been prepared for the Client in accordance with the Services Engagement Form (SEF), between the Client and Macquarie Geotechnical.

Reliance on Data

Macquarie Geotechnical has relied upon data and other information provided by the Client and other individuals. Macquarie Geotechnical has not verified the accuracy or completeness of the data, except as otherwise stated in the report. Recommendations in the report are based on the data.

Macquarie Geotechnical will not be liable in relation to incorrect recommendations should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed.

Geotechnical Investigation

Findings of Geotechnical Investigations are based extensively on judgment and experience. Geotechnical reports are prepared to meet the specific needs of individual clients. This report was prepared expressly for the Client and expressly for the Clients purposes.

This report is based on a subsurface investigation, which was designed for project-specific factors. Unless further geotechnical advice is obtained this report cannot be applied to an adjacent site nor can it be used when the nature of any proposed development is changed.

Limitations of Site investigation

As a result of the limited number of sub-surface excavations or boreholes there is the possibility that variations may occur between test locations. The investigation undertaken is an estimate of the general profile of the subsurface conditions. The data derived from the investigation and laboratory testing are extrapolated across the site to form a geological model. This geological model infers the subsurface conditions and their likely behavior with regard to the proposed development.

The actual conditions at the site might differ from those inferred to exist.

No subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies.

Time Dependence

This report is based on conditions, which existed at the time of subsurface exploration. Construction operations at or adjacent to the site, and natural events such as floods, or groundwater fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report.

Macquarie Geotechnical should be kept appraised of any such events, and should be consulted for further geotechnical advice if any changes are noted.

Avoid Misinterpretation

A geotechnical engineer or engineering geologist should be retained to work with other design professionals explaining relevant geotechnical findings and in reviewing the adequacy of their plans and specifications relative to geotechnical issues.

No part of this report should be separated from the Final Report.

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5



Sub-surface Logs

Sub-surface logs are developed by geoscientific professionals based upon their interpretation of field logs and laboratory evaluation of field samples. These logs should not under any circumstances be redrawn for inclusion in any drawings.

Geotechnical Involvement During Construction

During construction, excavation frequently exposes subsurface conditions. Geotechnical consultants should be retained through the construction stage, to identify variations if they are exposed.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and no other party. Other parties should not rely upon the report or the accuracy or completeness of any recommendations and should make their own enquiries and obtain independent advice in relation to such matters

Macquarie Geotechnical assumes no responsibility and will not be liable to any other person or organisations for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisations arising from matters dealt with or conclusions expressed in the report.

Other limitations

Macquarie Geotechnical will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

Other Information

For further information reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by the Institution of Engineers Australia, 1987.



ENVIRONMENTAL IMPACT STATEMENT

Appendix 4

BOGAN SHIRE COUNCIL

Nyngan Waste and Resource Management Facility Report No. 800/02

Appendix A – General Notes





Explanatory Notes

Soil Description

In engineering terms soil includes every type of uncemented or partially cemented inorganic material found in the ground. In practice, if the material can be remoulded by hand in its field condition or in water it is described as a soil. The dominant soil constituent is given in capital letters, with secondary textures in lower case. The dominant feature is assessed from the Unified Soil Classification system and a soil symbol is used to define a soil layer as follows:

UNIFIED SOIL CLASSIFICATION

The appropriate symbols are selected on the result of visual examination, field tests and available laboratory tests, such as, sieve analysis, liquid limit and plasticity index.

USC Symbol	Description
GW	Well graded gravel
GP	Poorly graded gravel
GM	Silty gravel
GC	Clayey gravel
SW	Well graded sand
SP	Poorly graded sand
SM	Silty sand
SC	Clayey sand
ML	Silt of low plasticity
CL	Clay of low plasticity
OL	Organic soil of low plasticity
МН	Silt of high plasticity
CH	Clay of high plasticity
ОН	Organic soil of high plasticity
Pt	Peaty Soil

MOISTURE CONDITION

Dry	 Cohesive soils are friable or powdery
	Cohesionless soil grains are free-running

Moist – Soil feels cool, darkened in colour Cohesive soils can be moulded Cohesionless soil grains tend to adhere

Wet - Cohesive soils usually weakened Free water forms on hands when handling

For cohesive soils the following codes may also be used:

MC>PL	Moisture Content greater than the Plastic
	Limit.
MC~PL	Moisture Content near the Plastic Limit.

MC<PL Moisture Content less than the Plastic

PLASTICITY

The potential for soil to undergo change in volume with moisture change is assessed from its degree of plasticity. The classification of the degree of plasticity in terms of the Liquid Limit (LL) is as follows:

Description of Plasticity	LL (%)
Low	<35
Medium	35 to 50
High	>50

COHESIVE SOILS - CONSISTENCY

The consistency of a cohesive soil is defined by descriptive terminology such as very soft, soft, firm, stiff, very stiff and hard. These terms are assessed by the shear strength of the soil as observed visually, by the pocket penetrometer values and by resistance to deformation to hand moulding.

A Pocket Penetrometer may be used in the field or the laboratory to provide approximate assessment of unconfined compressive strength of cohesive soils. The values are recorded in kPa, as follows:

Strength	Sy m bo I	Pocket Penetrometer Reading (kPa)
Very	VS	< 25
Soft		
Soft	S	20 to 50
Firm	F	50 to 100
Stiff	St	100 to 200
Very	VSt	200 to 400
Stiff		

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Hard H > 400

COHESIONLESS SOILS - RELATIVE DENSITY

Relative density terms such as very loose, loose, medium, dense and very dense are used to describe silty and sandy material, and these are usually based on resistance to drilling penetration or the Standard Penetration Test (SPT) 'N' values. Other condition terms, such as friable, powdery or crumbly may also be used.

The Standard Penetration Test (SPT) is carried out in accordance with AS 1289, 6.3.1. For completed tests the number of blows required to drive the split spoon sampler 300 mm are recorded as the N value. For incomplete tests the number of blows and the penetration beyond the seating depth of 150 mm are recorded. If the 150 mm seating penetration is not achieved the number of blows to achieve the measured penetration is recorded. SPT correlations may be subject to corrections for overburden pressure and equipment type.

Term	Symbol	Density Index	N Value (blows/0.3 m)
Very Loose	VL	0 to 15	0 to 4
Loose	L	15 to 35	4 to 10
Medium Dense	MD	35 to 65	10 to 30
Dense	D	65 to 85	30 to 50
Very Dense	VD	>85	>50

Name	Subdivision	Size
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 μm to 2.36 mm
	medium	200 μm to 600 μm
	fine	75 μm to 200 μm

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Rock Description

The rock is described with strength and weathering symbols as shown below. Other features such as bedding and dip angle are given.

ROCK QUALITY

The fracture spacing is shown where applicable and the Rock Quality Designation (RQD) or Total Core Recovery (TCR) is given where:

RQD (%) = $\frac{\text{Sum of Axial lengths of core} > 100 \text{mm long}}{\text{total length considered}}$

TCR (%) = $\frac{\text{length of core recovered}}{\text{length of core run}}$

ROCK STRENGTH

Rock strength is described using AS1726 and ISRM - Commission on Standardisation of Laboratory and Field Tests, "Suggested method of determining the Uniaxial Compressive Strength of Rock materials and the Point Load Index", as follows:

Term	Symbol	Point Load Index	
		Is(50) (MPa)	
Extremely Low	EL	< 0.03	
Very Low	VL	0.03 to 0.1	
Low	L	0.1 to 0.3	
Medium	M	0.3 to 1	
High	Н	1 to 3	
Very High	VH	3 to 10	
Extremely High	EH	>10	

ROCK MATERIAL WEATHERING

 $Rock\ weathering\ is\ described\ using\ the\ following\ abbreviation\ and\ definitions\ used\ in\ AS1726:$

Abbreviation	Term
RS	Residual soil
XW	Extremely weathered
DW	Distinctly weathered
SW	Slightly weathered
FR	Fresh

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DEFECT SPACING/BEDDING THICKNESS

Measured at right angles to defects of same set or bedding.

Term	Defect Spacing	Bedding
Extremely closely spaced	<6 mm	Thinly Laminated
	6 to 20 mm	Laminated
Very closely spaced	20 to 60 mm	Very Thin
Closely spaced	0.06 to 0.2 m	Thin
Moderately widely spaced	0.2 to 0.6 m	Medium
Widely spaced	0.6 to 2 m	Thick
Very widely spaced	>2 m	Very Thick

DEFECT DESCRIPTION

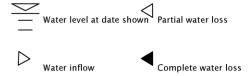
Type:	Description
В	Bedding
F	Fault
C	Cleavage
J	Joint
S	Shear Zone
D	Drill break
DI't'D	

${\bf Planarity/Roughness:}$

Class	Description
I	rough or irregular, stepped
II	smooth, stepped
III	slickensided, stepped
IV	rough or irregular, undulating
V	smooth, undulating
VI	slickensided, undulating
VII	rough or irregular, planar
VIII	smooth, planar
IX	slickensided, planar

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

WATER



Groundwater not observed: The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.

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Graphic Symbols for Soils and Rocks

Typical symbols for soils and rocks are as follows. Combinations of these symbols may be used to indicated mixed materials such as clayey sand.

Soil Syml	pols	Rock Sy	Rock Symbols		
Main com	ponents	Sedimen	Sedimentary Rocks		
	CLAY	:::::	SANDSTONE		
	SILT		SILTSTONE		
	SAND		CLAYSTONE, MUDSTONE		
	GRAVEL		SHALE		
00	BOULDERS / COBBLES		LAMINITE		
}	TOPSOIL		COAL		
* * **	PEAT		LIMESTONE		
Minor Co	mponents		CONGLOMERATE		
	Clayey	Igneous	Rocks		
	Silty	+++ ++ +++	GRANITE		
· · ·	Sandy	^^	BASALT		
0 q 0 q	Gravelly	 	UNDIFFERENTIATED IGNEOUS		
Other		Metamor	phic Rocks		
\bowtie	FILL	~~~	SLATE, PHYLLITE, SCHIST		
	BITUMEN		GNEISS		
Δ · Δ ·	CONCRETE	q q	QUARTZITE		

Groundwater not encountered: The borehole/test pit was dry soon after excavation, however groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.





Engineering Classification of Shales and Sandstones in the Sydney Region - A Summary Guide

The Sydney Rock Class classification system is based on rock strength, defect spacing and allowable seams as set out below. All three factors must be satisfied.

CLASSIFICATION FOR SANDSTONE

Class	Uniaxial Compressive Strength (MPa)	Defect Spacing (mm)	Allowable Seams (%)
1	>24	>600	<1.5
II	>12	>600	<3
III	>7	>200	<5
IV	>2	>60	<10
V	>1	N.A.	N.A.

CLASSIFICATION FOR SHALE

Class	Uniaxial Compressive Strength (MPa)	Defect Spacing (mm)	Allowable Seams (%)
1	>16	>600	<2
II	>7	>200	<4
Ш	>2	>60	<8
IV	>1	>20	<25
V	>1	N.A.	N.A.

 $M: \verb|\| 2011 \\ | 11-009-GHD-Intersection of the Orange \ distributor \& \ Telopea \ Way in north orange-Pl\&D\\ | Appendix \ A.doc1 \ February, \ 2011 \\ | 11-009-GHD-Intersection of the Orange \ distributor \& \ Telopea \ Way in north orange-Pl\&D\\ | Appendix \ A.doc1 \ February, \ 2011 \\ | 11-009-GHD-Intersection of the Orange \ distributor \& \ Telopea \ Way in north orange-Pl\&D\\ | Appendix \ A.doc1 \ February, \ 2011 \\ | 11-009-GHD-Intersection of the Orange \ distributor \& \ Telopea \ Way in north orange-Pl\&D\\ | Appendix \ A.doc1 \ February, \ 2011 \\ | 11-009-GHD-Intersection of the Orange \ distributor \& \ Telopea \ Way in north orange-Pl\&D\\ | Appendix \ A.doc1 \ February, \ 2011 \\ | 11-009-GHD-Intersection of the Orange \ distributor \& \ Telopea \ Way in north orange-Pl&D\\ | Appendix \ A.doc1 \ February, \ 2011 \\ | 11-009-GHD-Intersection of the Orange \ Advanced \ Appendix \ Advanced \ Appendix \ Advanced \ Appendix \ Advanced \ Appendix \$





UNIAXIAL COMPRESSIVE STRENGTH (UCS)

For expedience in field/construction situations the uniaxial (unconfined) compressive strength of the rock is often inferred, or assessed using the point load strength index (Iss_0) test (Iss_0) test (Iss_0) but the multiplier may range from about 10 to 30 depending on the rock type and characteristics. In the absence of UCS tests, the assigned Sydney Rock Class classification may therefore include rock strengths outside the nominated UCS range.

DEFECT SPACING

The terms relate to spacing of natural fractures in NMLC, NQ and HQ diamond drill cores and have the following definitions:

Defect Spacing (mm)	Terms Used to Describe Defect Spacing ¹
>2000	Very widely spaced
600 - 2000	Widely spaced
200 - 600	Moderately spaced
60 - 200	Closely spaced
20 - 60	Very closely spaced
<20	Extremely closely spaced

¹After ISO/CD14689 and ISRM.

ALLOWABLE SEAMS

Seams include clay, fragmented, highly weathered or similar zones, usually sub-parallel to the loaded surface. The limits suggested in the tables relate to a defined zone of influence. For pad footings, the zone of influence is defined as 1.5 times the least footing dimension. For socketed footings, the zone includes the length of the socket plus a further depth equal to the width of the footing. For tunnel or excavation assessment purposes the defects are assessed over a length of core of similar characteristics.

Source: Based on Pells et al (1978), as revised by Pells et al (1998).

Pells, P.J.N, Mostyn, G. and Walker, B.F. - Foundations on Sandstone and Shale in the Sydney Region. Australian Geomechanics Journal, No 33 Part 3, December 1998.

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ENVIRONMENTAL IMPACT STATEMENT

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Summary of Soil Logging Procedures

Coarse Material: grain size - colour - particle shape - secondary components - minor constituents - moisture condition - relative density - origin - additional observations. e w.r.t. plasticity - consistency - origin - additional observations

	Fine Material: plasticity - colour - secondary components - minor constituents - moisture									
	Guide to the Description, Identification and Classification of Soils									
	Major Divisions SYMBO			DL		Typical Nam	es			
> 2	00mm	BOU	LDERS							
60 to	200mm	COE	BLES							
	s E	VEL	50% action m	GW		Well-graded gr	avels, gravel-sand mixtures, little or	no fines.		
	ss le .076	5	than 50 irse frad 2.36mm	GP		Poorly graded	gravels and gravel-sand mixtures, litt	le or no fines, uniform gravels.		
¥	/ ma	Gravelly Soils	More than 50% of course fraction > 2.36mm	GM		Silty gravels, gr	ravel-sand-silt mixtures.			
SE GRAINED	More than 50% by dry mass less than 60mm is greater that 0.076mm	Gravelli Soils	of or w	GC		Clayey gravels	gravel-sand-clay mixtures			
Se	gree	SANDS	2% tion	SW		Well-graded sa	nds, gravelly sands, little or no fines			
SOARSE	m S	SP S	s than 50 urse fract 2.36mm	SP		Poorly graded sands and gravelly sands; little or no fines, uniform sands.				
8	fe th	Sandy	More than 50% of coarse fraction < 2.36mm	SM		Silty sands, san	Sity sands, sand-sit mixtures.			
	# ™	Sar	δρ.	sc		Clayey sands, sand-clay mixtures.				
	dry m is	Ī	×2	ML		Inorganic silts	and very fine sands, rock flour, silty	or clayey fine sands or clayey silts		
띨	by d Omm	Liquid Limit	> 20%	CL		Inorganic clays	of low to medium plasticity, gravell	y clays, sandy clays, silty clays.		
FINE GRAINED SOILS	More than 50% by dry mass less than 60mm is less than 0.076mm	3		OL		Organic silts ar	nd organic silty clays of low plasticity	y.		
SOIL.	han es th	Ĭ		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.				
<u>z</u>	More than lass less t less than	Liquid Limit	> 20%	CH		Inorganic clays of high plasticity, fat clays.				
_	≥ § −	3	^	ОН		Organic clays of medium to high plasticity, organic silts.				
HIGH	LYORG	SANIC	SOILS	Pt		Peat and other highly organic soils.				
	40	\neg	'A-I	.ine'			Grai	n sizes		
1	y 30	+	\vdash	- ~	_	\vdash	Gravel	Sand		
	8	0	1 1	~						

Coarse - 2.36 to 0.6mm Medium - 0.6 to 0.2mm Coarse - 63 to 20mm Medium - 20 to 6 mm Fine - 6 to 2.36mm Fine - 0.2 to 0.075mm

GEOLOGICAL ORIGIN:Fill - artificial soils / deposits
Alluvial - soils deposited by the action of water
Aeolian - soils deposited by the action of wind

Topsoil - soils supporting plant life containing significant organic content Residual - soils derived from insitu weathering of parent rock.

Colluvial - transported debris usually unsorted, loose and deposited

Field Identification of Fine Grained Soils - Silt or Clay?

Dry Strength - Allow the soil to they completely and then text his strength by breaking and crumbling between the fingers.
High dy strength - (lays, Very sight of strength - Silts.

Toughness Text - the soil is rolled by hand into a thread about 8mm in diameter. The thread is then folded and re-rolled repeatedly until it has dried suitcently to break into large. In this condition inorganic clays are fairly stiff and bough while inorganic silts produce a week and often soil thread which may be difficult to form and readily breaks and crumbles.

Distancy Text - As distilicion without the soil, held in the pailm of the hand, to make it so that not stidy. Shake hoticontably, stifking vigorously against the other hand several times. Dilatency is indicated by the appearance of a shiny film on the surface of the soil. If the soil is then squeezed or pressed with the fingers, the surface becomes dull as the soil stiffers and eventually crumbles. These reactions are pronounced only for predominantly sit size material. Plastic clays give no reaction.

	Descriptive Term	sfor Mater	ial Portions			
CC	DARSE GRAINED SOILS	FINE GRAINED SOILS				
% Fines	Term/Modifier	% Coarse	Term/Modifier			
< 5 Omit, or use "trace"		< 15	Omit, or use "trace"			
> 5, < 12	"with clay/silt" as applicable	> 15, < 30	"with sand/gravel" as applicable			
> 12	Prefix soil as "silty/clayey"	> 30	Prefix as "sandy/gravelly"			

	Moisture Condition					
for non-cohe	sive soils:					
Dry -	runs freely through fingers.					
Moist -	does not run freely but no free water visible on soil surface.					
Wet -	free water visible on soil surface.					
for cohesive :	soils:					
MC > PL	Moisture content estimated to be greater than the plastic limit.					
MC~ PL	Moisture content estimated to be approximately equal to the plastic limit.					
	The soil can be moulded					
MC < PL	Moisture content estimated to be less than the plastic limit. The soil is hard					
	and friable, or powdery.					

	Consistency - For Clays & Silts				
Description	UCS(kPa)	Field guide to consistency			
Very soft	< 25	Exudes between the fingers when squeezed in hand			
Soft	25 - 50	Can be moulded by light finger pressure			
Firm	50 - 100	Can be moulded by strong finger pressure			
Stiff	100 - 200	Cannot be moulded by fingers. Can be indented by thumb.			
Very stiff	200 - 400	Can be indented by thumb nail			
Hard	> 400	Can be indented with difficulty by thumb nail			
Friable	-	Crumbles or powders when scraped by thumbnail			

(D) D
lex (ID) Range %
< 15
5 - 35
85 - 65
65 - 85
> 85 1 February 2011



Summary of Rock Logging Procedures

Description order: constituents - rock name - grain size - colour - weathering - strength - minor constituents - additional observations.

- IIIIIIOI COIIS	minor constituents - moisture w.r.t. plasticity - consistency - origin - additional observations.											
Definition - Sedimentary Rock												
Conglomerate	more than 50% of the rock consists of gravel (> 2mm) sized fragments											
Sandstone	more than 50% of the rock consists of sand (0.06 to 2mm) sized grains											
au.												

Conglomerate	more than 50% of the rock consists of gravel (> 2mm) sized fragments
Sandstone	more than 50% of the rock consists of sand (0.06 to 2mm) sized grains
Sitstone	more than 50% of the rock consists of silt sized granular particles and the rock is not laminated
Claystone	more than 50% of the rock consists of clay or mica material and the rock is not laminated
Shale	more than 50% of the rock consists of clay or silt sized particles and the rock is laminated
Giac	into that 50 % of the fook contact of only of an alexa particles and the fook to familiaeco

	Weathering						
Residual	RS	Soil developed on extremely weathered rock; the mass structure and					
Soil		substance fabric are no longer evident; there is a change in volume					
		but the soil has not significantly transported.					
Extremely	EW	Rock is weathered to such an extent that it has 'soil' properties; ie. it either					
Weathered		disintegrates or can be remoulded, in water					
Distinctly	DW	Rock strength usually changed by weathering. The rock may be highly					
Weathered		discoloured, usually by iron-staining. Porosity may be increased by leaching,					
		or may be decreased due to deposition of weathering products in pores.					
Slightly	SW	Rock is slightly discoloured but shows little or no change					
Weathered		of strength from fresh rock.					
Fresh	FR	Rock shows no sign of decomposition or staining.					

ı		Stra	tification			
ı	thinly laminated	< 6mm	medium bedded	0.2 - 0.6m		
ı	laminated	6 - 20mm	thickly bedded	0.6 - 2m		
ı	very thinly bedded	20 - 60mm	very thickly bedded	> 2m		
ı	thinly bedded	60mm - 0.2m				

			Discontinuities		
order of de	escription: depth - typ	oe - orientation	- spacing - roughness / planarit	y - thickness	- coating
	Type	Class	Roughness/Planarity	Class	Roughness/Planarity
В	Bedding	1	rough or irregular, stepped	VI	slickensided, undulating
F	Fault	II .	smooth, stepped	VII	rough or irregular, planar
С	Cleavage	III	slickensided, stepped	VIII	smooth, planar
J	Joint	IV	rough or irregular, undulating	IX	slickensided, planar
S	Shear Zone	V	smooth, undulating		
D	Drill brook				

			Rock Strength
Term		IS (50)	Field Guide
Extremely EL.			Easily remoulded by hand to a material with soil properties.
Low			
		0.03	
Very low	VL		May be crumbled in the hand. Sandstone is "sugary" and friable
		0.1	
Low	L		A piece of core 150 mm long x 50 mm dia. may be broken by
			hand and easily scored with a knife. Sharp edges of core may
			be friable and break during handling.
		0.3	
Medium	М		A piece of core 150 mm long x 50 mm dia. can be broken by hand
			with considerable difficulty. Readily scored with knife.
		1	
High	Н		A piece of core 150 mm long x 50 mm dia. core cannot be broken
			by unaided hands, can be slightly scratched or scored with knife.
		3	
Very High	VH		A piece of core 150 mm long x 50 mm dia. May be broken readily
			with hand held hammer. Cannot be scratched with pen knife.
		10	
Extremely	BH	l	A piece of core 150 mm long x 50 mm dia. Is difficult to break with
High			hand held hammer. Rings when struck with a hammer.

	Degree of fracturing		
fragmented	The core is comprised primarily of fragments of length less than 20mm, and		
	mostly of width less than the core diameter		
highly Core lengths are generally less than 20mm - 40mm			
fractured	with occasional fragments.		
fractured	Core lengths are mainly 30mm - 100mm with occasional shorter		
	and longer lengths		
slightly	Core lengths are generally 300mm - 1000mm with occasional longer sections		
fractured	and shorter sections of 100mm 300mm.		
unbroken	The core does not contain any fracture.		

The fracture spacing is shown where applicable and the Pock Quality Designation is given by: PQD (%) = sum of unbroken core pieces 100 mm or longer

A.doc 1 total length considered 1 February, 2011

given by:

M:\2011\11-009-GHD-Intersection of the Orange distributor & Telopea Way in north orange-PI&D\Appendix A.doc

10



BOGAN SHIRE COUNCIL

ENVIRONMENTAL IMPACT STATEMENT

Appendix 4

Nyngan Waste and Resource Management Facility

Report No. 800/02

Appendix B

Site Plan & Test Pit Location

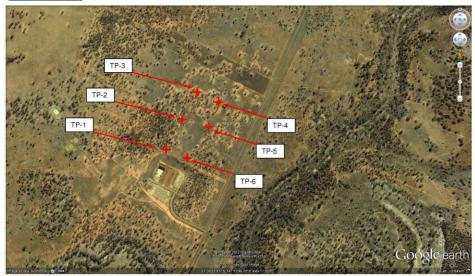




Geotechnical Engineers & Engineering Geologists NATA Accredited Construction Materials Testing Laboratory for Soils, Coal, Aggregates and Concrete Geotechnical & Environmental Drilling



Test Pit Locations

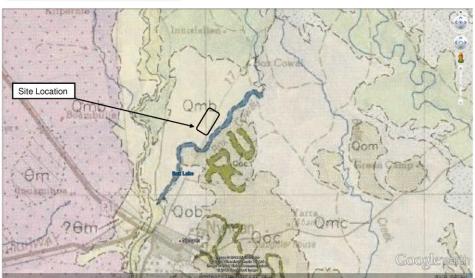




Geotechnical Engineers & Engineering Geologists NATA Accredited Construction Materials Testing Laboratory for Soils, Coal, Aggregates and Concrete Geotechnical & Environmental Drilling



Site Location with Geological Map Overlay



KEY:

Qmb: "Unconsolidated dark yellow brown clay, slightly silty with rare carbonate nodules and quartz sand. Common desiccation cracks. Laminated and contains rootlets"

Qob: "Unconsolidated pale grey to grey brown silt, clay and sand with rare carbonate nodules. Very poorly sorted. Commonly cracking."



BOGAN SHIRE COUNCIL

ENVIRONMENTAL IMPACT STATEMENT

Nyngan Waste and Resource Management Facility Report No. 800/02

Appendix 4

Appendix C - Test Pit Logs



_	MACQUARIE GEOŢECH CLIENT Bogan Shire Count PROJECT NUMBER 12-04					Macquarie Geotech 9 Bant Street Bathurst NSW 2795 Telephone: 63322011 Fax: 63344213		TEST	PIT NUMBE	R TP-01 PAGE 1 OF 1
							PROJECT NAME Propos		anagement Facility	
Н							_ PROJECT LOCATION N			
DA	ATE	STAR	TED .	6/2/1	2	COMPLETED _ 6/2/12	R.L. SURFACE		DATUM	
									BEARING	
									CHECKED BY JE	3
	TES			COTTAI						•
Method	Water	RL (E)	Depth (m)	Graphic Log	Classification Symbol	Material Descript	ion	Samples Tests Remarks	DCP (blows/100mm)	Additional Observations
			-		GL	Sandy CLAY with roots: red brown, medium to high firm, moist, moisture content ~ plastic limit (TOPSC	DIL) (ALLÜVIÄL).		0 5 10 15 2025	
			0 <u>.5</u>		CH	Sancty CLAY trace gravel : red brown, medium to his sand, fine subangular to subrounded gravel, stiff, d (ALLUVIAL).	gh plasticity clay, fine to coarse iry, moisture content < plastic limit			
			-					7		
			1.0			Borehole TP-01 terminated at 1.1m				
			- 1 <u>.5</u> -							
			2 <u>.0</u>							
			- 2 <u>.5</u>							
			3.0							



_			UA [EC		3	Macquarie Geotech 9 Bant Street Bathurst NSW 2795 Telephone: 63322011 Fax: 63344213		TEST	PIT NUMBI	ER TP-02 PAGE 1 OF	
CLI	IEN	Г _Во	gan S	hire C	Council		PROJECT NAME Proposed Waste Management Facility				
					2-047		PROJECT LOCATION _				
						COMPLETED <u>6/2/12</u>					
									BEARING		
EQUIPMENT Backhoe TEST PIT LOCA TEST PIT SIZE 450mm LOGGED BY											
TEST PIT SIZE _450mm NOTES							LOGGED BY KA		CHECKED BY _J	<u> </u>	
Method	Water	E)	Depth (m)	Graphic Log	Classification Symbol	Material Descripti	on	Samples Tests Remarks	DCP (blows/100mm)	Additional Observations	
					CL	CLAY with silt, sand and roots: brown, medium to his sand, very soft to soft, moist to wet, moisture conter	igh plasticity clay, fine to coarse it > plastic limit (ALLUVIAL).		0 5 10 15 2025		
			- 0. <u>5</u> 1. <u>0</u> 1. <u>5</u> 1		CH	Sandy CLAY with silf trace gravel: red brown, medicoarse sand, fine for medium subangular to subroun moisture content < plastic limit (ALLUVIAL). Borehole TP-02 terminated at 1.1m	um to high plasticity clay, fine to ded gravel, stiff to very stiff, dry,				

MACQUARIE GEOŢECH					1	Macquarie Geotech 9 Bant Street Bathurst NSW 2795 Telephone: 63322011 Fax: 63344213		TEST	PIT NUMBER	RTP-03	
CLI	ENT	_Bc	gan S	hire C	Council		PROJECT NAME Proposed Waste Management Facility				
PRC	IJЕ	CT N	UMBE	R _1	2-047		PROJECT LOCATION _N	lyngan			
DAT	ſΕŚ	STAR	TED	6/2/1	2	COMPLETED 6/2/12	R.L. SURFACE		DATUM		
			Bac				TEST PIT LOCATION				
TES	ST F	AL SE	ZE <u>4</u>	50mn	n		LOGGED BY KA		CHECKED BY JB		
NOT	ΓES										
Method	Water	RL (E)	Depth (m)	Graphic Log	Classification Symbol	Material Descri	iption	Samples Tests Remarks	DCP (blows/100mm)	Additional Observations	
			-		GL :	Sandy CLAY frace sift and roofs: red brown, med sand, firm, moist, moisture content ~ plastic limit	fium to high plasticity, fine to coarse (TOPSOIL) (ALLUVIAL).		0 5 10 15 2025		
			0 <u>.5</u>		CH	CLAY with sand and silf: red brown, medium to t dry to slightly moist, moisture content < plastic lin	high plasticity, fine to coarse sand, stiff, nit (ALLUMAL).				
	ļ		-					7			
+			1 <u>.0</u>			Borehole TP-03 ferminated at 1.1m					
			-								
			1 <u>.5</u>								
			2.0								
			-								
			- 2 <u>.5</u>								
			-								
			-	-							



	MACQUARIE GEOŢECH					Macquarie Geotech 9 Bant Street Bathurst NSW 2795 Telephone: 63322011		TEST	PIT NUMBE	R TP-04		
CLIE	NT	Bog	gan S	hire C	ouncil	Fax: 63344213	PROJECT NAME Proposed Waste Management Facility					
PROJ	IEC	T NL	IMBE	R _12	2-047		_ PROJECT LOCATION _1					
DATE	E ST	FART	ED	6/2/1	2	COMPLETED 6/2/12	R.L. SURFACE		DATUM			
EQUII	PME	ENT	Bac	khoe			_ TEST PIT LOCATION					
TEST	РΠ	r SIZ	E _4	50mm	1		LOGGED BY KA		CHECKED BY JB			
NOTE	s											
Method	ا المالا	EF (E)	Depth (m)	Graphic Log	Classification Symbol	Meterial Descript	tion	Samples Tests Remarks	DCP (blows/100mm)	Additional Observations		
			_		CL	Sandy CLAY with silft brown, medium to high plast slightly moist, moisture content < plastic limit (TOF	icity day, fine to coarse sand, firm, SOIL) (ALLUVIAL).		0 5 10 15 2025			
			0.5 - - 1.0 - 1.5		СН	Sity CLAY with sand trace gravel: red brown, med coarse sand, fine to medium subangular gravel, stillimit (ALLUVIAL). Borehole TP-04 terminated at 1.2m	ilum to high plasticity clay, fine to iff, dry, moisture content < plastic					

MACQUARIE GEOŢECH						Macquarie Geotech 9 Bant Street Bathurst NSW 2795 Telephone: 633222011 Fax: 63344213		TEST	PIT NUMBER	TP-05		
CL	.IEN	Г _Вс	gan S	hire C	Council		PROJECT NAME Proposed Waste Management Facility					
PR	OJE	CT N	UMBE	R _1	2-047		PROJECT LOCATION _1	Nyngan				
DA	ATE:	STAR	TED .	6/2/1	2	COMPLETED 6/2/12	R.L SURFACE		DATUM			
EC	JUIPI	MENT	Bac	khoe			TEST PIT LOCATION					
TE	ST	AL SI	ZE _4	50mn	n		LOGGED BY KA		CHECKED BY JB			
NC	TES					T		I				
Method	Water	RL (E)	Depth (m)	Graphic Log	Classification Symbol	Material Descr	iption	Samples Tests Remarks		Additional Observations		
			-		CL	Sandy CLAY with silt and roots: red brown, med coarse sand, firm, slightly moist, moisture conter (ALLUVIAL).	um to high plasticity clay, fine to t< plasfic limit (TOPSOIL)		10 5 10 15 2025			
			- 0 <u>.5</u>		CH	CLAY with sand and silf: red brown, medium to it stiff, dry, moisture content < plasfic limit (ALLUV	igh plasticity clay, fine to coarse sand, AL).					
			-									
			1 <u>.0</u>									
_			-			Borehole TP-05 terminated at 1.1m						
			1 <u>.5</u>									
			-									
			2 <u>.0</u>									
			-									
			2 <u>.5</u>	-								
			-	-								
			-	_								



GEOTECH 9 Bath					j	Macquarie Geotech 9 Bant Street Bathurst NSW 2795 Telephone: 63322011 Fax: 63344213		TEST	PIT NUMBE	R TP-0			
							PROJECT NAME Proposed Waste Management Facility						
PROJ	JECT	NUI	MBE	R _12	2-047		PROJECT LOCATION _N	yngan					
			RTED 6/2/12 COMPLETED 6/2/12										
									BEARING				
									ALE ALE DE 10				
NOTE		SIZI	E <u>_4</u>	<u>50mm</u>	1		LOGGED BY <u>KA</u>		CHECKED BY JB				
Method	Meterial Descri			Classification Symbol	Material Des	oription	Samples Tests Remarks	DCP (blaws/100mm)	Additional Observations				
			_		CL	Sandy CLAY with silt and roots: red brown, me coarse sand, firm, slightly moist, moisture cont (ALLUVIAL).	edium to high plasticity clay, fine to ent ~ plastic limit (TOPSOIL)		0 5 10 15 2025				
			- 0 <u>.5</u>		СН	Sandy CLAY with silt trace gravel: red brown, orarse sand, fine subangular to subrounded groontent < plassic limit (ALLUVIAL).	medium to high plasticity clay, fine to ravel, stiff, dry to slightly moist, moisture						
			1.0										
						Borehole TP-08 terminated at 1.1m							
			1 <u>.5</u>										
			-										
			2 <u>.0</u>										
			_										
			2 <u>.5</u> _										
			-										

ENVIRONMENTAL IMPACT STATEMENT

Annandiy 1

BOGAN SHIRE COUNCIL

Nyngan Waste and Resource Management Facility Report No. 800/02

Appendix D – Laboratory Test Results



			HEAD PERN Test Method	AS 1289 6.7.2					
					I		ı		
Client:		Bogan Shire Council			Job No:		12-047		
Client Address:		PO Box 221, Nyngan,	NSW, 2825		Sample N	o:	8010		
				Report No	o:	01-FHP			
Project Locatio	n:	Proposed Waste Mar	nagement Facility, Ny	Date Test	ed:	08/02/2012			
•		,			Source:		TP1 0.80-1.00m		
			SAMP	LE DETAI					
	T								
Sample Number:	8010			Sampling N	lethod:	Sampled in	accordance with A	51289.6.7.2	
Date Sampled: 06/02/2012				Material Ty	rpe:	Soil			
Date Tested:	08/02/201	2		Sample Loc	ation	TP1 0.80-1	00m		
Sampled By:	Macquarie	Geotechnical staff		Sample Des	scription	Silty/Sandy	CLAY		
Remarks:									
			RESULT	S OF TESTIN	<u>G</u>				
Compaction Met	hod		AS1289.5.1.1 - Stan	dard Compa	ction				
Maximum Dry De	ensity (t/m³)		1.73	Hydraulic Gradient				0.0	
Optimum Moistu	re Content (%	5)	18.2	Surcharge (kPa)			0.0		
Placement Moist	ure Content (%)	18.1	Head Pressure Applied (kPa)				0.0	
Moisture Ratio (%	%)		99.6	Water Type				Тар	
Placement Dry D	ensity (t/m³)		1.70	Percentage Material Retained/Sieve Size (mm)				0 % on 9.5 mm	
Density Ratio (%)	1		98.1	Sample Hei	ght and Dia	meter (mm)		103.81 by 100.33 mr	
	PER	MEABILITY	k ₍₂₀₎ =		3.48	E-09	(m/sec)		
			Perme	ability					
3.000E-08									
2.500E-08	-								
2.000E-08									
_									
1,sec)									
1.500E-08									
				\wedge					
7.500E-08					~	•			
1.500E-08 1.000E-08 5.000E-09						•			
1.500E-08 1.000E-08 5.000E-09 0.000E+00	15								
1.500E-08 1.000E-08 5.000E-09	This do	cument is issued in accor					Authorised Signatory:		
1.500E-08 1.000E-08 5.000E-09	This do NATA's Accredi 17025.	accreditation re- ted for compliance with This document shal	quirements. 1 ISO/IEC				Authorised Signatory:	him	
1.500E-08 1.000E-08 5.000E-09	This do NATA's Accredi 17025. reprodu	accreditation re- ted for compliance with This document shal ced, except in full.	quirements. 1 ISO/IEC			Ja Date:	Authorised Signatory: son Lewis 15/02/2012	April Page 1	



			Test Method	AS 1289 6.7.				
		I			1		I	
Client:		Bogan Shire Council			Job No:		12-047	
Client Address:		PO Box 221, Nyngan,	NSW, 2825		Sample N	lo:	8011	
				Report No	o:	02-FHP		
Project Location	:	Proposed Waste Mar	nagement Facility, N	Date Test	ed:	08/02/2012		
			9		Source:		TP2 0.80-1.00m	
			SAME	LE DETA	<u>ILS</u>			
Sample Number:	8011			Sampling N	Method:	Sampled in	accordance with A	S1289.6.7.2
Date Sampled:		2				Soil	decordance with A	51205.0.7.2
	06/02/201			Material T				
Date Tested:	08/02/201			Sample Lo		TP2 0.80-1		
Sampled By:	Macquarie	Geotechnical staff		Sample De	scription	Silty/Sandy	CLAY	
Remarks:			DECI	TS OF TESTIN	ıe			
Compaction Meth			AS1289.5.1.1 - Star					
Maximum Dry Der	nsity (t/m³)		1.72	Hydraulic Gradient				0.0
Optimum Moistur	e Content (%	6)	18.8	Surcharge (kPa)			0.0	
Placement Moistu	re Content (%)	18.8	Head Pressure Applied (kPa)			0.0	
Moisture Ratio (%			99.8	Water Type Percentage Material Retained/Sieve Size (mm)			e: ()	Тар
Placement Dry Der Density Ratio (%)	nsity (t/m ⁻)		1.68 98.0	Sample Height and Diameter (mm)			0 % on 9.5 mm 103.98 by 99.66 mm	
seriotey natio (78)	PER	MEABILITY	k ₍₂₀₎ =				(m/sec)	
			Perme					
4.000E-07							*	
3.500E-07							$-$ /\	
3,000E-07								
2.500E-07								
2.000E-07	•				_			
1.500E-07						\vee		
1.000E-07			\					
5.000E-08								
0.000E+00								
Remarks/Comments		and the feet of the	-1					
NATA	NATA's Accredi 17025.	ted for compliance with	quirements. h ISO/IEC			1-	Authorised Signatory:	Jim
~						Ja	son Lewis	$\overline{}$
NATA Accredited La	boratory Nun	nber: 14874				Date:	15/02/2012 Macquarie Geotec	Page 1



		IALLING	HEAD PERN Test Method					
Client:	В	ogan Shire Council			Job No:		12-047	
Client Address:	P	O Box 221, Nyngan,	NSW, 2825		Sample N	o:	8012	
				Report No	o:	03-FHP		
Project Location	n: P	roposed Waste Mar	nagement Facility, Nyngan		Date Test	ed:	08/02/2012	
					Source:		TP3 0.80-1.00m	
	·		SAMPI	LE DETAI	<u>LS</u>			
Sample Number:	8012			Sampling N	Method:	Sampled in	accordance with A	51289 6 7 2
Sample Number: 8012							decordance with A	51265.0.7.2
Date Sampled:	06/02/2012			Material Ty		Soil		
Date Tested:	08/02/2012			Sample Loc		TP3 0.80-1		
Sampled By:	Macquarie Ge	eotechnical staff		Sample De	scription	Silty/Sandy	CLAY	
Remarks:			BEC. " T	e oe tretin	6			
	- 1			S OF TESTIN				
Compaction Metho			AS1289.5.1.1 - Stand					
Maximum Dry Der	nsity (t/m³)		1.74	Hydraulic Gradient				0.0
Optimum Moisture	e Content (%)		18.1	Surcharge (kPa)			0.0	
Placement Moistu	ire Content (%)		17.9	Head Pressure Applied (kPa)			0.0	
Moisture Ratio (%)	_		99.1	Water Type Percentage Material Retained/Sieve Size (mm)				Тар
Placement Dry Der Density Ratio (%)	Placement Dry Density (t/m³)				ght and Dia			0 % on 9.5 mm 103.7 by 98.87 mm
Seriotty Natio (70)	DEDA	AE A DULITY	98.1					
	PERIV	1EABILITY	k ₍₂₀₎ =		3.90	E-09	(m/sec)	
			Permea	.hilit.				
				ability				
2.000E-08				авшту				
1.800E-08	1			ability				
				эршц				
1.800E-08 1.600E-08		\		ability				
1.800E-08 1.600E-08 1.400E-08 1.200E-08 1.000E-08				ability				
1.800E-08 1.600E-08 1.400E-08				аошту				
1.800E-08 1.600E-08 1.400E-08 1.200E-08 1.000E-08				ability				
1.600E-08 1.600E-08 1.400E-08 1.200E-08 1.000E-08 8.000E-09				ability	^_			
1.800E-08 1.600E-08 1.400E-08 1.400E-08 1.200E-08 1.000E-09 6.000E-09 4.000E-09 2.000E-09				ability	^	•		
1.800E-08 1.800E-08 1.400E-08 1.200E-08 8 1.000E-09 6.000E-09 4.000E-09				ability	^	•		
1.800E-08 1.800E-08 1.400E-08 1.200E-08 1.000E-08 1.000E-09 6.000E-09 4.000E-09 2.000E-09				ability	^_	•		
1.800E-08 1.600E-08 1.400E-08 1.200E-08 1.000E-08 6.000E-09 2.000E-09 0.000E+00	This docu NATA's Accredited 17025.	for compliance with This document shall	rdance with quirements.	ability		•	Authorised Signatory:	Anim
1.800E-08 1.600E-08 1.400E-08 1.200E-08 1.1000E-08 1.000E-09 1.000E-09 1.000E-09 1.000E-09 1.000E-09 1.000E-09 1.000E-09 1.000E-09	This documents of the NATA's Accredited 17025.	accreditation red for compliance with This document shall t, except in full.	rdance with quirements.	ability			son Lewis	Anin
1.800E-08 1.600E-08 1.400E-08 1.200E-08 1.1000E-08 1.000E-09 1.000E-09 1.000E-09 1.000E-09 1.000E-09 1.000E-09 1.000E-09 1.000E-09 1.000E-09	This documents of the NATA's Accredited 17025.	accreditation red for compliance with This document shall t, except in full.	rdance with quirements.	ability	^	Ja Date:		Page 1



Illent Address: PO Box 221, Nyngan, NSW, 2825 Sample No: 04-FHP						Test Method					
PO Box 221, Nyngan, NSW, 2825 Sample No: 8013 Report No: 04-FHP							1				
Report No: 04-FHP Project Location: Proposed Waste Management Facility, Nyngan SAMPLE DETAILS Sample Number: 8013 Sampling Method: Sampled in accordance with A\$1289.6.7.2 Material Type: Soil Os/02/2012 Sampled (06/02/2012 Sampled Location TP4 0.80-1.00m Sampled By: Macquarie Geotechnical staff RESULTS OF TESTING Compaction Method A\$1289.5.1.1 - Standard Compaction Madimum Dry Density (f/m²) 1.71 Hydraulic Gradient Sprimum Moisture Content (%) 18.6 Surcharge (R²a) Placement Moisture Content (%) 18.5 Head Pressure Applied (R²a) Moisture Ratio (%) 99.5 Water Type Macquarie Geotechnical Staff Permeability PERMEABILITY K ₍₂₀₎ = 7.44E-11 (m/sec) Permeability Permeability Authorized Signatory: Authorized Sig		12-047	12-04	Job No:			Bogan Shire Council		lient:		
Project Location: Proposed Waste Management Facility, Nyngan Saurce: TP4 0.80-1.00m SAMPLE DETAILS Sample Number: Sample Number: Sold: Macquarie Geotechnical staff: Sample Description Silty/Sandy CLAY Remarks: RESULTS OF TESTING Compaction Method A31289.5.1.1 - Standard Compaction Maximum Dry Density (t/m²) 1.71		8013	8013	Sample No		, NSW, 2825	PO Box 221, Nyngan,		lient Address:		
Sample Number: 8013 Sampling Method: Sampled in accordance with AS1289.6.7.2 Date Sampled: 06/02/2012 Material Type: Soil Date Tested: 08/02/2012 Sample Location TP4 0.80-1.00m Sampled By: Macquarie Geotechnical staff Remarks: RESULTS OF TESTING Compaction Method AS1289.5.1.1 - Standard Compaction Maximum Dry Density (Vm³) 1.71 Hydraulic Gradient Optimum Moisture Content (%) 1.8.6 Surcharge (kPa) Placement Moisture Content (%) 99.5 Water Type Placement Dry Density (Vm³) 1.68 Percentage Material Retained/Sieve Size (mm) 0 % of Density Ratio (%) 98.1 Sample Height and Diameter (mm) 103.5 to Permeability PERMEABILITY K ₍₂₀₎ = 7.44E-11 (m/sec)		04-FHP	04-FI	Report No							
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Client:		Bogan Shire Council			Job No:		12-047	
Client Address:		PO Box 221, Nyngan,	NSW, 2825		Sample N	lo:	8014	
				Report N	0:	05-FHP		
Project Location	n:	Proposed Waste Mar	nagement Facility, I	Date Test	ed:	08/02/2012		
				Source:		TP5 0.80-1.00m		
			SAM	PLE DETA	<u>LS</u>			
Sample Number:	8014			Sampling N	Aethod:	Sampled in	accordance with A	S1289 6 7 2
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Date Sampled:	06/02/2012	2		Material T	ype:	Soil		
Date Tested:	08/02/2012	2		Sample Lo	cation	TP5 0.80-1	.00m	
Sampled By:	Macquarie	Geotechnical staff		Sample De	scription	Silty/Sandy	CLAY	
Remarks:								
			RESU	ILTS OF TESTIN	<u>iG</u>			
Compaction Meth	od		AS1289.5.1.1 - Sta	andard Compa	action			
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Optimum Moistur	e Content (%	5)	15.2	Surcharge	Surcharge (kPa)			0.0
Placement Moistu	re Content (%)	15.2	Head Press	Head Pressure Applied (kPa)			0.0
Moisture Ratio (%	.)		100.0	Water Typ	e	Тар		
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Client: Bogan Shire Council		Bogan Shire Council			Job No:		12-047	
Client Address: PO Box 221, Nyngan		NSW, 2825		Sample N	o:	8015		
		Į,		Report No	o:	06-FHP		
Project Location: Proposed Waste Ma		Proposed Waste Mar	nagement Facility, Nyngan [Date Test	ed:	08/02/2012	
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Date Tested:	08/02/2012			Sample Loc		TP6 0.80-1		
Sampled By:	Macquarie	Geotechnical staff		Sample De	scription	Silty/Sandy	CLAY	
Remarks:								
				S OF TESTIN				
Compaction Meth	od		AS1289.5.1.1 - Stan	dard Compa	ection			
Maximum Dry Der	nsity (t/m³)		1.72	Hydraulic (Gradient			0.0
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Placement Moistu	re Content (%)	18.1	Head Pressure Applied (kPa)		0.0		
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BOGAN SHIRE COUNCIL

ENVIRONMENTAL IMPACT STATEMENT

Nyngan Waste and Resource Management Facility Report No. 800/02

Appendix 4

Appendix E – Test Pit Photographs







Test Pit TP-1 : GL to 1.10m





Test Pit TP-2 : GL to 1.10m





Test Pit TP-3: GL to 1.10m





Test Pit TP-4 : GL to 1.20m





Test Pit TP-5 : GL to 1.10m





Test Pit TP-6: GL to 1.10m





Geotechnical Engineers & Engineering Geologists
NATA Accredited Laboratories for Asphalt, Aggregate, Coal,
Concrete, Environmental, Soil & Rock
Geotechnical & Environmental Drilling

Geotechnical Investigation for Proposed Waste Management Facility, Nyngan

Bogan Shire Council

10th December 2012

Ref: 12/047



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5	Site Soils Error! Bookmark not define	
6	RECOMMENDATIONS	. 3
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APPENDICES

Appendix A – General Notes Appendix B – Site & Test Pit Location Plans Appendix C – Test Pit Logs & Photographs Appendix D – Laboratory Results

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1 INTRODUCTION

At the request of Christy Hill from R.W. Corkery on behalf of Bogan Shire Council, Macquarie Geotechnical has carried out a Geotechnical investigation for permeability assessment of stabilised material at the proposed waste management facility, Nyngan.

The objectives of this investigation were to determine the sub-surface conditions and provide stabilization options to achieve the targeted permeability.

2 METHOD OF INVESTIGATION

Fieldwork was undertaken on 23rd November 2012 by an Engineering Geologist from our Bathurst office.

The fieldwork was undertaken in accordance with AS1726 - "Geotechnical Site Investigations" and our proposal dated 14th November 2012.

The fieldwork comprised six test pits up to 1.2m depth located as close as possible to the original test pits undertaken on 6th February 2012. For exact offsets of the test pits, refer to test pit logs in Appendix B.

The test pits were excavated using a backhoe fitted with a 450mm toothed bucket. The test pits were identified as TP7 to TP12 inclusive. The test pit locations are shown in Appendix B and the test pit logs are located in Appendix C.

The soil samples were returned to Macquarie Geotechnical NATA accredited laboratory in Bathurst for further assessment and testing.

Laboratory testing was carried out on selected samples and included the following:

- Three (3) Falling Head Permeability tests stabilized with 2% Hydrated Lime for soil permeability characteristics.
- Three (3) Falling Head Permeability tests stabilized with 4% Hydrated Lime for soil permeability characteristics.
- Three (3) Falling Head Permeability tests stabilized with 1% Bentonite for soil permeability characteristics.
- Three (3) Falling Head Permeability tests stabilized with 2% Bentonite for soil permeability characteristics.

Subsequently, the results of the field investigation and laboratory testing were assessed and this report prepared.



2.1 Testing Methods

Falling Head Permeability Testing:

Falling Head Permeability testing was carried out as per AS1289 6.7.2.

Moisture Contents:

The moisture contents of the samples were determined in accordance with AS1289 2.1.1.

Maximum Dry Density:

The maximum dry density of the samples was determined in accordance with AS1289 5.1.1.

3 SITE DESCRIPTION

The site is located off the Nyngan – Mundaroo Road, behind the existing Nyngan Waste Facility, approximately 5km North of Nyngan.

At the time of the investigation the test pits were located in relatively flat lying scrubland with an elevation of 170m.

The site plan and test pit locations are attached within Appendix B.

3.1 Regional Geology

Reference to the Nyngan Geological map (1 250:000) sheet SH/55-15 and indicates that the geology underlying the site consists of the following:

"Unconsolidated dark yellow brown clay, slightly silty with rare carbonate nodules and quartz sand. Common desiccation cracks. Laminated and contains rootlets."

4 RESULTS OF INVESTIGATION

4.1 Sub-surface conditions

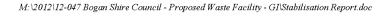
The existing ground conditions have been summarised as follows:

Table 1: Subsurface Conditions TP-7 to TP-12

Depth (m)	Log	Descriptions
0.0 - 0.60		Sandy CLAY with roots: red brown, medium to high plasticity clay, fine to coarse sand, firm, moist, moisture content ~ plastic limit (TOPSOIL) (ALLUVIAL)
0.60 – 1.20		Sandy CLAY trace gravel: red brown, medium to high plasticity clay, fine to coarse sand, fine subangular to subrounded gravel, stiff, dry, moisture content < plastic limit (ALLUVIAL).

Note: Please refer to logs for detailed descriptions.

Groundwater was not encountered in the test pits.



4.2 Site Soils

The investigation indicates that the site comprised of alluvial clay to a depth of 1.20m, the investigation undertaken on the 6^{th} February indicated site soils with a permeability between 9×10^{-8} to 2×10^{-11} .

Groundwater was not encountered in any of the test pits.

Based on our investigation, the previous laboratory test results and our experience with similar soils, the samples were stabilised with 2 & 4% Hydrated Lime and 1 & 2% Bentonite.

4.3 Laboratory Test Results

Laboratory testing in this area is summarised as follows;

Table 2: Results of Falling Head Permeability

Test Pit Number	Depth (m)	Permeability from previous investigation	Permeability (m/sec) (2% Hydrated Lime)	Permeability (m/sec) (4% Hydrated Lime)	Permeability (m/sec) (1% Bentonite)	Permeability (m/sec) (2% Bentonite)
TP-7	0.8 – 1.0	(TP-1) 3.48 x 10 ⁻⁹	-	1.08 x 10 ⁻⁹	-	2.34 x 10 ⁻¹⁰
TP-8	0.8 – 1.0	(TP-2) 9.17 x 10 ⁻⁸	2.32 x 10 ⁻⁸	-	8.17 x 10 ⁻¹¹	-
TP-9	0.8 – 1.0	(TP-3) 3.90 x 10 ⁻⁹	-	7.31 x 10 ⁻¹⁰	-	4.87 x 10 ⁻¹⁰
TP-10	0.8 – 1.0	(TP-4) 7.44 x 10 ⁻¹¹	-	4.28 x 10 ⁻⁹	-	4.42 x 10 ⁻¹⁰
TP-11	0.8 – 1.0	(TP-5) 7.13 x 10 ⁻⁹	5.46 x 10 ⁻¹⁰	-	1.99 x 10 ⁻¹⁰	-
TP-12	0.8 – 1.0	(TP-6) 2.05 x 10 ⁻¹¹	9.26 x 10 ⁻¹⁰	-	8.07x 10 ⁻¹¹	-

5 RECOMMENDATIONS

5.1 Stabilisation Results

The laboratory results indicated that the majority of the soil samples showed a decrease in permeability as part of the stabilisation with Hydrated Lime and Bentonite.

Variations in the permeability between the original investigation and the present investigation are down to the samples being taken from slightly different locations (Which were as close as practicable to the previous locations) and due to variation in the sand content of the material.

Based on the stabilisation results hydrated lime did not achieve the target permeability on all the samples, there could be the option to stabilise the material at a higher blend than the trials, however this wouldn't be recommended due to variations in the clay mineralogy which may not respond as well to the hydrated lime and also the potential of making the soil brittle and prone to cracking.

The bentonite trials for both 1% & 2% all met the target permeability and based on the trial blends undertaken we would recommend that the insitu and stockpiled material is stabilised with 2% bentonite.



3

5.2 Construction

It is understood that the proposed lining thickness for the cells is to be approximately 900mm, the insitu material that is proposed to be used for the liner should be stockpiled within a relatively clean area of hardstanding.

It is recommended that a suitably qualified Geotechnical Engineer/Engineering Geologist is on site to verify the material on removal or if any significant difference in the material is noted.

The subgrade should be stripped of all soft, organic or moisture affected materials and the material at the base of the cell walls should be ripped to a depth of 300mm and have a blend of 2% Bentonite mixed with the material prior to compaction, the compacted subgrade is to have a minimum dry density ratio of 98% relative to standard compaction at a moisture ratio of 80-110% of the optimum moisture content.

It is recommended that the bentonite is blended with the stockpiled material prior to placement in 200mm compacted thick layers, however if this is not possible then the material can be stabilised once placed in 300mm layers.

The filled material is to be rolled and compacted to a minimum dry density ratio of 98% relative to standard compaction at a moisture ratio of 80-110% of the optimum moisture content.

For compaction testing and proof rolling it is recommended that Level 1 Inspection and Testing is undertaken as specified in AS3798-2007, testing frequencies will be based on Table 8.1.

6 CONCLUSION

The findings of our report were based on our fieldwork, in-situ testing, laboratory testing, technical assessment and local knowledge for this site. We trust the foregoing is sufficient for your present purposes, and if you have any questions please contact either of the undersigned.

Yours sincerely

John Boyle Senior Engineering Geologist BSc (Hons) Affil MIE Aust Reviewed by

Jason P Lewis
Principal Geotechnical Engineer
B.E. (Civil) MIE Aust CP Eng

References: Australian Standard 1726 – 2007 Geotechnical Site Investigations

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LIMITATIONS OF GEOTECHNICAL SITE INVESTIGATION

Scope of Services

This report has been prepared for the Client in accordance with the Services Engagement Form (SEF), between the Client and Macquarie Geotechnical.

Reliance on Data

Macquarie Geotechnical has relied upon data and other information provided by the Client and other individuals. Macquarie Geotechnical has not verified the accuracy or completeness of the data, except as otherwise stated in the report. Recommendations in the report are based on the data

Macquarie Geotechnical will not be liable in relation to incorrect recommendations should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed.

Geotechnical Investigation

Findings of Geotechnical Investigations are based extensively on judgment and experience. Geotechnical reports are prepared to meet the specific needs of individual clients. This report was prepared expressly for the Client and expressly for the Client purposes.

This report is based on a subsurface investigation, which was designed for project-specific factors. Unless further geotechnical advice is obtained this report cannot be applied to an adjacent site nor can it be used when the nature of any proposed development is changed.

Limitations of Site investigation

As a result of the limited number of sub-surface excavations or boreholes there is the possibility that variations may occur between test locations. The investigation undertaken is an estimate of the general profile of the subsurface conditions. The data derived from the investigation and laboratory testing are extrapolated across the site to form a geological model. This geological model infers the subsurface conditions and their likely behavior with regard to the proposed development.

The actual conditions at the site might differ from those inferred to exist.

No subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies.

Time Dependence

This report is based on conditions, which existed at the time of subsurface exploration. Construction operations at or adjacent to the site, and natural events such as floods, or groundwater fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report.

Macquarie Geotechnical should be kept appraised of any such events, and should be consulted for further geotechnical advice if any changes are noted.

Avoid Misinterpretation

A geotechnical engineer or engineering geologist should be retained to work with other design professionals explaining relevant geotechnical findings and in reviewing the adequacy of their plans and specifications relative to geotechnical issues.

No part of this report should be separated from the Final Report.

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Sub-surface Logs

Sub-surface logs are developed by geoscientific professionals based upon their interpretation of field logs and laboratory evaluation of field samples. These logs should not under any circumstances be redrawn for inclusion in any drawings.

Geotechnical Involvement During Construction

During construction, excavation frequently exposes subsurface conditions. Geotechnical consultants should be retained through the construction stage, to identify variations if they are exposed.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and no other party. Other parties should not rely upon the report or the accuracy or completeness of any recommendations and should make their own enquiries and obtain independent advice in relation to such matters

Macquarie Geotechnical assumes no responsibility and will not be liable to any other person or organisations for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisations arising from matters dealt with or conclusions expressed in the report.

Other limitations

Macquarie Geotechnical will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report

Other Information

For further information reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by the Institution of Engineers Australia, 1987.



6

ENVIRONMENTAL IMPACT STATEMENT

Appendix 4

BOGAN SHIRE COUNCIL

Nyngan Waste and Resource Management Facility Report No. 800/02

Appendix A – General Notes





Explanatory Notes

Soil Description

In engineering terms soil includes every type of uncemented or partially cemented inorganic material found in the ground. In practice, if the material can be remoulded by hand in its field condition or in water it is described as a soil. The dominant soil constituent is given in capital letters, with secondary textures in lower case. The dominant feature is assessed from the Unified Soil Classification system and a soil symbol is used to define a soil layer as follows:

UNIFIED SOIL CLASSIFICATION

The appropriate symbols are selected on the result of visual examination, field tests and available laboratory tests, such as, sieve analysis, liquid limit and plasticity index.

USC Symbol	Description
GW	Well graded gravel
GP	Poorly graded gravel
GM	Silty gravel
GC	Clayey gravel
SW	Well graded sand
SP	Poorly graded sand
SM	Silty sand
SC	Clayey sand
ML	Silt of low plasticity
CL	Clay of low plasticity
OL	Organic soil of low plasticity
МН	Silt of high plasticity
CH	Clay of high plasticity
ОН	Organic soil of high plasticity
Pt	Peaty Soil

MOISTURE CONDITION

Dry	 Cohesive soils are friable or powdery
	Cohesionless soil grains are free-running

Moist - Soil feels cool, darkened in colour

Cohesive soils can be moulded

Cohesionless soil grains tend to adhere

Wet - Cohesive soils usually weakened

Free water forms on hands when
handling

For cohesive soils the following codes may also be used:

MC>PL	Moisture Content greater than the Plastic	С
	Limit.	
MC. DI	Maistura Contant near the Blastic Limit	

MC~PL Moisture Content near the Plastic Limit.

MC<PL Moisture Content less than the Plastic

PLASTICITY

The potential for soil to undergo change in volume with moisture change is assessed from its degree of plasticity. The classification of the degree of plasticity in terms of the Liquid Limit (LL) is as follows:

Description of Plasticity	LL (%)
Low	<35
Medium	35 to 50
High	>50

COHESIVE SOILS - CONSISTENCY

The consistency of a cohesive soil is defined by descriptive terminology such as very soft, soft, firm, stiff, very stiff and hard. These terms are assessed by the shear strength of the soil as observed visually, by the pocket penetrometer values and by resistance to deformation to hand moulding.

A Pocket Penetrometer may be used in the field or the laboratory to provide approximate assessment of unconfined compressive strength of cohesive soils. The values are recorded in kPa, as follows:

Strength	Symbo I	Pocket Penetrometer Reading (kPa)
Very	VS	< 25
Soft		
Soft	S	20 to 50
Firm	F	50 to 100
Stiff	St	100 to 200
Very	VSt	200 to 400
Stiff		

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Appendix 4



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COHESIONLESS SOILS - RELATIVE DENSITY

Relative density terms such as very loose, loose, medium, dense and very dense are used to describe silty and sandy material, and these are usually based on resistance to drilling penetration or the Standard Penetration Test (SPT) 'N' values. Other condition terms, such as friable, powdery or crumbly may also be used.

The Standard Penetration Test (SPT) is carried out in accordance with AS 1289, 6.3.1. For completed tests the number of blows required to drive the split spoon sampler 300 mm are recorded as the N value. For incomplete tests the number of blows and the penetration beyond the seating depth of 150 mm are recorded. If the 150 mm seating penetration is not achieved the number of blows to achieve the measured penetration is recorded. SPT correlations may be subject to corrections for overburden pressure and equipment type.

Term	Symbol	Density Index	N Value (blows/0.3 m)
Very Loose	VL	0 to 15	0 to 4
Loose	L	15 to 35	4 to 10
Medium Dense	MD	35 to 65	10 to 30
Dense	D	65 to 85	30 to 50
Very Dense	VD	>85	>50

Name	Subdivision	Size
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 μm to 2.36 mm
	medium	200 μm to 600 μm
	fine	75 μm to 200 μm

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Rock Description

The rock is described with strength and weathering symbols as shown below. Other features such as bedding and dip angle are given.

ROCK QUALITY

The fracture spacing is shown where applicable and the Rock Quality Designation (RQD) or Total Core Recovery (TCR) is given where:

RQD (%) = $\frac{\text{Sum of Axial lengths of core} > 100 \text{mm long}}{\text{total length considered}}$

TCR (%) = $\frac{\text{length of core recovered}}{\text{length of core run}}$

ROCK STRENGTH

Rock strength is described using AS1726 and ISRM - Commission on Standardisation of Laboratory and Field Tests, "Suggested method of determining the Uniaxial Compressive Strength of Rock materials and the Point Load Index", as follows:

Term	Symbol	Point Load Index
		Is(50) (MPa)
Extremely Low	EL	< 0.03
Very Low	VL	0.03 to 0.1
Low	L	0.1 to 0.3
Medium	M	0.3 to 1
High	Н	1 to 3
Very High	VH	3 to 10
Extremely High	EH	>10

ROCK MATERIAL WEATHERING

 $Rock\ weathering\ is\ described\ using\ the\ following\ abbreviation\ and\ definitions\ used\ in\ AS1726:$

Abbreviation	Term
RS	Residual soil
XW	Extremely weathered
DW	Distinctly weathered
SW	Slightly weathered
FR	Fresh

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DEFECT SPACING/BEDDING THICKNESS

Measured at right angles to defects of same set or bedding.

Term	Defect Spacing	Bedding
Extremely closely spaced	<6 mm	Thinly Laminated
	6 to 20 mm	Laminated
Very closely spaced	20 to 60 mm	Very Thin
Closely spaced	0.06 to 0.2 m	Thin
Moderately widely spaced	0.2 to 0.6 m	Medium
Widely spaced	0.6 to 2 m	Thick
Very widely spaced	>2 m	Very Thick

DEFECT DESCRIPTION

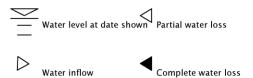
Type:	Description
В	Bedding
F	Fault
C	Cleavage
J	Joint
S	Shear Zone
D	Drill break
DI't'D	

${\bf Planarity/Roughness:}$

Class	Description
I	rough or irregular, stepped
II	smooth, stepped
III	slickensided, stepped
IV	rough or irregular, undulating
V	smooth, undulating
VI	slickensided, undulating
VII	rough or irregular, planar
VIII	smooth, planar
IX	slickensided, planar

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

WATER



Groundwater not observed: The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.

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Graphic Symbols for Soils and Rocks

Typical symbols for soils and rocks are as follows. Combinations of these symbols may be used to indicated mixed materials such as clayey sand.

Soil Syml	pols	Rock Sy	Rock Symbols		
Main com	ponents	Sedimen	Sedimentary Rocks		
	CLAY	:::::	SANDSTONE		
	SILT		SILTSTONE		
	SAND		CLAYSTONE, MUDSTONE		
000	GRAVEL		SHALE		
00	BOULDERS / COBBLES		LAMINITE		
} }}	TOPSOIL		COAL		
* * * *	PEAT		LIMESTONE		
Minor Co	mponents		CONGLOMERATE		
	Clayey	Igneous	Rocks		
	Silty	+++ ++ +++	GRANITE		
	Sandy	^^	BASALT		
0 ° ° ° ° ° ° ° ° ° ° ° ° ° ° ° ° ° ° °	Gravelly	 	UNDIFFERENTIATED IGNEOUS		
Other		Metamor	phic Rocks		
	FILL	~~~	SLATE, PHYLLITE, SCHIST		
	BITUMEN		GNEISS		
ν Α. Υ . Υ .	CONCRETE	q q	QUARTZITE		

Groundwater not encountered: The borehole/test pit was dry soon after excavation, however groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.





Engineering Classification of Shales and Sandstones in the Sydney Region - A Summary Guide

The Sydney Rock Class classification system is based on rock strength, defect spacing and allowable seams as set out below. All three factors must be satisfied.

CLASSIFICATION FOR SANDSTONE

Class	Uniaxial Compressive Strength (MPa)	Defect Spacing (mm)	Allowable Seams (%)	
I	>24	>600	<1.5	
II	>12	>600	<3	
III	>7	>200	< 5	
IV	>2	>60	<10	
V	>1	N.A.	N.A.	

CLASSIFICATION FOR SHALE

Class	Uniaxial Compressive Strength (MPa)	Defect Spacing (mm)	Allowable Seams (%)
1	>16	>600	<2
II	>7	>200	<4
III	>2	>60	<8
IV	>1	>20	<25
V	>1	N.A.	N.A.

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UNIAXIAL COMPRESSIVE STRENGTH (UCS)

For expedience in field/construction situations the uniaxial (unconfined) compressive strength of the rock is often inferred, or assessed using the point load strength index (Iss_0) test (Iss_0) test (Iss_0) but the multiplier may range from about 10 to 30 depending on the rock type and characteristics. In the absence of UCS tests, the assigned Sydney Rock Class classification may therefore include rock strengths outside the nominated UCS range.

DEFECT SPACING

The terms relate to spacing of natural fractures in NMLC, NQ and HQ diamond drill cores and have the following definitions:

Defect Spacing (mm)	Terms Used to Describe Defect Spacing ¹
>2000	Very widely spaced
600 - 2000	Widely spaced
200 - 600	Moderately spaced
60 - 200	Closely spaced
20 - 60	Very closely spaced
<20	Extremely closely spaced

¹After ISO/CD14689 and ISRM.

ALLOWABLE SEAMS

Seams include clay, fragmented, highly weathered or similar zones, usually sub-parallel to the loaded surface. The limits suggested in the tables relate to a defined zone of influence. For pad footings, the zone of influence is defined as 1.5 times the least footing dimension. For socketed footings, the zone includes the length of the socket plus a further depth equal to the width of the footing. For tunnel or excavation assessment purposes the defects are assessed over a length of core of similar characteristics.

Source: Based on Pells et al (1978), as revised by Pells et al (1998).

Pells, P.J.N, Mostyn, G. and Walker, B.F. - Foundations on Sandstone and Shale in the Sydney Region. Australian Geomechanics Journal, No 33 Part 3, December 1998.

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ENVIRONMENTAL IMPACT STATEMENT

Appendix 4

BOGAN SHIRE COUNCIL

Nyngan Waste and Resource Management Facility Report No. 800/02





Summary of Soil Logging Procedures

Coarse Material: grain size - colour - particle shape - secondary components - minor constituents - moisture condition - relative density - origin - additional observations.

	Fine Material: plasticity - colour - secondary components - minor constituents - moisture								
	Guide to the Description, Identification and Classification of Soils								
	Major D	ivisio	ns	SYMBOL		Typical Names			
> 2	00mm	BOL	JLDERS						
60 to	200mm	CO	BBLES						
_	8 E	GRAVEL	osk tion	GW	Well-graded g	ravels, gravel-sand mixtures, little or	no fines.		
묘	ss le .076		than 50 urse fract 2.36mm	GP	Poorly graded	gravels and gravel-sand mixtures, lit	tle or no fines, uniform gravels.		
GRAINED	y ma hat 0	Gravelly Soils	More than 50% of coarse fraction > 2.36mm	GM	Silty gravels, g	ravel-sand-silt mixtures.			
SE GR.	by dr		of of o	GC	Clayey gravels	, gravel-sand-clay mixtures			
SS	gree	SANDS	0% tion	SW	Well-graded sa	Well-graded sands, gravelly sands, little or no fines.			
COARSE	More than 50% by dry mass less than 60mm is greater that 0.076mm	SA	More than 50% of coarse fraction < 2.36mm	SP	Poorly graded	sands and gravelly sands; little or no	fines, uniform sands.		
8		Sandy	ne th	SM	Silty sands, sar	nd-silt mixtures.			
SC Clayey sands, sand-clay mixto			nd-clay mixtures.						
	2 = -		Ĕ.	ML	Inorganic silts	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts			
밀	by d Omm	:	< 50%	CL	Inorganic clay	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays.			
FINE GRAINED SOILS	More than 50% by dry mass less than 60mm is less than 0.076mm	_ :	3	OL	Organic silts a	nd organic silty clays of low plasticit	ly.		
S	than ess th than		Ĭ.,	MH	Inorganic silts,	micaceous or diatomaceous fine sar	ndy or silty soils, elastic silts.		
l≝	More t hass le less i		MIG EIII	CH	Inorganic clay	s of high plasticity, fat clays.			
O No				c silts.					
HIGH	LYORG	ANIC	SOILS	Pt	Peat and other	highly organic soils.	·		
	40	-	- 'A	-Line'	\neg	Gra	in sizes		
	, »			\vdash	Gravel	Sand			

	40				t-Line	_	_	_
	20					EH	/	Ш
de %	20		o		$ \ $		٥	
9	10			Ň			10.2	
-	Ē	O.	$\overline{}$		Ă.			
		2) 3	D) 4 Liquid	0 5 Limit(%)	0 6	10	70

	G a	III GEOD		
Gra	avel	Sand		
Coarse -	63 to 20mm	Coarse -	2.36 to 0.6mm	
Medium -	20 to 6 mm	Medium -	0.6 to 0.2mm	
Fine -	6 to 2.36mm	Fine -	0.2 to 0.075mm	

GEOLOGICAL ORIGIN:FIII - artificial solis / deposite
Altivial - solis deposited by the action of water
Acolian - solis deposited by the action of wind

Topsoil - solis supporting plant life containing significant organic content
Residual - solis derived from insitu weathering of parent rock.

Colluvial - transported debris usually unsorted, lose and deposited

Curuma: ramsporred dectris usually unsorted, loose and deposited Field Identification of Fine Grained Soils - Silt or Clay?

Dy Strength - Allow the soil to dry completely and then test its strength by breaking and crumbing between the fingers. High dry strength - Clays, Very sight dry strength - Silts.

Toughess Test - the odi is felled by hand into a thread about Serm in diameter. The thread is then loided and re-rolled repeatedly until it has dried sufficiently to break into lamps. In this contilion incorpact clays are fally stiff and tough while incorpant sits produce a weak and often soft thread which may be difficial to the mad ready break and crumbles.

The made and the soil is field by the soil is sittled by the soil is the soil is the soil by the sits of the field, to make 5 not but not decide, Shale horisonship, stifling vigorously against the other hand several times. Dilatercy is indicated by the appearance of a shiny tim on the surface of the soil. If the soil is then squared or present with the fingers, the surface both and the soil stiffers and eventually crumbles. These reactions are pronounced only for predominantly sit size material. Plastic clays give no reaction.

•••	Winter presently defined only differ deather a debervations.								
	Descriptive Terms for Material Portions								
	CC	DARSE GRAINED SOILS	FINE GRAINED SOILS						
	% Fines	Term/Modifier	% Coarse	Term/Modifier					
	< 5	Omit, or use "trace"	< 15	Omit, or use "trace"					
	> 5, < 12	"with clay/silt" as applicable	> 15, < 30	"with sand/gravel" as applicable					
	> 12	Prefix soil as "silty/clayey"	> 30	Prefix as "sandy/gravelly"					

	Moisture Condition				
for non-cohes	rive soils:				
Dry -	runs freely through fingers.				
Moist -	does not run freely but no free water visible on soil surface.				
Wet -	free water visible on soil surface.				
for cohesive s	poils:				
MC > PL	Moisture content estimated to be greater than the plastic limit.				
MC ~ PL	Moisture content estimated to be approximately equal to the plastic limit.				
	The soil can be moulded				
MC < PL	Moisture content estimated to be less than the plastic limit. The soil is hard				
	and friable, or powdery.				

Consistency - For Clays & Silts								
Description	UCS(kPa)	Field guide to consistency						
Very soft	< 25	Exudes between the fingers when squeezed in hand						
Soft	25 - 50	Can be moulded by light finger pressure						
Firm	50 - 100	Can be moulded by strong finger pressure						
Stiff	100 - 200	Cannot be moulded by fingers. Can be indented by thumb.						
Very stiff	200 - 400	Can be indented by thumb nail						
Hard	> 400	Can be indented with difficulty by thumb nail						
Friable	-	Crumbles or powders when scraped by thumbnail						

	Relative Density for Gravels and Sands									
Description	SPT "N" Value	Density Index (ID) Range %								
Very loose	0 - 4	< 15								
Loose	4 - 10	15 - 35								
Medium dense	10 - 30	35 - 65								
Dense	30 - 50	65 - 85								
Very dense	> 50	> 85 1 February, 2011								



Summary of Rock Logging Procedures

Description order: constituents - rock name - grain size - colour - weathering - strength - minor constituents - additional observations.

 minor constituents - moisture w.r.t. plasticity - consistency - origin - additional observations. 									
Definition - Sedimentary Rock									
Conglomerate	more than 50% of the rock consists of gravel (> 2mm) sized fragments								
Sandstone	more than 50% of the rock consists of sand (0.06 to 2mm) sized grains								
Siltstone	more than 50% of the rock consists of silt sized granular particles and the rock is not laminated								
Claystone	more than 50% of the rock consists of clay or mica material and the rock is not laminated								
Shale	more than 50% of the rock consists of clay or silt sized particles and the rock is laminated								

	Weathering							
Residual	Residual RS Soil developed on extremely weathered rock; the mass structure and							
Soil	Soil substance fabric are no longer evident; there is a change in volume							
		but the soil has not significantly transported.						
Extremely	EW	Rock is weathered to such an extent that it has 'soil' properties; ie. it either						
Weathered	Weathered disintegrates or can be remoulded, in water							
Distinctly	DW	Pock strength usually changed by weathering. The rock may be highly						
Weathered		discoloured, usually by iron-staining. Porosity may be increased by leaching,						
		or may be decreased due to deposition of weathering products in pores.						
Slightly	SW	Pock is slightly discoloured but shows little or no change						
Weathered		of strength from fresh rock.						
Fresh	FR	Rock shows no sign of decomposition or staining.						

	9tr	atification		
thinly laminated	< 6mm	medium bedded	0.2 - 0.6m	
laminated	6 - 20mm	thickly bedded	0.6 - 2m	
very thinly bedded	20 - 60mm	very thickly bedded	> 2m	
thinly bedded	60mm - 0.2m			

Discontinuities										
order of description: depth - type - orientation - spacing - roughness / planarity - thickness - coating										
	Type	Class	Roughness/Planarity	Class	Roughness/Planarity					
В	Bedding	1	rough or irregular, stepped	VI	slickensided, undulating					
F	Fault	II	smooth, stepped	VII	rough or irregular, planar					
С	Cleavage	III	slickensided, stepped	VIII	smooth, planar					
J	Joint	IV	rough or irregular, undulating	IX	slickensided, planar					
S	Shear Zone	V	smooth, undulating							
D	Drill break									

Rock Strength									
Term		IS (50)	Field Guide						
Extremely	且		Easily remoulded by hand to a material with soil properties.						
Low									
		0.03							
Very low	VL		May be crumbled in the hand. Sandstone is "sugary" and friable						
		0.1							
Low	L		A piece of core 150 mm long x 50 mm dia. may be broken by						
			hand and easily scored with a knife. Sharp edges of core may						
			be friable and break during handling.						
		0.3							
Medium	М		A piece of core 150 mm long x 50 mm dia. can be broken by hand						
			with considerable difficulty. Peadily scored with knife.						
		1							
High	Н		A piece of core 150 mm long x 50 mm dia. core cannot be broken						
			by unaided hands, can be slightly scratched or scored with knife.						
		3							
Very High	VH		A piece of core 150 mm long x 50 mm dia. May be broken readily						
' '			with hand held hammer. Cannot be scratched with pen knife.						
		10							
Extremely	BH		A piece of core 150 mm long x 50 mm dia. Is difficult to break with						
High		l	hand held hammer. Rings when struck with a hammer.						

	Degree of fracturing									
fragmented The core is comprised primarily of fragments of length less than 20mm, and										
	mostly of width less than the core diameter									
highly	Core lengths are generally less than 20mm - 40mm									
fractured	with occasional fragments.									
fractured	Core lengths are mainly 30mm - 100mm with occasional shorter									
	and longer lengths									
slightly	Core lengths are generally 300mm - 1000mm with occasional longer sections									
fractured	and shorter sections of 100mm 300mm.									
unbroken	The core does not contain any fracture.									

The fracture spacing is shown where applicable and the Pock Quality Designation is given by: PQD (%) = sum of unbroken core pieces 100 mm or longer

A.doc 1 February, 2011

given by:

M:\2011\11-009-GHD-Intersection of the Orange distributor & Telopea Way in north orange-PI&D\Appendix A.doc

10

BOGAN SHIRE COUNCIL

ENVIRONMENTAL IMPACT STATEMENT

Appendix 4

Nyngan Waste and Resource Management Facility Report No. 800/02

Site Plan & Test Pit Location

Appendix B



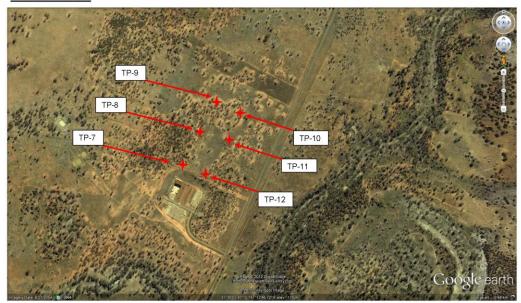
Appendix 4



Geotechnical Engineers & Engineering Geologists NATA Accredited Construction Materials Testing Laboratory for Soils, Coal, Aggregates and Concrete Geotechnical & Environmental Drilling



Test Pit Locations



Appendix 4

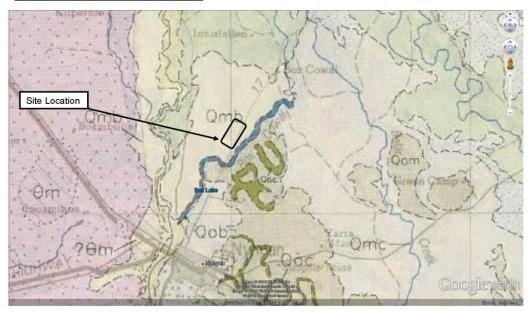
Nyngan Waste and Resource Management Facility Report No. 800/02



Geotechnical Engineers & Engineering Geologists NATA Accredited Construction Materials Testing Laboratory for Soils, Coal, Aggregates and Concrete Geotechnical & Environmental Drilling



Site Location with Geological Map Overlay



KEY:

Qmb: "Unconsolidated dark yellow brown clay, slightly silty with rare carbonate nodules and quartz sand. Common desiccation cracks. Laminated and contains rootlets"

Qob: "Unconsolidated pale grey to grey brown silt, clay and sand with rare carbonate nodules. Very poorly sorted. Commonly cracking."

ENVIRONMENTAL IMPACT STATEMENT

Appendix 4

BOGAN SHIRE COUNCIL

Nyngan Waste and Resource Management Facility Report No. 800/02

Appendix C - Test Pit Logs

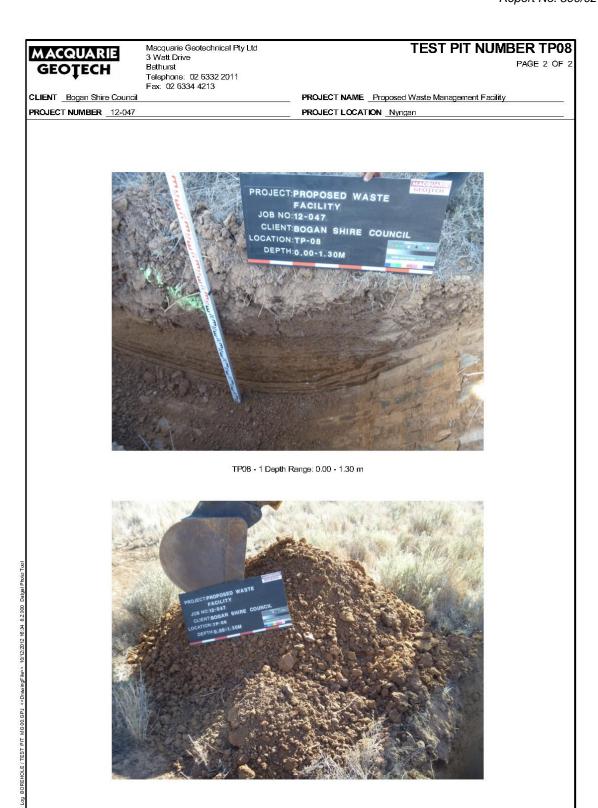


			UA [EC		l	Macquarie Geotechnical Pty Ltd 3 Watt Drive Bathurst Telephone: 02 6332 2011 Fax: 02 6334 4213		TEST	FPIT NU		R TP07	
					ouncil		PROJECT NAME Propos		anagement Fa	cility		
					2-047		PROJECT LOCATION N		ngan			
						COMPLETED _23/11/12						
									BEARING			
						50mm Toothed Bucket	TEST PIT LOCATION LOGGED BY <u>KA</u>		OLEOVER.	DW 10		
	SI F TES		ZE <u>4</u>	<u>sumn</u>	1		LOGGED BY KA		CHECKED	BY JB		
				P)	noi			Samples				
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Descripti	on	Tests Remarks	D((blows/	100mm)	Additional Observations	
		. ,	-	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		Silty SAND trace day: light brown, fine to coarse sa	nd, medium dense, dry (TOPSOIL).		0 5 10	15 20 25		
			-		CL	CLAY with sand: red brown, medium plasticity day, moisture content < plastic limit (ALLUVIAL).	fine to coarse sand, stiff, dry,					
			0 <u>.5</u>									
			-					1				
			1 <u>.0</u>									
			_			Borehole TP07 termineted at 1.2m						
			1 <u>.5</u>									
			-									
			2 <u>.0</u>									
			-									
			2 <u>.5</u> –									
			-									





MACQUARIE GEOŢECH CLIENT Bogan Shire Council						Macquarie Geotechnical Pty Ltd 3 Watt Drive Bathurst Telephone: 02 6332 2011 Fax: 02 6334 4213			P	R TP08 AGE 1 OF 2	
							PROJECT NAME Propos		anagement F	acility	
\vdash	ROJECT NUMBER 12-047						PROJECT LOCATION N				
DA	TE	STAR	TED	23/1	1/12	COMPLETED _23/11/12	R.L. SURFACE		DATUM		
						50mm Toothed Bucket			BEARING		
							LOGGED BY KA		CHECKE	1 RY IR	
	Σ TES			OUTIN					. OI LOIKL	<u> </u>	
Method	Water	RL (E)	Depth (m)	Graphic Log	Classification Symbol	Material Descripti	on	Samples Tests Remarks	(blow	OCP s/100mm)	Additional Observations
Г				21 Ly	SM	Sifty SAND with clay: brown, fine to coarse sand, lot (TOPSOIL).	ose to medium dense, dry			1 3 2123	
		. , . ,	(c. 3 ³ t)	CL.	CLAY with sand trace gravel and roots: brown, med sand, fine subangular fo subrounded gravel, stiff, dr < plastic limit (ALLUVIAL). Borehole TP08 terminated at 1.4m	lium plasticity clay, fine to coarse y to slightly moist, moisture content					
b			- - 2 <u>.0</u>	-							
· ·			- - 2 <u>.5</u> - - -								



TP08 - 2 Depth Range: 0.00 - 1.30 m



MACQUARIE GEOŢECH CLIENT Bogan Shire Council						Macquarie Geotechnical Pty Ltd 3 Watt Drive Bathurst Telephone: 02 6332 2011 Fax: 02 6334 4213				PA	R TP09 AGE 1 OF 2	
							PROJECT NAME _Propo		anagemen	Eacility		
	ROJECT NUMBER 12-047						PROJECT LOCATION _N					
						COMPLETED _23/11/12						
									BEARIN	iG		
						50mm Toothed Bucket	TEST PIT LOCATION LOGGED BY _KA		01501			
	SI I		ZE _4	150mn	п		LOGGED BY _KA		CHECK	ED BA -	JB_	
H	71 63	<u>, </u>										
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Descrip	pition	Samples Tests Remarks	(bk	DCP pws/100mn	n) 20-25	Additional Observations
			-	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	SM	Sandy SILT with day trace gravel: red brown, fine moist (TOPSOIL).	to coarse sand, firm to stiff, slightly					
			-		CL	CLAY with sand: brown in places white, medium p stiff, slightly moist, moisture content < plastic limit						l
			0 <u>.5</u>									1
			-									1
			-					1				
			1 <u>.0</u>					4				l
			-									1
			1.5			Borehole TP09 terminated at 1.4m						
			-									
			-									1
			2 <u>.0</u>									1
			-									
			2 <u>.5</u>									
			-									
			-									
l			-	1								1



TP09 - 2 Depth Range: 0.00 - 1.40 m

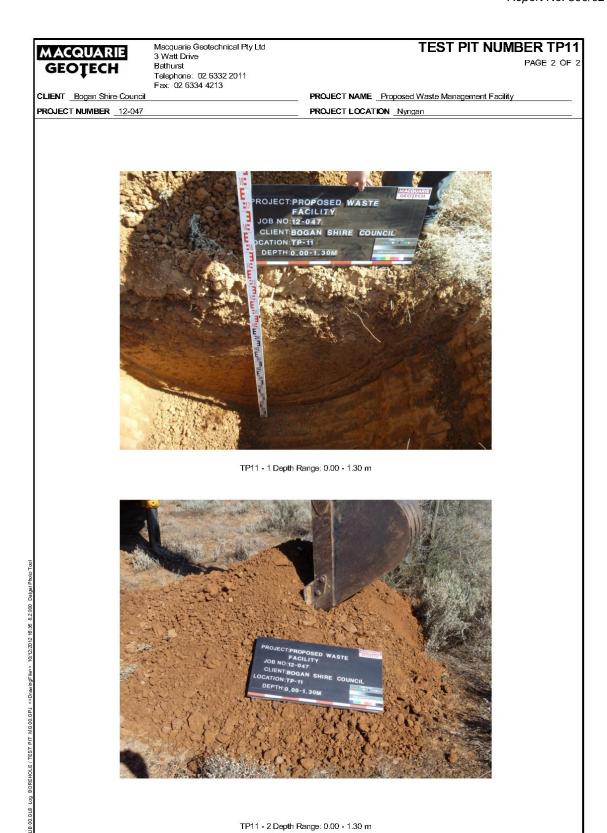


MAC GEC				l	Macquarie Geotechnical Pty Ltd 3 Watt Drive Bathurst Telephone: 02 6332 2011 Fax: 02 6334 4213		TES	FPIT NU		R TP1 AGE 1 OF
LIENT						PROJECT NAME _Propos		anagement Faci	lity	
ROJEC						PROJECT LOCATION N				
ATE ST	ART	ED _	23/11	1/12	COMPLETED 23/11/12	R.L SURFACE		DATUM		
					50mm Toothed Bucket				-	
						LOGGED BY KA			Y JB	
OTES										
	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Descrip	ption	Samples Tests Remarks	DCF (blows/10	Omm)	Addition Observation
			1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	SM	Sandy SILT with day trace roots: brown, fine to or (TOPSOIL).	parse sand, firm to stiff, dry		0 5 10 1	5 20 25	
		- 0. <u>5</u> - - - 1. <u>0</u>		a.	CLAY with sand trace gravel: brown, medium pla subangular fo subrounded gravel, stiff, dry to slig limit (ALLUVIAL). Borehole TP10 terminated at 1.3m	sticity clay, fine to coarse sand, fine httly moist, moisture content < plastic	1			
		1 <u>.5</u> –								
		_								
		_								
		2 <u>.0</u>								
		_								
		_	1							
		-								
		-								
		_								
		2 <u>.5</u>								
		-								
		_								
		_	1							
		-								[



TP10 - 2 Depth Range: 0.00 - 1.30 m

•	GE	O (ŢΕ¢			Macquarie Geotechnical Pty Ltd 3 Watt Drive Bathurst Telephone: 02 6332 2011 Fax: 02 6334 4213	DDO ISOT MARKE D			P	R TP11 AGE 1 OF 2
1					<u>Xouncil</u> 2-047		PROJECT NAME Propo PROJECT LOCATION N		anagement F	асшу	
						A0199 5759 6011116					
						COMPLETED 23/11/12					
						50mm Toothed Bucket			BLAINING		
							LOGGED BY KA		CHECKE	DBY JB	
	TES										
Method	Water	RL (E)	Depth (m)	Graphic Log	Classification Symbol	Material Descrip	otion	Samples Tests Remarks	(blows)CP s/100mm) 1 15 20 25	Additional Observations
Г				71.15	SM	Sandy SILT with clay: light brown, fine to coarse s	and, firm to stiff, dry (TOPSOIL).		1 5 1	15 20 25	
סינוס סינוסים ביץ סינומוסים ברוך והחסיסים יו יוסימים או או המצבי היוסים סיבוסים שקורו הסירוסים בין סינומוסים בי			0.5 		CL	CLAY with sand trace gravel and roots: brown, ms and, fine subangular gravels, stiff, slightly moist, (ALLUVIAL). Borehole TP11 terminated at 1.3m	actium plasticity clay, fine to coarse moisture content < plastic limit				
			-	-							





			UA [EC	RIE H		Macquarie Geotechnical Pty Ltd 3 Watt Drive Bathurst Telephone: 02 6332 2011 Fax: 02 6334 4213		TES	FPIT NUM		R TP12 GE 1 OF
					ouncil		PROJECT NAME Propos		anagement Facilit	У	
				R _12			PROJECT LOCATION _N				
						COMPLETED 23/11/12					
						50mm Toothed Bucket			BEARING		
							LOGGED BY KA		CHECKED BY	JB	
	TES										
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Descrip	otion	Samples Tests Remarks	DCP (blows/100n		Additional Observation
				1 12 V	SM	Sandy SILT with clay: brown, fine to coarse sand,	firm to stiff, dry (TOPSOIL).		0 5 10 15	20.25	
			- 0. <u>5</u> - - - 1. <u>0</u>		CL.	Sandy CLAY trace gravel: red brown, medium pla subangular to subrounded gravel, firm to stiff, slig < plastic limit (ALLUVIAL). Borehole TP12 terminated at 1.4m	asticity clay, fine to coarse sand, fine thitly moist to moist, moisture content	7			
			1 <u>.5</u> 2 <u>.0</u>								
			- - - 2 <u>.5</u>								





BOGAN SHIRE COUNCIL

ENVIRONMENTAL IMPACT STATEMENT

Nyngan Waste and Resource Management Facility Report No. 800/02

Appendix 4

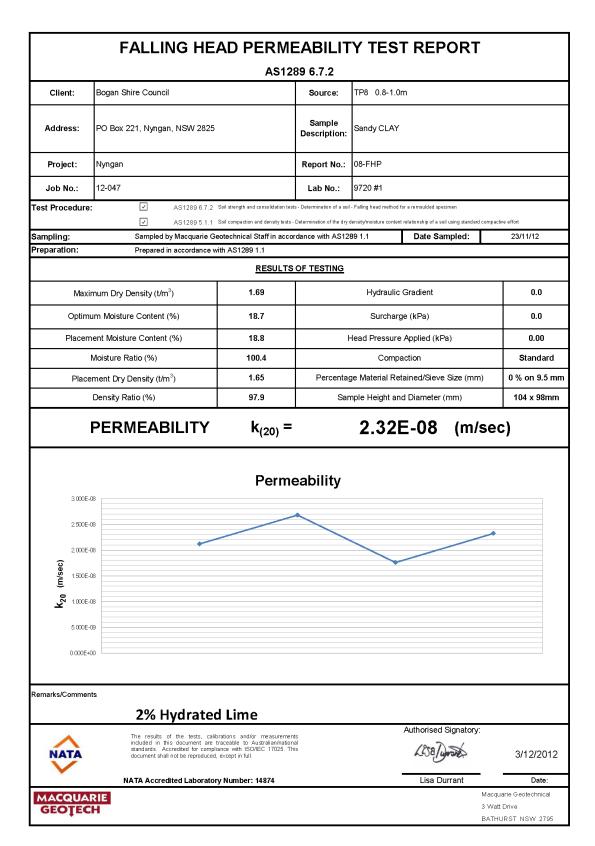
Appendix D – Laboratory Test Results



		AS128	39 6.7.2		
Client:	Bogan Shire Council		Source:	TP7 0.8-1.0m	
Address:	PO Box 221, Nyngan, NSW 2825		Sample Description:	Sandy CLAY	
Project:	Nyngan		Report No.:	07-FHP	
Job No.:	12-047		Lab No.:	9719 #1	
est Procedure				- Falling head method for a remoulded specimen	
ampling:	AS1289 5.1.1 S Sampled by Macquarie Ge			density/moisture content relationship of a soil using standard comp 89 1.1 Date Sampled:	23/11/2012
reparation:	Prepared in accordance wi		dance with AS12	Date Sampled.	23/11/2012
		RESULTS	OF TESTING		
Maxi	mum Dry Density (t/m³)	1.70		Hydraulic Gradient	0.0
Optimo	um Moisture Content (%)	18.6		Surcharge (kPa)	0.0
Placem	nent Moisture Content (%)	18.2	ŀ	Head Pressure Applied (kPa)	0.00
	Moisture Ratio (%)	98.1		Compaction	Standard
			Doroonto	ge Material Retained/Sieve Size (mm)	0 % on 9.5 mr
Place	ement Dry Density (t/m³)	1.67	reiceilla	ge Material Netallied/Oleve Olze (IIIII)	- /•
Place	ement Dry Density (t/m³) Density Ratio (%)	98.3		nple Height and Diameter (mm)	104 x 98mm
		98.3 k ₍₂₀₎ =	Sar	. ,	104 x 98mm
	Density Ratio (%) PERMEABILITY	98.3 k ₍₂₀₎ =		nple Height and Diameter (mm)	104 x 98mm
	Density Ratio (%) PERMEABILITY	98.3 k ₍₂₀₎ =	Sar	nple Height and Diameter (mm)	104 x 98mm
	PERMEABILITY	98.3 k ₍₂₀₎ =	Sar	nple Height and Diameter (mm)	104 x 98mm
2500E-4 2000E-4	Density Ratio (%) PERMEABILITY	98.3 k ₍₂₀₎ =	Sar	nple Height and Diameter (mm)	104 x 98mm
2,500E-4	Density Ratio (%) PERMEABILITY	98.3 k ₍₂₀₎ =	Sar	nple Height and Diameter (mm)	104 x 98mm
2,500E-4	Density Ratio (%) PERMEABILITY	98.3 k ₍₂₀₎ =	Sar	nple Height and Diameter (mm)	104 x 98mm
2.500E-4 2.000E-4 (398)JLJ	Density Ratio (%) PERMEABILITY	98.3 k ₍₂₀₎ =	Sar	nple Height and Diameter (mm)	104 x 98mm
2500E-4 2000E-4	Density Ratio (%) PERMEABILITY 09 00 00	98.3 k ₍₂₀₎ =	Sar	nple Height and Diameter (mm)	104 x 98mm
2500E-4 2,000E-4 1,500E-4	Density Ratio (%) PERMEABILITY 09 09 09 10	98.3 k ₍₂₀₎ =	Sar	nple Height and Diameter (mm)	104 x 98mm
2500E4 2000E4 1,500E4 1,000E4 5,000E-	Density Ratio (%) PERMEABILITY 09 09 09 10	98.3 k ₍₂₀₎ =	Sar	nple Height and Diameter (mm)	104 x 98mm
2,500E-4 2,000E-4 1,500E-4 1,000E-4 5,000E-	Density Ratio (%) PERMEABILITY 09 09 09 10	98.3 k ₍₂₀₎ =	Sar	nple Height and Diameter (mm)	104 x 98mm
2,500E-4 2,000E-4	Density Ratio (%) PERMEABILITY 09 09 09 10	98.3 k ₍₂₀₎ =	Sar	nple Height and Diameter (mm)	104 x 98mm
2,500E-4 2,000E-4	Density Ratio (%) PERMEABILITY 09 09 09 10 10 The results of the tests, calib	98.3 k ₍₂₀₎ = Perme	eability	nple Height and Diameter (mm)	104 x 98mm
2,500E-4 2,000E-4	PERMEABILITY	98.3 k ₍₂₀₎ = Perme Lime aceable to Australian/astiona aceable to Australian/astiona me with ISO/IEC 17025. This	eability	1.08E-09 (m/se	104 x 98mm
2,500E-4 2,000E-4 1,500E-4 5,000E-4	Density Ratio (%) PERMEABILITY 09 09 10 10 The results of the tests, calibincluded in this document are tristandards. Accredited for complia	98.3 k ₍₂₀₎ = Perme Lime Paions and/or measurements aceable to Australian/habtona nce with ISO/IEC 17025. This except in full.	eability	1.08E-09 (m/se	104 x 98mm

Issue 1 - Revision A - Issue Date 1/2/12





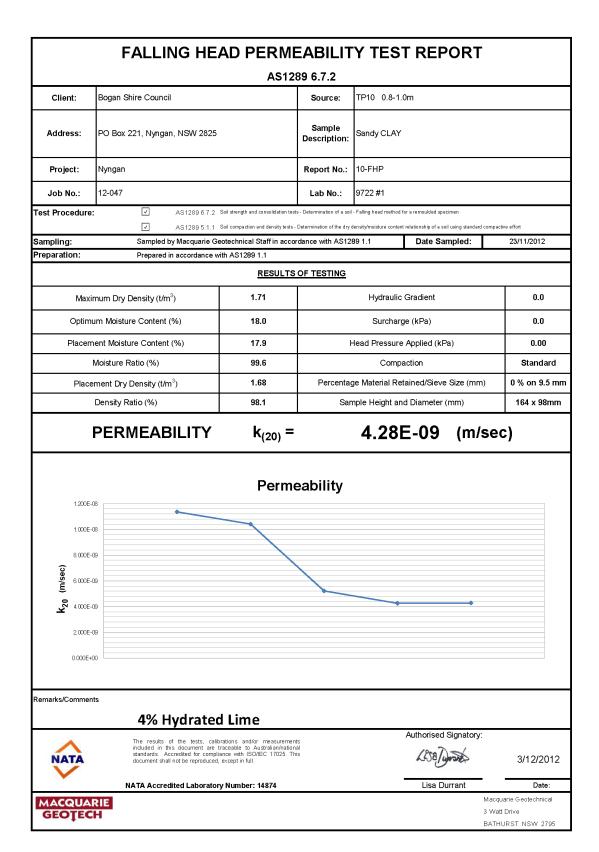
Report Form: FHP Issue 1 - Revision A - Issue Date 1/2/12



		A C 4 O C	39 6.7.2			RT	
Client:	Bogan Shire Council	A5128	Source:	TP9 0.8-1.0r	n		
Address:	PO Box 221, Nyngan, NSW 2825		Sample Description:	Sandy CLAY			
			•				
Project:	Nyngan		Report No.:	09-FHP			
Job No.:	12-047		Lab No.:	9721 #1			
est Procedure:		Soil strength and consolidation tests Soil compaction and density tests - I				standard comp	active effort
ampling:	Sampled by Macquarie Ge				Date Sample		23/11/2012
reparation:	Prepared in accordance w	ith AS1289 1.1			-		
		RESULTS	OF TESTING				
Maxii	mum Dry Density (t/m³)	1.66		Hydraulic	Gradient		0.0
Optimu	um Moisture Content (%)	20.0		Surcharg	e (kPa)		0.0
Placem	ent Moisture Content (%)	19.8	H	lead Pressure	Applied (kPa)		0.00
ĺ	Moisture Ratio (%)	99.1		Compa	ction		Standard
Place	ment Dry Density (t/m³)	1.63	Percentag	ge Material Ret	ained/Sieve Size	e (mm)	0 % on 9.5 mr
	Density Ratio (%)	98.2	San	nple Height and	d Diameter (mm)	104 x 98mm
	PERMEABILITY	k ₍₂₀₎ =		7.31E	Ξ-10 (m/se	ec)
		Daves					
1.400E-0		Perme	eability				
1.400E-0 1.200E-0		Perme	eability				
	09	Perme	eability				
1.200E-0	0.0	Perme	eability				
1.200E-0	0.00	Perme	eability			,	
1.200E-0	0.00	Perme	eability			,	
1.200E-0 1.000E-0 8.000E-1	239	Perme	eability			^	
1.200E-4 1.000E-4 8.000E- 6.000E-	De 200	Perme	eability			A	
1,200E-4 1,000E-4 1,000E-4 8,000E-4 6,000E-4 4,000E-4	0.00	Perme	eability			,	
1,200E-0 1,000E-0 1,000E-0 1,000E-0	000	Perme	eability			,	
1,2006-0 1,0006-0 8,0006-0 6,0006-0 4,0006-0 2,0006-0	000		eability			,	
1,200E-0	ts 4% Hydrated The results of the tests, calit	d Lime prations and/or measurement	5		Authorised Sign	natory:	
1,200E-0 1,000E-0 1,000E-0 1,000E-0	ts 4% Hydrated	J Lime prations and/or measurement raceable to Australan/autons and anoe with 180/16C 17025. This	5		Authorised Sign	natory:	3/12/2012
1,200E-4 1,000E-4 (39 8,000E (39 8,000E (4,000E (0,000E+6)	ts 4% Hydrated The results of the tests, calit included in this document are standards. Accreteled for complete	S Lime Stations and/or measurement raceable to Australan/nationa ance with 180/IEC 17025. This except in full.	5		Authorised Sign	\$	3/12/2012 Date:

Issue 1 - Revision A - Issue Date 1/2/12





Issue 1 - Revision A - Issue Date 1/2/12



		AS128	39 6.7.2		
Client:	Bogan Shire Council		Source:	TP11 0.8-1.0m	
Address:	PO Box 221, Nyngan, NSW 2825		Sample Description:	Sandy CLAY	
Project:	Nyngan		Report No.:	11-FHP	
Job No.:	12-047		Lab No.:	9723 #1	
est Procedure	AS1289 6.7.2	Soil strength and consolidation tests	- Determination of a soil	- Falling head method for a remoulded specimen	
				density/moisture content relationship of a soil using standard compa	
ampling: reparation:	Sampled by Macquarie Ge Prepared in accordance wi		dance with AS12	89 1.1 Date Sampled:	23/11/2012
			OF TESTING		
Maxi	mum Dry Density (t/m³)	1.75		Hydraulic Gradient	0.0
Optimo	um Moisture Content (%)	17.5		Surcharge (kPa)	0.0
Placem	nent Moisture Content (%)	17.5	ŀ	Head Pressure Applied (kPa)	0.00
	Moisture Ratio (%)	99.9		Compaction	Standard
Place	ement Dry Density (t/m³)	1.71	Percentag	ge Material Retained/Sieve Size (mm)	0 % on 9.5 mr
	Density Ratio (%) PERMEABILITY	^{97.9} k ₍₂₀₎ =	Sar	5.46E-10 (m/se	
	Density Ratio (%)	k ₍₂₀₎ =			
	Density Ratio (%) PERMEABILITY	k ₍₂₀₎ =	_{Sar}		
	Density Ratio (%) PERMEABILITY	k ₍₂₀₎ =			
9.000E-	Density Ratio (%) PERMEABILITY	k ₍₂₀₎ =			
9.000E- 8.000E- 7.000E- 6.000E-	Density Ratio (%) PERMEABILITY	k ₍₂₀₎ =			
9.000E- 8.000E- 7.000E- 6.000E-	Density Ratio (%) PERMEABILITY	k ₍₂₀₎ =			
9000E- 8000E- 7000E- 6000E- (395)	Density Ratio (%) PERMEABILITY	k ₍₂₀₎ =			
9.000E- 8.000E- 7.000E- 6.000E-	Density Ratio (%) PERMEABILITY	k ₍₂₀₎ =			
9000E- 8000E- 7000E- 6000E- 395 ,500E- 997 ,1111	Density Ratio (%) PERMEABILITY 10 10 10 10 10 10	k ₍₂₀₎ =			
9000- 3000- 7000- 6000- 4000- 4000- 3000- 3000-	Density Ratio (%) PERMEABILITY 10 10 10 10 10 10 10	k ₍₂₀₎ =			103 X 98mm
9,0008- 3,0008- 3,0008- 4,0008- 4,0008- 3,0008- 2,0008- 2,0008-	Density Ratio (%) PERMEABILITY 10 10 10 10 10 10 10 10	k ₍₂₀₎ =			
9,000E- 8,000E- 7,000E- 6,000E- 4,000E- 1,000E- 0,000E-4	Density Ratio (%) PERMEABILITY 10 10 10 10 10 10 10 10 10 10 10 10 10	k ₍₂₀₎ =			
9,000E- 8,000E- 7,000E- 6,000E- 4,000E- 2,000E- 1,000E-	Density Ratio (%) PERMEABILITY 10 10 10 10 10 10 10 10 10 10 10 10 10	k ₍₂₀₎ =			
9,000E- 8,000E- 7,000E- 6,000E- 4,000E- 1,000E- 0,000E-4	Density Ratio (%) PERMEABILITY 10 10 10 10 10 10 10 10 10 10 10 10 10	k ₍₂₀₎ =	eability		
9,000E- 8,000E- 7,000E- 6,000E- 4,000E- 1,000E- 0,000E-4	Density Ratio (%) PERMEABILITY 10 10 10 10 10 10 10 10 10 10 10 10 10	R ₍₂₀₎ = Perme Lime rations and/or measurements accepte to Australian/nationa noce with 1950/EC 17025. This	eability	5.46E-10 (m/se	
9000E- 8000E- 7000E- 6000E- (398)4 4000E- 2000E- 1000E- 0000E- 4	Density Ratio (%) PERMEABILITY 10 10 10 10 10 10 10 10 10 10 10 10 10	Perme LLime rations and/or measurements accepte to Australian/habtona nice with ISO/IEC 17025. This except in full.	eability	5.46E-10 (m/se	c)

Issue 1 - Revision A - Issue Date 1/2/12



		AS128	39 6.7.2		
Client:	Bogan Shire Council		Source:	TP12 0.8-1.0m	
Address:	PO Box 221, Nyngan, NSW 2825		Sample Description:	Sandy CLAY	
Project:	Nyngan		Report No.:	12-FHP	
Job No.:	12-047		Lab No.:	9724 #1	
est Procedure				- Falling head method for a remoulded specimen	
				density/moisture content relationship of a soil using standard com	
ampling: Preparation:	Sampled by Macquarie Ge Prepared in accordance w		dance with AS12	89 1.1 Date Sampled:	23/11/2012
			OF TESTING		
Max	kimum Dry Density (t/m³)	1.66		Hydraulic Gradient	0.0
Optin	num Moisture Content (%)	21.0		Surcharge (kPa)	0.0
Placer	ment Moisture Content (%)	21.2	ŀ	Head Pressure Applied (kPa)	0.00
	Moisture Ratio (%)	100.8		Compaction	Standard
Plac	ement Dry Density (t/m³)	1.63	Percentag	ge Material Retained/Sieve Size (mm)	0 % on 9.5 m
	Density Ratio (%)	97.9	Sar	nple Height and Diameter (mm)	104 x 98mm
	PERMEADILLI	K(20) =		9 26E-10 (m/se	3C1
	PERMEABILITY	k ₍₂₀₎ =	eability	9.26E-10 (m/se	ec)
1.600E			eability	9.26E-10 (m/se	ec)
1.600E 1.400E	E-09		eability	9.26E-10 (m/se	ec)
1. 400E	E-00		eability	9.26E-10 (m/se	ec)
1.400E	E-00 E-00		eability	9.26E-10 (m/se	ec)
1,400E 1,200E	5-00 5-00 5-00		eability	9.26E-10 (m/se	ec)
1,400E 1,200E	E-00 E-00 E-09 E-10		eability	9.26E-10 (m/se	ec)
1,400E 1,200E 1,200E 1,200E 1,200E 1,400E	E-09 E-09 E-09 E-10		eability	9.26E-10 (m/se	ec)
1,400E 1,200E	E-09 E-09 E-09 E-10		eability	9.26E-10 (m/se	ec)
1,400E 1,200E 1,200E 1,200E 1,200E 1,400E	E-09 E-00 E-09 E-10 E-10		eability	9.26E-10 (m/se	ec)
1,400E	E-09 E-09 E-09 E-09 E-10 E-10 E-10		eability	9.26E-10 (m/se	ec)
1.4006 1.2006 1.0006 8.0006 8.0006 4.0006 0.0006	E-09 E-09 E-09 E-10 E-10 E-10 E-10 E-10		eability	9.26E-10 (m/se	ec)
1.400E 1.200E 1.000E 8.000E 8.000E 4.000E	E-09 E-09 E-09 E-09 E-10 E-10 E-10 E-10 E-10	Perme	eability	9.26E-10 (m/se	ec)
1.4006 1.2006 1.0006 8.0006 8.0006 4.0006 0.0006	2% Hydrated The results of the tests calif	Perme		Authorised Signatory:	ec)
1.4006 1.2006 1.0006 8.0006 8.0006 4.0006 0.0006	2% Hydrated	Perme J Lime prations and/or measurements raceable to Australian/nationa ance with 180/16C 17025. This			3/12/2012

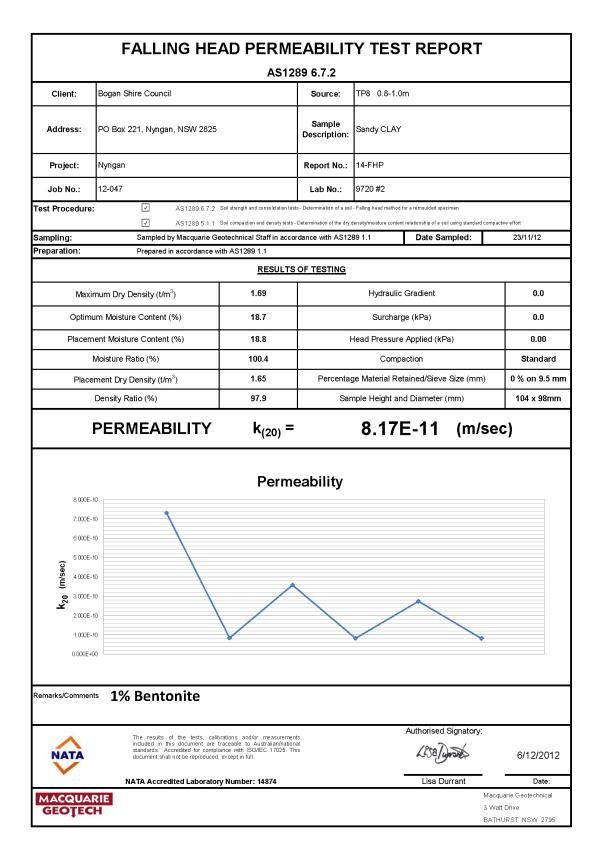
Issue 1 - Revision A - Issue Date 1/2/12



	FALLING HE	AD PERME	ABILIT	Y TEST REPOR	 T
		AS128	89 6.7.2		
Client:	Bogan Shire Council		Source:	TP7 0.8-1.0m	
Address:	PO Box 221, Nyngan, NSW 2825		Sample Description:	Sandy CLAY	
Project:	Nyngan		Report No.:	13-FHP	
Job No.:	12-047		Lab No.:	9719 #2	
Test Procedure:	_			- - Falling head method for a remoulded specimen lensity/moisture content relationship of a soil using stan	idard compactive effort
Sampling:	Sampled by Macquarie Ge				•
Preparation:	Prepared in accordance wi				
		RESULTS	OF TESTING		
Maxir	mum Dry Density (t/m³)	1.70		Hydraulic Gradient	0.0
Optimu	ım Moisture Content (%)	18.6		Surcharge (kPa)	0.0
Placem	ent Moisture Content (%)	18.2	ŀ	Head Pressure Applied (kPa)	0.00
ľ	Moisture Ratio (%)	98.1		Compaction	Standard
Place	ment Dry Density (t/m³)	1.67	Percentag	ge Material Retained/Sieve Size (r	mm) 0 % on 9.5 mm
	Density Ratio (%)	98.3	San	nple Height and Diameter (mm)	104 x 98mm
	PERMEABILITY	k ₍₂₀₎ =		2.34E-10 (m	ı/sec)
		Perme	eability		
2.500E-1	0	-	,		
2.000E-1	0				
4,5005					
() 1.500E-1	0				
K ₂₀ (m/sec)	0			/	
<u>~</u>					
5.000E-1	И				
0.000E+0	0				
Remarks/Comment	s 2% Bentonite				
	The results of the tosts calib		-	Authorised Signato	ory:
NATA	The results of the tests, calib included in this document are to standards. Accredited for complia document shall not be reproduced,	raceable to Australian/nationa ance with ISO/IEC 17025. This	d.	258 Junio	6/12/2012
	NATA Accredited Laboratory	y Number: 14874		Lisa Durrant	Date:
MACQUA	RIE				Macquarie Geotechnical
GEOŢEC	H				3 Watt Drive

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Report Form: FHP

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	FALLING HE		EABILIT 89 6.7.2	Y IES	I KEPO	RT	
Client:	Bogan Shire Council	A312	Source:	TP9 0.8-1.0	m		
Address:	PO Box 221, Nyngan, NSW 2825		Sample Description:	Sandy CLAY			
Project:	Nyngan		Report No.:	15-FHP			
Job No.:	12-047		Lab No.:	9721 #2			
est Procedure		Soil strength and consolidation tes					
		Soil compaction and density tests					
ampling: Preparation:	Sampled by Macquarie Ge Prepared in accordance w		rdance with AS12	89 1.1	Date Sampl	led:	23/11/2012
reparation.	riepaied ili accordance w		OF TESTING				
Mavi	imum Dry Density (t/m³)	1.66	1	Hydraulic	Gradient		0.0
· · · · · · · · · · · · · · · · · · ·	num Moisture Content (%)	20.0		Surcharg			0.0
	ment Moisture Content (%) Moisture Ratio (%)	19.8 99.1	ľ	Head Pressure Compa			0.00 Standard
	ement Dry Density (t/m³)	1.63	Percentag	·	ained/Sieve Siz	ze (mm)	0 % on 9.5 mi
1 1000	Density Ratio (%)	98.2	<u> </u>		d Diameter (mn		104 x 98mm
	DEDMEADII ITV	k =		1 97	= 10 /	Imle	·oc)
	PERMEABILITY	k ₍₂₀₎ =	,	4.87	E-10 ((m/s	ec)
4,0006-			eability	4.87	E-10 ((m/s	ec)
4.000E-	-09		eability	4.87	Ξ-10 ((m/s	ec)
4.000E- 3.500E-	-09		eability	4.87	≣-10 ((m/s	ec)
4,000E- 3,500E- 3,000E-	-09		eability	4.87	Ξ-10 ((m/s	ec)
4000E- 3500E- 3000E- 2500E-	00 00 00		eability	4.87	≣-10 ((m/s	ec)
4000E- 3500E- 3000E- 2500E-	00 00 00		eability	4.87	Ξ-10 ((m/s	ec)
4000E- 3500E- 3000E- 2500E-	09 09 09		eability	4.87	E-10 ((m/s	ec)
4,000E- 3,500E- 3,000E- 2,500E- 2,000E-			eability	4.876	E-10 ((m/s	ec)
4,000E- 3,000E- 2,000E- 2,000E- 1,500E-			eability	4.876	E-10 ((m/s	ec)
4,000E- 3,500E- 3,000E- 2,500E- 2,000E- 1,500E- 1,000E-	09 09 09 09 09 09 09 09 09 09 09 09 09 0		eability	4.87	E-10 ((m/s	ec)
4,0005- 3,5006- 3,0006- 2,5006- 2,5006- 1,5006- 1,5006- 5,0006-	09 09 09 09 09 09 09 09 09 09 09 09 09 0		eability	4.876	E-10 ((m/s	ec)
40006- 3,5006- 3,5006- 3,5006- 3,5006- 3,5006- 3,5006- 3,5006- 3,5006- 3,5006- 3,5006- 3,5006-	09 09 09 09 09 09 09 09 09 09 09 09 09 0		eability	4.876	Ξ-10 ((m/s	ec)
40006- 3,5006- 3,5006- 3,5006- 3,5006- 3,5006- 3,5006- 3,5006- 3,5006- 3,5006- 3,5006- 3,5006-	09 09 09 09 09 09 00 00 00 The results of the tests, calit	Permo	ıs	4.87	E-10 (ec)
40006- 3005- 3002- 3002- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003- 3003-	as as a second of the second o	Permo	IS all	4.87			6/12/2012
4000E- 3500E- 3500E- 2500E- 2500E- 1,500E- 5,000E-	The results of the tests, calificated included in this document are standards. Accredited for a results and ards.	Permo	IS all	4.87		inatory:	

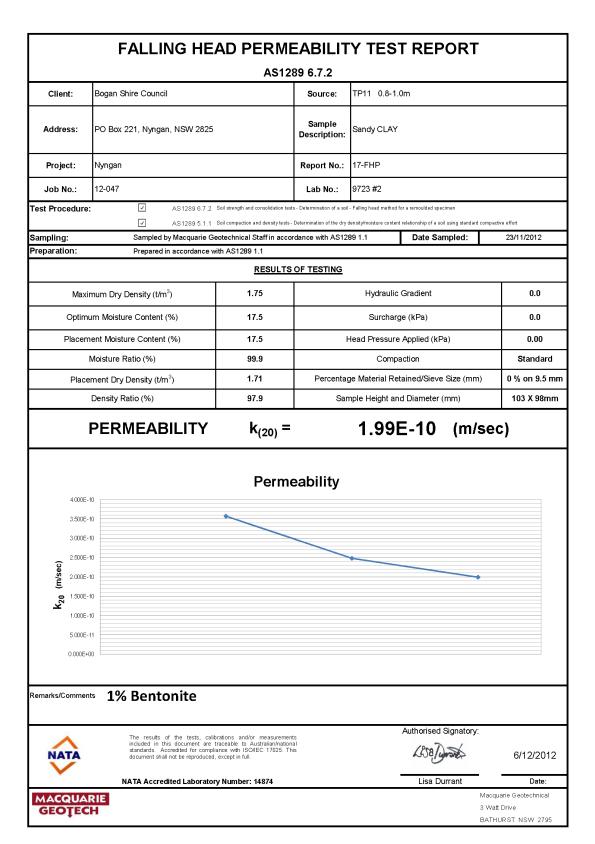
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Source TP10 0.8-1.0m Source TP10 S	Address: PO Box 221, Nyngan, NSW 2825 Project: Nyngan Report No.: 16-FHP Job No.: 12-047 Lab No.: 9722 #2 AS1289 6 7.2 Sol decept and decestly text. Consensation of the dry density content retained for a remodel companies white ampling: Sampled by Macquaine Coefficients Staff and accordance with AS1289 1.1 Date Sampled: 23/11/2012 reparation: Prepared in accordance with AS1289 1.1 RESULTS OF TESTING Maximum Dry Density (I/m²) 1.71 Hydraulic Gradient 0.0 Placement Moisture Content (%) 17.9 Head Pressure Applied (KPa) 0.0 Placement Moisture Content (%) 99.6 Compaction Standard Placement Dry Density (I/m²) 1.68 Percentage Material Retained/Seve Size (mm) Density Ratio (%) 98.1 Sample Height and Diameter (mm) 164 x 98mn PERMEABILITY Results Of Testing Permeability Permeability			AS12	89 6.7.2			
Address: PO Box 221, Nyngan, NSW 2825 Project: Nyngan Report No: 16-FHP Job No: 12-047 Lab No.: 9722 #2 est Procedure: AS1229 6.7.2 Sal design and consolidate later. Determinate of a self-filting hand self-act for a remarked specimes. AS1229 6.7.1 Sal comparison and dentity free. Determinate of a self-filting hand self-act for a remarked specimes. AS1229 6.7.2 Sal design and consolidate later. Determinate of a self-filting hand self-act for a remarked specimes. AS1229 6.7.2 Sal design and consolidate later. Determinates of a self-filting hand self-act for a remarked specimes. AS1229 6.7.2 Sal design and self-act for a remarked specimes. AS1229 6.7.2 Sal design and self-act for a remarked specimes. AS1229 6.7.2 Sal design and self-act for a remarked specimes. AS1229 6.7.2 Sal design and self-act for a remarked specimes. AS1229 6.7.2 Sal design and self-act for a remarked specimes. AS1229 6.7.2 Sal design and self-act for a remarked specimes. RESULTS OF TESTING. Maximum Dry Density (t/m²) 1.7.1 Hydraulic Gradient 0.0 Placement Moisture Content (%) 18.0 Surcharge (kPa) 0.0 Placement Moisture Content (%) 19.6 Compaction Standard. Placement Dry Density (t/m²) 1.68 Percentage Material Retained/Seve Size (mm) 0 % on 9.5 m Density Ratio (%) 98.1 Sample Height and Diameter (mm) 164 x 98mm PERMEABILITY k ₍₂₀₎ = 4.42E-10 (m/sec) Permeability **COCC-10** **COCC-10** **COCC-10** **AS1229 6.7.2 Sal design and	Sample Description: Sample	Client:	Bogan Shire Council	, (0.12	T	TP10 0.8-1.	0m	
Sob No.: 12-047	Job No.: 12-047 set Procedure:				Sample	Sandy CLAY		
AS 1289 6.7.2 Soil stereigh and connectation texts. Outermination of a soil. Falling head morbod for a remodated specimen AS 1289 5.1.1 Soil compection and density texts. Outermination of the stry density/miniture content relationship of a soil using standard compactine and density texts. Outermination of the stry density/miniture content relationship of a soil using standard compactine and density texts. Outermination of the stry density/miniture content content compactine and density texts. Outermination of the stry density/miniture content compactine afford. Sampled by Macquarie Geotechnical Staff in accordance with AS1289 1.1 Date Sampled: 23/11/2012	### Procedure: AS 1288 6.7.2 Sell stereigh and comorbidation texts. Commission of a sell. Falling head marked for a remoded appriment AS 1288 5.1.1 Sell compection and density texts. Determination of the dry density minister content relationship of a soil using standard compective effort AS 1288 5.1.1 Sell compection and density texts. Determination of the dry density/minister content indicationship of a soil using standard compective effort AS 1288 5.1.1 Sell compection and density texts. Determination of the dry density/minister content of the dry density for a remoded approximate content of the dry density for a remoded approximate content of the dry density for a remoded approximate content of the dry density for a remoded and unusual density self-content of the dry density for a remoded for a remoded of the dry density for a remode of the dry density for a remoded of the dry density for a remoded of the dry density for a remode of the dry density for a	Project:	Nyngan		Report No.:	16-FHP		
As 1289 5.1.1 Sol compaction and density tests - Determination of the day density/mosture content relationship of a soil using standard compactive effort ampling: Sampled by Macquarie Geotechnical Staff in accordance with AS1289 1.1 RESULTS OF TESTING	As 1289 5.1.1 Sol compaction and denisty tests - Determination of the dry denisty/industries content relationship of a soil using standard compactive effort ampling: Sampled by Macquarie Geotechnical Staff in accordance with AS1289 1.1 RESULTS OF TESTING Maximum Dry Density (t/m²) 1.71	Job No.:	12-047		Lab No.:	9722 #2		
### Sampled by Macquarie Geotechnical Staff in accordance with AS1289 1.1 Prepared in accordance with AS1289 1.1 RESULTS OF TESTING	Sampled by Macquarie Geotechnical Staff in accordance with AS1289 1.1 Date Sampled: 23/11/2012 reparation: Prepared in accordance with AS1289 1.1	est Procedure						compactive offert
Prepared in accordance with AS1289 1.1	Prepared in accordance with AS1289 1.1	ammlin ar						
Maximum Dry Density (t/m²) 1.71	Maximum Dry Density (t/m²) 1.71				rdance with AS12	89 1.1	Date Sampled:	23/11/2012
Maximum Dry Density (t/m³) 1.71 Hydraulic Gradient 0.0	Maximum Dry Density (t/m³) 1.71 Hydraulic Gradient 0.0	reparation.	riepaied in accordance wi		OF TESTING			
Description	Desire D		D D 11 44 35			l lumbra dia	Cradiant	
Placement Moisture Content (%) 17.9 Head Pressure Applied (kPa) 0.00	Placement Moisture Content (%) 17.9 Head Pressure Applied (kPa) 0.00							
Moisture Ratio (%) Placement Dry Density (t/m³) Density Ratio (%) PERMEABILITY Moisture Ratio (%) Permeability Permeability Permeability Permeability Permeability	Moisture Ratio (%) Placement Dry Density (t/m³) Density Ratio (%) PERMEABILITY Moisture Ratio (%) Permeability Permeability Permeability Permeability Permeability							
Placement Dry Density (t/m³) Density Ratio (%) PERMEABILITY Region 1.68 Percentage Material Retained/Sieve Size (mm) 164 x 98mm 164 x 98m	Placement Dry Density (t/m³) Density Ratio (%) PERMEABILITY Region 1.68 Percentage Material Retained/Sieve Size (mm) PERMEABILITY Permeability Permeability Permeability 1.68 Percentage Material Retained/Sieve Size (mm) 1.64 x 98mm 1.64 x 98mm Permeability Permeability 1.68 Percentage Material Retained/Sieve Size (mm) 1.64 x 98mm 1.68 Percentage Material Retained/Sieve Size (mm) 1.64 x 98mm 1.68 Percentage Material Retained/Sieve Size (mm) 1.64 x 98mm 1.68 Percentage Material Retained/Sieve Size (mm) 1.64 x 98mm 1.68 Percentage Material Retained/Sieve Size (mm) 1.64 x 98mm 1.68 Percentage Material Retained/Sieve Size (mm) 1.64 x 98mm 1.68 Percentage Material Retained/Sieve Size (mm) 1.64 x 98mm 1.68 Percentage Material Retained/Sieve Size (mm) 1.64 x 98mm 1.68 Percentage Material Retained/Sieve Size (mm) 1.64 x 98mm 1.68 Percentage Material Retained/Sieve Size (mm) 1.64 x 98mm 1.68 Percentage Material Retained/Sieve Size (mm) 1.64 x 98mm 1.68 Percentage Material Retained/Sieve Size (mm) 1.64 x 98mm 1.68 Percentage Material Retained/Sieve Size (mm) 1.64 x 98mm 1.68 Percentage Material Retained/Sieve Size (mm) 1.64 x 98mm 1.64 x 98mm 1.68 Percentage Material Retained/Sieve Size (mm) 1.64 x 98mm 1.64 x 98mm 1.68 Percentage Material Retained/Sieve Size (mm) 1.64 x 98mm 1.64 x 98mm 1.64 x 98mm 1.65 x 90mm 1.66 x		` ,				,	
PERMEABILITY k ₍₂₀₎ = 4.42E-10 (m/sec) Permeability 164 x 98mm	PERMEABILITY k ₍₂₀₎ = 4.42E-10 (m/sec) Permeability 164 x 98mm		, ,		Percentag	<u>.</u>		
PERMEABILITY $k_{(20)} = 4.42E-10$ (m/sec) Permeability $ \begin{array}{c} 089 \\ 4.600E-10 \\ 4.600E$	PERMEABILITY $k_{(20)} = 4.42E-10$ (m/sec) Permeability $k_{(20)} = 4.42E-10$ (m/sec)			00.4	0			
4500E-10 4000E-10 3500E-10 2500E-10 2500E-10 1500E-10 1000E-10 5000E-11	4500E-10 400E-10 3500E-10 2500E-10 2500E-10 1500E-10 1500E-10 5000E-11			_	San			L
4,000E-10 3,500E-10 2,500E-10 2,500E-10 1,500E-10 1,500E-10 5,500E-11	4000E-10 3500E-10 2500E-10 2000E-10 1500E-10 1000E-10 5000E-11			k ₍₂₀₎ =				L
3,500E-10 2,500E-10 2,500E-10 1,500E-10 1,000E-10 5,000E-11	3500E-10 2500E-10 2000E-10 1.500E-10 1.000E-10 5.000E-11		PERMEABILITY	k ₍₂₀₎ =				L
33000E-10 2000E-10 2000E-10 1000E-10 5000E-11	3300E-10 2500E-10 2000E-10 1,000E-10 1,000E-10 5000E-11	5.000E-	PERMEABILITY	k ₍₂₀₎ =				
2.500E-10 2.000E-10 1.000E-10 5.000E-11	2500E-10 2000E-10 1,000E-10 5,000E-11	5.000E- 4.500E-	PERMEABILITY	k ₍₂₀₎ =				L
1.000E-10 5.000E-11	1.000E-10 5.000E-11	5.000E- 4.500E- 4.000E-	PERMEABILITY	k ₍₂₀₎ =				
1.000E-10 5.000E-11	1.000E-10 5.000E-11	5,000E- 4,500E- 4,000E- 3,500E-	PERMEABILITY	k ₍₂₀₎ =				L
1.000E-10 5.000E-11	1.000E-10 5.000E-11	5,000E- 4,500E- 4,000E- 3,500E-	PERMEABILITY	k ₍₂₀₎ =				L
5.000E-11	5.000E-11	5,000E- 4,500E- 4,000E- 3,500E-	PERMEABILITY 10 10 10 10 10 10	k ₍₂₀₎ =				L
5.000E-11	5.000E-11	5,000E- 4,500E- 4,000E- 3,500E- 3,000E- 2,000E- 2,000E-	PERMEABILITY	k ₍₂₀₎ =				
		5,000E- 4,000E- 3,000E- 2,000E- 2,000E- 2,000E- 1,000E-	PERMEABILITY	k ₍₂₀₎ =				
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		A \$ 1 2 9	39 6.7.2			
	<u></u>	A3120				
Client:	Bogan Shire Council		Source:	TP12 9.8-1.	0m	
Address:	PO Box 221, Nyngan, NSW 2925		Sample Description:	Sandy CLAY		
Project:	Nyngan		Report No.:	18-FHP		
Job No.:	12-047		Lab No.:	9724#3		
est Procedure	e: 🗹 AS1289 6.7.2	Soil strength and consolidation tests	s - Determination of a soil	- Falling head method	for a remoulded specimen	
	☑ AS1289 5.1.1	Soil compaction and density tests - I	Determination of the dry	density/moisture conten	t relationship of a soil using standard con	npactive effort
Sampling:	Sampled by Macquarie Ge		dance with AS12	89 1.1	Date Sampled:	23/11/2012
reparation:	Prepared in accordance w	ith AS1289 1.1				
		RESULTS	OF TESTING			
Maxi	imum Dry Density (t/m³)	1.66		Hydraulic	Gradient	0.0
Optim	num Moisture Content (%)	21.0		Surcharg	ge (kPa)	0.0
Placen	ment Moisture Content (%)	20.5	ŀ	lead Pressure	Applied (kPa)	0.00
	Moisture Ratio (%)	97.7		Comp	action	Standard
Place	ement Dry Density (t/m³)	1.63	Percentag	je Material Re	ained/Sieve Size (mm)	0 % on 9.5 mi
	Density Ratio (%)	97.9	San	nple Height an	d Diameter (mm)	104 x 98 mm
	PERMEABILITY	k ₍₂₀₎ =		8.071	E-11 (m/s	ec)
	PERMEABILITY		eability	8.071	E-11 (m/s∈	ec)
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