



Douglas Partners
Geotechnics | Environment | Groundwater

Report on
Geotechnical Investigation

Mudgee Hospital Redevelopment
Lewis Street
Mudgee

Prepared for
Health Infrastructure

Project 86091.00
April 2018

Integrated Practical Solutions





Douglas Partners

Geotechnics | Environment | Groundwater

Document History

Document details

Project No.	86091.00	Document No.	R.002
Document title	Report on Geotechnical Investigation Mudgee Hospital Redevelopment		
Site address	Lewis Street, Mudgee		
Report prepared for	Health Infrastructure		
File name	86091.00.R.002.Rev0.Mudgee Geotech		

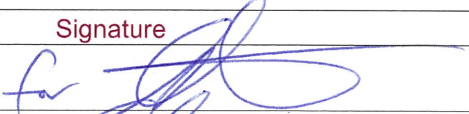
Document status and review

Revision	Prepared by	Reviewed by	Date issued
DftA	P Oitmaa	S Easton	29 September 2017
Rev0	P Oitmaa	S Easton	27 April 2018

Distribution of copies

Revision	Electronic	Paper	Issued to
DftA	1	-	TSA Management Pty Ltd
Rev0	1	-	TSA Management Pty Ltd

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		27 April 2018
Reviewer		27 April 2018



Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
96 Hermitage Road
West Ryde NSW 2114
PO Box 472
West Ryde NSW 1685
Phone (02) 9809 0666
Fax (02) 9809 4095

Table of Contents

	Page
1. Introduction.....	1
2. Site Description	1
3. Regional Geology and Hydrogeology	2
4. Field Work Methods	2
5. Field Work Results	3
6. Laboratory Testing	3
7. Geotechnical Model	4
8. Proposed Development.....	4
9. Comments	5
9.1 Excavation	5
9.2 Excavation Support.....	5
9.2.1 General	5
9.2.2 Earth Pressures	5
9.3 Site Preparation	6
9.4 Groundwater	6
9.5 Foundations	7
9.5.1 Site Classification.....	7
9.5.2 Spread Footings.....	7
9.5.3 Raft Slabs.....	8
9.5.4 Piles	8
9.6 Pavements	9
9.7 Aggressivity.....	9
9.8 Seismicity.....	9
10. Limitations	9
Appendix A: About this Report	
Appendix B: Drawings	
Appendix C: Site Photographs	
Appendix D: Field Work Results	
Appendix E: Laboratory Test Results	

Report on Geotechnical Investigation

Mudgee Hospital Redevelopment

Lewis Street, Mudgee

1. Introduction

This report presents the results of a geotechnical investigation undertaken for the proposed redevelopment of Mudgee Hospital located at Lewis Street, Mudgee. The work was commissioned by Health Infrastructure in consultation with TSA Management Pty Ltd, project managers.

The project involves demolition, construction and refurbishment of facilities at Mudgee Hospital. It is likely that the works will be undertaken across numerous stages and will include a new Emergency Department, a General Medical and Surgical Unit, Operating Theatre and Perioperative Service, a new Maternity Unit, and a new Renal Dialysis Unit, Ambulatory Care, Oral Health and Oncology Unit.

Investigation was undertaken to provide information on the subsurface conditions on the site and included the drilling of augered boreholes, laboratory testing and engineering analysis. Details of the field work and laboratory testing programme, and comments relevant to design and construction are provided in this report.

A Preliminary Site Investigation for contamination assessment purposes was undertaken at the same time as the geotechnical investigation and is reported separately.

2. Site Description

Mudgee Hospital is located in the central part of town and is bounded by a railway line to the north, Lewis Street to the east, Meares Street to the south and Church Street to the west. Mudgee Medical Centre is also located in the central-western portion of this block but is separate to the hospital. The hospital site is approximately 3.8 ha in area. The ground surface on the site slopes gently downwards to the north-east and north-west; surface levels vary between about RL 478 m and RL 472 m AHD.

The location of the site is shown on Drawing 1 in Appendix B.

The site is currently used as a hospital. Several buildings are scattered around the site and the remainder of the area is generally vacant. Relevant site features are shown on Drawing 2 in Appendix B.

Photographs of the site taken during the investigation are provided in Appendix C. The location and orientation of each photograph is shown in Drawing 3 in Appendix B.

3. Regional Geology and Hydrogeology

Geological mapping indicates that the site is close to a boundary between Quaternary alluvium (gravel, sand, silt and clay) and the Queens Pinch Group (sandstone, mudstone, conglomerate and limestone). The Tannabutta Group (rhyolite and sandstone) is shown to the west of the site. An extract from the geological map is shown in Figure 1.



Figure 1: Extract from geological map

The topography of the site suggests that groundwater is likely to flow in a northerly direction towards the Cudgegong River.

4. Field Work Methods

The field work for the geotechnical investigation included the drilling of 10 boreholes to depths of between 2.5 m and 8.0 m at the locations shown on Drawing 4 in Appendix B. All boreholes were drilled using solid flight augers. Standard penetration tests (SPTs) were undertaken at regular depth intervals and all field work was supervised on site by a geotechnical engineer.

The ground surface levels at the bores (to AHD) were interpolated from a survey plan using coordinates measured using a differential global positioning system (dGPS) receiver.

5. Field Work Results

The subsurface conditions encountered in the boreholes are presented in the borehole logs in Appendix D. Notes defining descriptive terms and classification methods are included in Appendix A.

The boreholes encountered the following materials:

-) Concrete: 80 mm thick concrete pavement in BH3 only.
-) Topsoil/filling: clayey, silty and sandy topsoil with varying proportions of gravel to depths of between 0.1 m and 0.9 m.
-) Natural Soils: typically clayey soils with varying proportions of quartz gravel, ironstone gravel, sand and silt to depths of between 1.3 m and 6.5 m. The soils were firm to hard in consistency.
-) Weathered Bedrock: typically extremely low to low strength siltstone and sandstone to the base of the bore holes at depths of between 2.5 m and 8.0 m.

Seepage was observed at 3.5 m depth in BH8 only. Seepage/groundwater was not observed at the other test locations during drilling. The boreholes were backfilled immediately on completion and no long term monitoring has been carried out.

6. Laboratory Testing

Selected soil samples were analysed to assess the strength of the soils for pavement design purposes, the plasticity and reactivity of the soils, and the aggressivity of the soils to buried steel and concrete elements. A summary of the results is provided in Tables 1 and 2.

Table 1: Summary of Laboratory Test Results for Physical Properties

Sample	Depth (m)	Type	CBR (%)	MDD (t/m ³)	W _L (%)	W _P (%)	PI (%)
BH7	0.25-0.5	Clay	6	1.81	46	16	30
BH8	0.1-0.3	Silty clay	11	1.69	34	20	14
BH1	1.0-1.45	Clay	-	-	43	16	27
BH10	2.5-2.95	Clay	-	-	50	17	33

Notes: CBR = California bearing ratio; MDD = maximum dry density; W_L = liquid limit; W_P = plastic limit; PI = plasticity index

Table 2: Summary of Laboratory Test Results for Chemical Properties

Sample	Depth (m)	Type	pH (pH units)	EC (mS/cm)	Chloride ion (mg/kg)	Sulphate ion (mg/kg)
BH1	4.0-4.35	Siltstone	4.6	840	420	1100
BH3	2.4-2.5	Clay	9.0	150	20	36
BH6	0-0.1	Clay	7.6	33	<10	<10
BH9	0.4-0.5	Clay	8.5	830	310	1200

Notes: EC = electrical conductivity; All samples mixed 1(soil):5(water) prior to testing

The detailed laboratory test results are provided in Appendix E.

7. Geotechnical Model

The site appears to be underlain by a thin layer of topsoil/filling overlying natural clayey soils. The natural soils were typically stiff or stronger. The laboratory test results indicate that the clays are of medium to high plasticity which suggests that they are moderately reactive to changes in moisture content. The CBR results suggest that the clays lose strength when saturated.

The soils were underlain by either siltstone or sandstone bedrock which was initially of extremely low to very low strength. The depth to the top of rock varied between 1.3 m and 6.5 m based on the results of the augered boreholes.

Groundwater was not encountered within the depth of investigation and is likely to be well below the bedrock surface. Seepage was observed at 3.5 m depth in one location (BH8) which is likely to have been perched water above the bedrock.

8. Proposed Development

The project will involve the construction of new buildings in a staged programme that will ultimately replace existing buildings on the site. The new structures are likely to be up to 2-storeys in height with column loads between 2000 kN and 3000 kN (working) depending on the nature of the final structures. Hardstand pavement areas will also be constructed.

The geotechnical issues considered relevant to the proposed development include excavation, excavation support, site preparation, groundwater, foundations and pavements. Comments on aggressivity and seismicity are also provided.

9. Comments

9.1 Excavation

Excavation on the site will likely be required in clayey soils and possibly weathered bedrock. The strength of materials requiring excavation will depend on the final design levels. Excavation in soil and extremely low to very low strength rock should be readily achievable using conventional earthmoving equipment such as hydraulic excavators with bucket attachments. Excavation in low strength and stronger rock (if encountered) will probably require the use of ripping equipment and/or rock hammers.

It should be noted that any off-site disposal of spoil will generally require assessment for re-use or classification in accordance with current *Waste Classification Guidelines* (NSW EPA, 2014).

9.2 Excavation Support

9.2.1 General

Vertical excavations in engineered filling and clayey soils are not expected to be self-supporting for any extended period of time. Temporary batters should be feasible on the site. A maximum temporary batter slope of 1(H):1(V) is recommended for cuts up to 3 m in height in the natural clay soils and filling comprising clay and weathered rock excavated from the site.

Permanent batters should be no steeper than 3(H):1(V) and should be covered with appropriate vegetation to reduce the risk of erosion and dispersion of the clayey soils.

9.2.2 Earth Pressures

Temporary or permanent retaining walls may be required on the site. Suitable design parameters for retention systems are shown in Table 3.

Table 3: Design Parameters for Retaining Walls

Material	Coefficient of Active Earth Pressure (K_a)	Coefficient of Passive Earth Pressure (K_p)	Bulk Unit Weight (kN/m^3)
Engineered Filling	0.35	2.75	20
Stiff Clay	0.30	3.33	20
Very Stiff to Hard Clay	0.25	4.00	20
Weathered Rock	0.15	300 kPa	20

Note: Multiply K_a values by 1.5 to get K_o values for retaining wall design

Cantilevered retaining walls could be designed assuming a triangular lateral earth pressure distribution. Allowance for appropriate drainage (or hydrostatic pressure), sloping ground surfaces and surcharge loads should also be made where applicable. Drainage must be provided, otherwise the design should include allowance for hydrostatic pressures.

Passive pressures can only be used to provide lateral support to retaining walls that are founded below the ground surface at the base of the wall. The upper 1 m of soil in the passive zone (where present) should be ignored to account for soil shrinkage which could be expected to occur over time.

9.3 Site Preparation

Areas on the site that are to be filled to support structures, pavements and services should be stripped of vegetation, organic topsoil and any existing filling (if present). The exposed subgrade should be proof-rolled in the presence of an experienced geotechnical professional using a minimum 8 tonne pad-foot or steel smooth drum roller. Any areas on the site exhibiting excessive deflection should be excavated and replaced with suitable granular material compacted in layers. Specific remediation advice can be provided on site once the subgrade has been inspected.

Any filling required on the site should be placed in layers not exceeding a loose thickness of 250 mm and compacted to a dry density ratio of between 98% and 102% relative to Standard compaction. If the filling exhibits clay-like properties then it should be prepared within 2% of the Standard optimum moisture content.

The soil and weathered rock on the development site should be suitable for reuse from a geotechnical perspective providing all deleterious materials (e.g. particles greater than 150 mm diameter, organic material etc.) are removed from the filling prior to compaction. The Atterberg limit and linear shrinkage test results indicate that the soils on the site are moderately reactive to changes in moisture content and it is therefore important to place this material as close to optimum moisture as possible to reduce the potential for significant shrink/swell movements.

For the construction phase of the project, consideration should be given to placing a 150 mm thick layer of granular material (e.g. ripped or crushed rock) as the top layer of unformed roads in order to provide a trafficable surface that will be less prone to disturbance from machinery and wet weather.

Filling placed and compacted in accordance with this report may experience long-term settlements of 0.1% to 0.3% of the filling depth. This is in addition to settlement caused by the application of loads on the surface of the filling and from reactive soil movements.

Australian Standard AS 3798 – 2007 *Guidelines on earthworks for commercial and residential developments* provides guidance as to appropriate testing frequencies for the testing of filling. It is recommended that all compaction control testing in areas that will support buildings and pavements be undertaken at Level 1 responsibility.

9.4 Groundwater

Groundwater was not observed on the site and is expected to be well below the bedrock surface. Seepage through the soils and weathered rock would be expected to occur during and following periods of significant rainfall and may be encountered in excavations and bored piles on the site. Drainage should be provided for any subsurface structures proposed.

A pump may need to be used during the construction of bored piles (if used) to remove seepage from the pile holes prior to pouring concrete. If significant water inflows eventuate then a tremie system may be needed to construct the piles.

9.5 Foundations

9.5.1 Site Classification

The laboratory testing programme indicates that a Class M-D classification would be appropriate in accordance with Australian Standard AS 2870 – 2011 *Residential slabs and footings*. Areas underlain by uncontrolled filling may be Class P, depending on the depth of the filling, and site preparation would be required in these areas to achieve a Class M-D classification. The presence of trees in the area of works may also require a more stringent classification, depending on the locations of the buildings.

9.5.2 Spread Footings

Spread footings (e.g. pad footings and strip footings) may be suitable for supporting new structures on the site. The parameters provided in Table 4 could be used to design spread footings.

Table 4: Design Parameters for Spread Footings

Material	Allowable Bearing Pressure (kPa)	Ultimate Bearing Pressure (kPa)	Modulus of Elasticity (MPa)
Engineered Filling	150	300	15
Stiff Clay	150	300	15
Very Stiff to Hard Clay	250	500	25
ELS and VLS Rock	500	1500	50

Notes: ELS = extremely low strength; VLS = very low strength

The settlement of a spread footing is dependent on the loads applied to the footing, the foundation conditions below the footing and the footing dimensions. The total settlement of a spread footing designed using the parameters provided in this report would be expected to be less than about 1% of the footing width upon application of the design load.

It is noted that the laboratory test results indicate moderately reactive soil conditions on the site which may be exacerbated by the removal of trees and the resulting increase in soil moisture content likely to be experienced. Australian Standard AS 2870 – 2011 *Residential slabs and footings* indicates unrestrained free-surface movements of up to 40 mm for sites of moderate reactivity. Allowance for some ground movement should therefore be made in the design of structural elements founded in the clayey soils.

All footing excavations should be inspected by a geotechnical engineer to check the adequacy of the foundation material.

9.5.3 Raft Slabs

Raft slabs founded in engineered filling or clayey soil may be appropriate in the case that spread footings cannot support the column loads. The design of a raft slab is an iterative process but for initial design purposes a modulus of subgrade reaction (k_s) in the order of 5 kPa/mm to 7 kPa/mm could be assumed for engineered filling and clayey soils. This was calculated assuming a raft slab distributes a 3000 kN column load over a slab area of 8 m by 8 m.

9.5.4 Piles

Bored piles could be used to support heavier column loads or to provide uplift resistance if required. The parameters provided in Table 5 could be used to design bored piles. Parameters for both the working stress and limit-state approaches have been provided.

Table 5: Design Parameters for Bored Piles

Material	Allowable End-Bearing Pressure (kPa)	Allowable Shaft Adhesion* (kPa)	Ultimate End-Bearing Pressure (kPa)	Ultimate Shaft Adhesion* (kPa)	Modulus of Elasticity (MPa)
Engineered Filling	NA	NA	NA	NA	NA
Stiff Clay	NA	15	NA	30	15
Very Stiff to Hard Clay	NA	25	NA	50	25
ELS and VLS Rock	500	50	1500	100	50
LS Rock**	2000	200	6000	600	200
MS Rock**	3500	350	10,000	1000	500

Notes: ELS = extremely low strength; VLS = very low strength; LS = low strength; MS = medium strength; NA = not applicable

*Reduce by 50% for tension piles; **Would need to be proven with cored boreholes

A geotechnical strength reduction factor (ϕ_g) should be applied to the ultimate values provided in Table 5 if the limit-state design process is undertaken to design the piles. Australian Standard AS 2159 – 2009 *Piling – Design and installation* provides information on how to determine an appropriate value of ϕ_g which is based on a risk assessment. The pile designer will need to confirm a ϕ_g value when the piling contractor is selected, however it is suggested that a preliminary value of 0.50 be adopted at this stage, or 0.40 if pile testing is to be avoided.

It should be noted that the serviceability limit-state is likely to govern the design of the piles and the ultimate bearing pressures provided in Table 5 are unlikely to be achieved in practice.

The settlement of a pile is dependent on the loads applied to the pile and the foundation conditions in the socket zone and below the pile toe. The total settlement of a pile designed using the 'allowable' parameters in Table 5 would be expected to be less than 5 mm upon application of the design load.

It is recommended that the upper 1 m of clayey soil/filling (where present) be ignored in the design of the piles to account for soil shrinkage which could be expected to occur over time.

All bored pile excavations should be inspected by a geotechnical engineer to check the adequacy of the foundation material and, in the case of piles relying on shaft adhesion, the socket roughness.

9.6 Pavements

The laboratory test results for CBR ranged from 6% to 11%. It is recommended that a design subgrade CBR of 3% be adopted for the site to account for weaker areas of subgrade that would be expected in the clayey soils. This equates to a long-term Young Modulus of 20 MPa for pavement design purposes.

Pavement areas subjected only to light traffic (e.g. passenger vehicles and commercial vehicles up to 2 tonne gross vehicle mass) could be constructed by preparing the subgrade in accordance with Section 9.3 of this report and placing 250 mm of DGB20, less the thickness of the asphalt wearing surface, on the subgrade. The DGB20 should be compacted to a dry density ratio of at least 100% relative to Standard compaction.

Pavements subjected to heavier vehicles should be designed according to the proposed traffic loading, required design life and other operational factors.

Appropriate cross-fall and subsurface drainage should be provided to reduce the risk of the clayey subgrade becoming saturated during periods of wet weather. Good construction practice, such as installing subsurface drains around the perimeter of any garden or grassed areas, will also help to reduce the chance of subgrade deterioration caused by excessive irrigation.

9.7 Aggressivity

The laboratory test results for soil aggressivity were compared with the exposure classifications outlined in Australian Standard AS 2159 – 2009 *Piling – Design and installation*. The results indicate that the soils are mildly aggressive to buried steel and concrete elements.

9.8 Seismicity

A Hazard Factor (Z) of 0.08 would be appropriate for the development site in accordance with Australian Standard AS 1170.4 – 2007 *Structural design actions – Part 4: Earthquake actions in Australia*. The site sub-soil class is expected to be Class C_e.

10. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for the Mudgee Hospital redevelopment, Lewis Street, Mudgee, in accordance with Contract HI17285 between Health Infrastructure and Douglas Partners. The report is provided for the use of Health Infrastructure for this project only and for the purpose(s) described in the report. It should not be used for other projects or by a third party.

The results provided in the report are indicative of the sub-surface conditions only at the specific sampling or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological processes and also as a result of anthropogenic influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be limited by undetected variations in ground conditions between sampling locations. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

This report must be read in conjunction with all of the attached notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion given in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk.

Douglas Partners Pty Ltd

Appendix A

About this Report

About this Report

Douglas Partners



Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

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

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

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

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

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

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

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

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

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

Drawings









 Borehole location

Appendix C

Site Photographs



Photo 1 - South-western corner looking north



Photo 2 - South-western corner looking east



Site Photographs

Preliminary Site Investigation

MUDGEES

CLIENT: Health Infrastructure

PROJECT: 86091.00

PLATE No: S1

REV: 0

DATE: 22-Sep-17



Photo 3 - Area to east of Community Health building looking north-east



Photo 4 - Area to north of Community Health building looking north-west



Site Photographs

Preliminary Site Investigation

MUDGEES

CLIENT: Health Infrastructure

PROJECT: 86091.00

PLATE No: S2

REV: 0

DATE: 22-Sep-17



Photo 5 - Area to south of Wellness Centre looking east



Photo 6 - View of Boiler House looking north



Site Photographs
Preliminary Site Investigation
MUDGEES

CLIENT: Health Infrastructure

PROJECT: 86091.00

PLATE No: S3

REV: 0

DATE: 22-Sep-17



Photo 7 - Area to north of Wellness Centre looking north towards dwelling



Photo 8 - Area to north of Boiler House looking east towards Helipad



Site Photographs

Preliminary Site Investigation

MUDGEES

CLIENT: Health Infrastructure

PROJECT: 86091.00

PLATE No: S4

REV: 0

DATE: 22-Sep-17



Photo 9 - Northern part of Boiler House looking east



Photo 10 - North-western area of Main Building looking east



Site Photographs

Preliminary Site Investigation

MUDGEES

CLIENT: Health Infrastructure

PROJECT: 86091.00

PLATE No: S5

REV: 0

DATE: 22-Sep-17



Photo 11 - Gas tanks and electricity substation to south-west of Main Building



Photo 12 - Main Building from south-eastern corner of site looking west



Photo 13 - View from south-eastern corner of site looking north



Photo 14 - Main Building from central eastern boundary looking west



Site Photographs

Preliminary Site Investigation

MUDGEES

CLIENT: Health Infrastructure

PROJECT: 86091.00

PLATE No: S7

REV: 0

DATE: 22-Sep-17



Photo 15 - Vacant building north of Main Building looking west



Photo 16 - View from north-eastern corner looking south

 Douglas Partners Geotechnics Environment Groundwater	Site Photographs		PROJECT: 86091.00
	Preliminary Site Investigation		PLATE No: S8
	MUDGEES		REV: 0
	CLIENT: Health Infrastructure		DATE: 22-Sep-17



Photo 17 - View of northern portion of site looking west



Photo 18 - View of northern portion of site looking west



Site Photographs

Preliminary Site Investigation

MUDGEES

CLIENT: Health Infrastructure

PROJECT: 86091.00

PLATE No: S9

REV: 0

DATE: 22-Sep-17

Appendix D

Field Work Results



Sampling

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

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

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low

reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

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

The test results are reported in the following form.

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

Sampling Methods

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.



Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 - 5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.



Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 2007. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approximate Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and longer sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

Douglas Partners



Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U ₅₀	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

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

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

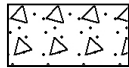
General



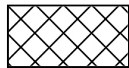
Asphalt



Road base



Concrete



Filling

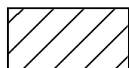
Soils



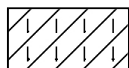
Topsoil



Peat



Clay



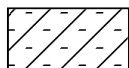
Silty clay



Sandy clay



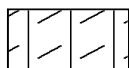
Gravelly clay



Shaly clay



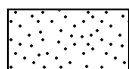
Silt



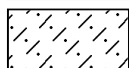
Clayey silt



Sandy silt



Sand



Clayey sand



Silty sand



Gravel



Sandy gravel



Cobbles, boulders



Talus

Sedimentary Rocks



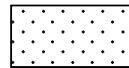
Boulder conglomerate



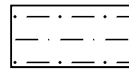
Conglomerate



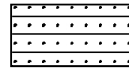
Conglomeratic sandstone



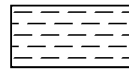
Sandstone



Siltstone



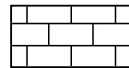
Laminite



Mudstone, claystone, shale

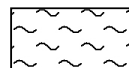


Coal

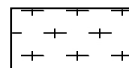


Limestone

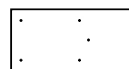
Metamorphic Rocks



Slate, phyllite, schist

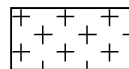


Gneiss

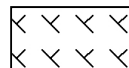


Quartzite

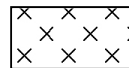
Igneous Rocks



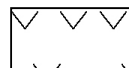
Granite



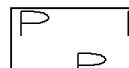
Dolerite, basalt, andesite



Dacite, epidote



Tuff, breccia



Porphyry

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Mudgee Hospital Redevelopment
LOCATION: Lewis Street, Mudgee

SURFACE LEVEL: 473.6 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 86091.00
DATE: 17/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
473 472 471 470 469 468 467 466 465 464	0.35	TOPSOIL - dark grey, sandy silt topsoil with some gravel (possibly ash), humid		D/E	0.0 0.1					
		CLAY - very stiff, red-brown mottled grey clay with traces of coarse sand and silt, damp		D/E	0.5 0.6		pp = 320			
	1			S	1.0 1.45		5,7,11 N = 18		1	
	2	1.9m: turning orange							2	
	2.5			S	2.5 2.95		3,2,5 N = 7			
	3	CLAY - firm, orange mottled grey clay with traces of medium to coarse sand and quartz gravel							3	
	3.0				4.0 4.45		4,16,15/50mm refusal bouncing		4	
	4	SILTSTONE - extremely low to very low strength, yellow-brown siltstone, damp		S						
	4.45	Bore discontinued at 4.45m - target depth reached								
	5								5	
	6								6	
	7								7	
	8								8	
	9								9	

RIG: Edson 3000

DRILLER: A Britton

LOGGED: LS

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



Douglas Partners
 Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Mudgee Hospital Redevelopment
LOCATION: Lewis Street, Mudgee

SURFACE LEVEL: 474.8 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 86091.00
DATE: 17/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
474 473 472 471 470 469 468 467 466 465	0.11	TOPSOIL - dark grey, sandy silt topsoil with some gravel, damp CLAY - brown clay with some ironstone gravel, moist		D/E	0.0 0.1					
	1.1	CLAY - stiff to very stiff, orange mottled grey clay with some silt, damp		S	1.0 1.45		2,5,11 N = 16			
	1.8	CLAY - hard, light brown mottled grey clay with some ironstone gravel and silt, damp (possibly extremely weathered siltstone)			1.8		drill crunching			
				S	2.5 2.95		12,15,21 N = 36			
		3.2m: quartz gravel								
		4.0m: moist		S	4.0		9,22/100mm refusal bouncing			
		4.8m: damp		S	5.0		4,13,11/50mm refusal bouncing			
	5.5	SANDSTONE - extremely low to very low strength, yellow-brown sandstone, damp								
	5.95	Bore discontinued at 5.95m - target depth reached								

RIG: Edson 3000

DRILLER: A Britton

LOGGED: LS

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



Douglas Partners
 Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Mudgee Hospital Redevelopment
LOCATION: Lewis Street, Mudgee

SURFACE LEVEL: 476.2 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 86091.00
DATE: 18/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
476	0.08	CONCRETE		D/E	0.0					
	0.4	FILLING - dark grey clay topsoil with some medium grained sand, moist		D/E	0.1					
					0.4					
					0.5					
	0.9	FILLING - grey mottled yellow-grey, clay topsoil with some medium grained sand and ironstone gravel, moist		E	0.9					
1				S	1.0		3,4,5 N = 9		1	
		GRAVELLY CLAY - stiff, brown, gravelly clay, ironstone and gravel, with traces of medium to fine sand, damp			1.45					
	1.7									
2	2.0	CLAY - red-brown clay with traces of medium grained sand, damp							2	
		CLAY - stiff to very stiff, grey mottled orange clay, damp		E	2.4					
				S	2.5		4,8,7 N = 15			
					2.95				3	
3										
	4.1	SILTSTONE - extremely low to very low strength, yellow-brown siltstone, damp		S	4.0		4,8,17 N = 25		4	
		4.5m: quartz gravel			4.45					
4										
	5								5	
				S	5.5		2,12,16/10mm refusal bouncing			
5.8		Bore discontinued at 5.8m - target depth reached							6	
6										
	7								7	
	8								8	
	9								9	

RIG: Edson 3000

DRILLER: A Britton

LOGGED: LS

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



Douglas Partners
 Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Mudgee Hospital Redevelopment
LOCATION: Lewis Street, Mudgee

SURFACE LEVEL: 473.7 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 86091.00
DATE: 17/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
473 472 471 470 469 468 467 466 465 464	0.35	TOPSOIL - dark grey, sandy clay topsoil, fine grained sand with some silt, damp		D/E*	0.0 0.1					
		CLAY - brown clay with traces of fine sand, silt, moist			0.5 0.6					
	1	0.9m: turning orange-brown			1.0					
	1.22	CLAY - hard, brown mottled grey clay with some fine to medium sand, silt and ironstone gravel		S	1.45		4,14,24 N = 38			
		1.4m: turning grey mottled orange			1.5		1.5-2.5m: hard drilling			
	2									
		2.5m: stiff		S	2.5		3,5,8 N = 13			
	3				2.95					
	4	4.0m: hard (possibly extremely weathered siltstone)		S	4.0		4,10,22 N = 32			
					4.45					
6 7 8 9	5.95	Bore discontinued at 5.95m - target depth reached in very low to low strength siltstone		S	5.5		4,25/100mm refusal bouncing			

RIG: Edson 3000

DRILLER: A Britton

LOGGED: LS

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: *Replicate sample T5 collected

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



Douglas Partners
 Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Mudgee Hospital Redevelopment
LOCATION: Lewis Street, Mudgee

SURFACE LEVEL: 474.8 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 86091.00
DATE: 17/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
474 473 472 471 470 469 468 467 466 465	0.3	TOPSOIL - dark grey clay topsoil with some sand and silt and traces of ironstone, damp		D/E	0.0					
	0.5	CLAY - brown clay with some silt, damp		D/E	0.1					
		CLAY - very stiff, orange-brown mottled grey clay with traces of fine sand, silt and ironstone, damp			0.4					
					0.5					
	1			E	0.9					
				S	1.0		4,9,15 N = 24			
		1.5m: sandstone/ironstone gravel			1.45					
	2									
	2.5			E+S	2.5		5,20/100mm refusal bouncing			
	3	CLAY - hard, grey mottled orange clay with some ironstone and siltstone gravel and traces of fine sand, damp (possibly extremely weathered sandstone)								
468 467 466 465	4	4.0m: moist		S	4.0		5,13,17 N = 30			
					4.45					
	5	4.8m: damp								
	5.5			S	5.5		5,14,15/50mm refusal bouncing			
	5.95	SILTSTONE - very low to low strength, yellow-brown siltstone, damp								
	6	Bore discontinued at 5.95m - target depth reached								
	7									
	8									
	9									

RIG: Edson 3000

DRILLER: A Britton

LOGGED: LS

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: *Replicate samples T1 and T2 collected

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



Douglas Partners
 Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Mudgee Hospital Redevelopment
LOCATION: Lewis Street, Mudgee

SURFACE LEVEL: 476.6 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 86091.00
DATE: 18/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
476	0.4	TOPSOIL - dark brown clay topsoil with some ironstone gravel and traces of sand, humid		D/E	0.0					
				0.1						
1		GRAVELLY CLAY - very stiff, light brown, gravelly clay with traces of medium grained sand, humid		D/E	0.5					
					0.6					
475				E	1.0					
				S	1.45					
2		CLAY - very stiff, grey mottled orange clay, damp								
3				S	2.5					
					2.95					
4		- turning grey mottled red with traces of ironstone								
473					4.0					
				S	4.45					
5										
472										
6		CLAY - very stiff to hard, brown mottled grey clay with traces of siltstone gravel, damp			5.0					
471				S	5.5					
					5.95					
7		SILTSTONE - very low to low strength, yellow-brown siltstone, damp								
				S	7.0					
8		Bore discontinued at 7.95m - target depth reached								
9										

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Mudgee Hospital Redevelopment
LOCATION: Lewis Street, Mudgee

SURFACE LEVEL: 476.3 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: BH7
PROJECT No: 86091.00
DATE: 18/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
476	0.25	TOPSOIL - brown silty clay topsoil with traces of fine sand and ironstone, humid		E/D	0.0					
					0.1					
					0.25		0.25-0.5m: Bulk sample			
	0.5	CLAY - red-brown clay with traces of fine sand and silt, damp		E/D	0.4					
					0.5					
		CLAY - very stiff, orange mottled grey clay with some silt, damp								
1				E	1.0				1	
				S			4,10,12 N = 22			
					1.45					
2		2.2m: turning grey mottled orange							2	
					2.5					
		2.8m: turning grey mottled red		S			6,9,10 N = 19			
					2.95				3	
3	3.2	SILTSTONE - very low to low strength, yellow-brown siltstone, damp								
4				S	4.0		7,15,20/100mm refusal bouncing		4	
4.45		Bore discontinued at 4.45m - target depth reached								
5									5	
6									6	
7									7	
8									8	
9									9	

RIG: Edson 3000

DRILLER: A Britton

LOGGED: LS

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



Douglas Partners
 Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Mudgee Hospital Redevelopment
LOCATION: Lewis Street, Mudgee

SURFACE LEVEL: 474.2 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: BH8
PROJECT No: 86091.00
DATE: 17/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
474	0.1	TOPSOIL - dark grey silty clay topsoil, humid		D/E	0.0					
				B	0.1					
		SILTY CLAY - very stiff, brown silty clay with traces of gravel, humid		D/E	0.3					
					0.4					
					0.5					
1				E	1.0					
473				S	1.45		8,13,15 N = 28			
1.6		SILTSTONE - extremely low to very low strength, grey mottled red and orange siltstone with some ironstone								
2										
472										
		2.6m: siltstone gravel		S	2.5		5,10,15 N = 25			
2.9		SILTSTONE - extremely low to very low strength, yellow-brown siltstone, moist			2.95					
3										
471										
				S	4.0		18/100mm refusal bouncing			
4	4.1	Bore discontinued at 4.1m - target depth reached								
470										
5										
469										
6										
468										
7										
467										
8										
466										
9										
465										

RIG: Edson 3000

DRILLER: A Britton

LOGGED: LS

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger

WATER OBSERVATIONS: Seepage observed at 3.5m

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



Douglas Partners
 Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Mudgee Hospital Redevelopment
LOCATION: Lewis Street, Mudgee

SURFACE LEVEL: 475.3 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: BH9
PROJECT No: 86091.00
DATE: 17/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
475	0.3	TOPSOIL - brown clay topsoil with some medium grained sand and some ironstone gravel, humid		E/D*	0.0 0.1					
		CLAY - very stiff, brown clay with traces of medium sand, humid		E/D	0.4 0.5					
1	1.3	SILTSTONE - very low to low strength, yellow-brown siltstone, damp		E	1.0		5,9,11 N = 20			
1.45	1.45	SILTSTONE - very low to low strength, yellow-brown siltstone, damp		S	1.45					
2	2.2	SILTSTONE - low to medium strength, red siltstone, damp		D	2.3					
2.5	2.5	Bore discontinued at 2.5m - auger refusal			2.5					
	3									
	4									
	5									
	6									
	7									
	8									
	9									

RIG: Edson 3000

DRILLER: A Britton

LOGGED: LS

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: *Replicate samples T3 and T4 collected

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



Douglas Partners
 Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Mudgee Hospital Redevelopment
LOCATION: Lewis Street, Mudgee

SURFACE LEVEL: 477.1 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: BH10
PROJECT No: 86091.00
DATE: 18/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
477		TOPSOIL - brown silty clay topsoil with traces of gravel and medium grained sand, humid		D/E*	0.0					
	0.35				0.1					
	0.4	CLAY - red-brown clay with traces of silt and fine sand, damp		D/E	0.4					
					0.5					
	1	CLAY - very stiff, light brown clay with some siltstone gravel and traces of fine sand, damp		S	1.0		4,11,13 N = 24		1	
					1.45					
	1.9	CLAY - very stiff, grey mottled orange clay with some silt		S	2.5		4,9,15 N = 24		2	
					2.95					
	3								3	
	3.6	SILTSTONE - extremely low to extremely weathered rock, grey-orange siltstone		S	4.0		13,22/100mm refusal bouncing		4	
	4	4.0m: quartzite gravel								
	4.45	Bore discontinued at 4.45m - target depth reached in very low to low strength siltstone								
	5								5	
	6								6	
	7								7	
	8								8	
	9								9	

RIG: Edson 3000

DRILLER: A Britton

LOGGED: LS

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: *Replicate sample T6 collected

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



Douglas Partners
 Geotechnics | Environment | Groundwater

Appendix E

Laboratory Test Results

Material Test Report

Report Number: 86091.00-1
Issue Number: 1
Date Issued: 14/09/2017
Client: Health Infrastructure (ABN 89600377397)
 PO Box 1060, North Sydney NSW 2059
Contact: Catherine Lee
Project Number: 86091.00
Project Name: Masterplan Investigation
Project Location: Lewis Street, MUDGEE
Work Request: 1458
Sample Number: 17-1458A
Date Sampled: 28/08/2017
Sampling Method: Sampled by Engineering Department
Sample Location: BH7 (0.25-0.5m)
Material: Red brown clay, trace sand & silt



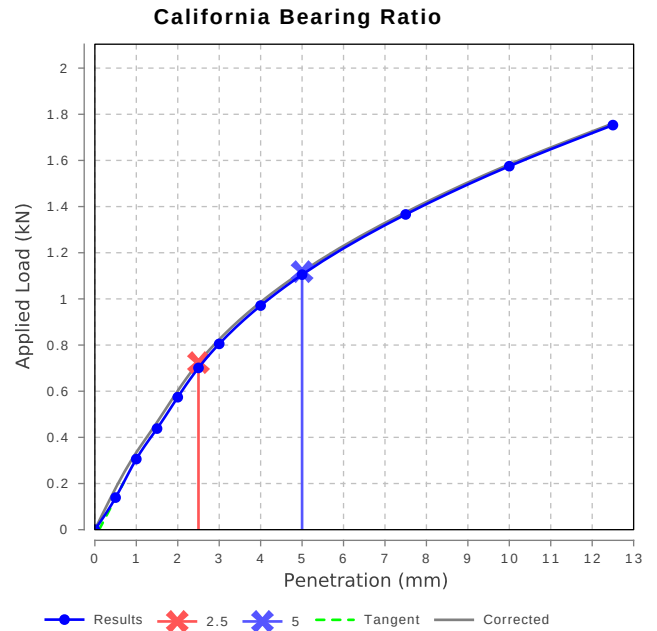
Mark Matthews

Approved Signatory: Mark Matthews

NATA Accredited Laboratory Number: 828

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	6		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m^3)	1.81		
Optimum Moisture Content (%)	17.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.0		
Moisture Content at Placement (%)	16.9		
Moisture Content Top 30mm (%)	20.4		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	46		
Plastic Limit (%)	16		
Plasticity Index (%)	30		



Material Test Report

Report Number: 86091.00-1
Issue Number: 1
Date Issued: 14/09/2017
Client: Health Infrastructure (ABN 89600377397)
 PO Box 1060, North Sydney NSW 2059
Contact: Catherine Lee
Project Number: 86091.00
Project Name: Masterplan Investigation
Project Location: Lewis Street, MUDGEE
Work Request: 1458
Sample Number: 17-1458B
Date Sampled: 28/08/2017
Sampling Method: Sampled by Engineering Department
Sample Location: BH8 (0.1-0.3m)
Material: Brown silty clay, trace gravel



Mark Matthews

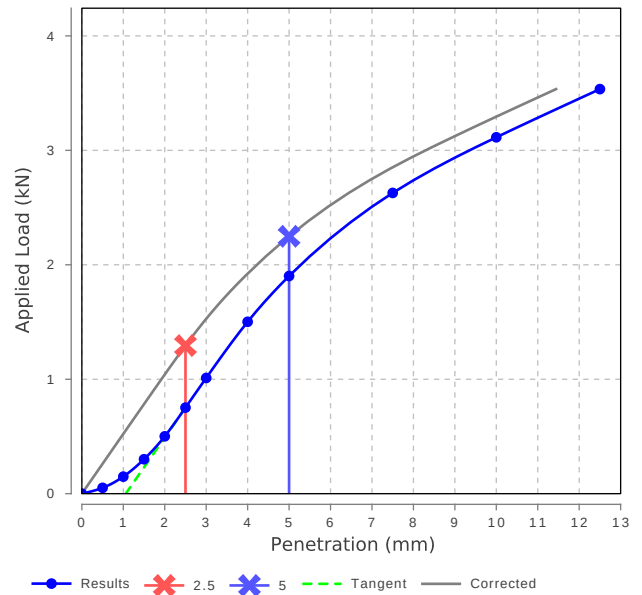
Approved Signatory: Mark Matthews

NATA Accredited Laboratory Number: 828

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	11		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m ³)	1.69		
Optimum Moisture Content (%)	14.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.0		
Moisture Content at Placement (%)	14.2		
Moisture Content Top 30mm (%)	20.4		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	1		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	34		
Plastic Limit (%)	20		
Plasticity Index (%)	14		

California Bearing Ratio



Material Test Report

Report Number: 86091.00-1
Issue Number: 1
Date Issued: 14/09/2017
Client: Health Infrastructure (ABN 89600377397)
PO Box 1060, North Sydney NSW 2059
Contact: Catherine Lee
Project Number: 86091.00
Project Name: Masterplan Investigation
Project Location: Lewis Street, MUDGEE
Work Request: 1458
Sample Number: 17-1458C
Date Sampled: 28/08/2017
Sampling Method: Sampled by Engineering Department
Sample Location: BH1 (1-1.45m)
Material: Red brown mottled grey clay, trace sand & silt



Douglas Partners Pty Ltd

Sydney Laboratory

96 Hermitage Road West Ryde NSW 2114

Phone: (02) 9809 0666

Fax: (02) 9809 0666

Email: mark.matthews@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing



Approved Signatory: Mark Matthews

NATA Accredited Laboratory Number: 828

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	43		
Plastic Limit (%)	16		
Plasticity Index (%)	27		

Material Test Report

Report Number: 86091.00-1
Issue Number: 1
Date Issued: 14/09/2017
Client: Health Infrastructure (ABN 89600377397)
PO Box 1060, North Sydney NSW 2059
Contact: Catherine Lee
Project Number: 86091.00
Project Name: Masterplan Investigation
Project Location: Lewis Street, MUDGEE
Work Request: 1458
Sample Number: 17-1458D
Date Sampled: 28/08/2017
Sampling Method: Sampled by Engineering Department
Sample Location: BH10 (2.5-2.95m)
Material: Grey mottled orange clay, some silt



Douglas Partners Pty Ltd

Sydney Laboratory

96 Hermitage Road West Ryde NSW 2114

Phone: (02) 9809 0666

Fax: (02) 9809 0666

Email: mark.matthews@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing



Approved Signatory: Mark Matthews

NATA Accredited Laboratory Number: 828

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	50		
Plastic Limit (%)	17		
Plasticity Index (%)	33		

Misc Inorg - Soil					
Our Reference		174352-3	174352-6	174352-9	174352-12
Your Reference	UNITS	BH1	BH3	BH6	BH9
Depth		4.0-4.35	2.4-2.5	0-0.1	0.4-0.5
Date Sampled		17/08/2017	18/08/2017	18/08/2017	17/08/2017
Type of sample		SOIL	SOIL	SOIL	SOIL
Date prepared	-	30/08/2017	30/08/2017	30/08/2017	30/08/2017
Date analysed	-	30/08/2017	30/08/2017	30/08/2017	30/08/2017
pH 1:5 soil:water	pH Units	4.6	9.0	7.6	8.5
Electrical Conductivity 1:5 soil:water	µS/cm	840	150	33	830
Chloride, Cl 1:5 soil:water	mg/kg	420	20	<10	310
Sulphate, SO4 1:5 soil:water	mg/kg	1,100	36	<10	1,200