# Report on Site Classification

## Stage 1 Pitt Street, Teralba

CGS1785

Prepared for
McCloy Teralba

2 June 2015

Cardno
Geotech Solutions
Shaping the Future

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## Document Information

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|---|---|
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## Document History

| Version | Effective Date | Description of Revision | Prepared by: | Reviewed by: |
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| 0 | 02/06/15 | First issue | David Bastian | Jules Darras |
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# 1 Introduction

This report presents the results of earthworks compaction testing and geotechnical investigation undertaken by Cardno Geotech Solutions (CGS) on Stage 1 Pitt Street, Teralba. The work was conducted at the request of Mr Shane Boslem of McCloy Group Pty Ltd.

Investigation was required to provide site classification in accordance with Australian Standard AS 2870-2011 Residential Slabs and Footings [1]. Comment on earthworks conducted by Keller Civil Engineering ('KCE') is also provided.

Proposed subdivision plans prepared by GCA Engineering Solutions were provided, with drawing no. C02 utilised for the purpose of the investigation titled *'Proposed Subdivision, Pitt Street, Teralba'* project no. 14007C, revision 5 dated 2.9.14.

# 2 Site Description

The site is defined as Stage 1 of the Pitt Street, Teralba development and is situated at the end of the existing Pitt Street road alignment. The site is located on the south-western edge of Teralba on elevated terrain to the west of Cockle Bay. Cockle Bay is situated in the northern portion of Lake Macquarie.

The site is bounded to the north and north-east by existing residential developments, and to the east, south and west by undeveloped bushland.

The development comprises 31 residential allotments (lots 101-131) and approximately 680 m of internal road pavement.

Topographically the site is located on the end of a south-west to north-east trending spur and situated within locally undulating terrain. The site generally slopes from south-west to north-east, with the natural slopes modified through cut and fill earthworks conducted during construction.

With reference to the client supplied information, levels at the site fall from reduced level ('RL') 53 m in the south-western site extent through to RL 32 m in the north-east. Retaining walls have been constructed along several allotment boundaries in the south-western portion of the development to create level building platforms.

At the time of investigation construction of Stage 1 was nearing completion, with inter-allotment retaining walls and site drainage practically completed. Construction of two sections of the Pitt Street pavement was yet to be completed, with the remaining road sections awaiting bitumen seal.

Stockpiles of mulch situated across part lots 113-114 and 129-130 and a site compound on part lots 111-112 restricted machinery access during the investigation. Large stockpiles of site-won materials were evident along the rear of lots 123-128 which also restricted access, with test locations restricted to the front of the lots.

Drainage across the site is expected to comprise surface flows following the constructed surfaces to the constructed inter allotment and internal road way drainage network. Detention basins have been constructed at the south-eastern and north-western extents of the development to detain stormwater flows.

# 3 Lot Regrade Earthworks

## 3.1 Overview

Earthworks undertaken within the Stage 1 residential allotments by KCE during construction are summarised as follows.

> Majority lots 103-105 and part lot 106: Filling of an existing gully to depths of up to approximately 4 m.

> Lots 115-122: Predominantly cut and minor fill to create level building platforms, with retaining walls constructed along boundaries.

Testing was undertaken on lot fill in accordance with Section 8 of AS 3798-2007 [2]. It is noted that site regrade activities were sporadic due to inclement weather.

## 3.2 Material Quality

Earthworks were undertaken utilising surplus material acquired from road cuttings and regrade and generally comprised sandy gravelly clay, sandy gravel and clayey sandy gravel. Onsite materials other than topsoil were generally deemed suitable for use as fill. Some materials required moisture reconditioning and removal of organic matter prior to use.

## 3.3 Methodology

Regrade operations were undertaken by removing the topsoil, and any uncontrolled fill to expose the natural in situ soils which were free of significant organic matter. Natural surfaces were inspected and proof rolled using a compactor or wheeled construction equipment that was available at the time of inspection. Unsuitable materials were removed and replaced with select fill.

Fill operations were undertaken by placing layers of approximately 200mm to 300mm thickness and compacting to specified limits. Compacted fill layers were then tested for compaction in accordance with the guidelines indicated in AS 3798-2007 Guidelines for Earthworks on Residential and Commercial Developments (Australian Standard AS3798-2007) [2]. Table 5.1 Item 1 of AS 3798-2007 was adopted as the appropriate compaction criteria by the client for the work with a minimum relative compaction of 95% standard required as appropriate for residential - lot fill housing sites.

Fill was tested in accordance with Table 8.1 Frequency of Field Density Tests for Type 1 Large Scale Operations (Australian Standard AS3798-2007) [2]. Placement and compaction of fill was undertaken with CGS site personnel providing onsite inspection and testing services during earthworks activities.

## 3.4 Lot Regrade Compaction Test Results

Results of compaction testing conducted by CGS indicate that the filling operations have satisfied the compaction criteria for “controlled fill” as defined in Clause 1.8.13 of AS2870-2011 [1].

All testing has either met with or exceeded the specification adopted of 95% standard compaction at moisture contents of generally 85% to 115% of Optimum Moisture Content (OMC) at the time of placement with any failures being re-worked and retested.

Geotechnical services provided during regrade comply with AS 3798-2007 [2], with testing undertaken to the minimum frequency as indicated in Table 8.1 for Type 1 – Large Scale Operations.

A total of twenty eight (28) lot regrade compaction test results are included in this report. The results of compaction testing, along with proof rolling, meet the requirements of Lake Macquarie City Council’s Engineering Guidelines to the Development Control Plan, Part 2 – Construction Guidelines [3].

Compaction results for lot fill are shown on NATA accredited test certificates, attached in Appendix E with permission from KCE Pty Ltd.

# 4 Investigation Methodology

Field investigation was undertaken on the 28 April 2015 and comprised the excavation of 15 test bores (TB301-TB315) using a 3.5T excavator fitted with a 300 mm auger. Test bores were excavated to a target depth of 1.8 m, with fourteen test bores terminated due to prior refusal on conglomerate rock. Dynamic Cone Penetrometer (DCP) tests were conducted adjacent to selected test bores to aid in the assessment of subsurface strength conditions. Thin wall tube (50mm diameter) samples of selected materials from the bores were collected for subsequent laboratory testing.

All fieldwork including logging of subsurface profiles and collection of samples was carried out by a Senior Technical Officer from CGS. Test bores were located by reference to allotment boundaries as shown on Drawing 1 attached as Appendix A. Subsurface conditions are summarised in Section 5.2 and detailed in the engineering logs of test bores attached in Appendix B together with explanatory notes.

Laboratory testing on selected samples recovered during fieldwork comprised of shrink swell tests carried out on thin wall tube (50mm diameter) samples of the natural clays and fill materials encountered at the site to measure soil volume change over an extreme soil moisture content range.

Results of laboratory testing are detailed in the reports sheets attached in Appendix C and summarised in Section 5.3 below.

# 5 Investigation Findings

## 5.1 Published Data

Reference to the 1:100,000 Newcastle Coalfield Regional Geology Map [4], indicates that Stages 1 and 2 are situated within the Moon Island Beach Subgroup of the Newcastle Coal Measures and Clifton Subgroup of the Narrabeen Group. The formations are known to comprise conglomerate, siltstone, sandstone, claystone, coal and tuff rock types.

## 5.2 Subsurface Conditions

The subsurface conditions encountered in the test bores excavated across the site are detailed on the report log sheets, with a summary presented below in Table 5-1.

**Table 5-1 Summary of Subsurface Conditions**

| Test bore | Lot number | Summary of subsurface profile |
|---|---|---|
| TB301 | 109 / 110 | Sandy Gravelly CLAY / XW CONGLOMERATE |
| TB302 | 107 / 108 | Gravelly SILT / Silty Gravelly CLAY / XW CONGLOMERATE |
| TB303 | 105 / 106 | FILL, Sandy Gravelly CLAY / FILL, Sandy Clayey GRAVEL |
| TB304 | 103 / 104 | FILL, Sandy Gravelly CLAY / FILL, Sandy GRAVEL |
| TB305 | 101 / 102 | Gravelly SILT / Silty Gravelly CLAY / XW CONGLOMERATE |
| TB306 | 123 / 124 | DW CONGLOMERATE |
| TB307 | 125 / 126 | XW CONGLOMERATE |
| TB308 | 127 / 128 | FILL, Sandy GRAVEL / Silty CLAY / DW CONGLOMERATE |
| TB309 | 129 | Sandy Clayey GRAVEL / Silty CLAY / DW SANDSTONE |
| TB310 | 115 | XW CONGLOMERATE |
| TB311 | 117 | DW SILTSTONE |
| TB312 | 118 | XW SANDSTONE |

| Test bore | Lot number | Summary of subsurface profile |
|---|---|---|
| TB313 | 119 / 120 | Silty Gravelly CLAY / XW CONGLOMERATE |
| TB314 | 121 | Silty Gravelly CLAT / DW SANDSTONE |
| TB315 | 122 | FILL, Sandy Gravelly CLAY |

Notes:

NE – not encountered

XW – extremely weathered

DW – distinctly weathered

No groundwater or seepage was encountered in the test bores at the time of fieldwork. It should be noted that groundwater levels are likely to fluctuate with variations in climatic and site conditions.

## 5.3 Laboratory Test Results

The results of the laboratory shrink swell tests undertaken on samples of the clay soils encountered during the investigation are detailed on the laboratory test report sheets attached in Appendix C, and are summarised below in Table 5-2.

**Table 5-2 Summary of Shrink Swell Test Results**

| Test Bore | Depth (m) | Soil Type | Esw (%) | Esh (%) | Iss (%) |
|---|---|---|---|---|---|
| TB303 | 0.50-0.80 | Sandy Gravelly CLAY | 0.2 | 1.3 | 0.8 |
| TB304 | 0.40-0.75 | Sandy Gravelly CLAY | 0.0 | 1.1 | 0.6 |
| TB308 | 0.25-0.50 | Silty CLAY | 0.6 | 1.4 | 1.0 |

Notes:

| | |
|---|---|
| Esw | Swelling strain |
| Esh | Shrinkage strain |
| Iss | Shrink swell Index |

The results of the laboratory shrink swell tests summarised in Table 5-2 indicate that the tested natural clay soils and materials placed as fill are slightly reactive.

Results of soil aggressivity testing conducted on selected samples collected during the fieldwork is summarised below.

**Table 5-3 Summary of Soil Aggressivity Test Results**

| Test bore | Depth (m) | Soil Type | pH | EC (µS/cm) | Chloride (mg/kg) | Sulphate (mg/kg) |
|---|---|---|---|---|---|---|
| TB303 | 0.70 | Sandy Gravelly CLAY | 5.2 | 57 | 24 | 21 |
| TB308 | 0.40 | Silty CLAY | 4.6 | 89 | 10 | 60 |

The above aggressivity testing was conducted externally by Envirolab laboratories, with NATA accredited certificates of analysis along with shrink swell reports attached in Appendix C.

# 6 Comments and Recommendations

## 6.1 Site Classification

Australian Standard AS 2870-2011 [1] establishes performance requirements and specific designs for common foundation conditions as well as providing guidance on the design of footing systems using engineering principles. Site classes as defined on Table 2.1 and 2.3 of AS 2870 are presented on Table 6-1 below.

**Table 6-1 General Definition of Site Classes**

| Site Class | Foundation | Characteristic Surface Movement |
|---|---|---|
| A | Most sand and rock sites with little or no ground movement from moisture changes | |
| S | Slightly reactive clay sites, which may experience only slight ground movement from moisture changes | 0 - 20mm |
| M | Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes | 20 - 40mm |
| H1 | Highly reactive clay sites, which may experience high ground movement from moisture changes | 40 - 60mm |
| H2 | Highly reactive clay sites, which may experience very high ground movement from moisture changes | 60 - 75mm |
| E | Extremely reactive sites, which may experience extreme ground movement from moisture changes | > 75mm |
| A to P | Filled sites (refer to clause 2.4.6 of AS 2870) | |
| P | Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise. | |

Reactive sites are sites consisting of clay soils that swell on wetting and shrink on drying, resulting in ground movements that can damage lightly loaded structures. The amount of ground movement is related to the physical properties of the clay and environmental factors such as climate, vegetation and watering. A higher probability of damage can occur on reactive sites where abnormal moisture conditions occur, as defined in AS 2870, due to factors such as:

- Presence of trees on the building site or adjacent site, removal of trees prior to or after construction, and the growth of trees too close to a footing. The proximity of mature trees and their effect on foundations should be considered when determining building areas within each allotment (refer to AS 2870);
- Failure to provide adequate site drainage or lack of maintenance of site drainage, failure to repair plumbing leaks and excessive or irregular watering of gardens;
- Unusual moisture conditions caused by removal of structures, ground covers (such as pavements), drains, dams, swimming pools, tanks etc.

In regard to the performance of footings systems, AS 2870 states:

> “footing systems designed and constructed in accordance with this Standard on a normal site (see Clause 1.3.2) [1] that is:
>
> (a) not subject to abnormal moisture conditions; and
>
> (b) maintained such that the original site classification remains valid and abnormal moisture conditions do not develop;
>
> are expected to experience usually no damage, a low incidence of damage category 1 and an occasional incidence of damage category 2.”

Damage categories are defined in Appendix C of AS 2870, which is reproduced in CSIRO Information Sheet BTF 18, Foundation Maintenance and Footing Performance: A Homeowner's Guide.

The laboratory shrink swell test results summarised in Table 5-2 indicate that the tested natural clay soils and clays placed as fill are slightly reactive, with Iss values in the range of 0.6% to 1.0%.

The classification of sites with controlled fill of depths greater than 0.4m (deep fill) comprising of material other than sand would be Class P. An alternative classification may however be given to sites with controlled fill where consideration is made to the potential for movement of the fill and underlying soil based on the moisture conditions at the time of construction and the long term equilibrium moisture conditions.

Based on the subsurface profiles encountered during the investigation, previous investigation and laboratory shrink swell test results, and in accordance with the AS2870-2011 [1]; the lots in their existing condition and in the absence of abnormal moisture conditions would be classified as detailed in Table 6-2.

**Table 6-2 Recommended Site Classifications**

| Lot Numbers | Site Classification |
|---|---|
| 100-131 | Class M, Moderately Reactive |

A characteristic surface movement in the order of 5 mm to 20 mm has been calculated for the lots dependent on the soil profile, depth of fill and depth to rock encountered at test locations. It is noted that the calculated surface movement correlates to a site classification of Class S, Slightly reactive, however adoption of Class M, Moderately reactive is recommended due to the potential for variable founding conditions at footing subgrade elevation.

It should be appreciated that the site classifications provided above are based on test bores and laboratory testing of multiple layers over the depth of total soil suction change in the soil profile. It should be noted that individual lot development may include future geotechnical studies and care should be taken that single laboratory results are not allocated to the full depth of the soil profile, as biased site classifications can result.

The above site classifications and footing recommendations are for the site conditions present at the time of fieldwork and consequently the site classification may need to be reviewed with consideration of any site works that may be undertaken subsequent to the investigation and this report.

Site works may include:

> Changes to the existing soil profile by cutting and filling;

> Landscaping, including trees removed or planted in the general building area; and

> Drainage and watering systems.

Designs and design methods presented in AS 2870-2011 [1] are based on the performance requirement that significant damage can be avoided provided that site conditions are properly maintained. Performance requirements and foundation maintenance are outlined in Appendix B of AS 2870. The above site classification assumes that the performance requirements as set out in Appendix B of AS 2870 are acceptable and that site foundation maintenance is undertaken to avoid extremes of wetting and drying.

Details on appropriate site and foundation maintenance practices are presented in Appendix B of AS 2870-2011 and in CSIRO Information Sheet BTF 18, Foundation Maintenance and Footing Performance: A Homeowner's Guide, which is attached as Appendix D of this report, along with Australian Geoguide (LR8) Hillside Construction Practice.

Adherence to the detailing requirement outlined in Section 5 of AS 2870-2011 [1] is essential, in particular Section 5.6 Additional requirements for Classes M, H1, H2 and E sites, including architectural restrictions, plumbing and drainage requirements.

## 6.2 Footings

All foundations should be designed and constructed in accordance with AS 2870-2011, Residential Slabs and Footings [1] with reference to site classifications as presented in Table 6-2.

All footings should be founded below any topsoil, slopewash, deleterious soils or uncontrolled fill (if encountered). All footings for the same structure should be founded on strata of similar stiffness and reactivity to minimise the risk of differential movements.

Inspection of all footing excavations should be undertaken by Cardno to confirm the founding conditions exposed are consistent with this report, and the base of the excavation should be cleared of fall-in prior to the formation of the footing.

### 6.2.1 High-Level Footings

High-level footing alternatives could be expected to comprise slabs on ground with edge beams or pad footings for the support of concentrated loads. Such footings designed in accordance with engineering principles and founded in stiff or better natural soils (below topsoil, slopewash, uncontrolled fill if encountered or other deleterious material) or in controlled fill (placed and compacted in accordance with AS3798-2007 [2]) may be proportioned on an allowable bearing capacity of 100 kPa. Shallow footings founded uniformly in weathered conglomerate or sandstone rock may be proportioned on an allowable bearing capacity of 400 kPa.

The founding conditions should be assessed by a geotechnical consultant or experienced engineer to confirm suitable conditions.

### 6.2.2 Piered Footings

Piered footings are considered as an alternative to deep edge beams or high level footings. It is suggested that piered footings, founded in stiff or better clay soils or controlled fill could be proportioned on an end bearing pressure of 100 kPa. Where uniformly founded in the underlying weathered rock an end bearing pressure of 400 kPa could be adopted and where founded on rock (i.e. at refusal depths encountered in the investigation), an end bearing pressure of 600 kPa could be adopted.

Where piered footings are utilised, the potential for volume change in the subsurface profile should be taken into consideration by the designer, along with potential settlement where founded in controlled fill.

Reference to AS2159 [5] indicates that the samples tested for aggressivity would generally be considered mildly aggressive to steel and concrete.

# 7 Conclusions

The Stage 1 Pitt Street development comprises 31 residential allotments and associated internal roadways. Earthworks conducted by KCE during construction comprised cutting and filling using site won materials to achieve design levels and create level building platforms in the noted allotments.

Materials placed within lots as fill have been tested by CGS throughout earthworks and have been placed as controlled fill in accordance with AS3798-2007 [2].

With reference to AS2870-2011 [1] the classification of sites with deep controlled fill is Class P, however an alternative classification has been given to the lots with consideration to long term moisture equilibrium conditions. Based on the subsurface profiles encountered, the laboratory test results and in accordance with AS2870-2011 [1] recommended classifications for lots 100-131 are Class M, Moderately reactive.

Footings founded in natural stiff or better clay soils or controlled fill may be proportioned on an allowable bearing pressure of 100 kPa, and footings founded uniformly on weathered conglomerate on an allowable bearing pressure of 400 kPa. Piered footings founded uniformly on rock could be proportioned on an allowable bearing pressure of 600 kPa. Footings should be founded in strata of similar consistency and reactivity, with the controlled fill considered similar to the residual clay soils for the purpose of footing design.

Confirmation of the recommended site classification for lots where access was restricted during the investigation is required by Cardno if conditions are found to vary from those described herein. Footing excavation inspections by a Cardno or suitably qualified geotechnical consultant are required to confirm that the conditions exposed are consistent with the recommendations of this report.

# 8 Limitations

Cardno Geotech Solutions (CGS) have performed investigation and consulting services for this project in general accordance with current professional and industry standards. The extent of testing was limited to discrete test locations and variations in ground conditions can occur between test locations that cannot be inferred or predicted.

A geotechnical consultant or qualified engineer shall provide inspections during construction to confirm assumed conditions in this assessment. If subsurface conditions encountered during construction differ from those given in this report, further advice shall be sought without delay.

Cardno Geotech Solutions, or any other reputable consultant, cannot provide unqualified warranties nor does it assume any liability for the site conditions not observed or accessible during the investigations. Site conditions may also change subsequent to the investigations and assessment due to ongoing use.

This report and associated documentation was undertaken for the specific purpose described in the report and shall not be relied on for other purposes. This report was prepared solely for the use by McCloy Teralba and any reliance assumed by other parties on this report shall be at such parties own risk.

# 9 References

[1] Australian Standard AS2870-2011, “Residential Slabs and Footings,” Standards Australia, 2011.

[2] Australian Standard AS3798-2007, “Guidelines on Earthworks for Commercial and Residential Structures,” Standards Australia, 2007.

[3] LMCC Engineering Guidelines to the Development Control Plan, “Part 2 - Construction Guidelines,” Lake Macquarie City Council, December 2013.

[4] Newcastle 1:250,000 Geology Map, “Geological Series Sheet SI 56-2 (First Edition),” NSW Department of Mines, 1966.

[5] Australian Standard AS 2159-2009 – Piling – Design & Installation.

[6] LMCC Engineering Guidelines to the Development Control Plan, “Part 1 - Design Guidelines,” Lake Macquarie City Council, December 2013.

# APPENDIX

# A

# DRAWING

NOTES:

Drawing adapted from GCA Engineering Solutions plan, 'Proposed Subdivision, Pitt Street, Teralba' project no. 14007C, drawing no. C02, revision 5 dated 2.9.14.

LEGEND:

⊕ Approximate test bore locations and numbers

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DRAWING TITLE: TEST BORE LOCATION PLAN
PROJECT NAME: FINAL SITE CLASSIFICATION
SITE LOCATION: STAGE 1 PITT STREET, TERALBA

CLIENT: McCloy Group
PROJECT NO: CGS1785
DRAWING NO: 1
FILE REF: 1785-012

DRAWN BY: DGB
OFFICE: 4/5 Arunga Drive, Beresfield NSW 2322
DATE:29 April 2015

CHECKED BY:

# APPENDIX

# B

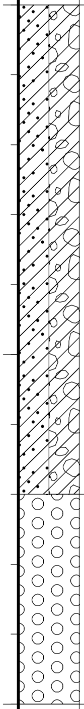
# ENGINEERING LOGS

# TESTBORE LOG

*CLIENT : McCloy Group Pty Ltd*
*PROJECT : Site Classification*
*LOCATION : Pitt Street, Teralba*

**HOLE NO : TB301**
**PROJECT REF : CGS1785**
SHEET : 1 OF 1

EQUIPMENT TYPE : 3.5t Excavator
METHOD : 300mm auger
DATE EXCAVATED : 28/4/15
LOGGED BY : DGB
CHECKED BY : JD
LOCATION : See Drawing for location



| GROUND WATER LEVELS | SAMPLES & FIELD TESTS | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MATERIAL DESCRIPTION<br>Soil Type, plasticity or particle characteristic, colour<br>Rock Type, grain size, colour<br>Secondary and minor components | MOISTURE / WEATHERING | CONSISTENCY / REL DENSITY / ROCK STRENGTH | DYNAMIC PENETROMETER | HAND PENETRO-METER (kPa)<br>100 200 300 400 | STRUCTURE<br>& Other Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.0 | | | Sandy Gravelly CLAY, low plasticity, mottled orange & grey | | | | | mulched surface |
| | | 0.5 | | | | MC > PL | | | | |
| | | | | | 0.70m | | | | | |
| | | | | | CONGLOMERATE, orange mottled grey | XW | EL | | | |
| | | 1.0 | | | 1.00m | | | | | |
| | | | | | Testbore TB301 terminated at 1.00 m<br>Refusal<br>on conglomerate rock | | | | | |
| | | 1.5 | | | | | | | | |
| | | 2.0 | | | | | | | | |

**WATER / MOISTURE**
D - Dry
M - Moist
W - Wet
OMC - Optimum MC
PL - Plastic Limit
▶— Water inflow

**SAMPLES & FIELD TESTS**
U - Undisturbed Sample
D - Disturbed Sample
ES - Environmental sample
B - Bulk Disturbed Sample
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer

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

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

**ROCK STRENGTH**
EL - Extremely low
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

**ROCK WEATHERING**
RS - Residual soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh rock

See Explanatory Notes for
details of abbreviations
& basis of descriptions.

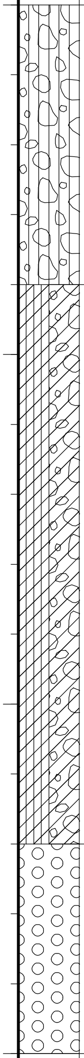
CARDNO GEOTECH SOLUTIONS

# TESTBORE LOG

*CLIENT : McCloy Group Pty Ltd*
*PROJECT : Site Classification*
*LOCATION : Pitt Street, Teralba*

**HOLE NO : TB302**
**PROJECT REF : CGS1785**
SHEET : 1 OF 1

EQUIPMENT TYPE : 3.5t Excavator
METHOD : 300mm auger
DATE EXCAVATED : 28/4/15
LOGGED BY : DGB
CHECKED BY : JD
LOCATION : See Drawing for location



| GROUND WATER LEVELS | SAMPLES & FIELD TESTS | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MATERIAL DESCRIPTION Soil Type, plasticity or particle characteristic, colour Rock Type, grain size, colour Secondary and minor components | MOISTURE / WEATHERING | CONSISTENCY / REL DENSITY / ROCK STRENGTH | DYNAMIC PENETROMETER | HAND PENETRO-METER (kPa) 100 200 300 400 | STRUCTURE & Other Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.0 | | | Gravelly SILT, grey | M | F | 2<br>2<br>3 | | |
| | | | | | 0.40m Silty Gravelly CLAY, low plasticity, mottled orange, red & grey | MC > PL | St | 3<br>8<br>16<br>VR | | |
| | | 0.5 | | | | | | | | |
| | | 1.0 | | | | MC = PL | VSt | | | |
| | | | | | 1.20m CONGLOMERATE, orange mottled grey | XW | EL | | | |
| | | 1.5 | | | 1.50m Testbore TB302 terminated at 1.50 m<br>Refusal<br>on conglomerate rock | | | | | |
| | | 2.0 | | | | | | | | |

**WATER / MOISTURE**

| | | |
|---|---|---|
| D | - | Dry |
| M | - | Moist |
| W | - | Wet |
| OMC | - | Optimum MC |
| PL | - | Plastic Limit |
| ▶── | | Water inflow |

**SAMPLES & FIELD TESTS**

| | | |
|---|---|---|
| U | - | Undisturbed Sample |
| D | - | Disturbed Sample |
| ES | - | Environmental sample |
| B | - | Bulk Disturbed Sample |
| SPT | - | Standard Penetration Test |
| HP | - | Hand/Pocket Penetrometer |

**CONSISTENCY**

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

**RELATIVE DENSITY**

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

**ROCK STRENGTH**

| | | |
|---|---|---|
| EL | - | Extremely low |
| VL | - | Very low |
| L | - | Low |
| M | - | Medium |
| H | - | High |
| VH | - | Very high |
| EH | - | Extremely high |

**ROCK WEATHERING**

| | | |
|---|---|---|
| RS | - | Residual soil |
| XW | - | Extremely weathered |
| DW | - | Distinctly weathered |
| SW | - | Slightly weathered |
| FR | - | Fresh rock |

See Explanatory Notes for
details of abbreviations
& basis of descriptions.

CARDNO GEOTECH SOLUTIONS

# TESTBORE LOG

*CLIENT : McCloy Group Pty Ltd*
*PROJECT : Site Classification*
*LOCATION : Pitt Street, Teralba*

**HOLE NO : TB303**
**PROJECT REF : CGS1785**
SHEET : 1 OF 1

EQUIPMENT TYPE : 3.5t Excavator
METHOD : 300mm auger
DATE EXCAVATED : 28/4/15
LOGGED BY : DGB
CHECKED BY : JD
LOCATION : See Drawing for location

| GROUND WATER LEVELS | SAMPLES & FIELD TESTS | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MATERIAL DESCRIPTION<br>Soil Type, plasticity or particle characteristic, colour<br>Rock Type, grain size, colour<br>Secondary and minor components | MOISTURE / WEATHERING | CONSISTENCY / REL DENSITY / ROCK STRENGTH | DYNAMIC PENETROMETER | HAND PENETRO-METER (kPa) 100 200 300 400 | STRUCTURE & Other Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.0 | | | FILL, Sandy Gravelly CLAY, low plasticity, mottled grey, orange & red | MC > PL | | | | |
| | 0.50m<br>B | 0.5 | | | | | | | | |
| | 0.80m | | | | 0.80m<br>FILL, Sandy Clayey GRAVEL, fine to coarse sub rounded to rounded, mottled grey, orange & red | D - M | | | | |
| | | 1.0 | | | | | | | | |
| | | | | | 1.30m<br>Testbore TB303 terminated at 1.30 m<br>Refusal<br>on possible conglomerate rock | | | | | |
| | | 1.5 | | | | | | | | |
| | | 2.0 | | | | | | | | |

**WATER / MOISTURE**

| | |
|---|---|
| D | - Dry |
| M | - Moist |
| W | - Wet |
| OMC | - Optimum MC |
| PL | - Plastic Limit |
| ▶── | Water inflow |

**SAMPLES & FIELD TESTS**

| | |
|---|---|
| U | - Undisturbed Sample |
| D | - Disturbed Sample |
| ES | - Environmental sample |
| B | - Bulk Disturbed Sample |
| SPT | - Standard Penetration Test |
| HP | - Hand/Pocket Penetrometer |

**CONSISTENCY**

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

**RELATIVE DENSITY**

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

**ROCK STRENGTH**

| | |
|---|---|
| EL | - Extremely low |
| VL | - Very low |
| L | - Low |
| M | - Medium |
| H | - High |
| VH | - Very high |
| EH | - Extremely high |

**ROCK WEATHERING**

| | |
|---|---|
| RS | - Residual soil |
| XW | - Extremely weathered |
| DW | - Distinctly weathered |
| SW | - Slightly weathered |
| FR | - Fresh rock |

See Explanatory Notes for
details of abbreviations
& basis of descriptions.

CARDNO GEOTECH SOLUTIONS

# TESTBORE LOG

*CLIENT : McCloy Group Pty Ltd*
*PROJECT : Site Classification*
*LOCATION : Pitt Street, Teralba*

**HOLE NO : TB304**
**PROJECT REF : CGS1785**
SHEET : 1 OF 1

| | |
|---|---|
| EQUIPMENT TYPE : 3.5t Excavator | METHOD : 300mm auger |
| DATE EXCAVATED : 28/4/15 | LOGGED BY : DGB · CHECKED BY : JD |
| LOCATION : See Drawing for location | |

| GROUND WATER LEVELS | SAMPLES & FIELD TESTS | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MATERIAL DESCRIPTION Soil Type, plasticity or particle characteristic, colour Rock Type, grain size, colour Secondary and minor components | MOISTURE / WEATHERING | CONSISTENCY / REL DENSITY / ROCK STRENGTH | DYNAMIC PENETROMETER | HAND PENETRO-METER (kPa) 100 200 300 400 | STRUCTURE & Other Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.0 | ▨ | | FILL, Sandy Gravelly CLAY, low plasticity, mottled grey, orange & red | | | 5<br>6 | | |
| | 0.40m<br>U50 | | ▨ | | | | | 9 | | |
| | | 0.5 | ▨ | | | MC > PL | | 10<br>15<br>R | | |
| | 0.75m | | ▨ | | | | | | | |
| | | 1.0 | ▨ | | 1.00m<br>FILL, Sandy GRAVEL, fine to coarse sub rounded to rounded, mottled grey, orange & red, with clay | D - M | | | | |
| | | | | | 1.40m<br>Testbore TB304 terminated at 1.40 m<br>Refusal<br>on possible conglomerate rock | | | | | |
| | | 1.5 | | | | | | | | |
| | | 2.0 | | | | | | | | |

**WATER / MOISTURE**
D - Dry
M - Moist
W - Wet
OMC - Optimum MC
PL - Plastic Limit
▶── Water inflow

**SAMPLES & FIELD TESTS**
U - Undisturbed Sample
D - Disturbed Sample
ES - Environmental sample
B - Bulk Disturbed Sample
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer

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

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

**ROCK STRENGTH**
EL - Extremely low
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

**ROCK WEATHERING**
RS - Residual soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh rock

See Explanatory Notes for
details of abbreviations
& basis of descriptions.

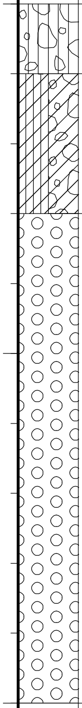
CARDNO GEOTECH SOLUTIONS

# TESTBORE LOG

*CLIENT : McCloy Group Pty Ltd*
*PROJECT : Site Classification*
*LOCATION : Pitt Street, Teralba*

**HOLE NO : TB305**
**PROJECT REF : CGS1785**
SHEET : 1 OF 1

EQUIPMENT TYPE : 3.5t Excavator
METHOD : 300mm auger
DATE EXCAVATED : 28/4/15
LOGGED BY : DGB
CHECKED BY : JD
LOCATION : See Drawing for location

| GROUND WATER LEVELS | SAMPLES & FIELD TESTS | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MATERIAL DESCRIPTION Soil Type, plasticity or particle characteristic, colour Rock Type, grain size, colour Secondary and minor components | MOISTURE / WEATHERING | CONSISTENCY / REL DENSITY / ROCK STRENGTH | DYNAMIC PENETROMETER | HAND PENETRO-METER (kPa) 100 200 300 400 | STRUCTURE & Other Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.0 |  | | Gravelly SILT, dark grey | M | | | | |
| | | | | 0.10m | Silty Gravelly CLAY, low plasticity, brown-orange | MC > PL | | | | |
| | | | | 0.30m | CONGLOMERATE, mottled grey & orange | XW | EL | | | |
| | | 0.5 | | | | | | | | |
| | | 1.0 | | 1.00m | Testbore TB305 terminated at 1.00 m<br>Refusal<br>on conglomerate rock | | | | | |
| | | 1.5 | | | | | | | | |
| | | 2.0 | | | | | | | | |

**WATER / MOISTURE**
D - Dry
M - Moist
W - Wet
OMC - Optimum MC
PL - Plastic Limit
▶— Water inflow

**SAMPLES & FIELD TESTS**
U - Undisturbed Sample
D - Disturbed Sample
ES - Environmental sample
B - Bulk Disturbed Sample
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer

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

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

**ROCK STRENGTH**
EL - Extremely low
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

**ROCK WEATHERING**
RS - Residual soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh rock

See Explanatory Notes for
details of abbreviations
& basis of descriptions.

CARDNO GEOTECH SOLUTIONS

# TESTBORE LOG

*CLIENT : McCloy Group Pty Ltd*
*PROJECT : Site Classification*
*LOCATION : Pitt Street, Teralba*

**HOLE NO : TB306**
**PROJECT REF : CGS1785**
SHEET : 1 OF 1

EQUIPMENT TYPE : 3.5t Excavator
METHOD : 300mm auger
DATE EXCAVATED : 28/4/15
LOGGED BY : DGB
CHECKED BY : JD
LOCATION : See Drawing for location

| GROUND WATER LEVELS | SAMPLES & FIELD TESTS | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MATERIAL DESCRIPTION<br>Soil Type, plasticity or particle characteristic, colour<br>Rock Type, grain size, colour<br>Secondary and minor components | MOISTURE / WEATHERING | CONSISTENCY / REL DENSITY / ROCK STRENGTH | DYNAMIC PENETROMETER | HAND PENETRO-METER (kPa) 100 200 300 400 | STRUCTURE & Other Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.0 | | 0.10m | CONGLOMERATE, grey mottled orange | DW | VL | | | rock exposed on surface adjacent bore |
| | | | | | Testbore TB306 terminated at 0.10 m<br>Refusal<br>on conglomerate rock | | | | | |
| | | 0.5 | | | | | | | | |
| | | 1.0 | | | | | | | | |
| | | 1.5 | | | | | | | | |
| | | 2.0 | | | | | | | | |

**WATER / MOISTURE**
D - Dry
M - Moist
W - Wet
OMC - Optimum MC
PL - Plastic Limit
▶── Water inflow

**SAMPLES & FIELD TESTS**
U - Undisturbed Sample
D - Disturbed Sample
ES - Environmental sample
B - Bulk Disturbed Sample
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer

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

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

**ROCK STRENGTH**
EL - Extremely low
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

**ROCK WEATHERING**
RS - Residual soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh rock

See Explanatory Notes for
details of abbreviations
& basis of descriptions.

CARDNO GEOTECH SOLUTIONS

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# TESTBORE LOG

*CLIENT : McCloy Group Pty Ltd*
*PROJECT : Site Classification*
*LOCATION : Pitt Street, Teralba*

**HOLE NO : TB307**
**PROJECT REF : CGS1785**
SHEET : 1 OF 1

EQUIPMENT TYPE : 3.5t Excavator
METHOD : 300mm auger
DATE EXCAVATED : 28/4/15
LOGGED BY : DGB
CHECKED BY : JD
LOCATION : See Drawing for location

| GROUND WATER LEVELS | SAMPLES & FIELD TESTS | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MATERIAL DESCRIPTION<br>Soil Type, plasticity or particle characteristic, colour<br>Rock Type, grain size, colour<br>Secondary and minor components | MOISTURE / WEATHERING | CONSISTENCY / REL DENSITY / ROCK STRENGTH | DYNAMIC PENETROMETER | HAND PENETRO-METER (kPa)<br>100 200 300 400 | STRUCTURE<br>& Other Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.0 | | | CONGLOMERATE, grey mottled orange | XW | EL | | | |
| | | 0.5 | | | | | | | | |
| | | | | 0.80m | Testbore TB307 terminated at 0.80 m<br>Refusal<br>on conglomerate rock | | | | | |
| | | 1.0 | | | | | | | | |
| | | 1.5 | | | | | | | | |
| | | 2.0 | | | | | | | | |

**WATER / MOISTURE**
D - Dry
M - Moist
W - Wet
OMC - Optimum MC
PL - Plastic Limit
▶— Water inflow

**SAMPLES & FIELD TESTS**
U - Undisturbed Sample
D - Disturbed Sample
ES - Environmental sample
B - Bulk Disturbed Sample
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer

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

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

**ROCK STRENGTH**
EL - Extremely low
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

**ROCK WEATHERING**
RS - Residual soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh rock

See Explanatory Notes for
details of abbreviations
& basis of descriptions.

CARDNO GEOTECH SOLUTIONS

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# TESTBORE LOG

*CLIENT : McCloy Group Pty Ltd*
*PROJECT : Site Classification*
*LOCATION : Pitt Street, Teralba*

**HOLE NO : TB308**
**PROJECT REF : CGS1785**
SHEET : 1 OF 1

EQUIPMENT TYPE : 3.5t Excavator
METHOD : 300mm auger
DATE EXCAVATED : 28/4/15
LOGGED BY : DGB
CHECKED BY : JD
LOCATION : See Drawing for location

| GROUND WATER LEVELS | SAMPLES & FIELD TESTS | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MATERIAL DESCRIPTION Soil Type, plasticity or particle characteristic, colour Rock Type, grain size, colour Secondary and minor components | MOISTURE / WEATHERING | CONSISTENCY / REL DENSITY / ROCK STRENGTH | DYNAMIC PENETROMETER | HAND PENETRO-METER (kPa) 100 200 300 400 | STRUCTURE & Other Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.0 | | | FILL, Sandy GRAVEL, coarse sub angular to angular, dark red<br>0.20m | M | | | | |
| | 0.25m<br>U50<br>0.50m | | | | Silty CLAY, medium to high plasticity, grey mottled red, trace sand<br>0.50m | MC > PL | St | | | |
| | | 0.5 | | | CONGLOMERATE, mottled grey & orange<br>0.70m | DW | VL | | | |
| | | 1.0<br>1.5<br>2.0 | | | Testbore TB308 terminated at 0.70 m<br>Refusal<br>on conglomerate rock | | | | | |

**WATER / MOISTURE**
D - Dry
M - Moist
W - Wet
OMC - Optimum MC
PL - Plastic Limit
▶── Water inflow

**SAMPLES & FIELD TESTS**
U - Undisturbed Sample
D - Disturbed Sample
ES - Environmental sample
B - Bulk Disturbed Sample
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer

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

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

**ROCK STRENGTH**
EL - Extremely low
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

**ROCK WEATHERING**
RS - Residual soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh rock

See Explanatory Notes for
details of abbreviations
& basis of descriptions.

CARDNO GEOTECH SOLUTIONS

# TESTBORE LOG

*CLIENT : McCloy Group Pty Ltd*
*PROJECT : Site Classification*
*LOCATION : Pitt Street, Teralba*

**HOLE NO : TB309**
**PROJECT REF : CGS1785**
SHEET : 1 OF 1

EQUIPMENT TYPE : 3.5t Excavator
METHOD : 300mm auger
DATE EXCAVATED : 28/4/15
LOGGED BY : DGB
CHECKED BY : JD
LOCATION : See Drawing for location

| GROUND WATER LEVELS | SAMPLES & FIELD TESTS | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MATERIAL DESCRIPTION<br>Soil Type, plasticity or particle characteristic, colour<br>Rock Type, grain size, colour<br>Secondary and minor components | MOISTURE / WEATHERING | CONSISTENCY / REL DENSITY / ROCK STRENGTH | DYNAMIC PENETROMETER | HAND PENETRO-METER (kPa) 100 200 300 400 | STRUCTURE & Other Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.0 | | | Sandy Clayey GRAVEL, fine to coarse sub rounded to rounded, orange mottled grey<br>0.30m | M | MD | 5<br>10 | | |
| | | 0.5 | | | Silty CLAY, medium plasticity, grey mottled red & orange, with sand<br>0.80m | MC > PL | VSt | 12<br>R | | |
| | | | | | SANDSTONE, fined grained, orange<br>0.90m | DW | VL | | | |
| | | 1.0 | | | Testbore TB309 terminated at 0.90 m<br>Refusal<br>on sandstone rock | | | | | |
| | | 1.5 | | | | | | | | |
| | | 2.0 | | | | | | | | |

| WATER / MOISTURE | SAMPLES & FIELD TESTS | CONSISTENCY | RELATIVE DENSITY | ROCK STRENGTH | ROCK WEATHERING |
|---|---|---|---|---|---|
| D - Dry | U - Undisturbed Sample | VS - Very Soft | VL - Very Loose | EL - Extremely low | RS - Residual soil |
| M - Moist | D - Disturbed Sample | S - Soft | L - Loose | VL - Very low | XW - Extremely weathered |
| W - Wet | ES - Environmental sample | F - Firm | MD - Medium Dense | L - Low | DW - Distinctly weathered |
| OMC - Optimum MC | B - Bulk Disturbed Sample | St - Stiff | D - Dense | M - Medium | SW - Slightly weathered |
| PL - Plastic Limit | SPT - Standard Penetration Test | VSt - Very Stiff | VD - Very Dense | H - High | FR - Fresh rock |
| ▶— Water inflow | HP - Hand/Pocket Penetrometer | H - Hard | | VH - Very high | |
| | | | | EH - Extremely high | |

See Explanatory Notes for
details of abbreviations
& basis of descriptions.

CARDNO GEOTECH SOLUTIONS

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# TESTBORE LOG

*CLIENT : McCloy Group Pty Ltd*
*PROJECT : Site Classification*
*LOCATION : Pitt Street, Teralba*

**HOLE NO : TB310**
**PROJECT REF : CGS1785**
SHEET : 1 OF 1

EQUIPMENT TYPE : 3.5t Excavator
METHOD : 300mm auger
DATE EXCAVATED : 28/4/15
LOGGED BY : DGB
CHECKED BY : JD
LOCATION : See Drawing for location

| GROUND WATER LEVELS | SAMPLES & FIELD TESTS | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MATERIAL DESCRIPTION<br>Soil Type, plasticity or particle characteristic, colour<br>Rock Type, grain size, colour<br>Secondary and minor components | MOISTURE / WEATHERING | CONSISTENCY / REL DENSITY / ROCK STRENGTH | DYNAMIC PENETROMETER | HAND PENETRO-METER (kPa) 100 200 300 400 | STRUCTURE & Other Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.0 | | | CONGLOMERATE, pale brown-orange | XW | EL | | | |
| | | 0.5 | | | | | | | | |
| | | | | | 0.70m | | | | | |
| | | | | | Testbore TB310 terminated at 0.70 m<br>Refusal<br>on conglomerate rock | | | | | |
| | | 1.0 | | | | | | | | |
| | | 1.5 | | | | | | | | |
| | | 2.0 | | | | | | | | |

**WATER / MOISTURE**
D - Dry
M - Moist
W - Wet
OMC - Optimum MC
PL - Plastic Limit
▶── Water inflow

**SAMPLES & FIELD TESTS**
U - Undisturbed Sample
D - Disturbed Sample
ES - Environmental sample
B - Bulk Disturbed Sample
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer

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

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

**ROCK STRENGTH**
EL - Extremely low
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

**ROCK WEATHERING**
RS - Residual soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh rock

See Explanatory Notes for details of abbreviations & basis of descriptions.

CARDNO GEOTECH SOLUTIONS

# TESTBORE LOG

*CLIENT : McCloy Group Pty Ltd*
*PROJECT : Site Classification*
*LOCATION : Pitt Street, Teralba*

**HOLE NO : TB311**
**PROJECT REF : CGS1785**
SHEET : 1 OF 1

EQUIPMENT TYPE : 3.5t Excavator
METHOD : 300mm auger
DATE EXCAVATED : 28/4/15
LOGGED BY : DGB
CHECKED BY : JD
LOCATION : See Drawing for location

| GROUND WATER LEVELS | SAMPLES & FIELD TESTS | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MATERIAL DESCRIPTION<br>Soil Type, plasticity or particle characteristic, colour<br>Rock Type, grain size, colour<br>Secondary and minor components | MOISTURE / WEATHERING | CONSISTENCY / REL DENSITY / ROCK STRENGTH | DYNAMIC PENETROMETER | HAND PENETRO-METER (kPa) 100 200 300 400 | STRUCTURE & Other Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.0 | | | SILTSTONE, grey | DW | VL | | | |
| | | | | | 0.20m | | | | | |
| | | | | | Testbore TB311 terminated at 0.20 m<br>Refusal<br>on siltstone rock | | | | | |
| | | 0.5 | | | | | | | | |
| | | 1.0 | | | | | | | | |
| | | 1.5 | | | | | | | | |
| | | 2.0 | | | | | | | | |

**WATER / MOISTURE**
D - Dry
M - Moist
W - Wet
OMC - Optimum MC
PL - Plastic Limit
▶—— Water inflow

**SAMPLES & FIELD TESTS**
U - Undisturbed Sample
D - Disturbed Sample
ES - Environmental sample
B - Bulk Disturbed Sample
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer

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

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

**ROCK STRENGTH**
EL - Extremely low
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

**ROCK WEATHERING**
RS - Residual soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh rock

See Explanatory Notes for
details of abbreviations
& basis of descriptions.

CARDNO GEOTECH SOLUTIONS

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# TESTBORE LOG

*CLIENT : McCloy Group Pty Ltd*
*PROJECT : Site Classification*
*LOCATION : Pitt Street, Teralba*

**HOLE NO : TB312**
**PROJECT REF : CGS1785**
SHEET : 1 OF 1

| | |
|---|---|
| EQUIPMENT TYPE : 3.5t Excavator | METHOD : 300mm auger |
| DATE EXCAVATED : 28/4/15 | LOGGED BY : DGB CHECKED BY : JD |
| LOCATION : See Drawing for location | |

| GROUND WATER LEVELS | SAMPLES & FIELD TESTS | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MATERIAL DESCRIPTION Soil Type, plasticity or particle characteristic, colour Rock Type, grain size, colour Secondary and minor components | MOISTURE / WEATHERING | CONSISTENCY / REL DENSITY / ROCK STRENGTH | DYNAMIC PENETROMETER | HAND PENETRO-METER (kPa) 100 200 300 400 | STRUCTURE & Other Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.0 | | | SANDSTONE, fine to medium grained, orange | XW | EL | | | |
| | | | | | 0.30m | | | | | |
| | | | | | Testbore TB312 terminated at 0.30 m<br>Refusal<br>on sandstone rock | | | | | |
| | | 0.5 | | | | | | | | |
| | | 1.0 | | | | | | | | |
| | | 1.5 | | | | | | | | |
| | | 2.0 | | | | | | | | |

**WATER / MOISTURE**
D - Dry
M - Moist
W - Wet
OMC - Optimum MC
PL - Plastic Limit
▶— Water inflow

**SAMPLES & FIELD TESTS**
U - Undisturbed Sample
D - Disturbed Sample
ES - Environmental sample
B - Bulk Disturbed Sample
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer

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

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

**ROCK STRENGTH**
EL - Extremely low
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

**ROCK WEATHERING**
RS - Residual soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh rock

See Explanatory Notes for
details of abbreviations
& basis of descriptions.

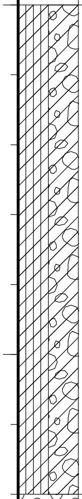
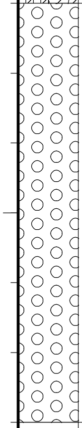
CARDNO GEOTECH SOLUTIONS

# TESTBORE LOG

*CLIENT : McCloy Group Pty Ltd*
*PROJECT : Site Classification*
*LOCATION : Pitt Street, Teralba*

**HOLE NO : TB313**
**PROJECT REF : CGS1785**
SHEET : 1 OF 1

EQUIPMENT TYPE : 3.5t Excavator
METHOD : 300mm auger
DATE EXCAVATED : 28/4/15
LOGGED BY : DGB
CHECKED BY : JD
LOCATION : See Drawing for location

| GROUND WATER LEVELS | SAMPLES & FIELD TESTS | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MATERIAL DESCRIPTION<br>Soil Type, plasticity or particle characteristic, colour<br>Rock Type, grain size, colour<br>Secondary and minor components | MOISTURE / WEATHERING | CONSISTENCY / REL DENSITY / ROCK STRENGTH | DYNAMIC PENETROMETER | HAND PENETRO-METER (kPa) 100 200 300 400 | STRUCTURE & Other Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.0 – 0.70m |  | | Silty Gravelly CLAY, low plasticity, grey | MC > PL | St | | | |
| | | 0.70m – 1.30m |  | | CONGLOMERATE, brown-grey mottled orange | XW | EL | | | |
| | | 1.30m | | | Testbore TB313 terminated at 1.30 m<br>Refusal<br>on conglomerate rock | | | | | |

Depth scale: 0.0, 0.5, 1.0, 1.5, 2.0

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▶— Water inflow

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EL - Extremely low
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See Explanatory Notes for
details of abbreviations
& basis of descriptions.

CARDNO GEOTECH SOLUTIONS

GEOTECH_SOLUTIONS_03 LIBRARY.GLB Log CGS_TESTHOLE_LOG_02 CGS_1785_PITT_STREET_TERALBA.GPJ 29/05/2015 14:08 8.30.003

# TESTBORE LOG

*CLIENT : McCloy Group Pty Ltd*
*PROJECT : Site Classification*
*LOCATION : Pitt Street, Teralba*

**HOLE NO : TB314**
**PROJECT REF : CGS1785**
SHEET : 1 OF 1

EQUIPMENT TYPE : 3.5t Excavator
METHOD : 300mm auger
DATE EXCAVATED : 28/4/15
LOGGED BY : DGB
CHECKED BY : JD
LOCATION : See Drawing for location

| GROUND WATER LEVELS | SAMPLES & FIELD TESTS | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MATERIAL DESCRIPTION<br>Soil Type, plasticity or particle characteristic, colour<br>Rock Type, grain size, colour<br>Secondary and minor components | MOISTURE / WEATHERING | CONSISTENCY / REL DENSITY / ROCK STRENGTH | DYNAMIC PENETROMETER | HAND PENETRO-METER (kPa)<br>100 200 300 400 | STRUCTURE<br>& Other Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.0 | | | Silty Gravelly CLAY, low plasticity, grey | MC > PL | St | | | |
| | | 0.60m | | | SANDSTONE, fine grained, orange | DW | VL | | | |
| | | 0.70m | | | Testbore TB314 terminated at 0.70 m<br>Refusal<br>on sandstone rock | | | | | |
| | | 1.0 | | | | | | | | |
| | | 1.5 | | | | | | | | |
| | | 2.0 | | | | | | | | |

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D - Dry
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See Explanatory Notes for
details of abbreviations
& basis of descriptions.

CARDNO GEOTECH SOLUTIONS

# TESTBORE LOG

*CLIENT : McCloy Group Pty Ltd*
*PROJECT : Site Classification*
*LOCATION : Pitt Street, Teralba*

**HOLE NO : TB315**
**PROJECT REF : CGS1785**
SHEET : 1 OF 1

EQUIPMENT TYPE : 3.5t Excavator
METHOD : 300mm auger
DATE EXCAVATED : 28/4/15
LOGGED BY : DGB
CHECKED BY : JD
LOCATION : See Drawing for location

| GROUND WATER LEVELS | SAMPLES & FIELD TESTS | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MATERIAL DESCRIPTION<br>Soil Type, plasticity or particle characteristic, colour<br>Rock Type, grain size, colour<br>Secondary and minor components | MOISTURE / WEATHERING | CONSISTENCY / REL DENSITY / ROCK STRENGTH | DYNAMIC PENETROMETER | HAND PENETRO-METER (kPa) 100 200 300 400 | STRUCTURE & Other Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.0 | ▨ | | FILL, Sandy Gravelly CLAY, low plasticity, brown-orange, bands of sandy gravel throughout | M | | | | |
| | | 0.5 | ▨ | | | | | | | |
| | | 1.0 | ▨ | | | | | | | |
| | | 1.5 | | 1.50m | Testbore TB315 terminated at 1.50 m<br>Target depth | | | | | |
| | | 2.0 | | | | | | | | |

**WATER / MOISTURE**
D - Dry
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W - Wet
OMC - Optimum MC
PL - Plastic Limit
▶— Water inflow

**SAMPLES & FIELD TESTS**
U - Undisturbed Sample
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B - Bulk Disturbed Sample
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RS - Residual soil
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See Explanatory Notes for
details of abbreviations
& basis of descriptions.

CARDNO GEOTECH SOLUTIONS

GEOTECH_SOLUTIONS_03 LIBRARY.GLB Log CGS_TESTHOLE_LOG_02 CGS_1785_PITT_STREET_TERALBA.GPJ 29/05/2015 14:08 8.30.003

# Explanatory Notes

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS1726-1993 Geotechnical Site Investigations. Material descriptions are deduced from field observation or engineering examination, and may be appended or confirmed by in situ or laboratory testing. The information is dependent on the scope of investigation, the extent of sampling and testing, and the inherent variability of the conditions encountered.

Subsurface investigation may be conducted by one or a combination of the following methods.

| **Method** | |
|---|---|
| Test Pitting: excavation/trench | |
| BH | Backhoe bucket |
| EX | Excavator bucket |
| X | Existing excavation |
| Natural Exposure: existing natural rock or soil exposure | |
| Manual drilling: hand operated tools | |
| HA | Hand Auger |
| Continuous sample drilling | |
| PT | Push tube |
| Hammer drilling | |
| AH | Air hammer |
| AT | Air track |
| Spiral flight auger drilling | |
| AS | Large diameter short spiral auger |
| AD/V | Continuous spiral flight auger: V-Bit |
| AD/T | Continuous spiral flight auger: TC-Bit |
| Hollow flight auger drilling | |
| HFA | Continuous hollow flight auger |
| Rotary non-core drilling | |
| WS | Washbore (mud drilling) |
| RR | Rock roller |
| Rotary core drilling | |
| HQ | 63mm diamond-tipped core barrel |
| NMLC | 52mm diamond-tipped core barrel |
| NQ | 47mm diamond-tipped core barrel |
| Concrete coring | |
| DT | Diatube |

Sampling is conducted to facilitate further assessment of selected materials encountered.

| **Sampling method** | |
|---|---|
| Disturbed sampling | |
| B | Bulk disturbed sample |
| D | Disturbed sample |
| ES | Environmental soil sample |
| Undisturbed sampling | |
| SPT | Standard Penetration Test sample |
| U | Thin wall tube 'undisturbed' sample |
| Water samples | |
| EW | Environmental water sample |

Field testing may be conducted as a means of assessment of the in situ conditions of materials.

| **Field testing** | | |
|---|---|---|
| SPT | Standard Penetration Test (blows/150mm) | |
| HP/PP | Hand/Pocket Penetrometer | |
| Dynamic Penetrometers (generally blows/150mm) | | |
| | DCP | Dynamic Cone Penetrometer |
| | PSP | Perth Sand Penetrometer |
| MC | Moisture Content | |
| VS | Vane Shear | |
| PBT | Plate Bearing Test | |
| PID | Photo Ionization Detector | |

If encountered, refusal (R) or virtual refusal (VR) of SPT or dynamic penetrometers may be noted.

The quality of the rock can be assessed be the degree of fracturing and the following.

| **Rock quality description** | |
|---|---|
| TCR | Total Core Recovery (%)<br>(length of core recovered divided by the length of core run) |
| RQD | Rock Quality Designation (%)<br>(sum of axial lengths of core greater than 100mm long divided by the length of core run) |

Notes on groundwater conditions encountered may include.

| **Groundwater** | |
|---|---|
| Not Encountered | Excavation is dry in the short term |
| Not Observed | Water level observation not possible |
| Seepage | Water seeping into hole |
| Inflow | Water flowing/flooding into hole |

Perched groundwater may result in a misleading indication of the depth to the true water table. Groundwater levels are also likely to fluctuate with variations in climatic and site conditions.

Notes on the stability of excavations may include.

| **Excavation conditions** | |
|---|---|
| Stable | No obvious/gross short term instability noted |
| Spalling | Material falling into excavation (minor/major) |
| Unstable | Collapse of the majority, or one or more face of the excavation |

# Explanatory Notes: General Soil Description

The methods of description and classification of soils used in this report are based on Australian Standard AS1726-1993 Geotechnical Site Investigations. In practice, a material is described as a soil if it can be remoulded by hand in its field condition or in water. The dominant component is shown in upper case, with secondary components in lower case. In general descriptions cover: soil type, plasticity or particle size/shape, colour, strength or density, moisture and inclusions.

In general, soil types are classified according to the dominant particle on the basis of the following particle sizes.

| Soil Classification | | Particle Size |
|---|---|---|
| CLAY | | < 0.002mm |
| SILT | | 0.002mm 0.075mm |
| SAND | fine | 0.075mm to 0.2mm |
| | medium | 0.2mm to 0.6mm |
| | coarse | 0.6mm to 2.36mm |
| GRAVEL | fine | 2.36mm to 6mm |
| | medium | 6mm to 20mm |
| | coarse | 20mm to 63mm |
| COBBLES | | 63mm to 200mm |
| BOULDERS | | > 200mm |

Soil types are qualified by the presence of minor components on the basis of field examination or the particle size distribution.

| Description | Percentage of minor component |
|---|---|
| Trace | < 5% in coarse grained soils |
| | < 15% in fine grained soils |
| With | 5% to 12% in coarse grained soils |
| | 15% to 30% in fine grained soils |

The strength of cohesive soils is classified by engineering assessment or field/laboratory testing as follows.

| Strength | Symbol | Undrained shear strength |
|---|---|---|
| Very Soft | VS | < 12kPa |
| Soft | S | 12kPa to 25kPa |
| Firm | F | 25kPa to 50kPa |
| Stiff | St | 50kPa to 100kPa |
| Very Stiff | VSt | 100kPa to 200kPa |
| Hard | H | > 200kPa |

Cohesionless soils are classified on the basis of relative density as follows.

| Relative Density | Symbol | Density Index |
|---|---|---|
| Very Loose | VL | < 15% |
| Loose | L | 15% to 35% |
| Medium Dense | MD | 35% to 65% |
| Dense | D | 65% to 85% |
| Very Dense | VD | > 85% |

The moisture condition of soil is described by appearance and feel and may be described in relation to the Plastic Limit (PL) or Optimum Moisture Content (OMC).

| Moisture condition and description | |
|---|---|
| Dry | Cohesive soils: hard, friable, dry of plastic limit. Granular soils: cohesionless and free-running |
| Moist | Cool feel and darkened colour: Cohesive soils can be moulded. Granular soils tend to cohere |
| Wet | Cool feel and darkened colour: Cohesive soils usually weakened and free water forms when handling. Granular soils tend to cohere |

The plasticity of cohesive soils is defined as follows.

| Plasticity | Liquid Limit |
|---|---|
| Low plasticity | ≤ 35% |
| Medium plasticity | > 35% ≤ 50% |
| High plasticity | > 50% |

The structure of the soil may be described as follows.

| Zoning | Description |
|---|---|
| Layer | Continuous across exposure or sample |
| Lens | Discontinuous layer (lenticular shape) |
| Pocket | Irregular inclusion of different material |

The structure of soil layers may include: defects such as softened zones, fissures, cracks, joints and root-holes; and coarse grained soils may be described as strongly or weakly cemented.

The soil origin may also be noted if possible to deduce.

| Soil origin and description | |
|---|---|
| Fill | Man-made deposits or disturbed material |
| Topsoil | Material affected by roots and root fibres |
| Colluvial | Transported down slopes by gravity |
| Aeolian | Transported and deposited by wind |
| Alluvial | Deposited by rivers |
| Lacustrine | Deposited by lakes |
| Marine | Deposits in beaches, bays and estuaries |
| Residual | Developed on weathered rock |

The origin of the soil generally cannot be deduced on the appearance of the material only and may be determined based on further geological evidence or other field observation.

# Explanatory Notes: General Rock Description

The methods of description and classification of rocks used in this report are based on Australian Standard AS1726-1993 Geotechnical Site Investigations. In practice, if a material cannot be remoulded by hand in its field condition or in water, it is described as a rock. In general, descriptions cover: rock type, grain size, structure, colour, degree of weathering, strength, minor components or inclusions, and where applicable, the defect types, shape, roughness and coating/infill.

Sedimentary rock types are generally described according to the predominant grain size as follows.

| Rock Type | Description |
|---|---|
| CONGLOMERATE | Rounded gravel sized fragments (>2mm) cemented in a finer matrix |
| SANDSTONE | Sand size particles defined by the following grain sizes:<br>fine 0.06mm to 0.2mm<br>medium 0.2mm to 0.6mm<br>coarse 0.6mm to 2mm |
| SILTSTONE | Predominately silt sized particles |
| SHALE | Fine particles (silt or clay) and fissile |
| CLAYSTONE | Predominately clay sized particles |

The classification of rock weathering is described based on definitions in AS1726 and summarised as follows.

| Term and symbol | | Definition |
|---|---|---|
| Residual Soil | RS | Soil developed on rock with the mass structure and substance of the parent rock no longer evident |
| Extremely weathered | XW | Weathered to such an extent that the rock has 'soil-like' properties |
| Distinctly weathered | DW | The strength is usually changed and may be highly discoloured. Porosity may be increased by leaching, or decreased due to deposition in pores |
| Slightly weathered | SW | Slightly discoloured; little or no change of strength from fresh rock |
| Fresh Rock | FR | The rock shows no sign of decomposition or staining |

The rock material strength can be defined based on the point load index as follows.

| Term and symbol | | Point Load Index $I_s50$ |
|---|---|---|
| Extremely low | EL | < 0.03MPa |
| Very Low | VL | 0.03MPa to 0.1MPa |
| Low | L | 0.1MPa to 0.3MPa |
| Medium | M | 0.3MPa to 1MPa |
| High | H | 1MPa to 3MPa |
| Very High | VH | 3MPa to 10MPa |
| Extremely High | EH | > 10MPa |

It is important to note that the rock material strength as above is distinct from the rock mass strength which can be significantly weaker due to the effect of defects.

A preliminary assessment of rock strength may be made using the field guide detailed in AS1726, and this is conducted in the absence of point load testing.

The defect spacing and bedding thickness, measured normal to defects of the same set or bedding, is described as follows.

| Definition | Defect Spacing |
|---|---|
| Thinly laminated | < 6mm |
| Laminated | 6mm to 20mm |
| Very thinly bedded | 20mm to 60mm |
| Thinly bedded | 60mm to 0.2m |
| Medium bedded | 0.2m to 0.6m |
| Thickly bedded | 0.6m to 2m |
| Very thickly bedded | > 2m |

Terms for describing rock and defects are as follows.

| Terms | | | |
|---|---|---|---|
| Joint | JT | Sheared zone | SZ |
| Bed Parting | BP | Sheared surface | SS |
| Contact | CO | Seam | SM |
| Dyke | DK | Crushed Seam | CS |
| Decomposed Zone | DZ | Infilled Seam | IS |
| Fracture | FC | Foliation | FL |
| Fracture Zone | FZ | Vein | VN |

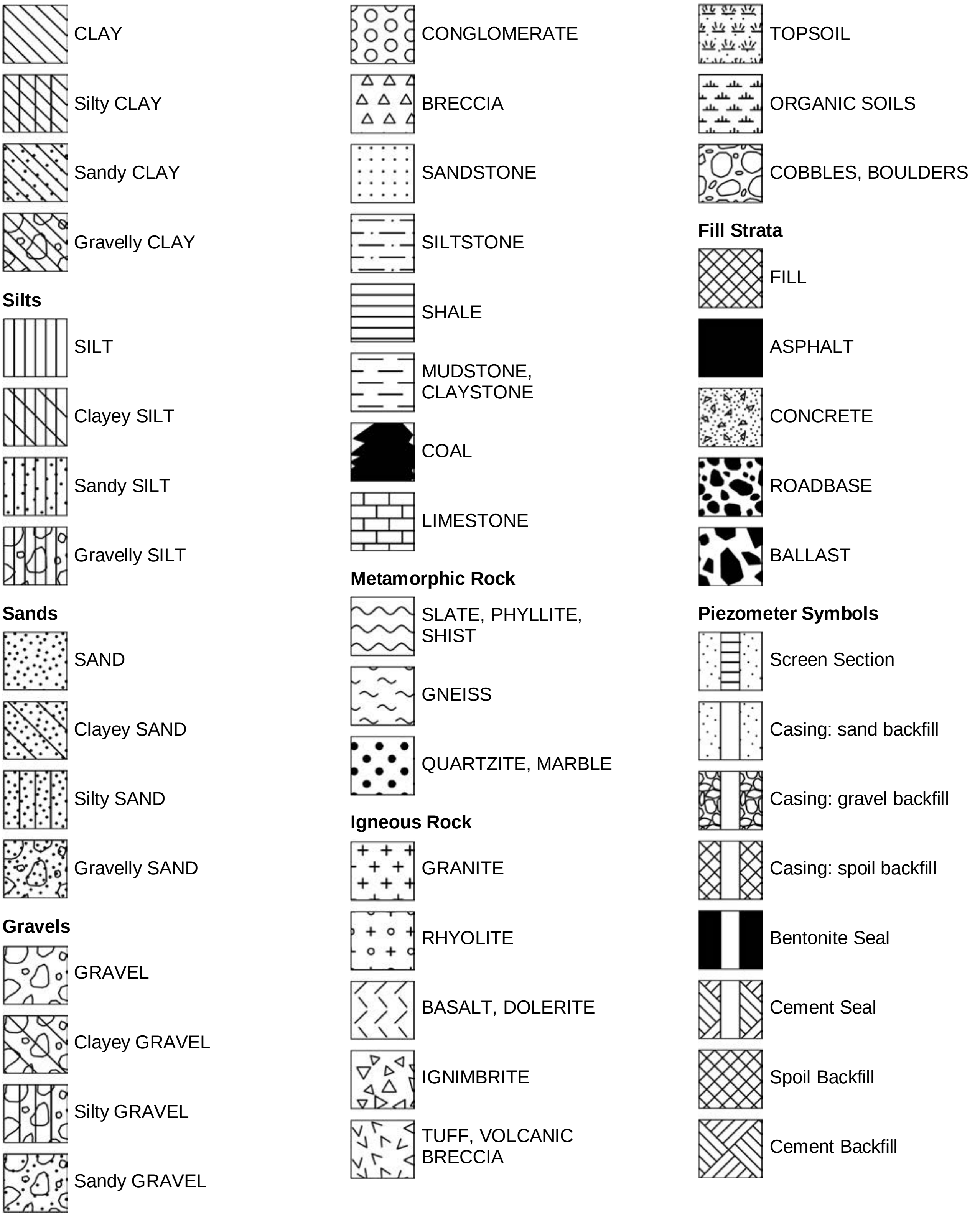
The shape and roughness of defects in the rock mass are described using the following terms.

| Planarity | | Roughness | |
|---|---|---|---|
| Planar | PR | Very Rough | VR |
| Curved | CU | Rough | RF |
| Undulating | U | Smooth | S |
| Irregular | IR | Polished | POL |
| Stepped | ST | Slickensides | SL |

The coating or infill associated with defects in the rock mass are described as follows.

| Definition | Description |
|---|---|
| Clean | No visible coating or infilling |
| Stain | No visible coating or infilling; surfaces discoloured by mineral staining |
| Veneer | Visible coating or infilling of soil or mineral substance (<1mm). If discontinuous over the plane; patchy veneer |
| Coating | Visible coating or infilling of soil or mineral substance (>1mm) |

# Graphic Symbols Index



**Clays**

- CLAY
- Silty CLAY
- Sandy CLAY
- Gravelly CLAY

**Silts**

- SILT
- Clayey SILT
- Sandy SILT
- Gravelly SILT

**Sands**

- SAND
- Clayey SAND
- Silty SAND
- Gravelly SAND

**Gravels**

- GRAVEL
- Clayey GRAVEL
- Silty GRAVEL
- Sandy GRAVEL

**Sedimentary Rock**

- CONGLOMERATE
- BRECCIA
- SANDSTONE
- SILTSTONE
- SHALE
- MUDSTONE, CLAYSTONE
- COAL
- LIMESTONE

**Metamorphic Rock**

- SLATE, PHYLLITE, SHIST
- GNEISS
- QUARTZITE, MARBLE

**Igneous Rock**

- GRANITE
- RHYOLITE
- BASALT, DOLERITE
- IGNIMBRITE
- TUFF, VOLCANIC BRECCIA

**Other Soils**

- TOPSOIL
- ORGANIC SOILS
- COBBLES, BOULDERS

**Fill Strata**

- FILL
- ASPHALT
- CONCRETE
- ROADBASE
- BALLAST

**Piezometer Symbols**

- Screen Section
- Casing: sand backfill
- Casing: gravel backfill
- Casing: spoil backfill
- Bentonite Seal
- Cement Seal
- Spoil Backfill
- Cement Backfill

# APPENDIX

# C

## LABORATORY TEST RESULTS

Cardno (NSW/ACT) Pty Ltd trading as
Cardno Geotech Solutions
ABN 95 001 145 035
P.O Box 4224, Edgeworth 2285
Unit 4/5 Arunga Dr, Beresfield 2322
[P] 0249 494300
[F] 0249 660485
[E] geotech@cardno.com.au

# Shrink Swell Index Report

| | | | |
|---|---|---|---|
| Client : | **McCloy Group Pty Ltd** | Report Number: | **CGS/1785 - 11** |
| Address : | **PO Box 2214 , Dangar, NSW, 2309** | Report Date : | **18/05/2015** |
| Project Name : | **Site Classification** | Order Number : | |
| Project Number : | **CGS/1785** | Test Method : | **AS1289.2.1.1 & AS1289.7.1.1** |
| Location: | **Stage 1 Pitt Street, Teralba** | | **Page 1 of 1** |

| Sample Number : | 15/2406 | 15/2407 | 15/2408 | |
|---|---|---|---|---|
| Test Number : | | | | |
| Sampling Method : | AS1289.1.2.1 c6.5.3 | AS1289.1.2.1 c6.5.3 | AS1289.1.2.1 c6.5.3 | |
| Sampled By : | David Bastian | David Bastian | David Bastian | |
| Date Sampled : | 28/04/2015 | 28/04/2015 | 28/04/2015 | |
| Date Tested : | 14/05/2015 | 14/05/2015 | 14/05/2015 | |
| Material Type : | | | | |
| Material Source : | In situ | In situ | In situ | |
| Sample Location : | Bore No TB303<br>Sample type Bulk<br>Sample Depth 0.50-0.80m | Bore No TB304<br>Sample type U50<br>Sample Depth 0.40-0.75m | Bore No TB308<br>Sample type U50<br>Sample Depth 0.25-0.50m | |
| Inert Material Estimate (%) : | 5 | 5 | 10 | |
| PP before (kPa) : | - | 410 | 470 | |
| PP after (kPa) : | 330 | 410 | 200 | |
| Shrinkage Moisture Content (%) : | 14 | 17.2 | 16.6 | |
| Shrinkage (%) : | **1.3** | **1.1** | **1.4** | |
| Swell Moisture Content Before (%) : | 15.4 | 17.3 | 22.5 | |
| Swell Moisture Content After (%) : | 18 | 18 | 23.3 | |
| Swell (%) : | **0.2** | **0** | **0.6** | |
| Unit Weight ($t/m^3$) : | 1.94 | 1.93 | 1.96 | |
| Shrink Swell Index Iss (%) : | **0.8** | **0.6** | **1** | |
| Visual Classification : | Sandy Gravelly CLAY, mottled grey orange & red | Sandy Gravelly CLAY, mottled grey orange & red | Silty CLAY, mottled red | |
| Cracking : | Moderate | Moderate | Moderate | |
| Crumbling : | Moderate | Moderate | Moderate | |
| Remarks : | Sample 15/2406 remoulded at field moisture content. | | | |

WORLD RECOGNISED ACCREDITATION

**This document is issued in accordance with NATA's accreditation requirements.**

APPROVED SIGNATORY

Ian Piper - Principal Technical Officer
NATA Accreditation Number
15689

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12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
enquiries@envirolabservices.com.au
www.envirolabservices.com.au

# CERTIFICATE OF ANALYSIS 127265

**Client:**

**Cardno Geotech Solutions**
PO Box 4224
Edgeworth
NSW 2285

**Attention:** Dimce Stojanovski

**Sample log in details:**

| | | | |
|---|---|---|---|
| Your Reference: | **CGS1785** | | |
| No. of samples: | 2 Soils | | |
| Date samples received / completed instructions received | 01/05/15 | / | 01/05/15 |

**Analysis Details:**

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

***Please refer to the last page of this report for any comments relating to the results.***

**Report Details:**

| | | | |
|---|---|---|---|
| Date results requested by: / Issue Date: | 8/05/15 | / | 8/05/15 |
| Date of Preliminary Report: | Not Issued | | |

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**Results Approved By:**

Jacinta Hurst
Laboratory Manager

| Misc Inorg - Soil | | | |
|---|---|---|---|
| Our Reference: | UNITS | 127265-1 | 127265-2 |
| Your Reference | ------------- | TB303 | TB308 |
| Depth | ------------ | 0.7 | 0.4 |
| Date Sampled | | 28/04/2015 | 28/04/2015 |
| Type of sample | | Soil | Soil |
| Date prepared | - | 06/05/2015 | 06/05/2015 |
| Date analysed | - | 06/05/2015 | 06/05/2015 |
| pH 1:5 soil:water | pH Units | 5.2 | 4.6 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 57 | 89 |
| Chloride, Cl 1:5 soil:water | mg/kg | 24 | 10 |
| Sulphate, SO4 1:5 soil:water | mg/kg | 21 | 60 |

| Method ID | Methodology Summary |
|---|---|
| Inorg-001 | pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times. |
| Inorg-002 | Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA latest edition 2510 and Rayment & Lyons. |
| Inorg-081 | Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. |

| QUALITY CONTROL<br>Misc Inorg - Soil | UNITS | PQL | METHOD | Blank | Duplicate Sm# | Duplicate results<br>Base II Duplicate II %RPD | Spike Sm# | Spike % Recovery |
|---|---|---|---|---|---|---|---|---|
| Date prepared | - | | | 06/05/2015 | 127265-1 | 06/05/2015 \|\| 06/05/2015 | LCS-1 | 06/05/2015 |
| Date analysed | - | | | 06/05/2015 | 127265-1 | 06/05/2015 \|\| 06/05/2015 | LCS-1 | 06/05/2015 |
| pH 1:5 soil:water | pH Units | | Inorg-001 | [NT] | 127265-1 | 5.2 \|\| 5.3 \|\| RPD: 2 | LCS-1 | 101% |
| Electrical Conductivity 1:5 soil:water | µS/cm | 1 | Inorg-002 | <1 | 127265-1 | 57 \|\| 55 \|\| RPD: 4 | LCS-1 | 97% |
| Chloride, Cl 1:5 soil:water | mg/kg | 10 | Inorg-081 | <10 | 127265-1 | 24 \|\| 44 \|\| RPD: 59 | LCS-1 | 90% |
| Sulphate, SO4 1:5 soil:water | mg/kg | 10 | Inorg-081 | <10 | 127265-1 | 21 \|\| 24 \|\| RPD: 13 | LCS-1 | 102% |

**Report Comments:**

| | |
|---|---|
| Asbestos ID was analysed by Approved Identifier: | Not applicable for this job |
| Asbestos ID was authorised by Approved Signatory: | Not applicable for this job |

| | | |
|---|---|---|
| INS: Insufficient sample for this test | PQL: Practical Quantitation Limit | NT: Not tested |
| NA: Test not required | RPD: Relative Percent Difference | NA: Test not required |
| <: Less than | >: Greater than | LCS: Laboratory Control Sample |

## Quality Control Definitions

**Blank**: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

**Duplicate**: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

**Matrix Spike** : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

**LCS (Laboratory Control Sample)** : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

**Surrogate Spike:** Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

## Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Stage 1 Pitt Street, Teralba

# APPENDIX

# D

## CSIRO INFORMATION SHEET BTF 18

# Foundation Maintenance and Footing Performance:

## A Homeowner's Guide

BTF 18
replaces
Information
Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

### Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

### Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

**GENERAL DEFINITIONS OF SITE CLASSES**

| Class | Foundation |
|---|---|
| A | Most sand and rock sites with little or no ground movement from moisture changes |
| S | Slightly reactive clay sites with only slight ground movement from moisture changes |
| M | Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes |
| H | Highly reactive clay sites, which can experience high ground movement from moisture changes |
| E | Extremely reactive sites, which can experience extreme ground movement from moisture changes |
| A to P | Filled sites |
| P | Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise |

Tree root growth
Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

## Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

## Effects of Uneven Soil Movement on Structures

Erosion and saturation
Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

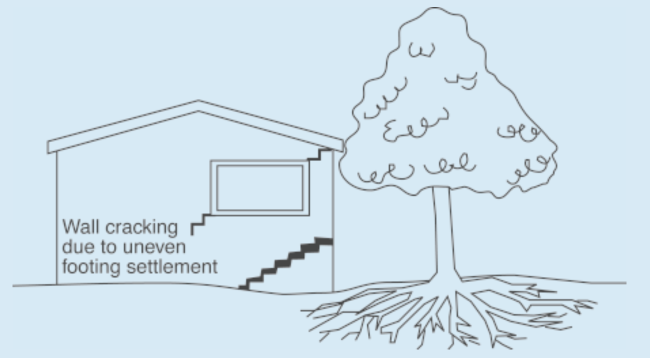
Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

Seasonal swelling/shrinkage in clay
Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

**Trees can cause shrinkage and damage**



As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots
In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself
Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures
Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures
Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures
Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

## Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.
Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

## Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

## Prevention/Cure

Plumbing
Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage
In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

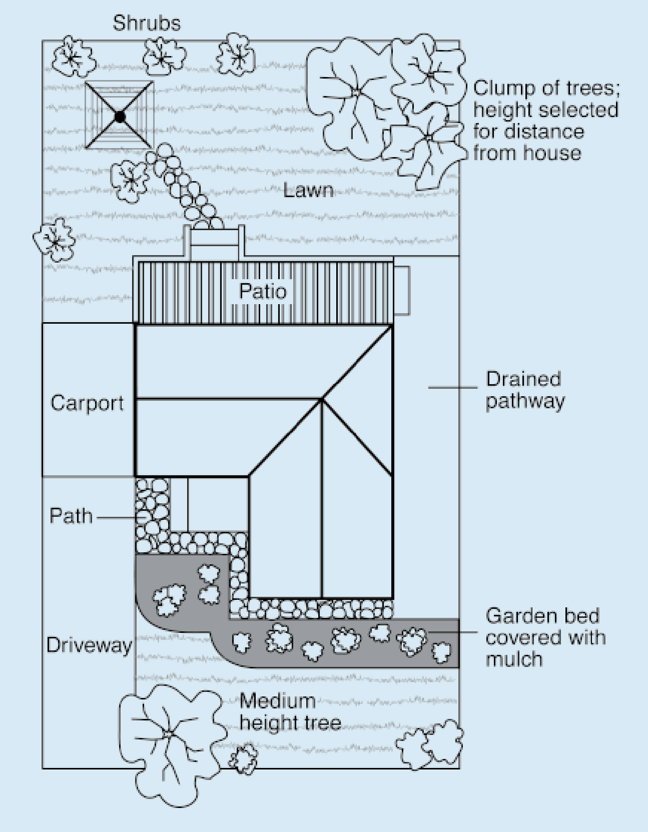
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

### CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

| Description of typical damage and required repair | Approximate crack width limit (see Note 3) | Damage category |
|---|---|---|
| Hairline cracks | <0.1 mm | 0 |
| Fine cracks which do not need repair | <1 mm | 1 |
| Cracks noticeable but easily filled. Doors and windows stick slightly | <5 mm | 2 |
| Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired | 5–15 mm (or a number of cracks 3 mm or more in one group) | 3 |
| Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted | 15–25 mm but also depend on number of cracks | 4 |

**Gardens for a reactive site**



should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

### Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

*Warning:* Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

### The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

### Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

### Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

### Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

## Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

**This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.**

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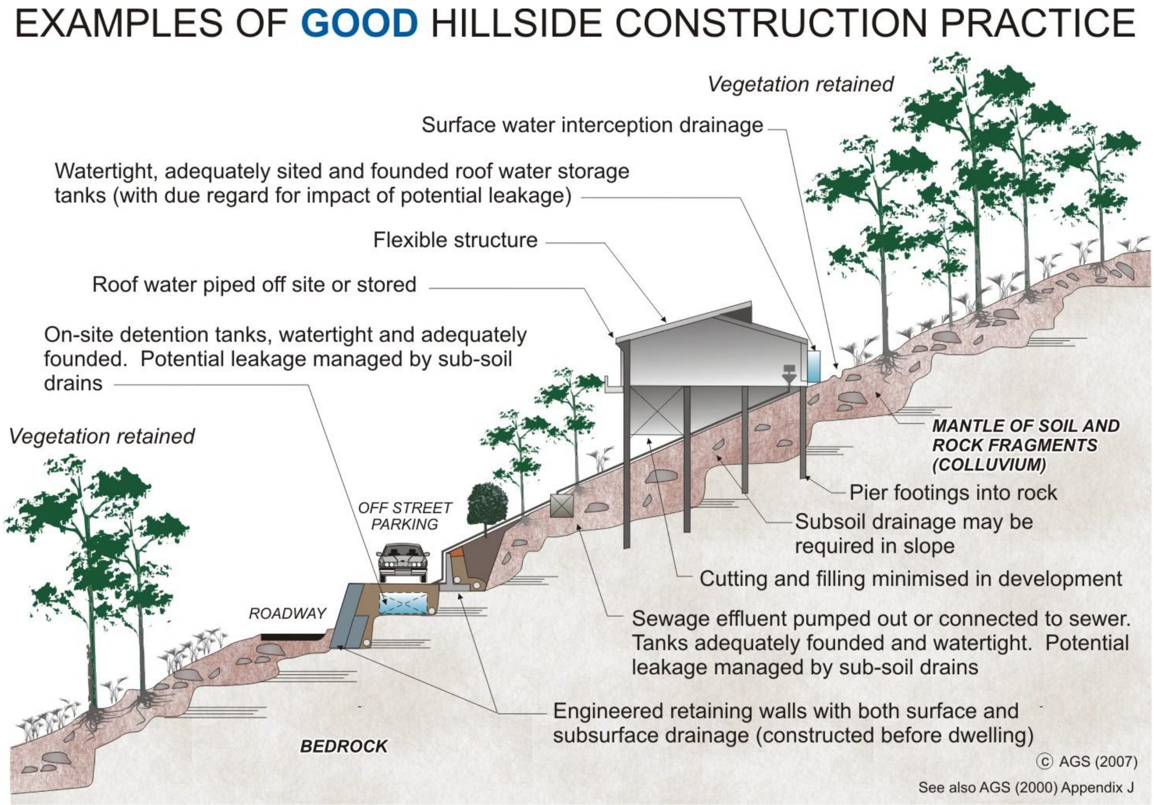
# AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

## HILLSIDE CONSTRUCTION PRACTICE

Sensible development practices are required when building on hillsides, particularly if the hillside has more than a low risk of instability (GeoGuide LR7). Only building techniques intended to maintain, or reduce, the overall level of landslide risk should be considered. Examples of good hillside construction practice are illustrated below.



### WHY ARE THESE PRACTICES GOOD?

**Roadways and parking areas -** are paved and incorporate kerbs which prevent water discharging straight into the hillside (GeoGuide LR5).

**Cuttings -** are supported by retaining walls (GeoGuide LR6).

**Retaining walls -** are engineer designed to withstand the lateral earth pressures and surcharges expected, and include drains to prevent water pressures developing in the backfill. Where the ground slopes steeply down towards the high side of a retaining wall, the disturbing force (see GeoGuide LR6) can be two or more times that in level ground. Retaining walls must be designed taking these forces into account.

**Sewage -** whether treated or not is either taken away in pipes or contained in properly founded tanks so it cannot soak into the ground.

**Surface water -** from roofs and other hard surfaces is piped away to a suitable discharge point rather than being allowed to infiltrate into the ground. Preferably, the discharge point will be in a natural creek where ground water exits, rather than enters, the ground. Shallow, lined, drains on the surface can fulfil the same purpose (GeoGuide LR5).

**Surface loads** - are minimised. No fill embankments have been built. The house is a lightweight structure. Foundation loads have been taken down below the level at which a landslide is likely to occur and, preferably, to rock. This sort of construction is probably not applicable to soil slopes (GeoGuide LR3). If you are uncertain whether your site has rock near the surface, or is essentially a soil slope, you should engage a geotechnical practitioner to find out.

**Flexible structures -** have been used because they can tolerate a certain amount of movement with minimal signs of distress and maintain their functionality.

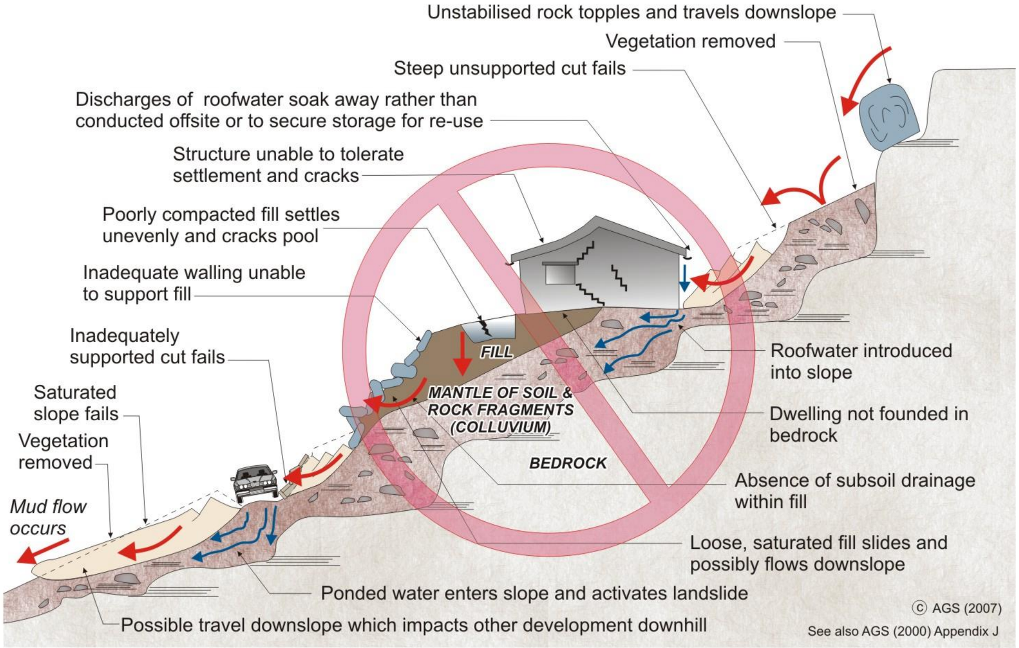
**Vegetation clearance -** on soil slopes has been kept to a reasonable minimum. Trees, and to a lesser extent smaller vegetation, take large quantities of water out of the ground every day. This lowers the ground water table, which in turn helps to maintain the stability of the slope. Large scale clearing can result in a rise in water table with a consequent increase in the likelihood of a landslide (GeoGuide LR5). An exception may have to be made to this rule on steep rock slopes where trees have little effect on the water table, but their roots pose a landslide hazard by dislodging boulders.

Possible effects of ignoring good construction practices are illustrated on page 2. Unfortunately, these poor construction practices are not as unusual as you might think and are often chosen because, on the face of it, they will save the developer, or owner, money. You should not lose sight of the fact that the cost and anguish associated with any one of the disasters illustrated, is likely to more than wipe out any apparent savings at the outset.

**ADOPT GOOD PRACTICE ON HILLSIDE SITES**

# AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

## EXAMPLES OF POOR HILLSIDE CONSTRUCTION PRACTICE



### WHY ARE THESE PRACTICES POOR?

**Roadways and parking areas -** are unsurfaced and lack proper table drains (gutters) causing surface water to pond and soak into the ground.

**Cut and fill -** has been used to balance earthworks quantities and level the site leaving unstable cut faces and added large surface loads to the ground. Failure to compact the fill properly has led to settlement, which will probably continue for several years after completion. The house and pool have been built on the fill and have settled with it and cracked. Leakage from the cracked pool and the applied surface loads from the fill have combined to cause landslides.

**Retaining walls -** have been avoided, to minimise cost, and hand placed rock walls used instead. Without applying engineering design principles, the walls have failed to provide the required support to the ground and have failed, creating a very dangerous situation.

**A heavy, rigid, house** - has been built on shallow, conventional, footings. Not only has the brickwork cracked because of the resulting ground movements, but it has also become involved in a man-made landslide.

**Soak-away drainage -** has been used for sewage and surface water run-off from roofs and pavements. This water soaks into the ground and raises the water table (GeoGuide LR5). Subsoil drains that run along the contours should be avoided for the same reason. If felt necessary, subsoil drains should run steeply downhill in a chevron, or herring bone, pattern. This may conflict with the requirements for effluent and surface water disposal (GeoGuide LR9) and if so, you will need to seek professional advice.

**Rock debris** - from landslides higher up on the slope seems likely to pass through the site. Such locations are often referred to by geotechnical practitioners as "debris flow paths". Rock is normally even denser than ordinary fill, so even quite modest boulders are likely to weigh many tonnes and do a lot of damage once they start to roll. Boulders have been known to travel hundreds of metres downhill leaving behind a trail of destruction.

**Vegetation** - has been completely cleared, leading to a possible rise in the water table and increased landslide risk (GeoGuide LR5).

**DON'T CUT CORNERS ON HILLSIDE SITES - OBTAIN ADVICE FROM A GEOTECHNICAL PRACTITIONER**

**More information relevant to your particular situation may be found in other Australian GeoGuides:**

- GeoGuide LR1 - Introduction
- GeoGuide LR2 - Landslides
- GeoGuide LR3 - Landslides in Soil
- GeoGuide LR4 - Landslides in Rock
- GeoGuide LR5 - Water & Drainage
- GeoGuide LR6 - Retaining Walls
- GeoGuide LR7 - Landslide Risk
- GeoGuide LR9 - Effluent & Surface Water Disposal

GeoGuide LR10 - Coastal Landslides

- GeoGuide LR11 - Record Keeping

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The Australian GeoGuides (LR series) are a set of publications intended for property owners; local councils; planning authorities; developers; insurers; lawyers and, in fact, anyone who lives with, or has an interest in, a natural or engineered slope, a cutting, or an excavation. They are intended to help you understand why slopes and retaining structures can be a hazard and what can be done with appropriate professional advice and local council approval (if required) to remove, reduce, or minimise the risk they represent. The GeoGuides have been prepared by the Australian Geomechanics Society, a specialist technical society within Engineers Australia, the national peak body for all engineering disciplines in Australia, whose members are professional geotechnical engineers and engineering geologists with a particular interest in ground engineering. The GeoGuides have been funded under the Australian governments' National Disaster Mitigation Program.

# APPENDIX

# E

# COMPACTION TEST REPORTS

# LOT FILL TEST REPORTS

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Cardno Geotech Solutions
Shaping the Future

# Nuclear Hilf Density Ratio Report

| | | | |
|---|---|---|---|
| Client : | **Keller Civil Engineering** | Report Number: | **CGS/2498 - 34** |
| Client Address: | **1 Balbu Close Beresfield NSW 2322** | Report Date: | **17/02/2015** |
| Job Number : | **CGS/2498** | Folder Number: | |
| Project : | **Subdivision** | Test Method: | **AS1289 5.7.1 & 5.8.1** |
| Location : | **Pitt Street , Teralba** | **Page 1 of 1** | |

| | | | | |
|---|---|---|---|---|
| Lab No : | 15/605 | 15/606 | 15/607 | 15/608 |
| ID No : | 82 | 83 | 84 | 85 |
| Lot No : | - | - | - | - |
| Sampling Method : | AS1289.1.2.1 c6.4 (b) EW | AS1289.1.2.1 c6.4 (b) EW | AS1289.1.2.1 c6.4 (b) EW | AS1289.1.2.1 c6.4 (b) EW |
| Date Sampled : | 6/2/2015 | 6/2/2015 | 6/2/2015 | 6/2/2015 |
| Date Tested : | 6/2/2015 | 6/2/2015 | 6/2/2015 | 6/2/2015 |
| Material Source : | Site Won | Site Won | Site Won | Site Won |
| For Use As : | Lot Fill | Lot Fill | Lot Fill | Lot Fill |
| Sample Location : | Carabal Street Gully Fill<br>CH:60m<br>11m Left of CL<br>Layer 11 | Carabal Street Gully Fill<br>CH:65m<br>10m Left of CL<br>Layer 12 | Carabal Street Gully Fill<br>CH:60m<br>11.5m Left of CL<br>Layer 13 | Carabal Street Gully Fill<br>CH:65m<br>10.5m Left of CL<br>Layer 14 |
| Test Depth/Layer (mm) | **275 / 300** | **275 / 300** | **275 / 300** | **275 / 300** |
| Max Size (mm) : | **19** | **19** | **19** | **19** |
| Percent Oversize (%): | **6.8** | **1.1** | **9.1** | **0.0** |
| Field Wet Density (t/m³) : | **2.25** | **2.17** | **2.17** | **2.16** |
| Field Moisture Cont (%) : | **13.6** | **12.9** | **13.8** | **12.7** |
| PCWD (t/m³) : | **2.19*** | **2.15*** | **2.18*** | **2.16** |
| Maximum Converted Dry Density (t/m³) : | **1.98** | **1.92** | **1.91** | **1.92** |
| Optimum Moisture Content (%) : | **13.5** | **12.5** | **14.5** | **13.0** |
| Apparent OMC (%) : | **-0.1** | **-0.2** | **0.5** | **0.2** |
| Compactive Effort : | **Standard** | **Standard** | **Standard** | **Standard** |
| Relative Compaction (%) : | **103.0** | **101.0** | **99.0** | **100.0** |
| Moisture Ratio / Spec : | **100.7 / 85-115%** | **103.2 / 85-115%** | **95.2 / 85-115%** | **97.7 / 85-115%** |
| Moisture Variation (%) : | **0% (wet)** | **0% (wet)** | **0.5% (dry)** | **0% (dry)** |

Remarks:

*** - Denotes adjusted for oversize**

| Lab Number: | Soil Description |
|---|---|
| **15/605** | **Sandy Gravelly CLAY, brown** |
| **15/606** | **Sandy Gravelly CLAY, brown** |
| **15/607** | **Sandy Gravelly CLAY, brown** |
| **15/608** | **Sandy Gravelly CLAY, brown** |

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# Nuclear Hilf Density Ratio Report

| | | | |
|---|---|---|---|
| Client : | **Keller Civil Engineering** | Report Number: | **CGS/2498 - 33** |
| Client Address: | **1 Balbu Close Beresfield NSW 2322** | Report Date: | **17/02/2015** |
| Job Number : | **CGS/2498** | Folder Number: | |
| Project : | **Subdivision** | Test Method: | **AS1289 5.7.1 & 5.8.1** |
| Location : | **Pitt Street , Teralba** | **Page 1 of 1** | |

| | | | | |
|---|---|---|---|---|
| Lab No : | 15/609 | 15/610 | 15/611 | 15/612 |
| ID No : | 86 | 87 | 88 | 89 |
| Lot No : | - | - | - | - |
| Sampling Method : | AS1289.1.2.1 c6.4 (b) EW | AS1289.1.2.1 c6.4 (b) EW | AS1289.1.2.1 c6.4 (b) EW | AS1289.1.2.1 c6.4 (b) EW |
| Date Sampled : | 6/2/2015 | 6/2/2015 | 6/2/2015 | 6/2/2015 |
| Date Tested : | 6/2/2015 | 6/2/2015 | 6/2/2015 | 6/2/2015 |
| Material Source : | Site Won | Site Won | Site Won | Site Won |
| For Use As : | Lot Fill | Lot Fill | Lot Fill | Lot Fill |
| Sample Location : | Lot 122-118<br>N. 6351297.11<br>E. 369064.59<br>R.L 46.138 | Lot 122-118<br>N. 6351303.62<br>E. 369061.79<br>R.L 46.18 | Lot 122-118<br>N. 63513023.56<br>E. 396062.82<br>R.L 46.14 | Lot 122-118<br>N. 6351296.98<br>E. 369268.68<br>R.L 46.75 |
| Test Depth/Layer (mm) | **275 / 300** | **275 / 300** | **275 / 300** | **275 / 300** |
| Max Size (mm) : | **19** | **19** | **19** | **19** |
| Percent Oversize (%): | **7.9** | **10.4** | **9.4** | **6.5** |
| Field Wet Density (t/m³) : | **2.16** | **2.12** | **2.13** | **2.16** |
| Field Moisture Cont (%) : | **14.8** | **15.6** | **13.5** | **13.6** |
| PCWD (t/m³) : | **2.16*** | **2.15*** | **2.17*** | **2.15*** |
| Maximum Converted Dry Density (t/m³) : | **1.88** | **1.83** | **1.88** | **1.90** |
| Optimum Moisture Content (%) : | **13.0** | **14.0** | **13.5** | **13.5** |
| Apparent OMC (%) : | **-1.6** | **-1.7** | **-0.2** | **-0.1** |
| Compactive Effort : | **Standard** | **Standard** | **Standard** | **Standard** |
| Relative Compaction (%) : | **100.0** | **99.0** | **98.0** | **100.5** |
| Moisture Ratio / Spec : | **113.8 / 85-115%** | **111.4 / 85-115%** | **100.0 / 85-115%** | **100.7 / 85-115%** |
| Moisture Variation (%) : | **1.5% (wet)** | **1.5% (wet)** | **0% (wet)** | **0% (wet)** |
| Remarks: | | | | |

*** - Denotes adjusted for oversize**

| Lab Number: | Soil Description |
|---|---|
| **15/609** | **Gravelly Sandy CLAY, brown** |
| **15/610** | **Gravelly Sandy CLAY, brown** |
| **15/611** | **Gravelly Sandy CLAY, brown** |
| **15/612** | **Gravelly Sandy CLAY, brown** |

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# Nuclear Hilf Density Ratio Report

| | | | |
|---|---|---|---|
| Client : | **Keller Civil Engineering** | Report Number: | **CGS/2498 - 31** |
| Client Address: | **1 Balbu Close Beresfield NSW 2322** | Report Date: | **17/02/2015** |
| Job Number : | **CGS/2498** | Folder Number: | |
| Project : | **Subdivision** | Test Method: | **AS1289 5.7.1 & 5.8.1** |
| Location : | **Pitt Street , Teralba** | **Page 1 of 1** | |

| | | | | |
|---|---|---|---|---|
| Lab No : | 15/660 | | | |
| ID No : | 99 | | | |
| Lot No : | - | | | |
| Sampling Method : | AS1289.1.2.1 c6.4 (b) EW | | | |
| Date Sampled : | 9/2/2015 | | | |
| Date Tested : | 9/2/2015 | | | |
| Material Source : | Site Won | | | |
| For Use As : | Lot Fill | | | |
| Sample Location : | Between Lot 122-lot-118<br>N. 6351292.18<br>E369077.73<br>R.L.47.38 Layer 5 | | | |
| Test Depth/Layer (mm) | **275 / 300** | | | |
| Max Size (mm) : | **19** | | | |
| Percent Oversize (%): | **8.3** | | | |
| Field Wet Density (t/m³) : | **2.14** | | | |
| Field Moisture Cont (%) : | **11.0** | | | |
| PCWD (t/m³) : | **2.05*** | | | |
| Maximum Converted Dry Density (t/m³) : | **1.93** | | | |
| Optimum Moisture Content (%) : | **13.5** | | | |
| Apparent OMC (%) : | **2.5** | | | |
| Compactive Effort : | **Standard** | | | |
| Relative Compaction (%) : | **104.5** | | | |
| Moisture Ratio / Spec : | **81.5 / 85-115%** | | | |
| Moisture Variation (%) : | **2.5% (dry)** | | | |
| Remarks: | | | | |

*** - Denotes adjusted for oversize**

| Lab Number: | Soil Description |
|---|---|
| **15/660** | **Sandy Gravelly CLAY, brown** |
| | |
| | |
| | |

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# Nuclear Hilf Density Ratio Report

| | | | |
|---|---|---|---|
| Client : | **Keller Civil Engineering** | Report Number: | **CGS/2498 - 39** |
| Client Address: | **1 Balbu Close Beresfield NSW 2322** | Report Date: | **20/02/2015** |
| Job Number : | **CGS/2498** | Folder Number: | |
| Project : | **Subdivision** | Test Method: | **AS1289 5.7.1 & 5.8.1** |
| Location : | **Pitt Street , Teralba** | **Page 1 of 1** | |

| | | | | |
|---|---|---|---|---|
| Lab No : | 15/777 | 15/778 | | |
| ID No : | 104 | 105 | | |
| Lot No : | - | - | | |
| Sampling Method : | AS1289.1.2.1 c6.4 (b) EW | AS1289.1.2.1 c6.4 (b) EW | | |
| Date Sampled : | 12/2/2015 | 12/2/2015 | | |
| Date Tested : | 18/2/2015 | 18/2/2015 | | |
| Material Source : | Site Won | Site Won | | |
| For Use As : | Lot Fill | Lot Fill | | |
| Sample Location : | Regatta Close Lot 102-105 CH 100-165<br>Lot 104 CH130<br>O/S Right of CL<br>Layer 1 | Regatta Close Lot 102-105 CH 100-165<br>Lot 104 CH125<br>O/S Right of CL 27<br>Layer 2 | | |
| Test Depth/Layer (mm) | **275 / 300** | **275 / 300** | | |
| Max Size (mm) : | **19** | **19** | | |
| Percent Oversize (%): | **4.9** | **11.9** | | |
| Field Wet Density (t/m³) : | **2.05** | **2.00** | | |
| Field Moisture Cont (%) : | **14.5** | **14.0** | | |
| PCWD (t/m³) : | **2.05*** | **2.13*** | | |
| Maximum Converted Dry Density (t/m³) : | **1.79** | **1.75** | | |
| Optimum Moisture Content (%) : | **16.5** | **15.5** | | |
| Apparent OMC (%) : | **1.9** | **1.5** | | |
| Compactive Effort : | **Standard** | **Standard** | | |
| Relative Compaction (%) : | **100.0** | **94.0** | | |
| Moisture Ratio / Spec : | **87.9 / 85-115%** | **90.3 / 85-115%** | | |
| Moisture Variation (%) : | **2% (dry)** | **1.5% (dry)** | | |

Remarks:

*** - Denotes adjusted for oversize**

| Lab Number: | Soil Description |
|---|---|
| **15/777** | **Sandy Silty CLAY, dark brown** |
| **15/778** | **Sandy Silty CLAY, dark brown** |
| | |
| | |

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# Nuclear Hilf Density Ratio Report

| | | | |
|---|---|---|---|
| Client : | **Keller Civil Engineering** | Report Number: | **CGS/2498 - 46** |
| Client Address: | **1 Balbu Close Beresfield NSW 2322** | Report Date: | **25/02/2015** |
| Job Number : | **CGS/2498** | Folder Number: | |
| Project : | **Subdivision** | Test Method: | **AS1289 5.7.1 & 5.8.1** |
| Location : | **Pitt Street , Teralba** | **Page 1 of 1** | |

| | | | | |
|---|---|---|---|---|
| Lab No : | 15/875 | 15/876 | 15/877 | |
| ID No : | 109 | 110 | 111 | |
| Lot No : | - | - | - | |
| Sampling Method : | AS1289.1.2.1 c6.4 (b) EW | AS1289.1.2.1 c6.4 (b) EW | AS1289.1.2.1 c6.4 (b) EW | |
| Date Sampled : | 13/2/2015 | 13/2/2015 | 13/2/2015 | |
| Date Tested : | 20/2/2015 | 20/2/2015 | 20/2/2015 | |
| Material Source : | Site Won | Site Won | Site Won | |
| For Use As : | Lot Fill | Lot Fill | Lot Fill | |
| Sample Location : | Lot 102-105 (Regatta Close Ch:100-165)<br>Lot 104<br>Ch: 135m, 22m Right of cL<br>Layer 3 | Lot 102-105 (Regatta Close Ch:100-165)<br>Lot 104<br>Ch: 128m, 19m Right of cL<br>Layer 4 | Lot 102-105 (Regatta Close Ch:100-165)<br>Lot 104<br>Ch: 130m, @ cL<br>Layer 5 | |
| Test Depth/Layer (mm) | **275 / 300** | **275 / 300** | **275 / 300** | |
| Max Size (mm) : | **19** | **19** | **19** | |
| Percent Oversize (%): | **12.0** | **7.7** | **18.1** | |
| Field Wet Density (t/m³) : | **2.10** | **2.12** | **2.07** | |
| Field Moisture Cont (%) : | **13.7** | **12.4** | **14.4** | |
| PCWD (t/m³) : | **2.09*** | **2.09*** | **2.19*** | |
| Maximum Converted Dry Density (t/m³) : | **1.85** | **1.89** | **1.81** | |
| Optimum Moisture Content (%) : | **15.5** | **14.5** | **14.5** | |
| Apparent OMC (%) : | **1.4** | **2.0** | **0.2** | |
| Compactive Effort : | **Standard** | **Standard** | **Standard** | |
| Relative Compaction (%) : | **100.5** | **101.0** | **94.5** | |
| Moisture Ratio / Spec : | **88.4 / 85-115%** | **85.5 / 85-115%** | **99.3 / 85-115%** | |
| Moisture Variation (%) : | **1.5% (dry)** | **2% (dry)** | **0% (dry)** | |
| Remarks: | | | | |

*** - Denotes adjusted for oversize**

| Lab Number: | Soil Description |
|---|---|
| **15/875** | **Sandy Gravelly CLAY, brown** |
| **15/876** | **Sandy Gravelly CLAY, brown** |
| **15/877** | **Sandy Gravelly CLAY, brown** |
| | |

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# Nuclear Hilf Density Ratio Report

| | | | |
|---|---|---|---|
| Client : | **Keller Civil Engineering** | Report Number: | **CGS/2498 - 49** |
| Client Address: | **1 Balbu Close Beresfield NSW 2322** | Report Date: | **26/02/2015** |
| Job Number : | **CGS/2498** | Folder Number: | |
| Project : | **Subdivision** | Test Method: | **AS1289 5.7.1 & 5.8.1** |
| Location : | **Pitt Street , Teralba** | **Page 1 of 1** | |

| | | | | |
|---|---|---|---|---|
| Lab No : | 15/893 | | | |
| ID No : | 118 | | | |
| Lot No : | - | | | |
| Sampling Method : | AS1289.1.2.1 c6.4 (b) EW | | | |
| Date Sampled : | 16/2/2015 | | | |
| Date Tested : | 20/2/2015 | | | |
| Material Source : | Site Won | | | |
| For Use As : | Lot Fill | | | |
| Sample Location : | Fill Gully<br>Lot 104<br>Regatta Ch: 135m<br>22m Right of cL, Layer 5 | | | |
| Test Depth/Layer (mm) | **275 / 300** | | | |
| Max Size (mm) : | **19** | | | |
| Percent Oversize (%): | **4.2** | | | |
| Field Wet Density (t/m³) : | **2.19** | | | |
| Field Moisture Cont (%) : | **13.6** | | | |
| PCWD (t/m³) : | **2.04*** | | | |
| Maximum Converted Dry Density (t/m³) : | **1.93** | | | |
| Optimum Moisture Content (%) : | **15.5** | | | |
| Apparent OMC (%) : | **1.7** | | | |
| Compactive Effort : | **Standard** | | | |
| Relative Compaction (%) : | **107.0** | | | |
| Moisture Ratio / Spec : | **87.7 / 85-115%** | | | |
| Moisture Variation (%) : | **1.5% (dry)** | | | |

Remarks:

*** - Denotes adjusted for oversize**

| Lab Number: | Soil Description |
|---|---|
| **15/893** | **Silty Gravelly CLAY, dark brown** |
| | |
| | |
| | |

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|---|---|---|---|
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# Nuclear Hilf Density Ratio Report

| | | | |
|---|---|---|---|
| Client : | **Keller Civil Engineering** | Report Number: | **CGS/2498 - 51** |
| Client Address: | **1 Balbu Close Beresfield NSW 2322** | Report Date: | **26/02/2015** |
| Job Number : | **CGS/2498** | Folder Number: | |
| Project : | **Subdivision** | Test Method: | **AS1289 5.7.1 & 5.8.1** |
| Location : | **Pitt Street , Teralba** | **Page 1 of 1** | |

| | | | | |
|---|---|---|---|---|
| Lab No : | 15/895 | | | |
| ID No : | 120 | | | |
| Lot No : | - | | | |
| Sampling Method : | AS1289.1.2.1 c6.4 (b) EW | | | |
| Date Sampled : | 17/2/2015 | | | |
| Date Tested : | 20/2/2015 | | | |
| Material Source : | Site Won | | | |
| For Use As : | Lot Fill | | | |
| Sample Location : | Gully Fill<br>Lot 104<br>Regatta Ch: 130m<br>18m Right of cL, Layer 6 | | | |
| Test Depth/Layer (mm) | **275 / 300** | | | |
| Max Size (mm) : | **19** | | | |
| Percent Oversize (%): | **13.1** | | | |
| Field Wet Density (t/m³) : | **2.15** | | | |
| Field Moisture Cont (%) : | **9.6** | | | |
| PCWD (t/m³) : | **2.17*** | | | |
| Maximum Converted Dry Density (t/m³) : | **1.96** | | | |
| Optimum Moisture Content (%) : | **11.5** | | | |
| Apparent OMC (%) : | **1.9** | | | |
| Compactive Effort : | **Standard** | | | |
| Relative Compaction (%) : | **99.5** | | | |
| Moisture Ratio / Spec : | **83.5 / 85-115%** | | | |
| Moisture Variation (%) : | **2% (dry)** | | | |

Remarks:

*** - Denotes adjusted for oversize**

| Lab Number: | Soil Description |
|---|---|
| **15/895** | **Sandy Gravelly CLAY, brown** |
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# Nuclear Hilf Density Ratio Report

| | | | |
|---|---|---|---|
| Client : | **Keller Civil Engineering** | Report Number: | **CGS/2498 - 53** |
| Client Address: | **1 Balbu Close Beresfield NSW 2322** | Report Date: | **26/02/2015** |
| Job Number : | **CGS/2498** | Folder Number: | |
| Project : | **Subdivision** | Test Method: | **AS1289 5.7.1 & 5.8.1** |
| Location : | **Pitt Street , Teralba** | **Page 1 of 1** | |

| | | | | |
|---|---|---|---|---|
| Lab No : | 15/915 | | | |
| ID No : | 122 | | | |
| Lot No : | - | | | |
| Sampling Method : | AS1289.1.2.1 c6.4 (b) EW | | | |
| Date Sampled : | 17/2/2015 | | | |
| Date Tested : | 20/2/2015 | | | |
| Material Source : | Site Won | | | |
| For Use As : | Lot Fill | | | |
| Sample Location : | Gully Fill<br>Lot 104<br>Regatta Ch:125m<br>4m Right of cL, Layer 7 | | | |
| Test Depth/Layer (mm) | **275 / 300** | | | |
| Max Size (mm) : | **19** | | | |
| Percent Oversize (%): | **11.5** | | | |
| Field Wet Density (t/m³) : | **2.26** | | | |
| Field Moisture Cont (%) : | **8.7** | | | |
| PCWD (t/m³) : | **2.18*** | | | |
| Maximum Converted Dry Density (t/m³) : | **2.08** | | | |
| Optimum Moisture Content (%) : | **11.0** | | | |
| Apparent OMC (%) : | **2.1** | | | |
| Compactive Effort : | **Standard** | | | |
| Relative Compaction (%) : | **104.0** | | | |
| Moisture Ratio / Spec : | **79.1 / 85-115%** | | | |
| Moisture Variation (%) : | **2% (dry)** | | | |

Remarks:

*** - Denotes adjusted for oversize**

| Lab Number: | Soil Description |
|---|---|
| **15/915** | **Clayey Sandy GRAVEL, brown** |
| | |
| | |
| | |

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# Nuclear Hilf Density Ratio Report

| | | | |
|---|---|---|---|
| Client : | **Keller Civil Engineering** | Report Number: | **CGS/2498 - 55** |
| Client Address: | **1 Balbu Close Beresfield NSW 2322** | Report Date: | **26/02/2015** |
| Job Number : | **CGS/2498** | Folder Number: | |
| Project : | **Subdivision** | Test Method: | **AS1289 5.7.1 & 5.8.1** |
| Location : | **Pitt Street , Teralba** | **Page 1 of 1** | |

| | | | | |
|---|---|---|---|---|
| Lab No : | 15/974 | 15/975 | | |
| ID No : | 126 | 127 | | |
| Lot No : | - | - | | |
| Sampling Method : | AS1289.1.2.1 c6.4 (b) EW | AS1289.1.2.1 c6.4 (b) EW | | |
| Date Sampled : | 18/2/2015 | 18/2/2015 | | |
| Date Tested : | 23/2/2015 | 23/2/2015 | | |
| Material Source : | Site won | Site won | | |
| For Use As : | Lot Fill | Lot Fill | | |
| Sample Location : | Gully Fill<br>Lot 105<br>Regatta Ch: 110m<br>Layer 8, 6m Right of cL | Gully Fill<br>Lot 104<br>Regatta Ch: 138m<br>Layer 9, 18m Right of cL | | |
| Test Depth/Layer (mm) | **275 / 300** | **275 / 300** | | |
| Max Size (mm) : | **19** | **19** | | |
| Percent Oversize (%): | **5.6** | **7.4** | | |
| Field Wet Density (t/m³) : | **2.04** | **2.14** | | |
| Field Moisture Cont (%) : | **11.9** | **8.6** | | |
| PCWD (t/m³) : | **2.04*** | **2.15*** | | |
| Maximum Converted Dry Density (t/m³) : | **1.82** | **1.97** | | |
| Optimum Moisture Content (%) : | **14.5** | **11.5** | | |
| Apparent OMC (%) : | **2.5** | **2.6** | | |
| Compactive Effort : | **Standard** | **Standard** | | |
| Relative Compaction (%) : | **100.0** | **100.0** | | |
| Moisture Ratio / Spec : | **82.1 / 85-115%** | **74.8 / 85-115%** | | |
| Moisture Variation (%) : | **2.5% (dry)** | **2.5% (dry)** | | |

Remarks:

*** - Denotes adjusted for oversize**

| Lab Number: | Soil Description |
|---|---|
| **15/974** | **Sandy Gravelly CLAY, brown** |
| **15/975** | **Sandy Gravelly CLAY, brown** |
| | |
| | |

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# Nuclear Hilf Density Ratio Report

| | | | |
|---|---|---|---|
| Client : | **Keller Civil Engineering** | Report Number: | **CGS/2498 - 57** |
| Client Address: | **1 Balbu Close Beresfield NSW 2322** | Report Date: | **26/02/2015** |
| Job Number : | **CGS/2498** | Folder Number: | |
| Project : | **Subdivision** | Test Method: | **AS1289 5.7.1 & 5.8.1** |
| Location : | **Pitt Street , Teralba** | **Page 1 of 1** | |

| | | | | |
|---|---|---|---|---|
| Lab No : | 15/1037 | 15/1038 | 15/1039 | |
| ID No : | 130 | 131 | 132 | |
| Lot No : | - | - | - | |
| Sampling Method : | AS1289.1.2.1 c6.4 (b) EW | AS1289.1.2.1 c6.4 (b) EW | AS1289.1.2.1 c6.4 (b) EW | |
| Date Sampled : | 19/2/2015 | 19/2/2015 | 19/2/2015 | |
| Date Tested : | 23/2/2015 | 23/2/2015 | 23/2/2015 | |
| Material Source : | Site Won | Site Won | Site Won | |
| For Use As : | Lot Fill | Lot Fill | Lot Fill | |
| Sample Location : | Gully Fill<br>Lot 104<br>Regatta Ch:130m<br>10m Right of cL, Layer 10 | Gully Fill<br>Lot 104<br>Regatta Ch: 135m<br>8m Right of cL, Layer 11 | Gully Fill<br>Lot 105<br>Regatta Ch: 135m<br>6m Right of cL, Layer 12 | |
| Test Depth/Layer (mm) | **275 / 300** | **275 / 300** | **275 / 300** | |
| Max Size (mm) : | **19** | **19** | **19** | |
| Percent Oversize (%): | **8.0** | **16.6** | **6.1** | |
| Field Wet Density (t/m³) : | **2.01** | **2.15** | **2.07** | |
| Field Moisture Cont (%) : | **10.4** | **11.0** | **12.0** | |
| PCWD (t/m³) : | **2.06*** | **2.17*** | **2.09*** | |
| Maximum Converted Dry Density (t/m³) : | **1.82** | **1.94** | **1.85** | |
| Optimum Moisture Content (%) : | **13.0** | **11.0** | **14.0** | |
| Apparent OMC (%) : | **2.5** | **-0.1** | **1.8** | |
| Compactive Effort : | **Standard** | **Standard** | **Standard** | |
| Relative Compaction (%) : | **97.0** | **99.0** | **99.0** | |
| Moisture Ratio / Spec : | **80.0 / 85-115%** | **100.0 / 85-115%** | **85.7 / 85-115%** | |
| Moisture Variation (%) : | **2.5% (dry)** | **0% (wet)** | **2% (dry)** | |
| Remarks: | | | | |

*** - Denotes adjusted for oversize**

| Lab Number: | Soil Description |
|---|---|
| **15/1037** | **Sandy Gravelly CLAY, brown** |
| **15/1038** | **Sandy Gravelly CLAY, brown** |
| **15/1039** | **Sandy Gravelly CLAY, brown** |
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# Nuclear Hilf Density Ratio Report

| | | | |
|---|---|---|---|
| Client : | **Keller Civil Engineering** | Report Number: | **CGS/2498 - 59** |
| Client Address: | **1 Balbu Close Beresfield NSW 2322** | Report Date: | **4/03/2015** |
| Job Number : | **CGS/2498** | Folder Number: | |
| Project : | **Subdivision** | Test Method: | **AS1289 5.7.1 & 5.8.1** |
| Location : | **Pitt Street , Teralba** | **Page 1 of 1** | |

| | | | | |
|---|---|---|---|---|
| Lab No : | 15/1334 | | | |
| ID No : | 133 | | | |
| Lot No : | - | | | |
| Sampling Method : | AS1289.1.2.1 c6.4 (b) EW | | | |
| Date Sampled : | 24/2/2015 | | | |
| Date Tested : | 26/2/2015 | | | |
| Material Source : | Site Won | | | |
| For Use As : | Lot Fill | | | |
| Sample Location : | Pitt Street North Batter<br>Lot 112<br>13m from CL<br>Layer 3 | | | |
| Test Depth/Layer (mm) | **275 / 300** | | | |
| Max Size (mm) : | **19** | | | |
| Percent Oversize (%): | **8.2** | | | |
| Field Wet Density (t/m³) : | **2.17** | | | |
| Field Moisture Cont (%) : | **10.5** | | | |
| PCWD (t/m³) : | **2.16*** | | | |
| Maximum Converted Dry Density (t/m³) : | **1.96** | | | |
| Optimum Moisture Content (%) : | **12.0** | | | |
| Apparent OMC (%) : | **1.5** | | | |
| Compactive Effort : | **Standard** | | | |
| Relative Compaction (%) : | **100.5** | | | |
| Moisture Ratio / Spec : | **87.5 / 85-115%** | | | |
| Moisture Variation (%) : | **1.5% (dry)** | | | |

Remarks:

*** - Denotes adjusted for oversize**

| Lab Number: | Soil Description |
|---|---|
| **15/1334** | **Silty Clayey GRAVEL, brown** |
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# Nuclear Hilf Density Ratio Report

| | | | |
|---|---|---|---|
| Client : | **Keller Civil Engineering** | Report Number: | **CGS/2498 - 65** |
| Client Address: | **1 Balbu Close Beresfield NSW 2322** | Report Date: | **16/03/2015** |
| Job Number : | **CGS/2498** | Folder Number: | |
| Project : | **Subdivision** | Test Method: | **AS1289 5.7.1 & 5.8.1** |
| Location : | **Pitt Street , Teralba** | **Page 1 of 1** | |

| | | | | |
|---|---|---|---|---|
| Lab No : | 15/1487 | | | |
| ID No : | 136 | | | |
| Lot No : | - | | | |
| Sampling Method : | AS1289.1.2.1 c6.4 (b) EW | | | |
| Date Sampled : | 3/3/2015 | | | |
| Date Tested : | 9/3/2015 | | | |
| Material Source : | Site Won | | | |
| For Use As : | Lot Fill | | | |
| Sample Location : | Pit Street Ch: 75m<br>20m left of cL<br>Lots 111-112 | | | |
| Test Depth/Layer (mm) | **275 / 300** | | | |
| Max Size (mm) : | **19** | | | |
| Percent Oversize (%): | **6.8** | | | |
| Field Wet Density (t/m³) : | **2.06** | | | |
| Field Moisture Cont (%) : | **8.4** | | | |
| PCWD (t/m³) : | **2.10*** | | | |
| Maximum Converted Dry Density (t/m³) : | **1.90** | | | |
| Optimum Moisture Content (%) : | **11.0** | | | |
| Apparent OMC (%) : | **2.6** | | | |
| Compactive Effort : | **Standard** | | | |
| Relative Compaction (%) : | **98.0** | | | |
| Moisture Ratio / Spec : | **76.4 / 85-115%** | | | |
| Moisture Variation (%) : | **2.5% (dry)** | | | |
| Remarks: | | | | |

*** - Denotes adjusted for oversize**

| Lab Number: | Soil Description |
|---|---|
| **15/1487** | **Gravelly Silty CLAY, brown** |
| | |
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# Nuclear Hilf Density Ratio Report

| | | | |
|---|---|---|---|
| Client : | **Keller Civil Engineering** | Report Number: | **CGS/2498 - 61** |
| Client Address: | **1 Balbu Close Beresfield NSW 2322** | Report Date: | **10/03/2015** |
| Job Number : | **CGS/2498** | Folder Number: | |
| Project : | **Subdivision** | Test Method: | **AS1289 5.7.1 & 5.8.1** |
| Location : | **Pitt Street , Teralba** | **Page 1 of 1** | |

| | | | | |
|---|---|---|---|---|
| Lab No : | 15/1491 | 15/1492 | | |
| ID No : | 140 | 141 | | |
| Lot No : | Retest of 105 | Retest of 111 | | |
| Sampling Method : | AS1289.1.2.1 c 6.4 (b) P | AS1289.1.2.1 c 6.4 (b) P | | |
| Date Sampled : | 3/3/2015 | 3/3/2015 | | |
| Date Tested : | 9/3/2015 | 6/3/2015 | | |
| Material Source : | Site Won | Site Won | | |
| For Use As : | Lot Fill | Lot Fill | | |
| Sample Location : | Regatta Close Lot 102-105 CH100-165<br>Lot 104/CH125<br>27m R of CL/Layer2 | Regatta Close Lot 102-105 CH100-165<br>Lot 104/CH130<br>ON CL/Layer5 | | |
| Test Depth/Layer (mm) | **275 / 300** | **275 / 300** | | |
| Max Size (mm) : | **19** | **19** | | |
| Percent Oversize (%): | **11.7** | **2.5** | | |
| Field Wet Density (t/m³) : | **2.14** | **2.13** | | |
| Field Moisture Cont (%) : | **13.6** | **11.6** | | |
| PCWD (t/m³) : | **2.11*** | **2.12*** | | |
| Maximum Converted Dry Density (t/m³) : | **1.88** | **1.91** | | |
| Optimum Moisture Content (%) : | **15.0** | **13.0** | | |
| Apparent OMC (%) : | **1.4** | **1.2** | | |
| Compactive Effort : | **Standard** | **Standard** | | |
| Relative Compaction (%) : | **101.0** | **100.5** | | |
| Moisture Ratio / Spec : | **90.7 / 85-115%** | **89.2 / 85-115%** | | |
| Moisture Variation (%) : | **1.5% (dry)** | **1% (dry)** | | |
| Remarks: | | | | |

*** - Denotes adjusted for oversize**

| Lab Number: | Soil Description |
|---|---|
| **15/1491** | **Gravelly Sandy CLAY, brown** |
| **15/1492** | **Gravelly Sandy CLAY, brown** |
| | |
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# Nuclear Hilf Density Ratio Report

| | | | |
|---|---|---|---|
| Client : | **Keller Civil Engineering** | Report Number: | **CGS/2498 - 66** |
| Client Address: | **1 Balbu Close Beresfield NSW 2322** | Report Date: | **16/03/2015** |
| Job Number : | **CGS/2498** | Folder Number: | |
| Project : | **Subdivision** | Test Method: | **AS1289 5.7.1 & 5.8.1** |
| Location : | **Pitt Street , Teralba** | **Page 1 of 1** | |

| | | | | |
|---|---|---|---|---|
| Lab No : | 15/1565 | 15/1566 | | |
| ID No : | 144 | 145 | | |
| Lot No : | - | - | | |
| Sampling Method : | AS1289.1.2.1 c6.4 (b) EW | AS1289.1.2.1 c6.4 (b) EW | | |
| Date Sampled : | 5/3/2015 | 5/3/2015 | | |
| Date Tested : | 10/3/2015 | 10/3/2015 | | |
| Material Source : | Site Won | Site Won | | |
| For Use As : | Lot Fill | Lot Fill | | |
| Sample Location : | Pitt Street Ch: 27m<br>27m Left of cL<br>Lot 112 | Pitt Street Ch: 80m<br>28m Left of cL<br>Lot 111 | | |
| Test Depth/Layer (mm) | **275 / 300** | **275 / 300** | | |
| Max Size (mm) : | **19** | **19** | | |
| Percent Oversize (%): | **6.3** | **8.0** | | |
| Field Wet Density (t/m³) : | **2.19** | **2.17** | | |
| Field Moisture Cont (%) : | **12.7** | **10.7** | | |
| PCWD (t/m³) : | **2.10*** | **2.15*** | | |
| Maximum Converted Dry Density (t/m³) : | **1.94** | **1.96** | | |
| Optimum Moisture Content (%) : | **14.5** | **12.5** | | |
| Apparent OMC (%) : | **1.6** | **1.8** | | |
| Compactive Effort : | **Standard** | **Standard** | | |
| Relative Compaction (%) : | **104.5** | **101.0** | | |
| Moisture Ratio / Spec : | **87.6 / 85-115%** | **85.6 / 85-115%** | | |
| Moisture Variation (%) : | **1.5% (dry)** | **2% (dry)** | | |
| Remarks: | | | | |

*** - Denotes adjusted for oversize**

| Lab Number: | Soil Description |
|---|---|
| **15/1565** | **Gravelly CLAY, brown** |
| **15/1566** | **Gravelly CLAY, brown** |
| | |
| | |

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