Proposed Subdivision – The Bower Stage 1
Site Classification

Boundary Road, Medowie

NEW15P-0033-AE
31 May 2017
31 May 2017

McCloy Development Management
Suite 1, Level 3, 426 King Street
NEWCASTLE WEST NSW 2302

Attention: Mr Sam Rowe

Dear Sam

RE: Proposed Subdivision – The Bower Stage 1 (lots 101 to 137)
Boundary Road, Medowie
Site Classification

Please find enclosed our geotechnical report for Stage 1 of the proposed residential subdivision ‘The Bower’ to be located off Boundary Road, Medowie.

The report includes recommendations for Site Classification in accordance with AS2870-2011, “Residential Slabs and Footings”, and excavation conditions.

If you have any questions regarding this report, please do not hesitate to contact Shannon Kelly or the undersigned.

For and on behalf of Qualtest Laboratory (NSW) Pty Ltd

Jason Lee
Principal Geotechnical Engineer
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1.0 Introduction

Qualtest Laboratory NSW Pty Ltd (Qualtest) is pleased to present this geotechnical assessment report on behalf of McCloy Development Management (McCloy), for the proposed residential subdivision of The Bower, Stage 1, located off Boundary Road, Medowie.

Based on the brief and Sales Plan provided, Stage 1 is understood to comprise of 37 residential allotments (Lots 101 to 137).

The scope of work for the geotechnical investigation included providing discussion and recommendations on the following:

- Site classification to AS2870-2011, “Residential Slabs and Footings” for proposed subdivision Lots 101 to 137;
- Recommendations for excavation conditions for the Stage 1 site.

This report presents the results of the field work investigations and laboratory testing, and provides recommendations for the scope outlined above.

This report also includes selected results from a previous geotechnical assessment carried out for Stages 1, 2 & 3 by Qualtest (Ref. NEW15P-0033-AC.Rev1, 25 August 2016), to supplement information collected during the current investigations where applicable.

2.0 Field Work

The field work investigations were carried out on 3 May 2017 and comprised of:

- DBYD search was undertaken to check proposed test locations for the presence of underground services;
- Site walkover to make observations of surface features at the property and in the immediate surrounding area;
- Excavation of 16 test pits (TP101 to TP116) using a 4 tonne rubber tracked excavator equipped with a 450mm wide bucket to depths of up to 2.10m or prior refusal on weathered rock;
- Undisturbed samples (U50 tubes) and small bag samples were taken for subsequent laboratory testing;
- Test pits were backfilled with the excavation spoil and compacted using the excavator bucket and tracks.

Investigations were carried out by an experienced Geotechnical Engineer from Qualtest who located the test pits, carried out the testing and sampling, produced field logs of the test pits, and made observations of the site surface conditions.

Engineering logs of the test pits are presented in Appendix A.

Approximate test pit locations are shown on the attached Figure AE1. Test pits were located in the field by handheld GPS and relative to existing site features including topographic features, lot boundaries, existing developments and trees.
3.0 Site Description

3.1 Surface Conditions

The site of Stage 1 is located at Boundary Road, Medowie, as shown in Figure AE1. The site is located about 2km east of Grahamstown Lake, and about 80m east of Medowie Road on the northern side of Boundary Road. The site is bounded by Western Road to the west, and by proposed future stages of the subdivision to the north and east. The area of the proposed future stages generally comprises disused farmland and bushland, with low density residential development fronting Boundary Road.

The site is situated in an area of gently undulating topography, on the mid slopes of a local hill formation with low relief. Natural surface slopes are typically in the order of about 1° to 2° towards the northeast. Based on the site contour plan provided by the client (Ref. HD08 Revision 14) with 1m contour intervals, ground levels within Stage 1 are understood to range from about RL 27m (AHD) on the north-eastern area, to about RL 32m (AHD) in the south-western area.

Existing development within Stage 1 includes recently constructed sections of Royal Avenue which is aligned east-west, and Bower Road which is aligned north-south. An existing single storey masonry clad dwelling is present on Lot 108. A pre-existing dwelling had recently been removed from Lot 101, with sections of the concrete slab foundations still present on the day of the investigation.

At the time of the site investigation, trafficability by way of 4WD vehicle was good.

Based on observations on the days of the investigation which was carried out during fine weather, the site was judged to typically be moderately to well drained primarily by way of surface runoff towards the northeast.

Photographs of the site taken on the day of the site investigations are shown below.

**Photograph 1:** Facing southwest from near TP116 (on Lot 107/108 boundary). Boundary Road beside treeline in background.

**Photograph 2:** Facing west from near TP116 (on Lot 107/108 boundary) towards proposed Stage 1.
**Photograph 3:** Facing north from near TP115 (Lot 106 boundary), showing Bower Road.

**Photograph 4:** Facing south from near TP112 (on Lot 109/110 boundary).

**Photograph 5:** Facing southeast from near TP103 (Lot 129/130 boundary), Royal Avenue in background.

**Photograph 6:** Facing west from near TP103, with spoil from TP103 visible in right bottom corner.

**Photograph 7:** Facing northeast in the vicinity of TP113 (on Lot 101/102 boundary).

**Photograph 8:** Facing southeast in the vicinity of TP113 (on Lot 101/102 boundary).
3.2 Subsurface Conditions

Reference to the 1:100,000 Newcastle Coalfield Regional Geology Sheet indicates the site to be underlain by the Permian Aged Tomago Coal Measures, which are characterised by Siltstone, Sandstone, Coal, Tuff and Claystone rock types.

Table 1 presents a summary of the typical soil types encountered at test pit locations during the field investigation, divided into representative geotechnical units.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Soil Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FILL</td>
<td>Variable materials at different test pit locations including Gravelly CLAY / Clayey GRAVEL, Sandy GRAVEL, Clayey Sandy GRAVEL, Gravelly Clayey SAND / Sandy CLAY, Silty SAND, Sandy CLAY. Cobbles and boulders of Silty SANDSTONE and Sandy SILTSTONE rock fragments present in TP-Q17. Root affected in places.</td>
</tr>
<tr>
<td>2</td>
<td>TOPSOIL</td>
<td>Sandy CLAY, Clayey Silty SAND, Silty CLAY and Sandy CLAY / Silty Clayey SAND - low to medium plasticity, dark brown to grey, fine to medium grained sand, root affected. Becoming less root affected topsoil / slopewash in places.</td>
</tr>
<tr>
<td>3</td>
<td>COLLUVIUM</td>
<td>Not encountered in test pits within Stage 1.</td>
</tr>
<tr>
<td>4</td>
<td>RESIDUAL SOIL</td>
<td>CLAY – medium plasticity to high plasticity, varying colours including pale brown and grey, brown to red, orange to pale brown, pale grey, trace to some fine to medium grained sand, trace of fine to medium grained gravel in places. Mostly very stiff or hard consistency, stiff in places. Some gravelly pockets / layers in places, some tree roots in places. Sandy CLAY with some relict rock structure / pockets of weathered sandy siltstone / silty sandstone in places, generally at increased depths.</td>
</tr>
<tr>
<td>5</td>
<td>EXTREMELY WEATHERED (XW) ROCK (with soil properties)</td>
<td>Extremely weathered Sandy SILTSTONE / SILTSTONE / TUFF with soil properties, excavated as Clayey Sandy GRAVEL - mostly fine to medium grained, angular, grey / pale brown to orange, fines of medium plasticity. Extremely weathered Silty SANDSTONE able to be broken down into Sandy CLAY - medium plasticity, pale grey to white with some pale brown to orange. Assessed to generally be of extremely low to low rock strength.</td>
</tr>
<tr>
<td>6</td>
<td>HIGHLY WEATHERED (HW) ROCK</td>
<td>Sandy SILTSTONE, Silty SANDSTONE, SILTSTONE and SANDSTONE – grey / pale grey to white / brown / orange / brown to red, sand mostly fine to medium grained, estimated strength ranging from very low to high. Generally fractured or semi-fractured. Extremely to highly weathered / extremely weathered layers in places. Some brown semi-carbonaceous layers in places.</td>
</tr>
</tbody>
</table>
Table 2 contains a summary of the distribution of the above geotechnical units at the test pit locations.

**TABLE 2 – SUMMARY OF GEOTECHNICAL UNITS ENCOUNTERED AT EACH TEST PIT LOCATION**

<table>
<thead>
<tr>
<th>Location</th>
<th>Unit 1 Fill</th>
<th>Unit 2 Topsoil</th>
<th>Unit 3 Colluvium</th>
<th>Unit 4 Residual Soil</th>
<th>Unit 5 Extremely Weathered Rock</th>
<th>Unit 6 Highly Weathered Rock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth in metres (m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP101 0.00 - 0.40</td>
<td>-</td>
<td>-</td>
<td>0.40 - 2.00</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>TP102 -</td>
<td>0.00 - 0.10</td>
<td>-</td>
<td>0.10 - 1.70</td>
<td>-</td>
<td>1.70 - 2.10^</td>
<td></td>
</tr>
<tr>
<td>TP103 -</td>
<td>0.00 - 0.24</td>
<td>-</td>
<td>0.24 - 1.60</td>
<td>-</td>
<td>1.60 - 2.10^</td>
<td></td>
</tr>
<tr>
<td>TP104 -</td>
<td>0.00 - 0.16</td>
<td>-</td>
<td>0.16 - 1.00</td>
<td>-</td>
<td>1.00 - 1.40^</td>
<td></td>
</tr>
<tr>
<td>TP105 -</td>
<td>0.00 - 0.25</td>
<td>-</td>
<td>0.25 - 2.00</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>TP106 -</td>
<td>0.00 - 0.25</td>
<td>-</td>
<td>0.25 - 2.00</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>TP107 -</td>
<td>0.00 - 0.20</td>
<td>-</td>
<td>0.20 - 1.30</td>
<td>-</td>
<td>1.30 - 1.60^</td>
<td></td>
</tr>
<tr>
<td>TP108 -</td>
<td>0.00 - 0.15</td>
<td>-</td>
<td>0.15 - 0.90</td>
<td>-</td>
<td>0.90 - 1.20^</td>
<td></td>
</tr>
<tr>
<td>TP109 -</td>
<td>0.00 - 0.10</td>
<td>-</td>
<td>0.10 - 0.80</td>
<td>-</td>
<td>0.80 - 2.00^</td>
<td></td>
</tr>
<tr>
<td>TP110 -</td>
<td>0.00 - 0.15</td>
<td>-</td>
<td>0.15 - 0.50</td>
<td>-</td>
<td>0.50 - 0.60^</td>
<td></td>
</tr>
<tr>
<td>TP111 -</td>
<td>0.00 - 0.15</td>
<td>-</td>
<td>0.15 - 0.60</td>
<td>0.60 - 0.90</td>
<td>0.90 - 1.00^</td>
<td></td>
</tr>
<tr>
<td>TP112 -</td>
<td>0.00 - 0.09</td>
<td>-</td>
<td>0.09 - 1.00</td>
<td>1.00 - 1.30</td>
<td>1.30 - 1.60^</td>
<td></td>
</tr>
<tr>
<td>TP113 -</td>
<td>0.00 - 0.40</td>
<td>-</td>
<td>0.40 - 0.80</td>
<td>-</td>
<td>0.80 - 1.30^</td>
<td></td>
</tr>
<tr>
<td>TP114 -</td>
<td>0.00 - 0.08</td>
<td>-</td>
<td>-</td>
<td>0.08 - 0.50</td>
<td>0.50 - 1.00^</td>
<td></td>
</tr>
<tr>
<td>TP115 -</td>
<td>0.00 - 0.30</td>
<td>-</td>
<td>0.30 - 0.35</td>
<td>0.40 - 0.80</td>
<td>0.35 - 0.40</td>
<td>0.80 - 1.75^</td>
</tr>
<tr>
<td>TP116 -</td>
<td>0.00 - 0.22</td>
<td>-</td>
<td>0.22 - 0.85</td>
<td>-</td>
<td>0.85 - 1.00^</td>
<td></td>
</tr>
</tbody>
</table>

Previous Geotechnical Assessment (Ref: NEW15P-0033-AC.Rev1, August 2016)

<table>
<thead>
<tr>
<th>Location</th>
<th>Unit 1 Fill</th>
<th>Unit 2 Topsoil</th>
<th>Unit 3 Colluvium</th>
<th>Unit 4 Residual Soil</th>
<th>Unit 5 Extremely Weathered Rock</th>
<th>Unit 6 Highly Weathered Rock</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP-Q15 0.00 - 0.30</td>
<td>-</td>
<td>-</td>
<td>0.30 - 0.60</td>
<td>-</td>
<td>0.60 - 0.90^</td>
<td></td>
</tr>
<tr>
<td>TP-Q16 -</td>
<td>0.00 - 0.30</td>
<td>-</td>
<td>0.30 - 0.60</td>
<td>-</td>
<td>0.60 - 0.90^</td>
<td></td>
</tr>
<tr>
<td>TP-Q17 0.00 - 1.50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>TP-Q20 0.00 - 0.30</td>
<td>-</td>
<td>-</td>
<td>0.30 - 2.00</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>TP-Q26 -</td>
<td>0.00 - 0.20</td>
<td>-</td>
<td>0.20 - 1.70</td>
<td>-</td>
<td>1.70 - 2.00</td>
<td></td>
</tr>
<tr>
<td>TP-Q27 -</td>
<td>0.00 - 0.30</td>
<td>-</td>
<td>0.30 - 1.80</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>TP-Q28 0.00 - 0.50</td>
<td>0.50 - 0.70</td>
<td>-</td>
<td>0.70 - 1.40</td>
<td>-</td>
<td>1.40 - 1.90</td>
<td></td>
</tr>
</tbody>
</table>
Practical refusal or slow to very slow progress on rock of the excavator was encountered as indicated in Table 2, and shown on the appended engineering logs.

No groundwater levels or inflows were encountered in the test pits during the limited time that they remained open on the day of the field investigations.

It should be noted that groundwater conditions can vary due to rainfall and other influences including regional groundwater flow, temperature, permeability, recharge areas, surface condition, and subsoil drainage.

4.0 Laboratory Testing

Samples collected during the current field investigations were returned to our NATA accredited Warabrook Laboratory for testing which comprised of:

- (11 no.) Shrink / Swell tests;
- (5 no.) Atterberg Limits tests;

Results of the laboratory testing are presented in Appendix B, with a summary of the Shrink/Swell and Atterberg Limits test results presented in Table 3 and Table 4, respectively.

The tables also include a summary of laboratory testing information where applicable from the previous Geotechnical Assessment by Qualtest.
### TABLE 3 – SUMMARY OF SHRINK / SWELL TESTING RESULTS

<table>
<thead>
<tr>
<th>Location</th>
<th>Depth (m)</th>
<th>Material Description</th>
<th>Is (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP102</td>
<td>0.70 – 0.85</td>
<td>(CH) CLAY</td>
<td>3.7</td>
</tr>
<tr>
<td>TP103</td>
<td>1.30 – 1.70</td>
<td>(CH) CLAY</td>
<td>4.9</td>
</tr>
<tr>
<td>TP104</td>
<td>0.50 – 0.64</td>
<td>(CH) CLAY</td>
<td>4.2</td>
</tr>
<tr>
<td>TP105</td>
<td>1.00 – 1.40</td>
<td>(CH) CLAY</td>
<td>3.9</td>
</tr>
<tr>
<td>TP106</td>
<td>0.40 – 0.58</td>
<td>(CH) CLAY</td>
<td>3.3</td>
</tr>
<tr>
<td>TP108</td>
<td>0.30 – 0.60</td>
<td>(CH) CLAY</td>
<td>3.5</td>
</tr>
<tr>
<td>TP109</td>
<td>0.70 – 0.95</td>
<td>(CI) Sandy CLAY</td>
<td>2.5</td>
</tr>
<tr>
<td>TP110</td>
<td>0.40 – 0.60</td>
<td>(CH) CLAY</td>
<td>3.0</td>
</tr>
<tr>
<td>TP111</td>
<td>0.40 – 0.60</td>
<td>(CH) CLAY</td>
<td>2.6</td>
</tr>
<tr>
<td>TP112</td>
<td>0.60 – 0.80</td>
<td>(CH) CLAY</td>
<td>1.4</td>
</tr>
<tr>
<td>TP116</td>
<td>0.50 – 0.70</td>
<td>(CH) CLAY</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Previous Geotechnical Assessment (Ref: NEW15P-0033-AC.Rev1, August 2016)

<table>
<thead>
<tr>
<th>Location</th>
<th>Depth (m)</th>
<th>Material Description</th>
<th>Liquid Limit (%)</th>
<th>Plasticity Index (%)</th>
<th>Linear Shrinkage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP-Q41</td>
<td>0.35 - 0.50</td>
<td>(CH) CLAY</td>
<td>70</td>
<td>46</td>
<td>11.0</td>
</tr>
<tr>
<td>TP-Q42</td>
<td>0.20 - 0.45</td>
<td>(CH) CLAY</td>
<td>90</td>
<td>62</td>
<td>11.5</td>
</tr>
<tr>
<td>TP-Q43</td>
<td>0.30 - 0.45</td>
<td>(CH) CLAY</td>
<td>62</td>
<td>33</td>
<td>13.0</td>
</tr>
<tr>
<td>TP-Q44</td>
<td>0.20 - 0.50</td>
<td>(CH) CLAY</td>
<td>90</td>
<td>56</td>
<td>15.0</td>
</tr>
</tbody>
</table>

Note: TP-Q41 to TP-Q44 are located along neighbouring boundaries of the current proposed subdivision lots, but results have been included for information purposes due to their close proximity to the site.

The results of laboratory shrink / swell tests indicate that the residual clays at the site are generally highly reactive.

### TABLE 4 – SUMMARY OF ATTERBERG LIMITS TESTING RESULTS

<table>
<thead>
<tr>
<th>Location</th>
<th>Depth (m)</th>
<th>Material Description</th>
<th>Liquid Limit (%)</th>
<th>Plasticity Index (%)</th>
<th>Linear Shrinkage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP101</td>
<td>1.00 – 1.40</td>
<td>(CH) CLAY</td>
<td>70</td>
<td>46</td>
<td>11.0</td>
</tr>
<tr>
<td>TP107</td>
<td>0.60 – 0.75</td>
<td>(CH) CLAY</td>
<td>90</td>
<td>62</td>
<td>11.5</td>
</tr>
<tr>
<td>TP113</td>
<td>0.60 – 0.90</td>
<td>(CH) CLAY</td>
<td>70</td>
<td>35</td>
<td>13.0</td>
</tr>
<tr>
<td>TP114</td>
<td>0.20 – 0.40</td>
<td>(XW) Sandy SILTSTONE with soil properties</td>
<td>62</td>
<td>33</td>
<td>13.0</td>
</tr>
<tr>
<td>TP115</td>
<td>0.50 – 0.75</td>
<td>(XW) Sandy SILTSTONE with soil properties</td>
<td>90</td>
<td>56</td>
<td>15.0</td>
</tr>
</tbody>
</table>
5.0 Discussion and Recommendations

5.1 Site Classification to AS2870-2011

Based on the results of the field work and laboratory testing, residential lots located within The Bower Stage 1, Boundary Road, Medowie are classified in their current condition in accordance with AS2870-2011 ‘Residential Slabs and Footings’, as shown in Table 5.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Lot Numbers</th>
<th>Site Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>101 to 137</td>
<td>H1</td>
</tr>
</tbody>
</table>

A characteristic free surface movement in the range of 40mm to 60mm is estimated for the lots classified as Class ‘H1’ in their existing condition. The effects of changes to the soil profile by additional cutting and filling and the effects of past and future trees should be considered in selection of the design value for differential movement.

If site re-grading works involving cutting or filling are performed after the date of this assessment the classification may change and further advice should be sought.

Final site classification will be dependent on the type of fill and level of supervision carried out. Re-classification of lots should be confirmed by the geotechnical authority at the time of construction following any site re-grade works.

Footings for the proposed development should be designed and constructed in accordance with the requirements of AS2870-2011.

The classification presented above assumes that:

- All footings are founded in controlled fill (if applicable) or in the residual clayey soils or rock below all non-controlled fill, topsoil material and root zones, and fill under slab panels meets the requirements of AS2870-2011, in particular, the root zone must be removed prior to the placement of fill materials beneath slabs.
- The performance expectations set out in Appendix B of AS2870-2011 are acceptable, and that site foundation maintenance is undertaken to avoid extremes of wetting and drying.
- Footings are to be founded outside of or below all zones of influence resulting from existing or future service trenches.
- The constructional and architectural requirements for reactive clay sites set out in AS2870-2011 are followed.
- Adherence to the detailing requirement outlined in Section 5 of AS2870-2011 ‘Residential Slabs and Footings’ is essential, in particular Section 5.6, ‘Additional requirements for Classes M, H1, H2 and E sites’ including architectural restrictions, plumbing and drainage requirements.
- Site maintenance complies with the provisions of CSIRO Sheet BTF 18, “Foundation Maintenance and Footing Performance: A Homeowner’s Guide”, a copy of which is attached in Appendix C.

All structural elements on all lots should be supported on footings founded beneath all uncontrolled fill, layers of inadequate bearing capacity, soft/loose, wet or other potentially deleterious material.
If any localised areas of uncontrolled fill of depths greater than 0.4m are encountered during construction, footings should be designed in accordance with engineering principles for Class ‘P’ sites.

### 5.2 Excavation Conditions

The depths of fill, topsoil, colluvium, residual soils and weathered rock, together with depths of slow progress or refusal of the excavator where encountered, are summarised in Section 3.2.

In terms of excavation conditions, site materials can generally be divided into:

- **Clayey and Granular Soils (Units 1, 2, 3, 4 & 5).** It is anticipated that these materials could be excavated by a conventional excavator or backhoe bucket;

- **Highly Weathered Rock or better (Unit 6).** Rippability is dependent on rock strength, degree of weathering and number of defects within the rock mass which can vary significantly.

It is anticipated that the Weathered Rock (Unit 6) material encountered could be excavated by conventional excavator bucket at least to the depths indicated on the appended test pit logs.

It is expected that material below the depth of excavator bucket slow progress or refusal encountered during the excavation will be excavatable by ripping to some greater depth, although this has not been assessed as part of the current investigation.

The use of toothed buckets, ripping tines, and/or hydraulic rock hammers may be required if hard bands of weathered rock are encountered or for deep confined excavations such as for service trenches. Higher strength rock or randomly occurring hard bands within the rock mass if encountered, are likely to occur towards the base of deeper cuts.

It is recommended that targeted investigations are carried out if significant excavations are proposed where bedrock depth or excavatability is important to design or construction.

There is potential for groundwater to exist at localised areas of the site such as within the topsoil profile, from water perched above the residual clay / bedrock profile. It is possible that slow water inflow may be encountered from such layers, particularly if earthworks are carried out during or following periods of wet weather, or in the vicinity of farm dams and gullies when water is present. If groundwater is encountered, it is generally expected to be manageable by de-watering by sump and pump methods.

Excavations should be supported by properly designed and constructed retaining walls or else battered at 1V:2H or flatter and protected from erosion.

Temporary excavations should be battered at 1V:1H or flatter in cohesive soils, or 1V:1.5H or flatter in granular soils, and protected from erosion. Steeper excavations may be supported by means of temporary shoring.

Temporary excavations to depths of up to 1.2m in competent compact material with sufficient cohesion, such as clay of stiff consistency or better may be battered vertically, subject to inspection during excavation by the geotechnical authority.

The safe working procedures of Work Cover NSW Excavation work code of practice, dated July 2014 should be followed.

Care should be taken not to disturb or destabilise existing underground services or structures.
6.0 Limitations

The findings presented in the report and used as the basis for recommendations presented herein were obtained using normal, industry accepted geotechnical design practices and standards. To our knowledge, they represent a reasonable interpretation of the general conditions of the site.

The extent of testing associated with this assessment is limited to discrete test pit locations. It should be noted that subsurface conditions between and away from the test pit locations may be different to those observed during the field work and used as the basis of the recommendations contained in this report.

If subsurface conditions encountered during construction differ from those given in this report, further advice should be sought without delay.

Data and opinions contained within the report may not be used in other contexts or for any other purposes without prior review and agreement by Qualtest. If this report is reproduced, it must be in full.

If you have any further questions regarding this report, please do not hesitate to contact Shannon Kelly or the undersigned.

For and on behalf of Qualtest Laboratory (NSW) Pty Ltd.

Jason Lee
Principal Geotechnical Engineer
FIGURES

FIGURE AE1:
Approximate Test Pit Location Plan
Based on site plan provided by client, overlayed over Google Earth Image by Qualtest.

Previous investigation undertaken by Qualtest Pty Ltd (November 2015).

 approximate test pit location.

 approximate test pit location.
APPENDIX A:
Results of Field Investigations
### Engineering Log - Test Pit

**CLIENT:** McCLOY DEVELOPMENT MANAGEMENT  
**PROJECT:** THE BOWER - STAGE 1  
**LOCATION:** BOUNDARY ROAD, MEDOWIE

---

**EQUIPMENT TYPE:** 4 TONNE EXCAVATOR  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**DATE:** 3/5/17

---

**Not Encountred**

---

<table>
<thead>
<tr>
<th>METHOD</th>
<th>WATER</th>
<th>SAMPLES</th>
<th>RL (m)</th>
<th>DEPTH (m)</th>
<th>MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components</th>
<th>MOISTURE CONDITION</th>
<th>CONSISTENCY</th>
<th>DENSITY</th>
<th>CONSISTENCY</th>
<th>DENSITY</th>
<th>FIELD TEST</th>
<th>STRUCTURE AND ADDITIONAL OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FILL: Silty SAND - fine to medium grained, grey-brown, with fine to medium grained gravel, sub-angular, root affected.</td>
<td>M</td>
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<td></td>
<td>FILL: Sandy CLAY - low plasticity, grey-brown, fine grained sand, with fine gravel, sub-angular to angular.</td>
<td>H</td>
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<td></td>
<td></td>
<td>CLAY - medium plasticity, brown to orange-brown and grey, fine sand, trace tree roots.</td>
<td>M &gt; w_p</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td>CLAY - High plasticity, grey and red-brown.</td>
<td>M &lt; w_p</td>
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</tbody>
</table>

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**Hole Terminated at 2.00 m**

---

### Notes, Samples and Tests

**Drilling and Sampling**

<table>
<thead>
<tr>
<th>Method</th>
<th>Water Level</th>
<th>(Date and time shown)</th>
<th>Water Inflow</th>
<th>Water Outflow</th>
<th>Strata Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td>Gradational or transitional strata</td>
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<tr>
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<td>Definitive or distinct strata change</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Field Tests</th>
<th>Notes, Samples and Tests</th>
<th>Consistency</th>
<th>UCS (kPa)</th>
<th>Moisture Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>PID</td>
<td>Photionsisation detector reading (ppm)</td>
<td>VS: Very Soft</td>
<td>25 - 50</td>
<td>D: Dry</td>
</tr>
<tr>
<td>DCP(x-y)</td>
<td>Dynamic penetrometer test (test depth interval shown)</td>
<td>F: Firm</td>
<td>50 - 100</td>
<td>M: Moist</td>
</tr>
<tr>
<td>HP</td>
<td>Hand Penetrometer test (UCS kPa)</td>
<td>S: Soft</td>
<td>100 - 200</td>
<td>W: Wet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>St: Stiff</td>
<td></td>
<td>W_p: Plastic Limit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VSt: Very Stiff</td>
<td>200 - 400</td>
<td>W_l: Liquid Limit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H: Hard</td>
<td>&gt;400</td>
<td>Fs: Flnr</td>
</tr>
</tbody>
</table>

---

**Consistency**

- VS: Very Soft
- S: Soft
- F: Firm
- St: Stiff
- VSt: Very Stiff
- H: Hard
- Fs: Flnr

**UCS (kPa)**

- 25 - 50
- 50 - 100
- 100 - 200
- 200 - 400
- >400

**Moisture Condition**

- D: Dry
- M: Moist
- W: Wet
- W_p: Plastic Limit
- W_l: Liquid Limit

---

**Density**

- V: Very Loose
- L: Loose
- MD: Medium Dense
- D: Dense
- VD: Very Dense

**Density Index**

- Density Index <15%
- Density Index 15 - 35%
- Density Index 35 - 65%
- Density Index 65 - 85%
- Density Index 85 - 100%
**MATERIAL DESCRIPTION:** Soil type, plasticity/particle characteristics, colour, minor components

**MOISTURE CONDITION:** Wet, Moist, Dry

**CONSISTENCY:** Very Soft, Soft, Firm, Stiff, Very Stiff, Hard

**DENSITY:** Very Loose, Loose, Medium Dense, Dense, Very Dense

**CONSISTENCY Moisture Condition:**
- VS Very Soft
- S Soft
- F Firm
- St Stiff
- VSt Very Stiff
- H Hard
- M Moist
- W Wet
- Wp Plastic Limit
- Wl Liquid Limit
- D Dry
- E Environmental sample
- ASS Acid Sulfate Soil Sample
- B Bulk Sample
- CBR Bulk sample for CBR testing
- E Environmental sample
- PID Photionisation detector reading (ppm)
- DOP Dynamic penetrometer test (test depth interval shown)
- HP Hand Penetrometer test (UCS kPa)

**LEGEND:**
- Water Level
  - Water Inflow
  - Water Outflow
- Gradational or transitional strata
- Definitive or distinct strata change
- Definitive or distinct strata change

**Notes, Samples and Tests:**
- U<sub>50</sub> 50mm Diameter tube sample
- GBR Bulk sample for GBR testing
- E Environmental sample (Glass jar, sealed and chilled on site)
- ASS Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)

**Tests:**
- UCS (kPa)
- Density (g/cc)
- Moisture Index

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

**Density:**
- V Very Loose
- L Loose
- MD Medium Dense
- D Dense
- VD Very Dense
- VD Very Dense

**Structure and additional observations:**
- Sandy SILTSTONE - pale grey-white with some orange to red-brown, moderately fractured, estimated medium strength, with some thin clay bands.
- CLAY - high plasticity, grey, with some orange to red-brown.

**Field Test:**
- Structure and additional observations:
  - Hole Terminated at 2.10 m
  - Very slow progress

**METHOD CLASSIFICATION SYMBOL:**
- SM Silty SAND - fine to medium grained, with tree mulch, root affected.
- CH CLAY - medium to high plasticity, brown to orange, some fine grained sand.
  - 0.70m
- VSt CLAY - high plasticity, grey, with some orange to red-brown.
  - 0.70m
- CH Sandy SILTSTONE - pale grey-white with some orange to red-brown, moderately fractured, estimated medium strength, with some thin clay bands.
  - 0.70m
- Fb Friable

**Field Tests:**
- TOPSOIL
- RESIDUAL SOIL
- HIGHLY WEATHERED ROCK

**Drilling and Sampling:**
- WATER SAMPLES RL (m) DEPTH (m)

**Material description and profile information:**
- 0.10m
- 0.30m
- 1.70m
- 2.10m

**EQUIPMENT TYPE:** 4 TONNE EXCAVATOR

**SURFACE RL:**
- Drill Terminated at 2.10 m
- Very slow progress

**TEST PIT NO:** TP102

**CLIENT:** McCLOY DEVELOPMENT MANAGEMENT

**PROJECT:** THE BOWER - STAGE 1

**LOCATION:** BOUNDARY ROAD, MEDOWIE

**LOGGED BY:** BE

**DATE:** 3/5/17
### Drilling and Sampling

<table>
<thead>
<tr>
<th>Depth</th>
<th>ROCK TYPE</th>
<th>MATERIAL DESCRIPTION</th>
<th>Test Type</th>
<th>MOISTURE CONDITION</th>
<th>Result</th>
<th>Structure and additional observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.08m</td>
<td>ST</td>
<td>Silty SAND - fine to medium grained, dark brown, with clay, root affected.</td>
<td>M</td>
<td></td>
<td>TOPSOIL</td>
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</tr>
<tr>
<td>0.24m</td>
<td>SM</td>
<td>Sandy CLAY - low plasticity, dark grey, fine grained sand.</td>
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<td></td>
<td>TOPSOIL/SLOPE WASH</td>
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<tr>
<td>0.5m</td>
<td>CL</td>
<td>CLAY - medium to high plasticity, grey to brown and orange, with some fine grained sand.</td>
<td>HP 180</td>
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<td>RESIDUAL SOIL</td>
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<tr>
<td>0.90m</td>
<td>U50</td>
<td>CLAY - high plasticity, pale grey with some orange.</td>
<td>HP 300</td>
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<td>RESIDUAL SOIL</td>
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<tr>
<td>1.15m</td>
<td>U50</td>
<td>Sandy SILTSTONE - pale grey with some orange, estimated medium strength.</td>
<td>HP 320</td>
<td></td>
<td>RESIDUAL SOIL</td>
<td></td>
</tr>
<tr>
<td>1.30m</td>
<td>U50</td>
<td>Hole Terminated at 2.10 m Very slow progress</td>
<td>HP 220</td>
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<td>RESIDUAL SOIL</td>
<td></td>
</tr>
<tr>
<td>1.70m</td>
<td>U50</td>
<td></td>
<td>HP 210</td>
<td></td>
<td>RESIDUAL SOIL</td>
<td></td>
</tr>
<tr>
<td>2.0m</td>
<td>U50</td>
<td></td>
<td>HP 250</td>
<td></td>
<td>RESIDUAL SOIL</td>
<td></td>
</tr>
<tr>
<td>2.10m</td>
<td>U50</td>
<td></td>
<td></td>
<td></td>
<td>RESIDUAL SOIL</td>
<td></td>
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### Consistency

<table>
<thead>
<tr>
<th>Consistency</th>
<th>UCS (kPa)</th>
<th>Moisture Condition</th>
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</thead>
<tbody>
<tr>
<td>VS Very Soft</td>
<td>&lt;25</td>
<td>D Dry</td>
</tr>
<tr>
<td>S Soft</td>
<td>25 - 50</td>
<td>M Moist</td>
</tr>
<tr>
<td>F Firm</td>
<td>50 - 100</td>
<td>W Wet</td>
</tr>
<tr>
<td>St Stiff</td>
<td>100 - 200</td>
<td>W&lt;sub&gt;s&lt;/sub&gt; Plastic Limit</td>
</tr>
<tr>
<td>VSt Very Stiff</td>
<td>200 - 400</td>
<td>W&lt;sub&gt;s&lt;/sub&gt; Liquid Limit</td>
</tr>
<tr>
<td>H Hard</td>
<td>&gt;400</td>
<td>Fs Fiable</td>
</tr>
</tbody>
</table>

### Density

<table>
<thead>
<tr>
<th>Density</th>
<th>Consistency</th>
<th>Moisture Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>V Very Loose</td>
<td>VS Very Soft</td>
<td>D Dry</td>
</tr>
<tr>
<td>L Loose</td>
<td>VS Very Soft</td>
<td>D Dry</td>
</tr>
<tr>
<td>MD Medium Dense</td>
<td>S Soft</td>
<td>M Moist</td>
</tr>
<tr>
<td>D Dense</td>
<td>F Firm</td>
<td>W Wet</td>
</tr>
<tr>
<td>VD Very Dense</td>
<td>St Stiff</td>
<td>W&lt;sub&gt;s&lt;/sub&gt; Plastic Limit</td>
</tr>
</tbody>
</table>

### Notes, Samples and Tests

- **U<sub>50</sub>**: 50mm Diameter tube sample
- **CBR**: Bulk sample for CBR testing
- **ASS**: Acid Sulfate Soil Sample
- **E**: Environmental sample
- **B**: Bulk Sample
- **PID**: Photionisation detector reading (ppm)
- **DOP(x,y)**: Dynamic penetrometer test (test depth interval shown)
- **HP**: Hand Penetrometer test (UCS kPa)
### Drilling and Sampling

#### Method

<table>
<thead>
<tr>
<th>WATER</th>
<th>SAMPLES</th>
<th>RL (m)</th>
<th>DEPTH (m)</th>
<th>GRADE LOG</th>
<th>CLASSIFICATION SYMBOL</th>
<th>MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components</th>
<th>MOISTURE CONDITION</th>
<th>CONSISTENCY</th>
<th>DENSITY</th>
<th>STRUCTURE AND ADDITIONAL OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Silty SAND - fine to medium grained, grey-brown, with some fine grained gravel, sub-angular to angular, root affected.</td>
<td>M</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>0.50m</td>
<td>0.64m</td>
<td>CH</td>
<td></td>
<td>Clay - high plasticity, pale grey with some pale orange-brown and red-brown.</td>
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<tr>
<td></td>
<td></td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td>Sandy SILTSTONE - pale grey-white with some orange to red-brown, moderately fractured, estimated medium strength, with some thin clay bands.</td>
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<tr>
<td></td>
<td></td>
<td>1.40m</td>
<td></td>
<td></td>
<td></td>
<td>Hole Terminated at 1.40 m Very slow progress</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Notes, Samples and Tests

- **U**: 50mm Diameter tube sample
- **GBR**: Bulk sample for CBR testing
- **E**: Environmental sample
- **ASS**: Acid Sulfate Soil Sample
- **B**: Bulk Sample

#### Field Tests

- **PID**: Photionisation detector reading (ppm)
- **DOP(x,y)**: Dynamic penetrometer test (test depth interval shown)
- **HP**: Hand Penetrometer test (UCS kPa)

#### Consistency

- **VS**: Very Soft
- **S**: Soft
- **F**: Firm
- **St**: Stiff
- **VSt**: Very Stiff
- **H**: Hard
- **Fs**: Finesample

#### UCS (kPa)

- **D**: Dry
- **V**: Very Loose
- **L**: Loose
- **MD**: Medium Dense
- **D**: Dense
- **VD**: Very Dense

#### Moisture Condition

- **VS**: <25
- **S**: 25 - 50
- **F**: 50 - 100
- **St**: 100 - 200
- **VSt**: 200 - 400
- **H**: >400

### Legend

- **Water**: Water Level (Date and time shown)
- **E**: Environmental sample
- **ASS**: Acid Sulfate Soil Sample
- **B**: Bulk Sample

### Structure and Additions

- **Legend**: Gradational or transitional strata
- **Definitive or distinct strata change**
<table>
<thead>
<tr>
<th>METHOD</th>
<th>WATER</th>
<th>SAMPLES</th>
<th>RL (m)</th>
<th>DEPTH (m)</th>
<th>MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components</th>
<th>MOISTURE CONDITION</th>
<th>CONSISTENCY</th>
<th>DENSITY</th>
<th>TEST TYPE</th>
<th>RESULT</th>
<th>STRUCTURE AND ADDITIONAL OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Silty SAND - fine to medium grained, dark brown, with clay, root affected.</td>
<td>M</td>
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<td></td>
<td></td>
<td></td>
<td>TOPSOIL</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sandy CLAY - low plasticity, dark grey, fine grained sand.</td>
<td>M &lt; w&lt;sub&gt;p&lt;/sub&gt;</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CLAY - medium to high plasticity, grey to brown and orange, with some fine grained sand.</td>
<td>M &gt; w&lt;sub&gt;p&lt;/sub&gt;</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.60m</td>
<td>CLAY - high plasticity, pale grey with some orange.</td>
<td>St</td>
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<td></td>
<td></td>
<td></td>
<td>2.00m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hole Terminated at 2.00 m</td>
</tr>
</tbody>
</table>

**LEGEND:**
- Water: Water Level (Date and time shown)
- Water Inflow
- Water Outflow
- Strata Changes: Gradational or transitional strata
- Definitive or distinct strata change

**Notes, Samples and Tests:**
- U<sub>SR</sub>: 50mm Diameter tube sample
- GBR: Bulk sample for GBR testing
- E: Environmental sample
- (Glass jar, sealed and chilled on site)
- ASS: Acid Sulfate Soil Sample
- (Plastic bag, air expelled, chilled)
- B: Bulk Sample

**Consistency:**
- VS Very Soft
- S Soft
- F Firm
- St Stiff
- VSt Very Stiff
- H Hard
- Fs Fiable

**U<sub>C</sub> (kPa):**
- Very Soft: <20
- Soft: 20 - 50
- Firm: 50 - 100
- Stiff: 100 - 200
- Very Stiff: 200 - 400
- Hard: >400

**Density:**
- Very Loose
- Loose
- Medium Dense
- Dense
- Very Dense

**Moisture Condition:**
- Dry
- Moist
- Wet
- Plastic Limit
- Liquid Limit
- Density Index <15%
- Density Index 15 - 35%
- Density Index 35 - 65%
- Density Index 65 - 85%
- Density Index 85 - 100%
**ENGINEERING LOG - TEST PIT**

**CLIENT:** McCLOY DEVELOPMENT MANAGEMENT  
**PROJECT:** THE BOWER - STAGE 1  
**LOCATION:** BOUNDARY ROAD, MEDOWIE

**EQUIPMENT TYPE:** 4 TONNE EXCAVATOR  
**TEST PIT LENGTH:** 2.0 m  
**SURFACE RL:**  
**WIDTH:** 0.5 m  
**DATUM:**

### Drilling and Sampling

<table>
<thead>
<tr>
<th>METHOD</th>
<th>WATER</th>
<th>SAMPLES</th>
<th>RL (m)</th>
<th>DEPTH (m)</th>
<th>GRAPHIC LOG</th>
<th>MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components</th>
<th>MOISTURE CONDITION</th>
<th>CONSISTENCY</th>
<th>DENSITY</th>
<th>CONSISTENCY</th>
<th>DENSITY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WATER</td>
<td>Samples</td>
<td></td>
<td></td>
<td>SANDY CLAY</td>
<td>- low plasticity, dark grey, fine grained sand.</td>
<td>M &lt; w_p</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.40m</td>
<td></td>
<td>CLAY</td>
<td>- high plasticity, grey and pale brown to orange.</td>
<td>M &gt; w_p</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.5m</td>
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<td>CH</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>U50</td>
<td></td>
<td>0.5m</td>
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<td>0.58m</td>
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<td></td>
<td></td>
<td></td>
<td>2.0m</td>
<td>2.00m</td>
<td></td>
<td>Hole Terminated at 2.00 m</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes, Samples and Tests

- **U50:** 50mm Diameter tube sample  
- **GSR:** Bulk sample for GSR testing  
- **E:** Environmental sample  
- **ASS:** Acid Sulfate Soil Sample  
- **B:** Bulk Sample  
- **PID:** Photionisation detector reading (ppm)  
- **DOP(x-y):** Dynamic penetrometer test (test depth interval shown)  
- **HP:** Hand Penetrometer test (UCS kPa)

### Field Test

<table>
<thead>
<tr>
<th>CONSISTENCY</th>
<th>UCS (kPa)</th>
<th>MOISTURE CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>VS Very Soft</td>
<td>&lt;25</td>
<td>D Dry</td>
</tr>
<tr>
<td>S Soft</td>
<td>25 - 50</td>
<td>M Moist</td>
</tr>
<tr>
<td>F Firm</td>
<td>50 - 100</td>
<td>W Wet</td>
</tr>
<tr>
<td>St Stiff</td>
<td>100 - 200</td>
<td>W_p Plastic Limit</td>
</tr>
<tr>
<td>VSt Very Stiff</td>
<td>200 - 400</td>
<td>W_L Liquid Limit</td>
</tr>
<tr>
<td>H Hard</td>
<td>&gt;400</td>
<td>Fs Fiable</td>
</tr>
</tbody>
</table>

### Structure and Additional Observations

- TOPSOIL / SLOPE WASH
- RESIDUAL SOIL

---

**LEGEND:**
- **Water:** Water Level (Date and time shown)  
- **Water Inflow:** Water Inflow  
- **Water Outflow:** Water Outflow  
- **Strata Changes:** Gradational or transitional strata, Definitive or distinct stratigraphic change

**Density:**
- V Very Loose  
- L Loose  
- MD Medium Dense  
- D Dense  
- VD Very Dense  

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

**Moisture Condition:**
- D Dry  
- M Moist  
- W Wet  
- W_p Plastic Limit  
- W_L Liquid Limit

---

**CLIENT:** McCLOY DEVELOPMENT MANAGEMENT  
**PROJECT:** THE BOWER - STAGE 1  
**LOCATION:** BOUNDARY ROAD, MEDOWIE  
**EQUIPMENT TYPE:** 4 TONNE EXCAVATOR  
**TEST PIT LENGTH:** 2.0 m  
**SURFACE RL:**  
**WIDTH:** 0.5 m  
**DATUM:**

---

**CLIENT:** McCLOY DEVELOPMENT MANAGEMENT  
**PROJECT:** THE BOWER - STAGE 1  
**LOCATION:** BOUNDARY ROAD, MEDOWIE  
**EQUIPMENT TYPE:** 4 TONNE EXCAVATOR  
**TEST PIT LENGTH:** 2.0 m  
**SURFACE RL:**  
**WIDTH:** 0.5 m  
**DATUM:**

---

**CLIENT:** McCLOY DEVELOPMENT MANAGEMENT  
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**DATUM:**

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**CLIENT:** McCLOY DEVELOPMENT MANAGEMENT  
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**TEST PIT LENGTH:** 2.0 m  
**SURFACE RL:**  
**WIDTH:** 0.5 m  
**DATUM:**

---

**CLIENT:** McCLOY DEVELOPMENT MANAGEMENT  
**PROJECT:** THE BOWER - STAGE 1  
**LOCATION:** BOUNDARY ROAD, MEDOWIE  
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**TEST PIT LENGTH:** 2.0 m  
**SURFACE RL:**  
**WIDTH:** 0.5 m  
**DATUM:**

---

**CLIENT:** McCLOY DEVELOPMENT MANAGEMENT  
**PROJECT:** THE BOWER - STAGE 1  
**LOCATION:** BOUNDARY ROAD, MEDOWIE  
**EQUIPMENT TYPE:** 4 TONNE EXCAVATOR  
**TEST PIT LENGTH:** 2.0 m  
**SURFACE RL:**  
**WIDTH:** 0.5 m  
**DATUM:**

---

**CLIENT:** McCLOY DEVELOPMENT MANAGEMENT  
**PROJECT:** THE BOWER - STAGE 1  
**LOCATION:** BOUNDARY ROAD, MEDOWIE  
**EQUIPMENT TYPE:** 4 TONNE EXCAVATOR  
**TEST PIT LENGTH:** 2.0 m  
**SURFACE RL:**  
**WIDTH:** 0.5 m  
**DATUM:**

---

**CLIENT:** McCLOY DEVELOPMENT MANAGEMENT  
**PROJECT:** THE BOWER - STAGE 1  
**LOCATION:** BOUNDARY ROAD, MEDOWIE  
**EQUIPMENT TYPE:** 4 TONNE EXCAVATOR  
**TEST PIT LENGTH:** 2.0 m  
**SURFACE RL:**  
**WIDTH:** 0.5 m  
**DATUM:**

---

**CLIENT:** McCLOY DEVELOPMENT MANAGEMENT  
**PROJECT:** THE BOWER - STAGE 1  
**LOCATION:** BOUNDARY ROAD, MEDOWIE  
**EQUIPMENT TYPE:** 4 TONNE EXCAVATOR  
**TEST PIT LENGTH:** 2.0 m  
**SURFACE RL:**  
**WIDTH:** 0.5 m  
**DATUM:**
**Drilling and Sampling**

<table>
<thead>
<tr>
<th>METHOD</th>
<th>WATER SAMP</th>
<th>RL (m)</th>
<th>DEPTH (m)</th>
<th>MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components</th>
<th>MOISTURE CONDITION</th>
<th>CONSISTENCY</th>
<th>DENSITY</th>
<th>FIELD TEST</th>
<th>CONSISTENCY</th>
<th>DENSITY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>VS Very Soft - 50mm Diameter tube sample</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>S Very Soft - Bulk sample for CBR testing</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>F Firm - Environmental sample</td>
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<td></td>
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<td></td>
<td></td>
<td>F Firm - Glass jar, sealed and chilled on site</td>
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<td></td>
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<td></td>
<td></td>
<td>ASS Acid Sulfate Soil Sample</td>
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<td></td>
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<td></td>
<td></td>
<td>ASS Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)</td>
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<td></td>
<td>B Bulk Sample</td>
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<td>B Bulk Sample</td>
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<td></td>
<td></td>
<td>Strata Changes</td>
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<td></td>
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<td></td>
<td></td>
<td>Gradational or transitional strata</td>
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<td></td>
<td>Definitive or distinct strata change</td>
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<td></td>
<td></td>
<td>Structure and additional observations</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Notes, Samples and Tests**

- Water Level (Date and time shown)
- Water Inflow
- Water Outflow
- Strata Changes

**LEGEND:**

- Water
- Gradational or transitional strata
- Definitive or distinct strata change

- Water Level: VS Very Soft, S Soft, F Firm, St Stiff, VSt Very Stiff, H Hard
- Water Inflow: LS Loose, MD Medium Dense, D Dense, VD Very Dense

**Density:**

- V Very Loose
- L Loose
- MD Medium Dense
- D Dense
- VD Very Dense

**Consistency:**

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

**UCS (kPa):**

- VS Very Soft: <25
- S Soft: 25 - 50
- F Firm: 50 - 100
- St Stiff: 100 - 200
- VSt Very Stiff: 200 - 400
- H Hard: >400

**Moisture Condition:**

- D Dry
- W Wet
- Wp Plastic Limit
- Wli Liquid Limit

**Field Tests:**

- PID Photonisation detector reading (ppm)
- DCP(x-y) Dynamic penetrometer test (test depth interval shown)
- HP Hand Penetrometer test (UCS kPa)
Drilling and Sampling

<table>
<thead>
<tr>
<th>Method</th>
<th>Water</th>
<th>Samples</th>
<th>RL (m)</th>
<th>Depth (m)</th>
<th>Class Log</th>
<th>Graphic Log</th>
<th>Material Description: Soil type, plasticity/particle characteristics, colour, minor components</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>SM</td>
<td>0.15m</td>
<td>0.30m</td>
<td>Silty SAND - fine grained, grey, root affected in top 0.05m.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CL</td>
<td>0.5m</td>
<td>0.60m</td>
<td>Sandy CLAY - medium plasticity, grey-brown, with some orange, fine grained sand.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CI</td>
<td>0.95m</td>
<td>1.0m</td>
<td>Sandy SILTSTONE - dark grey, fine grained sand, with extremely weathered pockets, estimated low strength.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.2m</td>
<td>1.5m</td>
<td>Silty SANDSTONE - slightly fractured, pale grey-white, with some orange, estimated medium strength.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Field Test

- Structure and additional observations
- Hole Terminated at 1.20 m Practical Refusal

**Notes, Samples and Tests**

- Water
  - U50: 50mm Diameter tube sample
  - CB: Bulk sample for CBR testing
  - E: Environmental sample
  - ASS: Acid Sulfate Soil Sample
  - B: Bulk Sample

- Field Tests
  - PID: Photionisation detector reading (ppm)
  - DCP(x-y): Dynamic penetrometer test (test depth interval shown)
  - HP: Hand Penetrometer test (UCS kPa)

**Consistency**

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

**UCS (kPa)**

- V: <25
- F: 25 - 50
- M: 50 - 100
- W: 100 - 200
- W*: 200 - 400
- H*: 400

**Density**

- V: Very Loose
- L: Loose
- MD: Medium Dense
- D: Dense
- VD: Very Dense

**Moisture Condition**

- D: Dry
- M: Moist
- W: Wet
- W*: Plastic Limit
- W**: Liquid Limit
- >400

**Density Index**

- >0%
- 15 - 35%
- 35 - 65%
- 65 - 85%
- 85 - 100%
### Material description and profile information

<table>
<thead>
<tr>
<th>Method</th>
<th>Water</th>
<th>Samples</th>
<th>RL (m)</th>
<th>Depth (m)</th>
<th>Material Description: Soil type, plasticity/particle characteristics, colour, minor components</th>
<th>Moisture Condition</th>
<th>Consistency</th>
<th>Density</th>
<th>Field Test</th>
<th>Notes, Samples and Tests</th>
<th>CONSISTENCY</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>SAW thematic</td>
<td>0.10m</td>
<td>0.80m</td>
<td>2.00m</td>
<td>TOPSOIL, residual soil/colluvium, highly weathered rock.</td>
<td>D - M</td>
<td>St</td>
<td>HP 180</td>
<td>HP 180</td>
<td>HOLE TERMINATED AT 2.00m</td>
<td>TOPSOIL</td>
<td>RESIDUAL SOIL/COLLUVIUM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sandy CLAY - medium to high plasticity, grey, fine grained sand, trace coal gravel.</td>
<td></td>
<td></td>
<td>HP 180</td>
<td></td>
<td></td>
<td></td>
<td>HIGHLY WEATHERED ROCK</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sandy SILTSTONE - highly fractured, pale grey-white, with some orange, estimated low strength, with extremely weathered pockets.</td>
<td></td>
<td></td>
<td>HP 180</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Textual Notes
- Hole Terminated at 2.00 m
- Very slow progress
### Engineering Log - Test Pit

**Client:** McCLOY DEVELOPMENT MANAGEMENT  
**Project:** THE BOWER - STAGE 1  
**Location:** BOUNDARY ROAD, MEDowie

**Equipment Type:** 4 Tonne Excavator  
**Test Pit Length:** 2.0 m  
**Width:** 0.5 m  
**Surface RL:**  
**Datum:**

#### Drilling and Sampling

<table>
<thead>
<tr>
<th>Method</th>
<th>Water</th>
<th>Samples</th>
<th>RL (m)</th>
<th>Depth (m)</th>
<th>Classification Symbol</th>
<th>Material Description</th>
<th>Moisture Condition</th>
<th>Consistency</th>
<th>Density</th>
<th>Field Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>VM CL CH SM</td>
<td>Silty SAND - fine to medium grained, dark grey, trace fine gravel, angular to sub-angular, root affected.</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CL CH S</td>
<td>Sandy CLAY - low plasticity, grey, fine grained sand, with silt.</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Not Encountered</td>
<td>0.30m</td>
<td></td>
<td></td>
<td>CL</td>
<td>CLAY - high plasticity, grey to pale grey, with some fine grained sand, with some fine to medium grained, trace coal gravel, with fine grained sand.</td>
<td>M &gt; W&lt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>U50</td>
<td>0.55m</td>
<td>0.50m</td>
<td>CH</td>
<td>CLAY - high plasticity, grey to pale grey, with some fine grained sand.</td>
<td>M &gt; W&lt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Silty SANDSTONE - slightly to moderately fractured, pale grey-white, with orange, estimated medium strength, with extremely weathered pockets.</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hole Terminated at 0.60 m  
Practical Refusal

**Legend:**
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow
- Gradational or transitional strata
- Definitive or distinct strata change

**Notes, Samples and Tests**
- 50mm Diameter tube sample
- Bulk sample for GBR testing
- Environmental sample (Glass jar, sealed and chilled on site)
- Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
- Bulk Sample

**Field Tests**
- Photionisation detector reading (ppm)
- Dynamic penetrometer test (test depth interval shown)
- Hand Penetrometer test (UCS kPa)

**Surface RL:**  
**Depth:**

**Consistency:**
- VS Very Soft  
- S Soft  
- F Firm  
- St Stiff  
- VISt Very Stiff  
- H Hard  
- Fs Fissile

**Density:**
- V Very Loose  
- L Loose  
- MD Medium Dense  
- D Dense  
- VD Very Dense

**UCS (kPa):**
- D Dry
- W Wet
- W< Plastic Limit
- W> Liquid Limit
- U<15%  
- U<35%  
- U<65%  
- U<85%  
- U<100%
### Material description and profile information

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Material Description</th>
<th>Moisture Condition</th>
<th>Test Type</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.15m</td>
<td>Silty SAND - fine to medium grained, grey-brown, with some fine grained gravel, sub-angular to angular, root affected.</td>
<td>M</td>
<td>HP</td>
<td>250</td>
</tr>
<tr>
<td>0.60m</td>
<td>CLAY - High plasticity, grey, with some orange.</td>
<td>M</td>
<td>HP</td>
<td>320</td>
</tr>
<tr>
<td>0.90m</td>
<td>Extremely weathered SILTSTONE with soil properties, excavates as Gravelly CLAY - high plasticity, dark grey, medium to coarse grained gravel, sub-angular.</td>
<td>M &gt; W</td>
<td>HP</td>
<td>250</td>
</tr>
<tr>
<td>0.95m</td>
<td>Silty SANDSTONE - slightly to moderately fractured, pale grey-white, with orange, estimated medium strength.</td>
<td>D</td>
<td>HP</td>
<td>320</td>
</tr>
</tbody>
</table>

**Structure and additional observations**

Hole Terminated at 1.00 m Practical Refusal
## Drilling and Sampling

<table>
<thead>
<tr>
<th>METHOD</th>
<th>WATER</th>
<th>SAMSPELS</th>
<th>RL (m)</th>
<th>DEPTH (m)</th>
<th>MATERLAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components</th>
</tr>
</thead>
<tbody>
<tr>
<td>WATER</td>
<td>SM</td>
<td>0.60m</td>
<td></td>
<td></td>
<td>Silty SAND - fine to medium grained, grey-brown, with some fine grained gravel, sub-angular to angular, root affected.</td>
</tr>
<tr>
<td></td>
<td>CH</td>
<td>1.00m</td>
<td></td>
<td></td>
<td>CLAY - High plasticity, grey, with some orange.</td>
</tr>
<tr>
<td></td>
<td>CH</td>
<td>1.30m</td>
<td></td>
<td></td>
<td>Extremely weathered SILTSTONE with soil properties, excavates as gravelly CLAY - High plasticity, dark grey, medium to coarse grained gravel, sub-angular.</td>
</tr>
<tr>
<td></td>
<td>CH</td>
<td>1.60m</td>
<td></td>
<td></td>
<td>Silty SANDSTONE - Slightly to moderately fractured, pale grey-white, with orange, estimated medium strength.</td>
</tr>
<tr>
<td></td>
<td>2.00m</td>
<td></td>
<td></td>
<td></td>
<td>Hole Terminated at 1.60 m Very slow progress</td>
</tr>
</tbody>
</table>

## Notes, Samples and Tests

- **U50** 50mm Diameter tube sample
- **CBR** Bulk sample for CBR testing
- **E** Environmental sample
- **ASS** Acid Sulfate Soil Sample
- **B** Bulk Sample
- **FS** Fissile
- **U** Upper
- **D** Lower
- **M** Medium
- **W** Wet
- **Wp** Plastic Limit
- **WL** Liquid Limit
- **VS** Very Soft
- **S** Soft
- **F** Firm
- **St** Stiff
- **VST** Very Stiff
- **H** Hard
- **VOD** Very Dense
- **D** Dense
- **MD** Medium Dense
- **L** Loose
- **W** Water
- **Water Level**
- **Water Inflow**
- **Water Outflow**
- **Gradational or transitional strata**
- **Definitive or distinct strata change**
- **Field Tests**
  - **PID** Photionisation detector reading (ppm)
  - **DOP(x-y)** Dynamic penetrometer test (test depth interval shown)
  - **HP** Hand Penetrometer test (UCS kPa)

## Material Description and Profile Information

- **TOPSOIL**
- **RESIDUAL SOIL**
- **EXTREMELY WEATHERED ROCK**
- **HIGHLY WEATHERED ROCK**

### LEGEND:
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow
- Gradational or transitional strata
- Definitive or distinct strata change
- Field Tests

### CONSISTENCY

- **D** Dry
- **M** Moist
- **W** Wet
- **Wp** Plastic Limit
- **WL** Liquid Limit

### DENSITY

- **V** Very Loose
- **L** Loose
- **MD** Medium Dense
- **D** Dense
- **VD** Very Dense

### UCS (kPa)

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

### MOISTURE CONDITION

- **VS** Very Soft
- **S** Soft
- **F** Firm
- **St** Stiff
- **VST** Very Stiff
- **H** Hard
### Material Description and Profile Information

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Soil Type</th>
<th>Physical Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.06m</td>
<td>TOPSOIL</td>
<td>Silt - fine to medium grained, grey-brown, with fine gravel, sub-angular.</td>
</tr>
<tr>
<td>0.40m</td>
<td>HIGHLY WEATHERED ROCK</td>
<td>Sandy CLAY - low plasticity, dark grey-black, fine sand, with silt.</td>
</tr>
<tr>
<td>0.60m</td>
<td>RESIDUAL SOIL</td>
<td>CLAY - high plasticity, grey with some orange.</td>
</tr>
<tr>
<td>0.90m</td>
<td>RESIDUAL SOIL - SANDY SILTSTONE</td>
<td>Sandy SILTSTONE - pale grey to grey, highly fractured, excavates as Clayey Sandy GRAVEL - fine to coarse grained gravel, sub-angular, fines of high plasticity, fine grained sand, estimated low to medium strength.</td>
</tr>
</tbody>
</table>

- Hole Terminated at 1.30 m
- Very slow progress

### Notes, Samples and Tests

- Water Level
- Gradational or transitional strata
- Definitive or distinct strata change
- Gradational or transitional strata change
- Definitive or distinct strata change

### Field Tests

<table>
<thead>
<tr>
<th>Field Test</th>
<th>Consistency</th>
<th>UCS (kPa)</th>
<th>Moisture Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>VS</td>
<td>Very Soft</td>
<td>&lt;20</td>
<td>D - Dry</td>
</tr>
<tr>
<td>S</td>
<td>Soft</td>
<td>25 - 50</td>
<td>M - Moist</td>
</tr>
<tr>
<td>F</td>
<td>Firm</td>
<td>50 - 100</td>
<td>W - Wet</td>
</tr>
<tr>
<td>St</td>
<td>Stiff</td>
<td>100 - 200</td>
<td>W&lt;sub&gt;p&lt;/sub&gt; - Plastic Limit</td>
</tr>
<tr>
<td>VSt</td>
<td>Very Stiff</td>
<td>200 - 400</td>
<td>W&lt;sub&gt;L&lt;/sub&gt; - Liquid Limit</td>
</tr>
<tr>
<td>H</td>
<td>Hard</td>
<td>&gt;400</td>
<td>Fs - Frangible</td>
</tr>
</tbody>
</table>

### Consistency

- V: Very Loose
- L: Loose
- MD: Medium Dense
- D: Dense
- VD: Very Dense

### Density

- Density Index <15%
- Density Index 15 - 35%
- Density Index 35 - 65%
- Density Index 65 - 85%
- Density Index 85 - 100%
**Material description and profile information**

<table>
<thead>
<tr>
<th>METHOD WATER</th>
<th>SAMPLES</th>
<th>RL (m)</th>
<th>DEPTH (m)</th>
<th>GRAPHIC LOG</th>
<th>CLASSIFICATION SYMBOL</th>
<th>MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components</th>
<th>MOISTURE CONDITION</th>
<th>TEST TYPE</th>
<th>RESULT</th>
<th>Structure and additional observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SM</td>
<td>Silty SAND - fine to medium grained, grey-brown, root affected. Extremely weathered SILTSTONE with soil properties, excavates as Gravelly CLAY - high plasticity, dark grey with some orange, fine to coarse grained gravel, sub-angular to angular.</td>
<td>M</td>
<td>HP</td>
<td>190</td>
<td>TOPSOIL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.20m</td>
<td></td>
<td></td>
<td>B</td>
<td>SILTSTONE - excavates as Clayey GRAVEL - fine to coarse grained, sub-angular to angular, dark grey with some orange, fines of high plasticity, clay of very stiff consistency, estimated low strength, highly fractured.</td>
<td>M</td>
<td>HP</td>
<td>190</td>
<td>EXTREMELY WEATHERED ROCK</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.40m</td>
<td>0.5</td>
<td></td>
<td>CH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>EXTREMELY TO HIGHLY WEATHERED ROCK</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.0</td>
<td></td>
<td></td>
<td>Hole Terminated at 1.00 m Practical Refusal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES, SAMPLES AND TESTS**

- **Consistency**
  - VS Very Soft
  - S Soft
  - F Firm
  - St Stiff
  - VSt Very Stiff
  - H Hard
- **Ucs (kPa)**
  - D Dry
  - M Moist
  - W Wet
  - Wp Plastic Limit
  - WL Liquid Limit
- **Density**
  - V Very Loose
  - L Loose
  - MD Medium Dense
  - D Dense
  - VD Very Dense

**LEGEND:**

- Water Level
- Water inflow
- Water outflow
- Gradational or transitional strata
- Definitive or distinct strata change

**EQUIPMENT TYPE:** 4 TONNE EXCAVATOR

**TEST PIT LENGTH:** 2.0 m **WIDTH:** 0.5 m

**NOTES, SAMPLES AND TESTS**

- **50mm Diameter tube sample**
- **Bulk sample for CBR testing**
- **Environmental sample**
- **Acid Sulfate Soil Sample**
- **Bulk sample**
- **Photosionisation detector reading (ppm)**
- **Dynamic penetrometer test (test depth interval shown)**
- **Hand Penetrometer test (UCS kPa)**
## Material description and profile information

<table>
<thead>
<tr>
<th>Sample</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM</td>
<td>Silty SAND - fine to medium grained, grey-brown, with some fine grained gravel, sub-angular to angular, root affected.</td>
</tr>
<tr>
<td>CL</td>
<td>Sandy CLAY - low plasticity, grey, fine sand, with silt.</td>
</tr>
<tr>
<td>CH</td>
<td>Silty SANDSTONE - highly fractured, pale grey-white, with orange, estimated low to medium strength.</td>
</tr>
<tr>
<td>U50</td>
<td>Extremely weathered SILTSTONE with soil properties, excavates as Gravelly CLAY - high plasticity, dark grey, medium to coarse grained gravel, sub-angular.</td>
</tr>
<tr>
<td>D</td>
<td>Silty SANDSTONE - slightly to moderately fractured, pale grey-white, with orange, estimated medium strength.</td>
</tr>
</tbody>
</table>

### Notes, Samples and Tests

- **Water Level:** 50mm Diameter tube sample
- **E:** Bulk sample for CBR testing (Glass jar, sealed and chilled on site)
- **ASS:** Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
- **B:** Bulk Sample

### Field Tests

- **PID:** Photionisation detector reading (ppm)
- **DOP(x-y):** Dynamic penetrometer test (test depth interval shown)
- **HP:** Hand Penetrometer test (UCS kPa)

### Structure and additional observations

- Hole Terminated at 1.75 m
- Very slow progress

---

### Legend:

- **Water:** Water Level (Date and time shown)
- **H:** Gradational or transitional strata
- **E:** Definitive or distinct strata change

### Equipment Type:

- 4 Tonne Excavator

### Drilling and Sampling:

- Method: WATER
- Samples: WATER
- RL (m): 0.30m, 0.50m, 0.75m
- Depth (m): 0.30m, 0.35m, 0.40m, 0.80m, 1.75m

### Surface RL:

- DATUM:
- SURFACE RL:

---

### Notes on Soil Properties:

- **UCS (kPa):**
  - D: Dry
  - M: Moist
  - W: Wet
  - W_p: Plastic Limit
  - W_L: Liquid Limit

- **D:** Very Loose
  - Very Loose
  - Medium Dense
  - Dense
  - Very Dense

- **Density:**
  - V: Very Loose
  - L: Loose
  - MD: Medium Dense
  - D: Dense
  - VD: Very Dense

- **Density Index:**
  - <15%
  - 15 - 35%
  - 35 - 65%
  - 65 - 85%
  - 85 - 100%

---

### Field Tests:

- **Field Test:**
  - Structure and additional observations

---

### Log Details:

- **Client:** McCLOY DEVELOPMENT MANAGEMENT
- **Project:** THE BOWER - STAGE 1
- **Location:** BOUNDARY ROAD, MEDOWIE
- **Equipment Type:** 4 Tonne Excavator
- **Test Pit Length:** 2.0 m
- **Width:** 0.5 m
- **Test Pit No:** TP115
### Material Description and Profile Information

<table>
<thead>
<tr>
<th>Sample</th>
<th>Material Description: Soil type, plasticity/particle characteristics, colour, minor components</th>
</tr>
</thead>
<tbody>
<tr>
<td>U50</td>
<td>Silty SAND - fine to medium grained, dark grey, trace fine gravel, angular to sub-angular, root affected.</td>
</tr>
<tr>
<td>0.70m</td>
<td>Sandy CLAY - low plasticity, grey, fine grained sand.</td>
</tr>
<tr>
<td>1.00m</td>
<td>CLAY - high plasticity, grey to pale grey, with some fine grained sand.</td>
</tr>
<tr>
<td></td>
<td>with fine to medium grained sand.</td>
</tr>
<tr>
<td></td>
<td>Silty SANDSTONE - fine grained, pale grey-white and brown, with some orange, estimated low to medium strength.</td>
</tr>
</tbody>
</table>

Hole Terminated at 1.00 m
Practical Refusal

### Consistency and UCS

<table>
<thead>
<tr>
<th>Consistency</th>
<th>UCS (kPa)</th>
<th>Moisture Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>VS</td>
<td>&lt;25</td>
<td>D Dry</td>
</tr>
<tr>
<td>S</td>
<td>25 - 50</td>
<td>M Moist</td>
</tr>
<tr>
<td>F</td>
<td>50 - 100</td>
<td>W Wet</td>
</tr>
<tr>
<td>St</td>
<td>100 - 200</td>
<td>W&lt;sub&gt;p&lt;/sub&gt; Plastic Limit</td>
</tr>
<tr>
<td>VSt</td>
<td>200 - 400</td>
<td>W&lt;sub&gt;L&lt;/sub&gt; Liquid Limit</td>
</tr>
<tr>
<td>H</td>
<td>&gt;400</td>
<td>VD Very Dense</td>
</tr>
<tr>
<td>Fs</td>
<td>Frible</td>
<td></td>
</tr>
</tbody>
</table>

### Notes, Samples and Tests

<table>
<thead>
<tr>
<th>Water Level</th>
<th>Water Inflow</th>
<th>Water Outflow</th>
<th>Strata Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Date and time shown)</td>
<td>(Glass jar, sealed and chilled on site)</td>
<td>(Plastic bag, air expelled, chilled)</td>
<td>Gradational or transitional strata</td>
</tr>
</tbody>
</table>

- **U<sub>50</sub>**: 50mm Diameter tube sample
- **OBR**: Bulk sample for CBR testing
- **E**: Environmental sample
- **ASS**: Acid Sulfate Soil Sample
- **B**: Bulk Sample

- **PID**: Photoionisation detector reading (ppm)
- **DOP(x,y)**: Dynamic penetrometer test (test depth interval shown)
- **HP**: Hand Penetrometer test (UCS kPa)
**Material description and profile information**

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00m</td>
<td>TOPSOIL</td>
</tr>
<tr>
<td>0.30m</td>
<td>Clayey Silty SAND - fine to medium grained, grey, fines of low plasticity, root affected.</td>
</tr>
<tr>
<td>0.60m</td>
<td>CLAY - high plasticity, grey with some pale brown to orange, trace to some fine to medium grained sand.</td>
</tr>
<tr>
<td>0.90m</td>
<td>Silty SANDSTONE - fine to medium grained, white to pale grey and pale brown, estimated high strength. (start depth 0.8m at western end of pit)</td>
</tr>
</tbody>
</table>

**Hole Terminated at 0.90 m**

**Practical Refusal**

---

**LEGEND:**
- Water Level
- Water Inflow
- Water Outflow
- Gradational or transitional strata
- Definitive or distinct strata change

**Notes, Samples and Tests**

- Water
  - U: 50mm Diameter tube sample
  - E: Bulk sample for CBR testing
  - ASS: Acid Sulfate Soil Sample
  - B: Bulk Sample

- Strata Changes
  - Gradational or transitional strata
  - Definitive or distinct strata change

- Field Tests
  - PID: Photionisation detector reading (ppm)
  - DCP(x-y): Dynamic penetrometer test (test depth interval shown)
  - HP: Hand Penetrometer test (UCS kPa)

**Not Encountered**

---

**Structure and additional observations**

- TOPSOIL
- RESIDUAL SOIL
- HIGHLY WEATHERED ROCK

---

**Surface RL:**

**Drilling and Sampling**

<table>
<thead>
<tr>
<th>Method</th>
<th>Water</th>
<th>Samples</th>
<th>RL (m)</th>
<th>Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WATER</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SM</td>
<td></td>
<td>0.30m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH</td>
<td></td>
<td>0.50m</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.90m</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Geotechnical Tests**

- **MATERIAL DESCRIPTION:** Soil type, plasticity/particle characteristics, colour, minor components
- **CONSISTENCY:** Moisture Condition
- **CONSISTENCY:** Consistency
- **CONSISTENCY:** DENSITY
- **CONSISTENCY:** HARDNESS

---

**Consistency**

- **UCS (kPa):**
  - VS: Very Soft
  - S: Soft
  - F: Firm
  - St: Stiff
  - VSt: Very Stiff
  - H: Hard

- **Moisture Condition:**
  - D: Dry
  - M: Moist
  - W: Wet
  - Wp: Plastic Limit
  - Wl: Liquid Limit

---

**Density**

- **Density:**
  - V: Very Loose
  - L: Loose
  - MD: Medium Dense
  - D: Dense
  - VD: Very Dense

- **Density Index:**
  - <15%
  - 15% - 35%
  - 35% - 65%
  - 65% - 100%
**Material description and profile information**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Classification</th>
<th>Symbol</th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.30</td>
<td>CL</td>
<td></td>
<td>Sandy CLAY - low to medium plasticity, dark brown, fine to coarse grained sand, trace of fine to coarse grained gravel, root affected. (no obvious gravel layers on outer 600m of road)</td>
</tr>
<tr>
<td>0.50</td>
<td>CH</td>
<td></td>
<td>CLAY - high plasticity, grey, trace of fine to medium grained sand, some tree roots.</td>
</tr>
<tr>
<td>0.90</td>
<td></td>
<td></td>
<td>Silty SANDSTONE - fine to medium grained, white to pale grey with grey joints, estimated high strength, semi-fractured.</td>
</tr>
<tr>
<td>0.90 - 1.5</td>
<td></td>
<td></td>
<td>Hole Terminated at 0.90 m Practical Refusal</td>
</tr>
<tr>
<td>1.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Structure and additional observations**

- TOPSOIL - DISTURBED
- RESIDUAL SOIL
- HIGHLY WEATHERED ROCK

**Legend:**

- Water Level (Date and time shown)
- Gradational or transitional strata
- Definitive or distinct strata change
- Water Inflow
- Water Outflow
- Notes, Samples and Tests
- Field Tests

**Consistency**: VS Very Soft, V Very Loose, L Loose, D Dry

**UCS (kPa)**: <25, 25 - 50, 50 - 100, 100 - 200, 200 - 400, >400

**Moisture Condition**: D Dry, M Moist, W Wet, Wp Plastic Limit, Wl Liquid Limit

**Density**: V Very Loose, K Loose, MD Medium Dense, D Dense, VD Very Dense

**Consistency Index**: Density Index 15 - 35%, Density Index 35 - 65%, Density Index 65 - 100%
**Material description and profile information**

<table>
<thead>
<tr>
<th>METHOD</th>
<th>WATER</th>
<th>SAMPLES</th>
<th>RL (m)</th>
<th>DEPTH (m)</th>
<th>MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FILL: Gravelly CLAY / Clayey GRAVEL - high plasticity, grey with white gravel, fine to coarse grained angular gravel (including silty sandstone / sandy siltstone, possibly tuffaceous), root affected upper 0.3m.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.30m</td>
<td></td>
<td>CBR: Cobble and boulders of Silty SANDSTONE / Sandy SILTSTONE, possibly tuffaceous, estimated medium to high strength.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.70m</td>
<td></td>
<td>FILL - APPEARS NOT TO BE WELL COMPACTED BUT FEW VISIBLE VOIDS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.0</td>
<td></td>
<td>M - W</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.5</td>
<td></td>
<td>Hole Terminated at 1.50 m Slow progress due to cave-in</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Test Pit No:** TP-Q17

**Equipment Type:** 5t Excavator (Eurocomach)

**Test Pit Length:** 1.5 m **Width:** 0.3 m

**Surface RL:** DATUM:

---

**LEGEND:**

- Water
  - Water Level
  (Date and time shown)
- Water Inflow
- Water Outflow
- Strata Changes
  - Gradational or transitional strata
  - Definitive or distinct strata change

**Notes, Samples and Tests**

<table>
<thead>
<tr>
<th>Consistency</th>
<th>UCS (kPa)</th>
<th>Moisture Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>VS Very Soft</td>
<td>&lt;25</td>
<td>D Dry</td>
</tr>
<tr>
<td>St Stiff</td>
<td>100 - 200</td>
<td>W Wet</td>
</tr>
<tr>
<td>VSt Very Stiff</td>
<td>200 - 400</td>
<td>W&lt;sub&gt;p&lt;/sub&gt; Plastic Limit</td>
</tr>
<tr>
<td>H Hard</td>
<td>&gt;400</td>
<td>W&lt;sub&gt;l&lt;/sub&gt; Liquid Limit</td>
</tr>
<tr>
<td>L Loose</td>
<td>25 - 50</td>
<td>M Moist</td>
</tr>
<tr>
<td>F Firm</td>
<td>50 - 100</td>
<td>W</td>
</tr>
<tr>
<td>M Medium</td>
<td>50 - 100</td>
<td>W</td>
</tr>
<tr>
<td>D Dense</td>
<td>&gt;400</td>
<td>W</td>
</tr>
<tr>
<td>VD Very Dense</td>
<td>85 - 100</td>
<td>Density Index 85 - 100%</td>
</tr>
</tbody>
</table>

**Density**

<table>
<thead>
<tr>
<th>Density</th>
<th>V Very Loose</th>
<th>Density Index &lt;15%</th>
</tr>
</thead>
<tbody>
<tr>
<td>L Loose</td>
<td></td>
<td>Density Index 15 - 35%</td>
</tr>
<tr>
<td>MD Medium Dense</td>
<td>35 - 65%</td>
<td></td>
</tr>
<tr>
<td>D Dense</td>
<td></td>
<td>Density Index 65 - 85%</td>
</tr>
<tr>
<td>VD Very Dense</td>
<td>85 - 100%</td>
<td></td>
</tr>
</tbody>
</table>
### Material Description and Profile Information

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50m</td>
<td>FILL: Sandy CLAY - medium plasticity, green to brown and brown, fine to medium grained sand, about 10% to 20% cobble sized concrete fragments, some tree roots. Clays are medium to low plasticity.</td>
</tr>
<tr>
<td>0.70m</td>
<td>FILL: POSSIBLY LOCAL SOIL MIXED WITH SOME CONCRETE</td>
</tr>
<tr>
<td>1.00m</td>
<td>CLAY - high plasticity, pale brown to pale grey and brown to red, trace of fine to medium grained sand, some tree roots. Pale grey and brown to red. CHs are high plasticity.</td>
</tr>
<tr>
<td>1.50m</td>
<td>RESIDUAL SOIL</td>
</tr>
<tr>
<td>2.00m</td>
<td>Hole Terminated at 2.00 m</td>
</tr>
</tbody>
</table>

### Summary of Test Results

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Consistency</th>
<th>UCS (kPa)</th>
<th>Moisture Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP</td>
<td>M &gt; Wp</td>
<td>230</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>M &gt; Wl</td>
<td>300</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>M &gt; Wl</td>
<td>240</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>M &gt; Wl</td>
<td>220</td>
<td>W</td>
</tr>
</tbody>
</table>

### Notes and Samples

- **U**: 50mm Diameter tube sample
- **CBR**: Bulk sample for CBR testing
- **E**: Environmental sample (Glass jar, sealed and chilled on site)
- **ASS**: Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
- **B**: Bulk Sample

### Density

- **V**: Very Loose
- **L**: Loose
- **M**: Medium
- **D**: Dense
- **VD**: Very Dense

### Moisture Condition

- **Dry**
- **Wet**
- **Plastic Limit**
- **Liquid Limit**

### Field Test

- **PID**: Photoionisation detector reading (ppm)
- **DOP(x-y)**: Dynamic penetrometer test (test depth interval shown)
- **HP**: Hand Penetrometer test (UCS kPa)
### Material Description and Profile Information

#### Method

<table>
<thead>
<tr>
<th>Water Samples</th>
<th>RL (m)</th>
<th>Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Graph Log

- **0.30m**
  - **CBR**
- **0.60m**
  - **CBR**
- **1.00m**
  - **CH**
- **1.50m**
  - **CH**
- **2.00m**
  - **CH**

#### Material Description

- **TOPSOIL**
  - **Clay** - medium to high plasticity, grey and dark grey, some fine to medium grained sand, root affected.
  - **MOISTURE CONDITION**: **M - w**
  - **CONSISTENCY**: **P**

- **RESIDUAL SOIL**
  - **Clay** - high plasticity, pale grey and pale brown, trace of fine to medium grained sand.

- **HIGHLY WEATHERED ROCK**
  - **Siltstone** - grey to pale grey, estimated low to medium strength, fractured.

- **2.00m**
  - **Hole Terminated at 2.00 m**

### Notes, Samples and Tests

#### Consistency

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

#### UCS (kPa)

- **D**: Dry
- **M**: Moist
- **W**: Wet
- **W**: Plastic Limit
- **W**: Liquid Limit

#### Moisture Condition

- **V**: Very Loose
- **L**: Loose
- **MD**: Medium Dense
- **D**: Dense
- **VD**: Very Dense

#### Density

- **Density Index**
  - **<15%**
  - **15 - 35%**
  - **35 - 65%**
  - **65 - 85%**
  - **85 - 100%**
### Drill and Sampling

<table>
<thead>
<tr>
<th>METHOD</th>
<th>WATER</th>
<th>SAMPLES</th>
<th>RL (m)</th>
<th>DEPTH (m)</th>
<th>GRAPHIC LOG SYMBOL</th>
<th>MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components</th>
<th>MOISTURE CONDITION</th>
<th>CONSISTENCY</th>
<th>DENSITY</th>
<th>FIELD TEST</th>
<th>Structure and additional observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.30</td>
<td></td>
<td></td>
<td>Silty CLAY - low to medium plasticity, grey to dark brown, some fine grained sand, root affected.</td>
<td>TOPSOIL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.5</td>
<td></td>
<td></td>
<td>CLAY - high plasticity, pale grey and pale brown, trace of fine to medium grained sand.</td>
<td>VSt</td>
<td>HP 250</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.0</td>
<td></td>
<td></td>
<td>Pale grey with some brown to red and pale brown to orange.</td>
<td>M &gt; w</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.5</td>
<td></td>
<td></td>
<td>Hole Terminated at 1.80 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Field Tests

- **PID**: Photionisation detector reading (ppm)
- **DOP(x-y)**: Dynamic penetrometer test (test depth interval shown)
- **HP**: Hand Penetrometer test (UCS kPa)

### Notes, Samples and Tests

- **U<sub>50</sub>**: 50mm Diameter tube sample
- **GSR**: Bulk sample for GSR testing
- **E**: Environmental sample
- **ASS**: Acid Sulfate Soil Sample
- **B**: Bulk Sample
- **F<sub>D</sub>**: Dynamic Density Index <15%
- **F<sub>50</sub>**: Dynamic Density Index 15 - 35%
- **F<sub>65</sub>**: Dynamic Density Index 35 - 65%
- **F<sub>85</sub>**: Dynamic Density Index 65 - 85%
- **F<sub>100</sub>**: Dynamic Density Index 85 - 100%
- **V<sub>50</sub>**: Very Loose
- **V**: Very Soft
- **S**: Soft
- **F**: Firm
- **St**: Stiff
- **VSt**: Very Stiff
- **H**: Hard
- **M**: Medium
- **W**: Wet
- **W<sub>p</sub>**: Plastic Limit
- **W<sub>l</sub>**: Liquid Limit

### Legend:

- Trapping or transitional strata
- Definitive or distinct strata change

### Client:
- **McCLOY MEDOWIE PTY LTD**

### Project:
- **PROPOSED SUBDIVISION**

### Location:
- **BOUNDARY ROAD, MEDOWIE**

### Engineering Log - Test Pit

- **EQUIPMENT TYPE:** 5t Excavator (Eurocomach)
- **TEST PIT LENGTH:** 1.5 m
- **WIDTH:** 0.3 m
- **HOLE TERMINATED AT:** 1.80 m

---

**Drilling and Sampling**

**Material description and profile information**

**Field Test**

**Structure and additional observations**

---

**Notes, Samples and Tests**

**PID**: Photionisation detector reading (ppm)

**Consistency**

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

**UCS (kPa)**

- **<25**: D Dry
- **25 - 50**: M Moist
- **50 - 100**: W Wet
- **100 - 200**: W<sub>p</sub> Plastic Limit
- **200 - 400**: W<sub>l</sub> Liquid Limit
- **>400**: F<sub>D</sub> F<sub>50</sub> F<sub>65</sub> F<sub>85</sub> F<sub>100</sub>

**Density**

- **V**: Very Loose
- **L**: Loose
- **MD**: Medium Dense
- **D**: Dense
- **VD**: Very Dense

**Moisture Condition**

- **<15%**: Density Index <15%
- **15 - 35%**: Density Index 15 - 35%
- **35 - 65%**: Density Index 35 - 65%
- **65 - 85%**: Density Index 65 - 85%
- **85 - 100%**: Density Index 85 - 100%
**ENGINEERING LOG - TEST PIT**

**CLIENT:** McCLOY MEDOWIE PTY LTD

**PROJECT:** PROPOSED SUBDIVISION

**LOCATION:** BOUNDARY ROAD, MEDOWIE

**EQUIPMENT TYPE:** 5t Excavator (Eurocomach)

**TEST PIT LENGTH:** 1.5 m  **WIDTH:** 0.3 m

**METHOD**

<table>
<thead>
<tr>
<th>WATER</th>
<th>SAMPLER</th>
<th>RL (m)</th>
<th>DEPTH (m)</th>
<th>GRAPHIC LOG SYMBOL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.50</td>
<td>0.90</td>
<td>FILL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.40</td>
<td>1.90</td>
<td>Topsoil - Disturbed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.30</td>
<td>2.00</td>
<td>Residual Soil</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Extremely to Highly Weathered Rock</td>
</tr>
</tbody>
</table>

**MATERIAL DESCRIPTION:** Soil type, plasticity/particle characteristics, colour, minor components

- **FILL:** Sandy CLAY / Gravelly Clayey SAND - low to medium plasticity, brown to grey, fine to coarse grained sand, fine to coarse grained gravel, some plastic, tile / concrete fragments, glass, metal.

- **CLAY:** High plasticity, grey with some pale brown, trace of fine to medium grained sand, with some large tree roots and pockets of fill.

- **CLAY:** High plasticity, grey with some pale brown, trace of some fine to medium grained sand, with tree roots.

- **Silty SANDSTONE:** Fine to medium grained, pale grey to white with some pale brown to orange, with residual soil / extremely weathered pockets, estimated low strength.

- **Some brown semi-carbonaceous layers.**

**Hole Terminated at 1.90 m**

**NOTES:**

- **GRADATIONAL OR TRANSITIONAL STRATA:**
- **DEFINITIVE OR DISTINCT STRATA CHANGE:**

**LABORATORY TESTING:**

- **CONSISTENCY:**
  - Very Soft (VS)
  - Soft (S)
  - Firm (F)
  - Stiff (St)
  - Very Stiff (VSt)
  - Hard (H)
  - Friable (Ff)

- **DENSITY:**
  - Very Loose (VD)
  - Loose (L)
  - Medium Dense (MD)
  - Dense (D)
  - Very Dense (Vd)

- **UICR**
  - 50mm Diameter tube sample
  - Bulk sample for CBR testing
  - Environmental sample (Glass jar, sealed and chilled on site)
  - Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)

- **CONSISTENCY INDEX:**
  - <25
  - 25 - 50
  - 50 - 100
  - 100 - 200
  - 200 - 400
  - >400

- **MORPHOLOGY:**
  - Very Soft (VS)
  - Soft (S)
  - Firm (F)
  - Stiff (St)
  - Very Stiff (VSt)
  - Hard (H)
  - Friable (Ff)

- **UICR:**
  - Dry (D)
  - Moist (M)
  - Wet (W)
  - Plastic Limit (Wp)
  - Liquid Limit (Wl)

- **UICR TESTS:**
  - Dynamic Penetrometer test (UCS kPa)
  - Hand Penetrometer test (UCS kPa)

- **DENSITY:**
  - Very Loose (VD)
  - Loose (L)
  - Medium Dense (MD)
  - Dense (D)
  - Very Dense (Vd)

- **DENSITY INDEX:**
  - <15%
  - 15 - 35%
  - 35 - 65%
  - 65 - 85%
  - 85 - 100%
### Drilling and Sampling

<table>
<thead>
<tr>
<th>METHOD</th>
<th>WATER</th>
<th>SAMPLES RL (m)</th>
<th>DEPTH (m)</th>
<th>GRAPHIC LOG</th>
<th>CLASSIFICATION SYMBOL</th>
<th>MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components</th>
<th>MOISTURE CONDITION</th>
<th>CONSISTENCY</th>
<th>DENSITY</th>
<th>FIELD TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sandy CLAY - low to medium plasticity, dark brown, fine to medium grained sand, root affected.</td>
<td>M - w_p</td>
<td>VS</td>
<td>V</td>
<td>Topsoil</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CLAY - high plasticity, grey with some pale brown, trace of fine to medium grained sand.</td>
<td>M &gt; w_p</td>
<td>HS</td>
<td>VS</td>
<td>Residual Soil</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SANDSTONE - fine to medium grained, pale grey to white and pale brown to orange, estimated low strength.</td>
<td>M</td>
<td>H</td>
<td>F</td>
<td>Extremely to Highly Weathered Rock</td>
</tr>
</tbody>
</table>

**Hole Terminated at 1.25 m**

Very slow progress

### Notes, Samples and Tests

<table>
<thead>
<tr>
<th>LEGEND</th>
<th>Notes, Samples and Tests</th>
<th>Consistency</th>
<th>UCS (kPa)</th>
<th>Moisture Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Water Level (Date and time shown)</td>
<td>VS Very Soft</td>
<td>&lt;25</td>
<td>D Dry</td>
</tr>
<tr>
<td>U_50</td>
<td>50mm Diameter tube sample</td>
<td>S Soft</td>
<td>25 - 50</td>
<td>M Moist</td>
</tr>
<tr>
<td>ASS</td>
<td>Bulk sample for GBR testing</td>
<td>F Firm</td>
<td>50 - 100</td>
<td>W Wet</td>
</tr>
<tr>
<td>CH</td>
<td>Environmental sample</td>
<td>St Stiff</td>
<td>100 - 200</td>
<td>W_p Plastic Limit</td>
</tr>
<tr>
<td>B</td>
<td>(Glass jar, sealed and chilled on site)</td>
<td>VSt Very Stiff</td>
<td>200 - 400</td>
<td>W_L Liquid Limit</td>
</tr>
<tr>
<td></td>
<td>Acid Sulfate Soil Sample</td>
<td>H Hard</td>
<td>&gt;400</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Plastic bag, air expelled, chilled)</td>
<td>Fs Frangible</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Test Pit Length:** 1.5 m  **Width:** 0.3 m  **Surface RL:** DATUM: **Test Pit NO:** TPQ41 **Surface RL:** DATUM: **Surficial Horizon Depth:** 2.0 m

**Notes:**
- Hole Terminated at 1.25 m
- Very slow progress

**Tests:**
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow
- Stratigraphic Changes
- Gradational or transitional strata
- Definitive or distinct stratal change
- Field Tests
- Photionisation detector reading (ppm)
- Dynamic penetrometer test (test depth interval shown)
- Hand Penetrometer test (UCS kPa)

**Consistency:**
- VS Very Soft
- S Soft
- F Firm
- St Stiff
- VSt Very Stiff
- H Hard
- Fs Frangible

**UCS (kPa):**
- <25
- 25 - 50
- 50 - 100
- 100 - 200
- 200 - 400
- >400

**Moisture Condition:**
- D Dry
- M Moist
- W Wet
- W_p Plastic Limit
- W_L Liquid Limit

**Density:**
- V Very Loose
- L Loose
- MD Medium Dense
- D Dense
- VD Very Dense

**Density Index:**
- <15%
- 15 - 35%
- 30 - 65%
- 65 - 85%
- 85 - 100%
### Field Test Results

<table>
<thead>
<tr>
<th>Material Description</th>
<th>Moisture Condition</th>
<th>Consistency</th>
<th>Density Index</th>
<th>UCS (kPa)</th>
<th>Field Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOPSOIL</td>
<td>M</td>
<td>VS</td>
<td>&lt;15%</td>
<td>&lt;20</td>
<td>PID, DCP(x)</td>
</tr>
<tr>
<td>RESIDUAL SOIL</td>
<td>M &gt; w</td>
<td>S</td>
<td>15-35%</td>
<td>20-40</td>
<td></td>
</tr>
<tr>
<td>EXTREMELY WEATHERED</td>
<td>M</td>
<td>H</td>
<td>&gt;35%</td>
<td>&gt;100</td>
<td></td>
</tr>
</tbody>
</table>

### Drilling and Sampling

- **METHOD**: Water
- **WATER**: Samples
- **SAMPLES**: RL (m) DEPTH (m)
- **GRAPHIC LOG**: MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components
- **CLASSIFICATION SYMBOL**: Sandy CLAY - low to medium plasticity, dark brown, fine to medium grained sand, root affected.
- **SYMBOL**: CLAY - High plasticity, grey with some pale brown, trace of fine to medium grained sand.
- **CL**: Silty SANDSTONE - fine to medium grained, pale grey to white, fractured with weathered defects/residual soil/extremely weathered pockets, estimated strength varies from very low to high.
- **CH**: Some brown semi-carbonaceous layers.
- **ULS**: 0.20 m
- **ULS5**: 0.45 m
- **U50**: 0.20 m
- **CL**: 0.70 m

### Structure and Additional Observations

- Becoming mostly extremely weathered.
- Hole Terminated at 1.90 m
**ENGINEERING LOG - TEST PIT**

**CLIENT:** McCLOY MEDOWIE PTY LTD  
**PROJECT:** PROPOSED SUBDIVISION  
**LOCATION:** BOUNDARY ROAD, MEDOWIE

---

**Material description and profile information**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00m</td>
<td>TOPSOIL CLAY / Sandy CLAY - medium to high plasticity, grey and dark grey, some fine to medium grained sand, root affected.</td>
</tr>
<tr>
<td>0.45m</td>
<td>RESIDUAL SOIL CLAY - high plasticity, grey, trace of fine to coarse grained sand, a few tree roots.</td>
</tr>
<tr>
<td>0.80m</td>
<td>HIGHLY WEATHERED ROCK SILTSTONE - brown to grey and pale grey, estimated high strength, fractured upper zone.</td>
</tr>
</tbody>
</table>

---

**Field Test**

- **UCS (kPa)**
  - M > W
  - St
  - HP 180

---

**Drilling and Sampling**

- **METHOD:** WATER
- **WATER:** Not Encountered
- **SAMPLES:** U50
- **RL (m):** 0.30m

---

**Notes, Samples and Tests**

- **U50:** 50mm Diameter tube sample
- **CBR:** Bulk sample for CBR testing
- **ASS:** Acid Sulfate Soil Sample
- **E:** Environmental sample
- **B:** Bulk Sample
- **PID:** Photionisation detector reading (ppm)
- **DOP(x-y):** Dynamic penetrometer test (test depth interval shown)
- **HP:** Hand Penetrometer test (UCS kPa)

---

**Consistency**

- **VS:** Very Soft
- **S:** Soft
- **F:** Firm
- **St:** Stiff
- **VSt:** Very Stiff
- **H:** Hard
- **D:** Dry
- **M:** Moist
- **W:** Wet
- **Wp:** Plastic Limit
- **Wl:** Liquid Limit
- **Wd:** Drained Limit

---

**Density**

- **MD:** Medium Dense
- **D:** Dense
- **VD:** Very Dense

---

**Legend:**

- **Water Level** (Date and time shown)
- **Water Inflow**
- **Water Outflow**
- **Gradational or transitional strata**
- **Definitive or distinct strata change**

---

**Drill and Sample:**

- **Sample:** Hole Terminated at 0.80 m Practical Refusal
Silty CLAY - low to medium plasticity, grey to dark brown, some fine grained sand, root affected.

CLAY - high plasticity, grey, pale grey with some pale brown, trace of fine to coarse grained sand.

SILTSTONE - grey to pale grey, semi-fractured, estimated high strength.

Hole Terminated at 1.00 m
Becoming slow progress, some cave-in
APPENDIX B:

Results of Laboratory Testing
Shrink Swell Index Report

Sample Details

<table>
<thead>
<tr>
<th>Sample Details</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample ID:</td>
<td>NEW17W-1684--S02</td>
</tr>
<tr>
<td>Test Request No.:</td>
<td>-</td>
</tr>
<tr>
<td>Material:</td>
<td>Clay</td>
</tr>
<tr>
<td>Source:</td>
<td>On-Site</td>
</tr>
<tr>
<td>Specification:</td>
<td>No Specification</td>
</tr>
<tr>
<td>Project Location:</td>
<td>Boundary Road, Medowie, NSW</td>
</tr>
<tr>
<td>Sample Location:</td>
<td>TP102 - (0.7 - 0.85m)</td>
</tr>
<tr>
<td>Borehole Number:</td>
<td>TP102</td>
</tr>
<tr>
<td>Borehole Depth (m):</td>
<td>0.7 - 0.85</td>
</tr>
</tbody>
</table>

Swell Test

<table>
<thead>
<tr>
<th>Swell Test</th>
<th>AS 1289.7.1.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swell on Saturation (%)</td>
<td>-0.5</td>
</tr>
<tr>
<td>Moisture Content before (%)</td>
<td>32.4</td>
</tr>
<tr>
<td>Moisture Content after (%)</td>
<td>33.9</td>
</tr>
<tr>
<td>Est. Unc. Comp. Strength before (kPa):</td>
<td>280</td>
</tr>
<tr>
<td>Est. Unc. Comp. Strength after (kPa):</td>
<td>280</td>
</tr>
</tbody>
</table>

Shrink Test

<table>
<thead>
<tr>
<th>Shrink Test</th>
<th>AS 1289.7.1.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shrink on drying (%)</td>
<td>6.7</td>
</tr>
<tr>
<td>Shrinkage Moisture Content (%)</td>
<td>31.9</td>
</tr>
<tr>
<td>Est. inert material (%)</td>
<td>1.0</td>
</tr>
<tr>
<td>Crumbling during shrinkage:</td>
<td>Nil</td>
</tr>
<tr>
<td>Cracking during shrinkage:</td>
<td>Minor</td>
</tr>
</tbody>
</table>

Shrink Swell

Shrink Swell Index - Iss (%): 3.7

Comments
Shrink Swell Index Report

Client: McCloy Development Management
Suite 1 Level 3, 426 King Street
Newcastle NSW 2300

Principal:
Project No.: NEW15P-0033
Project Name: The Bower Subdivision - Stage 1

Sample Details
Sample ID: NEW17W-1684--S03
Test Request No.: -
Material: Clay
Source: On-Site
Specification: No Specification
Project Location: Boundary Road, Medowie, NSW
Sample Location: TP103 - (1.3 - 1.7m)
Borehole Number: TP103
Borehole Depth (m): 1.3 - 1.7

Shrink Test

Shrink on drying (%): 8.8
Shrinkage Moisture Content (%): 41.7
Est. inert material (%): 2.0
Crumbling during shrinkage: Nil
Cracking during shrinkage: Nil

Swell Test

Swell on Saturation (%): -0.8
Moisture Content before (%): 42.5
Moisture Content after (%): 42.2
Est. Unc. Comp. Strength before (kPa): 270
Est. Unc. Comp. Strength after (kPa): 270

Shrink Swell

Shrink Swell Index - Iss (%): 4.9

Comments
Shrink Swell Index Report

Sample Details

<table>
<thead>
<tr>
<th>Sample ID:</th>
<th>NEW17W-1684--S04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Request No.:</td>
<td>-</td>
</tr>
<tr>
<td>Material:</td>
<td>Clay</td>
</tr>
<tr>
<td>Source:</td>
<td>On-Site</td>
</tr>
<tr>
<td>Specification:</td>
<td>No Specification</td>
</tr>
<tr>
<td>Project Location:</td>
<td>Boundary Road, Medowie, NSW</td>
</tr>
<tr>
<td>Sample Location:</td>
<td>TP104 - (0.5 - 0.64m)</td>
</tr>
<tr>
<td>Borehole Number:</td>
<td>TP104</td>
</tr>
<tr>
<td>Borehole Depth (m):</td>
<td>0.5 - 0.64</td>
</tr>
</tbody>
</table>

| Client Sample ID:  | -                    |
| Sampling Method:   | AS1289.1.2.1 cl 6.5  |
| Date Sampled:      | 3/05/2017            |
| Date Submitted:    | 5/05/2017            |

Shrink Test - AS 1289.7.1.1

| Swell on Saturation (%): | -0.8 |
| Moisture Content before (%): | 38.9 |
| Moisture Content after (%): | 41.7 |
| Est. Unc. Comp. Strength before (kPa): | 230 |
| Est. Unc. Comp. Strength after (kPa): | 210 |

Shrink Test - AS 1289.7.1.1

| Shrink on drying (%): | 7.6 |
| Shrinkage Moisture Content (%): | 38.7 |
| Est. inert material (%): | 2.5 |
| Crumbling during shrinkage: | Nil |
| Cracking during shrinkage: | Minor |

Shrink Swell

Shrink Swell Index - Iss (%): 4.2

Comments
# Shrink Swell Index Report

Client: McCloy Development Management  
Suite 1 Level 3, 426 King Street  
Newcastle NSW 2300

Principal:  
Project No.: NEW15P-0033  
Project Name: The Bower Subdivision - Stage 1

## Sample Details

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Client Sample ID</th>
<th>Test Request No.</th>
<th>Sampling Method</th>
<th>Date Sampled</th>
<th>Date Submitted</th>
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<tr>
<td>NEW17W-1684--S05</td>
<td>-</td>
<td>-</td>
<td>AS1289.1.2.1 cl 6.5</td>
<td>3/05/2017</td>
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<table>
<thead>
<tr>
<th>Material</th>
<th>Source</th>
<th>Specification</th>
<th>Project Location</th>
<th>Sample Location</th>
<th>Borehole Number</th>
<th>Borehole Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>On-Site</td>
<td>No Specification</td>
<td>Boundary Road, Medowie, NSW</td>
<td>TP105 - (1.0 - 1.4m)</td>
<td>TP105</td>
<td>1.0 - 1.4</td>
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## Swell Test

<table>
<thead>
<tr>
<th>Swell on Saturation (%)</th>
<th>Moisture Content before (%)</th>
<th>Moisture Content after (%)</th>
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</thead>
<tbody>
<tr>
<td>-0.4</td>
<td>30.8</td>
<td>32.1</td>
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<table>
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<tr>
<th>Est. Unc. Comp. Strength before (kPa)</th>
<th>Est. Unc. Comp. Strength after (kPa)</th>
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<tr>
<td>190</td>
<td>190</td>
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## Shrink Test

<table>
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<tr>
<th>Shrink on drying (%)</th>
<th>Shrinkage Moisture Content (%)</th>
<th>Est. inert material (%)</th>
<th>Crumbling during shrinkage</th>
<th>Cracking during shrinkage</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.0</td>
<td>30.8</td>
<td>1.0</td>
<td>Nil</td>
<td>Nil</td>
</tr>
</tbody>
</table>

## Shrink Swell

**Shrink Swell Index - Iss (%)**: 3.9

### Comments

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# Shrink Swell Index Report

**Client:** McCloy Development Management  
Suite 1 Level 3, 426 King Street  
Newcastle NSW 2300

**Principal:**  
Project No.: NEW15P-0033  
Project Name: The Bower Subdivision - Stage 1

## Sample Details

| Sample ID: | NEW17W-1684--S06 | Client Sample ID: | - |
| Test Request No.: | - | Sampling Method: | AS1289.1.2.1 cl 6.5 |
| Material: | Clay | Date Sampled: | 3/05/2017 |
| Source: | On-Site | Date Submitted: | 5/05/2017 |
| Specification: | No Specification | |
| Project Location: | Boundary Road, Medowie, NSW | |
| Sample Location: | TP106 - (0.4 - 0.58m) | |
| Borehole Number: | TP106 | |
| Borehole Depth (m): | 0.4 - 0.58 | |

## Swell Test

**AS 1289.7.1.1**

| Swell on Saturation (%) | -1.6 |
| Moisture Content before (%) | 33.3 |
| Moisture Content after (%) | 33.4 |
| Est. Unc. Comp. Strength before (kPa): | 175 |
| Est. Unc. Comp. Strength after (kPa): | 100 |

## Shrink Test

**AS 1289.7.1.1**

| Shrink on drying (%) | 5.9 |
| Shrinkage Moisture Content (%) | 33.6 |
| Est. inert material (%) | 5.0 |
| Crumbling during shrinkage: | Nil |
| Cracking during shrinkage: | Minor |

## Shrink Swell

### Shrink Swell Index - Iss (%): 3.3

**Comments**
Shrink Swell Index Report

Client: McCloy Development Management
Suite 1 Level 3, 426 King Street
Newcastle NSW 2300

Principal:

Project No.: NEW15P-0033
Project Name: The Bower Subdivision - Stage 1

Sample Details

Sample ID: NEW17W-1684--S08
Test Request No.: -
Material: Clay
Source: On-Site
Specification: No Specification
Project Location: Boundary Road, Medowie, NSW
Sample Location: TP108 - (0.3 - 0.6m)
Borehole Number: TP108
Borehole Depth (m): 0.3 - 0.6

Swell Test - AS 1289.7.1.1

<table>
<thead>
<tr>
<th>Swell on Saturation (%)</th>
<th>Moisture Content before (%)</th>
<th>Moisture Content after (%)</th>
<th>Est. Unc. Comp. Strength before (kPa)</th>
<th>Est. Unc. Comp. Strength after (kPa)</th>
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<tbody>
<tr>
<td>-0.8</td>
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<td>39.0</td>
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Shrink Test - AS 1289.7.1.1

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<tr>
<th>Shrink on drying (%)</th>
<th>Shrinkage Moisture Content (%)</th>
<th>Est. inert material (%)</th>
<th>Crumbling during shrinkage</th>
<th>Cracking during shrinkage</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3</td>
<td>33.9</td>
<td>1.0</td>
<td>Nil</td>
<td>Nil</td>
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</tbody>
</table>

Shrink Swell

![Graph showing Shrinkage and Swell over Moisture Content]

Shrink Swell Index - Iss (%): 3.5

Comments
Shrink Swell Index Report

Client: McCloy Development Management
Suite 1 Level 3, 426 King Street
Newcastle NSW 2300

Principal: NEW15P-0033
Project Name: The Bower Subdivision - Stage 1

Sample Details
Sample ID: NEW17W-1684--S09
Test Request No.: -
Material: Clay
Source: On-Site
Specification: No Specification
Project Location: Boundary Road, Medowie, NSW
Sample Location: TP109 - (0.7 - 0.95m)
Borehole Number: TP109
Borehole Depth (m): 0.7 - 0.95

Swell Test
AS 1289.7.1.1
Swell on Saturation (%): 1.0
Moisture Content before (%): 32.4
Moisture Content after (%): 36.1
Est. Unc. Comp. Strength before (kPa): > 600
Est. Unc. Comp. Strength after (kPa): 160

Shrink Test
AS 1289.7.1.1
Shrink on drying (%): 4.0
Shrinkage Moisture Content (%): 31.6
Est. inert material (%): 2.0
Crumbling during shrinkage: Nil
Cracking during shrinkage: Minor

Shrink Swell

Shrink Swell Index - Iss (%): 2.5

Comments
Shrink Swell Index Report

Sample Details

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<tr>
<td>Material:</td>
<td>Clay</td>
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<tr>
<td>Source:</td>
<td>On-Site</td>
</tr>
<tr>
<td>Specification:</td>
<td>No Specification</td>
</tr>
<tr>
<td>Project Location:</td>
<td>Boundary Road, Medowie, NSW</td>
</tr>
<tr>
<td>Sample Location:</td>
<td>TP110 - (0.4 - 0.6m)</td>
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<tr>
<td>Borehole Number:</td>
<td>TP110</td>
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<td>Borehole Depth (m):</td>
<td>0.4 - 0.6</td>
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Shrink Test - AS 1289.7.1.1

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<th>Property</th>
<th>Value</th>
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<tr>
<td>Shrink on drying (%)</td>
<td>5.4</td>
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<tr>
<td>Shrinkage Moisture Content (%)</td>
<td>35.0</td>
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<tr>
<td>Est. inert material (%)</td>
<td>2.0</td>
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<tr>
<td>Crumbling during shrinkage</td>
<td>Nil</td>
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<tr>
<td>Cracking during shrinkage</td>
<td>Minor</td>
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Swell Test - AS 1289.7.1.1

<table>
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<th>Property</th>
<th>Value</th>
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<tbody>
<tr>
<td>Swell on Saturation (%)</td>
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<tr>
<td>Moisture Content before (%)</td>
<td>35.8</td>
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<td>Moisture Content after (%)</td>
<td>36.4</td>
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<td>Est. Unc. Comp. Strength before (kPa):</td>
<td>200</td>
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<td>Est. Unc. Comp. Strength after (kPa):</td>
<td>160</td>
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Shrink Swell Index - Iss (%): 3.0

Comments
Shrink Swell Index Report

Client: McCloy Development Management
Suite 1 Level 3, 426 King Street
Newcastle NSW 2300

Principal:
Project No.: NEW15P-0033
Project Name: The Bower Subdivision - Stage 1

Sample Details

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<tr>
<td>Source:</td>
<td>On-Site</td>
</tr>
<tr>
<td>Specification:</td>
<td>No Specification</td>
</tr>
<tr>
<td>Project Location:</td>
<td>Boundary Road, Medowie, NSW</td>
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<tr>
<td>Sample Location:</td>
<td>TP111 - (0.4 - 0.6m)</td>
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<tr>
<td>Borehole Number:</td>
<td>TP111</td>
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<td>Borehole Depth (m):</td>
<td>0.4 - 0.6</td>
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Test Request No.: -
Sampling Method: AS1289.1.2.1 cl 6.5
Date Sampled: 3/05/2017
Date Submitted: 5/05/2017

Swell Test

<table>
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<th>Parameter</th>
<th>Value</th>
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<tbody>
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<td>Swell on Saturation (%)</td>
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<td>Moisture Content before (%)</td>
<td>28.6</td>
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<tr>
<td>Moisture Content after (%)</td>
<td>31.2</td>
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<tr>
<td>Est. Unc. Comp. Strength before (kPa)</td>
<td>460</td>
</tr>
<tr>
<td>Est. Unc. Comp. Strength after (kPa)</td>
<td>360</td>
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Shrink Test

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Shrink on drying (%)</td>
<td>4.6</td>
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<tr>
<td>Shrinkage Moisture Content (%)</td>
<td>28.1</td>
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<tr>
<td>Est. inert material (%)</td>
<td>5.0</td>
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<tr>
<td>Crumbling during shrinkage</td>
<td>Nil</td>
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<tr>
<td>Cracking during shrinkage</td>
<td>Nil</td>
</tr>
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</table>

Shrink Swell

Shrink Swell Index - Iss (%): 2.6

Comments

Report No: SSI:NEW17W-1684--S11
Issue No: 1

Accredited for compliance with ISO/IEC 17025
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards

Date of Issue: 16/05/2017

NATA Accredited Laboratory Number: 18666

Qualtest Laboratory (NSW) Pty Ltd (20708)
8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4963 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

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Form No: 18932, Report No: SSI:NEW17W-1684--S11
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Shrink Swell Index Report

Client: McCloy Development Management
Suite 1 Level 3, 426 King Street
Newcastle NSW 2300

Principal:
Project No.: NEW15P-0033
Project Name: The Bower Subdivision - Stage 1

Sample Details
Sample ID: NEW17W-1684--S12
Test Request No.: -
Material: Clay
Source: On-Site
Specification: No Specification
Project Location: Boundary Road, Medowie, NSW
Sample Location: TP112 - (0.6 - 0.8m)
Borehole Number: TP112
Borehole Depth (m): 0.6 - 0.8

Swell Test
AS 1289.7.1.1
Swell on Saturation (%): -0.2
Moisture Content before (%): 24.3
Moisture Content after (%): 26.7
Est. Unc. Comp. Strength before (kPa): 275
Est. Unc. Comp. Strength after (kPa): 260

Shrink Test
AS 1289.7.1.1
Shrink on drying (%): 2.5
Shrinkage Moisture Content (%): 22.4
Est. inert material (%): 0%
Crumbling during shrinkage: Nil
Cracking during shrinkage: Moderate

Shrink Swell
Shrink Swell Index - Iss (%): 1.4

Comments
Shrink Swell Index Report

Sample Details

Sample ID: NEW17W-1684--S16
Test Request No.: -
Material: Clay
Source: On-Site
Specification: No Specification
Project Location: Boundary Road, Medowie, NSW
Sample Location: TP116 - (0.5 - 0.7m)
Borehole Number: TP116
Borehole Depth (m): 0.5 - 0.7

Swell Test

<table>
<thead>
<tr>
<th>Moisture Content before (%)</th>
<th>Swell on Saturation (%)</th>
</tr>
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<tbody>
<tr>
<td>32.5</td>
<td>-0.4</td>
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<tr>
<td>Moisture Content after (%)</td>
<td>37.1</td>
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<tr>
<td>Est. Unc. Comp. Strength before (kPa): 250</td>
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<tr>
<td>Est. Unc. Comp. Strength after (kPa): 210</td>
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Shrink Test

<table>
<thead>
<tr>
<th>Moisture Content before (%)</th>
<th>Shrink on drying (%)</th>
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</thead>
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<tr>
<td>Crumbling during shrinkage:</td>
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<tr>
<td>Cracking during shrinkage:</td>
<td>Nil</td>
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Shrink Swell Index - Iss (%): 4.0

Comments
Material Test Report

Client: McCloy Development Management
Suite 1 Level 3, 426 King Street
Newcastle NSW 2300

Principal:
Project No.: NEW15P-0033
Project Name: The Bower Subdivision - Stage 1

Sample Details
Sample ID: NEW17W-1684--S01
Sampling Method: AS1289.1.2.1 cl 6.5
Date Sampled: 03/05/2017
Source: On-Site
Material: Clay
Specification: No Specification
Project Location: Boundary Road, Medowie, NSW
Sample Location: TP101 - (1.0 - 1.4m)

Test Results

<table>
<thead>
<tr>
<th>Description</th>
<th>Method</th>
<th>Result</th>
<th>Limits</th>
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<tbody>
<tr>
<td>Sample History</td>
<td>AS 1289.1.1</td>
<td>Air-dried</td>
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</tr>
<tr>
<td>Preparation</td>
<td>AS 1289.1.1</td>
<td>Dry Sieved</td>
<td></td>
</tr>
<tr>
<td>Linear Shrinkage (%)</td>
<td>AS 1289.3.4.1</td>
<td>11.0</td>
<td>250</td>
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<tr>
<td>Mould Length (mm)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Crumbling</td>
<td></td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Curling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cracking</td>
<td></td>
<td>Yes</td>
<td></td>
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<tr>
<td>Liquid Limit (%)</td>
<td>AS 1289.3.1.1</td>
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<td>4</td>
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<tr>
<td>Method</td>
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<td>Four Point</td>
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<tr>
<td>Plastic Limit (%)</td>
<td>AS 1289.3.2.1</td>
<td>24</td>
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<td>Plasticity Index (%)</td>
<td>AS 1289.3.3.1</td>
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Comments
N/A
Material Test Report

Client: McCloy Development Management  
Suite 1 Level 3, 426 King Street  
Newcastle NSW 2300

Principal:  
Project No.: NEW15P-0033  
Project Name: The Bower Subdivision - Stage 1

Sample Details
Sample ID: NEW17W-1684--S07  
Client Sample ID: -  
Sampling Method: AS1289.1.2.1 cl 6.5  
Date Sampled: 03/05/2017  
Source: On-Site  
Material: Clay  
Specification: No Specification  
Project Location: Boundary Road, Medowie, NSW  
Sample Location: TP107 - (0.6 - 0.75m)

Test Results

<table>
<thead>
<tr>
<th>Description</th>
<th>Method</th>
<th>Result</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample History</td>
<td>AS 1289.1.1</td>
<td>Air-dried</td>
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<tr>
<td>Preparation</td>
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<tr>
<td>Linear Shrinkage (%)</td>
<td>AS 1289.3.4.1</td>
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<tr>
<td>Mould Length (mm)</td>
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<tr>
<td>Crumbling</td>
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<tr>
<td>Curling</td>
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<td>Plasticity Index (%)</td>
<td>AS 1289.3.3.1</td>
<td>62</td>
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Comments
N/A
# Material Test Report

**Client:** McCloy Development Management  
**Suite 1 Level 3, 426 King Street  
Newcastle NSW 2300**

**Principal:**  
**Project No.:** NEW15P-0033  
**Project Name:** The Bower Subdivision - Stage 1

## Sample Details

<table>
<thead>
<tr>
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<td><strong>Sampling Method:</strong></td>
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<tr>
<td><strong>Date Sampled:</strong></td>
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<tr>
<td><strong>Source:</strong></td>
</tr>
<tr>
<td><strong>Material:</strong></td>
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<tr>
<td><strong>Specification:</strong></td>
</tr>
<tr>
<td><strong>Project Location:</strong></td>
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<tr>
<td><strong>Sample Location:</strong></td>
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## Test Results

<table>
<thead>
<tr>
<th>Description</th>
<th>Method</th>
<th>Result</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample History</td>
<td>AS 1289.1.1</td>
<td>Air-dried</td>
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<tr>
<td>Preparation</td>
<td>AS 1289.1.1</td>
<td>Dry Sieved</td>
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<tr>
<td>Linear Shrinkage (%)</td>
<td>AS 1289.3.4.1</td>
<td>13.0</td>
<td>250</td>
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<tr>
<td>Mould Length (mm)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Crumbling</td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Curling</td>
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## Comments

N/A
Material Test Report

Client:  McCloy Development Management
        Suite 1 Level 3, 426 King Street
        Newcastle  NSW  2300

Principal:  
Project No.:  NEW15P-0033
Project Name:  The Bower Subdivision - Stage 1

Sample Details
Sample ID:  NEW17W-1684--S14
Client Sample ID:  -
Sampling Method:  AS1289.1.2.1 cl 6.5
Date Sampled:  03/05/2017
Source:  On-Site
Material:  Clay
Specification:  No Specification
Project Location:  Boundary Road, Medowie, NSW
Sample Location:  TP114 - (0.2 - 0.4m)

Test Results

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Comments
N/A
Material Test Report

Client: McCloy Development Management
Suite 1 Level 3, 426 King Street
Newcastle NSW 2300

Principal: 
Project No.: NEW15P-0033
Project Name: The Bower Subdivision - Stage 1

Sample Details

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Test Results

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<td>Mould Length (mm)</td>
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<td>Crumbling</td>
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Comments

N/A
Shrink Swell Index Report

Client: McCloy Medowie Pty Ltd
Suite 1 Level 3, 426 King Street
Newcastle NSW 2300

Principal:

Project No.: NEW15P-0033
Project Name: Proposed Subdivision - Boundary Road, Medowie

Sample Details
Sample ID: NEW15W-2564--S18
Test Request No.: -
Material: Clay
Source: On-Site
Specification: No Specification
Project Location: Medowie, NSW
Sample Location: TPQ41 - (0.35 - 0.50m)
Borehole Number: TPQ41
Borehole Depth (m): 0.35 to 0.50m

Swell Test
Swell on Saturation (%): -0.1
Moisture Content before (%): 24.9
Moisture Content after (%): 25.5
Est. Unc. Comp. Strength before (kPa): 400
Est. Unc. Comp. Strength after (kPa): 260

Shrink Test
Shrink on drying (%): 5.1
Shrinkage Moisture Content (%): 27.9
Est. inert material (%): 1
Crumbling during shrinkage: Nil
Cracking during shrinkage: Major

Shrink Swell
Shrink Swell Index - Iss (%): 2.8

Comments
Shrink Swell Index Report

Report No: SSI:NEW15W-2564--S19

Client: McCloy Medowie Pty Ltd
Suite 1 Level 3, 426 King Street
Newcastle NSW 2300

Principal:

Project No.: NEW15P-0033
Project Name: Proposed Subdivision - Boundary Road, Medowie

Sample Details

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<td>Borehole Depth (m):</td>
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</table>

Shrink Test

AS 1289.7.1.1

| Shrink on drying (%) | 9.6 |
| Shrinkage Moisture Content (%) | 38.8 |
| Est. inert material (%) | 1 |
| Crumbling during shrinkage | Nil |
| Cracking during shrinkage | Minor |

Swell Test

AS 1289.7.1.1

| Swell on Saturation (%) | -0.2 |
| Moisture Content before (%) | 39.6 |
| Moisture Content after (%) | 42.3 |
| Est. Unc. Comp. Strength before (kPa) | 200 |
| Est. Unc. Comp. Strength after (kPa) | 120 |

Shrink Swell Index - Iss (%): 5.3

Comments
Shrink Swell Index Report

Client: McCloy Medowie Pty Ltd
Suite 1 Level 3, 426 King Street
Newcastle NSW 2300

Principal:

Project No.: NEW15P-0033
Project Name: Proposed Subdivision - Boundary Road, Medowie

Sample Details
Sample ID: NEW15W-2564--S08
Test Request No.: -
Material: Clay
Source: On-Site
Specification: No Specification
Project Location: Medowie, NSW
Sample Location: TPQ43 - (0.3 - 0.45m)
Borehole Number: TPQ43
Borehole Depth (m): 0.3 to 0.45m

Shrink Test AS 1289.7.1.1
Shrink on drying (%): 10.8
Shrinkage Moisture Content (%): 42.8
Est. inert material (%): 1
Crumbling during shrinkage: Nil
Cracking during shrinkage: Nil

Swell Test AS 1289.7.1.1
Swell on Saturation (%): -0.4
Moisture Content before (%): 44.1
Moisture Content after (%): 45.4
Est. Unc. Comp. Strength before (kPa): 170
Est. Unc. Comp. Strength after (kPa): 150

Shrink Swell Index - Iss (%): 6.0

Comments

Accredited for compliance with ISO/IEC 17025
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards

NATA Accredited Laboratory Number: 18686
Date of Issue: 2/12/2015
APPENDIX C:

CSIRO Sheet BTF 18

Foundation Maintenance and Footing Performance: A Homeowner’s Guide
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.

Building Maintenance and Footing Performance: A Homeowner’s Guide
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.

<table>
<thead>
<tr>
<th>Class</th>
<th>Foundation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Most sand and rock sites with little or no ground movement from moisture changes</td>
</tr>
<tr>
<td>S</td>
<td>Slightly reactive clay sites with only slight ground movement from moisture changes</td>
</tr>
<tr>
<td>M</td>
<td>Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes</td>
</tr>
<tr>
<td>H</td>
<td>Highly reactive clay sites, which can experience high ground movement from moisture changes</td>
</tr>
<tr>
<td>E</td>
<td>Extremely reactive sites, which can experience extreme ground movement from moisture changes</td>
</tr>
<tr>
<td>A to P</td>
<td>Filled sites</td>
</tr>
<tr>
<td>P</td>
<td>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</td>
</tr>
</tbody>
</table>
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.

Doming and dishing are also affected by weather in other ways. Areas 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 fail 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 grate 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**

<table>
<thead>
<tr>
<th>Description of typical damage and required repair</th>
<th>Approximate crack width limit (see Note 3)</th>
<th>Damage category</th>
</tr>
</thead>
<tbody>
<tr>
<td>H airline cracks</td>
<td>&lt;0.1 mm</td>
<td>0</td>
</tr>
<tr>
<td>Fine cracks which do not need repair</td>
<td>&lt;1 mm</td>
<td>1</td>
</tr>
<tr>
<td>Cracks noticeable but easily filled. Doors and windows stick slightly</td>
<td>&lt;5 mm</td>
<td>2</td>
</tr>
<tr>
<td>Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weather tightness often impaired</td>
<td>5–15 mm (or a number of cracks 3 mm or more in one group)</td>
<td>3</td>
</tr>
<tr>
<td>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</td>
<td>15–25 mm but also depend on number of cracks</td>
<td>4</td>
</tr>
</tbody>
</table>
The development of other problems, notably cracking in buildings, should be noted. Subfloor moisture can significantly slow the process of drying 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.

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 noted 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.

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.