Appendix D:
Foundation Laboratory Testing
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Annexure DD  Direct Shear Tests - TriLabs
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Annexure DF  CIU Triaxial Tests – Trilabs
Annexure DG  Oedometer Consolidation Tests
Annexure DH  CRS Consolidation Tests
Annexure DI  Miscellaneous Tests
Annexure DJ  Laboratory Test Procedures
D1. Introduction

This appendix provides details on the engineering properties of the foundation and fill materials described in Appendix C. The engineering properties are largely based on the results of laboratory tests undertaken as part of the ITRB investigations, supplemented by other testing which includes:

- Previous laboratory investigations;
- Laboratory investigations undertaken in parallel to the ITRB investigations; and
- Limited field testing.

The scope of testing and a summary of the results of the testing are provided in the following sections while details of test procedures and test certificates are provided in the annexures to this appendix.

D2. ITRB Laboratory Testing

D2.1 Overview

ITRB investigations for the Cadia NTSF embankment failure are discussed in Appendix C. Samples collected as part of these investigations included:

- Disturbed samples;
- Undisturbed block samples;
- Thin walled undisturbed samples, 63mm diameter; and
- Lexan undisturbed samples, 100mm diameter.

Testing of selected samples of foundation and construction materials from these investigations was undertaken by:

- Trilab – Brisbane, Qld
- Golder – Perth, WA
- Fugro – Perth, WA
- Microanalysis – Perth, WA
- Hensel Geosciences – Mudgeeraba, Qld
- Consultant Palynological Services – Canberra, ACT

The type and number of tests completed by each organization is shown in Table D2-1.
Table D2-1: Type and number of tests completed by laboratory

<table>
<thead>
<tr>
<th>Test</th>
<th>Trilab - Brisbane</th>
<th>Golder - Perth</th>
<th>Fugro - Perth</th>
<th>Microanalysis - Perth</th>
<th>Hensel Geoscience</th>
<th>Palynological Services</th>
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<tbody>
<tr>
<td>Atterberg Limits</td>
<td>25</td>
<td>8</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear Shrinkage</td>
<td>23</td>
<td>8</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrometer / PSD</td>
<td>22</td>
<td>8</td>
<td>3</td>
<td></td>
<td></td>
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<tr>
<td>Specific Gravity</td>
<td>13</td>
<td>9</td>
<td>3</td>
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<tr>
<td>Bulk Density</td>
<td>4</td>
<td>2</td>
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</tr>
<tr>
<td>Standard Compaction</td>
<td>1</td>
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<td>3</td>
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<tr>
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<td></td>
<td></td>
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<tr>
<td>Direct Shear Test</td>
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<tr>
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<td>Direct Simple Shear (DSS) - Undisturbed</td>
<td></td>
<td>17</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DSS - Remoulded</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>CIU Triaxial – Single Stage</td>
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<td>9</td>
<td></td>
<td></td>
<td>3</td>
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<tr>
<td>CIU Triaxial – Multi Stage</td>
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<tr>
<td>X-Ray Diffraction – Semi Quantitative</td>
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<tr>
<td>Petrographic Analysis</td>
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<td></td>
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</tr>
<tr>
<td>Age Determination by Palynology</td>
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</tbody>
</table>
Table D2-2 provides a breakdown of tests according to material type.

<table>
<thead>
<tr>
<th>Test</th>
<th>Residual Basalt</th>
<th>Paleoc Alluvium</th>
<th>Unit A – Forest Reef Volcanics</th>
<th>Unit B – Forest Reef Volcanics</th>
<th>Forest Reef Volcanics Bedrock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atterberg Limits</td>
<td>4</td>
<td>8</td>
<td>13</td>
<td>12</td>
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</tr>
<tr>
<td>Linear Shrinkage</td>
<td>4</td>
<td>8</td>
<td>13</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Hydrometer / PSD</td>
<td>4</td>
<td>5</td>
<td>14</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>3</td>
<td>4</td>
<td>13</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Bulk Density</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
</tr>
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<td>Organic Content (Loss on Ignition)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Standard Compaction</td>
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<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Oedometer Consolidation</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant Rate of Strain Consolidation</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Direct Shear Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct Simple Shear (DSS) - Undisturbed</td>
<td>6</td>
<td>5</td>
<td>9</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>DSS - Remoulded</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CIU Triaxial – Single Stage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIU Triaxial – Multi Stage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>X-Ray Diffraction – Semi Quantitative</td>
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<td>3</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Petrographic Analysis</td>
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<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Age Determination by Palynology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>
D2.2 Test Details

D2.2.1 Test Methods

Where available, tests were completed to Australian Standards (AS) and these are listed below.

- Moisture Content AS1289.2.1.1
- Atterberg Limits AS1289.3.1.1, .3.2.1, .3.3.1
- Linear shrinkage AS1289.3.4.1
- Particle size distribution by wash sieving AS1289.3.6.1
- Particle size distribution by hydrometer AS1289.3.6.3
- Specific gravity AS1289.3.5.2
- Bulk density AS1289.6.4.1
- Standard Compaction AS1289.5.1.1
- Oedometer consolidation AS1289.6.6.1
- Direct Shear AS1289.6.2.2
- Isotropically Consolidated Undrained (CIU) Triaxial AS1289.6.4.2

Procedures adopted for advanced testing of foundation materials are included in Annexure DJ. The procedures adopted were often specific to the laboratory undertaking the testing but were generally in accordance with the American Society for Testing and Materials (ASTM). Applicable ASTM standards are:

- D4767 Consolidated undrained triaxial compression (CIU)
- D6528 Consolidated undrained direct simple shear (DSS)
- D4186 Controlled Strain Loading Oedometer (CRS)
- D6467 Torsional Ring Shear (RS)

Standards were not used for petrographic analysis or age determination by palynology.

D2.2.2 Test Certificates

Certificates for various tests undertaken by the ITRB are provided in annexures to this report.

D3. Other Laboratory Testing

D3.1 Pre-Construction Testing

Prior to the construction of the NTSF, laboratory testing of soil samples from the investigations was limited and included the following:

- Atterberg Limits;
- Particle Size Distributions;
- Emerson Class;
- Moisture density tests (Standard Compaction);
- Consolidated undrained (CIU) triaxial tests on 4 re-compacted samples; and
- Constant head permeability tests on 4 samples.
Three CIU triaxial tests, completed on re-compacted specimens from the 2000 investigations for the STSF, were subsequently incorporated into the NTSF data base.

Results of the pre-construction testing are included in references 1995-001, 1997-001 and 1997-002. (Appendix J)

D3.2 Construction Testing
During construction, soil index tests and compaction tests were undertaken on low permeability materials as part of the Quality Assurance (QA) for the various stages of the NTSF. Particle size distribution tests were also completed on Stage 1 filter materials. No QA testing was completed on rockfill materials.

In general, only summaries of these data are provided in construction reports. Results for Stages 1 and 2 of the NTSF are included in references 1998-001, 2000-002, 2002-001 and 2003-001 (Appendix K).

D3.3 Supplementary Testing

D3.3.1 ATC Williams
ATC Williams (ATCW) recovered undisturbed samples of foundation materials at five (5) locations around the perimeter of the NTSF and STSF (reference 2018-005, Appendix K). Although the samples were taken in mid-February 2018, results of laboratory testing was not available until July 2018.

The testing included:

- Atterberg Limits;
- Particle size distribution (by hydrometer);
- Oedometer consolidation tests on 3 samples; and
- Anisotropically consolidated triaxial compression tests (CAU) on 4 samples.

D3.3.2 GHD
Following the NTSF embankment failure, GHD were engaged by Newcrest to assist CVO in minimizing the impacts of the failure (containment) and resuming production through a resumption in tailings emplacement in the STSF. As part of these activities GHD drilled nineteen (19) investigation holes and undertook laboratory testing that included:

- Atterberg Limits;
- Particle Size Distributions;
- Emerson Class;
- Consolidated undrained (CIU) triaxial tests;
- Unconsolidated undrained (UU) triaxial tests;
- Direct shear tests, and
- Oedometer consolidation tests.

D3.4 Test Certificates
Test certificates for the previous and supplementary testing are included in the relevant references and are not reproduced in this appendix. Results are incorporated in the following sections where they are deemed to be both relevant and of an appropriate quality.
D4. Foundation Properties

D4.1 Foundation Materials

The geological units intersected in the immediate vicinity of the NTSF slump are highlighted on Figure D4-1. The field characteristics of these units are discussed in Appendix C, while the engineering properties will be presented in the following sections.

Figure D4-1: Geological units intersected at NTSF slump

D4.2 Residual Basalt

D4.2.1 Index Tests

Atterberg Limit and index tests completed on four samples of residual basaltic soil are summarised in Table D4-1. Atterberg Limits are plotted on Figure D4-2.

<table>
<thead>
<tr>
<th>Hole No.</th>
<th>Depth Range (m)</th>
<th>Atterberg Limits</th>
<th>Linear Shrinkage (%)</th>
<th>Field Moisture (%)</th>
<th>Dry Density (t/m³)</th>
<th>Specific Gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE411</td>
<td>3.00 3.45</td>
<td>59 21 38</td>
<td>15.0</td>
<td>30.3</td>
<td>1.52</td>
<td>2.79</td>
</tr>
<tr>
<td>CE412</td>
<td>39.50 39.72</td>
<td>81 37 44</td>
<td>1.5</td>
<td>48.5</td>
<td></td>
<td>2.55</td>
</tr>
<tr>
<td>CE413</td>
<td>53.50 53.80</td>
<td>39 15 24</td>
<td>12.5</td>
<td>20.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP401</td>
<td>0.70 1.00</td>
<td>53 20 33</td>
<td>14.5</td>
<td>21.7</td>
<td>1.76</td>
<td>2.80</td>
</tr>
</tbody>
</table>

Table D4-1: Residual Basalt - Atterberg Limits and Index Tests
D4.2.2 Direct Simple Shear Tests

Direct simple shear tests were completed on two samples of residual basaltic soil. These test results are summarized in Table D4-2.

Table D4-2: Residual Basalt – Undrained shear strength data

<table>
<thead>
<tr>
<th>Sample No</th>
<th>Depth (m)</th>
<th>Consol. Stress (kPa)</th>
<th>Dry Density (kN/m3)</th>
<th>Shear Strength Peak (kPa)</th>
<th>Post Peak (kPa)</th>
<th>SS Ratio Peak</th>
<th>SS Ratio Post Peak</th>
<th>Test Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP401</td>
<td>0.70 – 1.00</td>
<td>400</td>
<td>1.76</td>
<td>270</td>
<td>270</td>
<td>0.68</td>
<td>0.68</td>
<td>G/DSS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>800</td>
<td>1.76</td>
<td>277</td>
<td>219</td>
<td>0.35</td>
<td>0.27</td>
<td>G/DSS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1200</td>
<td>1.77</td>
<td>408</td>
<td>372</td>
<td>0.34</td>
<td>0.31</td>
<td>G/DSS</td>
</tr>
<tr>
<td>CE411</td>
<td>3.00 – 3.45</td>
<td>400</td>
<td>1.52</td>
<td>114</td>
<td>110</td>
<td>0.29</td>
<td>0.28</td>
<td>F/DSS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>800</td>
<td>1.50</td>
<td>209</td>
<td>198</td>
<td>0.26</td>
<td>0.25</td>
<td>F/DSS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1200</td>
<td>1.54</td>
<td>332</td>
<td>306</td>
<td>0.28</td>
<td>0.26</td>
<td>F/DSS</td>
</tr>
</tbody>
</table>

The peak mobilized friction ($\phi_m'$) from the DSS tests was 15.2° and 16.5° for CE411A and TP401 respectively, while the post peak mobilized friction at 25% strain ranged between 14.4° and 15.9°.

Shear stress versus vertical effective stress determined from the two DSS tests is plotted on Figure D4-3.
D4.2.3 Consolidation Tests

One oedometer consolidation test was completed on residual basalt. The sample was loaded to 400kPa, unloaded to 100kPa, reloaded to 3200kPa, then unloaded to 25kPa. The results are presented in Figure D4-4 as a void ratio / vertical effective stress plot and summarized in Table D4-3.
Table D4-3: Residual Basalt - Summary of consolidation test data

<table>
<thead>
<tr>
<th>ID</th>
<th>Depth (m)</th>
<th>RL</th>
<th>$\gamma_d$ (t/m$^3$)</th>
<th>$w$ (%)</th>
<th>$e_o$</th>
<th>Cr</th>
<th>$C_c$</th>
<th>$\sigma_p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE411</td>
<td>3.13 - 3.18</td>
<td>686.89</td>
<td>1.52</td>
<td>26.2</td>
<td>0.824</td>
<td>0.021</td>
<td>0.180</td>
<td>70</td>
</tr>
</tbody>
</table>

The apparent pre-consolidation pressure ($\sigma_p$) indicated in Table D4-3 was calculated using the Casagrande Method.

D4.3 Paleo Alluvium

D4.3.1 Index Tests

Atterberg Limit and index tests completed on nine samples of paleo alluvium are summarised in Table D4-4.

Samples CE417 18.50 to 19.00 and 19.50 to 20.00, were described as high plasticity, black CLAY with some organic matter. The organic content of CE417 18.50 to 19.00 was determined as 7.1% based on Loss on Ignition.

Atterberg Limits are plotted on Figure D4-5.

Table D4-4: Paleo Alluvium - Atterberg Limits and Index Tests

<table>
<thead>
<tr>
<th>Hole No.</th>
<th>Depth Range (m)</th>
<th>Atterberg Limits</th>
<th>Linear Shrinkage (%)</th>
<th>Field Moisture (%)</th>
<th>Dry Density (t/m$^3$)</th>
<th>Specific Gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>From To</td>
<td>LL</td>
<td>PL</td>
<td>PI</td>
<td>Linear Shrinkage</td>
<td>Field Moisture</td>
</tr>
<tr>
<td>CE406</td>
<td>18.40 18.50</td>
<td>71</td>
<td>24</td>
<td>47</td>
<td>19.0</td>
<td>27.5</td>
</tr>
<tr>
<td>CE411A</td>
<td>12.50 12.95</td>
<td>53</td>
<td>27</td>
<td>26</td>
<td>12.0</td>
<td>25.8</td>
</tr>
<tr>
<td>CE411A</td>
<td>14.50 15.00</td>
<td>53</td>
<td>25</td>
<td>28</td>
<td>12.0</td>
<td>25.7</td>
</tr>
<tr>
<td>CE411A</td>
<td>15.00 15.35</td>
<td>54</td>
<td>27</td>
<td>27</td>
<td>11.5</td>
<td>28.4</td>
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<td>21.85 21.90</td>
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<td>22.0</td>
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<td>61</td>
<td>24</td>
<td>36</td>
<td>12.5</td>
<td>27.4</td>
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<td>18.50 19.00</td>
<td>80</td>
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<td>48</td>
<td>19.0</td>
<td>42.3</td>
</tr>
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<td>19.50 20.00</td>
<td>58</td>
<td>22</td>
<td>36</td>
<td>13.0</td>
<td>34.9</td>
</tr>
<tr>
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<td>20.80 20.85</td>
<td>48</td>
<td>19</td>
<td>29</td>
<td>13.0</td>
<td>26.3</td>
</tr>
</tbody>
</table>
**D4.3.2 Strength Data**

Direct simple shear tests and CIU triaxial tests were completed on five samples of paleo alluvium. Undrained shear strength data are summarized in Table D4-5.

**Table D4-5: Paleo Alluvium – Undrained shear strength data**

<table>
<thead>
<tr>
<th>Sample No</th>
<th>Depth (m)</th>
<th>Consol. Stress (kPa)</th>
<th>Dry Density (kN/m³)</th>
<th>Shear Strength</th>
<th>SS Ratio</th>
<th>Test Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE411A</td>
<td>14.50 – 15.00</td>
<td>398</td>
<td>1.64</td>
<td>234</td>
<td>0.59</td>
<td>T/CIU M</td>
</tr>
<tr>
<td></td>
<td></td>
<td>786</td>
<td></td>
<td>412</td>
<td>0.52</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1194</td>
<td></td>
<td>595</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>387</td>
<td>0.32</td>
<td></td>
</tr>
<tr>
<td>CE411A</td>
<td>15.00 – 15.35</td>
<td>400</td>
<td>1.58</td>
<td>162</td>
<td>0.41</td>
<td>F/DSS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>800</td>
<td></td>
<td>301</td>
<td>0.38</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1200</td>
<td></td>
<td>389</td>
<td>0.32</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>376</td>
<td>0.32</td>
<td></td>
</tr>
<tr>
<td>CE417</td>
<td>16.50 - 16.86</td>
<td>1000</td>
<td>1.49</td>
<td>438</td>
<td>0.44</td>
<td>G/DSS</td>
</tr>
<tr>
<td>CE417</td>
<td>18.50 – 19.00</td>
<td>194</td>
<td>1.22</td>
<td>135</td>
<td>0.70</td>
<td>T/CIU M</td>
</tr>
<tr>
<td></td>
<td></td>
<td>394</td>
<td></td>
<td>198</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>799</td>
<td></td>
<td>260</td>
<td>0.33</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>119</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>CE417</td>
<td>19.50 – 20.00</td>
<td>1000</td>
<td>1.46</td>
<td>302</td>
<td>0.30</td>
<td>G/DSS</td>
</tr>
</tbody>
</table>
The data in Table D4-5 indicates a minimal reduction in post peak strength for DSS tests, while triaxial tests in both the inorganic and organic paleo alluvium exhibit a substantial reduction in post peak strength. A plot of undrained shear strength ratio vs consolidation stress provided as Figure D4-6 indicates the undrained shear strength ratio in DSS tests is approximately 70% of that measured in triaxial tests.

**Figure D4-6: Paleo Alluvium – Undrained shear strength ratio vs consolidation stress**

MIT stress paths for CIU triaxial tests are graphed on Figure D4-7, together with effective stress, strength parameters calculated for the triaxial tests.

**Figure D4-7: Paleo Alluvium – MIT stress paths & effective stress strength parameters**
D4.3.3 Consolidation Tests

Three oedometer consolidation tests were completed on undisturbed samples of paleo-alluvium. The samples were loaded to 400kPa, unloaded to 100kPa, reloaded to 3200kPa, then, in the case of one sample, unloaded to 25kPa. The results are presented in Figure D4-8 as a void ratio / $p'$ plot and summarized in Table D4-6.

The void ratio and compression index of the organic clay (CE417 18.50 – 19.00) is substantially higher than that of the two ‘remaining samples.

![Figure D4-8: Paleo Alluvium – Oedometer consolidation plots](image)

![Table D4-6: Paleo Alluvium -Summary of consolidation test data](table)

<table>
<thead>
<tr>
<th>ID</th>
<th>Depth</th>
<th>RL</th>
<th>$γ_d$ (t/m3)</th>
<th>w (%)</th>
<th>eo</th>
<th>Cr</th>
<th>Cc</th>
<th>$σ'_p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE411A</td>
<td>12.91 – 12.95</td>
<td>677.09</td>
<td>1.52</td>
<td>25.8</td>
<td>0.786(1)</td>
<td>0.040</td>
<td>0.210</td>
<td>580</td>
</tr>
<tr>
<td>CE411A</td>
<td>14.50 – 15.00</td>
<td>675.00</td>
<td>1.56</td>
<td>26.0</td>
<td>0.732</td>
<td>0.030</td>
<td>0.125</td>
<td>425</td>
</tr>
<tr>
<td>CE417</td>
<td>18.50 – 19.00</td>
<td>681.58</td>
<td>1.20</td>
<td>45.5</td>
<td>1.077</td>
<td>0.045</td>
<td>0.380</td>
<td>675</td>
</tr>
</tbody>
</table>

The apparent pre-consolidation pressure ($σ'_p$) indicated in Table D4-6 was calculated using the Casagrande Method.
D4.4 Unit A - Forest Reef Volcanics

D4.4.1 Index Tests

Atterberg Limit and index tests completed on eleven samples of Unit A of the Forest Reef Volcanics (FRV) are summarised in Table D4-7.

Table D4-7: Unit A FRV - Atterberg Limits and Index Tests

<table>
<thead>
<tr>
<th>Hole No.</th>
<th>Depth Range (m)</th>
<th>Atterberg Limits</th>
<th>Linear Shrinkage (%)</th>
<th>Field Moisture (%)</th>
<th>Dry Density (t/m3)</th>
<th>Specific Gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>From  To</td>
<td>LL</td>
<td>PL</td>
<td>PI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE411A</td>
<td>16.00 16.50</td>
<td>61</td>
<td>31</td>
<td>30</td>
<td>12.5</td>
<td>37.7</td>
</tr>
<tr>
<td>CE415</td>
<td>4.12 4.30</td>
<td>52</td>
<td>33</td>
<td>19</td>
<td>8.5</td>
<td>38.4</td>
</tr>
<tr>
<td>CE415</td>
<td>6.00 6.50</td>
<td>56</td>
<td>31</td>
<td>25</td>
<td>9.0</td>
<td>43.8</td>
</tr>
<tr>
<td>CE416</td>
<td>23.00 23.50</td>
<td>59</td>
<td>28</td>
<td>31</td>
<td>12.0</td>
<td>27.7</td>
</tr>
<tr>
<td>CE416</td>
<td>24.00 24.33</td>
<td>63</td>
<td>26</td>
<td>37</td>
<td>11.5</td>
<td>25.6</td>
</tr>
<tr>
<td>CE416</td>
<td>24.50 25.00</td>
<td>73</td>
<td>33</td>
<td>40</td>
<td>13.0</td>
<td>34</td>
</tr>
<tr>
<td>CE416</td>
<td>25.00 25.50</td>
<td>67</td>
<td>32</td>
<td>35</td>
<td>14.0</td>
<td>39.3</td>
</tr>
<tr>
<td>CE416</td>
<td>25.50 25.95</td>
<td>60</td>
<td>29</td>
<td>31</td>
<td>11.0</td>
<td>38.7</td>
</tr>
<tr>
<td>CE416</td>
<td>26.50 27.00</td>
<td>64</td>
<td>30</td>
<td>34</td>
<td>14.5</td>
<td>38.4</td>
</tr>
<tr>
<td>CE416</td>
<td>27.00 27.45</td>
<td>67</td>
<td>25</td>
<td>41</td>
<td>13.0</td>
<td>37.9</td>
</tr>
<tr>
<td>CE417</td>
<td>24.00 24.30</td>
<td>55</td>
<td>28</td>
<td>27</td>
<td>10.5</td>
<td>35.9</td>
</tr>
<tr>
<td>CE417</td>
<td>25.90 26.00</td>
<td>54</td>
<td>30</td>
<td>24</td>
<td>9.0</td>
<td>36</td>
</tr>
<tr>
<td>PL01</td>
<td>0.00 0.50</td>
<td>51</td>
<td>25</td>
<td>26</td>
<td>13.5</td>
<td>33.5</td>
</tr>
</tbody>
</table>

The following graphs are provided for the various index tests.

Atterberg Limits are plotted on Figure D4-9.

Particle size distributions are plotted on Figure D4-10

Figure D4-11 is a graph of the initial dry density of Unit A samples with depth. The dry density of Unit A samples is typically below 1.40t/m³ although there are some isolated samples with higher values.

Figure D4-12 is a graph of the initial void ratio of Unit A samples (open circles) and ‘as tested’ void ratio (closed circles) against confining stress.
Figure D4-9: Unit A FRV – Plasticity Chart

Figure D4-10: Unit A FRV – Particle Size Distributions
Figure D4-11: Unit A FRV – Initial dry density vs depth
Figure D4-12: Unit A FRV – Initial & tested void ratio vs vertical stress
### D4.4.2 Strength Data

Direct simple shear tests and CIU triaxial tests were completed on eight samples of FRV Unit A while direct shear tests and one ring shear test were completed on a remoulded sample of FRV Unit A.

Undrained shear strength data is summarized in Table D4-8.

#### Table D4-8: Unit A FRV– Undrained shear strength data

<table>
<thead>
<tr>
<th>Sample No</th>
<th>Depth (m)</th>
<th>Consol. Stress (kPa)</th>
<th>Dry Density (kN/m³)</th>
<th>Shear Strength</th>
<th>SS Ratio</th>
<th>Test Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Peak</td>
<td>Post Peak</td>
<td>Peak</td>
</tr>
<tr>
<td>CE415</td>
<td>6.00 – 6.50</td>
<td>600</td>
<td>1.33</td>
<td>225</td>
<td>200</td>
<td>0.38</td>
</tr>
<tr>
<td>CE415</td>
<td></td>
<td>1000</td>
<td>1.36</td>
<td>275</td>
<td>195</td>
<td>0.28</td>
</tr>
<tr>
<td>CE415</td>
<td></td>
<td>1000</td>
<td>1.28</td>
<td>395</td>
<td>223</td>
<td>0.40</td>
</tr>
<tr>
<td>CE416</td>
<td>23.00 – 23.50</td>
<td>400</td>
<td>1.57</td>
<td>222</td>
<td></td>
<td>0.56</td>
</tr>
<tr>
<td>CE416</td>
<td></td>
<td>801</td>
<td></td>
<td>347</td>
<td>164</td>
<td>0.43</td>
</tr>
<tr>
<td>CE416</td>
<td></td>
<td>1199</td>
<td>1.59</td>
<td>490</td>
<td>242</td>
<td>0.41</td>
</tr>
<tr>
<td>CE416</td>
<td>24.00 – 24.33</td>
<td>1000</td>
<td>1.59</td>
<td>340</td>
<td>320</td>
<td>0.34</td>
</tr>
<tr>
<td>CE416</td>
<td>25.50 – 25.95</td>
<td>400</td>
<td>1.33</td>
<td>260</td>
<td></td>
<td>0.65</td>
</tr>
<tr>
<td>CE416</td>
<td></td>
<td>799</td>
<td></td>
<td>379</td>
<td></td>
<td>0.47</td>
</tr>
<tr>
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<td>1203</td>
<td></td>
<td>491</td>
<td>86</td>
<td>0.41</td>
</tr>
<tr>
<td>CE416</td>
<td>26.50 – 27.00</td>
<td>403</td>
<td>1.41</td>
<td>240</td>
<td></td>
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</tr>
<tr>
<td>CE416</td>
<td></td>
<td>791</td>
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<td>380</td>
<td></td>
<td>0.48</td>
</tr>
<tr>
<td>CE416</td>
<td></td>
<td>1204</td>
<td>1.36</td>
<td>342</td>
<td>77</td>
<td>0.28</td>
</tr>
<tr>
<td>CE416</td>
<td>27.00 – 27.45</td>
<td>1200</td>
<td>1.41</td>
<td>315</td>
<td>252</td>
<td>0.26</td>
</tr>
<tr>
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<td></td>
<td>1000</td>
<td>1.33</td>
<td>347</td>
<td>257</td>
<td>0.35</td>
</tr>
<tr>
<td>CE417</td>
<td>24.00 – 24.30</td>
<td>600</td>
<td>1.31</td>
<td>334</td>
<td>316</td>
<td>0.56</td>
</tr>
<tr>
<td>CE417</td>
<td></td>
<td>800</td>
<td>1.35</td>
<td>385</td>
<td>385</td>
<td>0.48</td>
</tr>
<tr>
<td>PL1</td>
<td>0.00 – 0.50</td>
<td>400</td>
<td>1.36</td>
<td>204</td>
<td>204</td>
<td>0.51</td>
</tr>
<tr>
<td>PL1</td>
<td></td>
<td>1000</td>
<td>1.43</td>
<td>390</td>
<td>235</td>
<td>0.39</td>
</tr>
<tr>
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<td>0.00 – 0.50 Remoulded</td>
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<td>1.46</td>
<td>244</td>
<td>244</td>
<td>0.98</td>
</tr>
<tr>
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<td>1.48</td>
<td>319</td>
<td>312</td>
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</tr>
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<td>1000</td>
<td>1.49</td>
<td>396</td>
<td>359</td>
<td>0.40</td>
</tr>
</tbody>
</table>

A plot of undrained shear strength ratio vs consolidation stress is provided as Figure D4-13. Equations defining the trend lines indicated on Figure D4-13 are:

- Peak triaxial strength  \( Su/p' = 0.72 – 0.000300 \sigma_v' \)
- Peak DSS strength  \( Su/p' = 0.66 – 0.000300 \sigma_v' \)
- Post Peak DSS strength  \( Su/p' = 0.45 – 0.000200 \sigma_v' \)
MIT stress paths for representative CIU triaxial tests are graphed on Figure D4-14, together with effective stress, strength parameters calculated for these tests.

A ring shear test and direct shear tests were undertaken on a single sample of FRV Unit A (CE416 24.5 – 25.0) remoulded at its in situ moisture content and dry density (~34% & ~1.40t/m³).
Due to equipment limitations the ring shear test was completed at one normal pressure (500kPa) on material passing 75 µm. The direct shear test was completed at three normal pressures on material as received (passing 2.36 mm). In order to provide a direct comparison with the ring shear test, an additional direct shear test was completed on < 75 µm material and a normal pressure of 500 KPa. Residual values (after 4 to 5 reversal cycles) are plotted on Figure D4-15 indicate an average mobilised friction $\phi_m' = 16°$ at normal stresses above 800kPa.

![Figure D4-15: Unit A FRV – Residual values from direct shear and ring shear tests](image)

**D4.4.3 Consolidation Tests**

Two constant rate of strain (CRS) consolidation tests were completed on undisturbed samples of Unit A. The samples were loaded to 400kPa, unloaded to 100kPa, reloaded to 3200kPa, then, unloaded to 25kPa. The results are presented in Figure D4-16 as void ratio / vertical effective stress and in Figure D4-17 as Coefficient of Consolidation / log $p'$. Results are summarized in Table D4-9.

**Table D4-9: Unit A FRV - Summary of CRS consolidation test data**

<table>
<thead>
<tr>
<th>ID</th>
<th>Depth</th>
<th>RL</th>
<th>$\gamma_d$ (t/m^3)</th>
<th>w (%)</th>
<th>eo</th>
<th>Cr</th>
<th>Cc</th>
<th>$\sigma'_p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE415</td>
<td>6.00 – 6.50</td>
<td>680.20</td>
<td>1.28</td>
<td>41.5</td>
<td>1.25</td>
<td>0.025</td>
<td>0.095</td>
<td>170</td>
</tr>
<tr>
<td>CE417</td>
<td>24.00 -24.30</td>
<td>676.08</td>
<td>1.23</td>
<td>37.1</td>
<td>1.32</td>
<td>0.013</td>
<td>0.075</td>
<td>130</td>
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</table>

The apparent pre-consolidation pressure ($\sigma_p$) indicated in Table D4-9 was calculated using the Casagrande Method.
Figure D4-16: Unit A FRV – CRS Void Ratio

Figure D4-17: Unit A FRV – CRS Coefficient of Consolidation
D4.5 Unit B – Forest Reef Volcanics

D4.5.1 Index Tests

Table D4-10 provides a summary of Atterberg Limit and index tests completed on ITRB, GHD and ATCW samples taken from Unit B FRV. Atterberg Limits and particle size distributions are plotted on Figure D4-18 and Figure D4-19 respectively.

![Figure D4-18: Unit B FRV – Plasticity chart](image)

![Figure D4-19: Unit B FRV – Particle size distributions](image)
<table>
<thead>
<tr>
<th>Hole No. (refer notes)</th>
<th>Depth Range (m)</th>
<th>Atterberg Limits</th>
<th>Linear Shrinkage (%)</th>
<th>Field Moisture (%)</th>
<th>Dry Density (t/m³)</th>
<th>Specific Gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>From To</td>
<td>LL</td>
<td>PL</td>
<td>PI</td>
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<td></td>
</tr>
<tr>
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<td>19.8</td>
</tr>
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<td>23.3</td>
</tr>
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</tr>
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</tr>
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<td>24</td>
<td>16</td>
<td>6.5</td>
<td>28.2</td>
</tr>
<tr>
<td>CE432</td>
<td>23.50 24.0</td>
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<td></td>
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<td>26.4</td>
</tr>
<tr>
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<td>9</td>
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<td>28.2</td>
</tr>
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</tr>
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<td>10.0</td>
<td>14.1</td>
</tr>
<tr>
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<td>48</td>
<td>34</td>
<td>14</td>
<td>31.8</td>
<td></td>
</tr>
<tr>
<td>CE383</td>
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<td>50</td>
<td>37</td>
<td>13</td>
<td>37.4</td>
<td></td>
</tr>
<tr>
<td>CE383</td>
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<td>43</td>
<td>32</td>
<td>11</td>
<td>34.8</td>
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</tr>
<tr>
<td>CE383</td>
<td>4.00 4.41</td>
<td>48</td>
<td>26</td>
<td>22</td>
<td>30.5</td>
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</tr>
<tr>
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<td>11</td>
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</tr>
<tr>
<td>CE392</td>
<td>2.00 2.45</td>
<td>43</td>
<td>20</td>
<td>23</td>
<td>12.0</td>
<td></td>
</tr>
<tr>
<td>CE392</td>
<td>3.50 3.66</td>
<td>34</td>
<td>18</td>
<td>16</td>
<td>9.5</td>
<td></td>
</tr>
<tr>
<td>BH2A</td>
<td>0.22 0.52</td>
<td>37</td>
<td>20</td>
<td>17</td>
<td>24.1</td>
<td></td>
</tr>
<tr>
<td>BH2B</td>
<td>1.30 1.50</td>
<td>46</td>
<td>25</td>
<td>21</td>
<td>19.0</td>
<td></td>
</tr>
<tr>
<td>BH2B</td>
<td>1.50 1.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BH2B</td>
<td>2.00 2.0</td>
<td>40</td>
<td>25</td>
<td>15</td>
<td>15.0</td>
<td></td>
</tr>
<tr>
<td>BH2B</td>
<td>3.00 3.40</td>
<td>39</td>
<td>22</td>
<td>17</td>
<td>11.5</td>
<td></td>
</tr>
<tr>
<td>BH3</td>
<td>1.00 1.50</td>
<td>40</td>
<td>25</td>
<td>15</td>
<td>18.0</td>
<td></td>
</tr>
</tbody>
</table>

**Notes**

Sample: ITRB, GHD, ATCW
The initial dry density of Unit B samples is plotted against depth on Figure D4-20. The dry density of these samples is typically above 1.40t/m³.

![Initial Dry Density vs Depth](image1)

**Figure D4-20: Unit B FRV – Initial dry density vs depth**

The initial void ratio of Unit B ITRB samples (open circles) and ‘as tested’ void ratios (closed circles) are plotted against confining stress on Figure D4-21.

![Initial & Tested Void Ratio vs Vertical Stress](image2)

**Figure D4-21: Unit B FRV – Initial & tested void ratio vs vertical stress**
D4.5.2 Strength Data

Direct simple shear tests and CIU triaxial tests were completed on six samples of Unit B of the Forest Reef Volcanics. Undrained shear strength data is summarized in Table D4-11.

Table D4-11: Unit B FRV – Undrained shear strength data

<table>
<thead>
<tr>
<th>Sample No</th>
<th>Depth (m)</th>
<th>Consol. Stress (kPa)</th>
<th>Dry Density (kN/m³)</th>
<th>Shear Strength</th>
<th>SS Ratio</th>
<th>Test Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Peak (kPa)</td>
<td>Post Peak (kPa)</td>
<td>Peak</td>
</tr>
<tr>
<td>CE411A</td>
<td>16.50 – 16.95</td>
<td>400</td>
<td>1.32</td>
<td>263</td>
<td>260</td>
<td>0.66</td>
</tr>
<tr>
<td></td>
<td>800</td>
<td>1.46</td>
<td>504</td>
<td>501</td>
<td>0.63</td>
<td>0.63</td>
</tr>
<tr>
<td></td>
<td>1200</td>
<td>1.49</td>
<td>529</td>
<td>527</td>
<td>0.44</td>
<td>0.44</td>
</tr>
<tr>
<td>CE432</td>
<td>19.80 – 20.30</td>
<td>202</td>
<td>1.61</td>
<td>234</td>
<td>296</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>400</td>
<td>390</td>
<td>0.98</td>
<td>0.74</td>
<td>T/CIU</td>
<td></td>
</tr>
<tr>
<td></td>
<td>795</td>
<td>511</td>
<td>0.64</td>
<td>0.20</td>
<td>T/CIU</td>
<td></td>
</tr>
<tr>
<td>CE432</td>
<td>20.30 – 20.80</td>
<td>204</td>
<td>1.52</td>
<td>203</td>
<td>186</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>398</td>
<td>255</td>
<td>0.91</td>
<td>0.64</td>
<td>T/CIU</td>
<td></td>
</tr>
<tr>
<td>CE432</td>
<td>22.80 – 23.20</td>
<td>400</td>
<td>1.70</td>
<td>468</td>
<td>410</td>
<td>1.17</td>
</tr>
<tr>
<td></td>
<td>800</td>
<td>718</td>
<td>0.90</td>
<td>0.59</td>
<td>T/CIU</td>
<td></td>
</tr>
<tr>
<td>CE432</td>
<td>23.50 – 24.00</td>
<td>400</td>
<td>1.58</td>
<td>321</td>
<td>221</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>796</td>
<td>624</td>
<td>0.78</td>
<td>0.32</td>
<td>T/CIU</td>
<td></td>
</tr>
<tr>
<td>TP405</td>
<td>1.90 – 2.20</td>
<td>250</td>
<td>1.58</td>
<td>90</td>
<td>90</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>165</td>
<td>0.33</td>
<td>0.32</td>
<td>G/DSS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>278</td>
<td>0.28</td>
<td>0.26</td>
<td>G/DSS</td>
<td></td>
</tr>
</tbody>
</table>

Results for tests on the above samples have been plotted on the following figures.

Figure D4-22 Undrained shear strength ratio vs consolidation stress for both DSS and CIU.

Figure D4-23. Shear stress versus vertical effective stress from DSS tests.

Figure D4-24. Stress paths for ITRB CIU triaxial tests.

Figure D4-25. MIT plot of shear strength at peak stress ratio for both ITRB and GHD data.
Figure D4-22: Unit B FRV: Undrained shear strength ratio vs consolidation stress

Figure D4-23: Unit B FRV – Shear stress versus vertical effective stress from DSS tests
One direct shear test was completed on a section of FRV Unit B sonic core from CE406. Residual shear stress values are plotted on Figure D4-26.
D4.5.3 Consolidation Tests

Two oedometer consolidation tests were completed on undisturbed samples of Unit B from Forest Reef Volcanics. The samples were loaded to 400kPa, unloaded to 100kPa, reloaded to 3200kPa, then, in the case of one sample, unloaded to 25kPa. The results are presented in Figure D4-27 as a plot of void ratio vs vertical effective stress and summarized in Table D4-12. The apparent pre-consolidation pressure ($\sigma_p$) indicated in Table D4-12 was calculated using the Casagrande Method.

<table>
<thead>
<tr>
<th>ID</th>
<th>Depth</th>
<th>RL</th>
<th>$\gamma_d$ (t/m$^3$)</th>
<th>$w$ (%)</th>
<th>$e_o$</th>
<th>$C_r$</th>
<th>$C_c$</th>
<th>$\sigma_p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE411A</td>
<td>16.70 – 16.74</td>
<td>673.3</td>
<td>1.44</td>
<td>30.9</td>
<td>0.982(1)</td>
<td>0.023</td>
<td>0.18</td>
<td>1000</td>
</tr>
<tr>
<td>CE412</td>
<td>65.50 – 66.00</td>
<td>666.6</td>
<td>1.50</td>
<td>26.1</td>
<td>0.758</td>
<td>0.022</td>
<td>0.18</td>
<td>400</td>
</tr>
</tbody>
</table>

Notes:

(1) Void ratio at initial loading stage
D5. Fill Materials and Nomenclature

D5.1 Embankment Zoning

The construction of the NTSF has been undertaken in ten (10) stages. The internal zoning and nomenclature has changed over the years and this is tracked in the following section.

The Stage 1 embankment had the following internal configuration;

- Zone A – A 5m wide sloping clay core, thickening to 12m at the base,
- Zone B – Upstream rockfill shoulder with a slope of 1.5H:1V,
- Zone D – Downstream rockfill shoulder with a slope of 1.5H:1V,
- Zone C1 – A 15m wide transition rockfill between the clay core and downstream rockfill shoulder of the embankment, and
- Zone C3 – A secondary 5 m wide transition rockfill between Zone C1 and Zone A up to an elevation of 670 m,

The Stage 2A embankment, a 7m high zoned earth and rockfill downstream raise had the following internal configuration;

- Zone A – A 5m wide sloping clay core,
- Zone B – Rockfill shoulders with upstream and downstream slopes of 1.5H:1V,
- Zone B1 – Downstream Rockfill platform with a slope of 1.5H:1V
- Zone C4 – A 3 m wide transition rockfill between the clay core and downstream rockfill shoulder of the embankment, and
- Zone F – A secondary 1 m wide filter between Zone C4 and Zone A,

The Stage 2B embankment was also designed as a 7m downstream raise with zoning identical to Stage 2A, however Stage 2B was constructed in two separate lifts, each of 3.5m height. At this stage the nomenclature for the zones was changed from alphabetical to numerical. The Stage 2B dam had the following internal configuration;

- Zone 1 – A 5m wide sloping clay core,
- Zone 3B – Rockfill shoulders with upstream and downstream slopes of 1.5H:1V
- Zone 3A – A 3 m wide transition rockfill between the clay core and downstream rockfill shoulder of the embankment, and
- Zone 2A – A secondary 1 m wide filter between Zone C4 and Zone A,

The Stage 3 embankment was designed as a 4.5 m central raise with the upstream shell founded on the Stage 2 tailings beach. The embankment has upstream and downstream slopes of 2H:IV and 1.5H:1V respectively, and a 9 m crest width. The Stage 3 dam had the following internal configuration;

- Zone 1 – A 3m wide vertical clay core with a 3m wide cap
- Zone 3B or 3A – Rockfill shoulders with an upstream slope of 2H:1V and downstream slope of 1.5H:1V
- Zone 3A – A 3 m wide transition rockfill between the clay core and downstream rockfill shoulder of the embankment, and
- Zone 3D – A working platform between the embankment and the tailings beach
Stages 4 through to 10 were designed as upstream raises of varying heights with upstream and downstream slopes of 2H:1V and 9m crests. These lifts had the following internal configurations:

- Zone 1 – A 4 m wide downstream sloping clay core with a 0.8 m horizontal clay blanket spanning the stage 3 Crest
- Zone 3B or 3A – Rockfill downstream shoulder with a slope of 2H:1V
- Zone 3A – A 3 m wide transition rockfill between the clay core and downstream rockfill shoulder of the embankment with a 0.6 m thick layer between the clay blanket and downstream rockfill, and
- Zone 3D – A working platform between the embankment and the tailings beach.

Table D5-1 provides a summary of the zone types for both Stage 1 / Stage 2A and Stage 2B.

<table>
<thead>
<tr>
<th>Fill Type</th>
<th>Embankment Zones</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stage 1 / Stage 2A</td>
<td>Stage 2B and Later</td>
</tr>
<tr>
<td>Clay Fill</td>
<td>Zone A</td>
<td>Zone 1</td>
</tr>
<tr>
<td>Rockfill</td>
<td>Zone B</td>
<td>Zone 3B</td>
</tr>
<tr>
<td></td>
<td>Zone D</td>
<td>Not Used</td>
</tr>
<tr>
<td></td>
<td>Zone B1</td>
<td>Not Used</td>
</tr>
<tr>
<td></td>
<td>Not Used</td>
<td>Zone 3C</td>
</tr>
<tr>
<td></td>
<td>Zone C4</td>
<td>Not Used</td>
</tr>
<tr>
<td></td>
<td>Not Used</td>
<td>Zone 3A</td>
</tr>
<tr>
<td></td>
<td>Not Used</td>
<td>Zone 3D</td>
</tr>
<tr>
<td>Filters</td>
<td>Zone C1</td>
<td>Not Used</td>
</tr>
<tr>
<td></td>
<td>Zone C3</td>
<td>Not Used</td>
</tr>
<tr>
<td></td>
<td>Zone F</td>
<td>Not Used</td>
</tr>
<tr>
<td></td>
<td>Not Used</td>
<td>Zone 2A</td>
</tr>
</tbody>
</table>
D5.2 Clay Fill

D5.2.1 Previous Investigations

Prior to construction, two rounds of tests were conducted on the clayey soils within the reservoir area and within the foundation footprint for the purpose of clay borrow investigations. The first was by Woodward-Clyde as part of the Cadia Mine Feasibility Study (1995-001) and the second by Pells Sullivan Meynink (1997-001) as part of a supplementary site investigation for detailed design. The samples taken by Pells Sullivan Meynink (PSM) were combined to create bulk samples as follows;

- TP100 to TP104 - upper right abutment, above RL705 m
- TP105 to TP107 - plateau area on right abutment at RL 705 m
- TP108 to TP112 - central right abutment
- TP113 to TP115 - lower right abutment, below about RL686 m
- TP118 to TP121 - left abutment (all residual andesite)

Effective stress strength parameters were determined on three Woodward Clyde and one PSM sample compacted to 98% of Standard Maximum Dry Density. The results of these tests are summarized in Table D5-2, together with the results of three similar tests completed by Woodward Clyde in 2000 (2000-003) on samples from Lower Rodds Creek (LRC) TSF, now the STSF. An MIT plot of these tests, together with three tests completed for Upper Rodds Creek (URC) dam or presented as Figure D5-1.

### Table D5-2: Results of preconstruction triaxial strength tests

<table>
<thead>
<tr>
<th>Test Pit</th>
<th>Depth (m)</th>
<th>MC (%)</th>
<th>$\gamma_d$ (kN/m$^3$)</th>
<th>$c'$ (kPa)</th>
<th>$\phi'$ (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Woodward-Clyde Investigation (1995)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TS12</td>
<td>0.3 - 0.6</td>
<td>19.3</td>
<td>1.71</td>
<td>18</td>
<td>30</td>
</tr>
<tr>
<td>TS6</td>
<td>0.2 - 1.4</td>
<td>19.8</td>
<td>1.71</td>
<td>79</td>
<td>22</td>
</tr>
<tr>
<td>TD38</td>
<td>1.9 - 4.1</td>
<td>18.4</td>
<td>1.71</td>
<td>32</td>
<td>25</td>
</tr>
<tr>
<td><strong>Pells Sullivan Meynink Investigation (1997)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP100 +TP107 Combined</td>
<td>27.2</td>
<td>1.48</td>
<td>6</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>TP4</td>
<td>0.6 - 1.5</td>
<td>16.0</td>
<td>-</td>
<td>20</td>
<td>26.5</td>
</tr>
<tr>
<td>TP6</td>
<td>0.6</td>
<td>17.1</td>
<td>-</td>
<td>15</td>
<td>27</td>
</tr>
<tr>
<td>TP26</td>
<td>1.0</td>
<td>19.4</td>
<td>-</td>
<td>20</td>
<td>22.5</td>
</tr>
</tbody>
</table>
D5.2.2 Construction

The specifications for Zone A/1 are provided in Table D5-3 and Table D5-4.

Table D5-3: Zone A/1 - Gradation specification

<table>
<thead>
<tr>
<th>Grain size (mm)</th>
<th>Percent Passing (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
</tr>
<tr>
<td>37.5</td>
<td>100</td>
</tr>
<tr>
<td>19</td>
<td>95</td>
</tr>
<tr>
<td>4.75</td>
<td>85</td>
</tr>
<tr>
<td>1.18</td>
<td>65</td>
</tr>
<tr>
<td>0.425</td>
<td>50</td>
</tr>
<tr>
<td>0.25</td>
<td>35</td>
</tr>
<tr>
<td>0.075</td>
<td>20</td>
</tr>
<tr>
<td>0.002</td>
<td>8</td>
</tr>
<tr>
<td>0.001</td>
<td>0</td>
</tr>
</tbody>
</table>

Table D5-4: Zone A/1 - Atterberg Limit Specification

<table>
<thead>
<tr>
<th>Atterberg Limits</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Limit (%)</td>
<td>25-80</td>
</tr>
<tr>
<td>Plasticity Index (%)</td>
<td>10-50</td>
</tr>
<tr>
<td>Linear Shrinkage (%)</td>
<td>&lt;20</td>
</tr>
</tbody>
</table>
Atterberg limits from Quality Assurance (QA) testing of Stage 1 and Stage 2A clay core materials, presented on Figure D5-2 and Figure D5-3 respectively, show that tested materials generally conformed to the construction specification.

**Figure D5-2: Stage 1 – Atterberg Limits from construction QA**

**Figure D5-3: Stage 2A – Atterberg limits from construction QA.**
### D5.2.3 ITRB Investigation Data

As part of the ITRB investigation program, one drill hole (CE407) was completed specifically to intersect and sample the Stage 1 embankment clay core. The clay core intersected, over a depth of 3.5m, was high plasticity brown clay and three undisturbed samples were recovered. Two CIU tests and one oedometer consolidation test were completed on these samples.

Undrained shear strength data from the two CIU tests are summarized in Table D5-5, while the undrained shear strength ratio for these and the pre-construction tests (Table D5-2) are plotted in Figure D5-4. As could be expected the post peak mobilized friction shows only a minimal post peak reduction.

An MIT plot of effective stress strength results for the ITRB and previous tests is presented as Figure D5-5, while consolidation test results are presented in Figure D5-6 and Table D5-6.

#### Table D5-5: Clay Core – Undrained shear strength data

<table>
<thead>
<tr>
<th>Sample No</th>
<th>Depth (m)</th>
<th>Consol. Stress (kPa)</th>
<th>Dry Density (kN/m³)</th>
<th>Shear Strength Stress Ratio</th>
<th>Test Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Peak (kPa)</td>
<td>Post Peak (kPa)</td>
</tr>
<tr>
<td>CE407</td>
<td>50.00 – 50.50</td>
<td>613</td>
<td>1.73</td>
<td>207</td>
<td>-</td>
</tr>
<tr>
<td>CE407</td>
<td>50.00 – 50.50</td>
<td>812</td>
<td>1.73</td>
<td>294</td>
<td>-</td>
</tr>
<tr>
<td>CE407</td>
<td>50.00 – 50.50</td>
<td>1203</td>
<td>1.73</td>
<td>396</td>
<td>345</td>
</tr>
<tr>
<td>CE407</td>
<td>51.00 - 51.50</td>
<td>1202</td>
<td>1.77</td>
<td>456</td>
<td>445</td>
</tr>
</tbody>
</table>

#### Figure D5-4: Clay Core – Undrained shear strength ratio results.
Figure D5-5: Clay Core – MIT plot of effective stress strength data

Figure D5-6: Clay Core – Oedometer consolidation test result
D5.3 Rockfill

D5.3.1 Construction

Rockfill (both Monzonite, and Silurian Sedimentary rock), was sourced from the initial stripping and mining operations for the open pit. The various specifications for these materials are summarised in Table D5-7.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Maximum Particle Size (mm)</th>
<th>Maximum Lift Thickness (m)</th>
<th>Compaction Requirements</th>
<th>Rock Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>B/3B</td>
<td>600</td>
<td>1.25</td>
<td>5 passes of a 10-tonne static weight vibrating roller</td>
<td>Fresh Monzonite Rock</td>
</tr>
<tr>
<td>B1</td>
<td>1000</td>
<td>10</td>
<td>End-dumped</td>
<td>Fresh Monzonite Rock</td>
</tr>
<tr>
<td>C4</td>
<td>300</td>
<td>0.3</td>
<td>2 passes of a 3-tonne static weight vibrating roller</td>
<td>Fresh Monzonite Rock</td>
</tr>
<tr>
<td>D</td>
<td>300</td>
<td>0.65</td>
<td>5 passes of a 10-tonne static weight vibrating roller</td>
<td>Silurian Sedimentary Rock</td>
</tr>
<tr>
<td>3A</td>
<td>300</td>
<td>0.6</td>
<td>5 passes of a 5-tonne static weight vibrating roller</td>
<td>Fresh Monzonite Rock</td>
</tr>
<tr>
<td>3C</td>
<td>1000</td>
<td>5</td>
<td>Trafficking of Haul Trucks with High Energy Impact Compaction.</td>
<td>Fresh Monzonite Rock</td>
</tr>
</tbody>
</table>

During construction of Stage 1, it became apparent that the volume of monzonite rock for Zone B was limited, and placement was constrained by double handling. As a consequence, the upstream shoulder was retained as Zone B (monzonite) while the downstream shoulder was changed to Silurian sedimentary rock (Zone D), compacted in the same manner as Zone B.

The Silurian sedimentary rockfill, designated as Zone D, was initially considered inferior to the igneous rock (Zone B) and as a consequence, the Stage 1 design was modified to incorporate a downstream waste rock berm (Zone B1), with a crest width of 32m at RL690m, and a downstream slope of 1.35H:1V. Zone B1 consisted of monzonite directly hauled from the open pit. Subsequently, direct shear tests on Zone D material indicated that it met the requirements of the original design, and placement of Zone B1 was postponed even though it formed part of the Stage 2 embankment. The direct shear tests on Zone D material are not reported in the construction documentation.

No quality control testing was completed on any of the rockfill zones.
D5.3.2 Design Shear Strength

Due to the difficulty (particle size and variability) and cost of performing large-scale tests on rockfill, no strength tests were completed for design nor insitu density tests during construction.

The bulk density used in design for the rockfill ranged between 19 kN/m$^3$ and 20 kN/m$^3$, while drained strength parameters of $c' = 0$ kPa and $\phi' = 40^\circ$ were adopted for rockfill and $c' = 0$ kPa and $\phi' = 42^\circ$ were adopted for the finer transition zone.

The rockfill strength parameters adopted for design were checked using Leps (1985) assembled published laboratory test data on rockfill strength and reported the friction angle as a function of normal pressures, as deduced from the Mohr diagram. A shortfall of the Leps data set is a lack of information at normal pressures below 70 kPa. Lepps also acknowledges that this data only provides a rough estimate of the effects of relative density, gradation, and the effect of crushing, and that there is no evaluation of particle shape or degree of saturation influence.

The Leps data set was subsequently been screened to include only fine grained igneous rocks similar to that which was used in the NTSF. This data is reproduced in Figure D5-7 and indicates that a friction angle of 40° to 42° is appropriate for a normal stress of 1000 to 2000 kPa.

![Figure D5-7: Leps (metric version) including fine grained igneous rocks](image)

The reduction in shearing strength with confining pressure observed in triaxial tests on rockfill can also be described by the equation:

\[ \tau = A \left(\sigma_n\right)^b \]

Where:
- \(\tau\) = rockfill shear strength
- \(\sigma_n\) = normal stress
- \(A\) & \(b\) are constants.
Haselsteiner et al. (2016) have looked at a more recent database of rockfill testing (2009) and have proposed four rock fill strength classes using the $A$ $b$ parameters as indicated in Figure D5-8.

![Figure D5-8: Rockfill strength parameters (Haselsteiner et al.)](image)

Parameters $A = 0.90$, $b = 0.97$ provide a reasonable approximation to the lower bound strength in Lepps, while parameters of $A = 1.9$, $b= 0.85$ provide a reasonable approximation of the average rockfill strength for fine grained igneous rock shown in Figure D5-7.

**D5.3.3 Deformation Modulus**

The modulus of compressibility (E) of the rockfill is dependent on the rock type, strength, shape and gradation of rock sizes in the rockfill and layer thickness. It is also dependent on the roller size and type, number of passes, whether water is added during compaction, the confining stresses on the rockfill and also the duration of loading, i.e. there is a creep component.

Hunter and Fell (2002) developed a method for estimating the secant modulus of rockfill during construction ($E_{rc}$) and pseudo modulus on first filling ($E_{rf}$) based on analysis of monitoring data, mostly for concrete faced rockfill dams. Hunter and Fell recommend determining the representative secant modulus at the end of construction $E_{rc}$ using the D80 of the rockfill for rockfill of various strength as indicated in Figure D5-9.

In the case of the NTSF, with only the maximum particle size specified for the rockfill, a coefficient of uniformity (CU) of 7.5 (used to prevent gap-graded filters) can be used to determine the D80. For the three rockfills specified above, the secant modulus can be estimated as an average of 75 MPa.
D5.3.4 Dynamic Shear Modulus

GHD were engaged by Newcrest to complete a geophysical investigation in the vicinity of the NTSF and STSF which comprised six ERI traverses and twelve Seismic Refraction Tomography (SRT) traverses.

Seismic refraction traverse Line 7 was located along the toe of the NTSF southern embankment. The traverse was approximately 1650m long and commenced on the eastern abutment of the NTSF and terminated on the partially constructed Stage 2 Buttress at approximately CH2500. As part of the seismic refraction traverse, Multi-channel Analysis of Surface Wave (MASW) soundings were completed at 18m intervals along the traverse. The output of the MASW soundings is a profile of shear wave velocity with depth which in turn can be interpreted as a profile of the dynamic shear modulus with depth.

A selection of MASW soundings completed along the Stage 2 Buttress were analysed to assess the dynamic shear modulus of the embankment rockfill. The results from nine MASW soundings are plotted on Figure D5-10 as the minimum, average and maximum shear wave velocity against the average thickness of the respective layers.

Figure D5-9: Representative secant modulus versus particle size and UCS
Due to the variable thickness of the rockfill at the toe of the southern embankment, the dynamic shear modulus calculated from specific soundings was compared with materials intersected in adjacent drillholes. In the case of drillholes CE403 and CE404, the midpoints of the soundings were located within 10m of the drillholes, while the nearest sounding to CE405 was located 100m to the east. The results for these three soundings are shown on Figure D5-11.

Taking into consideration possible errors in the layer thicknesses calculated from the MASW sounding, Table D5-8 provides a comparison of material type, shear wave velocity and dynamic shear modulus based on drillholes CE403, CE404 and CE405.
Figure D5-11: Stage 2 Buttress Rockfill – Comparison of MASW soundings and drillholes

Table D5-8: Comparison of shear wave velocity, dynamic shear modulus and material

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Shear Wave Velocity (m/sec)</th>
<th>Dynamic Shear Modulus (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rockfill</td>
<td>170 - 260</td>
<td>60 - 130</td>
</tr>
<tr>
<td>EW – HW Volcanics</td>
<td>810 – 1,090</td>
<td>1,310 – 2,390</td>
</tr>
<tr>
<td>MW Volcanics</td>
<td>1,250 – 1,340</td>
<td>3,140 – 3,580</td>
</tr>
<tr>
<td>SW- Fresh Volcanics</td>
<td>2,260 – 3,080</td>
<td>10,190 – 20,870</td>
</tr>
</tbody>
</table>
D5.4 Filters

D5.4.1 Construction

As Stages 1 and 2 of the NTSF were designed as water retaining structures, filters were provided between the clay core and the downstream rockfill. The specification for these materials are summarised in Table D5-9.

<table>
<thead>
<tr>
<th>Particle Size (mm)</th>
<th>Zone C1</th>
<th>Zone C3</th>
<th>Zone F</th>
</tr>
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<tbody>
<tr>
<td>300</td>
<td>100-100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>96-100</td>
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<td>100-100</td>
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<td>100-100</td>
</tr>
<tr>
<td>63</td>
<td>80-100</td>
<td>80-100</td>
<td>-</td>
</tr>
<tr>
<td>53</td>
<td>77-100</td>
<td>77-100</td>
<td>-</td>
</tr>
<tr>
<td>37.5</td>
<td>72-100</td>
<td>72-100</td>
<td>94-100</td>
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<tr>
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<td>-</td>
</tr>
<tr>
<td>19.0</td>
<td>60-98</td>
<td>60-98</td>
<td>90-100</td>
</tr>
<tr>
<td>13.2</td>
<td>54-92</td>
<td>54-92</td>
<td>-</td>
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<tr>
<td>9.5</td>
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<td>4.75</td>
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<td>38-75</td>
<td>60-100</td>
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<td>44-100</td>
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<td>19-50</td>
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<td>13-42</td>
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<td>6-32</td>
<td>0-45</td>
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<td>2-22</td>
<td>0-20</td>
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<td>0-10</td>
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<td>0.001</td>
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</tr>
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</table>

A major change to the design during construction, was the inclusion of transition, Zone C3, as an L shaped zone at the base of Zone C1 and between Zone C1 and the core. Whereas Zone C1 was < 300mm Silurian sedimentary rock visually selected in the open pit, Zone C3 was crushed to < 80mm, placed in 300mm loose layers and compacted with 1 pass of a 10 tonne static weight vibrating roller. The base leg of Zone C3 was 10m wide and extended up the abutments to RL695 as a 1m thick layer, while the upstand leg was 5m wide and extended full height to RL670 and then 3m height between RL670 and RL680.

Excavation beneath the clay core and transition/filter was undertaken to expose hard residual soil or extremely weathered rock. Where potentially permeable material was identified in the downstream side of the core trench, the core trench was widened (on the downstream side by 6m and blanketed with Zone A. Zone C3 filter was then extended over the widened section of core trench.
D5.4.2 Quality Control

Apart from the Clay Core, Zones C1 and C3 were the only materials that were tested regularly as part of the QA. The summarised results for Stage 1 QA on Zone C1 and C3 are shown in Figure D5-12, however the tests did not distinguish between Zone C1 and Zone C3, even though they had separate specifications.

During construction, concerns were raised regarding the particle size distribution of Zone C1, as the contractor consistently had difficulties in achieving the specified material grading. Test excavations in this material indicated that voids were filled. It was also decided to complete a large scale slot test to assess the potential for piping.

The test was completed in a 44-gallon drum and Zone C1 and Zone A materials were compacted in layers. An 8 mm cable, embedded into the Zone A material, was pulled out to create an artificial crack. The test confirmed, that under a significant head, the artificial crack in the did not propagate.

There exists no documentation for the QA/QC testing on Zone F, however the Stage 2A construction report states that "After some initial teething problems and plant modifications, a sand/gravel product meeting the specification requirements was consistently produced".

The average QA/QC data for Zone 2A is reproduced in Figure D5-13.
D5.4.3 Filter Design Criteria

A filter criteria analysis was completed to assess the suitability of Zone C1/C3 to act as a critical filter for Zone 2A. This analysis, based on Chapter 26 of the National Engineering Handbook (1994), assesses filtering criteria, permeability criteria, prevention of gap-graded filters, and segregation criteria. As shown in Figure D5-14, Zone C1/C3 complies with the permeability and filter criteria at the D15 size. However, it becomes too coarse and well graded to comply with gap-graded prevention and segregation criteria. Zone 2A complies with all criteria except for gap-graded prevention at the D60 size.

A second analysis was completed to determine the internal stability of both filters using the Kenny and Lau (1985) method. The Zone C1/C3 filters fall well within the unstable zone while the Zone 2A filter falls just outside of the zone.
Figure D5-14: Filter Criteria for Zone A/1 with Zone C1/C3 and Zone 2A

Figure D5-15: Internal stability analysis for Zone C1/C3 and Zone 2A
D6. References


Annexure DA
Index Tests
**Client:** Newcrest Mining  
**IPO Number:** 2018-017  
**Project:** Cadia NTSF Failure - Laboratory Testing  
**Location:** Cadia Valley Operations  
**Sample ID:** Refer to Table  
**Borehole ID:** Refer to Table

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<th>Tested By:</th>
<th>KM</th>
<th>Date:</th>
<th>Refer to Table</th>
<th>Checked By:</th>
<th>RC</th>
<th>Date:</th>
<th>26/09/2018</th>
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**ATTERBERG LIMITS**  
Test Method: AS1289.3.9.1, AS1289.3.2.1 and AS1289.3.3.2

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<th>Sample ID</th>
<th>Date Tested</th>
<th>Depth (m) From</th>
<th>Depth (m) To</th>
<th>W_L (%)</th>
<th>W_P (%)</th>
<th>I_P (%)</th>
<th>LS (%)</th>
<th>mode*</th>
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<td>2018-017-005</td>
<td>25/09/2018</td>
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<td>3.45</td>
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<td>15.0</td>
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<td>PT2</td>
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<td>18/09/2018</td>
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<td>22</td>
<td>12.5</td>
<td>Curling</td>
</tr>
</tbody>
</table>

* W_L = Liquid Limit, W_P = Plastic Limit, I_P = Plasticity Index, NP = Non Plastic, LS = Linear Shrinkage  
Method of preparation: Dry sieved, History of sample: Oven dried at 50°C  
mode = condition after drying

---

**Cadia NTSF Failure - Laboratory Testing**  
**Atterberg Limits**
### Particle Size Distribution

**Test Method:** AS1289.3.6.1 & AS1289.3.6.3

#### Sieve Analysis

<table>
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<th>Particle size (mm)</th>
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<th>Particle size (mm)</th>
<th>% passing</th>
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<td>75</td>
</tr>
<tr>
<td>19</td>
<td>90</td>
<td>0.425</td>
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<td>87</td>
<td>0.300</td>
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</tr>
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#### Hydrometer Analysis

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<th>% passing</th>
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**Project**

**Particle Size Distribution**

**Figure A1-1**
PARTICLE SIZE DISTRIBUTION
Test Method: AS1289.3.6.1 & AS1289.3.6.3

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<th>Particle size (mm)</th>
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<tbody>
<tr>
<td>75</td>
<td>100</td>
<td>1.18</td>
<td>64</td>
</tr>
<tr>
<td>37.5</td>
<td>100</td>
<td>0.600</td>
<td>52</td>
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<tr>
<td>19</td>
<td>93</td>
<td>0.425</td>
<td>47</td>
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<table>
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<th>Particle size (mm)</th>
<th>% passing</th>
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**Particle Size Distribution**

Test Method: AS1289.3.6.1 & AS1289.3.6.3

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**Hydrometer Analysis**

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## SOIL PARTICLE DENSITY OF FRACTION PASSING THE 2.36 mm SIEVE

**Test Method:** AS1289.3.5.1

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<th>Sample No.</th>
<th>Sample ID</th>
<th>Date Tested</th>
<th>Depth (m)</th>
<th>Soil Particle Density</th>
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<tbody>
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<td>CE411</td>
<td>PT1</td>
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<td>26/09/2018</td>
<td>3.13-3.18</td>
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<td>PT2</td>
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<td>26/09/2018</td>
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<td>26/09/2018</td>
<td>16.70-16.74</td>
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</tbody>
</table>
# Plasticity Index Test Report

## Client:
Hatch Pty Ltd  
61 Petrie Terrace Brisbane QLD 4000

## Project:
NTSF Embankment Failure ITRB

## Location:
Cadia Mine

## Date:
22/06/18

## Project No.:
18101980

## Test procedure:
AS 1289.2.1.1, AS 1289 3.9.1, AS 1289.3.2.1, AS 1289.3.3.2 & AS 1289.3.4.1

## Laboratory Reference Number:
180721

## Sample Identification:
18005 TP401 0.7-1.0m  
Block sample

## Sample Description:
CLAY (with sand, trace of gravel)

## Liquid Limit (%):
53

## Plastic Limit (%):
20

## Plasticity Index (%):
33

## Linear Shrinkage (%):
14.5

## Moisture Content (%):
ND

## Sample History:
Air Dried

## Method of Preparation:
Dry Sieved

## Length of Shrinkage Mould (mm):
125

## Cracking, Curling or Crumbling:
Yes

---

### Notes:
N.D. = Not Determined  
N.O. = Not Obtainable  
N.P. = Non Plastic

---

## Tested as received:
PLF1-041 RL0 21/11/17

## Certificate Reference:
18101980_180721_TR-180090_PI_Rev0

---

Sean Lenihan - Senior Laboratory Technician
# Plasticity Index Test Report

**Client:** Hatch  
61 Petrie Terrace, Brisbane  

**Project:** NTSF Embankment Failure ITRB  

**Location:** Cadia Mine  

**Date:** 29/06/18  

**Project No.:** 18101980  

**Test procedure:** AS 1289.2.1.1, AS 1289 3.9.1, AS 1289.3.2.1, AS 1289.3.3.2 & AS 1289.3.4.1

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<tr>
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<td>Linear Shrinkage (%)</td>
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<tr>
<td>Moisture Content (%)</td>
<td>ND</td>
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<tr>
<td>Sample History</td>
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<tr>
<td>Method of Preparation</td>
<td>Dry Sieved</td>
</tr>
<tr>
<td>Length of Shrinkage Mould (mm)</td>
<td>125</td>
</tr>
<tr>
<td>Cracking, Curling or Crumbling</td>
<td>No</td>
</tr>
</tbody>
</table>

**Notes:**

- N.D. = Not Determined  
- N.O. = Not Obtainable  
- N.P. = Non Plastic

Tested as received  

**Certificate Reference:** 18101980_180788_TR-180102_PI_Rev0  

**NATA Accreditation No:** 1961 Perth  

Accredited for compliance with ISO/IEC 17025  

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL  

Sean Lenihan - Senior Laboratory Technician
## Plasticity Index Test Report

**Perth Laboratory**
84 Guthrie Street Osborne Park
Perth WA 6017
P: +61 8 9441 0700 F: +61 8 9441 0701
www.golder.com
perthlab@golder.com.au

### Client:
Hatch
61 Petrie Terrace, Brisbane

### Project:
NTSF Embankment Failure ITRB

### Location:
Cadia Mine

**Date:** 25/09/18

**Project No.:** 18101980

**Test procedure:**
AS 1289.2.1.1, AS 1289 3.9.1, AS 1289.3.2.1, AS 1289.3.3.2 & AS 1289.3.4.1

<table>
<thead>
<tr>
<th>Laboratory Reference Number</th>
<th>181314</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Identification</td>
<td>18027 CE416 PT2</td>
</tr>
<tr>
<td>Sample Description</td>
<td>CLAY</td>
</tr>
<tr>
<td>Liquid Limit (%)</td>
<td>63</td>
</tr>
<tr>
<td>Plastic Limit (%)</td>
<td>26</td>
</tr>
<tr>
<td>Plasticity Index (%)</td>
<td>37</td>
</tr>
<tr>
<td>Linear Shrinkage (%)</td>
<td>11.5</td>
</tr>
<tr>
<td>Moisture Content (%)</td>
<td>ND</td>
</tr>
<tr>
<td>Sample History</td>
<td>Air Dried</td>
</tr>
<tr>
<td>Method of Preparation</td>
<td>Dry Sieved</td>
</tr>
<tr>
<td>Length of Shrinkage Mould (mm)</td>
<td>125</td>
</tr>
<tr>
<td>Cracking, Curling or Crumbling</td>
<td>No</td>
</tr>
</tbody>
</table>

**Notes:**

- **N.D.** = Not Determined
- **N.O.** = Not Obtainable
- **N.P.** = Non Plastic

---

**Tested as received**

**Certificate Reference:** 18101980_181314_TR-180150_PI_Rev0

**NATA Accreditation No:** 1961 Perth

Accredited for compliance with ISO/IEC 17025-Testing

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Sean Lenihan - Senior Laboratory Technician
# Plasticity Index Test Report

**Client:** Hatch  
61 Petrie Terrace, Brisbane  

**Project:** NTSF Embankment Failure ITRB  

**Location:** Cadia Mine  

**Date:** 25/09/18  

**Project No.:** 18101980  

**Test procedure:** AS 1289.2.1.1, AS 1289.3.9.1, AS 1289.3.2.1, AS 1289.3.3.2 & AS 1289.3.4.1  

<table>
<thead>
<tr>
<th>Laboratory Reference Number</th>
<th>181313</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Identification</td>
<td>18026 CE417 PT4</td>
</tr>
<tr>
<td></td>
<td>24.0-24.3m</td>
</tr>
<tr>
<td>Sample Description</td>
<td>CLAY</td>
</tr>
<tr>
<td>Liquid Limit (%)</td>
<td>55</td>
</tr>
<tr>
<td>Plastic Limit (%)</td>
<td>28</td>
</tr>
<tr>
<td>Plasticity Index (%)</td>
<td>27</td>
</tr>
<tr>
<td>Linear Shrinkage (%)</td>
<td>10.5</td>
</tr>
<tr>
<td>Moisture Content (%)</td>
<td>ND</td>
</tr>
<tr>
<td>Sample History</td>
<td>Air Dried</td>
</tr>
<tr>
<td>Method of Preparation</td>
<td>Dry Sieved</td>
</tr>
<tr>
<td>Length of Shrinkage Mould (mm)</td>
<td>125</td>
</tr>
<tr>
<td>Cracking, Curling or Crumbling</td>
<td>No</td>
</tr>
</tbody>
</table>

**Notes:**
- N.D. = Not Determined
- N.O. = Not Obtainable
- N.P. = Non Plastic

**Client:** Nata Accreditation No: 1961 Perth  

**Accredited for compliance with ISO/IEC 17025-Testing**  

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Sean Lenihan - Senior Laboratory Technician
# Plasticity Index Test Report

**Client:** Hatch  
61 Petrie Terrace, Brisbane  

**Project:** NTSF Embankment Failure ITRB  

**Location:** Cadia Mine  

**Date:** 25/09/18  

**Project No.:** 18101980  

**Test procedure:** AS 1289.2.1.1, AS 1289.3.2.1, AS 1289.3.3.2 & AS 1289.3.4.1  

## Laboratory Reference Number

<table>
<thead>
<tr>
<th>Laboratory Reference Number</th>
<th>181312</th>
</tr>
</thead>
</table>

## Sample Identification

<table>
<thead>
<tr>
<th>Sample Identification</th>
<th>18025 CE417 PT2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>19.5-20.0m</td>
</tr>
</tbody>
</table>

## Sample Description

<table>
<thead>
<tr>
<th>Sample Description</th>
<th>CLAY</th>
</tr>
</thead>
</table>

## Liquid Limit (%)

<table>
<thead>
<tr>
<th>Liquid Limit (%)</th>
<th>58</th>
</tr>
</thead>
</table>

## Plastic Limit (%)

<table>
<thead>
<tr>
<th>Plastic Limit (%)</th>
<th>22</th>
</tr>
</thead>
</table>

## Plasticity Index (%)

<table>
<thead>
<tr>
<th>Plasticity Index (%)</th>
<th>36</th>
</tr>
</thead>
</table>

## Linear Shrinkage (%)

<table>
<thead>
<tr>
<th>Linear Shrinkage (%)</th>
<th>13.0</th>
</tr>
</thead>
</table>

## Moisture Content (%)

<table>
<thead>
<tr>
<th>Moisture Content (%)</th>
<th>ND</th>
</tr>
</thead>
</table>

## Sample History

<table>
<thead>
<tr>
<th>Sample History</th>
<th>Air Dried</th>
</tr>
</thead>
</table>

## Method of Preparation

<table>
<thead>
<tr>
<th>Method of Preparation</th>
<th>Dry Sieved</th>
</tr>
</thead>
</table>

## Length of Shrinkage Mould (mm)

<table>
<thead>
<tr>
<th>Length of Shrinkage Mould (mm)</th>
<th>125</th>
</tr>
</thead>
</table>

## Cracking, Curling or Crumbling

<table>
<thead>
<tr>
<th>Cracking, Curling or Crumbling</th>
<th>Yes</th>
</tr>
</thead>
</table>

**N.D. = Not Determined**  
**N.O. = Not Obtainable**  
**N.P. = Non Plastic**

## Notes:

- Tested as received

**Certificate Reference:** 18101980_181312_TR-180150_PI_Rev0

**NATA Accreditation No:** 1961 Perth  
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Sean Lenihan - Senior Laboratory Technician
# Plasticity Index Test Report

**Client:** Hatch  
61 Petrie Terrace, Brisbane  
**Project:** NTSF Embankment Failure ITRB  
**Location:** Cadia Mine  
**Date:** 2/10/18  
**Project No.:** 18101980

**Test procedure:** AS 1289.2.1.1, AS 1289 3.9.1, AS 1289.3.2.1, AS 1289.3.3.2 & AS 1289.3.4.1

<table>
<thead>
<tr>
<th>Laboratory Reference Number</th>
<th>181204</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Identification</td>
<td>18024 CE416 PT4</td>
</tr>
<tr>
<td></td>
<td>27.0-27.45m</td>
</tr>
<tr>
<td>Sample Description</td>
<td>CLAY</td>
</tr>
<tr>
<td>Liquid Limit (%)</td>
<td>67</td>
</tr>
<tr>
<td>Plastic Limit (%)</td>
<td>25</td>
</tr>
<tr>
<td>Plasticity Index (%)</td>
<td>41</td>
</tr>
<tr>
<td>Linear Shrinkage (%)</td>
<td>13.0</td>
</tr>
<tr>
<td>Moisture Content (%)</td>
<td>ND</td>
</tr>
<tr>
<td>Sample History</td>
<td>Air Dried</td>
</tr>
<tr>
<td>Method of Preparation</td>
<td>Dry Sieved</td>
</tr>
<tr>
<td>Length of Shrinkage Mould (mm)</td>
<td>125</td>
</tr>
<tr>
<td>Cracking, Curling or Crumbling</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Notes:**  
N.D. = Not Determined  
N.O. = Not Obtainable  
N.P. = Non Plastic

**Tested as received**  
**PLF1-041 RL1 14/09/18**

**Certificate Reference:** 18101980_181204_TR-180139_PI_Rev0

NATA Accreditation No: 1961 Perth  
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Sean Lenihan - Senior Laboratory Technician
## Plasticity Index Test Report

**Client:** Hatch  
61 Petrie Terrace, Brisbane  

**Project:** NTSF Embankment Failure ITRB  

**Location:** Cadia Mine  

**Date:** 26/09/18  

**Project No.:** 18101980

**Test procedure:** AS 1289.2.1.1, AS 1289 3.9.1, AS 1289.3.2.1, AS 1289.3.3.2 & AS 1289.3.4.1

<table>
<thead>
<tr>
<th>Laboratory Reference Number</th>
<th>181203</th>
</tr>
</thead>
</table>
| Sample Identification      | 18023 CE417 PT1  
16.5-16.86m |
| Sample Description         | CLAY |
| Liquid Limit (%)           | 61 |
| Plastic Limit (%)          | 24 |
| Plasticity Index (%)       | 36 |
| Linear Shrinkage (%)       | 12.5 |
| Moisture Content (%)       | ND |
| Sample History             | Air Dried |
| Method of Preparation      | Dry Sieved |
| Length of Shrinkage Mould (mm) | 125 |
| Cracking, Curling or Crumbling | Yes |

N.D. = Not Determined  
N.O. = Not Obtainable  
N.P. = Non Plastic

### Notes:

- Tested as received
- PLF1-041 RL1 14/09/18

**Certificate Reference:** 18101980_181203_TR-180139_PI_Rev0  

**NATA Accreditation No:** 1961 Perth  
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Sean Lenihan - Senior Laboratory Technician
## Plasticity Index Test Report

### Client:
Hatch  
61 Petrie Terrace, Brisbane

### Project:
NTSF Embankment Failure ITRB  
Hatch  
61 Petrie Terrace, Brisbane  
Cadia Mine  
18101980

### Location:
Perth

### Test procedure:
AS 1289.2.1.1, AS 1289 3.9.1, AS 1289.3.2.1, AS 1289.3.3.2 & AS 1289.3.4.1

<table>
<thead>
<tr>
<th>Laboratory Reference Number</th>
<th>181205</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Identification</td>
<td>18022 CE415 PT1</td>
</tr>
<tr>
<td>Sample Description</td>
<td>SILT</td>
</tr>
<tr>
<td>Liquid Limit (%)</td>
<td>56</td>
</tr>
<tr>
<td>Plastic Limit (%)</td>
<td>31</td>
</tr>
<tr>
<td>Plasticity Index (%)</td>
<td>25</td>
</tr>
<tr>
<td>Linear Shrinkage (%)</td>
<td>9.0</td>
</tr>
<tr>
<td>Moisture Content (%)</td>
<td>ND</td>
</tr>
<tr>
<td>Sample History</td>
<td>Air Dried</td>
</tr>
<tr>
<td>Method of Preparation</td>
<td>Dry Sieved</td>
</tr>
<tr>
<td>Length of Shrinkage Mould (mm)</td>
<td>125</td>
</tr>
<tr>
<td>Cracking, Curling or Crumbling</td>
<td>No</td>
</tr>
</tbody>
</table>

N.D. = Not Determined  
N.O. = Not Obtainable  
N.P. = Non Plastic

### Notes:
- Tested as received
- PLF1-041 RL1 14/09/18
- Certificate Reference: 18101980_181205_TR-180139_PI_Rev0
- NATA Accreditation No: 1961 Perth
- Accredited for compliance with ISO/IEC 17025-Testing
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Sean Lenihan - Senior Laboratory Technician
Particle Size Distribution, Hydrometer & Plasticity Index Test Report

Client: Hatch Pty Ltd
Project: Foundation Laboratory Testing
Location: Queensland
Lab Reference Number: 180609
Sample Identification: Foundation Material

Laboratory Specimen Description: Sandy CLAY
AS1726 - Soil Classification: CH

<table>
<thead>
<tr>
<th>Particle Size Distribution (AS 1289 3.6.1)</th>
<th>Hydrometer (AS 1289 3.6.3)</th>
<th>Plasticity Index and Moisture Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Passing</td>
<td>Sieve Size</td>
<td>Sieve Size</td>
</tr>
<tr>
<td>150.0 mm</td>
<td>100</td>
<td>0.062 mm</td>
</tr>
<tr>
<td>75.0 mm</td>
<td>100</td>
<td>0.044 mm</td>
</tr>
<tr>
<td>53.0 mm</td>
<td>100</td>
<td>0.032 mm</td>
</tr>
<tr>
<td>37.5 mm</td>
<td>100</td>
<td>0.023 mm</td>
</tr>
<tr>
<td>26.5 mm</td>
<td>100</td>
<td>0.016 mm</td>
</tr>
<tr>
<td>19.0 mm</td>
<td>100</td>
<td>0.012 mm</td>
</tr>
<tr>
<td>9.5 mm</td>
<td>100</td>
<td>0.009 mm</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>100</td>
<td>0.006 mm</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>100</td>
<td>0.004 mm</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>95</td>
<td>0.003 mm</td>
</tr>
<tr>
<td>0.600 mm</td>
<td>87</td>
<td>0.001 mm</td>
</tr>
<tr>
<td>0.425 mm</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>0.300 mm</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>0.150 mm</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>0.075 mm</td>
<td>55</td>
<td></td>
</tr>
</tbody>
</table>

Notes on Hydrometer test:

<table>
<thead>
<tr>
<th>Pretreatment</th>
<th>Omitted</th>
<th>Type of Hydrometer</th>
<th>ASTM</th>
<th>Type of dispersion</th>
<th>Mechanical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured Particle Density</td>
<td>2.78 g/cm³</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:

Tested as received

Certificate Reference: 18101981_180609_TR-180078_HYD_Rev0
NATA Accreditation No: 1961 Perth
Accredited for compliance with ISO/IEC 17025
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Stephen Abbey - Laboratory Manager (VIC)
## Particle Size Distribution, Hydrometer & Plasticity Index Test Report

**Client:** Hatch Pty Ltd  
**Project:** NTSF Embankment Failure ITRB  
**Location:** Cadia Mine  
**Date:** 22/06/18  
**Lab Reference Number:** 180721  
**Sample Identification:** 18005 TP401 0.7-1.0m  
**Project No.:** 18101980

### Laboratory Specimen Description
- **CLAY (with sand, trace of gravel)**
- **AS1726 - Soil Classification:** CH

### Particle Size Distribution

<table>
<thead>
<tr>
<th>Sieve Size (mm)</th>
<th>% Passing</th>
<th>150.0 mm</th>
<th>75.0 mm</th>
<th>53.0 mm</th>
<th>37.5 mm</th>
<th>26.5 mm</th>
<th>19.0 mm</th>
<th>9.5 mm</th>
<th>4.75 mm</th>
<th>1.18 mm</th>
<th>0.600 mm</th>
<th>0.425 mm</th>
<th>0.300 mm</th>
<th>0.150 mm</th>
<th>0.075 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sieve Size (mm)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

### Hydrometer

<table>
<thead>
<tr>
<th>Sieve Size (mm)</th>
<th>% Passing</th>
<th>71 Linear Shrinkage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sieve Size (mm)</td>
<td>82</td>
</tr>
</tbody>
</table>

### Plasticity Index and Moisture Content

<table>
<thead>
<tr>
<th>Test</th>
<th>Method</th>
<th>Result</th>
<th>Spec.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Limit</td>
<td>% AS 1289.3.1.2</td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td>Plastic Limit</td>
<td>% AS 1289 3.2.1</td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td>Plasticity Index</td>
<td>% AS 1289 3.3.1</td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td>Linear Shrinkage</td>
<td>% AS 1289 3.4.1</td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td>Moisture Content</td>
<td>% AS 1289 2.1.1</td>
<td>212</td>
<td></td>
</tr>
</tbody>
</table>

### Notes on Hydrometer test
- **Notes:** Air Dried
- **Preparation Method:** Dry Sieved
- **Cracking/Crumbling/Curling of linear shrinkage:** ND = not determined
- **Linear shrinkage mould length (mm):** NO = not obtainable
- **NP = non plastic**

### Notes:
- **Sample History:** Air Dried
- **Preparation Method:** Dry Sieved
- **Type of Hydrometer - ASTM**
- **Type of dispersion - Mechanical**

---

**Certificate Reference:** 18101980_180721_TR-180090_HYD_Rev0  
**NATA Accreditation No:** 1961 Perth  
**Accredited for compliance with ISO/IEC 17025**

---

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Stephen Abbey - Laboratory Technician (VIC)
**Particle Size Distribution, Hydrometer & Plasticity Index Test Report**

**Client:** Hatch  
61 Petrie Terrace, Brisbane

**Project:** NTSE Embankment Failure ITRB  
**Location:** Cadia Mine  
**Date:** 29/06/18

**Lab Reference Number:** 180788  
**Sample Identification:** 18006 TP405 Block Sample  
1.9-2.2mm

**AS1726 - Soil Classification:** CI

<table>
<thead>
<tr>
<th>Particle Size Distribution</th>
<th>Hydrometer</th>
<th>Plasticity Index and Moisture Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve Size</td>
<td>% Passing</td>
<td>Sieve Size</td>
</tr>
<tr>
<td>150.0 mm</td>
<td>100</td>
<td>0.063 mm</td>
</tr>
<tr>
<td>75.0 mm</td>
<td>100</td>
<td>0.045 mm</td>
</tr>
<tr>
<td>37.5 mm</td>
<td>100</td>
<td>0.023 mm</td>
</tr>
<tr>
<td>26.5 mm</td>
<td>100</td>
<td>0.017 mm</td>
</tr>
<tr>
<td>19.0 mm</td>
<td>100</td>
<td>0.012 mm</td>
</tr>
<tr>
<td>9.5 mm</td>
<td>100</td>
<td>0.009 mm</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>100</td>
<td>0.006 mm</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>100</td>
<td>0.004 mm</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>100</td>
<td>0.003 mm</td>
</tr>
<tr>
<td>0.600 mm</td>
<td>99</td>
<td>0.001 mm</td>
</tr>
<tr>
<td>0.425 mm</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td>0.300 mm</td>
<td>98</td>
<td></td>
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<tr>
<td>0.150 mm</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>0.075 mm</td>
<td>93</td>
<td></td>
</tr>
</tbody>
</table>

Notes:

**Tested as received**  
**Certificate Reference:** 18101980_180788_TR-180102_HYD_Rev0

**NATA Accreditation No:** 1961 Perth  
**Accredited for compliance with ISO/IEC 17025**

Stephen Abbey – Laboratory Manager (VIC)

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Soils testing - Particle size distribution & consistency limits test report

Standard method (by sieving) with hydrometer follow on AS1289.3.6.1, 3.6.3, 2.1.1, 3.1.2, 3.3.1, 3.4.1 & 3.5.1

Test request #: TRM18-0430 Lab sample ID: LMEL201809261

Client: Hatch
Client address: 61, Petrie Terrace, Brisbane

Project ID: 18101980 Lab report ref.: LMEL_18019632
Project name: NTSF Embankment Failure ITRB
Location: Hatch

Specimen description:
(Based on visual and tactile assessment)

(CH) CLAY, high plasticity, brown, trace, fine to coarse grained sand

Sample depth (m): 24.00 - 24.33
Client sample ref: EW

Date reported: 

Specimen history/notes:
Preparation of specimen and testing performed on sample supplied to the laboratory

Hydrometer:
Loss on pre-treatment: n/a
Dispersant: Sodium Hexametaphosphate

Definitions:
LB S = Lower bound specification
UB S = Upper bound specification

GRADING SUMMARY

<table>
<thead>
<tr>
<th>Clay*</th>
<th>Silt*</th>
<th>Fines</th>
<th>Sand*</th>
<th>Gravel*</th>
<th>Cobbles*</th>
</tr>
</thead>
<tbody>
<tr>
<td>(&gt;2 μm)</td>
<td>(&gt;2 μm - &lt;75 μm)</td>
<td>(&lt;75 μm)</td>
<td>(&gt;75 μm - &lt;2 mm)</td>
<td>(&gt;2 mm - &lt;60 mm)</td>
<td>(&gt;60 mm - &lt;200 mm)</td>
</tr>
<tr>
<td>70.1%</td>
<td>26.4%</td>
<td>96.4%</td>
<td>3.6%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

*Proportions based on linear interpolation between sieve/particle of nearest size and smaller

Hydrometer type = ASTM

PARTICLE SIZE DISTRIBUTION

<table>
<thead>
<tr>
<th>Size (μm)</th>
<th>% Finer</th>
</tr>
</thead>
<tbody>
<tr>
<td>75.0</td>
<td>96%</td>
</tr>
<tr>
<td>41.8</td>
<td>96%</td>
</tr>
<tr>
<td>29.8</td>
<td>94%</td>
</tr>
<tr>
<td>21.2</td>
<td>92%</td>
</tr>
<tr>
<td>15.0</td>
<td>92%</td>
</tr>
<tr>
<td>11.1</td>
<td>87%</td>
</tr>
<tr>
<td>7.9</td>
<td>85%</td>
</tr>
<tr>
<td>4.7</td>
<td>80%</td>
</tr>
<tr>
<td>3.6</td>
<td>76%</td>
</tr>
<tr>
<td>2.7</td>
<td>73%</td>
</tr>
<tr>
<td>2.1</td>
<td>71%</td>
</tr>
<tr>
<td>1.2</td>
<td>64%</td>
</tr>
</tbody>
</table>

These tests were carried out in accordance with the Australian standards identified in this certificate.
## Soils testing - Particle size distribution & consistency limits test report

Standard method (by sieving) with hydrometer follow on AS1289.3.6.1, 3.6.3, 2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1 & 3.5.1

### Test request #: TRM18-0430  Lab sample ID: LMEL201809260

### Client: Hatch
### Client address: 61, Petrie Terrace, Brisbane

### Project ID: 18101980  Lab report ref.: LMEL_18019631

### Project name: NTSF Embankment Failure ITRB
### Sample depth (m): 24.00 - 24.30
### Client sample ref: Residual
### Location: Hatch

#### Specimen description:
(Based on visual and tactile assessment)

- **CLAY**
- **Residual**
- **NLobb**
- **NTSF Embankment Failure ITRB**

<table>
<thead>
<tr>
<th>Sieve Size (mm)</th>
<th>Passing</th>
<th>LB S</th>
<th>UB S</th>
<th>Standard:</th>
</tr>
</thead>
<tbody>
<tr>
<td>125 mm</td>
<td>100%</td>
<td></td>
<td></td>
<td>AS 1289.2.1.1</td>
</tr>
<tr>
<td>75 mm</td>
<td>100%</td>
<td></td>
<td></td>
<td>AS 1289.3.1.2</td>
</tr>
<tr>
<td>63 mm</td>
<td>100%</td>
<td></td>
<td></td>
<td>AS 1289.3.2.1</td>
</tr>
<tr>
<td>53 mm</td>
<td>100%</td>
<td></td>
<td></td>
<td>AS 1289.3.3.1</td>
</tr>
<tr>
<td>37.5 mm</td>
<td>100%</td>
<td></td>
<td></td>
<td>AS 1289.3.4.1</td>
</tr>
<tr>
<td>26.5 mm</td>
<td>100%</td>
<td></td>
<td></td>
<td>AS 1289.3.5.1</td>
</tr>
<tr>
<td>19 mm</td>
<td>100%</td>
<td></td>
<td></td>
<td>AS 1289.3.1.1</td>
</tr>
<tr>
<td>13.2 mm</td>
<td>100%</td>
<td></td>
<td></td>
<td>AS 1289.3.2.1</td>
</tr>
<tr>
<td>9.5 mm</td>
<td>100%</td>
<td></td>
<td></td>
<td>AS 1289.3.3.1</td>
</tr>
<tr>
<td>6.7 mm</td>
<td>100%</td>
<td></td>
<td></td>
<td>AS 1289.3.4.1</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>100%</td>
<td></td>
<td></td>
<td>AS 1289.3.5.1</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>99%</td>
<td></td>
<td></td>
<td>AS 1289.2.1.1</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>97%</td>
<td></td>
<td></td>
<td>AS 1289.3.2.1</td>
</tr>
<tr>
<td>600 μm</td>
<td>92%</td>
<td></td>
<td></td>
<td>AS 1289.3.3.1</td>
</tr>
<tr>
<td>425 μm</td>
<td>89%</td>
<td></td>
<td></td>
<td>AS 1289.3.4.1</td>
</tr>
<tr>
<td>300 μm</td>
<td>86%</td>
<td></td>
<td></td>
<td>AS 1289.3.5.1</td>
</tr>
<tr>
<td>150 μm</td>
<td>78%</td>
<td></td>
<td></td>
<td>AS 1289.2.1.1</td>
</tr>
<tr>
<td>75 μm</td>
<td>67%</td>
<td></td>
<td></td>
<td>AS 1289.3.2.1</td>
</tr>
</tbody>
</table>

### PARTICLE SIZE DISTRIBUTION

#### Hydrometer: (AS1289.3.6.3)

<table>
<thead>
<tr>
<th>Size (μm)</th>
<th>% Finer</th>
</tr>
</thead>
<tbody>
<tr>
<td>75.0</td>
<td>67%</td>
</tr>
<tr>
<td>62.7</td>
<td>65%</td>
</tr>
<tr>
<td>44.8</td>
<td>61%</td>
</tr>
<tr>
<td>32.0</td>
<td>57%</td>
</tr>
<tr>
<td>22.9</td>
<td>53%</td>
</tr>
<tr>
<td>16.3</td>
<td>51%</td>
</tr>
<tr>
<td>12.1</td>
<td>43%</td>
</tr>
<tr>
<td>8.7</td>
<td>39%</td>
</tr>
<tr>
<td>5.4</td>
<td>35%</td>
</tr>
<tr>
<td>4.1</td>
<td>30%</td>
</tr>
<tr>
<td>3.1</td>
<td>26%</td>
</tr>
<tr>
<td>2.4</td>
<td>24%</td>
</tr>
<tr>
<td>1.3</td>
<td>20%</td>
</tr>
</tbody>
</table>

### Hydrometer type = ASTM

**Proportions based on linear interpolation between sieve/particle of nearest size and smaller**

#### Hydrometer:
- **Loss on pre-treatment:** n/a
- **Dispersant:** Sodium Hexametaphosphate

#### Definitions:
- **LB S:** Lower bound specification
- **UB S:** Upper bound specification
- **NSM:** Non shrinking mould
- **PSD:** Particle size distribution

#### PSD = Particle size distribution

#### Linear shrinkage:
- **Cracking**
- **Curling**

### Grading Summary

<table>
<thead>
<tr>
<th>Clay*</th>
<th>Silt*</th>
<th>Fines</th>
<th>Sand*</th>
<th>Gravel*</th>
<th>Cobbles*</th>
</tr>
</thead>
<tbody>
<tr>
<td>(&lt;2 μm)</td>
<td>(&gt;2 μm - &lt;75 μm)</td>
<td>(&gt;75 μm - &lt;2 mm)</td>
<td>(&gt;2 mm - &lt;60 mm)</td>
<td>(&gt;60 mm - &lt;200 mm)</td>
<td></td>
</tr>
<tr>
<td>22.8%</td>
<td>44.3%</td>
<td>67.2%</td>
<td>32.0%</td>
<td>0.8%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

### Hydrometer type = ASTM

#### Specimen history/notes:
Preparation of specimen and testing performed on sample supplied to the laboratory

### Sampling co-ordinates:
- **Easting (m)**
- **Northing (m)**
- **Reduced Level**

### Summary

- **Project Reference:**
- **Lab report ref:** LMEL_18019631
- **Client:** Hatch
- **Sample depth (m):** 24.00 - 24.30
- **Sample type:** Residual
- **Location:** Hatch

### Soil Testing - Particle Size Distribution (PSD)

<table>
<thead>
<tr>
<th>Size (μm)</th>
<th>% Finer</th>
</tr>
</thead>
<tbody>
<tr>
<td>75.0</td>
<td>67%</td>
</tr>
<tr>
<td>62.7</td>
<td>65%</td>
</tr>
<tr>
<td>44.8</td>
<td>61%</td>
</tr>
<tr>
<td>32.0</td>
<td>57%</td>
</tr>
<tr>
<td>22.9</td>
<td>53%</td>
</tr>
<tr>
<td>16.3</td>
<td>51%</td>
</tr>
<tr>
<td>12.1</td>
<td>43%</td>
</tr>
<tr>
<td>8.7</td>
<td>39%</td>
</tr>
<tr>
<td>5.4</td>
<td>35%</td>
</tr>
<tr>
<td>4.1</td>
<td>30%</td>
</tr>
<tr>
<td>3.1</td>
<td>26%</td>
</tr>
<tr>
<td>2.4</td>
<td>24%</td>
</tr>
<tr>
<td>1.3</td>
<td>20%</td>
</tr>
</tbody>
</table>

### Testing performed by:
- **Cert.:** 18101980_18026 CE417 PT4_TRM18-0430_CLSF_s1809260_Rep18019631
- **NATA accreditation number:** 1961 - Site:1250 - Melbourne
- **Approved signatory:** Nick Lobb - Senior Technician

### Contact Information:
- **Phone:** +61 (03) 8862 3500
- **Fax:** +61 (03) 8862 3501
- **Email:** melbgeolab@golder.com.au
- **Web:** www.golder.com.au

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**THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL**
Soils testing - Particle size distribution & consistency limits test report

Test request #: TRM18-0407  Lab sample ID: LMEL201809106

Client: Hatch
Client address: 61 Petrie Terrace, Brisbane

Project ID: 18101980  Lab report ref.: LMEL_18019421_7

Project name: NTSF Embankment Failure ITRB  Exploratory Hole 18024 CE416

Location: Cadia Mine  Project Reference: -

Specimen description: CH/CLAY, high plasticity, red brown

PARTICLE SIZE DISTRIBUTION  AS 1289.3.6.1

Sieve Size  Passing  LB S  UB S  Standard:

<table>
<thead>
<tr>
<th>Size</th>
<th>% Passing</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>75 mm</td>
<td>100%</td>
<td>AS 1289.2.1.1</td>
</tr>
<tr>
<td>63 mm</td>
<td>100%</td>
<td>AS 1289.3.1.2</td>
</tr>
<tr>
<td>53 mm</td>
<td>100%</td>
<td>AS 1289.3.2.1</td>
</tr>
<tr>
<td>37.5 mm</td>
<td>100%</td>
<td>AS 1289.3.3.1</td>
</tr>
<tr>
<td>26.5 mm</td>
<td>100%</td>
<td>AS 1289.4.1</td>
</tr>
<tr>
<td>19 mm</td>
<td>100%</td>
<td>AS 1289.5.1</td>
</tr>
<tr>
<td>13.2 mm</td>
<td>100%</td>
<td>AS 1289.6.1</td>
</tr>
<tr>
<td>9.5 mm</td>
<td>100%</td>
<td>AS 1289.7.1</td>
</tr>
<tr>
<td>6.7 mm</td>
<td>100%</td>
<td>AS 1289.8.1</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>100%</td>
<td>AS 1289.9.1</td>
</tr>
<tr>
<td>3 mm</td>
<td>100%</td>
<td>AS 1289.10.1</td>
</tr>
<tr>
<td>0.6 mm</td>
<td>100%</td>
<td>AS 1289.11.1</td>
</tr>
</tbody>
</table>

Result: 37.7% Liquid limit

Curling/Crumbling/ Cracking

Hydrometer: Linear shrinkage mould

Sample depth (m): 27.00 - 27.45

Sample history/notes: Preparation of specimen and testing performed on sample supplied to laboratory

Grading Summary

Grading Summary

<table>
<thead>
<tr>
<th>Size</th>
<th>% Finer</th>
</tr>
</thead>
<tbody>
<tr>
<td>75.0 μm</td>
<td>98%</td>
</tr>
<tr>
<td>58.4 μm</td>
<td>97%</td>
</tr>
<tr>
<td>41.8 μm</td>
<td>92%</td>
</tr>
<tr>
<td>29.9 μm</td>
<td>88%</td>
</tr>
<tr>
<td>21.3 μm</td>
<td>85%</td>
</tr>
<tr>
<td>15.1 μm</td>
<td>83%</td>
</tr>
<tr>
<td>11.2 μm</td>
<td>79%</td>
</tr>
<tr>
<td>8.0 μm</td>
<td>74%</td>
</tr>
<tr>
<td>5.7 μm</td>
<td>70%</td>
</tr>
<tr>
<td>4.1 μm</td>
<td>63%</td>
</tr>
<tr>
<td>2.7 μm</td>
<td>54%</td>
</tr>
<tr>
<td>2.1 μm</td>
<td>50%</td>
</tr>
<tr>
<td>1.3 μm</td>
<td>39%</td>
</tr>
</tbody>
</table>

Hydrometer (AS1289.3.6.1):

<table>
<thead>
<tr>
<th>Size</th>
<th>% Finer</th>
</tr>
</thead>
<tbody>
<tr>
<td>75.0 μm</td>
<td>98%</td>
</tr>
<tr>
<td>58.4 μm</td>
<td>97%</td>
</tr>
<tr>
<td>41.8 μm</td>
<td>92%</td>
</tr>
<tr>
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<td>88%</td>
</tr>
<tr>
<td>21.3 μm</td>
<td>85%</td>
</tr>
<tr>
<td>15.1 μm</td>
<td>83%</td>
</tr>
<tr>
<td>11.2 μm</td>
<td>79%</td>
</tr>
<tr>
<td>8.0 μm</td>
<td>74%</td>
</tr>
<tr>
<td>5.7 μm</td>
<td>70%</td>
</tr>
<tr>
<td>4.1 μm</td>
<td>63%</td>
</tr>
<tr>
<td>2.7 μm</td>
<td>54%</td>
</tr>
<tr>
<td>2.1 μm</td>
<td>50%</td>
</tr>
<tr>
<td>1.3 μm</td>
<td>39%</td>
</tr>
</tbody>
</table>

These tests were carried out in accordance with the Australian standards identified in this certificate.

Certified by: 18101980_18024_CE416_TRM18-0407_CLSF_s1809106_Rep019421_7

NATA accreditation number: 1961 - Site:1250 - Melbourne
Accredited for compliance with ISO/IEC 17025 - Testing

Approved signatory: Gayani Samaradiwicka - Senior Laboratory Engineer

Golder Associates Pty Ltd
MELBOURNE GEOTECHNICAL LABORATORY
Building 7, Botanicca Corporate Park
570 - 588 Swan Street
Richmond, Victoria 3121

Lab report ref.: LMEL_18019421_7

E-mail: melgeolab@golder.com.au  Web: www.golder.com.au

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL
Soils testing - Particle size distribution & consistency limits test report
Standard method (by sieving) with hydrometer follow on AS1289.3.6.1, 3.6.3, 2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1 & 3.5.1

Client: Hatch
Client address: 61 Petrie Terrace, Brisbane
Project ID: 18101980
Project name: NTSF Embankment Failure ITRB
Location: Cadia Mine

Specimen description:
(Clarification by visual and tactile assessment)

**PARTICLE SIZE DISTRIBUTION**

<table>
<thead>
<tr>
<th>Sieve Size (mm)</th>
<th>Passing (%)</th>
<th>LB S</th>
<th>UB S</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>100</td>
<td></td>
<td></td>
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<tr>
<td>63</td>
<td>100</td>
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<tr>
<td>53</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37.5</td>
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<tr>
<td>26.5</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.2</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.5</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.7</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.75</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.36</td>
<td>98</td>
<td></td>
<td></td>
</tr>
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<td>1.18</td>
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</tr>
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</tbody>
</table>

Hydrometer (AS1289.3.6.3):

<table>
<thead>
<tr>
<th>Size (μm)</th>
<th>% Finer</th>
</tr>
</thead>
<tbody>
<tr>
<td>75.0</td>
<td>90%</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>45.2</td>
<td>83%</td>
</tr>
<tr>
<td>32.2</td>
<td>80%</td>
</tr>
<tr>
<td>23.0</td>
<td>76%</td>
</tr>
<tr>
<td>16.5</td>
<td>69%</td>
</tr>
<tr>
<td>12.1</td>
<td>66%</td>
</tr>
<tr>
<td>8.7</td>
<td>62%</td>
</tr>
<tr>
<td>6.2</td>
<td>57%</td>
</tr>
<tr>
<td>4.5</td>
<td>50%</td>
</tr>
<tr>
<td>3.0</td>
<td>45%</td>
</tr>
<tr>
<td>1.3</td>
<td>34%</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Grading Summary**

- **Clay** (<2 μm) 38.3%
- **Silt** (<2 μm - <75 μm) 51.5%
- **Fines** (<75 μm) 89.8%
- **Sand** (<75 μm - <2 mm) 7.9%
- **Gravel** (<2 mm - <60 mm) 2.3%
- **Cobbles** (<60 mm - <200 mm) 0.0%

**Hydrometer**:

- **Hydrometer type**: ASTM
- **Loss on pre-treatment**: n/a
- **Dispersant**: Sodium Hexametaphosphate
- **Definitions**
  - LSM = Linear shrinkage mould
  - UB S = Upper bound specification
  - LB S = Lower bound specification
  - NP = Non plastic
  - ND = Not determined

**Testing performed by**: LM
**Results reviewed by**: GSamaradiwakara
**Date reported**: 2/10/2018

**NATA accreditation number**: 1961 - Site: 1250 - Melbourne
Accredited for compliance with ISO/IEC 17025 - Testing

**Approved signatory**: Gayani Samaradiwakara - Senior Laboratory Engineer

**Company**

Golder Associates Pty Ltd
MELBOURNE GEOTECHNICAL LABORATORY
Building 7, Botanica Corporate Park
570 - 588 Swan Street
Richmond, Victoria 3121

**E-mail**: melbgeolab@golder.com.au
**Web**: www.golder.com.au

---

These tests were carried out in accordance with the Australian standards identified in this certificate.

Rep Combined PSD Hydro - RL18
Soils testing - Particle size distribution & consistency limits test report

Test request #: TRM18-0407  Lab sample ID: LMEL201809107

**Client:** Hatch

**Client address:** 61, Petrie Terrace, Brisbane

**Project ID:** 18101980  Lab report ref.: LMEL_18019419_6

**Project name:** NTFS Embankment Failure ITRB

**Location:** Cadia Mine

**Project Reference:** Exploratory Hole 18022 CE415

**Sample depth (m):** 6.00 - 6.50  **Client sample ref:** PT1

---

**PARTICLE SIZE DISTRIBUTION**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Passing</th>
<th>LB S</th>
<th>UB S</th>
<th>Standard:</th>
</tr>
</thead>
<tbody>
<tr>
<td>125 mm</td>
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<td></td>
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<tr>
<td>75 mm</td>
<td>100%</td>
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<tr>
<td>63 mm</td>
<td>100%</td>
<td></td>
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<td>100%</td>
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<tr>
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<td>100%</td>
<td></td>
<td></td>
<td>AS 1289.3.9.1</td>
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<tr>
<td>13.2 mm</td>
<td>100%</td>
<td></td>
<td></td>
<td>AS 1289.3.10.1</td>
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<tr>
<td>9.5 mm</td>
<td>100%</td>
<td></td>
<td></td>
<td>AS 1289.3.11.1</td>
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<td>6.7 mm</td>
<td>100%</td>
<td></td>
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<td>AS 1289.3.12.1</td>
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<td>4.75 mm</td>
<td>100%</td>
<td></td>
<td></td>
<td>AS 1289.3.13.1</td>
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<td>2.36 mm</td>
<td>100%</td>
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<td></td>
<td>AS 1289.3.14.1</td>
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<tr>
<td>1.18 mm</td>
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<td></td>
<td></td>
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<tr>
<td>600 μm</td>
<td>98%</td>
<td></td>
<td></td>
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<tr>
<td>425 μm</td>
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<td></td>
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<td>AS 1289.3.17.1</td>
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<tr>
<td>300 μm</td>
<td>97%</td>
<td></td>
<td></td>
<td>AS 1289.3.18.1</td>
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<tr>
<td>150 μm</td>
<td>95%</td>
<td></td>
<td></td>
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<tr>
<td>75 μm</td>
<td>93%</td>
<td></td>
<td></td>
<td>AS 1289.3.20.1</td>
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**Specimen description:** (Based on visual and tactile assessment) M(H) Clayey Silt, high liquid limit, red brown, trace sand

**Hydrometer:** Loss on pre-treatment: n/a  Dispersant: Sodium Hexametaphosphate

**Definitions:**
- LSM = Linear shrinkage mould
- ND = Not determined
- NP = Non plastic
- PSD = Particle size distribution
- UB S = Upper bound specification
- LB S = Lower bound specification
- No = Not applicable

**GRADING SUMMARY**

<table>
<thead>
<tr>
<th>Particle Size</th>
<th>Proportion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2 μm</td>
<td>44.1%</td>
</tr>
<tr>
<td>2 - &lt;75 μm</td>
<td>48.7%</td>
</tr>
<tr>
<td>75 - &lt;200 μm</td>
<td>92.9%</td>
</tr>
<tr>
<td>200 - &lt;600 μm</td>
<td>7.1%</td>
</tr>
<tr>
<td>&gt;600 μm</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

**Hydrometer type:** ASTM

---

**Testing performed by:** LM  **Results reviewed by:** GSamaradiwakara  **Date reported:** 2/10/2018

**Cert. ref.:** 18101980_18022 CE415_TRM18-0407_CLSF_s1809107_Rep019419_6  **Approved signatory:** Gayani Samaradiwakara - Senior Laboratory Engineer

---

**NATA accreditation number:** 1961 - Site:1250 - Melbourne

Approved for compliance with ISO/IEC 17025 - Testing

**THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL**

---

**Contact:**
- Phone: +61 (03) 8862 3500
- Fax: +61 (03) 8862 3501
- E-mail: melgeolab@golder.com.au
- Web: www.golder.com.au

---

These tests were carried out in accordance with the Australian standards identified in this certificate.
# Soil Particle Density Report

**Client:** Hatch  
61 Petrie Terrace, Brisbane  
**Project:** NTSP Embankment Failure ITRB  
**Location:** Cadia Mine  
**Date:** 29/06/18  
**Project No.:** 18101981  
**Test procedure:** AS 1289.3.5.1

<table>
<thead>
<tr>
<th>Laboratory Reference Number</th>
<th>180609</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Identification</td>
<td>PL-BS1</td>
</tr>
<tr>
<td>0-0.5m</td>
<td></td>
</tr>
<tr>
<td>Material Description</td>
<td>Sandy CLAY</td>
</tr>
<tr>
<td>Temperature of Test (°C)</td>
<td>21</td>
</tr>
<tr>
<td>The average apparent Particle Density of the fraction passing 2.36mm (g/cm³)</td>
<td>2.78</td>
</tr>
</tbody>
</table>

**Notes:** This test certificate replaces test certificate reference 18101981_180609_TR-180078_SG_Rev0

---

**Certificate Reference:** 18101981_180609_TR-180078_SG_REV1  
**NATA Accreditation No.:** 1961 Perth  
**Accredited for compliance with ISO/IEC 17025**  
**THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL**  
**Stephen Abbey - Laboratory Manager (VIC)**
## Soil Particle Density Report

**Perth Laboratory**  
84 Guthrie Street Osborne Park  
Perth WA 6017  
P: +61 8 9441 0700  F: +61 8 9441 0701  
www.golder.com  
perthlab@golder.com.au

| Client:       | Hatch  
|---------------|--------|
| Project:      | NTSF Embankment Failure ITRB  
| Location:     | Cadia Mine  
| Date:         | 29/06/18  
| Project No.:  | 18101980  
| Test procedure: | AS 1289.3.5.1  

### Laboratory Reference Number

- 180788

### Sample Identification

- 18006 TP405 Block Sample  
- 1.9-2.2m

### Material Description

- CLAY (trace of sand)

### Temperature of Test (°C)

- 20

### The average apparent Particle Density of the fraction passing 2.36mm (g/cm³)

- 2.75

---

**Notes:**

**Tested as received**  
PLF1-011 RL0 7/12/12
Sample preparation

A subsample was cored into a stainless steel ring. The subsample bulk density was measured directly from the internal volume of the ring and its wet mass. The subsample was removed from the ring and placed in a 110° oven for gravimetric moisture content measurement.

<table>
<thead>
<tr>
<th>Mass - As Received Sample</th>
<th>g</th>
<th>1478.7</th>
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</thead>
<tbody>
<tr>
<td>Water Content</td>
<td>%</td>
<td>19.8</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>t/m³</td>
<td>2.09</td>
</tr>
</tbody>
</table>
Sample preparation
A subsample was cored into a stainless steel ring. The subsample bulk density was measured directly from the internal volume of the ring and its wet mass. The subsample was removed from the ring and placed in a 110⁰ oven for gravimetric moisture content measurement.

<table>
<thead>
<tr>
<th>Mass - As Received Sample</th>
<th>g</th>
<th>1052.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Content</td>
<td>%</td>
<td>13.6</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>t/m³</td>
<td>2.05</td>
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</tbody>
</table>
# ATTERBERG LIMITS TEST REPORT

## Test Method:
AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

<table>
<thead>
<tr>
<th>Client</th>
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<tbody>
<tr>
<td>Address</td>
<td>PO Box 425 SPRING HILL QLD 4004</td>
</tr>
<tr>
<td>Report No.</td>
<td>18050383-AL</td>
</tr>
<tr>
<td>Workorder No.</td>
<td>0004181</td>
</tr>
<tr>
<td>Report Date</td>
<td>11/06/2018</td>
</tr>
</tbody>
</table>

## Project
H356804 - Cadia NTSF Failure - Containment Bund - Left Abutment

## Test Results

| Sample No. | 18050383 |
| Test Date  | 5/06/2018 |
| Client ID  | BM1 - BS1 |
| Depth (m)  | 1.00-1.20 |
| Liquid Limit (%) | 46 |
| Plastic Limit (%) | 25 |
| Plasticity Index (%) | 21 |
| Linear Shrinkage (%) | 11.5 * |
| Moisture Content (%) | 40.7 |

## NOTES/REMARKS:
The samples were tested oven dried, dry sieved and in a 125-250mm mould.

Sample/s supplied by the client: *
Cracking occurred + Curling occurred

Authorised Signatory

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in
this document are traceable to Australian/National Standards.
Tested at Trilab Brisbane Laboratory.

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
# ATTERBERG LIMITS TEST REPORT

**Test Method:** AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

<table>
<thead>
<tr>
<th>Client</th>
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<th>Report No.</th>
<th>18060849-AL</th>
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<tbody>
<tr>
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<td>Workorder No.</td>
<td>0004435</td>
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<tr>
<td>Project</td>
<td>H356804 - Cadia</td>
<td>Report Date</td>
<td>13/07/2018</td>
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<table>
<thead>
<tr>
<th>Sample No.</th>
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<tbody>
<tr>
<td>Test Date</td>
<td>12/07/2018</td>
</tr>
<tr>
<td>Client ID</td>
<td>DH-410</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>19.65-19.95</td>
</tr>
<tr>
<td>Liquid Limit (%)</td>
<td>33</td>
</tr>
<tr>
<td>Plastic Limit (%)</td>
<td>23</td>
</tr>
<tr>
<td>Plasticity Index (%)</td>
<td>10</td>
</tr>
<tr>
<td>Linear Shrinkage (%)</td>
<td>6.0 +</td>
</tr>
<tr>
<td>Moisture Content (%)</td>
<td>22.3</td>
</tr>
</tbody>
</table>

**NOTES/REMARKS:** The samples were tested in a natural state, wet sieved and in a 125-250mm mould.

Sample/s supplied by the client * Cracking occurred + Curling occurred

Authorised Signatory

T. Lockhart

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.
# ATTERBERG LIMITS TEST REPORT

**Test Method:** AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

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<td>Workorder No.</td>
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<td>Report Date</td>
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<table>
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<th>18080180</th>
<th>18080182</th>
<th>18080183</th>
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<tbody>
<tr>
<td>Test Date</td>
<td>20/08/18</td>
<td>20/08/18</td>
<td>20/08/18</td>
<td>23/08/18</td>
<td>23/08/18</td>
</tr>
<tr>
<td>Client ID</td>
<td>CE408 - DH401</td>
<td>CE407 - DH402</td>
<td>CE407 - DH402</td>
<td>CE413 - DH404</td>
<td>CE406 - DH410</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>16.00</td>
<td>23.00</td>
<td>30.50</td>
<td>53.50-53.80</td>
<td>18.40-18.50</td>
</tr>
<tr>
<td>Liquid Limit (%)</td>
<td>22</td>
<td>20</td>
<td>Not Obtainable</td>
<td>39</td>
<td>71</td>
</tr>
<tr>
<td>Plastic Limit (%)</td>
<td>17</td>
<td>15</td>
<td>Not Obtainable</td>
<td>15</td>
<td>24</td>
</tr>
<tr>
<td>Plasticity Index (%)</td>
<td>5</td>
<td>5</td>
<td>Non Plastic</td>
<td>24</td>
<td>47</td>
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<tr>
<td>Linear Shrinkage (%)</td>
<td>2.0 *</td>
<td>2.0</td>
<td>Not Obtainable</td>
<td>12.5 +</td>
<td>19.0 +</td>
</tr>
<tr>
<td>Moisture Content (%)</td>
<td>21.5</td>
<td>18.6</td>
<td>15.6</td>
<td>20.1</td>
<td>27.5</td>
</tr>
</tbody>
</table>

## NOTES/REMARKS:

The samples were tested air dried, dry sieved and in a 125-250mm mould.

Sample/s supplied by the client

* Cracking occurred  + Curling occurred

Authorised Signatory: C. Channon

Accredited for compliance with ISO/IEC 17025 - Testing. The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.
**ATTERBERG LIMITS TEST REPORT**

Test Method: AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

<table>
<thead>
<tr>
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<th>18080185</th>
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<th>18080189</th>
<th>18080192</th>
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<td>21/08/2018</td>
<td>23/08/2018</td>
<td>20/08/2018</td>
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<tr>
<td>Client ID</td>
<td>CE408 - DH401 - PS1</td>
<td>CE408 - DH402 - PS3</td>
<td>CE407 - DH404 - PS2</td>
<td>CE407 - DH402 - PS1</td>
<td>CE407 - DH402 - PT3</td>
<td>CE412 - DH405 - PT2</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>11.00-11.50</td>
<td>25.00-25.45</td>
<td>12.00-12.45</td>
<td>25.95-26.40</td>
<td>51.00-51.50</td>
<td>39.50-39.72</td>
</tr>
<tr>
<td>Liquid Limit (%)</td>
<td>21</td>
<td>Not Obtainable</td>
<td>21</td>
<td>18</td>
<td>51</td>
<td>81</td>
</tr>
<tr>
<td>Plastic Limit (%)</td>
<td>17</td>
<td>Not Obtainable</td>
<td>17</td>
<td>16</td>
<td>19</td>
<td>37</td>
</tr>
<tr>
<td>Plasticity Index (%)</td>
<td>4</td>
<td>Non Plastic</td>
<td>4</td>
<td>2</td>
<td>32</td>
<td>44</td>
</tr>
<tr>
<td>Linear Shrinkage (%)</td>
<td>1.0 *</td>
<td>Not Obtainable</td>
<td>1.0 *</td>
<td>0.5 *</td>
<td>15.0 +</td>
<td>17.5 +</td>
</tr>
<tr>
<td>Moisture Content (%)</td>
<td>20.2</td>
<td>17.8</td>
<td>23.1</td>
<td>21.6</td>
<td>23.2</td>
<td>48.5</td>
</tr>
</tbody>
</table>

**NOTES/REMARKS:** The samples were tested air dried, dry sieved and in a 125-250mm mould.

Sample/s supplied by the client  
* Cracking occurred  
+ Curling occurred

---

**Authorised Signatory**

T. Lockhart

C. Channon

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

**Laboratory No. 9926**

Trilab Pty Ltd  
ABN 25 065 630 506

**ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING**
# ATTERBERG LIMITS TEST REPORT

**Test Method:** AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

<table>
<thead>
<tr>
<th>Client</th>
<th>Hatch Pty Ltd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>PO Box 425 SPRING HILL QLD 4004</td>
</tr>
<tr>
<td>Project</td>
<td>H356804 - Cadia NTSF Failure</td>
</tr>
</tbody>
</table>

### Sample Details

<table>
<thead>
<tr>
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<th>Test Date</th>
<th>Client ID</th>
<th>Depth (m)</th>
<th>Liquid Limit (%)</th>
<th>Plastic Limit (%)</th>
<th>Plasticity Index (%)</th>
<th>Linear Shrinkage (%)</th>
<th>Moisture Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18080415</td>
<td>6/09/2018</td>
<td>CE412 - DH405 SA3</td>
<td>60.70-60.80</td>
<td>34</td>
<td>16</td>
<td>18</td>
<td>7.0 +</td>
<td>11.7</td>
</tr>
<tr>
<td>18080417</td>
<td>6/09/2018</td>
<td>CE412 - DH405 SA8</td>
<td>65.50-66.00</td>
<td>50</td>
<td>23</td>
<td>27</td>
<td>11.5</td>
<td>25.5</td>
</tr>
<tr>
<td>18080420</td>
<td>6/09/2018</td>
<td>CE417 - DH406 L2B</td>
<td>18.50-19.00</td>
<td>80</td>
<td>32</td>
<td>48</td>
<td>19.0 +</td>
<td>42.3</td>
</tr>
<tr>
<td>18080425</td>
<td>6/09/2018</td>
<td>CE417 - DH406 SA6</td>
<td>25.90-26.00</td>
<td>54</td>
<td>30</td>
<td>24</td>
<td>9.0 *</td>
<td>36.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Test Date</th>
<th>Client ID</th>
<th>Depth (m)</th>
<th>Liquid Limit (%)</th>
<th>Plastic Limit (%)</th>
<th>Plasticity Index (%)</th>
<th>Linear Shrinkage (%)</th>
<th>Moisture Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18080426</td>
<td>6/09/2018</td>
<td>CE415 - DH408 SA1</td>
<td>4.12-4.30</td>
<td>52</td>
<td>18</td>
<td>33</td>
<td>8.5 *</td>
<td>38.4</td>
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<tr>
<td>18080436</td>
<td>6/09/2018</td>
<td>CE416 - DH407 L1B</td>
<td>23.00-23.50</td>
<td>59</td>
<td>27</td>
<td>28</td>
<td>22.0 *</td>
<td>27.7</td>
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<tr>
<td>18080439</td>
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<td>60</td>
<td>29</td>
<td>31</td>
<td>11.0 *</td>
<td>38.7</td>
</tr>
</tbody>
</table>

### Notes/Remarks:
The samples were tested oven dried, dry sieved and in a 125-250mm mould.

Sample/s supplied by the client * Cracking occurred + Curling occurred

---

Accredited for compliance with ISO/IEC 17025 - Testing. The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards. Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Park

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated. Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
# ATTERBERG LIMITS TEST REPORT

---

## Test Method

- AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

---

### Client

Hatch Pty Ltd

### Report No.

18080441-AL

### Workorder No.

0004681

### Address

PO Box 425 SPRING HILL QLD 4004

### Report Date

12/09/2018

### Project

H356804 - Cadia NTSF Failure

---

## Sample Information

<table>
<thead>
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<td>Test Date</td>
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<tr>
<td>Client ID</td>
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</tr>
<tr>
<td>Depth (m)</td>
<td>26.50-27.00</td>
</tr>
<tr>
<td>Liquid Limit (%)</td>
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<tr>
<td>Linear Shrinkage (%)</td>
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</tr>
<tr>
<td>Moisture Content (%)</td>
<td>38.4</td>
</tr>
</tbody>
</table>

---

## Notes/Remarks:

The samples were tested oven dried, dry sieved and in a 125-250mm mould.

---

**Sample/s supplied by the client**

- * Cracking occurred
- + Curling occurred

---

**Authorised Signatory**

T. Lockhart

---

**Accredited for compliance with ISO/IEC 17025 - Testing**

The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

---

**Laboratory No. 9926**

TRILAB Pty Ltd

346A Bilsen Road, Geebung

QLD 4034

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Perth

2 Kimmer Place, Queens Park

WA 6107

Ph: +61 8 9258 8323

**STRICTLY CONFIDENTIAL**

ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING
### ATTERBERG LIMITS TEST REPORT

**Test Method:** AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

<table>
<thead>
<tr>
<th>Client</th>
<th>Hatch Pty Ltd</th>
<th>Report No.</th>
<th>18090290-AL</th>
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<tbody>
<tr>
<td>Address</td>
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<td>Workorder No.</td>
<td>0004846</td>
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<td>Project</td>
<td>H356804 - Cadia NTSF Failure - Request 8</td>
<td>Report Date</td>
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#### Sample No. 18090290

<table>
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<th>Test Date</th>
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<tbody>
<tr>
<td>Client ID</td>
<td>CE432 - L1B</td>
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<tr>
<td>Depth (m)</td>
<td>19.80-20.30</td>
</tr>
<tr>
<td>Liquid Limit (%)</td>
<td>40</td>
</tr>
<tr>
<td>Plastic Limit (%)</td>
<td>27</td>
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<tr>
<td>Plasticity Index (%)</td>
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</tr>
<tr>
<td>Linear Shrinkage (%)</td>
<td>8.0 *</td>
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<td>Moisture Content (%)</td>
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#### Sample No.

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<td></td>
</tr>
<tr>
<td>Plasticity Index (%)</td>
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<td>Linear Shrinkage (%)</td>
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<tr>
<td>Moisture Content (%)</td>
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</tbody>
</table>

**NOTES/REMARKS:** The samples were tested air dried, dry sieved and in a 125-250mm mould.

Sample/s supplied by the client * Cracking occurred + Curling occurred

**Authorised Signatory**

C. Channon

Laboratory No. 9926

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
## ATTERBERG LIMITS TEST REPORT

**Test Method:** AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

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<td>CE432 - L1C Lexan</td>
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<td>Liquid Limit (%)</td>
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<td>Linear Shrinkage (%)</td>
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<td>6.0 +</td>
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**NOTES/REMARKS:**

The samples were tested in an air dried state, dry sieved and in a 125-250mm mould.

Sample/s supplied by the client

* Cracking occurred + Curling occurred

**Accredited for compliance with ISO/IEC 17025 - Testing.**

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Tested at Trilab Brisbane Laboratory.

**Authorised Signatory**

C. Channon

**Laboratory No. 9926**

** ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING**
### ATTERBERG LIMITS TEST REPORT

**Test Method:** AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

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<td>23.50-24.00</td>
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<td>Plasticity Index (%)</td>
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<td>15</td>
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<td>Linear Shrinkage (%)</td>
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<td>N/A</td>
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<td>Moisture Content (%)</td>
<td>26.3</td>
<td>31.8</td>
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### NOTES/REMARKS:
The samples were tested air dried, dry sieved and in a 125-250mm mould.

Sample/s supplied by the client * Cracking occurred + Curling occurred

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in
this document are traceable to Australian/National Standards.

Authorised Signatory
C. Channon

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
# ATTERBERG LIMITS TEST REPORT

**Test Method:** AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

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**Sample No.**

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**Client ID**

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<th>Client ID</th>
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**Depth (m)**

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<tr>
<th>16.00-16.50</th>
<th>24.50-25.00</th>
<th>25.00-25.50</th>
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**Liquid Limit (%)**

<table>
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**Plastic Limit (%)**

<table>
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<th>33</th>
<th>32</th>
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**Plasticity Index (%)**

<table>
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<th>30</th>
<th>40</th>
<th>35</th>
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**Linear Shrinkage (%)**

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<tr>
<th>12.5 +</th>
<th>13.0 +</th>
<th>14.0 +</th>
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**Moisture Content (%)**

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<tr>
<th>37.7</th>
<th>34.0</th>
<th>39.3</th>
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</thead>
</table>

### NOTES/REMARKS:

The samples were tested air dried, dry sieved and in a 125-250mm mould.

Sample/s supplied by the client

* Cracking occurred
+ Curling occurred

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# PARTICLE SIZE DISTRIBUTION TEST REPORT

**Test Method:** AS 1289 3.6.1, 2.1.1

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<td><strong>Project</strong></td>
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<td><strong>Sample No.</strong></td>
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<td><strong>Test Date</strong></td>
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<td><strong>Client ID</strong></td>
<td>DH-410</td>
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<td><strong>Depth (m)</strong></td>
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<td><strong>Moisture (%)</strong></td>
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<table>
<thead>
<tr>
<th>AS SIEVE SIZE (mm)</th>
<th>PERCENT PASSING</th>
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<tbody>
<tr>
<td>150</td>
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<tr>
<td>63</td>
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<td>53</td>
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<td>37.5</td>
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<td>26.5</td>
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<td>19</td>
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<tr>
<td>13.2</td>
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<td>9.5</td>
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<td>6.7</td>
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<td>4.75</td>
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<td>2.36</td>
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<td>0.600</td>
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<td>0.425</td>
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**NOTES/REMARKS:**

Sample/s supplied by the client
**PARTICLE SIZE DISTRIBUTION TEST REPORT**

Test Method: AS 1289 3.6.1, 2.1.1

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<td>CE406 - DH410</td>
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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>150</td>
<td></td>
</tr>
<tr>
<td>75</td>
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</tr>
<tr>
<td>63</td>
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**NOTES/REMARKS:**

Sample/s supplied by the client

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**ACCRUATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING**
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<th>Sample No.</th>
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<th>Client ID</th>
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NOTES/REMARKS:
Sample/s supplied by the client

Authorised Signatory
C. Channon

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
## PARTICLE SIZE DISTRIBUTION TEST REPORT

**Test Method:** AS 1289 3.6.1, 2.1.1  

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<td>Test Date</td>
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**NOTES/REMARKS:**  
Sample/s supplied by the client
## PARTICLE SIZE DISTRIBUTION TEST REPORT

**Test Method:** AS 1289 3.6.1, 2.1.1

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**NOTES/REMARKS:**

Sample/s supplied by the client

---

Accredited for compliance with ISO/IEC 17025 - Testing. The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Park

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated. Reference should be made to Trilab’s “Standard Terms and Conditions of Business” for further details.
**PARTICLE SIZE DISTRIBUTION TEST REPORT**

**Test Method:** AS 1289 3.6.3, 3.5.1 & 2.1.1

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**NOTES/REMARKS:**
- Moisture Content 12.9%
- 2.36mm Soil Particle Density(t/m³) 2.66

Sample/s supplied by the client

Tested at Trilab Brisbane Laboratory.

**ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING**
### PARTICLE SIZE DISTRIBUTION TEST REPORT

#### Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

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#### Notes/Remarks:
- Moisture Content: 48.5%
- 2.36mm Soil Particle Density (t/m³): 2.55
- Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory
C. Park

Laboratory No. 9926

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
# PARTICLE SIZE DISTRIBUTION TEST REPORT

**Test Method:** AS 1289 3.6.3, 3.5.1 & 2.1.1

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<td>22/8/18-31/8/18</td>
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**Project:** H356804 - Cadia NTSF Failure

**Client ID:** CE412 - DH405 SA8

**Depth (m):** 65.50-66.00

## Sieve Size Distribution

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**NOTES/REMARKS:**

- Moisture Content: 25.5%
- 2.36mm Soil Particle Density (t/m³): 2.64

Sample/s supplied by the client.

Accredited for compliance with ISO/IEC 17025 - Testing.

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Tested at Trilab Brisbane Laboratory.

Reference should be made to Trilab’s “Standard Terms and Conditions of Business” for further details.

Trilab Pty Ltd ABN 25 065 630 506

**Authorised Signatory:**

C. Channon

Laboratory No. 9926

ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client: Hatch Pty Ltd

Report No.: 18080420-G

Workorder No.: 0004681

Address: PO Box 425 SPRING HILL QLD 4004

Test Date: 22/8/18-31/8/18

Report Date: 31/8/2018

Project: H356804 - Cadia NTSF Failure

Client ID: CE417 - DH406 L2B

Depth (m): 18.50-19.00

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Sample/s supplied by the client

NOTES/REMARKS:

- Moisture Content: 42.3%
- -2.36mm Soil Particle Density(t/m^3): 2.49

C. Channon
Authorised Signatory

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab Pty Ltd ABN 25 065 630 506

Laboratory No. 9926

Authorised Signatory

Page 1 of 1
PARTICLE SIZE DISTRIBUTION TEST REPORT

Client: Hatch Pty Ltd

Address: PO Box 425 SPRING HILL QLD 4004

Project: H356804 - Cadia NTSF Failure

Client ID: CE411A - DH409A L1

Depth (m): 14.50-15.00

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

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NOTES/REMARKS:
- Moisture Content: 25.7%
- -2.36mm Soil Particle Density (t/m³): 2.70
- Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
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Tested at Trilab Brisbane Laboratory.

Accredited Laboratory No. 9926

Authorised Signatory
C. Channon

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
**PARTICLE SIZE DISTRIBUTION TEST REPORT**

**Test Method:** AS 1289 3.6.3, 3.5.1 & 2.1.1

**Client:** Hatch Pty Ltd

**Report No.:** 18080436-G

**Workorder No.:** 0004681

**Address:** PO Box 425 SPRING HILL QLD 4004

**Test Date:** 27/8/18-3/9/18

**Report Date:** 3/9/2018

**Project:** H356804 - Cadia NTSF Failure

**Client ID:** CE416 - DH407 L1B

**Depth (m):** 23.00-23.50

### Sieve Size and Passing (%)

<table>
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<th>Particle Size (mm)</th>
<th>Passing %</th>
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<tbody>
<tr>
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<tr>
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**NOTES/REMARKS:**

- Moisture Content: 27.7%
- -2.36mm Soil Particle Density (t/m³): 2.77

Sample/s supplied by the client

Authorised Signatory: C. Channon

**ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING**
PARTICLE SIZE DISTRIBUTION TEST REPORT
Test Method: AS 1289 3.5.1 & 2.1.1

Client: Hatch Pty Ltd

Address: PO Box 425 SPRING HILL QLD 4004

Project: H356804 - Cadia NTSF Failure

Client ID: CE416 - DH407 PT3

Depth (m): 25.50-26.95

Sieve Size (mm) | Passing (%)
----------------|------
150.0           | 75.0
75.0            | 63.0
53.0            | 37.5
37.5            | 26.5
26.5            | 19.0
13.2            | 9.5
9.5             | 6.7
4.75            | 2.36
1.18            | 100
0.600           | 96
0.425           | 94
0.300           | 90
0.150           | 83
0.075           | 76
0.056           | 61
0.047           | 59
0.034           | 56
0.024           | 53
0.018           | 48
0.013           | 45
0.0093          | 41
0.0066          | 36
0.0046          | 33
0.0038          | 31
0.0033          | 26
0.0027          | 25
0.0023          | 24
0.0014          | 20

NOTES/REMARKS:
- Moisture Content: 38.7%
- 2.36mm Soil Particle Density (t/m³): 2.66

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Trilab Brisbane Laboratory.

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab’s “Standard Terms and Conditions of Business” for further details.

Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING
### PARTICLE SIZE DISTRIBUTION TEST REPORT

**Test Method:** AS 1289 3.5.3, 3.5.1 & 2.1.1

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**NOTES/REMARKS:**
- Moisture Content 38.4%
- -2.36mm Soil Particle Density(t/m³) 2.62

Sample/s supplied by the client

---

**TESTED AT TRILAB BRISBANE LABORATORY.**

**Authorised Signatory**

C. Channon

---

**ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING**
## PARTICLE SIZE DISTRIBUTION TEST REPORT

**Test Method:** AS 1289 3.6.3, 3.5.1 & 2.1.1

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**NOTES/REMARKS:**
- Moisture Content 37.7%
- 2.36mm Soil Particle Density(t/m³) 2.58

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing. The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Authorised Signatory: T. Lockhart

Authorised Signatory: C. Channon

Tested at Trilab Brisbane Laboratory

Laboratory No. 9926

Page 1 of 1

REP03904

Hatch Pty Ltd

H356804 - Cadia NTSF Failure

0005472

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
# PARTICLE SIZE DISTRIBUTION TEST REPORT

**Test Method:** AS 1289 3.6.3, 3.5.1 & 2.1.1

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**NOTES/REMARKS:**
- Moisture Content 34%
- 2.36mm Soil Particle Density(t/m³) 2.66

Sample/s supplied by the client

**Authorised Signatory:**

C. Park

Laboratory No. 9926

**ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING**
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client: Hatch Pty Ltd
Address: PO Box 425 SPRING HILL QLD 4004
Project: H356804 - Cadia NTSF Failure

Client ID: CE416 - L2C
Depth (m): 25.00-25.50

Sieve Size (mm) | Passing %
--- | ---
150.0 | 75.0 |
63.0 | 37.5 |
2.36 | 1.18 |
1.18 | 0.600 |
0.600 | 0.425 |
0.425 | 0.300 |
0.300 | 0.150 |
0.150 | 0.075 |
0.075 | 0.062 |
0.062 | 0.044 |
0.044 | 0.031 |
0.031 | 0.023 |
0.023 | 0.017 |
0.017 | 0.012 |
0.012 | 0.0089 |
0.0089 | 0.0063 |
0.0063 | 0.0045 |
0.0045 | 0.0037 |
0.0037 | 0.0032 |
0.0032 | 0.0026 |
0.0026 | 0.0023 |
0.0023 | 0.0013 |
0.0013 |

Moisture Content: 39.3%
-2.36mm Soil Particle Density(t/m³): 2.72

NOTES/REMARKS:
- Moisture Content: 39.3%
- -2.36mm Soil Particle Density: 2.72
- Sample/s supplied by the client

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
## UNIT WEIGHT TEST REPORT

**Test Method:** AS 1289 6.4.1

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### Project

**H356804 - Cadia NTSF Failure**

| Sample No. | 18080190 | 18080191 | 18080193 | 18080197 | - | - | - |
| Test Date   | 10/08/2018 | 10/08/2018 | 10/08/2018 | 10/08/2018 | - | - | - |
| Client ID   | CE407 - DH402 - PS2 | CE413 - DH404 - PS1 | CE413 - DH404 - PS3 | CE412 - DH405 - PT2 | - | - | - |
| Depth (m)   | 21.00-21.50 | 13.80-14.25 | 34.00-34.45 | 39.50-39.72 | - | - | - |
| Moisture (%)| 17.8 | 21.3 | 23.2 | 48.5 | - | - | - |
| Wet Density (t/m³) | 2.11 | 1.95 | 1.95 | 1.70 | - | - | - |
| Dry Density (t/m³) | 1.79 | 1.61 | 1.59 | 1.14 | - | - | - |

**NOTES/REMARKS:**

Sample/s supplied by the client

---

**Authorised Signatory**

T. Lockhart

C. Channon

Agreed for compliance with ISO/IEC 17025 - Testing:
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

**ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING**
## UNIT WEIGHT TEST REPORT

**Test Method:** AS 1289 6.4.1

### Client Details
- **Client:** Hatch Pty Ltd
- **Address:** PO Box 425 SPRING HILL QLD 4004
- **Report No.:** 19010703-UW
- **Workorder No.:** 0005472
- **Report Date:** 31/01/2019

### Project Details
- **Project:** H356804 - Cadia NTSF Failure

### Test Results

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### Notes/Remarks:
- Sample/s supplied by the client
- Tested at Trilab Brisbane Laboratory

**Accredited for compliance with ISO/IEC 17025 - Testing:**
- The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

**Authorised Signatory:**
- C. Channon

**Laboratory No. 9926**

**Strictly Confidential**

---

**Page 1 of 1 REP02802**

**Trilab Pty Ltd**
ABN 25 065 630 506

**ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING**
Annexure DB
Direct Simple Shear Tests - Golders
Monotonic Direct Simple Shear Test Report
Consolidated Undrained

Client: Hatch
Address: 61 Petrie Terrace, Brisbane
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine

Date: 10/06/2018
Project No.: 18101980
Sample ID: TP401 0.7-1.0m
Test ID: 18005 - DSS1 1200kPa

- Vertical Effective Stress (kPa): 1200
- Final Bulk Density (t/m$^3$): 2.17
- Diameter (mm): 60.5
- Final Dry Density (t/m$^3$): 1.77
- Shearing Height (mm): 20.6
- Shearing Strain Rate (mm/min): 0.006

Preparation Notes: Trimmed from block sample
"Dead zone"-type end platens

Shear Stress (kPa) vs. Shear Strain (%)
Shear Stress (kPa) vs. Vertical Effective Stress (kPa)

K. Koh
Reviewed by: R. Fanni / D. Reid

This document shall only be reproduced in full
**Monotonic Direct Simple Shear Test Report**

**Consolidated Undrained**

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<th>Hatch</th>
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<td>Sample ID:</td>
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**Shear Stress vs. Vertical Effective Stress**

- **Shear Stress (kPa):** 0, 5, 10, 15, 20, 25, 30, 300
- **Vertical Effective Stress (kPa):** 0, 100, 200, 300

---

**Shear Stress vs. Shear Strain**

- **Shear Stress (kPa):** 0, 100, 200, 300
- **Shear Strain (%):** 0, 100, 200, 300

---

**Preparation Notes:**
- Trimmed from block sample
- "Dead zone"-type end platens

**Tested by:** K. Koh

**Reviewed by:** R. Fanni / D. Reid

---

**THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL**
Monotonic Direct Simple Shear Test Report
Consolidated Undrained

Client: Hatch
Date: 17/06/2018
Address: 61 Petrie Terrace, Brisbane
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine

Vertical Effective Stress (kPa) 400
Diameter (mm) 60.5
Shearing height (mm) 19.0

Final Bulk Density (t/m$^3$) 2.16
Final Dry Density (t/m$^3$) 1.76
Shearing Strain Rate (mm/min) 0.006

Preparation Notes: Trimmed from block sample
"Dead zone"-type end platens

Tested by: K. Koh
Reviewed by: R. Fanni / D. Reid

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL
Monotonic Direct Simple Shear Test Report
Consolidated Undrained

Client: Hatch  Date: 20/06/2018
Address: 61 Petrie Terrace, Brisbane  Project No.: 18101980
Project: NTSF Embankment Failure ITRB  Sample ID: TP405 1.9-2.2m
Location: Cadia Mine  Test ID: 18006 - DSS1 1000kPa

<table>
<thead>
<tr>
<th>Vertical Effective Stress (kPa)</th>
<th>1000</th>
<th>Final Bulk Density (t/m³)</th>
<th>2.16</th>
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</thead>
<tbody>
<tr>
<td>Diameter (mm)</td>
<td>60.5</td>
<td>Final Dry Density (t/m³)</td>
<td>1.69</td>
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<tr>
<td>Shearing Height (mm)</td>
<td>19.2</td>
<td>Shearing Strain Rate (mm/min)</td>
<td>0.005</td>
</tr>
</tbody>
</table>

Preparation Notes: Trimmed from block sample
"Dead zone"-type end platens

Tested by: K. Koh
Reviewed by: R. Fanni / D. Reid

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL
Monotonic Direct Simple Shear Test Report
Consolidated Undrained

Client: Hatch
Date: 22/06/2018

Address: 61 Petrie Terrace, Brisbane
Project No.: 18101980

Project: NTBF Embankment Failure ITRB
Sample ID: TP405 1.9-2.2m
Test ID: 18006 - DSS2 500kPa

Location: Cadia Mine

Vertical Effective Stress (kPa) | 500 |
--- | --- |
Diameter (mm) | 60.5 |
Shearing Height (mm) | 19.4 |

Final Bulk Density (t/m$^3$) | 2.09 |
Final Dry Density (t/m$^3$) | 1.63 |
Shearing Strain Rate (mm/min) | 0.006 |

Shear Stress (kPa)
Shear Strain (%)

0 5 10 15 20 25 30 35
0 20 40 60 80 100 120 140 160 180

0 100 200 300 400 500 600
0 20 40 60 80 100 120 140 160 180

Preparation Notes: Trimmed from block sample
"Dead zone"-type end platens

Reviewed by: R. Fanni / D. Reid

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL
Monotonic Direct Simple Shear Test Report
Consolidated Undrained

Client: Hatch  Date: 25/06/2018
Address: 61 Petrie Terrace, Brisbane  Project No.: 18101980
Project: NTSF Embankment Failure ITRB  Sample ID: TP405 1.9-2.2m
Location: Cadia Mine  Test ID: 18006 - DSS3 250kPa

<table>
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<tr>
<th>Vertical Effective Stress (kPa)</th>
<th>Final Bulk Density (t/m³)</th>
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</thead>
<tbody>
<tr>
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<td>Final Dry Density (t/m³)</td>
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<td>60.5</td>
<td>1.58</td>
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<tr>
<td>Shearing Height (mm)</td>
<td>Shearing Strain Rate (mm/min)</td>
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<tr>
<td>19.3</td>
<td>0.006</td>
</tr>
</tbody>
</table>

Preparation Notes: Trimmed from block sample "Dead zone"-type end platens

Tested by: I. Orea
Reviewed by: R. Fanni / D. Reid

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL
Monotonic Direct Simple Shear Test Report
Consolidated Undrained

Client: Hatch
Address: 61 Petrie Terrace, Brisbane
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine

Date: 30/08/2018
Project No.: 18101980
Sample ID: CE415-PT1 6.0-6.5m
Test ID: 18022 - DSS1 1000kPa

<table>
<thead>
<tr>
<th>Vertical Effective Stress (kPa)</th>
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<tbody>
<tr>
<td>Final Bulk Density (t/m³)</td>
<td>1.95</td>
</tr>
<tr>
<td>Diameter (mm)</td>
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<tr>
<td>Final Dry Density (t/m³)</td>
<td>1.36</td>
</tr>
<tr>
<td>Shearing height (mm)</td>
<td>19.4</td>
</tr>
<tr>
<td>Shearing Strain Rate (mm/min)</td>
<td>0.006</td>
</tr>
</tbody>
</table>

Tested by: K. Koh
Reviewed by: D. Reid / R. Fanni

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Preparation Notes: Extruded and trimmed from tube sample "Dead zone"-type end platens

Vertical Effective Stress (kPa) vs. Shear Strain (%)

Shear Stress (kPa) vs. Vertical Effective Stress (kPa)
Monotonic Direct Simple Shear Test Report
Consolidated Undrained

Client: Hatch  Date: 28/08/2018
Address: 84 Guthrie Street, Osborne Park

Project: NTSF Embankment Failure ITRB  Sample ID: CE415-PT1 6.0-6.5m
Location: Cadia Mine  Test ID: 18022 - DSS2 600kPa

<table>
<thead>
<tr>
<th>Vertical Effective Stress (kPa)</th>
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</thead>
<tbody>
<tr>
<td>Final Bulk Density (t/m³)</td>
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<td>Diameter (mm)</td>
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<tr>
<td>Final Dry Density (t/m³)</td>
<td>1.33</td>
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<tr>
<td>Shearing height (mm)</td>
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</tr>
<tr>
<td>Shearing Strain Rate (mm/min)</td>
<td>0.005</td>
</tr>
</tbody>
</table>

Preparation Notes: Extruded and trimmed from tube sample "Dead zone"-type end platens
Tested by: I. Orea
Reviewed by: D. Reid / R. Fanni

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

Client: Hatch
Address: 61 Petrie Terrace, Brisbane
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine

Date: 5/09/2018
Project No.: 18101980
Sample ID: CE417-PT1 16.5-16.86m

<table>
<thead>
<tr>
<th>Vertical Effective Stress (kPa)</th>
<th>1000</th>
<th>Final Bulk Density (t/m³)</th>
<th>1.99</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter (mm)</td>
<td>60.5</td>
<td>Final Dry Density (t/m³)</td>
<td>1.49</td>
</tr>
<tr>
<td>Shearing height (mm)</td>
<td>22.8</td>
<td>Shearing Strain Rate (mm/min)</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Preparation Notes: Extruded and trimmed from tube sample
"Dead zone"-type end platens

Tested by: K. Koh
Reviewed by: D. Reid / R. Fanni

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

Client: Hatch  Date: 3/09/2018
Address: 61 Petrie Terrace, Brisbane
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine

Final Bulk Density (t/m³) 1.6
Diameter (mm) 60.5
Shearing height (mm) 22.6

Shear Stress (kPa) 350
Vertical Effective Stress (kPa) 1200

Shear Strain (%)
0 5 10 15 20 25 30
0 200 400 600 800 1000 1200 1400

Preparation Notes: Extruded and trimmed from tube sample
"Dead zone"-type end platens

Tested by: K. Koh
Reviewed by: R. Fanni

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

<table>
<thead>
<tr>
<th>Vertical Effective Stress (kPa)</th>
<th>800</th>
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</thead>
<tbody>
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<td>Diameter (mm)</td>
<td>60.5</td>
</tr>
<tr>
<td>Shearing height (mm)</td>
<td>22.4</td>
</tr>
<tr>
<td>Final Bulk Density (t/m³)</td>
<td>1.97</td>
</tr>
<tr>
<td>Final Dry Density (t/m³)</td>
<td>1.43</td>
</tr>
<tr>
<td>Shearing Strain Rate (mm/min)</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Preparation Notes: Extruded and trimmed from tube sample
"Dead zone"-type end platens

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### Monotonic Direct Simple Shear Test Report - Consolidated Undrained

**Client:** Hatch  
**Date:** 11/09/2018

**Address:** 61 Petrie Terrace, Brisbane  
**Project No.:** 18101980

**Project:** NTFS Embankment Failure ITRB  
**Sample ID:** CE417-PT2 19.5-20.0m

**Location:** Cadia Mine  
**Test ID:** 18025 - DSS1 1000kPa

<table>
<thead>
<tr>
<th>Vertical Effective Stress (kPa)</th>
<th>Final Bulk Density (t/m³)</th>
<th>Diameter (mm)</th>
<th>Final Dry Density (t/m³)</th>
<th>Shearing height (mm)</th>
<th>Shearing Strain Rate (mm/min)</th>
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<tr>
<td>1000</td>
<td>1.97</td>
<td>60.5</td>
<td>1.46</td>
<td>21.2</td>
<td>0.015</td>
</tr>
</tbody>
</table>

**Preparation Notes:** Extruded and trimmed from tube sample
“Dead zone”-type end platens

**Tested by:** I. Orea  
**Reviewed by:** R. Fanni
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

Perth Laboratory
84 Guthrie Street, Osborne Park

Client: Hatch
Date: 8/09/2018
Address: 61 Petrie Terrace, Brisbane
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine

Test ID: 18026 - DSS1 1200kPa

<table>
<thead>
<tr>
<th>Vertical Effective Stress (kPa)</th>
<th>1200</th>
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</thead>
<tbody>
<tr>
<td>Diameter (mm)</td>
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</tr>
<tr>
<td>Shearing height (mm)</td>
<td>19.8</td>
</tr>
<tr>
<td>Final Bulk Density (t/m³)</td>
<td>1.84</td>
</tr>
<tr>
<td>Final Dry Density (t/m³)</td>
<td>1.29</td>
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<tr>
<td>Shearing Strain Rate (mm/min)</td>
<td>0.006</td>
</tr>
</tbody>
</table>

Extruded and trimmed from tube sample
"Dead zone"-type end platens

Tested by: K. Koh
Reviewed by: R. Fanni

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL
### Monotonic Direct Simple Shear Test Report - Consolidated Undrained

#### Details:
- **Client:** Hatch
- **Address:** 61 Petrie Terrace, Brisbane
- **Project:** NTSE Embankment Failure ITRB
- **Location:** Cadia Mine
- **Date:** 17/09/2018
- **Project No.:** 18101980
- **Sample ID:** CE417-PT4 24.0-24.3m
- **Test ID:** 18026 - DSS2 800kPa
- **Client:** Hatch
- **Address:** 61 Petrie Terrace, Brisbane
- **Date:** 17/09/2018
- **Location:** Cadia Mine

#### Test Parameters:
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Vertical Effective Stress (kPa)</td>
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<tr>
<td>Final Bulk Density (t/m³)</td>
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<tr>
<td>Diameter (mm)</td>
<td>60.5</td>
</tr>
<tr>
<td>Final Dry Density (t/m³)</td>
<td>1.35</td>
</tr>
<tr>
<td>Shearing height (mm)</td>
<td>21.6</td>
</tr>
<tr>
<td>Shearing Strain Rate (mm/min)</td>
<td>0.007</td>
</tr>
</tbody>
</table>

#### Graphs:
1. Shear Stress (kPa) vs. Shear Strain (%)
2. Shear Stress (kPa) vs. Vertical Effective Stress (kPa)

#### Preparation Notes:
- Extruded and trimmed from tube sample
- "Dead zone"-type end platens

#### Tested by:
- K. Koh

#### Reviewed by:
- R. Fanni

---

**THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL**
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

Client: Hatch
Address: 61 Petrie Terrace, Brisbane
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine

Date: 13/09/2018
Project No.: 18101980
Sample ID: CE416-PT2 24.0-24.33m
Test ID: 180227 - DSS1 1000kPa

<table>
<thead>
<tr>
<th>Vertical Effective Stress (kPa)</th>
<th>1000</th>
<th>Final Bulk Density (t/m³)</th>
<th>2.10</th>
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</thead>
<tbody>
<tr>
<td>Diameter (mm)</td>
<td>60.5</td>
<td>Final Dry Density (t/m³)</td>
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<tr>
<td>Shearing height (mm)</td>
<td>21.6</td>
<td>Shearing Strain Rate (mm/min)</td>
<td>0.007</td>
</tr>
</tbody>
</table>

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Preparation Notes: Extruded and trimmed from tube sample
"Dead zone"-type end platens

Tested by: K. Koh
Reviewed by: R. Fanni
Monotonic Direct Simple Shear Test
Report - Consolidated Undrained

Client: Hatch Pty Ltd
Address: 61 Petrie Terrace
Project: Foundation Laboratory Testing
Location: Queensland

Date: 23/05/2018
Project No.: 18101981
Sample ID: DSS1

Preparation Notes: Sample cored from block sample
Tested by: K. Koh
Reviewed by: R. Fanni

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<table>
<thead>
<tr>
<th>Vertical Effective Stress (kPa)</th>
<th>Final Bulk Density (t/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>1.88</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>Final Dry Density (t/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60.5</td>
<td>1.43</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Final Height (mm)</th>
<th>Shearing Strain Rate (mm/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.0</td>
<td>0.006</td>
</tr>
</tbody>
</table>

Shear Stress (kPa) vs. Shear Strain (%)

Shear Stress (kPa) vs. Vertical Effective Stress (kPa)
Monotonic Direct Simple Shear Test
Report - Consolidated Undrained

Client: Hatch Pty Ltd
Date: 23/05/2018
Address: 61 Petrie Terrace
Project No.: 18101981
Project: Foundation Laboratory Testing
Sample ID: DSS2
Location: Queensland

<table>
<thead>
<tr>
<th>Vertical Effective Stress (kPa)</th>
<th>Final Bulk Density (t/m³)</th>
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<tbody>
<tr>
<td>400.6</td>
<td>1.88</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>Final Dry Density (t/m³)</th>
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</thead>
<tbody>
<tr>
<td>60.5</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Final Height (mm)</th>
<th>Shearing Strain Rate (mm/min)</th>
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</thead>
<tbody>
<tr>
<td>25.1</td>
<td>0.008</td>
</tr>
</tbody>
</table>

Vertical Effective Stress (kPa) vs. Shear Stress (kPa)

Shearing Strain Rate (mm/min) vs. Shear Stress (kPa)

Preparation Notes: Sample cored from block sample
Tested by: K. Koh
Reviewed by: R. Fanni

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Monotonic Direct Simple Shear Test Report - Consolidated Undrained

Perth Laboratory
84 Guthrie Street, Osborne Park

Client: Hatch Pty Ltd
Address: 81 Petrie Terrace
Project: Foundation Laboratory Testing
Location: Queensland
Sample ID: PL-BS1 0.0-0.5m

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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<tr>
<td>Vertical Effective Stress (kPa)</td>
<td>250.6</td>
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<tr>
<td>Diameter (mm)</td>
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<tr>
<td>Final Height (mm)</td>
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</tr>
<tr>
<td>Final Bulk Density (t/m³)</td>
<td>1.96</td>
</tr>
<tr>
<td>Final Dry Density (t/m³)</td>
<td>1.46</td>
</tr>
<tr>
<td>Shearing Strain Rate (mm/min)</td>
<td>0.005</td>
</tr>
</tbody>
</table>

Preparation Notes: Compacted to 98% SMDD (1.42 t/m³) at OMC (26% GWC)

Tested by: K. Koh
Reviewed by: R. Fanni

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

Client: Hatch Pty Ltd
Date: 24/05/2018

Address: 61 Petrie Terrace
Project No.: 18101981

Project: Foundation Laboratory Testing
Sample ID: DSS-4 (Compacted)

Location: Queensland

Preparation Notes: Compacted to 98% SMDD (1.42 t/m³) at OMC (26% GWC)

Tested by: K. Koh
Reviewed by: R. Fanni

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

Client: Hatch Pty Ltd
Address: 61 Petrie Terrace
Project: Foundation Laboratory Testing
Location: Queensland

<table>
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<th>Parameter</th>
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<tr>
<td>Vertical Effective Stress (kPa)</td>
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<td>Diameter (mm)</td>
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</tr>
<tr>
<td>Final Height (mm)</td>
<td>20.6</td>
</tr>
<tr>
<td>Final Bulk Density (t/m³)</td>
<td>1.98</td>
</tr>
<tr>
<td>Final Dry Density (t/m³)</td>
<td>1.49</td>
</tr>
<tr>
<td>Shearing Strain Rate (mm/min)</td>
<td>0.005</td>
</tr>
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</table>

Preparation Notes: Compacted to 98% SMDD (1.42 t/m³) at OMC (26% GWC)

Tested by: K. Koh
Reviewed by: R. Fanni

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL
Annexure DC
Direct Simple Shear Tests - Fugro
### Simple Shear Test

#### Test Method: AGLab Test Procedure FAM-18552

**Stage 1: Consolidation**

- **Vertical Stress, \( \sigma_v \) (kPa):**
  - Time (hours): 0 to 30
  - Graph showing stress over time with a peak at around 150 kPa

**Stage 2: Monotonic Shearing**

- **Shear Stress, \( \tau_{xy} \) (kPa):**
  - Shear Strain, \( \gamma \) (%): 0 to 40
  - Graph showing stress-strain relationship

- **Stress Ratio, \( \tau_{xy}/\sigma_v \):**
  - Shear Strain, \( \gamma \) (%): 0 to 40
  - Graph showing stress ratio over strain
SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

Stage 2: Monotonic Shearing
**Simple Shear Test**

**Stage 1: Consolidation**

**Stage 2: Monotonic Shearing**

---

**Cadia NTSF Failure - Laboratory Testing**

**Monotonic Simple Shear**

---

**Figure C2-Page 1**

---

**Figures and Tables**

- **Vertical Stress vs. Time**
- **Axial Strain vs. Time**
- **Shear Stress vs. Shear Strain**
- **Stress Ratio vs. Shear Strain**

---

**Sample Details**

- **Sample ID:** 2018-017-002
- **Borehole ID:** CE411
- **Depth:** 3.18 m to 3.22 m

**Test Details**

- **Test ID:** CVO-SS02R
- **Consolidation Stress (kPa):** 800
- **Shearing Rate (%/Hr):** 5

---

**Checked By:** SRJ

**Date:** 27/9/2018

---

**Notes:**

- Moisture content calculated using trimmings; may not be equal to moisture content of whole sample.

---

**Client:** Newcrest Mining

**Project:** Cadia NTSF Failure - Laboratory Testing

**Location:** Cadia Valley Operations

**IPO Number:** 2018-017

---

**Related M-Files:**

- FAM-18183

---

**F-Entity:** AGLab

---

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SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

Stage 2: Monotonic Shearing

![Graphs showing simple shear test results]
Simple Shear Test
Test Method: AGLab Test Procedure FAM-18552

Stage 1: Consolidation

Stage 2: Monotonic Shearing

Cadia NTSF Failure - Laboratory Testing
Monotonic Simple Shear
Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT1

IPO Number: 2018-017
Sample ID: 2018-017-003
Borehole ID: CE411
Depth: 3.26 m to 3.30 m

SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

Stage 2 : Monotonic Shearing

![Graphs showing shear stress vs shear strain and pore pressure vs shear strain.](image-url)
Cadia NTSF Failure - Laboratory Testing

Monotonic Simple Shear

**Simple Shear Test**

**Test Method:** AGLab Test Procedure FAM-18552

**Stage 1: Consolidation**

- **Test Details:**
  - Test ID: CVO-SS04
  - Consolidation Stress (kPa): 400
  - Shearing Rate (%/Hr): 5

**Stage 2: Monotonic Shearing**

- **Sample Details:**
  - Initial: 21.84
  - Final: 31.7

- **Sample Diameter (mm):**
  - Initial: 62.7
  - Final: 21.84

- **Dry Density (t/m³):**
  - Initial: 1.58
  - Final: 1.84

- **Moisture Content (%):**
  - Initial: 28.4 *
  - Final: 31.7

*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample.

**Checked By:** SRJ
**Date:** 27/9/2018
SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

Stage 2 : Monotonic Shearing

Shear Strain, γ (%) vs Vertical Stress, σ'v (kPa)

Shear Strain, γ (%) vs Pore Pressure, Δv (kPa)

Vertical Stress, σ'v (kPa) vs Shear Stress, t_{xy} (kPa)
Simple Shear Test

**Stage 1: Consolidation**

Test Method: AGLab Test Procedure FAM-18552

**Stage 2: Monotonic Shearing**

**Monotonic Simple Shear**
**SIMPLE SHEAR TEST**

Test Method: AGLab Test Procedure FAM-18552

Stage 2: Monotonic Shearing

---

**Figure C5-Page 2**

**Cadia NTSF Failure - Laboratory Testing**

**Monotonic Simple Shear**
Client: Newcrest Mining  
Project: Cadia NTSF Failure - Laboratory Testing  
Location: Cadia Valley Operations  
Sample No.: PT4  

**Test Details:**  
**Test ID:** CVO-SS06  
**Consolidation Stress (kPa):** 1200  
**Shearing Rate (%/Hr):** 5  

**Tested By:** SF  
**Date:** 17/09/2018  

**IPO Number:** 2018-017  
**Sample ID:** 2018-017-010  
**Borehole ID:** CE411A  
**Depth:** 15.18 m to 15.22 m  

**Sample Details:**  
<table>
<thead>
<tr>
<th>Initial</th>
<th>Final</th>
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</thead>
<tbody>
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<td>Sample Diameter (mm):</td>
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<tr>
<td>Sample Height (mm):</td>
<td>25.40</td>
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<tr>
<td>Dry Density (t/m³):</td>
<td>1.63</td>
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<tr>
<td>Moisture Content (%):</td>
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</tbody>
</table>

*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample.

**Checked By:** SRJ  
**Date:** 27/09/2018  

**SIMPLE SHEAR TEST**  
Test Method: AGLab Test Procedure FAM-18552  

**Stage 1: Consolidation**

**Stage 2: Monotonic Shearing**

**Cadia NTSF Failure - Laboratory Testing**  
**Monotonic Simple Shear**
SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

Stage 2 : Monotonic Shearing

Shear Strain, $\gamma$ (%)

Vertical Stress, $\sigma_v'$ (kPa)

Pore Pressure, $\Delta u$ (kPa)

Shear Strain, $\gamma$ (%)

Shear Stress, $t_{xy}$ (kPa)

Vertical Stress, $\sigma_v'$ (kPa)
**SIMPLE SHEAR TEST**

Test Method: AGLab Test Procedure FAM-18552

**Stage 1: Consolidation**

![Consolidation Stress vs. Time](image1)

**Stage 2: Monotonic Shearing**

![Shear Stress vs. Shear Strain](image2)

**Cadia NTSF Failure - Laboratory Testing**

**Monotonic Simple Shear**

---

*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample.*
Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT5

IPO Number: 2018-017
Sample ID: 2018-017-012
Borehole ID: CE411A
Depth: 16.86 m to 16.90 m

SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

Stage 2: Monotonic Shearing

![Graphs showing shear strain and stress relationships](image-url)
FUGRO

Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT5

Test Details:
Test ID: CVO-SS08
Consolidation Stress (kPa): 800
Shearing Rate (%/Hr): 5

Tested By: SF
Date: 08/09/2018

Sample Details:
Sample ID: 2018-017-008
Borehole ID: CE411A
Depth: 16.78 m to 16.82 m

Job No.LAB127730
M-Files: FAM-18183

SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

Stage 1: Consolidation

Stage 2: Monotonic Shearing

Cadia NTSF Failure - Laboratory Testing
Monotonic Simple Shear

Figure C8-Page 1

N:\agLAB\02.Projects\007.2018\LAB127730 - Cadia NTSF 03 Technical\04 Lab Testing\IPO 2018-017\11 Simple Shear\03 Final\For Report\CVO-SS08.xlsm

Client: Newcrest Mining
IPO Number: 2018-017
Sample ID: 2018-017-008
Borehole ID: CE411A
Depth: 16.78 m to 16.82 m

Test Method: AGLab Test Procedure FAM-18552

Date:

Checked By: SRJ
Date: 27/9/2018

Simple Shear Test Details:

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<tr>
<th>Test Details</th>
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<th>Final</th>
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<tr>
<td>Moisture Content (%)</td>
<td>37.4 *</td>
<td>41.3</td>
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Notes:
*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample.
Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT5

IPO Number: 2018-017
Sample ID: 2018-017-008
Borehole ID: CE411A
Depth: 16.78 m to 16.82 m

SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552
Stage 2 : Monotonic Shearing

Monotonic Simple Shear
**Client:** Newcrest Mining  
**Project:** Cadia NTSF Failure - Laboratory Testing  
**Location:** Cadia Valley Operations  
**Sample No.:** PT5  
**Job No:** LAB127730  

**Test Details:**  
**Test ID:** CVO-SS09R  
**Consolidation Stress (kPa):** 1200  
**Shearing Rate (%/Hr):** 5  
**Sample Details:**  
- **Sample Diameter (mm):** SF 39.8, 33.1  
- **Sample Height (mm):** 62.7  
- **Dry Density (t/m³):** Initial 1.49, Final 1.63  
- **Moisture Content (%):** Initial 33.1, Final 39.8  

*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample.*  

**Tested By:** SF  
**Date:** 10/09/2018  
**Checked By:** SRJ  
**Date:** 27/9/2018  

---  

**SIMPLE SHEAR TEST**  
**Test Method:** AGLab Test Procedure FAM-18552  

**Stage 1: Consolidation**  
- Vertical Stress, $\sigma_v$ (kPa)  
- Time (hours)  

**Stage 2: Monotonic Shearing**  
- Shear Stress, $\tau_{xy}$ (kPa)  
- Shear Strain, $\gamma$ (%)  
- Stress Ratio, $\tau_{xy}/\sigma_v$  
- Axial Strain, $\varepsilon_a$ (%)  
- Time (hours)  

---  

**Cadia NTSF Failure - Laboratory Testing**  
**Monotonic Simple Shear**  

**Figure C9-Page 1**
Cadia NTSF Failure - Laboratory Testing

Monotonic Simple Shear

Stage 2 : Monotonic Shearing

**Simple Shear Test**

Test Method: AGLab Test Procedure FAM-18552

Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT5

IPO Number: 2018-017
Sample ID: 2018-017-014
Borehole ID: CE411A
Depth: 16.74 m to 16.78 m

**Graphs:**
- Vertical Stress vs. Shear Strain
- Pore Pressure vs. Shear Strain
- Shear Stress vs. Vertical Stress

Job No.LAB127730
M-Files: FAM-18183
Rev: 4
F-Entity: AGLab
Annexure DD
Direct Shear Tests - TriLabs
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

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<tr>
<th>Client</th>
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<th>Report No.</th>
<th>18060849-DS</th>
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<td>Workorder No</td>
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<tr>
<td>Project</td>
<td>H356804 - Cadia</td>
<td>Test Date</td>
<td>13/07/2018</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>19.65-19.95</td>
<td>Report Date</td>
<td>23/07/2018</td>
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**SAMPLE DETAILS**

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<th>Specimen Condition</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Specimen Dimensions (mm)</td>
<td>69.5</td>
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<tr>
<td>Rate of Strain (mm/min)</td>
<td>0.010</td>
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<tr>
<td>Initial Moisture Content (%)</td>
<td>22.3</td>
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<tr>
<td>Initial Wet Density(t/m³)</td>
<td>1.94</td>
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**RESULTS OF TESTING**

<table>
<thead>
<tr>
<th>Test Stage</th>
<th>Residual Displacement (mm)</th>
<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
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<tr>
<td>Stage 1 - Peak</td>
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**Notes/Remarks:**
Note: Area correction based on circular sample equation.
Graph not to scale
Sample/s supplied by the client
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 18060849- DS

Shear Stress/Relative Displacement Plot

Notes/Remarks:
- Note: Area correction based on circular sample equation.
- Graph not to scale
- Sample/s supplied by the client

Authorised Signatory
C. Purvis

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Tested at Trilab Brisbane Laboratory

Shear Stress/Relative Displacement Plot

Shear Stress (kPa) vs. Relative Displacement (mm)

Stage 1 - Peak
Stage 2 - Residual 2
Stage 3 - Residual 3
Stage 4 - Residual 4
Stage 5 - Residual 5
Stage 6 - Residual 6

0 50 100 150 200 250 300
0 1 2 3 4 5 6 7 8

Shear Stress (kPa)
Relative Displacement (mm)
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 18060849-DS

Notes/Remarks:
Note: Area correction based on circular sample equation.
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Authorised Signatory
C. Purvis

Laboratory No. 9926

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
## DIRECT SHEAR TEST REPORT

**Test Method:** AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

### Client

<table>
<thead>
<tr>
<th>Report No.</th>
<th>Hatch Pty Ltd</th>
<th>18060849-DS</th>
</tr>
</thead>
</table>

### Failure Criteria

Residual @ 7, 7, 7, 7 mm Displacement

### Residual - Normal Stress vs Shear Stress

![Graph of Normal Stress vs Shear Stress](image)

### Notes/Remarks:

- Photo not to scale
- Sample/s supplied by the client

---

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**Trilab Pty Ltd**

**ABN 25 065 630 506**

**Laboratory No. 9926**

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd

Report No.: 18060849-DS

<table>
<thead>
<tr>
<th>Failure Criteria</th>
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Notes/Remarks:

Graph not to scale
Sample/s supplied by the client

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Authorised Signatory

C. Purvis

Laboratory No. 9926

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ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 18060849-DS

Stage 1 Consolidation

Displacement v's Time (Log Scale)

- $t_{50} = 0.10$ mins
- $t_{100} = 0.13$ mins
- Time to Failure = 367.62 mins
- Estimated Displacement to Failure = 5 mm
- Displacement Rate = 0.0136 mm/min

Notes/Remarks:
Graph not to scale
Sample/s supplied by the client

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Authorised Signatory

Laboratory No. 9926

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ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 18060849- DS

Before and After Photos

Notes/Remarks:
Graph not to scale
Sample/s supplied by the client

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Tested at TriLab Brisbane Laboratory

Lab No. 9926

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TriLab Pty Ltd
ABN 25 065 630 506
## DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

### Client
Hatch Pty Ltd

### Address
PO Box 425 SPRING HILL QLD 4004

### Project
H356804 - Cadia

### Client ID
DH-410

### Depth (m)
19.65-19.95

### Description
GRAVELLY CLAY - red/brown

### Sample Type
Single individual soil specimen - Undisturbed.

### SAMPLE DETAILS

<table>
<thead>
<tr>
<th>Specimen Condition</th>
<th>Inundated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specimen Dimensions (mm)</td>
<td>69.5</td>
</tr>
<tr>
<td>Rate of Strain (mm/min)</td>
<td>0.010</td>
</tr>
<tr>
<td>Initial Moisture Content (%)</td>
<td>22.3</td>
</tr>
<tr>
<td>Initial Wet Density(t/m$^3$)</td>
<td>1.88</td>
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</table>

### RESULTS OF TESTING

#### RESIDUAL RESULTS

<table>
<thead>
<tr>
<th>Test Stage</th>
<th>Residual Displacement (mm)</th>
<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1 - Peak</td>
<td>7.00</td>
<td>800.1</td>
<td>380.5</td>
<td>800.1</td>
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<td>369.1</td>
<td>800.1</td>
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#### PEAK RESULTS

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<tr>
<th>Test Stage</th>
<th>Normal Stress (kPa)</th>
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<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
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<td>Stage 6 - Residual 6</td>
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### Notes/Remarks:
Note: Area correction based on circular sample equation.

Graph not to scale

Sample/s supplied by the client

Page 1 of 7 REP07301

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AUTHORISED SIGNATORY

C. Purvis

Laboratory No. 9926

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ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 18060849- DS

Shear Stress/Relative Displacement Plot

- Stage 1 - Peak
- Stage 2 - Residual 2
- Stage 3 - Residual 3
- Stage 4 - Residual 4
- Stage 5 - Residual 5
- Stage 6 - Residual 6

Notes/Remarks:
Note: Area correction based on circular sample equation.
Graph not to scale
Sample/s supplied by the client

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Trilab Pty Ltd
ABN 25 065 630 506

Authorised Signatory
C. Purvis

Laboratory No. 9926

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
**DIRECT SHEAR TEST REPORT**

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

**Client** Hatch Pty Ltd

**Report No.** 18060849- DS

---

**Notes/Remarks:**

Note: Area correction based on circular sample equation.

Graph not to scale

Sample/s supplied by the client

---

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**TRILAB PTY LTD**

ABN 25 065 630 506

**ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING**
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 18060849-DS

Failure Criteria
Residual @ 7, 7, 7, 7 mm Displacement

Residual - Normal Stress vs Shear Stress

- Stage 1 - Residual 1
- Stage 2 - Residual 2
- Stage 3 - Residual 3
- Stage 4 - Residual 4
- Stage 5 - Residual 5
- Stage 6 - Residual 6

Normal Stress (kPa) vs Shear Stress (kPa)

Notes/Remarks:
Photo not to scale
Sample/s supplied by the client

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Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING
**DIRECT SHEAR TEST REPORT**

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

**Client:** Hatch Pty Ltd  
**Report No.:** 18060849- DS

<table>
<thead>
<tr>
<th>Failure Criteria</th>
<th>Peak</th>
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</thead>
</table>

**Plot:**
- Stage 1 - Peak
- Stage 2 - Peak 2
- Stage 3 - Peak 3
- Stage 4 - Peak 4
- Stage 5 - Peak 5
- Stage 6 - Peak 6

**Notes/Remarks:**
- Graph not to scale
- Sample/s supplied by the client

---

Trilab Pty Ltd  
ABN 25 065 630 506

Authorised Signatory  
C. Channon

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Tested at Trilab Brisbane Laboratory

Laboratory No. 9926

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
### DIRECT SHEAR TEST REPORT

**Test Method:** AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

**Client:** Hatch Pty Ltd  
**Report No.:** 18060849-DS

#### Stage 1 Consolidation

**Displacement v’s Time (Log Scale)**

- $t_{50} = 0.11$ mins
- $t_{100} = 0.25$ mins
- Time to Failure = 291.93 mins
- Estimated Displacement to Failure = 5 mm
- Displacement Rate = 0.01713 mm/min

**Notes/Remarks:**
- Graph not to scale
- Sample/s supplied by the client

---

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**Tested at Trilab Brisbane Laboratory**

---

**Authorised Signatory**

C. Purvis

**Laboratory No. 9926**

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**Trilab Pty Ltd**  
**ABN 25 065 630 506**

**ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING**
## DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

<table>
<thead>
<tr>
<th>Client</th>
<th>Hatch Pty Ltd</th>
<th>Report No.</th>
<th>18060849- DS</th>
</tr>
</thead>
</table>

### Before and After Photos

<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
<th>PROJECT:</th>
<th>H356804 - Cadia</th>
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<tbody>
<tr>
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<td>DATE:</td>
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### Notes/Remarks:
- Graph not to scale
- Sample/s supplied by the client

---

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**Tested at Trilab Brisbane Laboratory**

---

**Authorised Signatory**

C. Purvis

Laboratory No. 9926

**STRICTLY CONFIDENTIAL**

---

**ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING**
### DIRECT SHEAR TEST REPORT

**Test Method:** AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

<table>
<thead>
<tr>
<th>Client</th>
<th>Hatch Pty Ltd</th>
<th>Report No.</th>
<th>18060849-DS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>PO Box 425 SPRING HILL QLD 4004</td>
<td>Workorder No</td>
<td>0004435</td>
</tr>
<tr>
<td>Project</td>
<td>H356804 - Cadia</td>
<td>Test Date</td>
<td>13/07/2018</td>
</tr>
<tr>
<td>Client ID</td>
<td>DH-410</td>
<td>Report Date</td>
<td>23/07/2018</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>19.65-19.95</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Description:** GRAVELLY CLAY - red/brown  
**Sample Type:** Single individual soil specimen - Undisturbed.

### SAMPLE DETAILS

<table>
<thead>
<tr>
<th>Specimen Condition</th>
<th>Inundated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specimen Dimensions (mm)</td>
<td>69.5</td>
</tr>
<tr>
<td>Rate of Strain (mm/min)</td>
<td>0.010</td>
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<tr>
<td>Initial Moisture Content (%)</td>
<td>22.3</td>
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<tr>
<td>Initial Wet Density(t/m³)</td>
<td>1.86</td>
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### RESULTS OF TESTING

#### RESIDUAL RESULTS

<table>
<thead>
<tr>
<th>Test Stage</th>
<th>Residual Displacement (mm)</th>
<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1 - Peak</td>
<td>7.00</td>
<td>1200.1</td>
<td>682.7</td>
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<tr>
<td>Stage 2 - Residual 2</td>
<td>7.00</td>
<td>1200.1</td>
<td>623.0</td>
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<td>Stage 3 - Residual 3</td>
<td>7.00</td>
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<td>539.0</td>
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<td>Stage 4 - Residual 4</td>
<td>7.00</td>
<td>1200.1</td>
<td>579.9</td>
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<td>Stage 5 - Residual 5</td>
<td>7.00</td>
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<td>626.6</td>
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<td>Stage 6 - Residual 6</td>
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#### PEAK RESULTS

<table>
<thead>
<tr>
<th>Test Stage</th>
<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
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</thead>
<tbody>
<tr>
<td>Stage 1 - Peak</td>
<td>1200.1</td>
<td>694.9</td>
</tr>
<tr>
<td>Stage 2 - Residual 2</td>
<td>1200.1</td>
<td>634.7</td>
</tr>
<tr>
<td>Stage 3 - Residual 3</td>
<td>1200.1</td>
<td>539.0</td>
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<td>Stage 4 - Residual 4</td>
<td>1200.1</td>
<td>581.3</td>
</tr>
<tr>
<td>Stage 5 - Residual 5</td>
<td>1200.1</td>
<td>630.5</td>
</tr>
<tr>
<td>Stage 6 - Residual 6</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Notes/Remarks:

- Note: Area correction based on circular sample equation.
- Graph not to scale
- Sample/s supplied by the client

---

Accredited for compliance with ISO/IEC 17025 - Testing.  
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Tested at Trilab Brisbane Laboratory  

**Authorised Signatory**  

C. Purvis  

---

**ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING**
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 18060849- DS

Shear Stress/Relative Displacement Plot

Notes/Remarks:
- Note: Area correction based on circular sample equation.
- Graph not to scale
- Sample/s supplied by the client

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Authorised Signatory

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd

Notes/Remarks:
Note: Area correction based on circular sample equation.
Graph not to scale
Sample/s supplied by the client

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Authorised Signatory

C. Purvis

Laboratory No. 9926
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 18060849- DS

Failure Criteria: Residual @ 7, 7, 7, 7 mm Displacement

Residual - Normal Stress vs Shear Stress

Shear Stress (kPa)

Normal Stress (kPa)

Stage 1 - Residual 1
Stage 2 - Residual 2
Stage 3 - Residual 3
Stage 4 - Residual 4
Stage 5 - Residual 5
Stage 6 - Residual 6

Notes/Remarks:
Photo not to scale
Sample/s supplied by the client

References:
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Trilab Pty Ltd
ABN 25 065 630 506

Laboratory No. 9926

ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 18060849-DS

Failure Criteria: Peak

Peak - Normal Stress vs Shear Stress

Notes/Remarks:
Graph not to scale
Sample/s supplied by the client

Authorized Signatory: C. Channon

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 18060849-DS

Stage 1 Consolidation

Displacement v’s Time (Log Scale)

$t_{50}$ 0.15 mins
$t_{100}$ 0.41 mins
Time to Failure = 342.04 mins
Estimated Displacement to Failure = 5 mm
Displacement Rate = 0.01462 mm/min

Notes/Remarks:
Graph not to scale
Sample/s supplied by the client
# DIRECT SHEAR TEST REPORT

**Test Method:** AS 1289.6.2.2 / KH² based on K.H. Head Vol. 2

<table>
<thead>
<tr>
<th>Client</th>
<th>Hatch Pty Ltd</th>
<th>Report No.</th>
<th>18060849-DS</th>
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</thead>
</table>

## Before and After Photos

### Before Test

<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
<th>PROJECT:</th>
<th>H356804 - Cadia</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAB SAMPLE No.</td>
<td>18060849</td>
<td>BOREHOLE:</td>
<td>DH-410</td>
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<tr>
<td>DATE:</td>
<td>9/07/18</td>
<td>DEPTH:</td>
<td>19.65-19.95</td>
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</table>

### After Test

<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
<th>PROJECT:</th>
<th>H356804 - Cadia</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAB SAMPLE No.</td>
<td>18060849</td>
<td>BOREHOLE:</td>
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<tr>
<td>DATE:</td>
<td>27/07/18</td>
<td>DEPTH:</td>
<td>19.65-19.95</td>
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</tbody>
</table>

**Notes/Remarks:**

Graph not to scale

Sample/s supplied by the client

**Page 7 of 7 REP07301**

---

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Authorised Signatory

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Laboratory No. 9926

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Trilab Pty Ltd ABN 25 065 630 506

---

**ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING**
# DIRECT SHEAR TEST REPORT

**Test Method:** AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

<table>
<thead>
<tr>
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<th>Hatch Pty Ltd</th>
<th>Report No.</th>
<th>19020119A- DS</th>
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<tbody>
<tr>
<td>Address</td>
<td>PO Box 425 SPRING HILL QLD 4004</td>
<td>Workorder No</td>
<td>0005507</td>
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<tr>
<td>Project</td>
<td>H356804 - Cadia NTSF Failure</td>
<td></td>
<td></td>
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<tr>
<td>Client ID</td>
<td>CE416 - L2B</td>
<td>Test Date</td>
<td>8/02/2019</td>
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<tr>
<td>Depth (m)</td>
<td>24.50-25.00</td>
<td>Report Date</td>
<td>28/02/2019</td>
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**SAMPLE DETAILS**

<table>
<thead>
<tr>
<th>Specimen Condition</th>
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</thead>
<tbody>
<tr>
<td>Specimen Dimensions (mm)</td>
<td>60*60</td>
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<tr>
<td>Rate of Strain (mm/min)</td>
<td>0.008</td>
</tr>
<tr>
<td>Initial Moisture Content (%)</td>
<td>34.2</td>
</tr>
<tr>
<td>Initial Wet Density(t/m^3)</td>
<td>1.87</td>
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</tbody>
</table>

**RESULTS OF TESTING**

<table>
<thead>
<tr>
<th>Test Stage</th>
<th>Residual Displacement (mm)</th>
<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1 - Peak</td>
<td>6.00</td>
<td>500.2</td>
<td>272.5</td>
<td>500.2</td>
<td>276.3</td>
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<td>Stage 2 - Residual 2</td>
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<td>Stage 3 - Residual 3</td>
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<td>Stage 4 - Residual 4</td>
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<td>189.5</td>
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<td>183.6</td>
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<tr>
<td>Stage 6 - Residual 6</td>
<td>6.00</td>
<td>500.2</td>
<td>186.6</td>
<td>500.2</td>
<td>186.8</td>
</tr>
</tbody>
</table>

**Notes/Remarks:**

Note: Area correction based on square sample equation.

Graph not to scale

Sample/s supplied by the client

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Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Channon

Laboratory No. 9926

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Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 19020119A-DS

Shear Stress/Relative Displacement Plot

Notes/Remarks:
- Note: Area correction based on square sample equation.
- Graph not to scale
- Sample/s supplied by the client

Authorised Signatory: C. Channon

Laboratory No. 9926

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**DIRECT SHEAR TEST REPORT**

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd

Report No.: 19020119A- DS

---

**Vertical Displacement/Relative Displacement Plot**

Graph not to scale

Sample/s supplied by the client

---

**Notes/Remarks:**

Note: Area correction based on square sample equation.

Graph not to scale

Sample/s supplied by the client

---

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**Authorised Signatory**

C. Channon

---

Laboratory No. 9926

**STRICTLY CONFIDENTIAL**
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

<table>
<thead>
<tr>
<th>Client</th>
<th>Report No.</th>
<th>19020119A- DS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hatch Pty Ltd</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Failure Criteria
Residual @ 6, 6, 6, 6 mm Displacement

#### Residual - Normal Stress vs Shear Stress

![Graph showing Normal Stress vs Shear Stress](image)

**Notes/Remarks:**

Photo not to scale
Sample/s supplied by the client

---

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Trilab Pty Ltd
ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Client Report No.: 19020119A-DS

Peak - Normal Stress vs Shear Stress
- Stage 1 - Peak
- Stage 2 - Peak 2
- Stage 3 - Peak 3
- Stage 4 - Peak 4
- Stage 5 - Peak 5
- Stage 6 - Peak 6

Graph not to scale
Sample/s supplied by the client

Notes/Remarks:

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C. Channon

Laboratory No. 9926
Laboratory No.
ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd

Report No.: 19020119A-DS

Stage 1 Consolidation

Displacement v's Time (Log Scale)

Displacement Rate = 0.01372 mm/min

Notes/Remarks:
Graph not to scale
Sample/s supplied by the client

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Trilab Pty Ltd            ABN 25 065 630 506

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Trilab Pty Ltd

Authorised Signatory
C. Channon

Page 6 of 7  REP07301

Laboratory No. 9926

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 19020119A-DS

Before and After Photos

CLIENT: Hatch Pty Ltd
PROJECT: H356804 - Cadia NTSF Failure
LAB SAMPLE No.: 19020119
BOREHOLE: CE416 - L2B
AFTER TEST
DATE: 23/02/19
DEPTH: 24.50-25.00

Notes/Remarks:
Graph not to scale
Sample/s supplied by the client

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Trilab Pty Ltd
ABN 25 065 630 506

Laboratory No. 9926

Authorised Signatory
C. Channon
# DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

<table>
<thead>
<tr>
<th>Client</th>
<th>Hatch Pty Ltd</th>
<th>Report No.</th>
<th>19020119B- DS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>PO Box 425 SPRING HILL QLD 4004</td>
<td>Workorder No</td>
<td>0005507</td>
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<tr>
<td>Project</td>
<td>H356804 - Cadia NTSF Failure</td>
<td>Test Date</td>
<td>8/02/2019</td>
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<tr>
<td>Client ID</td>
<td>CE416 - L2B</td>
<td>Report Date</td>
<td>28/02/2019</td>
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</table>

### SAMPLE DETAILS

<table>
<thead>
<tr>
<th>Specimen Condition</th>
<th>Inundated</th>
</tr>
</thead>
<tbody>
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<tr>
<td>Initial Wet Density(t/m^3)</td>
<td>1.87</td>
</tr>
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</table>

### RESULTS OF TESTING

#### RESIDUAL RESULTS

<table>
<thead>
<tr>
<th>Test Stage</th>
<th>Residual Displacement (mm)</th>
<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1 - Peak</td>
<td>6.00</td>
<td>800.1</td>
<td>393.1</td>
<td>800.1</td>
<td>396.0</td>
</tr>
<tr>
<td>Stage 2 - Residual 2</td>
<td>6.00</td>
<td>800.1</td>
<td>310.0</td>
<td>800.1</td>
<td>366.3</td>
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<tr>
<td>Stage 3 - Residual 3</td>
<td>6.00</td>
<td>800.1</td>
<td>242.5</td>
<td>800.1</td>
<td>309.8</td>
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<td>Stage 4 - Residual 4</td>
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<td>800.1</td>
<td>231.7</td>
<td>800.1</td>
<td>273.6</td>
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<td>Stage 5 - Residual 5</td>
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<td>219.6</td>
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<td>227.9</td>
<td>800.1</td>
<td>248.1</td>
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### Notes/Remarks:

Note: Area correction based on square sample equation.

Graph not to scale

Sample/s supplied by the client

Page 1 of 7  REP07301

---

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Trilab Pty Ltd  ABN 25 065 630 506

Authorised Signatory

C. Channon

Laboratory No. 9926

ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING
**DIRECT SHEAR TEST REPORT**

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

**Client** Hatch Pty Ltd

**Report No.** 19020119B- DS

**Notes/Remarks:**

Note: Area correction based on square sample equation.

Graph not to scale Sample/s supplied by the client

**Shear Stress/Relative Displacement Plot**

- Stage 1 - Peak
- Stage 2 - Residual 2
- Stage 3 - Residual 3
- Stage 4 - Residual 4
- Stage 5 - Residual 5
- Stage 6 - Residual 6

**Authorised Signatory**

C. Channon

**Laboratory No.** 9926

**ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING**
NOTES/REMARKS:

Note: Area correction based on square sample equation.

Graph not to scale

Sample/s supplied by the client
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 19020119B-DS

Failure Criteria
Residual @ 6, 6, 6, 6 mm Displacement

Residual - Normal Stress vs Shear Stress

Notes/Remarks:
Photo not to scale
Sample/s supplied by the client
### DIRECT SHEAR TEST REPORT

**Test Method:** AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

**Client:** Hatch Pty Ltd  
**Report No.:** 19020119B- DS

#### Failure Criteria

**Peak**

<table>
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<th>Stage</th>
<th>Peaks</th>
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<tbody>
<tr>
<td>Stage 1</td>
<td>Peak 1</td>
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<tr>
<td>Stage 2</td>
<td>Peak 2</td>
</tr>
<tr>
<td>Stage 3</td>
<td>Peak 3</td>
</tr>
<tr>
<td>Stage 4</td>
<td>Peak 4</td>
</tr>
<tr>
<td>Stage 5</td>
<td>Peak 5</td>
</tr>
<tr>
<td>Stage 6</td>
<td>Peak 6</td>
</tr>
</tbody>
</table>

#### Notes/Remarks:

- Graph not to scale
- Sample/s supplied by the client

---

**Authorised Signatory**  
C. Channon  

---

**Accredited for compliance with ISO/IEC 17025 - Testing.**

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**Tested at Trilab Brisbane Laboratory**  

**Laboratory No. 9926**

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---

**ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING**
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd | Report No.: 19020119B-DS

Stage 1 Consolidation

Displacement v's Time (Log Scale)

\[
\begin{align*}
\text{Displacement (mm)} & \quad \text{Time (mins)} \\
4 & \quad 0.01 \\
5 & \quad 0.1 \\
6 & \quad 1 \\
7 & \quad 10 \\
8 & \quad 100 \\
9 & \quad 1000 \\
10 & \quad 10000
\end{align*}
\]

- \( t_{50} = 0.14 \) mins
- \( t_{100} = 5.13 \) mins
- Time to Failure = 386.38 mins
- Estimated Displacement to Failure = 5 mm
- Displacement Rate = 0.01294 mm/min

Notes/Remarks:
Graph not to scale | Sample/s supplied by the client

Trilab Pty Ltd | ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
## DIRECT SHEAR TEST REPORT

**Test Method:** AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

### Before and After Photos

<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROJECT:</td>
<td>H356804 - Cadia NTSF Failure</td>
</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>19020119</td>
</tr>
<tr>
<td>BOREHOLE:</td>
<td>CE416 - L2B</td>
</tr>
</tbody>
</table>

**AFTER TEST**

| DATE: | 25/02/19 |
| DEPTH: | 24.50-25.00 |

**Notes/Remarks:**

Graph not to scale

Sample/s supplied by the client

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Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Channon

Laboratory No. 9926

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TRILAB Pty Ltd  ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING
## DIRECT SHEAR TEST REPORT

**Test Method:** AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

<table>
<thead>
<tr>
<th>Client</th>
<th>Hatch Pty Ltd</th>
<th>Report No.</th>
<th>19020119C-DS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>PO Box 425 SPRING HILL QLD 4004</td>
<td>Workorder No</td>
<td>0005507</td>
</tr>
<tr>
<td>Project</td>
<td>H356804 - Cadia NTSF Failure</td>
<td>Test Date</td>
<td>8/02/2019</td>
</tr>
<tr>
<td>Client ID</td>
<td>CE416 - L2B</td>
<td>Report Date</td>
<td>28/02/2019</td>
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</table>

### SAMPLE DETAILS

<table>
<thead>
<tr>
<th>Specimen Condition</th>
<th>Inundated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specimen Dimensions (mm)</td>
<td>60*60</td>
</tr>
<tr>
<td>Rate of Strain (mm/min)</td>
<td>0.008</td>
</tr>
<tr>
<td>Initial Moisture Content (%)</td>
<td>34.2</td>
</tr>
<tr>
<td>Initial Wet Density(t/m$^3$)</td>
<td>1.87</td>
</tr>
</tbody>
</table>

### RESULTS OF TESTING

#### RESIDUAL RESULTS

<table>
<thead>
<tr>
<th>Test Stage</th>
<th>Residual Displacement (mm)</th>
<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1 - Peak</td>
<td>6.00</td>
<td>1200.0</td>
<td>301.6</td>
</tr>
<tr>
<td>Stage 2 - Residual 2</td>
<td>6.00</td>
<td>1200.0</td>
<td>354.6</td>
</tr>
<tr>
<td>Stage 3 - Residual 3</td>
<td>6.00</td>
<td>1200.0</td>
<td>348.7</td>
</tr>
<tr>
<td>Stage 4 - Residual 4</td>
<td>6.00</td>
<td>1200.0</td>
<td>368.2</td>
</tr>
<tr>
<td>Stage 5 - Residual 5</td>
<td>6.00</td>
<td>1200.0</td>
<td>361.8</td>
</tr>
<tr>
<td>Stage 6 - Residual 6</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

#### PEAK RESULTS

<table>
<thead>
<tr>
<th>Test Stage</th>
<th>Residual Displacement (mm)</th>
<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1 - Peak</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Stage 2 - Residual 2</td>
<td>6.00</td>
<td>1200.0</td>
<td>397.9</td>
</tr>
<tr>
<td>Stage 3 - Residual 3</td>
<td>6.00</td>
<td>1200.0</td>
<td>471.5</td>
</tr>
<tr>
<td>Stage 4 - Residual 4</td>
<td>6.00</td>
<td>1200.0</td>
<td>363.2</td>
</tr>
<tr>
<td>Stage 5 - Residual 5</td>
<td>6.00</td>
<td>1200.0</td>
<td>368.6</td>
</tr>
<tr>
<td>Stage 6 - Residual 6</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Notes/Remarks:

- Note: Area correction based on square sample equation.
- Graph not to scale
- Sample/s supplied by the client

---

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**Authorised Signatory**

C. Channon

**Laboratory No.** 9926

**ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING**
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 19020119C- DS

Shear Stress/Relative Displacement Plot

Notes/Remarks:
Note: Area correction based on square sample equation.
Graph not to scale
Sample/s supplied by the client

Authorised Signatory
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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 19020119C- DS

Vertical Displacement/Relative Displacement Plot

Notes/Remarks:
Note: Area correction based on square sample equation.
Graph not to scale
Sample/s supplied by the client

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Trilab Pty Ltd
ABN 25 065 630 506

Laboratory No. 9926

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
## DIRECT SHEAR TEST REPORT

### Test Method:
AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

### Client
Hatch Pty Ltd

### Report No.
19020119C- DS

### Failure Criteria
Residual @ 6, 6, 6, 6 mm Displacement

### Residual - Normal Stress vs Shear Stress

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Residual 1</td>
</tr>
<tr>
<td>2</td>
<td>Residual 2</td>
</tr>
<tr>
<td>3</td>
<td>Residual 3</td>
</tr>
<tr>
<td>4</td>
<td>Residual 4</td>
</tr>
<tr>
<td>5</td>
<td>Residual 5</td>
</tr>
<tr>
<td>6</td>
<td>Residual 6</td>
</tr>
</tbody>
</table>

### Notes/Remarks:
- Photo not to scale
- Sample/s supplied by the client

---

**Trilab Pty Ltd**

**ABN 25 065 630 506**

**ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING**
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 19020119C-DS

Failure Criteria

Peak - Normal Stress vs Shear Stress

Stage 1 - Peak
Stage 2 - Peak 2
Stage 3 - Peak 3
Stage 4 - Peak 4
Stage 5 - Peak 5
Stage 6 - Peak 6

Shear Stress (kPa)

Normal Stress (kPa)

Notes/Remarks:
Graph not to scale
Sample/s supplied by the client

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Authorized Signatory

C. Channon

LABORATORY NO. 9926

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 19020119C-DS

Stage 1 Consolidation

Displacement v's Time (Log Scale)

- $t_{50} = 1.52$ mins
- $t_{100} = 4.90$ mins
- Time to Failure = 315.92 mins
- Estimated Displacement to Failure = 5 mm
- Displacement Rate = 0.01583 mm/min

Notes/Remarks:
- Graph not to scale
- Sample/s supplied by the client

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 19020119C-DS

Before and After Photos

CLIENT: Hatch Pty Ltd
PROJECT: H356804 - Cadia NTSF Failure
LAB SAMPLE No.: 19020119
BOREHOLE: CE416 - L2B

AFTER TEST
DATE: 23/02/19
DEPTH: 24.50-25.00

Notes/Remarks:
Graph not to scale
Sample/s supplied by the client

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
## DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

### Client Information
- **Client:** Hatch Pty Ltd
- **Report No.:** 19020119D-DS
- **Workorder No.:** 0005507
- **Address:** PO Box 425 SPRING HILL QLD 4004
- **Test Date:** 4/03/2019
- **Project:** H356804 - Cadia NTFS Failure
- **Test Date:** 4/03/2019
- **Report Date:** 13/03/2019
- **Client ID:** CE416 - L2B
- **Depth (m):** 24.50-25.00

### Sample Details
- **Description:** SILTY CLAY - brown
- **Sample Type:** Single individual soil specimen - Remoulded as requested by the client.

### Results of Testing

#### Residual Results

<table>
<thead>
<tr>
<th>Test Stage</th>
<th>Residual Displacement (mm)</th>
<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1 - Peak</td>
<td>7.50</td>
<td>500.0</td>
<td>228.7</td>
</tr>
<tr>
<td>Stage 2 - Residual 2</td>
<td>7.50</td>
<td>500.0</td>
<td>156.6</td>
</tr>
<tr>
<td>Stage 3 - Residual 3</td>
<td>7.50</td>
<td>500.0</td>
<td>140.6</td>
</tr>
<tr>
<td>Stage 4 - Residual 4</td>
<td>7.50</td>
<td>500.0</td>
<td>134.3</td>
</tr>
<tr>
<td>Stage 5 - Residual 5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Stage 6 - Residual 6</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

#### Peak Results

<table>
<thead>
<tr>
<th>Test Stage</th>
<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1 - Peak</td>
<td>500.0</td>
<td>254.6</td>
</tr>
<tr>
<td>Stage 2 - Residual 2</td>
<td>500.0</td>
<td>167.7</td>
</tr>
<tr>
<td>Stage 3 - Residual 3</td>
<td>500.0</td>
<td>140.6</td>
</tr>
<tr>
<td>Stage 4 - Residual 4</td>
<td>500.0</td>
<td>134.3</td>
</tr>
<tr>
<td>Stage 5 - Residual 5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Stage 6 - Residual 6</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Notes/Remarks:** Maximum particle size tested -75 micron.

Note: Area correction based on square sample equation.

Graph not to scale Sample/s supplied by the client

---

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Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Channon

Lab No. 9926

**Accurate Quality Results for Tomorrow’s Engineering**
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 19020119D- DS

Shear Stress/Relative Displacement Plot

Notes/Remarks:
- Maximum particle size tested -75 micron.
- Note: Area correction based on square sample equation.
- Graph not to scale
- Sample/s supplied by the client

Authorised Signatory
C. Channon

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

STRICTLY CONFIDENTIAL
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd  
Report No.: 19020119D-DS

<table>
<thead>
<tr>
<th>Vertical Displacement/Relative Displacement Plot</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Graph" /></td>
</tr>
<tr>
<td>Notes/Remarks: Maximum particle size tested -75 micron. Note: Area correction based on square sample equation. Graph not to scale Sample/s supplied by the client</td>
</tr>
</tbody>
</table>

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Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Channon

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 19020119D-DS

Failure Criteria: Residual @ 7.5, 7.5, 7.5, 7.5 mm Displacement

Residual - Normal Stress vs Shear Stress

0 100 200 300 400 500 600
0 100 200 300 400 500 600

Notes/Remarks:
Photo not to scale Sample/s supplied by the client

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Trilab Pty Ltd      ABN 25 065 630 506

Authorised Signatory
C. Channon

LABORATORY No. 9926

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 19020119D- DS

Failure Criteria

Peak - Normal Stress vs Shear Stress

- Stage 1 - Peak
- Stage 2 - Peak 2
- Stage 3 - Peak 3
- Stage 4 - Peak 4
- Stage 5 - Peak 5
- Stage 6 - Peak 6

Notes/Remarks:
Graph not to scale
Sample/s supplied by the client

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Laboratory No. 9926

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Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING
DIRECT SHEAR TEST REPORT  
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2  

Client: Hatch Pty Ltd  
Report No.: 19020119D-DS  

Stage 1 Consolidation  

Displacement v’s Time (Log Scale)  

![Graph showing displacement vs time for Stage 1 Consolidation.](image)  

Notes/Remarks:  
Graph not to scale  
Sample/s supplied by the client  

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C. Channon  

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Trilab Pty Ltd  
ABN 25 065 630 506  

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
# DIRECT SHEAR TEST REPORT

**Client:** Hatch Pty Ltd  
**Report No.:** 19020119D-DS

### Before and After Photos

<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROJECT:</td>
<td>H356804 - Cadia NTSF Failure</td>
</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>19020119</td>
</tr>
<tr>
<td>BOREHOLE:</td>
<td>CE416 - L2B</td>
</tr>
<tr>
<td>AFTER TEST</td>
<td></td>
</tr>
<tr>
<td>DATE:</td>
<td>12/03/19</td>
</tr>
<tr>
<td>DEPTH:</td>
<td>24.50-25.00</td>
</tr>
</tbody>
</table>

**Notes/Remarks:**  
Graph not to scale  
Sample/s supplied by the client

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C. Channon

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**Trilab Pty Ltd ABN 25 065 630 506**

**Laboratory No. 9926**

**ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING**
# DIRECT SHEAR TEST REPORT

**Test Method:** AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

<table>
<thead>
<tr>
<th>Client</th>
<th>Hatch Pty Ltd</th>
<th>Report No.</th>
<th>19020119E- DS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>PO Box 425 SPRING HILL QLD 4004</td>
<td>Workorder No</td>
<td>0005507</td>
</tr>
<tr>
<td>Project</td>
<td>H356804 - Cadia NTSF Failure</td>
<td>Test Date</td>
<td>20/02/2019</td>
</tr>
<tr>
<td>Client ID</td>
<td>CE416 - L2B</td>
<td>Report Date</td>
<td>13/03/2019</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>24.50-25.00</td>
<td>Sample Type</td>
<td>Single individual soil specimen - Remoulded as requested by the client.</td>
</tr>
</tbody>
</table>

## SAMPLE DETAILS

<table>
<thead>
<tr>
<th>Specimen Condition</th>
<th>Inundated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specimen Dimensions (mm)</td>
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</tr>
<tr>
<td>Rate of Strain (mm/min)</td>
<td>0.008</td>
</tr>
<tr>
<td>Initial Moisture Content (%)</td>
<td>34.2</td>
</tr>
<tr>
<td>Initial Wet Density(t/m$^3$)</td>
<td>1.87</td>
</tr>
</tbody>
</table>

## RESULTS OF TESTING

### RESIDUAL RESULTS

<table>
<thead>
<tr>
<th>Test Stage</th>
<th>Residual Displacement (mm)</th>
<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1 - Peak</td>
<td>6.00</td>
<td>1200.0</td>
<td>548.8</td>
<td>1200.0</td>
<td>552.0</td>
</tr>
<tr>
<td>Stage 2 - Residual 2</td>
<td>6.00</td>
<td>1200.0</td>
<td>341.4</td>
<td>1200.0</td>
<td>428.6</td>
</tr>
<tr>
<td>Stage 3 - Residual 3</td>
<td>6.00</td>
<td>1200.0</td>
<td>399.7</td>
<td>1200.0</td>
<td>400.6</td>
</tr>
<tr>
<td>Stage 4 - Residual 4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Stage 5 - Residual 5</td>
<td>-</td>
<td>-</td>
<td>-</td>
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### PEAK RESULTS

<table>
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<tr>
<th>Test Stage</th>
<th>Normal Stress (kPa)</th>
<th>Corrected Shear Stress (kPa)</th>
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<tbody>
<tr>
<td>Stage 1 - Peak</td>
<td>1200.0</td>
<td>552.0</td>
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<tr>
<td>Stage 2 - Residual 2</td>
<td>1200.0</td>
<td>428.6</td>
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<td>Stage 3 - Residual 3</td>
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<td>Stage 4 - Residual 4</td>
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<td>Stage 5 - Residual 5</td>
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<tr>
<td>Stage 6 - Residual 6</td>
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</table>

### Notes/Remarks:

- Note: Area correction based on square sample equation.
- Graph not to scale
- Sample/s supplied by the client

---

Reference should be made to TriLab’s “Standard Terms and Conditions of Business” for further details.

**Authorised Signatory**

**C. Channon**

**Laboratory No. 9926**

**Accredited for compliance with ISO/IEC 17025 - Testing.**

The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

**ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING**
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd
Report No.: 19020119E-DS

Graph not to scale
Sample/s supplied by the client

Shear Stress/Relative Displacement Plot

Notes/Remarks:
Note: Area correction based on square sample equation.

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Tested at Trilab Brisbane Laboratory

Authorised Signatory
C. Channon

Laboratory No. 9926

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Trilab Pty Ltd
ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
DIRECT SHEAR TEST REPORT
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd   Report No.: 19020119E-DS

Notes/Remarks:
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Tested at TriLab Brisbane Laboratory

Authorised Signatory
C. Channon

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING
## Direct Shear Test Report

**Test Method:** AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

### Client
Hatch Pty Ltd

### Report No.
19020119E-DS

### Failure Criteria

<table>
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<th>Description</th>
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<td>1</td>
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<tr>
<td>2</td>
<td>Peak 2</td>
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<tr>
<td>3</td>
<td>Peak 3</td>
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<td>4</td>
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<td>Peak 5</td>
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<td>6</td>
<td>Peak 6</td>
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</tbody>
</table>

### Notes/Remarks:
- Graph not to scale
- Sample/s supplied by the client

---

**Authorized Signatory**

C. Channon

---

Trilab Pty Ltd  
ABN 25 065 630 506

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ACCURATE QUALITY RESULTS FOR TOMORROW’S ENGINEERING
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client: Hatch Pty Ltd

Report No.: 19020119E-DS

Stage 1 Consolidation

Displacement v’s Time (Log Scale)

Notes/Remarks:
Graph not to scale
Sample/s supplied by the client
## DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

<table>
<thead>
<tr>
<th>Client</th>
<th>Hatch Pty Ltd</th>
<th>Report No.</th>
<th>19020119E-DS</th>
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</thead>
<tbody>
<tr>
<td>Before and After Photos</td>
<td></td>
<td></td>
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</table>

### Notes/Remarks:
- Graph not to scale
- Sample/s supplied by the client

---

**CLIENT:** Hatch Pty Ltd  
**PROJECT:** I356804 - Cadia NTSF Failure  
**LAB SAMPLE No.:** 19020119  
**BOREHOLE:** CE416 - L2B  
**AFTER TEST**
- **DATE:** 23/02/19  
- **DEPTH:** 24.50-25.00

---

**Authorised Signatory**

C. Channon

---

**Accredited for compliance with ISO/IEC 17025 - Testing.**

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Trilab Pty Ltd  
ABN 25 065 630 506

---

**Lab No. 9926**

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---

**ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING**
Annexure DE
CIU Triaxial Tests - Golders
# Triaxial Test Report

## Isotropically Consolidated Undrained (CIU)

<table>
<thead>
<tr>
<th>Client:</th>
<th>Hatch</th>
<th>Date:</th>
<th>13/09/2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address:</td>
<td>61 Petrie Terrace, Brisbane</td>
<td>Project No.:</td>
<td>18101980</td>
</tr>
<tr>
<td>Project:</td>
<td>NTSF Embankment Failure ITRB</td>
<td>Sample ID:</td>
<td>CE415-PT1 6.0-6.5m</td>
</tr>
<tr>
<td>Location:</td>
<td>Cadia Mine</td>
<td>Test ID:</td>
<td>18022 - TX1 1000kPa</td>
</tr>
<tr>
<td>Initial Height (mm):</td>
<td>133.8</td>
<td>Strain Rate (mm/min):</td>
<td>0.03</td>
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<tr>
<td>Initial Diameter (mm):</td>
<td>62.5</td>
<td>B Response (%):</td>
<td>98%</td>
</tr>
<tr>
<td>Trimmings GWC (%):</td>
<td>-</td>
<td>Mean Effective Consolidation Stress (kPa):</td>
<td>1000</td>
</tr>
<tr>
<td>Initial Dry Density (t/m³):</td>
<td>1.28</td>
<td>Geostatic Stress Ratio $K_0$ (-):</td>
<td>1.00</td>
</tr>
<tr>
<td>Final Liquor Content (%):</td>
<td>41.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Dry Density (t/m³):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Void Ratio (-):</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Liquor Solids Conc. (g/L):</td>
<td>-</td>
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</table>

<table>
<thead>
<tr>
<th>Preparation Notes:</th>
<th>Sample was extruded and trimmed from push tube</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tested by:</td>
<td>I. Orea</td>
</tr>
<tr>
<td>Reviewed by:</td>
<td>R. Fanni</td>
</tr>
</tbody>
</table>
# Triaxial Test Report

**Isotropically Consolidated Undrained (CIU)**

<table>
<thead>
<tr>
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<td>Sample ID:</td>
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<td>Test ID:</td>
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<td>62.5</td>
<td>Final Dry Density (t/m$^3$):</td>
<td>1.39</td>
</tr>
<tr>
<td>Trimmins GWC (%):</td>
<td>43.5%</td>
<td>Final Void Ratio (-):</td>
<td>-</td>
</tr>
<tr>
<td>Initial Dry Density (t/m$^3$):</td>
<td>1.28</td>
<td>Final Liquor Solids Conc. (g/L):</td>
<td>-</td>
</tr>
</tbody>
</table>

- **Strain Rate (mm/min):** 0.03
- **B Response (%):** 98%
- **Mean Effective Consolidation Stress (kPa):** 1000
- **Geostatic Stress Ratio $K_0$ (-):** 1.00

![Deviator Stress vs. Axial Strain](image)

**Preparation Notes:** Sample was extruded and trimmed from push tube

**Tested by:** I. Orea

**Reviewed by:** R. Fanni

---

**THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL**
Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Client: Hatch
Address: 61 Petrie Terrace, Brisbane
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine

Date: 13/09/2018
Project No.: 18101980
Sample ID: CE415-PT1 6.0-6.5m
Test ID: 18022 - TX1 1000kPa

Preparation Notes: Sample was extruded and trimmed from push tube

<table>
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<th>Parameter</th>
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<tr>
<td>Initial Height (mm)</td>
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<tr>
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<td>0.03</td>
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<tr>
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<tr>
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</tr>
<tr>
<td>Mean Effective Consolidation Stress (kPa):</td>
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<tr>
<td>Initial Dry Density (t/m³):</td>
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</tr>
<tr>
<td>Final Liquor Solids Conc. (g/L)</td>
<td>-</td>
</tr>
<tr>
<td>Geostatic Stress Ratio Kᵣ (-):</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Deviator Stress q (kPa) vs. Mean Effective Stress ρ' (kPa)

Client: Hatch
Address: 61 Petrie Terrace, Brisbane
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine

Preparation Notes: Sample was extruded and trimmed from push tube

Tested by: I. Orea
Reviewed by: R. Fanni

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL
**Triaxial Test Report**

**Isotropically Consolidated Undrained (CIU)**

**Client:** Hatch  
**Date:** 13/09/2018

**Address:** 61 Petrie Terrace, Brisbane  
**Project No.:** 18101980

**Project:** NTSF Embankment Failure ITRB  
**Sample ID:** CE415-PT1 6.0-6.5m

**Location:** Cadia Mine  
**Test ID:** 18022 - TX1.1000kPa

<table>
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<tr>
<th>Initial Height (mm):</th>
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<th>Final Liquor Content (%):</th>
<th>41.3%</th>
<th>Strain Rate (mm/min):</th>
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<tbody>
<tr>
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<td>62.5</td>
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<td>1.39</td>
<td>B Response (%):</td>
<td>98%</td>
</tr>
<tr>
<td>Trimmings GWC (%):</td>
<td>43.5%</td>
<td>Final Void Ratio (-):</td>
<td>-</td>
<td>Mean Effective Consolidation Stress (kPa):</td>
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<tr>
<td>Initial Dry Density (t/m³):</td>
<td>1.28</td>
<td>Final Liquor Solids Conc. (g/L):</td>
<td>-</td>
<td>Geostatic Stress Ratio $K_0$ (-):</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**Graph:**
- **Mobilised Friction Angle (Degrees)** vs. **Axial Strain (%)**

**Preparation Notes:** Sample was extruded and trimmed from push tube

**Tested by:** I. Orea

**Reviewed by:** R. Fanni

---

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### Triaxial Test Report

**Isotropically Consolidated Undrained (CIU)**

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<td>18101980</td>
</tr>
<tr>
<td>Project:</td>
<td>NTSF Embankment Failure ITRB</td>
<td>Sample ID:</td>
<td>CE416 PT4 27.00-27.45</td>
</tr>
<tr>
<td>Location:</td>
<td>Cadia Mine</td>
<td>Test ID:</td>
<td>18024 - TX1 1000kPa</td>
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</tbody>
</table>

### Test Parameters

- **Mean Effective Consolidation Stress (kPa):** 95%
- **Strain Rate (mm/min):** 0.005
- **B Response (%):** 100%
- **Geostatic Stress Ratio $K_0$ (%):** 1.00

### Sample Details

<table>
<thead>
<tr>
<th>Initial Height (mm):</th>
<th>126.9</th>
<th>Final Liquor Content (%):</th>
<th>35.2%</th>
<th>Strain Rate (mm/min):</th>
<th>0.005</th>
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<tbody>
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<td>Initial Diameter (mm):</td>
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<td>Final Dry Density (t/m$^3$):</td>
<td>1.47</td>
<td>B Response (%):</td>
<td>95%</td>
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<td>Trimmings GWC (%):</td>
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</tbody>
</table>

### Preparation Notes:
Sample was extruded and trimmed from push tube

### Tested by:
I. Orea

Reviewed by: R. Fanni

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<table>
<thead>
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</tr>
<tr>
<td>Location</td>
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</tr>
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<td>Initial Height (mm)</td>
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<tr>
<td>Final Liquor Content (%)</td>
<td>35.2%</td>
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<tr>
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<tr>
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<td>95%</td>
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<tr>
<td>Trimmings GWC (%)</td>
<td>36.5%</td>
</tr>
<tr>
<td>Final Void Ratio (-)</td>
<td>-</td>
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<td>Mean Effective Consolidation Stress (kPa)</td>
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</tr>
<tr>
<td>Initial Dry Density (t/m³)</td>
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</tr>
<tr>
<td>Final Liquor Solids Conc. (g/L)</td>
<td>-</td>
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<tr>
<td>Geostatic Stress Ratio K₀ (-)</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**Preparation Notes:** Sample was extruded and trimmed from push tube

**Tested by:** I. Orea

**Reviewed by:** R. Fanni

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# Triaxial Test Report

## Isotropically Consolidated Undrained (CIU)

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<td>Project No.:</td>
<td>18101980</td>
</tr>
<tr>
<td>Project:</td>
<td>NTSF Embankment Failure ITRB</td>
<td>Sample ID:</td>
<td>CE416 PT4.27.00-27.45</td>
</tr>
<tr>
<td>Location:</td>
<td>Cadia Mine</td>
<td>Test ID:</td>
<td>18024 - TX1 1000kPa</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Preparation Notes:</th>
<th>Test ID:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample was extruded and trimmed from push tube</td>
<td>18024 - TX1 1000kPa</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Initial Height (mm):</th>
<th>126.9</th>
<th>Final Liquor Content (%):</th>
<th>35.2%</th>
<th>Strain Rate (mm/min):</th>
<th>0.005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Diameter (mm):</td>
<td>64.0</td>
<td>Final Dry Density (t/m³):</td>
<td>1.47</td>
<td>B Response (%):</td>
<td>95%</td>
</tr>
<tr>
<td>Trimmings GWC (%):</td>
<td>36.5%</td>
<td>Final Void Ratio (-):</td>
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<tr>
<td>Initial Dry Density (t/m³):</td>
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<td>Final Liquor Solids Conc. (g/L):</td>
<td>-</td>
<td>Geostatic Stress Ratio $K_0$ (-):</td>
<td>1.00</td>
</tr>
</tbody>
</table>

### Graph
- **Y-axis**: Deviator Stress $q$ (kPa)
- **X-axis**: Mean Effective Stress $p'$ (kPa)

### Notes
- **Location**: Cadia Mine
- **Client**: Hatch
- **Date**: 13/09/2018
- **Test ID**: 18024 - TX1 1000kPa
- **Preparation Notes**: Sample was extruded and trimmed from push tube
- **Tested by**: I. Orea
- **Reviewed by**: R. Fanni
Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Client: Hatch
Address: 61 Petrie Terrace, Brisbane
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine

Date: 13/09/2018
Project No.: 18101980
Sample ID: CE416 PT4.27.00-27.45
Test ID: 18024 - TX1 1000kPa

Initial Height (mm): 126.9
Initial Diameter (mm): 64.0
Trimmings GWC (%): 36.5%
Initial Dry Density (t/m³): 1.33

Final Liquor Content (%): 35.2%
Final Dry Density (t/m³): 1.47
Final Void Ratio (-): -
Final Liquor Solids Conc. (g/L): -

Strain Rate (mm/min): 0.005
B Response (%): 95%
Mean Effective Consolidation Stress (kPa): 1001
Geostatic Stress Ratio $K_0$: 1.00

Axial Strain (%) vs. Mobilised Friction Angle (Degrees)

Preparation Notes: Sample was extruded and trimmed from push tube

Tested by: I. Orea
Reviewed by: R. Fanni

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL
## Isotropically Consolidated Undrained (CIU)

### Sample Details

- **Location:** Cadia Mine
- **Client:** Hatch
- **Address:** 61 Petrie Terrace, Brisbane
- **Project:** NTSF Embankment Failure ITRB
- **Date:** 26/10/2018
- **Test ID:** 18027 - TX1 400kPa

<table>
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<tr>
<th>Parameter</th>
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<tbody>
<tr>
<td>Initial Height (mm)</td>
<td>126.0</td>
</tr>
<tr>
<td>Final Liquor Content (%)</td>
<td>28.8%</td>
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<tr>
<td>Strain Rate (mm/min)</td>
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<td>Initial Diameter (mm)</td>
<td>62.3</td>
</tr>
<tr>
<td>Final Dry Density (t/m³)</td>
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<tr>
<td>B Response (%)</td>
<td>96%</td>
</tr>
<tr>
<td>Trimmings GWC (%)</td>
<td>27.9%</td>
</tr>
<tr>
<td>Final Void Ratio (-)</td>
<td>0.82</td>
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<tr>
<td>Mean Effective Consolidation Stress (kPa)</td>
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<tr>
<td>Initial Dry Density (t/m³)</td>
<td>1.54</td>
</tr>
<tr>
<td>Final Liquor Solids Conc. (g/L)</td>
<td>-</td>
</tr>
<tr>
<td>Geostatic Stress Ratio $K_0$ (-)</td>
<td>0.99</td>
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</tbody>
</table>

| Preparation Notes                           | Sample was extruded and trimmed from push tube |
| Sample Before Test                          |                                             |
| Tested by                                   | I. Orea                                      |
| Sample After Test                           |                                             |
| Reviewed by                                 | R. Fanni                                     |

**THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL**
Isotropically Consolidated Undrained (CIU)

Client: Hatch
Date: 26/10/2018

Address: 61 Petrie Terrace, Brisbane

Project: NTSF Embankment Failure ITRB
Sample ID: CE416-PT2 24.00-24.33m

Location: Cadia Mine
Test ID: 18027 - TX1 400kPa

Initial Height (mm): 126.0
Final Liquor Content (%): 28.8%
Strain Rate (mm/min): 0.002

Initial Diameter (mm): 62.3
Final Dry Density (t/m$^3$): 1.57
B Response (%): 96%

Trimmings GWC (%): 27.9%
Final Void Ratio (-): 0.82
Mean Effective Consolidation Stress (kPa): 402

Initial Dry Density (t/m$^3$): 1.54
Final Liquor Solids Conc. (g/L): -
Geostatic Stress Ratio $K_0$ (-): 0.99

Preparation Notes: Sample was extruded and trimmed from push tube

Tested by: I. Orea
Reviewed by: R. Fanni

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL
### Triaxial Test Report

**Isotropically Consolidated Undrained (CIU)**

<table>
<thead>
<tr>
<th>Client:</th>
<th>Hatch</th>
<th>Date:</th>
<th>26/10/2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address:</td>
<td>61 Petrie Terrace, Brisbane</td>
<td>Project No.:</td>
<td>18101980</td>
</tr>
<tr>
<td>Project:</td>
<td>NTSF Embankment Failure ITRB</td>
<td>Sample ID:</td>
<td>CE416-PT2 24.00-24.33m</td>
</tr>
<tr>
<td>Location:</td>
<td>Cadia Mine</td>
<td>Test ID:</td>
<td>18027 - TX1 400kPa</td>
</tr>
<tr>
<td>Initial Height (mm):</td>
<td>126.0</td>
<td>Final Liquor Content (%):</td>
<td>28.8%</td>
</tr>
<tr>
<td>Initial Diameter (mm):</td>
<td>62.3</td>
<td>Final Dry Density (t/m^3):</td>
<td>1.57</td>
</tr>
<tr>
<td>Trimmings GWC (%):</td>
<td>27.9%</td>
<td>Final Void Ratio ((\varepsilon)):</td>
<td>0.82</td>
</tr>
<tr>
<td>Initial Dry Density (t/m^3):</td>
<td>1.54</td>
<td>Final Liquor Solids Conc. (g/L):</td>
<td>-</td>
</tr>
<tr>
<td>Strain Rate (mm/min):</td>
<td>0.002</td>
<td>Geostatic Stress Ratio (K_0) ((\varepsilon)):</td>
<td>0.99</td>
</tr>
</tbody>
</table>

**Preparation Notes:** Sample was extruded and trimmed from push tube

**Tested by:** I. Orea

**Reviewed by:** R. Fanni

---

**Graph:**

- **Deviator Stress** \(q\) (kPa) vs **Mean Effective Stress** \(p'\) (kPa)

---

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### Isotropically Consolidated Undrained (CIU)

**Client:** Hatch  
**Address:** 61 Petrie Terrace, Brisbane  
**Date:** 26/10/2018  
**Project No.:** 18101980  
**Project:** NTFS Embankment Failure ITRB  
**Sample ID:** CE416-PT2 24.00-24.33m  
**Location:** Cadia Mine  
**Test ID:** 18027 - TX1 400kPa

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Height (mm)</td>
<td>126.0</td>
</tr>
<tr>
<td>Final Liquor Content (%)</td>
<td>28.8%</td>
</tr>
<tr>
<td>Strain Rate (mm/min)</td>
<td>0.002</td>
</tr>
<tr>
<td>Initial Diameter (mm)</td>
<td>62.3</td>
</tr>
<tr>
<td>Final Dry Density (t/m³)</td>
<td>1.57</td>
</tr>
<tr>
<td>Trimmings GWC (%)</td>
<td>27.9%</td>
</tr>
<tr>
<td>Final Void Ratio (-)</td>
<td>0.82</td>
</tr>
<tr>
<td>Initial Dry Density (t/m³)</td>
<td>1.54</td>
</tr>
<tr>
<td>Final Liquor Solids Conc. (g/L)</td>
<td>-</td>
</tr>
<tr>
<td>Mean Effective Consolidation Stress (kPa)</td>
<td>402</td>
</tr>
<tr>
<td>Geostatic Stress Ratio $K_0$ (-)</td>
<td>0.99</td>
</tr>
</tbody>
</table>

**Preparation Notes:** Sample was extruded and trimmed from push tube

**Tested by:** I. Orea  
**Reviewed by:** R. Fanni
Annexure DF
CIU Triaxial Tests – Trilabs
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080195 - CU

Workorder No.: 0004644

Address: PO Box 425 SPRING HILL QLD 4004
Test Date: 6/09/2018

Project: H356804 - Cadia NTSF Failure
Report Date: 25/09/2018

Client Id.: CE407 - DH402 - PT2
Depth (m): 50.00-50.50

Description: CLAY - dark grey and brown

SAMPLE & TEST DETAILS

<table>
<thead>
<tr>
<th>Initial Height: 127.1 mm</th>
<th>Initial Moisture Content: 23.1 %</th>
<th>Rate of Strain: 0.005 %/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Diameter: 62.8 mm</td>
<td>Final Moisture Content: 17.5 %</td>
<td>B Response: 97 %</td>
</tr>
<tr>
<td>L/D Ratio: 2.0 : 1</td>
<td>Wet Density: 2.13 t/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dry Density: 1.73 t/m³</td>
<td></td>
</tr>
</tbody>
</table>

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

FAILURE DETAILS

<table>
<thead>
<tr>
<th>Effective Pressure</th>
<th>Confining Pressure</th>
<th>Back Pressure</th>
<th>Initial Pore</th>
<th>Failure Pore</th>
<th>Failure Effective Stresses</th>
<th>Deviator Stress</th>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>613 kPa</td>
<td>1101 kPa</td>
<td>488 kPa</td>
<td>488 kPa</td>
<td>672 kPa</td>
<td>842 kPa</td>
<td>429 kPa</td>
<td>1.964</td>
</tr>
<tr>
<td>812 kPa</td>
<td>1301 kPa</td>
<td>489 kPa</td>
<td>489 kPa</td>
<td>700 kPa</td>
<td>1177 kPa</td>
<td>601 kPa</td>
<td>1.958</td>
</tr>
<tr>
<td>1227 kPa</td>
<td>1703 kPa</td>
<td>476 kPa</td>
<td>476 kPa</td>
<td>800 kPa</td>
<td>1689 kPa</td>
<td>903 kPa</td>
<td>1.871</td>
</tr>
</tbody>
</table>

INTERPRETATION BETWEEN STAGES: 1 to 2 2 to 3 1 to 3

Interpretation between stages: 1 to 2 2 to 3 1 to 3

Cohesion C' (kPa): 3.3 60.0 34.0

Angle of Shear Resistance Φ' (Degrees): 18.7 15.0 16.3

Failure Criteria: Peak Principal Stress Ratio

FAILURES ENVELOPES

Remarks: Tested as Received
Sample/s supplied by the client

Page 1 of 7

TRIAXIAL TEST REPORT

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Authorised Signatory
C. Channon

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Authorised Signatory
T. Lockhart

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Laboratory Number
9926

ABN 25 065 630 506
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080195 - CU

Mohr Circle Diagram

Interpretation between stages: 1 to 2 2 to 3 1 to 3
Cohesion C' (kPa): 3.3 60.0 34.0
Angle of Shear Resistance \( \Phi' \) (Degrees): 18.7 15.0 16.3
Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

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C. Channon

Laboratory Number 9926

Page 2 of 7
REP03001
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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C. Channon

Page 3 of 7

Laboratory Number
9926

Authorised Signatory
T. Lockhart

Soil      Rock      Calibration

 Brisbane
346A Bilsen Road,
Geebung
QLD  4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA  6107
Ph: +61 8 9258 8323
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

s = (σ'₁ + σ'₃)/2  kPa

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ABN 25 065 630 506
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080195 - CU

Cambridge Method - Effective Stress Path

\[ p = \left( \frac{\sigma_1' + 2\sigma_3'}{3} \right) \ \text{kPa} \]

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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Trilab Pty Ltd
ABN 25 065 630 506
<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
<th>REPORT NO.:</th>
<th>18080195 - CU</th>
</tr>
</thead>
</table>

**PROJECT:** H356804 - Cadia NTSF Failure  
**LAB SAMPLE No.:** 18080195  
**BOREHOLE:** CE407 - DH402 - PT2  
**BEFORE TEST**  
**DATE:** 10/08/18  
**DEPTH:** 50.00-50.50

**AFTER TEST**  
**DATE:** 20/09/18  
**DEPTH:** 50.00-50.50
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080195 - CU

Volume v's Time (Log Scale)

<table>
<thead>
<tr>
<th>Stage</th>
<th>CV (m^2/year)</th>
<th>Mv (m^2/MN)</th>
<th>k (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.04</td>
<td>1.41E-12</td>
<td>0.01</td>
</tr>
<tr>
<td>2</td>
<td>0.01</td>
<td>0.109</td>
<td>0.131</td>
</tr>
<tr>
<td>3</td>
<td>0.05</td>
<td>0.095</td>
<td>1.39E-12</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Authorised Signatory
C. Channon

Laboratory Number
9926
# TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

**Client:** Hatch Pty Ltd

**Report No.:** 18080196 - CU

**Address:** PO Box 425 SPRING HILL QLD 4004

**Workorder No.:** 0004644

**Test Date:** 17/08/2018

**Report Date:** 12/09/2018

**Project:** H356804 - Cadia NTSF Failure

**Client Id.:** CE407 - DH402 - PT3

**Depth (m):** 51.00-51.50

**Description:** CLAY - brown

## SAMPLE & TEST DETAILS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Height</td>
<td>127.1 mm</td>
</tr>
<tr>
<td>Initial Diameter</td>
<td>62.8 mm</td>
</tr>
<tr>
<td>L/D Ratio</td>
<td>2.0 : 1</td>
</tr>
<tr>
<td>Initial Moisture Content</td>
<td>20.7 %</td>
</tr>
<tr>
<td>Final Moisture Content</td>
<td>15.9 %</td>
</tr>
<tr>
<td>Wet Density</td>
<td>2.14 t/m³</td>
</tr>
<tr>
<td>Dry Density</td>
<td>1.77 t/m³</td>
</tr>
<tr>
<td>Rate of Strain</td>
<td>0.004 %/min</td>
</tr>
<tr>
<td>B Response</td>
<td>98 %</td>
</tr>
</tbody>
</table>

- Sample Type: Single Individual Undisturbed Specimen

## TEST RESULTS

### FAILURE DETAILS

<table>
<thead>
<tr>
<th>Effective Pressure</th>
<th>Confining Pressure</th>
<th>Back Pressure</th>
<th>Initial Pore</th>
<th>Failure Pore</th>
<th>Principal Effective Stresses</th>
<th>Deviator Stress</th>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1202 kPa</td>
<td>1696 kPa</td>
<td>496 kPa</td>
<td>496 kPa</td>
<td>973 kPa</td>
<td>( \sigma_1 ) = 1590 kPa</td>
<td>( \sigma_3 ) = 725 kPa</td>
<td>( \sigma' / \sigma_3 ) = 2.194</td>
</tr>
</tbody>
</table>

### FAILURE ENVELOPES

- Interpretation between stages:
- Cohesion C’ (kPa):
- Angle of Shear Resistance \( \Phi' \) (Degrees):
- Failure Criteria: Peak Principal Stress Ratio

**Remarks:**
- Tested as Received
- Sample/s supplied by the client

---

**Authorised Signatory:**

C. Channon

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---

**Laboratory Number:**

9926

**NATA Accreditation:**

[Logo]

**Reference:**

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Trilab Pty Ltd

ABN 25 065 630 506

Page 1 of 7

REP03001
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080196 - CU

Mohr Circle Diagram

Interpretation between stages:

- Cohesion C' (kPa)
- Angle of Shear Resistance \( \Phi' \) (Degrees)

Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Authorised Signatory

C. Channon

Authorised Signatory

T. Lockhart

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TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080196 - CU

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

Stress/Strain & Pore Pressure/Strain Diagram

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Authorised Signatory
C. Channon

Laboratory Number
9926
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080196 - CU

MIT Method - Effective Stress Path

\[ s = \frac{(\sigma_1' + \sigma_3')}{2} \quad kPa \]

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080196 - CU

Cambridge Method - Effective Stress Path

\[ p = \left(\sigma'_1 + 2\sigma'_3\right)/3 \] kPa

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.

RE003001

Page 5 of 7
TRIAxIAL TEST REPORT  
Test Method: AS1289.6.4.2

<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
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</thead>
<tbody>
<tr>
<td>PROJECT:</td>
<td>H356804 - Cadia NTSF Failure</td>
</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>18080196</td>
</tr>
<tr>
<td>BOREHOLE:</td>
<td>CE407 - DH402 - PT3</td>
</tr>
<tr>
<td>BEFORE TEST</td>
<td>DATE: 13/08/18</td>
</tr>
<tr>
<td></td>
<td>DEPTH: 51.00-51.50</td>
</tr>
</tbody>
</table>

Remarks: Tested as Received
Sample/s supplied by the client

Note: Photo not to scale

Agreed this 23/08/18

C. Channon
Authorised Signatory

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Report No.: 18080196 - CU

Page 6 of 7
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080196 - CU

Volume v's Time (Log Scale)

Stage 1

CV (m²/year) : 0.09
Mv (m³/MN) : 0.074
k (m/s) : 2.10E-12

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Authorised Signatory
C. Channon

Page 7 of 7
## TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

<table>
<thead>
<tr>
<th>Client:</th>
<th>Hatch Pty Ltd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Report No.:</td>
<td>18080420 - CU</td>
</tr>
<tr>
<td>Workorder No.:</td>
<td>0004681</td>
</tr>
<tr>
<td>Address:</td>
<td>PO Box 425 SPRING HILL QLD 4004</td>
</tr>
<tr>
<td>Project:</td>
<td>H356804 - Cadia NTSF Failure</td>
</tr>
<tr>
<td>Client Id.:</td>
<td>CE417 - DH406 L2B</td>
</tr>
<tr>
<td>Depth (m):</td>
<td>18.50-19.00</td>
</tr>
</tbody>
</table>

**Description:** SILTY CLAY- orange and grey

### SAMPLE & TEST DETAILS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Height</td>
<td>130.7 mm</td>
</tr>
<tr>
<td>Initial Diameter</td>
<td>60.1 mm</td>
</tr>
<tr>
<td>L/D Ratio</td>
<td>2.2 : 1</td>
</tr>
<tr>
<td>Initial Moisture Content</td>
<td>38.6 %</td>
</tr>
<tr>
<td>Final Moisture Content</td>
<td>38.6 %</td>
</tr>
<tr>
<td>Rate of Strain</td>
<td>0.005 %/min</td>
</tr>
<tr>
<td>Wet Density</td>
<td>1.82 t/m³</td>
</tr>
<tr>
<td>Dry Density</td>
<td>1.31 t/m³</td>
</tr>
</tbody>
</table>

Sample Type: Single Individual Undisturbed Specimen

### TEST RESULTS

#### FAILURE DETAILS

<table>
<thead>
<tr>
<th>Effective Pressure</th>
<th>Confining Pressure</th>
<th>Back Pressure</th>
<th>Initial Pore Pressure</th>
<th>Failure Pore Pressure</th>
<th>Principal Effective Stresses</th>
<th>Deviator Stress</th>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>799 kPa</td>
<td>1299 kPa</td>
<td>500 kPa</td>
<td>500 kPa</td>
<td>938 kPa</td>
<td>881 kPa</td>
<td>361 kPa</td>
<td>2.439</td>
</tr>
</tbody>
</table>

#### FAILURE ENVELOPES

- Interpretation between stages:
- Cohesion C' (kPa):
- Angle of Shear Resistance Φ’ (Degrees):
- Failure Criteria: Peak Principal Stress Ratio

**Remarks:** Tested as Received

Sample/s supplied by the client
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080420 - CU

Interpretation between stages:
- Cohesion C' (kPa):
- Angle of Shear Resistance $\Phi'$ (Degrees):

Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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ABN 25 065 630 506

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Trilab Pty Ltd
ABN 25 065 630 506
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080420 - CU

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

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The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Channon

Laboratory Number
9926
MIT Method - Effective Stress Path

\[ s = \frac{\sigma_1' + \sigma_3'}{2} \text{ kPa} \]

Remark: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

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### TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

**Client:** Hatch Pty Ltd  
**Report No.:** 18080420 - CU

#### Cambridge Method - Effective Stress Path

![Graph](image)

\[
p = \frac{(\sigma'_1 + 2\sigma'_3)}{3} \text{ kPa}
\]

**Remarks:** Tested as Received  
Sample/s supplied by the client  
Note: Graph not to scale

---

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Tested at Trilab Brisbane Laboratory.

---

**Authorised Signatory**  
C. Channon

---

**Laboratory Number**  
9926

---

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Trilab Pty Ltd  
ABN 25 065 630 506
## TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PROJECT:</strong></td>
<td>H356804 - Cadia NTSF Failure</td>
</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>18080420</td>
</tr>
<tr>
<td>BOREHOLE:</td>
<td>CE417 - DH406 L2B</td>
</tr>
</tbody>
</table>

**BEFORE TEST**

- **DATE:** 28/08/13
- **DEPTH:** 18.50-19.00

### Remarks:
- Tested as Received
- Sample/s supplied by the client

### Note:
- Photo not to scale

---

<table>
<thead>
<tr>
<th>CLIENT:</th>
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</tr>
</thead>
<tbody>
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<td>H356804 - Cadia NTSF Failure</td>
</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>18080420</td>
</tr>
<tr>
<td>BOREHOLE:</td>
<td>CE417 - DH406 L2B</td>
</tr>
</tbody>
</table>

**AFTER TEST**

- **DATE:** 07-09-16
- **DEPTH:** 18.50-19.00

---

**Test Method:** AS1289.6.4.2

---

**Authorised Signatory:**
- C. Channon

---

**Laboratory Number:** 9926

---

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080420 - CU

Volume v's Time (Log Scale)

Stage 1

Volume (mls)

Time (mins)

Stage 1

CV (m²/year): 1.12

Mv (m³/MN): 0.069

k (m/s): 2.39E-11

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

Authorised Signatory

C. Channon

334 339 344 349 354 359 364 369

0.01 0.1 1 10 100 1000 10000

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Trilab Pty Ltd
ABN 25 065 630 506

Page 7 of 7
## TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

**Client:** Hatch Pty Ltd

**Report No.:** 18080420 - CU

**Workorder No.:** 0004681

**Address:** PO Box 425 SPRING HILL QLD 4004

**Project:** H356804 - Cadia NTSF Failure

**Client Id.:** CE417 - DH406 L2B

**Test Date:** 30/08/2018

**Report Date:** 12/09/2018

**Depth (m):** 18.50-19.00

**Description:** SILTY CLAY- orange and grey

### SAMPLE & TEST DETAILS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Height</td>
<td>130.8 mm</td>
</tr>
<tr>
<td>Initial Diameter</td>
<td>63.9 mm</td>
</tr>
<tr>
<td>L/D Ratio</td>
<td>2.0 : 1</td>
</tr>
<tr>
<td>Initial Moisture Content</td>
<td>41.1 %</td>
</tr>
<tr>
<td>Final Moisture Content</td>
<td>45.3 %</td>
</tr>
<tr>
<td>Wet Density</td>
<td>1.72 t/m³</td>
</tr>
<tr>
<td>Dry Density</td>
<td>1.22 t/m³</td>
</tr>
</tbody>
</table>

**Rate of Strain:** 0.005 %/min

**B Response:** 98 %

**Sample Type:** Single Individual Undisturbed Specimen

### TEST RESULTS

**FAILURES DETAILS**

<table>
<thead>
<tr>
<th>Effective Pressure</th>
<th>Confining Pressure</th>
<th>Back Pressure</th>
<th>Initial Pore</th>
<th>Failure Pore</th>
<th>Principal Effective Stresses</th>
<th>Deviator Stress</th>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>194 kPa</td>
<td>699 kPa</td>
<td>505 kPa</td>
<td>505 kPa</td>
<td>589 kPa</td>
<td>380 kPa</td>
<td>110 kPa</td>
<td>3.463 kPa</td>
</tr>
<tr>
<td>394 kPa</td>
<td>899 kPa</td>
<td>505 kPa</td>
<td>505 kPa</td>
<td>683 kPa</td>
<td>611 kPa</td>
<td>216 kPa</td>
<td>2.828 kPa</td>
</tr>
</tbody>
</table>

**FAILURES ENVELOPES**

- **Interpretation between stages:** 1 to 2
- **Cohesion C' (kPa):** 48.0
- **Angle of Shear Resistance \( \Phi' \) (Degrees):** 21.7
- **Failure Criteria:** Peak Principal Stress Ratio

**Remarks:** Tested as Received

Sample/s supplied by the client

---

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Channon

Laboratory Number

9926

STRICTLY CONFIDENTIAL
Interpretation between stages: 1 to 2
Cohesion $C'$ (kPa): 48.0
Angle of Shear Resistance $\Phi'$ (Degrees): 21.7
Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

Hatch Pty Ltd

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TriLab Pty Ltd
ABN 25 065 630 506
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080420 - CU

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

Stress/Strain & Pore Pressure/Strain Diagram

Shear Stress
Pore Pressure

Strain %

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Authorised Signatory
C. Channon

Laboratory Number
9926

Page 3 of 7

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080420 - CU

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

s = (σ'₁ + σ'₃)/2  kPa

MIT Method - Effective Stress Path

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Trilab Pty Ltd
ABN 25 065 630 506
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080420 - CU

Cambridge Method - Effective Stress Path

\[ p = \left( \sigma'_1 + 2\sigma'_3 \right) / 3 \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Authorised Signatory
C. Channon

Laboratory Number
9926

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Trilab Pty Ltd
ABN 25 065 630 506
## TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

### Client: Hatch Pty Ltd

### Report No.: 18080420 - CU

<table>
<thead>
<tr>
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<tr>
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<td>H356804 - Cadia NTSF Failure</td>
</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>18080420</td>
</tr>
<tr>
<td>BOREHOLE:</td>
<td>CE417 - DH406 L2B</td>
</tr>
</tbody>
</table>

### BEFORE TEST

| DATE: | 27/08/18 |
| DEPTH: | 18.50-19.00 |

### AFTER TEST

| DATE: | 21/09/18 |
| DEPTH: | 18.50-19.00 |

**Remarks:** Tested as Received  
Sample/s supplied by the client  

**Note:** Photo not to scale  

---

**Signed by:** T. Lockhart  
Trilab Pty Ltd  
Authorised Signatory

**Signed by:** C. Channon  
Authorised Signatory

**Laboratory Number:** 9926

---

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Trilab Pty Ltd  
ABN 25 065 630 506

---

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---
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080420 - CU

Volume v's Time (Log Scale)

Stage 1
Stage 2
Stage 3
Stage 4
Stage 5

Volume (mls)

Time (mins)

0.01 0.1 1 10 100 1000

Stage 1
Stage 2

CV (m^2/year) : 0.98 0.78
Mv (m^2/MN) : 0.118 0.109
k (m/s) : 3.60E-11 2.63E-11

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Authorised Signatory
C. Channon

Laboratory Number
9926

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Trilab Pty Ltd
ABN 25 065 630 506
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Address: PO Box 425 SPRING HILL QLD 4004

Project: H356804 - Cadia NTSF Failure

Client Id.: CE411A - DH409A L1

Description: SILTY CLAY- mottled orange yellow brown

Depth (m): 14.50-15.00

SAMPLE & TEST DETAILS

| Initial Height | 131.6 mm | Initial Moisture Content | 24.6 % | Rate of Strain | 0.005 %/min |
| Initial Diameter | 61.3 mm | Final Moisture Content | 24.3 % |
| L/D Ratio | 2.1 : 1 | Wet Density | 2.04 t/m³ |
| | | Dry Density | 1.64 t/m³ |

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

FAILURE DETAILS

<table>
<thead>
<tr>
<th>Effective Pressure (kPa)</th>
<th>Confining Pressure (kPa)</th>
<th>Back Pressure (kPa)</th>
<th>Initial Pore Pressure (kPa)</th>
<th>Failure Pressure (kPa)</th>
<th>Principal Effective Stresses (kPa)</th>
<th>Deviator Stress (kPa)</th>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>398</td>
<td>900</td>
<td>502</td>
<td>698</td>
<td>669</td>
<td>202, 3.12</td>
<td>467</td>
<td>3.20 %</td>
</tr>
<tr>
<td>786</td>
<td>1296</td>
<td>510</td>
<td>880</td>
<td>1239</td>
<td>416, 2.978</td>
<td>823</td>
<td>6.04 %</td>
</tr>
<tr>
<td>1194</td>
<td>1697</td>
<td>503</td>
<td>1063</td>
<td>1824</td>
<td>634, 2.877</td>
<td>1190</td>
<td>8.47 %</td>
</tr>
</tbody>
</table>

FAILURE ENVELOPES

Interpretation between stages: 1 to 2 2 to 3 1 to 3

Cohesion C’ (kPa): 40.2 37.2 39.2

Angle of Shear Resistance \( \Phi' \) (Degrees): 27.0 27.2 27.1

Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received

Sample/s supplied by the client

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Authorised Signatory

T. Lockhart

Authorised Signatory

C. Channon

NATA

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Page 1 of 7

REPO03001

Trilab Pty Ltd
ABN 25 065 630 506

Laboratory Number
9926
Interpretation between stages: 1 to 2 2 to 3 1 to 3
Cohesion C' (kPa): 40.2 37.2 39.2
Angle of Shear Resistance $\Phi'$ (Degrees): 27.0 27.2 27.1
Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080432 - CU

Stress/Strain & Pore Pressure/Strain Diagram

Deviator Stress kPa

Pore Pressure kPa

Strain %

Shear Stress

Pore Pressure

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory
C. Channon

Page 3 of 7

Laboratory Number
9926
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080432 - CU

MIT Method - Effective Stress Path

\[ t = \left( \frac{s'_1 - s'_3}{2} \right) \text{ kPa} \]

\[ s = \left( \frac{s'_1 + s'_3}{2} \right) \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

Page 4 of 7

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Tested at Trilab Brisbane Laboratory.
Cambridge Method - Effective Stress Path

\[ p = \frac{\sigma_1' + 2\sigma_3'}{3} \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale
# TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

**Client:** Hatch Pty Ltd

<table>
<thead>
<tr>
<th>CLIENT:</th>
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<tr>
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<td>H356804 - Cadia NTSF Failure</td>
</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>18080432</td>
</tr>
<tr>
<td>BOREHOLE:</td>
<td>CE411A - DH409A L1</td>
</tr>
</tbody>
</table>

**BEFORE TEST**

| DATE: | 27/08/18 |
| DEPTH: | 14.50-15.00 |

**AFTER TEST**

| DATE: | 27/08/18 |
| DEPTH: | 14.50-15.00 |

Remarks: Tested as Received  
Sample/s supplied by the client

Note: Photo not to scale

**Authorised Signatory:**

T. Lockhart

**Authorised Signatory:**

C. Channon

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Trilab Pty Ltd  
ABN 25 065 630 506
### TRIAXIAL TEST REPORT

**Client:** Hatch Pty Ltd  
**Report No.:** 18080432 - CU

---

**Volume v's Time (Log Scale)**

<table>
<thead>
<tr>
<th>Stage</th>
<th>CV (m²/year)</th>
<th>Mv (m³/MN)</th>
<th>k (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>0.88</td>
<td>0.091</td>
<td>2.47E-11</td>
</tr>
<tr>
<td>Stage 2</td>
<td>0.86</td>
<td>0.076</td>
<td>2.01E-11</td>
</tr>
<tr>
<td>Stage 3</td>
<td>0.56</td>
<td>0.070</td>
<td>1.22E-11</td>
</tr>
</tbody>
</table>

**Remarks:**  
Tested as Received  
Sample/s supplied by the client  
Note: Graph not to scale

---

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*Authorised Signatory*  
C. Channon

*Laboratory Number*  
9926
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080436 - CU

Address: PO Box 425 SPRING HILL QLD 4004
Workorder No.: 0004681

Test Date: 30/09/2018
Report Date: 13/09/2018

Project: H356804 - Cadia NTSF Failure

Client Id.: CE416 - DH407 L1B
Depth (m): 23.00-23.50

Description: SILTY CLAY- orange brown

---

SAMPLE & TEST DETAILS

- Initial Height: 130.5 mm
- Initial Diameter: 61.0 mm
- L/D Ratio: 2.1 : 1
- Initial Moisture Content: 26.3 %
- Final Moisture Content: 28.1 %
- Wet Density: 2.01 t/m³
- Dry Density: 1.59 t/m³
- Rate of Strain: 0.006 %/min
- B Response: 98 %

Sample Type: Single Individual Undisturbed Specimen

---

TEST RESULTS

<table>
<thead>
<tr>
<th>Effective Pressure</th>
<th>Confining Pressure</th>
<th>Back Pressure</th>
<th>Initial Pore</th>
<th>Failure Pore</th>
<th>σ₁'</th>
<th>σ₂'</th>
<th>σ₁' / σ₂'</th>
<th>Deviator Stress</th>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1199 kPa</td>
<td>1696 kPa</td>
<td>499 kPa</td>
<td>499 kPa</td>
<td>1085 kPa</td>
<td>1592 kPa</td>
<td>613 kPa</td>
<td>2.598</td>
<td>979 kPa</td>
<td>3.10 %</td>
</tr>
</tbody>
</table>

---

FAILURE ENVELOPES

Interpretation between stages:
- Cohesion C' (kPa):
- Angle of Shear Resistance Φ' (Degrees):
- Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client

---

Authorised Signatory

C. Channon

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Tested at Trilab Brisbane Laboratory.
Mohr Circle Diagram

Interpretation between stages:
- Cohesion $C'$ (kPa):
- Angle of Shear Resistance $\Phi'$ (Degrees):
- Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080436 - CU

Stress/Strain & Pore Pressure/Strain Diagram

0 5 10 15 20 25 30
0 100 200 300 400 500 600 700 800

Deviator Stress kPa
Pore Pressure kPa

Strain %

Shear Stress
Pore Pressure

Remarks: Tested as Received
Sample/s supplied by the client

Reference should be made to TriLab's "Standard Terms and Conditions of Business" for further details.

Authorised Signatory
T. Lockhart

Laboratory Number
9926

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Client: Hatch Pty Ltd

MIT Method - Effective Stress Path

Test Method: AS1289.6.4.2

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

Trilab Pty Ltd
ABN 25 065 630 506

Authorised Signatory
T. Lockhart

Tested at Trilab Brisbane Laboratory.

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Trilab Pty Ltd
ABN 25 065 630 506
Cambridge Method - Effective Stress Path

\[ q = (\sigma_1' - \sigma_3') \text{ kPa} \]

\[ p = (\sigma_1' + 2\sigma_3')/3 \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

[Diagram of stress path with labelled axes and equations]

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Tested at Trilab Brisbane Laboratory.

C. Channon
Authorised Signatory

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RE03001

Laboratory Number
9926

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Reference should be made to Trilab’s “Standard Terms and Conditions of Business” for further details.
Trilab Pty Ltd
ABN 25 065 630 506
### TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

#### Client:
Hatch Pty Ltd

#### Report No.:
18080436 - CU

#### Before Test

<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
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</thead>
<tbody>
<tr>
<td>PROJECT:</td>
<td>H356804 - Cadia NTSF Failure</td>
</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>18080436</td>
</tr>
<tr>
<td>BOREHOLE:</td>
<td>CE416 - DH407 LIB</td>
</tr>
<tr>
<td>DATE:</td>
<td>28/08/18</td>
</tr>
<tr>
<td>DEPTH:</td>
<td>23.00-23.50</td>
</tr>
</tbody>
</table>

#### After Test

<table>
<thead>
<tr>
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<td>H356804 - Cadia NTSF Failure</td>
</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>18080436</td>
</tr>
<tr>
<td>BOREHOLE:</td>
<td>CE416 - DH407 LIB</td>
</tr>
<tr>
<td>DATE:</td>
<td>07.09.18</td>
</tr>
<tr>
<td>DEPTH:</td>
<td>23.00-23.50</td>
</tr>
</tbody>
</table>

Remarks: Tested as Received
Sample/s supplied by the client

Note: Photo not to scale

Accredited for compliance with ISO/IEC 17025 - Testing.
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Tested at Trilab Brisbane Laboratory.

Authorised Signatory
C. Channon

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Trilab Pty Ltd
ABN 25 065 630 506

STRICTLY CONFIDENTIAL
**Volume v's Time (Log Scale)**

- **Stage 1**
  - CV (m²/year): 0.95
  - Mv (m³/Min): 0.056
  - k (m/s): 1.66E-11

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

---

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Authorised Signatory

C. Channon

Laboratory Number

9926

Rep03001

Page 7 of 7
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080436 - CU

Workorder No.: 0004681

Project: H356804 - Cadia NTSF Failure

Client Id.: CE416 - DH407 L1B
Depth (m): 23.00-23.50

Address: PO Box 425 SPRING HILL QLD 4004

Test Date: 30/08/2018
Report Date: 13/09/2018

Description: SILTY CLAY- orange brown

SAMPLE & TEST DETAILS

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Height</td>
<td>129.9 mm</td>
<td>Initial Moisture Content</td>
</tr>
<tr>
<td>Initial Diameter</td>
<td>61.0 mm</td>
<td>Final Moisture Content</td>
</tr>
<tr>
<td>L/D Ratio</td>
<td>2.1 : 1</td>
<td>Wet Density</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dry Density</td>
</tr>
</tbody>
</table>

Rate of Strain: 0.006 %/min
B Response: 97 %

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

FAILURE DETAILS

<table>
<thead>
<tr>
<th>Effective Pressure</th>
<th>Confining Pressure</th>
<th>Back Pressure</th>
<th>Initial Pore</th>
<th>Failure Pore</th>
<th>Principal Effective Stresses</th>
<th>Deviator Stress</th>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 kPa</td>
<td>901 kPa</td>
<td>501 kPa</td>
<td>654 kPa</td>
<td>691 kPa</td>
<td>444 kPa</td>
<td>2.800 kPa</td>
<td>1.59 %</td>
</tr>
<tr>
<td>801 kPa</td>
<td>1302 kPa</td>
<td>501 kPa</td>
<td>781 kPa</td>
<td>1205 kPa</td>
<td>694 kPa</td>
<td>2.357 kPa</td>
<td>2.68 %</td>
</tr>
</tbody>
</table>

FAILURE ENVELOPES

Interpretation between stages: 1 to 2
Cohesion C' (kPa): 75.7
Angle of Shear Resistance $\Phi'$ (Degrees): 18.7
Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client

Authorised Signatory
C. Channon

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LABORATORY NUMBER 9926

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ABN 25 065 630 506

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080436 - CU

Interpretation between stages: 1 to 2
Cohesion C' (kPa): 75.7
Angle of Shear Resistance $\Phi'$ (Degrees): 18.7
Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

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Authorised Signatory
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TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080436 - CU

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

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Trilab Pty Ltd
ABN 25 065 630 506

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Ph: +61 8 9258 8323

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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C. Channon

Laboratory Number

9926
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080436 - CU

Cambridge Method - Effective Stress Path

\[ p = \frac{(\sigma_1' + 2\sigma_3')}{3} \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.
## TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

### Client:
Hatch Pty Ltd

### Report No.:
18080436 - CU

<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROJECT:</td>
<td>H356804 - Cadia NTSF Failure</td>
</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>18080436</td>
</tr>
<tr>
<td>BOREHOLE:</td>
<td>CE416 - DH407 L1B</td>
</tr>
<tr>
<td>BEFORE TEST</td>
<td>27/09/18</td>
</tr>
<tr>
<td>DATE:</td>
<td>27/09/18</td>
</tr>
<tr>
<td>DEPTH:</td>
<td>23.00-23.50</td>
</tr>
</tbody>
</table>

### AFTER TEST

<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROJECT:</td>
<td>H356804 - Cadia NTSF Failure</td>
</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>18080436</td>
</tr>
<tr>
<td>BOREHOLE:</td>
<td>CE416 - DH407 L1B</td>
</tr>
<tr>
<td>DATE:</td>
<td>27/09/18</td>
</tr>
<tr>
<td>DEPTH:</td>
<td>23.00-23.50</td>
</tr>
</tbody>
</table>

### Remarks:
Tested as Received
Sample/s supplied by the client

Note: Photo not to scale

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TRIAxIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080436 - CU

Volume v's Time (Log Scale)

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Stage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV (m²/year):</td>
<td>0.94</td>
</tr>
<tr>
<td>Mv (m³/MN):</td>
<td>0.077</td>
</tr>
<tr>
<td>k (m/s):</td>
<td>2.25E-11</td>
</tr>
</tbody>
</table>

Remarks:
Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory
C. Channon

Laboratory Number
9926
## TRIAXIAL TEST REPORT

### Test Method: AS1289.6.4.2

<table>
<thead>
<tr>
<th>Client: Hatch Pty Ltd</th>
<th>Report No.: 18080439 - CU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address: PO Box 425 SPRING HILL QLD 4004</td>
<td>Workorder No.: 0004681</td>
</tr>
<tr>
<td>Project: H356804 - Cadia NTSF Failure</td>
<td>Test Date: 30/09/2018</td>
</tr>
<tr>
<td>Client Id.: CE416 - DH407 PT3</td>
<td>Report Date: 13/09/2018</td>
</tr>
<tr>
<td>Depth (m): 25.50-26.95</td>
<td></td>
</tr>
</tbody>
</table>

### Description: SILTY CLAY- brown

<table>
<thead>
<tr>
<th>SAMPLE &amp; TEST DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Height:</strong> 129.3 mm</td>
</tr>
<tr>
<td><strong>Initial Diameter:</strong> 63.3 mm</td>
</tr>
<tr>
<td><strong>L/D Ratio:</strong> 2.0 : 1</td>
</tr>
</tbody>
</table>

### TEST RESULTS

<table>
<thead>
<tr>
<th>Effective Pressure</th>
<th>Confining Pressure</th>
<th>Back Pressure</th>
<th>Initial Pore Pressure</th>
<th>Failure Pore Pressure</th>
<th>Initial Moisture Content: 38.7 %</th>
<th>Final Moisture Content: 38.8 %</th>
<th>Rate of Strain: 0.005 %/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 kPa</td>
<td>895 kPa</td>
<td>499 kPa</td>
<td>499 kPa</td>
<td>754 kPa</td>
<td>145 kPa</td>
<td>4.588 kPa</td>
<td>519 kPa</td>
</tr>
<tr>
<td>799 kPa</td>
<td>1298 kPa</td>
<td>499 kPa</td>
<td>499 kPa</td>
<td>893 kPa</td>
<td>1162 kPa</td>
<td>2.869 kPa</td>
<td>757 kPa</td>
</tr>
<tr>
<td>1203 kPa</td>
<td>1703 kPa</td>
<td>500 kPa</td>
<td>500 kPa</td>
<td>1008 kPa</td>
<td>1664 kPa</td>
<td>2.396 kPa</td>
<td>970 kPa</td>
</tr>
</tbody>
</table>

### Deviator Stress

<table>
<thead>
<tr>
<th>Deviator Stress</th>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1162 kPa</td>
<td>4.588 kPa</td>
</tr>
<tr>
<td>1664 kPa</td>
<td>2.396 kPa</td>
</tr>
<tr>
<td>970 kPa</td>
<td>519 kPa</td>
</tr>
</tbody>
</table>

### Interpretation between stages:

- 1 to 2
- 2 to 3
- 1 to 3

### Failure Envelopes

- Cohesion C’ (kPa): 139.6
- Angle of Shear Resistance Φ’ (Degrees): 18.3
- Failure Criteria: Peak Principal Stress Ratio

### Remarks:

- Tested as Received.
- Sample considered to have failed on Stage 1.
- Sample/s supplied by the client

---

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Channon

Laboratory Number

9926
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080439 - CU

Mohr Circle Diagram

Interpretation between stages: 1 to 2 2 to 3 1 to 3
Cohesion C’ (kPa): 139.6 174.9 151.6
Angle of Shear Resistance \( \Phi’ \) (Degrees): 18.3 15.6 16.9
Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received. Sample considered to have failed on Stage 1.
Sample/s supplied by the client

Note: Graph not to scale

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Tested at TriLab Brisbane Laboratory.

Authorised Signatory

C. Channon

Laboratory Number

9926

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TriLab Pty Ltd
ABN 25 065 630 506
Client: Hatch Pty Ltd
Report No.: 18080439 - CU

Remarks: Tested as Received. Sample considered to have failed on Stage 1.

Sample/s supplied by the client

Note: Graph not to scale

Stress/Strain & Pore Pressure/Strain Diagram

Shear Stress  
Pore Pressure

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Tested at Trilab Brisbane Laboratory.
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080439 - CU

MIT Method - Effective Stress Path

\[ s = \left( \sigma'_1 + \sigma'_3 \right)/2 \text{ kPa} \]

Remarks: Tested as Received. Sample considered to have failed on Stage 1.
Sample/s supplied by the client

Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory
C. Channon

Page 4 of 7

Laboratory Number
9926
Cambridge Method - Effective Stress Path

\[ p = (\sigma_1' + 2\sigma_3') / 3 \] kPa

Remarks: Tested as Received. Sample considered to have failed on Stage 1.
Sample/s supplied by the client
Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory
C. Channon

STRICTLY CONFIDENTIAL
## TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

### Client: Hatch Pty Ltd

### Report No.: 18080439 - CU

<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROJECT:</td>
<td>H356804 - Cadia NTSF Failure</td>
</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>18080439</td>
</tr>
<tr>
<td>BOREHOLE:</td>
<td>CE416 - DH407 PT3</td>
</tr>
</tbody>
</table>

### BEFORE TEST

- **DATE:** 27/08/18
- **DEPTH:** 25.50-26.95

### AFTER TEST

- **DATE:** 10/09/18
- **DEPTH:** 25.50-26.95

Remarks: Tested as Received. Sample considered to have failed on Stage 1.

Sample/s supplied by the client

Note: Photo not to scale

---

**Authorised Signatory**

C. Channon

---

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Trilab Pty Ltd

ABN 25 065 630 506
Volume v's Time (Log Scale)

Stage 1 | Stage 1 | Stage 1
---|---|---
\( CV \) \( (m^2/\text{year}) \): 4.49 | 4.64 | 0.20
\( Mv \) \( (m^3/\text{MN}) \): 0.073 | 0.070 | 0.068
\( k \) \( (m/s) \): 1.01E-10 | 1.00E-10 | 4.14E-12

Remarks: Tested as Received. Sample considered to have failed on Stage 1.
Sample/s supplied by the client
Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.
## TRIAXIAL TEST REPORT

### Test Method: AS1289.6.4.2

<table>
<thead>
<tr>
<th>Client: Hatch Pty Ltd</th>
<th>Report No.: 18080441 - CU</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Address</strong></td>
<td><strong>Workorder No.</strong></td>
</tr>
<tr>
<td>PO Box 425 SPRING HILL QLD 4004</td>
<td>0004681</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Project:</strong> H356804 - Cadia NTSF Failure</th>
<th><strong>Test Date:</strong> 30/09/2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Client Id.:</strong> CE416 - DH407 L3C</td>
<td><strong>Report Date:</strong> 13/09/2018</td>
</tr>
</tbody>
</table>

| Description: Silty clay- brown |

<table>
<thead>
<tr>
<th><strong>Sample &amp; Test Details</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Height: 129.3 mm</td>
</tr>
<tr>
<td>Initial Diameter: 61.4 mm</td>
</tr>
<tr>
<td>L/D Ratio: 2.1 : 1</td>
</tr>
<tr>
<td>Initial Moisture Content: 37.8 %</td>
</tr>
<tr>
<td>Final Moisture Content: 37.9 %</td>
</tr>
<tr>
<td>Wet Density: 1.88 t/m³</td>
</tr>
<tr>
<td>Dry Density: 1.36 t/m³</td>
</tr>
</tbody>
</table>

**Sample Type:** Single Individual Undisturbed Specimen

### TEST RESULTS

#### FAILURE DETAILS

<table>
<thead>
<tr>
<th>Effective Pressure (kPa)</th>
<th>Confining Pressure (kPa)</th>
<th>Back Pressure (kPa)</th>
<th>Initial Pore Failure Pressure (kPa)</th>
<th>Failure Pore (kPa)</th>
<th>Principal Effective Stresses (kPa)</th>
<th>Deviator Stress (kPa)</th>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1234</td>
<td>1701</td>
<td>497</td>
<td>1046</td>
<td>1338</td>
<td>655</td>
<td>2.039</td>
<td>681 kPa</td>
</tr>
</tbody>
</table>

**Remarks:** Tested as Received

Sample/s supplied by the client

### FAILURE ENVELOPES

- **Interpretation between stages:**
- **Cohesion C’ (kPa):**
- **Angle of Shear Resistance Φ’ (Degrees):**
- **Failure Criteria:** Peak Principal Stress Ratio

**Authorised Signatory**

C. Channon

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Tested at Trilab Brisbane Laboratory.
TRIAxIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080441 - CU

Mohr Circle Diagram

Interpretation between stages:
- Cohesion C' (kPa):
- Angle of Shear Resistance $\Phi'$ (Degrees):
- Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

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Authorised Signatory

C. Channon

Page 2 of 7

Laboratory Number 9926

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Trilab Pty Ltd
ABN 25 065 630 506
Client: Hatch Pty Ltd
Report No.: 18080441 - CU

Stress/Strain & Pore Pressure/Strain Diagram

Deviator Stress kPa

Pore Pressure kPa

Strain %

- Shear Stress
- Pore Pressure

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Authorised Signatory

C. Channon

Page 3 of 7

Laboratory Number

9926

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Trilab Pty Ltd
ABN 25 065 630 506
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080441 - CU

MIT Method - Effective Stress Path

\[
\begin{align*}
\tau &= (\sigma_1' - \sigma_3')/2 \text{ kPa} \\
s &= (\sigma_1' + \sigma_3')/2 \text{ kPa}
\end{align*}
\]

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.
TRIAXIAL TEST REPORT

Client: Hatch Pty Ltd
Report No.: 18080441 - CU

Test Method: AS1289.6.4.2

Cambridge Method - Effective Stress Path

\[ q = (\sigma'_1 - \sigma'_3) \text{ kPa} \]

\[ p = (\sigma'_1 + 2\sigma'_3)/3 \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory
C. Channon

Laboratory Number
9926
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Remarks: Tested as Received
Sample/s supplied by the client

Not: Photo not to scale

Tested at Trilab Brisbane Laboratory.

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Trilab Pty Ltd
ABN 25 065 630 506
**TRIAXIAL TEST REPORT**

**Test Method:** AS1289.6.4.2

**Client:** Hatch Pty Ltd  
**Report No.:** 18080441 - CU

---

**Stage 1**

- **CV (m²/year):** 0.71
- **Mv (m³/MN):** 0.092
- **k (m/s):** 2.02E-11

**Remarks:** Tested as Received  
Sample/s supplied by the client

**Note:** Graph not to scale

---

Accredited for compliance with ISO/IEC 17025 - Testing.  
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

**Authorised Signatory:**

C. Channon

---

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Trilab Pty Ltd  
ABN 25 065 630 506
TRIAXIAL TEST REPORT

Client: Hatch Pty Ltd
Address: PO Box 425 SPRING HILL QLD 4004

Report No.: 18080441 - CU
Workorder No.: 0004681
Test Date: 30/08/2018
Report Date: 13/09/2018

Project: H356804 - Cadia NTSF Failure
Client Id.: CE416 - DH407 L3C
Depth (m): 26.50-27.00

Description: SILTY CLAY - brown

<table>
<thead>
<tr>
<th>SAMPLE &amp; TEST DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Height: 131.2 mm</td>
</tr>
<tr>
<td>Initial Diameter: 61.1 mm</td>
</tr>
<tr>
<td>L/D Ratio: 2.1 : 1</td>
</tr>
<tr>
<td>Initial Moisture Content: 35.6 %</td>
</tr>
<tr>
<td>Final Moisture Content: 34.5 %</td>
</tr>
<tr>
<td>Wet Density: 1.91 t/m³</td>
</tr>
<tr>
<td>Dry Density: 1.41 t/m³</td>
</tr>
<tr>
<td>Rate of Strain: 0.005 %/min</td>
</tr>
<tr>
<td>B Response: 100 %</td>
</tr>
</tbody>
</table>

Interpretation between stages: 1 to 2
Cohesion C’ (kPa): 92.4
Angle of Shear Resistance Φ’ (Degrees): 17.8
Failure Criteria: Peak Principal Stress Ratio

Sample Type: Single Individual Undisturbed Specimen
Remarks: Tested as Received
Sample/s supplied by the client: Note: Graph not to scale

Trilab Pty Ltd
ABN 25 065 630 506

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TRIAXIAL TEST REPORT

H356804 - Cadia NTSF Failure
SILTY CLAY - brown
CE416 - DH407 L3C
26.50-27.00

Initial Height: 131.2 mm
Initial Diameter: 61.1 mm
L/D Ratio: 2.1 : 1
Initial Moisture Content: 35.6 %
Final Moisture Content: 34.5 %
Wet Density: 1.91 t/m³
Dry Density: 1.41 t/m³
Rate of Strain: 0.005 %/min
B Response: 100 %

Interpretation between stages: 1 to 2
Cohesion C’ (kPa): 92.4
Angle of Shear Resistance Φ’ (Degrees): 17.8
Failure Criteria: Peak Principal Stress Ratio

Sample Type: Single Individual Undisturbed Specimen
Remarks: Tested as Received
Sample/s supplied by the client: Note: Graph not to scale

Trilab Pty Ltd
ABN 25 065 630 506

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TRIAXIAL TEST REPORT

Client: Hatch Pty Ltd

Test Method: AS1289.6.4.2

Report No.: 18080441 - CU

Failure Details

<table>
<thead>
<tr>
<th>Effective Pressure</th>
<th>Confining Pressure</th>
<th>Back Pressure</th>
<th>Initial Pore</th>
<th>Failure Pore</th>
<th>Principal Effective Stresses</th>
<th>Deviator Stress</th>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>403 kPa</td>
<td>965 kPa</td>
<td>502 kPa</td>
<td>502 kPa</td>
<td>646 kPa</td>
<td>259 kPa</td>
<td>481 kPa</td>
<td>2.64 %</td>
</tr>
<tr>
<td>791 kPa</td>
<td>1295 kPa</td>
<td>504 kPa</td>
<td>504 kPa</td>
<td>719 kPa</td>
<td>1336 kPa</td>
<td>760 kPa</td>
<td>4.83 %</td>
</tr>
</tbody>
</table>

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

Page 2 of 6

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Channon

 Laboratory Number 9525

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Trilab Pty Ltd
ABN 25 065 630 506
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18080441 - CU

MIT Method - Effective Stress Path

$s = (\sigma_1' + \sigma_3')/2$ kPa

Note: Graph not to scale.

Sample Type: Single Individual Undisturbed Specimen
Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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C. Channon

Authorised Signatory

Laboratory Number 9926

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Trilab Pty Ltd
ABN 25 065 630 506
Cambridge Method - Effective Stress Path

\[ \sigma_1' = \frac{1}{3} \left( \sigma'_1 + 2 \sigma'_3 \right) \text{ kPa} \]

Note: Graph not to scale.

Sample Type: Single Individual Undisturbed Specimen
Remarks: Tested as Received
Sample/s supplied by the client: Note: Graph not to scale
## TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

### Client: Hatch Pty Ltd

### Report No.: 18080441 - CU

<table>
<thead>
<tr>
<th>CLIENT: Hatch Pty Ltd</th>
<th>PROJECT: H356804 - Cadia NTSF Failure</th>
<th>BEFORE TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAB SAMPLE No. 18080441</td>
<td>DATE: 27/08/18</td>
<td>DEPTH: 26.50-27.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CLIENT: Hatch Pty Ltd</th>
<th>PROJECT: H356804 - Cadia NTSF Failure</th>
<th>AFTER TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAB SAMPLE No. 18080441</td>
<td>DATE: 07/09/19</td>
<td>DEPTH: 26.50-27.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample Type: Single Individual Undisturbed Specimen</th>
<th>Remarks: Tested as Received</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample/s supplied by the client Note: Graph not to scale</td>
<td></td>
</tr>
</tbody>
</table>

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Trilab Pty Ltd
ABN 25 065 630 506

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**Authorised Signatory**

C. Channon

Laboratory Number 9926
TRIAXIAL TEST REPORT
Test Method: AS1289.6.2

Client: Hatch Pty Ltd
Report No.: 18080441 - CU

Sample Type: Single Individual Undisturbed Specimen
 Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

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Authorised Signatory
C. Channon

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Volume v's Time (Log Scale)

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Stage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV (m²/Year): 1.33</td>
<td>1.84</td>
</tr>
<tr>
<td>MV (m²/MN): 0.107</td>
<td>0.079</td>
</tr>
<tr>
<td>k (m/s): 4.42E-11</td>
<td>4.53E-11</td>
</tr>
</tbody>
</table>

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Trilab Pty Ltd
ABN 25 065 630 506
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18090290A - CU

Workorder No.: 0004846

Address: PO Box 425 SPRING HILL QLD 4004

Test Date: 25/09/2018

Report Date: 4/10/2018

Project: H356804 - Cadia NTSF Failure - Request 8

Client Id.: CE432 - L1B

Depth (m): 19.80-20.30

Description: SILTY CLAY - brown/pale-brown

<table>
<thead>
<tr>
<th>SAMPLE &amp; TEST DETAILS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Height: 131.4 mm</td>
<td>Initial Moisture Content: 24.2 %</td>
</tr>
<tr>
<td>Initial Diameter: 61.5 mm</td>
<td>Final Moisture Content: 24.8 %</td>
</tr>
<tr>
<td>L/D Ratio: 2.1 : 1</td>
<td>Wet Density: 2.00 t/m³</td>
</tr>
<tr>
<td></td>
<td>Dry Density: 1.61 t/m³</td>
</tr>
</tbody>
</table>

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

<table>
<thead>
<tr>
<th>FAILURE DETAILS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective Pressure</td>
<td>Confining Pressure</td>
</tr>
<tr>
<td>202 kPa</td>
<td>700 kPa</td>
</tr>
<tr>
<td>400 kPa</td>
<td>899 kPa</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FAILURE ENVELOPES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpretation between stages: 1 to 2</td>
<td></td>
</tr>
<tr>
<td>Cohesion C’ (kPa): 54.3</td>
<td></td>
</tr>
<tr>
<td>Angle of Shear Resistance Φ’ (Degrees): 30.8</td>
<td></td>
</tr>
<tr>
<td>Failure Criteria: Peak Principal Stress Ratio</td>
<td></td>
</tr>
</tbody>
</table>

Remarks: Tested as Received
Sample/s supplied by the client

Page 1 of 7

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Tested at Trilab Brisbane Laboratory.
Mohr Circle Diagram

Interpretation between stages: 1 to 2
Cohesion C' (kPa): 54.3
Angle of Shear Resistance $\Phi'$ (Degrees): 30.8
Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale
### TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

**Client:** Hatch Pty Ltd

**Report No.:** 18090290A - CU

<table>
<thead>
<tr>
<th>Sample/s supplied by the client</th>
<th>Note: Graph not to scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tested as Received</td>
<td></td>
</tr>
</tbody>
</table>

### Stress/Strain & Pore Pressure/Strain Diagram

- **Deviator Stress (kPa)**
- **Pore Pressure (kPa)**
- **Shear Stress**
- **Pore Pressure**

**Remarks:**

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Tested at Trilab Brisbane Laboratory.

**Authorised Signatory**

T. Lockhart

**Laboratory Number**

9926

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TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18090290A - CU

MIT Method - Effective Stress Path

\[ s = \frac{(\sigma'_1 + \sigma'_3)}{2} \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.

TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18090290A - CU

MIT Method - Effective Stress Path

\[ s = \frac{(\sigma'_1 + \sigma'_3)}{2} \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Test Method: AS1289.6.4.2

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TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18090290A - CU

MIT Method - Effective Stress Path

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TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18090290A - CU

MIT Method - Effective Stress Path

\[ s = \frac{(\sigma'_1 + \sigma'_3)}{2} \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.
Cambridge Method - Effective Stress Path

\[ q = (\sigma'_{1} - \sigma'_{3}) \, \text{kPa} \]

\[ p = (\sigma'_{1} + 2\sigma'_{3})/3 \, \text{kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory
T. Lockhart

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REP0001

Laboratory Number
9926
**TRIAXIAL TEST REPORT**

Test Method: AS1289.6.4.2

<table>
<thead>
<tr>
<th>Client:</th>
<th>Hatch Pty Ltd</th>
<th>Report No.:</th>
<th>18090290A - CU</th>
</tr>
</thead>
</table>

### Before Test

<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROJECT:</td>
<td>H356804 - Cadia NTSF Failure - Request 8</td>
</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>18090290A</td>
</tr>
<tr>
<td>BOREHOLE:</td>
<td>CE432 - L1B</td>
</tr>
<tr>
<td>DATE:</td>
<td>29/9/18</td>
</tr>
<tr>
<td>DEPTH:</td>
<td>19.80-20.30</td>
</tr>
</tbody>
</table>

### After Test

<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROJECT:</td>
<td>H356804 - Cadia NTSF Failure - Request 8</td>
</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>18090290A</td>
</tr>
<tr>
<td>BOREHOLE:</td>
<td>CE432 - L1B</td>
</tr>
<tr>
<td>DATE:</td>
<td>3/10/18</td>
</tr>
<tr>
<td>DEPTH:</td>
<td>19.80-20.30</td>
</tr>
</tbody>
</table>

Remarks: Tested as Received

Sample/s supplied by the client

Note: Photo not to scale

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Authorized Signatory

T. Lockhart

Laboratory Number

9926
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd  Report No.: 18090290A - CU

Volume v's Time (Log Scale)

- Stage 1
- Stage 2
- Stage 3
- Stage 4
- Stage 5

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Authorised Signatory

T. Lockhart

Laboratory Number

9926
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Address: PO Box 425 SPRING HILL QLD 4004

Report No.: 18090290B - CU

Workorder No.: 0004846

Test Date: 27/09/2018

Report Date: 4/10/2018

Project: H356804 - Cadia NTSF Failure - Request 8

Client Id.: CE432 - L1B

Depth (m): 19.80-20.30

Description: SILTY CLAY -brown/ pale-brown

<table>
<thead>
<tr>
<th>SAMPLE &amp; TEST DETAILS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Height: 134.1 mm</td>
<td>Initial Moisture Content: 24.2 %</td>
</tr>
<tr>
<td>Initial Diameter: 61.2 mm</td>
<td>Final Moisture Content: 25.6 %</td>
</tr>
<tr>
<td>L/D Ratio: 2.2 : 1</td>
<td>Wet Density: 1.98 t/m³</td>
</tr>
<tr>
<td></td>
<td>Dry Density: 1.59 t/m³</td>
</tr>
</tbody>
</table>

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

<table>
<thead>
<tr>
<th>FAILURE DETAILS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective Pressure</td>
<td>Principal Effective Stresses</td>
</tr>
<tr>
<td>795 kPa</td>
<td>1392 kPa</td>
</tr>
<tr>
<td>1299 kPa</td>
<td>384 kPa</td>
</tr>
<tr>
<td>504 kPa</td>
<td></td>
</tr>
</tbody>
</table>

FAILU RE ENVELOPES

Interpretation between stages :

- Cohesion C' (kPa) :
- Angle of Shear Resistance $\Phi'$ (Degrees) :
- Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client

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Authorised Signatory
T. Lockhart

Page 1 of 7

Tilab Pty Ltd
ABN 25 065 630 506
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18090290B - CU

Mohr Circle Diagram

Interpretation between stages:
- Cohesion $C'$ (kPa):
- Angle of Shear Resistance $\Phi'$ (Degrees):

Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory

T. Lockhart

Laboratory Number 9926
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18090290B - CU

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

Strain %

Deviator Stress kPa

Pore Pressure kPa

Shear Stress

Pore Pressure

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Tested at Triab Brisbane Laboratory.

Authorised Signatory
T. Lockhart

Laboratory Number
9926

Page 3 of 7

REPO3601

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Trilab Pty Ltd
ABN 25 065 630 506
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18090290B - CU

MIT Method - Effective Stress Path

\[ s = \frac{(\sigma'_1 + \sigma'_3)}{2} \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

T. Lockhart
Authorised Signatory

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Trilab Pty Ltd
ABN 25 065 630 506
Cambridge Method - Effective Stress Path

\[ q = (\sigma'_1 - \sigma'_3) \text{ kPa} \]

\[ p = \frac{(\sigma'_1 + 2\sigma'_3)}{3} \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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T. Lockhart

Laboratory Number
9926
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18090290B - CU

CLIENT: Hatch Pty Ltd
PROJECT: H356804 - Cadia NTSF Failure - Request 8
LAB SAMPLE No. 18090290
BOREHOLE: CE432 - L1B

BEFORE TEST
DATE: 19/09/18
DEPTH: 19.80-20.30

CLIENT: Hatch Pty Ltd
PROJECT: H356804 - Cadia NTSF Failure - Request 8
LAB SAMPLE No. 18090290
BOREHOLE: CE432 - L1B

AFTER TEST
DATE: 02/10/18
DEPTH: 19.80-20.30

Remarks: Tested as Received
Sample/s supplied by the client

Note: Photo not to scale

Authorised Signatory
C. Channon

Accredited for compliance with ISO/IEC 17025 - Testing.
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Tested at Trilab Brisbane Laboratory.

Authorised Signatory
T. Lockhart

Laboratory Number
9926
Volume v’s Time (Log Scale)

Stage 1

CV (m²/year) : 5.02
Mv (m³/MN) : 0.066
k (m/s) : 1.04E-10

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale
# TRIAXIAL TEST REPORT

## Test Method: AS1289.6.4.2

### Client: Hatch Pty Ltd

### Report No.: 18110003A - CU

### Workorder No.: 0005081

### Address: PO Box 425 SPRING HILL QLD 4004

### Test Date: 2/11/2018

### Project: H356804 - Cadia NTSF Failure

### Client Id.: CE432 - L1C - Lexan

### Depth (m): 20.30-20.80

### Description: SILTY CLAY- grey and orange brown

## SAMPLE & TEST DETAILS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Height (mm)</td>
<td>128.0</td>
</tr>
<tr>
<td>Initial Diameter (mm)</td>
<td>60.8</td>
</tr>
<tr>
<td>L/D Ratio</td>
<td>2.1 : 1</td>
</tr>
<tr>
<td>Initial Moisture Content (%)</td>
<td>28.2</td>
</tr>
<tr>
<td>Final Moisture Content (%)</td>
<td>27.8</td>
</tr>
<tr>
<td>Wet Density (t/m³)</td>
<td>1.94</td>
</tr>
<tr>
<td>Dry Density (t/m³)</td>
<td>1.52</td>
</tr>
<tr>
<td>Rate of Strain (%/min)</td>
<td>0.002</td>
</tr>
<tr>
<td>B Response (%)</td>
<td>98</td>
</tr>
</tbody>
</table>

Sample Type: Single Individual Undisturbed Specimen

## TEST RESULTS

### FAILURE DETAILS

<table>
<thead>
<tr>
<th>Effective Pressure (kPa)</th>
<th>Confining Pressure (kPa)</th>
<th>Back Pressure (kPa)</th>
<th>Initial Pore Pressure (kPa)</th>
<th>Failure Pore Pressure (kPa)</th>
<th>Principal Effective Stresses (kPa)</th>
<th>Deviator Stress (kPa)</th>
<th>Strain (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>196</td>
<td>700</td>
<td>504</td>
<td>504</td>
<td>583</td>
<td>$\sigma'_1$ = 481, $\sigma'_2$ = 117</td>
<td>$\sigma'_1'/\sigma'_3$ = 4.099</td>
<td>364</td>
</tr>
</tbody>
</table>

### INTERPRETATION BETWEEN STAGES:

- Cohesion $C'$ (kPa):
- Angle of Shear Resistance $\Phi'$ (Degrees):
- Failure Criteria: Peak Principal Stress Ratio

### Remarks:

- Tested as Received
- Sample/s supplied by the client

---

**Authorised Signatory**

T. Lockhart

ATC

Trilab Pty Ltd

ABN 25 065 630 506

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18110003A - CU

Interpretation between stages:

Cohesion C' (kPa):

Angle of Shear Resistance \( \Phi' \) (Degrees):

Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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Authorised Signatory

C. Channon

Laboratory Number 9926
Client: Hatch Pty Ltd

Test Method: AS1289.6.4.2

Report No.: 18110003A - CU

Stress/Strain & Pore Pressure/Strain Diagram

Deviator Stress kPa

Pore Pressure kPa

Shear Stress

Pore Pressure

Strain %

Remark: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale
MIT Method - Effective Stress Path

\[ s = \frac{(\sigma'_1 + \sigma'_3)}{2} \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18110003A - CU

Cambridge Method - Effective Stress Path

$p = (\sigma'_1 + 2\sigma'_3)/3$ kPa

Remarks:
Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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# TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

| Client: | Hatch Pty Ltd |
| Report No.: | 18110003A - CU |

## Before Test

| CLIENT: | Hatch Pty Ltd |
| PROJECT: | H356804 - Cadia NTSF Failure |
| LAB SAMPLE No. | 18110003 |
| BOREHOLE: | CE432 - L1C - Lexan |
| DATE: | 01/11/18 |
| DEPTH: | 20.30-20.80 |

## After Test

| CLIENT: | Hatch Pty Ltd |
| PROJECT: | H356804 - Cadia NTSF Failure |
| LAB SAMPLE No. | 18110003 |
| BOREHOLE: | CE432 - L1C - Lexan |
| DATE: | 12/11/18 |
| DEPTH: | 20.30-20.80 |

**Remarks:**
- Tested as Received
- Sample/s supplied by the client

**Note:** Photo not to scale

**Authorised Signatory:**
C. Channon

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**Laboratory Number:** 9926
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18110003A - CU

Volume v's Time (Log Scale)

Stage 1

CV (m²/year): 1.08
Mv (m³/MN): 0.124
k (m/s): 4.14E-11

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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C. Channon

Page 7 of 7

ABN 25 065 630 506
## TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

### SAMPLE & TEST DETAILS

<table>
<thead>
<tr>
<th>Description:</th>
<th>Silty Clay - brown/orange/yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Height:</td>
<td>129.0 mm</td>
</tr>
<tr>
<td>Initial Moisture Content:</td>
<td>28.2 %</td>
</tr>
<tr>
<td>Rate of Strain:</td>
<td>0.002 %/min</td>
</tr>
<tr>
<td>Initial Diameter:</td>
<td>61.3 mm</td>
</tr>
<tr>
<td>Final Moisture Content:</td>
<td>25.4 %</td>
</tr>
<tr>
<td>B Response:</td>
<td>97 %</td>
</tr>
<tr>
<td>L/D Ratio:</td>
<td>2.1 : 1</td>
</tr>
<tr>
<td>Wet Density:</td>
<td>1.95 t/m³</td>
</tr>
<tr>
<td>Dry Density:</td>
<td>1.52 t/m³</td>
</tr>
</tbody>
</table>

Sample Type: Single Individual Undisturbed Specimen

### TEST RESULTS

#### FAILURE DETAILS

<table>
<thead>
<tr>
<th>Effective Pressure</th>
<th>Confining Pressure</th>
<th>Back Pressure</th>
<th>Initial Pore Pressure</th>
<th>Failure Pore Pressure</th>
<th>Principal Effective Stresses</th>
<th>Deviator Stress</th>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>398 kPa</td>
<td>800 kPa</td>
<td>402 kPa</td>
<td>402 kPa</td>
<td>576 kPa</td>
<td>844 kPa</td>
<td>224 kPa</td>
<td>3,766</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>620 kPa</td>
<td>2.38 %</td>
<td></td>
</tr>
</tbody>
</table>

#### FAILURE ENVELOPES

- Interpretation between stages:
- Cohesion C' (kPa): [Value]
- Angle of Shear Resistance Φ' (Degrees): [Value]

**Failure Criteria:** Peak Principal Stress Ratio

### Remarks:

- Tested as Received
- Sample/s supplied by the client

---

**Authorised Signatory**

C. Channon

**Authorised Signatory**

T. Lockhart

---

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Trilab Pty Ltd
ABN 25 065 630 506
Interpretation between stages:
Cohesion $C'$ (kPa):
Angle of Shear Resistance $\Phi'$ (Degrees):
Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18110003B - CU

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

Stress/Strain & Pore Pressure/Strain Diagram

Shear Stress
Pore Pressure

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Authorised Signatory
T. Lockhart

Laboratory Number
9926
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18110003B - CU

MIT Method - Effective Stress Path

$s = \frac{(\sigma_1' + \sigma_3')}{2}$ kPa

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18110003B - CU

Cambridge Method - Effective Stress Path

\[ p = \frac{(\sigma_1' + 2\sigma_3')}{3} \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Authorised Signatory

T. Lockhart

Laboratory Number

9926
<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROJECT:</td>
<td>H356804 - Cadia NTSF Failure</td>
</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>18110003</td>
</tr>
<tr>
<td>BOREHOLE:</td>
<td>CE432 - L1C - Lexan</td>
</tr>
<tr>
<td>BEFORE TEST</td>
<td></td>
</tr>
<tr>
<td>DATE:</td>
<td>01/11/18</td>
</tr>
<tr>
<td>DEPTH:</td>
<td>20.30-20.80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROJECT:</td>
<td>H356804 - Cadia NTSF Failure</td>
</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>18110003</td>
</tr>
<tr>
<td>BOREHOLE:</td>
<td>CE432 - L1C - Lexan</td>
</tr>
<tr>
<td>AFTER TEST</td>
<td></td>
</tr>
<tr>
<td>DATE:</td>
<td>16/11/18</td>
</tr>
<tr>
<td>DEPTH:</td>
<td>20.30-20.80</td>
</tr>
</tbody>
</table>

Remarks: Tested as Received
Sample/s supplied by the client

Test Method: AS1289.6.4.2

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Authorised Signatory

T. Lockhart

Laboratory Number

9926
Client: Hatch Pty Ltd
Report No.: 18110003B - CU

Volume v’s Time (Log Scale)

Stage 1

CV (m²/year) : 3.69
Mv (m³/MN) : 0.094
k (m/s) : 1.07E-10

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale
## TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2  
**Client:** Hatch Pty Ltd  
**Address:** PO Box 425 SPRING HILL QLD 4004  
**Project:** H356804 - Cadia NTSF Failure  
**Report No.:** 18110004A - CU  
**Workorder No.:** 0005081  
**Test Date:** 2/11/2018  
**Report Date:** 15/11/2018

### SAMPLE & TEST DETAILS

<table>
<thead>
<tr>
<th>Description:</th>
<th>Sample Type: Single Individual Undisturbed Specimen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Height:</td>
<td>128.3 mm</td>
</tr>
<tr>
<td>Initial Moisture Content:</td>
<td>17.5 %</td>
</tr>
<tr>
<td>Rate of Strain:</td>
<td>0.004 %/min</td>
</tr>
<tr>
<td>Initial Diameter:</td>
<td>61.6 mm</td>
</tr>
<tr>
<td>Final Moisture Content:</td>
<td>20.3 %</td>
</tr>
<tr>
<td>B Response:</td>
<td>98 %</td>
</tr>
<tr>
<td>L/D Ratio:</td>
<td>2.1 : 1</td>
</tr>
<tr>
<td>Wet Density:</td>
<td>2.00 t/m³</td>
</tr>
<tr>
<td>Dry Density:</td>
<td>1.70 t/m³</td>
</tr>
</tbody>
</table>

### TEST RESULTS

#### FAILURE DETAILS

<table>
<thead>
<tr>
<th>Effective Pressure</th>
<th>Confining Pressure</th>
<th>Back Pressure</th>
<th>Initial Pore</th>
<th>Failure Pore</th>
<th>Principal Effective Stresses</th>
<th>Deviator Stress</th>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 kPa</td>
<td>900 kPa</td>
<td>500 kPa</td>
<td>500 kPa</td>
<td>669 kPa</td>
<td>892 kPa</td>
<td>231 kPa</td>
<td>3.857</td>
</tr>
</tbody>
</table>

#### Deviator Stress

<table>
<thead>
<tr>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.28 %</td>
</tr>
</tbody>
</table>

#### Interpretation between stages:

- **Failure Criteria:** Peak Principal Stress Ratio

### DISCLAIMER

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Authorised Signatory  
C. Channon

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18110004A - CU

Mohr Circle Diagram

Interpretation between stages:
- Cohesion C’ (kPa):
- Angle of Shear Resistance $\Phi'$ (Degrees):
- Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

Page 2 of 7

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TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18110004A - CU

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

Stress/Strain & Pore Pressure/Strain Diagram

Deviator Stress kPa
Pore Pressure kPa
Strain %

Shear Stress
Pore Pressure

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Authorised Signatory
C. Channon

Laboratory Number
9926

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Trilab Pty Ltd
ABN 25 065 630 506
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18110004A - CU

MIT Method - Effective Stress Path

\[ s = \frac{\sigma_1' + \sigma_3'}{2} \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

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Authorised Signatory
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Laboratory Number
9926
### TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

**Client:** Hatch Pty Ltd

**Report No.:** 18110004A - CU

---

#### Cambridge Method - Effective Stress Path

\[ p = \frac{(\sigma'_1 + 2\sigma'_3)}{3} \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

---

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Authorised Signatory
C. Channon

Laboratory Number
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Trilab Pty Ltd
ABN 25 065 630 506
## TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

### Client:

<table>
<thead>
<tr>
<th>Hatch Pty Ltd</th>
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### Report No.:

<table>
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<th>18110004A - CU</th>
</tr>
</thead>
</table>

### Project:

<table>
<thead>
<tr>
<th>H356804 - Cadia NTSF Failure</th>
</tr>
</thead>
</table>

### Before Test:

<table>
<thead>
<tr>
<th>LAB SAMPLE No.</th>
<th>18110004</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>BOREHOLE:</th>
<th>CE432 - L2 - Lexan</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>DATE:</th>
<th>01/11/19</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>DEPTH:</th>
<th>22.80-23.20</th>
</tr>
</thead>
</table>

### After Test:

<table>
<thead>
<tr>
<th>LAB SAMPLE No.</th>
<th>18110004</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>BOREHOLE:</th>
<th>CE432 - L2 - Lexan</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>DATE:</th>
<th>01/11/19</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>DEPTH:</th>
<th>22.80-23.20</th>
</tr>
</thead>
</table>

### Remarks:

- Tested as Received
- Sample/s supplied by the client

Note: Photo not to scale

---

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**Authorised Signatory**

C. Channon

Laboratory Number

9926

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**ABN 25 065 630 506**

Trilab Pty Ltd

ATMOSPHERIC & ENVIRONMENTAL TESTING
Volume v's Time (Log Scale)

Stage 1

CV (m²/year) : 3.72
Mv (m³/MN) : 0.065
k (m/s) : 7.49E-11

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale
### TRIAXIAL TEST REPORT

#### Test Method: AS1289.6.4.2

<table>
<thead>
<tr>
<th>Client:</th>
<th>Hatch Pty Ltd</th>
<th>Report No.:</th>
<th>18110004B - CU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>PO Box 425 SPRING HILL QLD 4004</td>
<td>Workorder No.:</td>
<td>0005081</td>
</tr>
<tr>
<td>Project:</td>
<td>H356804 - Cadia NTZF Failure</td>
<td>Test Date:</td>
<td>6/11/2018</td>
</tr>
<tr>
<td>Client Id.:</td>
<td>CE432 - L2 - Lexan</td>
<td>Report Date:</td>
<td>15/11/2018</td>
</tr>
<tr>
<td>Description:</td>
<td>SILTY CLAY- yellow brown</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### SAMPLE & TEST DETAILS

<table>
<thead>
<tr>
<th>Initial Height:</th>
<th>128.7 mm</th>
<th>Initial Moisture Content:</th>
<th>17.5 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Diameter:</td>
<td>59.6 mm</td>
<td>Final Moisture Content:</td>
<td>20.3 %</td>
</tr>
<tr>
<td>L/D Ratio:</td>
<td>2.2 : 1</td>
<td>Wet Density:</td>
<td>2.00 t/m³</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dry Density:</td>
<td>1.70 t/m³</td>
</tr>
</tbody>
</table>

Sample Type: Single Individual Undisturbed Specimen

#### TEST RESULTS

#### FAILURE DETAILS

<table>
<thead>
<tr>
<th>Effective Pressure</th>
<th>Confining Pressure</th>
<th>Back Pressure</th>
<th>Initial Pore</th>
<th>Failure Pore</th>
<th>Principal Effective Stresses</th>
<th>Deviator Stress</th>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 kPa</td>
<td>1299 kPa</td>
<td>499 kPa</td>
<td>499 kPa</td>
<td>800 kPa</td>
<td>1657 kPa</td>
<td>+499 kPa</td>
<td>3.322</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1158 kPa</td>
<td>4.00 %</td>
</tr>
</tbody>
</table>

#### FAILURE ENVELOPES

- Interpretation between stages:
- Cohesion C' (kPa):
- Angle of Shear Resistance Φ' (Degrees):
- Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client

Authorised Signatory
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Tested at Trilab Brisbane Laboratory.

Authorised Signatory
C. Channon

Laboratory Number
9926
Interpretation between stages:

Cohesion $C'$ (kPa):

Angle of Shear Resistance $\Phi'$ (Degrees):

Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18110004B - CU

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory
C. Channon

Laboratory Number
9926
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18110004B - CU

MIT Method - Effective Stress Path

\[ s = \frac{\sigma'_1 + \sigma'_3}{2} \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory
C. Channon

Laboratory Number
9926

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Trilab Pty Ltd
ABN 25 065 630 506
Cambridge Method - Effective Stress Path

\[ p = \left( \sigma'_1 + 2\sigma'_3 \right)/3 \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory
C. Channon

Laboratory Number
9926
### TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
<th>Report No.:</th>
<th>18110004B - CU</th>
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</thead>
<tbody>
<tr>
<td>PROJECT:</td>
<td>H356804 - Cadia NTSF Failure</td>
<td></td>
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</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>18110006</td>
<td>DATE:</td>
<td>01/11/18</td>
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<tr>
<td>BOREHOLE:</td>
<td>CE416 - L1C</td>
<td>DEPTH:</td>
<td>23.50-24.00</td>
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**Remarks:**
Tested as Received  
Sample/s supplied by the client  
Note: Photo not to scale

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>PROJECT:</td>
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<tr>
<td>LAB SAMPLE No.</td>
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<td>DATE:</td>
<td>12/11/18</td>
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<tr>
<td>BOREHOLE:</td>
<td>CE432 - L2 - Lexan</td>
<td>DEPTH:</td>
<td>22.80-23.20</td>
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</tbody>
</table>

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The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

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Authorised Signatory  
C. Channon  
Laboratory Number  9926

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Trilab Pty Ltd  
ABN 25 065 630 506
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18110004B - CU

Volume v's Time (Log Scale)

Stage 1

CV (m²/year) : 3.37
Mv (m³/MN) : 0.694
k (m/s) : 7.25E-10

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Authorised Signatory
C. Channon

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RA2201901

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TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18110006A - CU

Address: PO Box 425 SPRING HILL QLD 4004
Workorder No.: 0005081

Project: H356804 - Cadia NTSF Failure
Test Date: 6/11/2018

Report Date: 15/11/2018

Client Id.: CE416 - L1C
Depth (m): 23.50-24.00

Description: SILTY CLAY- orange/brown

SAMPLE & TEST DETAILS

<table>
<thead>
<tr>
<th>Initial Height: 129.4 mm</th>
<th>Initial Moisture Content: 26.4 %</th>
<th>Rate of Strain: 0.002 %/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Diameter: 61.5 mm</td>
<td>Final Moisture Content: 28.5 %</td>
<td>B Response: 97 %</td>
</tr>
<tr>
<td>L/D Ratio: 2.1 : 1</td>
<td>Wet Density: 2.00 t/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dry Density: 1.58 t/m³</td>
<td></td>
</tr>
</tbody>
</table>

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

<table>
<thead>
<tr>
<th>Confining Pressure</th>
<th>Back Pressure</th>
<th>Initial Pore Pressure</th>
<th>Failure Pore Pressure</th>
<th>Principal Effective Stresses</th>
<th>Deviator Stress</th>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 kPa</td>
<td>802 kPa</td>
<td>402 kPa</td>
<td>562 kPa</td>
<td>777 kPa</td>
<td>240 kPa</td>
<td>537 kPa</td>
</tr>
</tbody>
</table>

FAILURES ENVELOPES

Interpretation between stages:
- Cohesion C' (kPa):
- Angle of Shear Resistance Φ' (Degrees):
- Failure Criteria: Peak Principal Stress Ratio

Remarks:
- Tested as Received
- Sample/s supplied by the client

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ABN 25 065 630 506

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Authorized Signatory
T. Lockhart

Laboratory Number
9926

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TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18110006A - CU

Mohr Circle Diagram

Interpretation between stages:
- Cohesion C' (kPa):
- Angle of Shear Resistance $\phi'$ (Degrees):
- Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

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Authorised Signatory

Laboratory Number 9926
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

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Authorised Signatory
T. Lockhart

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MIT Method - Effective Stress Path

\[ s = \frac{\sigma_1' + \sigma_3'}{2} \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

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Authorised Signatory

T. Lockhart

Laboratory Number

9926
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18110006A - CU

Cambridge Method - Effective Stress Path

$q = (\sigma_1^' - \sigma_3^')$ kPa

$p = (\sigma_1^' + 2\sigma_3^')/3$ kPa

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

Authorised Signatory

T. Lockhart

Page 5 of 7

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# TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

## Client: Hatch Pty Ltd

### Report No.: 18110006A - CU

## Test Information

<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>Hatch Pty Ltd</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROJECT:</td>
<td>H356804 - Cadia NTSF Failure</td>
</tr>
<tr>
<td>LAB SAMPLE No.</td>
<td>18110006</td>
</tr>
<tr>
<td>BOREHOLE:</td>
<td>CE416 - L1C</td>
</tr>
</tbody>
</table>

### Before Test

- **DATE:** 01/11/18
- **DEPTH:** 23.50-24.00

### After Test

- **DATE:** 15/11/18
- **DEPTH:** 23.50-24.00

## Remarks:

- Tested as Received
- Sample/s supplied by the client

Note: Photo not to scale

---

**Authorised Signatory:**

C. Channon

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Volume v's Time (Log Scale)

- Stage 1
  - CV (m²/year): 1.09
  - Mv (m³/MN): 0.108
  - k (m/s): 3.63E-11

Remarks:
Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Authorised Signatory
T. Lockhart

Laboratory Number
9926
### TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

**Client:** Hatch Pty Ltd  
**Address:** PO Box 425 SPRING HILL QLD 4004  
**Project:** H356804 - Cadia NTSF Failure

<table>
<thead>
<tr>
<th>Description:</th>
<th>SILTY CLAY - orange/brown</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sample &amp; Test Details</strong></td>
<td></td>
</tr>
<tr>
<td>Initial Height:</td>
<td>129.7 mm</td>
</tr>
<tr>
<td>Initial Diameter:</td>
<td>61.4 mm</td>
</tr>
<tr>
<td>L/D Ratio:</td>
<td>2.1 : 1</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample Type:</td>
<td>Single Individual Undisturbed Specimen</td>
</tr>
</tbody>
</table>

**Test Results**

**Failure Details**

<table>
<thead>
<tr>
<th>Effective Pressure</th>
<th>Confining Pressure</th>
<th>Back Pressure</th>
<th>Initial Pore Failure Pore</th>
<th>Principal Effective Stresses</th>
<th>Deviator Stress</th>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>796 kPa</td>
<td>1301 kPa</td>
<td>505 kPa</td>
<td>609 kPa</td>
<td>1849 kPa</td>
<td>692 kPa</td>
<td>2.672</td>
</tr>
</tbody>
</table>

**Failure Envelopes**

- Interpretation between stages:
- Cohesion C' (kPa):
- Angle of Shear Resistance Φ' (Degrees):
- Failure Criteria: Peak Principal Stress Ratio

**Remarks:** Tested as Received  
Sample/s supplied by the client
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Interpretation between stages:

Cohesion $C'$ (kPa):

Angle of Shear Resistance $\Phi'$ (Degrees):

Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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Trilab Pty Ltd
ABN 25 065 630 506

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## TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

**Client:** Hatch Pty Ltd

**Report No.:** 18110006B - CU

### Stress/Strain & Pore Pressure/Strain Diagram

![Stress/Strain & Pore Pressure/Strain Diagram](image)

- **Deviator Stress (kPa)**
- **Pore Pressure (kPa)**
- **Strain (%)**

### Remarks:
- Tested as Received
- Sample/s supplied by the client

### Note:
Graph not to scale

---

**Authorised Signatory:**
- T. Lockhart

---

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18110006B - CU

MIT Method - Effective Stress Path

\[ \sigma_1' = \frac{\sigma_1 + \sigma_3}{2} \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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Page 4 of 7

Authorised Signatory

T. Lockhart

Laboratory Number

9926
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd
Report No.: 18110006B - CU

Cambridge Method - Effective Stress Path

\[ q = \left( \sigma_1' - \sigma_3' \right) \text{ kPa} \]
\[ p = \left( \sigma_1' + 2\sigma_3' \right) / 3 \text{ kPa} \]

Remarks: Tested as Received
Sample/s supplied by the client
Note: Graph not to scale

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Authorized Signatory
T. Lockhart

Laboratory Number
9926

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Trilab Pty Ltd
ABN 25 065 630 506
## TRIAXIAL TEST REPORT

**Test Method:** AS1289.6.4.2

### CLIENT:

Hatch Pty Ltd

### PROJECT:

H356804 - Cadia NTSF Failure

### LAB SAMPLE No.:

18110006

### BOREHOLE:

CE416 - L1C

### BEFORE TEST

- **DATE:** 01/11/18
- **DEPTH:** 23.50-24.00

### AFTER TEST

- **DATE:** 15/11/18
- **DEPTH:** 23.50-24.00

**Remarks:** Tested as Received

Sample/s supplied by the client

Note: Photo not to scale

**Authorised Signatory**

C. Channon

**Authorised Signatory**

T. Lockhart

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**Laboratory Number**

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Trilab Pty Ltd

ABN 25 065 630 506
TRIAXIAL TEST REPORT
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd  Report No.: 18110006B - CU

Volume v's Time (Log Scale)

Stage 1

CV (m²/year) : 0.69
Mv (m³/MN) : 0.073
k (m/s) : 1.56E-11

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

Page 7 of 7

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Trilab Pty Ltd
ABN 25 065 630 506
Annexure DG
Oedometer Consolidation Tests
OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Hatch Pty Ltd

Report No.: 18080196-OED

Workorder No.: 4644

Address: PO Box 425 SPRING HILL QLD 4004

Test Date: 13/08/2018

Report Date: 3/09/2018

Project: H356804 - Cadia NTSF Failure

Client Id.: CE407 - DH402 - PT3

Depth (m): 51.00-51.50

Description: CLAY- grey brown

Undisturbed sample supplied by the client

Remarks: Tested as Received

Applied Pressure (kPa)

Void Ratio

% Consolidation

Wet Density (t/m³): 1.99

Initial Moisture (%): 22.2

Test Condition: Inundated on load

Particle Density (t/m³): 2.57

Initial Voids Ratio: 0.578

Initial Degree of Saturation (%): 100.0

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Authorised Signatory

C. Channon

Accredited for compliance with ISO/IEC 17025 - Testing.
# OEDOMETER TEST REPORT

**Test Method:** AS1289.6.6.1, 3.5.1

<table>
<thead>
<tr>
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<th>Hatch Pty Ltd</th>
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<tbody>
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<td>Report No.:</td>
<td>18080196-OED</td>
</tr>
<tr>
<td>Workorder No.:</td>
<td>4644</td>
</tr>
<tr>
<td>Address:</td>
<td>PO Box 425 SPRING HILL QLD 4004</td>
</tr>
<tr>
<td>Test Date:</td>
<td>13/08/2018</td>
</tr>
<tr>
<td>Report Date:</td>
<td>3/09/2018</td>
</tr>
<tr>
<td>Project:</td>
<td>H356804 - Cadia NTSF Failure</td>
</tr>
<tr>
<td>Client Id.:</td>
<td>CE407 - DH402 - PT3</td>
</tr>
<tr>
<td>Depth (m):</td>
<td>51.00-51.50</td>
</tr>
<tr>
<td>Description:</td>
<td>CLAY- grey brown</td>
</tr>
</tbody>
</table>

## TEST RESULTS

<table>
<thead>
<tr>
<th>Stage</th>
<th>Load (kPa)</th>
<th>Cc</th>
<th>k</th>
<th>Cv (m²/yr)</th>
<th>Mv (kPa x 10⁻³)</th>
<th>Ca x 10⁻³</th>
<th>% Consolidation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25-49</td>
<td>0.009</td>
<td>1.5E-09</td>
<td>3.79</td>
<td>74.12</td>
<td>0.066</td>
<td>0.39</td>
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<tr>
<td>2</td>
<td>49-101</td>
<td>0.043</td>
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<td>0.87</td>
<td>29.23</td>
<td>0.165</td>
<td>0.85</td>
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<tr>
<td>3</td>
<td>101-199</td>
<td>0.079</td>
<td>1.4E-09</td>
<td>0.81</td>
<td>29.71</td>
<td>0.151</td>
<td>1.76</td>
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<tr>
<td>4</td>
<td>199-399</td>
<td>0.134</td>
<td>7.7E-10</td>
<td>0.43</td>
<td>18.90</td>
<td>0.131</td>
<td>1.78</td>
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<tr>
<td>5</td>
<td>399-200</td>
<td>0.040</td>
<td>2.3E-10</td>
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<td>18.25</td>
<td>0.040</td>
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<td>6</td>
<td>200-99</td>
<td>0.029</td>
<td>1.8E-11</td>
<td>0.26</td>
<td>0.97</td>
<td>0.058</td>
<td>1.21</td>
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<td>7</td>
<td>99-200</td>
<td>0.051</td>
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<td>14.96</td>
<td>0.101</td>
<td>0.42</td>
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<tr>
<td>8</td>
<td>200-400</td>
<td>0.024</td>
<td>1.2E-10</td>
<td>0.88</td>
<td>15.63</td>
<td>0.024</td>
<td>1.12</td>
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<tr>
<td>9</td>
<td>400-800</td>
<td>0.139</td>
<td>3.9E-10</td>
<td>0.24</td>
<td>18.01</td>
<td>0.069</td>
<td>3.36</td>
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<td>10</td>
<td>800-1602</td>
<td>0.181</td>
<td>6.4E-12</td>
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<td>0.44</td>
<td>0.046</td>
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<td>1602-3200</td>
<td>0.175</td>
<td>1.0E-11</td>
<td>0.29</td>
<td>1.38</td>
<td>0.023</td>
<td>2.75</td>
</tr>
</tbody>
</table>

Remarks: Tested as Received

---

Trilab Pty Ltd
ABN 25 065 630 506

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Trilab Pty Ltd
ABN 25 065 630 506

Authorised Signatory
C. Channon

Laboratory Number 9926

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Tested at Trilab Brisbane Laboratory.
OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Hatch Pty Ltd
Report No.: 18080417-OED

Address: PO Box 425 SPRING HILL QLD 4004
Workorder No. 4681

Test Date: 22/08/2018
Report Date: 11/09/2018

Project: H356804 - Cadia NTSF Failure

Client Id.: CE412 - DH405 SA8
Depth (m): 65.50-66.00

Description: SANDY SILT- brown

- Void Ratio
- % Consolidation

Wet Density (t/m³): 1.89
Initial Moisture (%): 26.1
Test Condition: Inundated on load

Particle Density (t/m³): 2.64
Initial Voids Ratio: 0.758
Initial Degree of Saturation (%): 91.5

Undisturbed sample supplied by the client
Remarks: Tested as Received

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory
C. Channon

STRICTLY CONFIDENTIAL
**OEDOMETER TEST REPORT**

Test Method: AS1289.6.6.1, 3.5.1

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**TEST RESULTS**

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<th>k (m/s)</th>
<th>Cv (m²/yr)</th>
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Remarks: Tested as Received

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**Tested at Trilab Brisbane Laboratory.**

**Authorised Signatory**

C. Channon

Laboratory Number

9926
OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Hatch Pty Ltd
Report No.: 18080420-OED

Workorder No. 4681

Address: PO Box 425 SPRING HILL QLD 4004
Test Date: 22/08/2018

Project: H356804 - Cadia NTSF Failure
Report Date: 7/09/2018

Client Id.: CE417 - DH406 L2B
Depth (m): 18.50-19.00

Description: SILTY CLAY- grey

Undisturbed sample supplied by the client
Remarks: Tested as Received

Wet Density (t/m³): 1.74
Initial Moisture (%): 45.5
Test Condition: Inundated on load

Particle Density (t/m³): 2.49
Initial Voids Ratio: 1.077
Initial Degree of Saturation (%): 100.0

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Authorised Signatory
C. Channon

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Laboratory Number 9926

Page 1 of 2
# OEDOMETER TEST REPORT

**Test Method:** AS1289.6.6.1, 3.5.1

| Client: | Hatch Pty Ltd |
| Report No.: | 18080420-OED |
| Workorder No.: | 4681 |
| Address: | PO Box 425 SPRING HILL QLD 4004 |
| Project: | H356804 - Cadia NTSF Failure |
| Client Id.: | CE417 - DH406 L2B |
| Depth (m): | 18.50-19.00 |
| Description: | SILTY CLAY- grey |

## TEST RESULTS

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<tr>
<th>Stage</th>
<th>Load (kPa)</th>
<th>Cc (m/s)</th>
<th>k (m²/yr)</th>
<th>Cv (m²/yr)</th>
<th>Mv (kPa x 10⁻³)</th>
<th>Cₐ x 10⁻³</th>
<th>% Consolidation</th>
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Remarks: Tested as Received

---

Authorised Signatory
C. Channon

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Trilab Pty Ltd
ABN 25 065 630 506

Laboratory Number
9926

---

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Page 2 of 2
**OEDOMETER TEST REPORT**

**Test Method:** AS1289.6.6.1, 3.5.1

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<thead>
<tr>
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<tbody>
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<td>Address:</td>
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</tr>
<tr>
<td>Workorder No.:</td>
<td>4681</td>
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<tr>
<td>Project:</td>
<td>H356804 - Cadia NTSF Failure</td>
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<tr>
<td>Client Id.:</td>
<td>CE411A - DH409A L1</td>
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<td>Depth (m):</td>
<td>14.50-15.00</td>
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<tr>
<td>Description:</td>
<td>SILTY CLAY- yellow brown</td>
</tr>
</tbody>
</table>

| Wet Density (t/m³): | 1.96 |
| Initial Moisture (%): | 26.0 |
| Test Condition: | Inundated on load |
| Particle Density (t/m³): | 2.70 |
| Initial Voids Ratio: | 0.732 |
| Initial Degree of Saturation (%): | 97.1 |

Undisturbed sample supplied by the client

**Remarks:** Tested as Received

**Test Date:** 23/08/2018  
**Report Date:** 10/09/2018

---

**Graph:**

- **Void Ratio**
- **% Consolidation**

---

**Authorised Signatory:**

C. Channon

---

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### OEDOMETER TEST REPORT

**Test Method:** AS1289.6.6.1, 3.5.1

**Client:** Hatch Pty Ltd

**Report No.:** 18080432-OED

**Workorder No.:** 4681

**Address:** PO Box 425 SPRING HILL QLD 4004

**Test Date:** 23/08/2018

**Report Date:** 10/09/2018

**Project:** H356804 - Cadia NTSF Failure

**Client Id.:** CE411A - DH409A L1

**Depth (m):** 14.50-15.00

**Description:** SILTY CLAY - yellow brown

### TEST RESULTS

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<th>Load (kPa)</th>
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<th>k (m/s)</th>
<th>Cv (m²/yr)</th>
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Remarks: Tested as Received

**Page 2 of 2**

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Laboratory Number 9926

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## 1-DIMENSIONAL CONSOLIDATION TEST

**Test Method:** AS 1289.6.6.1

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<th>$c_v$ (m$^3$/year)</th>
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</table>

*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample.

---

**Job No.** LAB127730

**Location:** Cadia Valley Operations

**Sample ID:** 2018-017-004

**Date:** 11/09/2018

**Checked By:** TC

**Date:** 27/9/2018

**Sample Details:**
- **Sample Diameter (mm):** 60.0
- **Sample Height (mm):** 21.85
- **Dry Density (t/m$^3$):** 1.52
- **Moisture Content (%):** 26.2
- **Soil Particle Density (t/m$^3$):** 2.79

**Test Details:**
- **Test Method:** AS 1289.6.6.1
- **Test ID:** CE-OED-01
- **Tested By:** BB/SL/KM
- **Checked By:** TC

---

**Cadia NTSF Failure - Laboratory Testing**

**Cadia NTSF Failure - Laboratory Testing**

**1-Dimensional Consolidation**

Figure B-1 - Page 1

M-Files: FAM-18208

Rev: 9

F-Entity: AGLab
1-DIMENSIONAL CONSOLIDATION TEST
Test Method: AS 1289.6.6.1

Vertical Stress, $\sigma_v$ (kPa)

0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8 0.85

1 10 100 1,000 10,000

Void Ratio, $e$

Cadia NTSF Failure - Laboratory Testing
1-Dimensional Consolidation

Figure B-1 - Page 2
## Test Details:

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## Sample Details:

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## Sample Details:

<table>
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<tr>
<th>Sample Details:</th>
<th>Initial</th>
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<td>Sample Height (mm):</td>
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<td>25.05</td>
</tr>
<tr>
<td>Dry Density (t/m³):</td>
<td>1.52</td>
<td>1.62</td>
</tr>
<tr>
<td>Moisture Content (%):</td>
<td>25.8 *</td>
<td>26.9</td>
</tr>
<tr>
<td>Soil Particle Density (t/m³):</td>
<td>2.87</td>
<td></td>
</tr>
</tbody>
</table>

*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample

---

### 1-DIMENSIONAL CONSOLIDATION TEST

**Test Method:** AS 1289.6.6.1

<table>
<thead>
<tr>
<th>Stage</th>
<th>σv (kPa)</th>
<th>e</th>
<th>c_v (m³/year)</th>
<th>m_v (m³/kN)</th>
<th>k (m/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading</td>
<td>1</td>
<td>25</td>
<td>-</td>
<td>-</td>
<td>4.6E-04</td>
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<tr>
<td></td>
<td>2</td>
<td>50</td>
<td>0.778</td>
<td>1,233.9</td>
<td>7.1E-08</td>
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<tr>
<td></td>
<td>3</td>
<td>100</td>
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<td>1,972.9</td>
<td>6.9E-08</td>
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<td>4</td>
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<td>0.752</td>
<td>2,007.9</td>
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<td>0.729</td>
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</tr>
<tr>
<td></td>
<td>7</td>
<td>100</td>
<td>0.737</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Re-Loading</td>
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<td>-</td>
<td>-</td>
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<td></td>
<td>9</td>
<td>400</td>
<td>0.727</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Loading</td>
<td>10</td>
<td>800</td>
<td>0.703</td>
<td>2,236.8</td>
<td>2.4E-08</td>
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<td>1,264.5</td>
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<td>Unloading</td>
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<td>800</td>
<td>0.617</td>
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<tr>
<td></td>
<td>14</td>
<td>200</td>
<td>0.643</td>
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<td>-</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>25</td>
<td>0.682</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

---

**Cadia NTSF Failure - Laboratory Testing**

1-Dimensional Consolidation

---

**Figure B-2 - Page 1**

---

**F-Entity:** AGLab
1-DIMENSIONAL CONSOLIDATION TEST

Test Method: AS 1289.6.6.1

Vertical Stress, $\sigma_v$ (kPa)

Void Ratio, $e$

Job No.LAB127730  
L:\agLAB\Projects\007.2018\LAB127730 - Cadia NTSF\03 Technical\04 Lab Testing\IPO 2018-017\Consolidation\03 Final\Rev 0 For Client\2018-017-015 CE-OED-03.xlsm

M-Files: FAM-18208  
Rev: 9  
F-Entity: AGLab
**Client:** Newcrest Mining  
**IPO Number:** 2018-017  
**Sample ID:** 2018-017-015  
**Location:** Cadia Valley Operations  
**Borehole ID:** CE411A  
**Depth:** 16.70 m to 16.74 m

**Test Details:**

<table>
<thead>
<tr>
<th>Test ID</th>
<th>CE-OED-03</th>
<th>Tested By</th>
<th>BB/SL/KM</th>
<th>Date: 11/09/2018</th>
<th>Checked By</th>
<th>TC</th>
<th>Date: 27/9/2018</th>
</tr>
</thead>
</table>

**Sample Details:**

<table>
<thead>
<tr>
<th>Sample Diameter (mm) :</th>
<th>Initial</th>
<th>Final</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Height (mm)</td>
<td>60.0</td>
<td>60.0</td>
</tr>
<tr>
<td>Dry Density (t/m³)</td>
<td>22.13</td>
<td>21.54</td>
</tr>
<tr>
<td>Moisture Content (%)</td>
<td>30.9</td>
<td>34.7</td>
</tr>
<tr>
<td>Soil Particle Density</td>
<td>2.83</td>
<td></td>
</tr>
</tbody>
</table>

*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample

---

**1-DIMENSIONAL CONSOLIDATION TEST**

**Test Method:** AS 1289.6.6.1

<table>
<thead>
<tr>
<th>Stage</th>
<th>Stage</th>
<th>σᵥ</th>
<th>e</th>
<th>cᵥ</th>
<th>mᵥ</th>
<th>k</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>kPa</td>
<td></td>
<td>m³/year</td>
<td>m³/kN</td>
<td>m/sec</td>
</tr>
<tr>
<td>Loading</td>
<td>1</td>
<td>25</td>
<td>0.982</td>
<td>-</td>
<td>4.0E-04</td>
<td>-</td>
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<td></td>
<td>2</td>
<td>50</td>
<td>0.978</td>
<td>2,330.5</td>
<td>8.6E-05</td>
<td>6.2E-08</td>
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<tr>
<td></td>
<td>3</td>
<td>100</td>
<td>0.973</td>
<td>2,944.2</td>
<td>4.8E-05</td>
<td>4.4E-08</td>
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<tr>
<td></td>
<td>4</td>
<td>200</td>
<td>0.970</td>
<td>4,052.3</td>
<td>1.7E-05</td>
<td>2.2E-08</td>
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<tr>
<td></td>
<td>5</td>
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<td>0.958</td>
<td>5,118.7</td>
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<td>4.9E-08</td>
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<td>0.961</td>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>100</td>
<td>0.963</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
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<td>1.9E-08</td>
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<td>0.928</td>
<td>4,446.5</td>
<td>1.2E-05</td>
<td>1.6E-08</td>
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<td>12</td>
<td>3,200</td>
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<td>15</td>
<td>25</td>
<td>0.923</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

---

**1-Dimensional Consolidation**
1-DIMENSIONAL CONSOLIDATION TEST
Test Method: AS 1289.6.6.1

![Graph showing 1-Dimensional Consolidation Test](image-url)

**Cadia NTSF Failure - Laboratory Testing**

**1-Dimensional Consolidation**

---

**Newcrest Mining**

**IPO Number:** 2018-017

**Project:** Cadia NTSF Failure - Laboratory Testing

**Location:** Cadia Valley Operations

**Sample ID:** 2018-017-015

**Borehole ID:** CE411A

**Sample No.:** PT5

**Depth:** 16.70 m to 16.74 m

---

**STRICTLY CONFIDENTIAL**
Annexure DH
CRS Consolidation Tests
Constant Rate of Strain Consolidation Test

Client: Hatch  Date: 2/7/2018
Address: 61 Petrie Terrace Brisbane  Project No.: 18101980
Project: NTSF Embankment Failure ITRB  Sample ID: TP401 0.7-1.0m
Location: Cadia Mine  18005 - CRS1

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>60.0</th>
<th>Specific gravity (-)</th>
<th>2.80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial water content (trimmings) (%)</td>
<td>21.3%</td>
<td>Initial Void Ratio (-)</td>
<td>0.68</td>
</tr>
<tr>
<td>Initial Height (mm)</td>
<td>18.44</td>
<td>Initial Dry Density (t/m³)</td>
<td>1.67</td>
</tr>
<tr>
<td>Final water content (specimen) (%)</td>
<td>22.6%</td>
<td>Average strain rate (%/hour)</td>
<td>0.2%</td>
</tr>
</tbody>
</table>

Testing procedure: ASTM D4186

1. Specimen Preparation: Trimmed from block
2. Maximum constant stress prior to flooding: 25kPa
3. Saturation: Cell flushed with CO2 prior to flooding deaired demineralised water
4. Flooding: Undertaken under constant height conditions
5. Maximum cell pressure: 500kPa (ramped over 2 days with double drainage)

Preparation Notes:

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Reviewed by: R.Fanni / D.Reid

Tested by: I.Orea
Constant Rate of Strain Consolidation Test

Client: Hatch
Address: 61 Petrie Terrace Brisbane
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine

Date: 2/7/2018
Project No.: 18101980
Sample ID: TP401 0.7-1.0m

Graphs showing excess pore pressure ratio (Ru) and constrained modulus (M) versus vertical effective stress (\(\sigma_v'\)) for First Loading and Reloading phases.

Reviewed by: R.Fanni / D.Reid
Tested by: I.Orea
Constant Rate of Strain Consolidation Test

Client: Hatch
Address: 61 Petrie Terrace Brisbane
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine

Date: 2/7/2018
Project No.: 18101980
Sample ID: TP401 0.7-1.0m

Address: 84 Guthrie Street, Osborne Park

Graphs showing:
- Void Ratio, e vs. Hydraulic Conductivity, k (m/s)
- Coefficient of Consolidation, c_v (m²/year) vs. Vertical Effective Stress, σ'_v (kPa)

Graphs indicate data points for First Loading and Reloading.
Constant Rate of Strain Consolidation Test

Client: Hatch
Date: 2/7/2018
Address: 61 Petrie Terrace Brisbane
Project No.: 18101980
Project: NTSF Embankment Failure ITRB
Sample ID: TP405 1.9-2.2 m
Location: Cadia Mine 18006 - CRS2

Diameter (mm): 60.0
Specific gravity (-): 2.75
Initial water content (trimmings) (%): 22.6%
Initial Void Ratio (-): 0.80
Initial Height (mm): 18.68
Initial Dry Density (t/m$^3$): 1.52
Final water content (specimen) (%): 26.6%
Average strain rate (%/hour): 4.7%

Testing procedure: ASTM D4186
1. Specimen Preparation: Trimmed from block
2. Maximum constant stress prior to flooding: 25kPa
3. Saturation: Cell flushed with CO2 prior to flooding deaired demineralised water
4. Flooding: Undertaken under constant height conditions
5. Maximum cell pressure: 500kPa (ramped over 2 days with double drainage)

Preparation Notes:

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Reviewed by: R.Fanni / D.Reid
Tested by: I.Orea
Constant Rate of Strain Consolidation Test

Client: Hatch
Date: 2/7/2018
Address: 61 Petrie Terrace Brisbane
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine

Sample ID: TP405 1.9-2.2 m
Project No.: 18101980

---

Vertical Effective Stress, $\sigma_v$ (kPa)

- Hydraulic Conductivity, $k$ (m/s)
- Coefficient of Consolidation, $c_v$ (m/year)

---

Graphs showing the relationship between void ratio, hydraulic conductivity, and vertical effective stress.
Constant Rate of Strain Consolidation Test

Client: Hatch
Date: 2/7/2018
Address: 61 Petrie Terrace Brisbane
Project No.: 18101980
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine
Sample ID: TP405 1.9-2.2 m

Diameter (mm) 60.0
Specific gravity (-) 2.75
Initial water content (trimmings) (%) 27.4%
Initial Void Ratio (-) 0.82
Initial Height (mm) 18.47
Initial Dry Density (t/m³) 1.51
Final water content (specimen) (%) 28.0%
Average strain rate (%/hour) 3.9%

Preparation Notes:
Testing procedure: ASTM D4186
1. Specimen Preparation: Trimmed from block
2. Maximum constant stress prior to flooding: 25kPa
3. Saturation: Cell flushed with CO2 prior to flooding deaired demineralised water
4. Flooding: Undertaken under constant height conditions
5. Maximum cell pressure: 500kPa (ramped over 2 days with double drainage)
Constant Rate of Strain Consolidation Test

Client: Hatch
Address: 61 Petrie Terrace Brisbane
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine

Date: 2/7/2018
Project No.: 18101980
Sample ID: TP405 1.9-2.2 m

Vertical Effective Stress, $\sigma'_v$ (kPa)

Excess Pore Pressure Ratio, $R_u$ (%)

Constrained Modulus, M (KPa)

STRICTLY CONFIDENTIAL
Constant Rate of Strain Consolidation Test

Client: Hatch  Date: 2/7/2018
Address: 61 Petrie Terrace Brisbane  Project: NTSF Embankment Failure ITRB
Project No.: 18101980  Sample ID: TP405 1.9-2.2 m
Location: Cadia Mine  18006 - CRS1

Hydraulic Conductivity, k (m/s)

Void Ratio, e (-)

Coefficient of Consolidation, c_v (m²/year)

Vertical Effective Stress, σ'_v (kPa)

Loading  e0

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Tested by: I.Orea  Reviewed by: R.Fanni / D.Reid
Constant Rate of Strain Consolidation Test

Perth Laboratory
84 Guthrie Street, Osborne Park

Client: Hatch
Date: 17/08/2018
Address: 61 Petrie Terrace Brisbane
Project No.: 18101980
Project: NTSF Embankment Failure ITRB
Sample ID: CE415-PT1 6.0-6.5 m
Location: Cadia Mine

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>60.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial water content (trimmings) (%)</td>
<td>41.5%</td>
</tr>
<tr>
<td>Initial Height (mm)</td>
<td>18.76</td>
</tr>
<tr>
<td>Initial Void Ratio (-)</td>
<td>1.25</td>
</tr>
<tr>
<td>Initial Dry Density (t/m³)</td>
<td>1.28</td>
</tr>
<tr>
<td>Final water content (specimen) (%)</td>
<td>43.0%</td>
</tr>
<tr>
<td>Specific gravity (-)</td>
<td>2.89</td>
</tr>
<tr>
<td>Average strain rate (%/hour)</td>
<td>1.3%</td>
</tr>
</tbody>
</table>

Preparation Notes:
1. Specimen Preparation: Extruded from tube
2. Maximum constant stress prior to flooding: 25kPa
3. Saturation: Cell flushed with CO₂ prior to flooding with deaired demineralised water
4. Flooding and back pressure saturation: Initially undertaken under constant height conditions; switched to constant stress (25 kPa) during back pressure saturation
5. Maximum cell pressure: 500kPa (ramped over 1 days with double drainage)

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THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL
TEST DID NOT MEET THE MINIMUM Ru recommended in ASTM D4186

Excess Pore Pressure Ratio, Ru (%) vs Vertical Effective Stress, $\sigma'_v$ (kPa)

Constrained Modulus, M (kPa) vs Vertical Effective Stress, $\sigma'_v$ (kPa)

Client: Hatch
Address: 61 Petrie Terrace Brisbane
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine

Date: 17/08/2018
Project No.: 18101980
Sample ID: CE415-PT1 6.0-6.5 m

Sample ID: 18022 - CRS1

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Constant Rate of Strain Consolidation Test

Client: Hatch  
Address: 61 Petrie Terrace Brisbane  
Project: NTMF Embankment Failure ITRB  
Location: Cadia Mine

Date: 17/08/2018  
Project No.: 18101980  
Sample ID: CE415-PT1 6.0-6.5m  
Location: 18022 - CRS1

---

**Graph 1:**

- **Void Ratio (e)** vs. **Hydraulic Conductivity (k)**
- **Reloading**
- **e0**

**Graph 2:**

- **Coefficient of Consolidation (c_v)** vs. **Vertical Effective Stress (σ_v')**
- **Reloading**

---

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Tested by: I.Orea  
Reviewed by: R.Fanni
## Constant Rate of Strain Consolidation Test

### Perth Laboratory
84 Guthrie Street, Osborne Park

**Client:** Hatch  
**Date:** 11/09/2018  
**Address:** 61 Petrie Terrace Brisbane  
**Project No.:** 18101980  
**Project:** NTSF Embankment Failure ITRB  
**Sample ID:** CE417-PT1 16.5-16.86m  
**Location:** Cadia Mine  
**Sample ID:** 18023 - CRS1

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>60.0</th>
<th>Specific gravity (-)</th>
<th>2.74</th>
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</thead>
<tbody>
<tr>
<td>Initial water content (trimmings) (%)</td>
<td>27.4%</td>
<td>Initial Void Ratio (-)</td>
<td>0.80</td>
</tr>
<tr>
<td>Initial Height (mm)</td>
<td>18.75</td>
<td>Initial Dry Density (t/m³)</td>
<td>1.52</td>
</tr>
<tr>
<td>Final water content (specimen) (%)</td>
<td>29.2%</td>
<td>Average strain rate (%/hour)</td>
<td>3.2%</td>
</tr>
</tbody>
</table>

### Testing procedure: ASTM D4186
1. Specimen Preparation: Trimmed from block
2. Maximum constant stress prior to flooding: 25kPa
3. Saturation: Cell flushed with CO2 prior to flooding deaired demineralised water
4. Flooding and back pressure saturation: Undertaken under constant height conditions and switched to constant stress (25kPa) during back pressure saturation
5. Maximum cell pressure: 500kPa (ramped over 2 days with double drainage)
6. Constant head permeability tests undertaken at 25 kPa and 3000 kPa total stresses

### Preparation Notes:

** Tested by:** I.Orea  
** Reviewed by:** R.Fanni

---

![Graph showing void ratio vs. vertical effective stress](image)

---

![Graph showing axial strain vs. vertical effective stress](image)

---

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---

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TEST EXCEEDED THE MAXIMUM $R_u$ recommended in ASTM D4186 standard ($R_u$ ranging between 3-15%).
Constant Rate of Strain Consolidation Test

Client: Hatch
Address: 61 Petrie Terrace Brisbane
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine

Date: 11/09/2018
Project No.: 18101980
Sample ID: CE417-PT1 16.5-16.86m

Hydraulic Conductivity, k (m/s)

- First Loading
- Reloading
- CH Permeability

 Void Ratio, e ( - )

- First Loading
- Reloading

Coefficient of Consolidation, c (m/year)

- First Loading
- Reloading

Vertical Effective Stress, $\sigma'_v$ (kPa)

- 6.15E-10, 0.79
  Total stress = 25
  Head = 5 kPa
- 5.45E-12, 0.67
  Total stress = 3000
  Head = 50 kPa

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Tested by: I.Orea
Reviewed by: R.Fanni
Constant Rate of Strain Consolidation Test

Testing procedure: ASTM D4186
1. Specimen Preparation: Trimmed from block
2. Maximum constant stress prior to flooding: 25kPa
3. Saturation: Cell flushed with CO2 prior to flooding deaired demineralised water
4. Flooding and back pressure saturation: Undertaken under constant height conditions and switched to constant stress (25 kPa) during back pressure saturation
5. Maximum cell pressure: 500kPa (ramped over 1 days with double drainage)
6. Constant head permeability tests undertaken at 25 kPa and 3000 kPa total stresses

Preparation Notes:

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Reviewed by: R.Fanni
Tested by: I.Orea

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>60.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial water content (trimmings) (%)</td>
<td>37.9%</td>
</tr>
<tr>
<td>Initial Void Ratio ( )</td>
<td>1.14</td>
</tr>
<tr>
<td>Initial Height (mm)</td>
<td>18.76</td>
</tr>
<tr>
<td>Initial Dry Density (t/m^3)</td>
<td>1.35</td>
</tr>
<tr>
<td>Final water content (specimen) (%)</td>
<td>40.6%</td>
</tr>
<tr>
<td>Average strain rate (%/hour)</td>
<td>6.1%</td>
</tr>
</tbody>
</table>

Initial Load and Flooding
Back Pressure Saturation
CRS

Vertical Effective Stress, \( \sigma'_v \) (kPa)
Void Ratio, \( e \)
Axial Strain, \( \varepsilon_a \) (%)
Vertical Effective Stress, \( \sigma'_v \) (kPa)
Constant Rate of Strain Consolidation Test

Client: Hatch
Address: 61 Petrie Terrace Brisbane
Project: NTSF Embankment Failure ITRB
Location: Cadia Mine
Date: 3/09/2018

Sample ID: CE416 PT4 27.00-27.45m
Project No.: 18101980

Graphs showing:
- Void Ratio, $e$ vs. Hydraulic Conductivity, $k$ (m/s)
- Coefficient of Consolidation, $c_v$ (m/year) vs. Vertical Effective Stress, $\sigma'_v$ (kPa)

Points:
- 2.44E-09, 1.13: Total stress = 25 kPa, Head = 5 kPa
- 9.61E-11, 0.83: Total stress = 3000 kPa, Head = 10 kPa
Annexure DI
Miscellaneous Tests
The sample was supplied by the client to Microanalysis Australia on 13th of August 2018 for the above mentioned analyses. A representative sub-sample was removed and lightly ground such that 90% was passing 20 µm. Grinding to this size helps eliminate preferred orientation.

Analytical

Only crystalline material present in the sample will give peaks in the XRD scan. Amorphous (non-crystalline) material will add to the background. The search match software used was Eva 4.2. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

No standards were used in the quantification process. The concentrations were calculated using the peak area integration method where the area of the 100% peak for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method allows for some attention to be paid to preferred orientation but is limited in considering substitution and lattice strain.

Summary

The phases are listed in order of interpreted concentration:

<table>
<thead>
<tr>
<th>Mineral phase</th>
<th>Concentration (%)</th>
<th>ICDD match probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albite low (Na (Al Si3 O8))</td>
<td>31</td>
<td>good</td>
</tr>
<tr>
<td>Kaolinite-1A (Al2 Si2 O5 (O H)4)</td>
<td>17</td>
<td>medium</td>
</tr>
<tr>
<td>Microcline (K Al Si3 O8)</td>
<td>14</td>
<td>good</td>
</tr>
<tr>
<td>Nontronite-15A (Ca0.1 Fe2 (Si, Al)4 O10 (O H)2 - 4 H2 O)</td>
<td>11</td>
<td>medium</td>
</tr>
<tr>
<td>Quartz, syn (Si O2)</td>
<td>10</td>
<td>good</td>
</tr>
<tr>
<td>Maghemite-C, syn (Fe2 O3)</td>
<td>5</td>
<td>medium</td>
</tr>
<tr>
<td>Hematite, syn (Fe2 O3)</td>
<td>5</td>
<td>good</td>
</tr>
<tr>
<td>Alunite (K Al3 (S O4)2 (O H)6)</td>
<td>3</td>
<td>low</td>
</tr>
<tr>
<td>Jadeite (Ca.29 Na.6 Al.76 Mg.21 Fe.08 Si1.99 O6)</td>
<td>3</td>
<td>low</td>
</tr>
</tbody>
</table>

The ICDD match probability is reported as an indication as to how well the peak positions and relative intensities for the sample matched those in the published literature (www.icdd.org) for that particular compound.
Sample preparation
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No standards were used in the quantification process. The concentrations were calculated using the peak area integration method where the area of the 100% peak for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method allows for some attention to be paid to preferred orientation but is limited in considering substitution and lattice strain.

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<tbody>
<tr>
<td>Quartz, syn (Si O2)</td>
<td>42</td>
<td>good</td>
</tr>
<tr>
<td>Albite, calcian (Na0.499 Ca0.491 (Al1.488 Si2.506 O8 ))</td>
<td>19</td>
<td>good</td>
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<tr>
<td>Microcline (K Al Si3 O8)</td>
<td>12</td>
<td>good</td>
</tr>
<tr>
<td>Kaolinite-1A (Al2 Si2 O5 (O H)4)</td>
<td>9</td>
<td>medium</td>
</tr>
<tr>
<td>Maghemite-C, syn (Fe2 O3)</td>
<td>7</td>
<td>medium</td>
</tr>
<tr>
<td>Natrojarosite, syn (Na Fe3 (S O4)2 (O H)6)</td>
<td>6</td>
<td>good</td>
</tr>
<tr>
<td>Goethite, syn (Fe O (O H))</td>
<td>3</td>
<td>medium</td>
</tr>
<tr>
<td>Muscovite-1M, syn (K Al (Mg0.2 Al0.8 ) (Al2.21 Si1.83)2 O10 (O H)2)</td>
<td>1</td>
<td>low</td>
</tr>
<tr>
<td>Nontronite-15A (Na0.3 Fe2 Si4 O10 (O H)2 -4 H2 O)</td>
<td>1</td>
<td>low</td>
</tr>
</tbody>
</table>

The ICDD match probability is reported as an indication as to how well the peak positions and relative intensities for the sample matched those in the published literature (www.icdd.org) for that particular compound.
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</tr>
</thead>
<tbody>
<tr>
<td>Goethite, syn (Fe O (O H))</td>
<td>10</td>
<td>medium</td>
</tr>
<tr>
<td>Hematite, syn (Fe2 O3)</td>
<td>5</td>
<td>medium</td>
</tr>
<tr>
<td>Quartz, syn (Si O2)</td>
<td>15</td>
<td>medium</td>
</tr>
<tr>
<td>Nontronite-15A (Na0.3 Fe2 Si4 O10 (O H)2 -4 H2 O)</td>
<td>7</td>
<td>medium</td>
</tr>
<tr>
<td>Microcline, intermediate (K Al Si3 O8)</td>
<td>6</td>
<td>medium</td>
</tr>
<tr>
<td>Kaolinite-1A (Al2 Si2 O5 (O H)4)</td>
<td>5</td>
<td>medium</td>
</tr>
<tr>
<td>Albite low (Na (Al Si3 O8))</td>
<td>4</td>
<td>medium</td>
</tr>
<tr>
<td>Muscovite-2M#2 (K0.77 Al1.93 (Al0.5 Si3.5 ) O10 (O H)2)</td>
<td>3</td>
<td>medium</td>
</tr>
<tr>
<td>Natrojarosite, syn (Na Fe3 (S O4)2 (O H)6)</td>
<td>2</td>
<td>medium</td>
</tr>
</tbody>
</table>

The ICDD match probability is reported as an indication as to how well the peak positions and relative intensities for the sample matched those in the published literature (www.icdd.org) for that particular compound.
Client: Golder Associates Pty Ltd
Job number: 18_1484
Sample: 18_1484_01
Client ID: CE406 SA3 22.2-22.3m
Date: 14-09-18
Analysis: Semi-quantitative XRD analysis

Sample preparation
The sample was supplied by the client to Microanalysis Australia on 5th of September 2018 for the above mentioned analyses. A representative sub-sample was removed and lightly ground such that 90% was passing 20 µm. Grinding to this size helps eliminate preferred orientation.

Analysis
Only crystalline material present in the sample will give peaks in the XRD scan. Amorphous (non crystalline) material will add to the background. The search match software used was Eva 4.2. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

No standards were used in the quantification process. The concentrations were calculated using the normalized reference intensity ratio method where the intensity of the 100% peak divided by the published I/Ic value for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method allows for slight attention to be paid to preferred orientation but is limited in considering other factors including but not limited to; variable crystallinity, alteration, fluorescence, substitution and lattice strain.

Summary
The phases are listed in order of interpreted concentration:

<table>
<thead>
<tr>
<th>Mineral phase</th>
<th>Concentration (%)</th>
<th>ICDD match</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz, syn (Si O2)</td>
<td>57</td>
<td>good</td>
</tr>
<tr>
<td>Microcline, intermediate (K Al Si3 O8)</td>
<td>20</td>
<td>good</td>
</tr>
<tr>
<td>Muscovite-2M1 (K (Al1.5 Mg0.5 ) (Si3.5 Al0.5 ) O10 (O H )2)</td>
<td>16</td>
<td>medium</td>
</tr>
<tr>
<td>Kaolinite-1A (Al2 Si2 O5 (O H )4)</td>
<td>4</td>
<td>medium</td>
</tr>
<tr>
<td>Clinochlore-1M#HH##b-2 (Mg, Al, Fe)6 (Si, Al)4 O10 (O H )8</td>
<td>2</td>
<td>low</td>
</tr>
</tbody>
</table>

The ICDD match probability is reported as an indication as to how well the peak positions and relative intensities for the sample matched those in the published literature (www.icdd.org) for that particular compound.

The sample was supplied by the client to Microanalysis Australia on 5th of September 2018 for the above mentioned analyses. A representative sub-sample was removed and lightly ground such that 90% was passing 20 µm. Grinding to this size helps eliminate preferred orientation.

Analyst: Ian Davies, B.Sc.(Chemistry)
Reported: Ian Davies, B.Sc.(Chemistry)
Approved: Michael Simeoni, B.Sc.(Chemistry), M.Sc. (Science Administration), Ph.D.
Sample preparation

The sample was supplied by the client to Microanalysis Australia on 5th of September 2018 for the above mentioned analyses. A representative sub-sample was removed and lightly ground such that 90% was passing 20 µm. Grinding to this size helps eliminate preferred orientation.

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Only crystalline material present in the sample will give peaks in the XRD scan. Amorphous (non-crystalline) material will add to the background. The search match software used was Eva 4.2. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

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<tbody>
<tr>
<td>Kaolinite-1A (Al2Si2O5(OH)4)</td>
<td>25</td>
<td>medium</td>
</tr>
<tr>
<td>Montmorillonite-1A (Ca0.2(Al, Mg)2Si4O10(OH)2·4H2O)</td>
<td>19</td>
<td>medium</td>
</tr>
<tr>
<td>Hematite, syn (Fe2O3)</td>
<td>16</td>
<td>good</td>
</tr>
<tr>
<td>Maghemite-C, syn (Fe2O3)</td>
<td>15</td>
<td>good</td>
</tr>
<tr>
<td>Goethite, syn (FeO(OH))</td>
<td>11</td>
<td>good</td>
</tr>
<tr>
<td>Quartz, syn (SiO2)</td>
<td>6</td>
<td>good</td>
</tr>
<tr>
<td>Muscovite-2M#2 (K0.77Al1.93(Al0.5Si3.5)O10(OH)2)</td>
<td>5</td>
<td>medium</td>
</tr>
<tr>
<td>Clinochlore-1M#H#b, ferroan ([Mg, Fe]6Si3.5O10(OH)8)</td>
<td>3</td>
<td>low</td>
</tr>
<tr>
<td>Jarosite, sodian, syn ([K0.61Na0.41Fe3(S4O12)2(OH)6]</td>
<td>1</td>
<td>low</td>
</tr>
</tbody>
</table>

The ICDD match probability is reported as an indication as to how well the peak positions and relative intensities for the sample matched those in the published literature (www.icdd.org) for that particular compound.
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<tbody>
<tr>
<td>Kaolinite-1A (Al2 Si2 O5 (OH)4)</td>
<td>43</td>
<td>medium</td>
</tr>
<tr>
<td>Quartz, syn (Si O2)</td>
<td>30</td>
<td>good</td>
</tr>
<tr>
<td>Hematite, syn (Fe2 O3)</td>
<td>13</td>
<td>good</td>
</tr>
<tr>
<td>Maghemite-Q (Fe1.966 O2.963)</td>
<td>12</td>
<td>medium</td>
</tr>
<tr>
<td>Goethite, syn (Fe O (OH))</td>
<td>2</td>
<td>medium</td>
</tr>
</tbody>
</table>

The ICDD match probability is reported as an indication as to how well the peak positions and relative intensities for the sample matched those in the published literature (www.icdd.org) for that particular compound.
Dry Density Moisture Content Relationship Report

In accordance with
AS 1289.5.1.1

Client: Hatch  Project No.: 18101981
Address  61 Petrie Terrace, Brisbane
Date: 29/06/18
Project: NTFS Embankment Failure ITRB
Location: Cadia Mine

Lab Ref No.: 180609  Sample Id: PL-BS1
Depth: 0-0.5m

AS 1726 - Soil Classification:CH  Description: Sandy CLAY

Test Procedure: AS 1289.5.1.1  Mould Type : A Type (1litre)
Natural Moisture Content 33.5%
Oversize material excluded from test: 0% retained on the 19 sieve.

Zero Air Voids for Particle Densities 2.3, 2.4 & 2.5 t/m³

Notes:
1. Tested as supplied.
2. Material was reused on negative 6 point due to insufficient sample.
3. This test certificate replaces test certificate reference 18101981_180609_TR-180078_MDD_Rev0

Certificate Reference: 18101981_180609_TR-180078_MDD_Rev1

NATA Accreditation No: 1961 Perth
Accredited for compliance with ISO/IEC 17025
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Sean Lenihan - Senior Laboratory Technician
# CERTIFICATE OF ANALYSIS

**Work Order**: EB1826989  
**Client**: TRILAB PTY LTD  
**Contact**: MR CHRIS CHANNON  
**Address**: 346A BILSEN RD, GEEBUNG QLD, AUSTRALIA 4031  
**Telephone**: +61 07 3265 5656  
**Project**: H356804 - Cadia NTSF Failure  
**Order number**: 1811017  
**Date Samples Received**: 07-Nov-2018 13:08  
**Order number**: 1811017  
**Date Analysis Commenced**: 13-Nov-2018  
**C-O-C number**: ----  
**Site**: ----  
**Quote number**: EN/333  
**No. of samples received**: 1  
**No. of samples analysed**: 1

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:
- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

**Signatories**

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<table>
<thead>
<tr>
<th>Signatories</th>
<th>Position</th>
<th>Accreditation Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kim McCabe</td>
<td>Senior Inorganic Chemist</td>
<td>Brisbane Inorganics, Stafford, QLD</td>
</tr>
</tbody>
</table>
General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key:
- CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
- LOR = Limit of reporting
- ^ = This result is computed from individual analyte detections at or above the level of reporting
- ø = ALS is not NATA accredited for these tests.
- ~ = Indicates an estimated value.

Analytical Results

<table>
<thead>
<tr>
<th>Compound</th>
<th>CAS Number</th>
<th>LOR</th>
<th>Unit</th>
<th>Result</th>
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<tr>
<td>EA101: Loss on Ignition</td>
<td>18110181 / CE417 - DH406 L2B / 18.50-19.00m</td>
<td>07-Nov-2018 00:00</td>
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Annexure DJ
Laboratory Test Procedures
Simple Shear – Rigid Boundary
Laboratory Testing Procedure

Document Number: FAM-18552

Responsible Person: APAC Director of GeoConsulting

<table>
<thead>
<tr>
<th>3</th>
<th>Issued for Use</th>
<th>Surendra Rajkamkar</th>
<th>Terry Chang Laboratory Manager</th>
<th>David Williams APAC Director of GeoConsulting</th>
<th>22/05/2018</th>
</tr>
</thead>
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<tr>
<td>Rev</td>
<td>Description</td>
<td>Prepared</td>
<td>Checked</td>
<td>Approved</td>
<td>Date</td>
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### RECORD OF CHANGES

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<th>Page Number(s)</th>
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<tr>
<td>3</td>
<td>■ Updated formatting to Fugro Standard</td>
<td>■ Throughout</td>
</tr>
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<td></td>
<td>■ Updated references</td>
<td>■ Throughout</td>
</tr>
<tr>
<td>2</td>
<td>Review and updated</td>
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<tr>
<td>1</td>
<td>OpCo removed and replaced with Fugro</td>
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1. OBJECTIVES

This procedure sets out methods for simple shear tests (monotonic, creep and cyclic) on undisturbed and reconstituted samples using the two different types of rigid boundary type simple shear apparatus at the Fugro Advanced Geotechnical Laboratory (AGLab) (namely Geocomp and Geojac). In these apparatus the specimen is confined using stack of rings. The test shall be conducted in a temperature controlled environment.

2. SCOPE

This test procedure applies to tests carried out in AGLab and field laboratories under AGLab control. Use Simple Shear Mono Static SS - (Geojac) Test Worksheet (FAM-18184), Simple Shear Mono Static - (GeoComp) Test Worksheet (FAM-18206), Simple Shear Mono Static SS - (Geojac) Creep Test Worksheet (FAM-18180) in conjunction with this procedure.

3. RESPONSIBILITIES

AGLab Manager

The AGLab Laboratory Manager has the responsibility to ensure that this procedure will be carried out by a trained and competent operator in accordance with the AGLab Laboratory Manual (FAM-17562).

Test Operator

The Test Operator has the responsibility to comply with this test procedure and where applicable the related processes and procedures stated in the AGLab Procedures Manual (FAM-17563).

4. APPARATUS

i. Normal loading device for applying normal load to the sample which is capable of maintaining constant load during the consolidation phase of a test, and allow continuous adjustment of displacement/load during shearing such that the specimen change in height is not more than 0.05% when using either active or passive height control;

ii. Horizontal loading device for applying load to the specimen with sufficient capacity and control to deform the specimen at the required rate of displacement;

iii. Two load cells, one for measuring normal load and one for measuring shear load, with an accuracy of ±1% of the applied maximum load for a given test;

iv. Two displacement measuring devices, one for vertical displacement and one for shear displacement, with an accuracy of at least 0.25% of full range;

v. Rigid stacked rings for providing lateral confinement to the sample. The thickness of the individual stacked rings is less than 1/10th of the specimen thickness in order to allow relatively uniform shear deformation;

vi. Water bath or burette, which stores distilled water for supplying water to the sample;

vii. A base pedestal and a top cap with drainage outlets of the same diameter as the test specimen;

viii. The top end cap is designed to have a central seating to connect to the axial load cell mounted to the loading ram;

ix. A shear slide table (base carrier) to hold the base pedestal, which allows at least 30% shear strain;
x. Guide to align the top cap during sample preparation, if required;
xi. Top and bottom skirt ing rings, which are designed to securely hold the specimen and transfer shear to the specimen without horizontal slippage at the interface;

xii. Porous discs with diameter slightly smaller than the specimen diameter and can be recessed into the top cap and base pedestal such that the contact interface is flush with the edge of the cap;

xiii. Filter paper of same diameter as the test specimen;

xiv. Seamless rubber membrane of internal diameter equal to or slightly less than the specimen diameter;

xv. O-rings of internal diameter slightly smaller than the diameter of the end caps;

xvi. Membrane stretcher and O-ring placing tool;

xvii. Trimming devices, e.g. cutting ring, wire saw, or spatulas;

xviii. Apparatus for determination of moisture content as described in AS1289.2.1.1;

xix. Balance with a limit of performance not greater than 0.1% of the specimen mass or 0.05g whichever is greater;

xx. Measuring device with a precision of not less than 0.1 mm.

xxi. Compaction mould with an extension collar and of the same internal diameter as the specimen;

xxii. Spacer plug with diameter slightly smaller than the specimen diameter, to which a removable lifting handle can be fitted.
5. RELATED DOCUMENTS

5.1 References

<table>
<thead>
<tr>
<th>Title</th>
<th>Document No.</th>
</tr>
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<tbody>
<tr>
<td>Simple Shear Testing of Cohesive Soils.</td>
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<tr>
<td>Australian Standard: Methods of testing soils for engineering</td>
<td>AS1289.2.1.1-2005</td>
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<td>purposes - Soil moisture content tests - Determination of the</td>
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<tr>
<td>moisture content of a soil - Oven drying method (standard method)</td>
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<tr>
<td>Australian Standard: Methods of Testing Soils for Engineering</td>
<td>AS1289.0-2014</td>
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<tr>
<td>Purposes – Definitions and General Requirements</td>
<td></td>
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<tr>
<td>AGLab Procedures Manual</td>
<td>FAM-17563</td>
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5.2 Records

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<th>Title</th>
<th>Document No.</th>
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<td>Laboratory Manager</td>
<td>7 Years</td>
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<tr>
<td>Simple Shear GeoComp Blank Test Worksheet</td>
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<td>Simple Shear Geojac Creep Blank Test Worksheet</td>
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<tr>
<td>Test Report</td>
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</tr>
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5.3 Superseded Documents

This document has been prepared and approved as part of the Fugro APAC BMS implementation. This document is a consolidation of similar pre-existing Fugro APAC Service Line specific process and does not introduce significant change to the BMS of Fugro operations within APAC. Documentation incorporated into, and superseded by this Procedure are:

- Simple Shear – Rigid Boundary Laboratory Testing Procedure (aL-PT45)
6. **SAMPLE TESTING**

The following describes the sample preparation method for simple shear using stacked rings confining system. The sample diameter can be between 45 mm and 80 mm, and the minimum height shall be 14 mm. The height to diameter ratio shall not exceed 0.4.

6.1 **Undisturbed Sample**

i. If required, the sample will be X-rayed prior to testing to check for suitability;

ii. Extrude sufficient material from the sampling tube to prepare the test sample.

iii. Gently push the cutting ring along the axis of the sample until the ring is fully embedded into the sample. Trim off the excess material so that the sample is flush with the edges of the ring by using appropriate trimming devices. Ensure that both the top and bottom ends of the specimen are trimmed flush with the ring;

iv. Measure and record the weight of the specimen and the cutting ring to the nearest 0.01 g;

v. Measure and record the diameter and height of the specimen to the nearest 0.01 mm;

vi. Determine the initial moisture content from the excess material trimmed off from the specimen in accordance with AS1289.2.1.1.

vii. Place a saturated porous disc and moist filter paper on the base pedestal. Gently push the test specimen from the ring to the base pedestal. After that, place the second porous disc and moist filter paper on top of the specimen followed by the top end cap. Sample preparation guide should be used to align the top and bottom caps, if applicable.

viii. Using the membrane stretcher and O-ring placing tool, place the rubber membrane around the specimen, using O-rings to seal the membrane to the base pedestal;

ix. Gently lower the skirting ring over the specimen until it rests on the O-ring, ensuring that the skirt protrudes at least 2-3 mm from the soil surface. Place the stack of smooth Teflon coated rings around the sample followed by the top skirting ring. The total thickness of the stacked rings should be such that at the end of consolidation, the top soil surface should be at least 2 mm above stacked rings. Use an O-ring to seal the membrane to the top end cap. Lock the stacked rings using locating pins;

6.2 **Reconstituted Sample**

There are a number of methods to prepare a reconstituted specimen.

6.2.1 **Compaction Method**

This method can be used for different types of materials (both fine and coarse grained materials) and generally includes:

i. Determine the dry density and moisture content required to prepare the sample;

ii. Determine the total weight of specimen required, adding an extra 10% for initial moisture content determination;

iii. Measure and record the height, internal diameter, to 0.01 mm and the weight of the compaction mould, to 0.01 g;
iv. Measure the depth of the extension collar, and the thickness of the spacer plug, to 0.1 mm. The thickness of the spacer plug should be equal to the depth of the extension collar. Fit the collar securely to the top of the mould.

v. Place a saturated porous disc and moist filter paper on the base pedestal;

vi. The material will be placed into the mould in three layers. Place one portion of the material into the mould. Compact the soil using a tamping rod until the thickness of material is about one-third of the height of the mould. The top surface of the compacted layer must be scarified before adding the next layer. Add another portion of the material to form a second layer and compact the soil until the height is about two-third of the height of the mould. Finally, add the last portion of the material into the mould, followed by the spacer plug. Compact the sample until the top of the plug is flush with the top of the collar.

vii. Remove the spacer plug and extension collar from the mould. Trim off the excess material so that the test specimen is flush with the edges of the mould by using appropriate trimming devices.

viii. Measure and record the weight of the specimen and the mould to the nearest 0.01g;

ix. Determine the initial moisture content from the leftover material in accordance with AS1289.2.1.1.

x. Transfer the test specimen to the base pedestal as described in clause 6.1 (vii) to 6.1 (ix).

6.2.2 Slurry Consolidation Method

This method can be used to reconstitute fine-grained specimens, e.g. silts and clays.

i. Sample can be prepared from undisturbed or disturbed materials;

ii. Mix material thoroughly by adding water until the mixture is homogenous and forming a thin paste;

iii. Apply vacuum to remove the entrapped air from the sample;

iv. Pour the slurry into a stainless steel tube with two-way drainage, ensuring that there is no entrapped air bubbles in the sample;

v. Allow the sample to settle on its own weight until no further settlement occurs;

vi. Apply a small seating load (1 to 2 kPa) to the sample and allow it to settle until no further settlement occurs;

vii. Apply load increments such as to double the previous load until final consolidation pressure is achieved. In each loading stage, allow the sample to consolidate before adding the next increment;

viii. On completion of the consolidation, the specimen is extruded from the tube. Prepare the specimen in accordance to steps specified in clause 6.1 (Undisturbed sample)

6.2.3 Vibration Method

This method can be used for oven-dried or wet granular material.

i. Place a porous disc and a filter paper on the base pedestal and a rubber membrane around the base pedestal. Use O-rings to seal the membrane to the base pedestal;
ii. Lower the skirting ring over the base pedestal until it rests on the O-ring. Place the stack of smooth Teflon coated rings on top of the bottom skirting ring, followed by the top skirting ring. The total thickness of the stacked rings should be such that at the end of consolidation, the top soil surface should be at least 2 mm above the stacked rings. Lock the stacked rings using locating pins;

iii. Fully stretch and fold the membrane over the top of skirting ring such that the surface of membrane is smooth and wrinkle free;

iv. Measure the diameter and required height of the mould assembly to the nearest 0.1 mm;

v. Attach the mould assembly to the vibrating table.

vi. Determine the total mass of material required to the prescribed density to the nearest 0.01 g. Adding an extra 10% for initial moisture content determination;

vii. Pour all the material into the empty space contained by membrane and stacked rings, followed by the spacer plug and the surcharge;

viii. Vibrate the sample with surcharge weight until the required height is reached. Amplitude of vibration should be selected in such a way that he target density is achieved within a few minutes without violent shaking;

ix. Gently remove the spacer plug from the specimen. Put the filter paper and porous stone, followed by the top end cap on top of the specimen;

x. Fold up the membrane around the top end cap and seal with O-rings
7. PROCEDURE

7.1 Sample Set Up

i. Transfer the sealed specimen to the base carrier of the machine. Lock the base pedestal to the base carrier. Lower the vertical loading ram and connect it to the top end cap.

ii. For system using water bath (e.g. Geocomp machine) for supplying water to the specimen, inundate the specimen with water by filling the water bath with distilled water to the level of specimen height;

iii. For system using burette (e.g. Geojac machine) for supplying water to the specimen, attach flow tubing or drainage lines to base pedestal and top end cap. Add distilled water to burette. Flush water through the specimen using a small head difference equivalent to about 3 kPa until all visible air has been removed from the drainage lines. Adjust the position of the drainage pipes to equalise the top and bottom pressures;

iv. Start the DSS test program and input specimen details, test details and test parameters. Note that the test is performed using a semi-automated system for test control and data acquisition, which allows the user to define the test conditions by entering the specimen information and test parameters into the system. Set the interval of readings to be taken. Ensure that all the readings (loads and displacements) are recorded by the data logger.

7.2 Consolidation

i. Set the target consolidation pressure and consolidation time target. Ensure that the consolidation time is sufficiently longer for the sample to fully consolidate.

ii. Start the test;

iii. Observe the vertical displacement change when the target pressure is reached. Allow the specimen to be fully consolidated before proceeding to the next step. Taylor’s root time plot method is monitored to ensure that the specimen is fully consolidated.

7.3 Monotonic Shear

i. For Geojac system, lock the vertical loading ram into fixed position to maintain constant specimen height;

ii. Remove the pin from the stacked rings;

iii. Specify the strain rate and maximum displacement (or strain limit);

iv. Start the test and shear the specimen at the preselected shear rate in the specified direction;

v. The test is continued until the stopping criteria or limit of machine is reached, whichever occurred first.

7.4 Creep Test

Creep is time dependent shear deformation caused by constant shear stress. The test is performed by having a sustained shear stress on the specimen and measuring the shear strain against time. (Note: The following procedure is only applicable for Geojac machine using Digishear software).
i. Calculate the target shear load where the creep test to be performed;
ii. Program a data acquisition schedule in the system (manual mode) based on time, which will be used for creep data processing;
iii. Stop consolidation phase.
iv. Remove the pin from the stacked rings;
v. In the ‘Shear’ mode interface, specify the strain limit and a very small displacement rate to ensure that the height is maintained during creep. The displacement rate selected should be small enough and does not cause significant effect on the test;
vi. In the load control tab of Horizontal axis window (manual mode), using the load control feature, specify target shear load and required ramp time;
vii. Start the time based data acquisition (manual mode);
viii. Click the “Start” button on the “Shear” mode interface to begin the dummy shear test;
ix. Click the “Start” button on the Horizontal axis window (manual mode) to begin the creep test;
x. In this phase, the specimen will be sheared at the preselected ramp time until target shear load is reached. The specimen will then be allowed to creep while maintaining the shear load constant;
x1. The test is continued until there is no horizontal movement or the specified strain limit is reached

7.5 Cyclic Shear Test

Cyclic shear test consists of cyclic shearing phase and post-cyclic monotonic shearing phase. (Note: The following procedure is only applicable for Geocomp system).

7.5.1 Cyclic Shearing

i. Cyclic shearing can be either stress controlled or displacement controlled. The test information required for a cyclic test include:
   a. Number of cycles.
   b. Frequency or cycle period;
   c. For stress controlled mode, specify the cyclic stress ratio and the strain limit to be applied.
   d. For displacement controlled mode, specify the cyclic strain and the minimum stress ratio to be applied.
   e. The termination criteria could be maximum number of cycles, or either maximum strain limit (for stress cyclic) or the minimum stress ratio (for strain cyclic), whichever occurs first.
   f. Start the test. The test is continued until the stopping criteria or limit of the machine is reached.

7.5.2 Post – Cyclic Monotonic Shearing (Optional)

i. In this phase, the specimen is shearedmonotonically after the cyclic shearing phase;
ii. Specify the strain rate and maximum displacement (or strain limit) required for the test;
iii. The test is continued until the stopping criteria or equipment limit is reached
7.6 Sample Removal

i. Disconnect cell from vertical loading ram. Release vertical and horizontal loads.

ii. Dismantle the setup and remove the specimen from the machine.

iii. Take photographs of the tested sample.

iv. Determine final moisture content by taking a portion of material from the specimen in accordance with AS1289.2.1.1.
8. **CALCULATION**

Calculate the initial density, $\rho_t$, of the specimen:

$$\rho_t = \frac{1000 m_o}{H_o A_o} \quad (1)$$

where

- $\rho_t$ = Initial density of the specimen, in t/m$^3$
- $m_o$ = Initial mass of specimen, in grams
- $H_o$ = Thickness of the specimen, in mm
- $A_o$ = Cross-sectional area of the specimen, in mm$^2$

$$A_o = \frac{\pi D_o^2}{4}$$

- $D_o$ = Diameter of the specimen, in mm

Calculate the initial dry density, $\rho_d$, of the specimen:

$$\rho_d = \frac{100 \rho_t}{100 + w_o} \quad (2)$$

where

- $\rho_d$ = Initial dry density of the specimen, in t/m$^3$
- $w_o$ = Initial moisture content of the specimen, in percent.

Calculate axial strain, $\varepsilon_a$, for a given applied load:

$$\varepsilon_a = \frac{\Delta H}{H} \cdot 100 \quad (3)$$

where

- $\varepsilon_a$ = Axial strain, in %
- $\Delta H$ = Change in height of the specimen, mm
- $H$ = $H_o$, initial height of specimen during consolidation phase calculation, mm
- $H$ = $H_f$, Height of specimen after consolidation during shear phase calculation, mm

Calculate shear strain, $\gamma$, for a given applied load:

$$\gamma = \frac{\Delta L}{H_{eff}} \cdot 100 \quad (4)$$
where

\[ \gamma = \text{Shear strain, in \%} \]
\[ \Delta L = \text{Change in horizontal displacement, mm} \]
\[ H_{\text{eff}} = \text{Total height of specimen between stacked rings} \]

Calculate the vertical stress, \( \sigma_v \), for a given applied load:

\[ \sigma_v = \frac{1000 F}{A} \quad \text{(5)} \]

where

\[ F = \text{Measured applied vertical load, N.} \]
\[ A = \text{Cross-sectional area of the specimen, in mm}^2 \]

Calculate the shear stress, \( \tau_{xy} \), for a given load:

\[ \tau_{xy} = \frac{1000 F_h}{A} \quad \text{(6)} \]

where

\[ \tau_{xy} = \text{Shear stress, kPa} \]
\[ F_h = \text{Measured applied horizontal load, N.} \]
\[ A = \text{Cross-sectional area of the specimen, in mm}^2 \]

Calculate stress ratio for a given load:

\[ \text{Stress ratio} = \frac{\tau_{xy}}{\sigma_v} \quad \text{(7)} \]

where

\[ \text{Stress ratio} = \text{Stress ratio based on horizontal (xy) plane} \]
\[ \sigma_v = \text{Vertical stress, kPa} \]

Calculate the excess pore water pressure, \( \Delta u \):

\[ \Delta u = \sigma_{v_0} - \sigma_v \quad \text{(8)} \]

where

\[ \sigma_{v_0} = \text{Initial vertical stress, kPa} \]
\[ \sigma_v = \text{Vertical stress during shearing, kPa} \]
9. TEST REPORT

9.1 General

The following results and general information are reported:

i. Project title and client;
ii. Date of test;
iii. Laboratory where the test was performed;
iv. Identifying number of specimen (i.e. client’s identifying number, laboratory sample id, etc.);
v. Reference to this procedure

9.2 Standard Reporting for Sample Details and Consolidation Phase

i. Initial and final moisture content to 0.1%;
ii. Initial dry density, of the specimen to 0.01 t/m$^3$;
iii. Initial specimen diameter and height to 0.1 mm.
iv. Consolidation stress (kPa).
v. For consolidation phase:
   a. Plot of vertical stress against time;
b. Plot of axial strain against time

9.3 Standard Reporting for Monotonic Shear Test

i. Shearing rate (mm/min), for monotonic test.
ii. Plot of shear stress against shear strain;
iii. Plot of stress ratio against shear strain;
iv. Plot of vertical stress against shear strain;
v. Plot of pore pressure against shear strain;
vi. Plot of shear stress against effective vertical stress

9.4 Standard Reporting for Creep Test

i. Creep stress, in kPa
ii. Plots of shear stress against time (during ramping stage and for the whole duration of the test);
iii. Plots of shear strain against time (during ramping stage and for the whole duration of the test);
iv. Plots of normal stress against time (during ramping stage and for the whole duration of the test).
LABORATORY TESTING PROCEDURES

Laboratory testing of the tailings and foundation soils is undertaken according to the procedures provided in Table 1 and Table 2, respectively.

Table 1: Laboratory testing procedures for tailings characterisation

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<tr>
<td>Bulk Sample Preparation</td>
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<tr>
<td>Total Dissolved Solids Measurement of Bulk Sample</td>
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<td>Triaxial Testing</td>
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<td>Specimen Preparation</td>
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<tr>
<td>Moist Tamped Loose Specimen Preparation for Triaxial Testing</td>
<td>GAPMW 3.1.1</td>
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<tr>
<td>Moist Tamped Dense Specimen Preparation for Triaxial Testing</td>
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<td>Testing</td>
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<tr>
<td>Strain Controlled Triaxial Test of Moist Tamped Reconstituted Specimen Isotropically Consolidated</td>
<td>GAPMW 3.2.1</td>
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<td>Constant Shear Drained Test with Servo Stress Controlled</td>
<td>GAPMW 3.2.4</td>
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<td>Constant Shear Drained Test with Dead-Weight Stress Controlled</td>
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<td>Cyclic Direct Simple Shear Testing</td>
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<tr>
<td>Specimen Preparation</td>
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<tr>
<td>Moist Tamped Loose Specimen Preparation for Direct Simple Shear Testing</td>
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Table 2: Laboratory testing procedures for foundation soil characterisation

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<td>Bulk Sample Preparation</td>
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<td>Tube Sample Preparation</td>
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<td>Constant Rate of Strain Consolidation Test</td>
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<td>Intact Specimen Preparation for Triaxial Testing</td>
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<td>Strain Controlled Triaxial Test of Intact Specimen Isotropically Consolidated</td>
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Foundation Soils
GAPMW 1.1.4 – BULK SAMPLE PREPARATION

Scope
The purpose of this procedure is to provide the steps for preparation of a bulk sample to a target moisture content.

Equipment
The sample preparation was undertaken using a mixing tray.

Procedure
The sample preparation is undertaken using the following steps:

1) The received sample is emptied from the bucket and placed on a mixing tray (Figure 1).

2) The sample is mixed thoroughly and sealed in a sample bag. A subsample is taken to determine the initial moisture content of the sample.

3) Demineralised water is added to bring the sample to a target moisture content.

4) The sample is mixed thoroughly in the bag and left to cure. A subsample is taken to check the moisture content of the cured sample before testing.

Figure 1: Received sample placed on a mixing tray
GAPMW 1.2.1 – TUBE SAMPLE PREPARATION

Scope
The purpose of this procedure is to provide the steps for preparation of a tube sample for testing.

Equipment
The tube samples were extruded using a Geo-Con Universal Vertical Extruder (Figure 1).

Figure 1: Geo-Con tube sample extruder
Procedure
The sample preparation is undertaken using the following steps:

1) The end caps of the tube sample are removed, and the length of voids measured from both ends of the tube to estimate available sample length for testing.

2) The tube is inverted and positioned with the top facing downwards in the extruder.

3) The sample is slowly extruded from the bottom of the tube for triaxial and index testings. For direct simple shear and constant rate of strain consolidation testings, the sample is slowly extruded into a stainless-steel ring of the same diameter as the tube.

4) The extruded specimen is cut and trimmed to the required size for testing.

5) The trimmings are used for gravimetric water content measurements and the remaining trimmings sealed in a sample bag for index testing.

6) The tube is wrapped with cling film, covered with end caps and stored for further testing.

Pictures of this procedure are provided in Figure 2 to Figure 7.
Figure 5: Sample extruded for triaxial testing

Figure 6: Sample extruded into a stainless-steel ring for DSS and CRS testings

Figure 7: Trimming of specimen to required size for testing
GAPMW 1.2.2 – BLOCK SAMPLE PREPARATION

Scope
The purpose of this procedure is to provide the steps for preparation of a block sample for testing.

Equipment
The block samples were prepared using stainless-steel coring rings and scalpel (Figure 1).

![Stainless-steel coring ring and scalpel](image)

Figure 1: Stainless-steel coring ring and scalpel

Procedure
The sample preparation is undertaken using the following steps:

1) The box is opened from the top to access the block sample.

2) Specimens are carefully cored from the surface of the block sample using stainless-steel coring rings and a scalpel.

3) The cored specimens are cut and trimmed to the required size for testing. The trimmed specimens are wrapped with cling film and stored in a sealed bag.

4) The trimmings are used for gravimetric water content measurements and the remaining trimmings sealed in a sample bag for index testing.

5) The block sample is wrapped with cling film and aluminium foil. The top of the box is sealed, and the block sample stored for further testing.

Pictures of this procedure are provided in Figure 2 to Figure 6.
Figure 2: As received block sample

Figure 3: Accessing block sample from the top of box

Figure 4: Coring specimen from block sample
Figure 5: Cored specimens: before coring (left) and after coring (right)

Figure 6: Wrapping and sealing block sample after coring
GAPMW 2.1 – CONSTANT RATE OF STRAIN CONSOLIDATION TEST

Scope

The purpose of this procedure is to provide the steps for undertaking constant rate of strain (CRS) consolidation testing. CRS testing can be undertaken significantly faster than a conventional oedometer as the typical rule of loading stages of 24 hours duration is not required. During the test the specimen is loaded continuously maintaining an approximate constant axial strain rate. During axial loading, excess pore pressure is allowed to develop at the base of the specimen to allow inference of hydraulic conductivity and coefficient of consolidation. The hydraulic conductivity can be also directly measured by undertaking constant head permeability testing at different loading stages, from the base pump to the top surface of the specimen.

Equipment

The CRS test is undertaken in a GDS automatic oedometer device, with the software capable to undertake CRS testing. Testing is undertaken in accordance with ASTM D4186\(^1\). The device is provided of a 50kN load frame, fully enclosed stainless-steel cell, cell and base pumps, pore pressure differential transducer (PPT) mounted at the base of the cell, 5 mm spring-loaded LVDT displacement sensor and 32 kN capacity submersible load cell. The GDS automatic oedometer is illustrated in a picture and schematically in Figure 1. The GDS automatic oedometer device is equipped of a stepper motor driven unit controlled either manually or from a PC. A CRS cell is fitted on the loading pedestal. The CRS cell is similar to a conventional triaxial cell as both cells are closed to the external environment allowing the cell to be entirely filled with water. However, in a CRS cell the specimen is exposed to the cell pressure, while in a triaxial cell, the specimen is separated from the cell environment by a membrane.

![GDS load frame with stainless-steel CRS cell](image1)

![Schematic of CRS testing device](image2)

Figure 1: GDS load frame with stainless-steel CRS cell (left) and schematic of CRS testing device (right)

---

Procedure

The CRS test is undertaken in a 60 mm diameter specimen. The specimen is restrained by a stainless-steel ring provided of top and bottom porous stones and filter papers. The base is separated from the cell environment via a system of sealing O-rings, allowing to measure excess pore pressure at the base of the specimen during axial loading. The specimen is confined in a stainless-steel chamber with axial stresses measured by a submersible load cell. Vertical strain is measured with a LVDT, pressures are provided by 3 MPa capacity pumps, while the specimen base pressure is measured using a pore pressure transducer.

The test is undertaken using the following steps:

1) The base porous stone and filter paper are placed dry on the CRS base to prevent swelling of the specimen.
2) The specimen is extruded from the tube\(^2\) or cored from the block\(^3\) sample and placed within a stainless-steel CRS ring. The top end of the specimen is trimmed to form a flat surface.
3) The top porous stone and filter paper are placed dry on the top end of the specimen inside the CRS ring and the bottom end of the specimen is trimmed to the size required for the testing.
4) Trimmings are taken during specimen preparation from both ends of the specimen to enable measurement of the initial gravimetric water content.
5) The specimen mass is taken, and initial height measured using a digital calliper.
6) The specimen is placed on the base porous stone and filter paper.
7) The remaining CRS components including the sealing O-rings are assembled (Error! Reference source not found.).
8) The CRS cell is closed and a seating load of 10 kPa applied.
9) The test commenced, and the stress is increased to 25 kPa and left to consolidate under this load.
10) The cell is flushed with CO\(_2\) for approximately 1 hour and then flooded with deaired demineralised water under constant height conditions.
11) Back pressure is ramped up to 500 kPa over a period of time depending on material type under double drainage and constant height conditions. If the stress dropped below 25 kPa, the back pressure saturation is interrupted to bring the stress back to 25 kPa before continuing saturation.
12) Once back pressure saturation is completed, constant head permeability test is undertaken under 25 kPa constant stress.
13) The constant rate of strain test is undertaken by targeting an axial strain rate until a target stress is achieved. The strain rate is guessed based on material type with the intent to provide excess pore pressure ratio ($R_u = \frac{\text{excess pore pressure}}{\text{total stress}}$) within 3% – 15%.
14) Unloading and reloading loop from 400 kPa to 100 kPa is undertaken.
15) The constant rate of strain test is continued to a target vertical stress of 3000 kPa.

\(^2\) GAPMW 1.2.1 Tube Sample Preparation
\(^3\) GAPMW 1.2.2 Block Sample Preparation
16) Once the target vertical stress is achieved, the total vertical stress is maintained, and constant head permeability test is undertaken.

17) The specimen and cell pressures are finally unloaded, and the CRS disassembled.

Figure 2: CRS test device setup: base porous stone and filter paper (left), specimen in stainless-steel ring with top porous stone and filter paper (middle), sealing components assembled (right)
GAPMW 3.1.5 – Intact Specimen Preparation for Triaxial Testing

Scope

The purpose of this procedure is to prepare an intact (undisturbed) specimen for triaxial testing. The specimen is generally extruded from a tube or cored from a block sample.

Equipment

The preparation is undertaken using a scalpel, split mould and membrane stretcher (Figure 1). Standard triaxial end caps (Figure 2) are used in this procedure.

Figure 1: Scalpel and split mould to trim specimen (left) and membrane stretcher (right)

Figure 2: Standard triaxial end caps with porous stones and filter papers
**Procedure**

The following steps are undertaken to prepare the intact specimen:

1) The specimen extruded from the tube sample\(^1\) is trimmed to a height of approximately 2 times the specimen diameter using a scalpel and a split mould to hold the specimen.

2) Initial specimen mass is measured and the dimensions taken using a digital calliper measuring both diameter and height at different locations.

3) Porous stone and filter paper are placed dry (to reduce initial swelling) on the bottom end cap and the specimen is placed on top.

4) A membrane is placed around the specimen using a membrane stretcher and sealed to the bottom end cap with sealing grease and O-rings.

5) Top filter paper and porous stone are placed dry on the specimen. The top end cap is added and the membrane is sealed.

6) The triaxial device is assembled and the cell filled with water.

The typical specimen during and after preparation is shown in Figure 3.

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\(^1\) GAPMW 1.2.1 Tube Sample Preparation
GAPMW 3.3.1 – STRAIN CONTROLLED TRIAXIAL TEST OF INTACT SPECIMEN ISOTROPICALLY CONSOLIDATED

Scope

Triaxial testing involves the preparation of a cylindrical specimen of material, wrapped in an impervious membrane. A confining stress is then applied to the specimen, and the material allowed to come to equilibrium under the applied stress. The initial stress can either be isotropic (the same all around the specimen), or $K_0$, which typically involves a higher vertical stress than horizontal stress on the specimen.

The purpose of this procedure is to undertake a strain controlled triaxial test of intact specimen extruded from a tube sample. Tests are undertaken consolidating a specimen isotropically and sheared under undrained strain control conditions.

Equipment

The tests were undertaken using a standard GDS triaxial device (Figure 1) with 50 kN digital load frame, 3 MPa 200 cc pressure volume controllers, submersible load cell, pore pressure transducer and linear variable displacement transducer.

Figure 1: Standard GDS triaxial device
Procedure

The test is undertaken using the following steps:

1) The specimen is prepared using the intact specimen preparation procedure.

2) The cell and back pressure are increased to promote back pressure saturation of the specimen. Ramping of the cell and back pressure is undertaken typically within a period of 24 hours. A back pressure of 500 kPa was generally used. During this process, an approximate difference between cell and back pressure of 20 kPa is maintained, to prevent the specimen being subjected to significant effective stresses.

3) Once the target saturation back pressure is reached and volume change is negligible, degree of saturation is assessed performing a B-value check. For this, the specimen drainage valves are closed, and an all-around pressure is applied to the specimen while monitoring and recording the pore pressure response at the base of the specimen. All tests undertaken in this study obtained a B-value of 0.95 or greater.

4) The specimen is consolidated to the target stress in one step, via two stages, one undrained loading stage and a final drained dissipation stage. In the undrained loading stage, the specimen drainage valves are closed, and an isotropic confining pressure is applied to the specimen until the pore pressure response is steady. In the drained dissipation stage, the specimen drainage valves are opened to allow consolidation.

5) Once consolidation is complete, the specimen is sheared either drained or undrained depending on the desired test conditions. The specimen is generally sheared to a minimum of 20% axial strain or terminated before if significant deformation occurs.

6) After the test is completed, the specimen drainage valves are closed and the water in the cell is emptied.

7) The specimen is removed and end of test moisture content is taken. Area correction is applied based on the visually-observed shape of the deformed specimen at the end of shearing (i.e. right cylinder, parabola or slip plane).

The typical end of test specimen is provided in Figure 2.
Figure 2: End of test typical deformed specimen with a slip plane
GAPMW 4.1.2 – COMPACTED SPECIMEN PREPARATION FOR DIRECT SIMPLE SHEAR TESTING

Scope
The purpose of this procedure is to prepare a compacted specimen for direct simple shear (DSS) testing.

Equipment
The preparation was undertaken using a special DSS mould designed to allow preparation of compacted specimen. This mould allows to undertake preparation of a specimen with accurate height control during compaction. The DSS mould is shown in Figure 1.

Procedure
The specimen preparation is undertaken using the following steps:

1) The DSS is prepared with the rings and a latex membrane neatly fixed against the inner wall of the rings.
2) The top end platen is attached to the top cap of the mould and the DSS bolted to the base of the mould.
3) The sample is prepared to its optimum moisture content and placed inside the DSS.
4) The sample is compacted to a known density (98% of standard maximum dry density) in one layer by lowering the top cap of the mould. The height and volume of the specimen is pre-determined by the inner dimensions of the DSS in the mould.
5) The DSS with compacted specimen is removed from the mould and finished to assemble to the device.
6) The DSS device is assembled and the top platen is lowered down using the computer-controlled software to a given bedding load of generally 25 kPa.

Figure 1: DSS mould for preparation of compacted specimen
7) The DSS base is tightened via four screws located at each corner to the main device, the restraint arms to reduce specimen rotation during shear assembled and the test commenced.

The specimen preparation procedure is shown in Figure 2 to Figure 5.

Figure 2: DSS prepared with rings and membrane

Figure 3: DSS bolted to the base of mould (left) and top end platen attached to top cap of mould (right)
Figure 4: DSS specimen inside compactor mould: before compaction (left) and after compaction (right)

Figure 5: DSS device assembled with restraint arms mounted
GAPMW 4.1.3 – INTACT SPECIMEN PREPARATION FOR DIRECT SIMPLE SHEAR TESTING

Scope
The purpose of this procedure is to prepare an intact (undisturbed) specimen for direct simple shear (DSS) testing. The specimen is generally extruded from a tube or cored from a block sample.

Equipment
The preparation is undertaken using a scalpel and 60 mm diameter stainless-steel ring shown in Figure 1.

Figure 1: 60 mm diameter stainless-steel ring and scalpel

Procedure
The specimen preparation is undertaken using the following steps:

1) The specimen extruded from 63 mm diameter tube sample¹ is trimmed to a diameter of 60 mm using a scalpel and 60 mm diameter stainless-steel ring. The specimen from block sample² is cored directly into a 60 mm stainless-steel ring.

2) The top and bottom ends are trimmed to a specimen height of approximately 27 mm.

3) The specimen is placed on the bottom platen of the DSS and the latex membrane and rings are placed around the specimen.

4) The DSS device is assembled and the top platen is lowered down using the computer-controlled software to a given bedding load of generally 10 kPa.

5) The DSS base is tightened via four screws located at each corner to the main device, the restrain arms to reduce specimen rotation during shear assembled and the test commenced.

The specimen preparation procedure is shown in Figure 2 to Figure 5.

¹ GAPMW 1.2.1 Tube Sample Preparation
² GAPMW 1.2.2 Block Sample Preparation
Figure 2: Trimming specimen extruded from 63 mm diameter tube sample to 60 mm diameter

Figure 3: Trimmed specimen on DSS base platen (left) and covered with membrane (right)

Figure 4: DSS rings in place (left) and membrane folded outwards for DSS device assembly (right)
Figure 5: DSS device assembled with restrain arms mounted
**GAPMW 4.2.1 – MONOTONIC DIRECT SIMPLE SHEAR TEST**

**Scope**

Direct simple shear (DSS) testing involves preparation of a cylindrical specimen with a typical height to diameter ratio of about 0.4 within a membrane that is laterally constrained by a stack of low-friction metal rings. The material is vertically consolidated to the desired stress with or without an initial static shear stress (α, bias). Owing to the lateral restraint provided by the stack of rings, consolidation occurs under a $K_0$ condition (i.e. zero lateral strain). Once consolidation is completed, the specimen is sheared monotonically by moving the lower platen horizontally while the top platen remains still. Monotonic loading is analogous to static undrained loading, such as when undrained conditions initiate within contractive material.

It should be noted that while DSS testing provides undrained strength parameters, the test itself is not undrained. Rather than restrict drainage, constant volume conditions are enforced via computer control of the test. Should the specimen contract, the top platen would begin to move downwards, reducing the height of the specimen. However, the computer control system prevents this from occurring by reducing the vertical stress to maintain a constant height. The excess pore pressures that would have developed within the specimen can then be inferred from the changes in vertical stress required to maintain constant height. This testing method has been shown to provide the same results as tests with enforced drainage conditions (Finn 1985\(^1\), Dyvik et al. 1987\(^2\)).

**Equipment**

Specimens were tested using a GDS electro-mechanical dynamic cyclic simple shear (EMDCSS) system shown in Figure 1.

![GDS electro-mechanical DSS device](image1)

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The device is capable of carrying out DSS testing under monotonic and cyclic conditions. The GDS DSS base and top platens are specially designed to allow saturation to occur by applying a flow, generally from the bottom of the specimen to its top via a pump or a water reservoir. Leaks are prevented introducing a series of O-rings at the base and top of the DSS platens and by placement of a sealing agent.

DSS testing is undertaken in 60 mm diameter compacted (bulk) and intact (tube or block) specimens using dead zone end platens (Figure 2 and Figure 3).

![Figure 2: Schematic of DSS specimen between dead zone end platens](image)

![Figure 3: Dead zone end platen](image)
Procedure

The test is undertaken using the following steps:

1) A specimen is prepared according to the compacted\(^3\) or intact\(^4\) specimen preparation procedures.

2) The DSS device is assembled and the top platen is lowered down using the computer-controlled software to a given bedding load of generally 10 kPa.

3) The initial specimen height is calculated based on height calibration undertaken using a block of known height, and the test is commenced.

4) The specimen is consolidated to the vertical effective stress for saturation and water is flushed through the specimen from the base to the top. If the sample appears saturated, the saturation step is not undertaken.

5) The specimen is consolidated to the target vertical effective stress in stages.

6) The specimen is sheared monotonically at a strain rate of around 2% per hour.

7) Once the test is completed, the DSS is disassembled, the specimen removed and dried in a 110°C oven to obtain the mass of dry solids and moisture content of the specimen.

The typical end of test specimen is provided in Figure 4.

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\(^3\) GAPMW 4.1.2 Compacted Specimen Preparation for Direct Simple Shear Testing

\(^4\) GAPMW 4.1.3 Intact Specimen Preparation for Direct Simple Shear Testing
Tailings
GAPMW 1.1.2 – BULK SAMPLE PREPARATION

Scope

The purpose of this procedure is to provide the steps for preparation of a bulk sample to a homogeneous condition that is suitable for testing.

Equipment

The sample preparation was undertaken using a 40°C oven, drying trays and 2.36 mm opening size sieve.

Procedure

The sample preparation is undertaken using the following steps:

1) The received sample is emptied from the bucket, placed on drying trays and dried in a 40°C oven to a moisture content of around 7~12% or first prepared as a thick slurry by adding process water before drying.

2) The 40°C oven-dried moist sample is passed through a 2.36 mm opening size sieve, separating the agglomerates from the sieved material. The agglomerates are broken down by hand and re-sieved until all material passes through the sieve.

3) The sieved sample is mixed thoroughly and sealed in a sample bag for testing.

Pictures of this procedure are provided in Figure 1 to Figure 4.

Figure 1: Sample prepared as thick slurry
Figure 2: As received sample in drying trays

Figure 3: Sieving process

Figure 4: Sieved material
GAPMW 1.1.5 – TOTAL DISSOLVED SOLIDS MEASUREMENT OF BULK SAMPLE

Scope
The purpose of this procedure is to provide the steps to measure the total dissolved solids of a bulk sample.

Equipment
The test is undertaken using a funnel, filter paper, syringe and beakers.

Procedure
The test is undertaken using the following steps:

1) A subsample is taken from the sample prepared according to the bulk sample preparation procedure¹
2) The specimen is placed in a beaker and dried in the 110°C oven
3) A known amount of demineralised water is added to the oven-dried specimen, mixed thoroughly, and left to settle
4) Clear solution is decanted using a syringe and filtered into another beaker through a funnel
5) The mass of the decanted solution is taken and the solution dried in the 110°C oven to determine the salt (dissolved solids) content
6) The total dissolved solids in the bulk sample is calculated from the salt content of decanted solution, amount of added demineralised water and the initial dry mass of the specimen.

Pictures of this procedure are provided in Figure 1 and Figure 2.

Figure 1: Filter-funnel setup and specimen before decanting

¹ GAPMW 1.1.2: Bulk Sample Preparation
Figure 2: Decanted clear solution and specimen after decanting
GAPMW 3.1.1 – MOIST TAMPED LOOSE SPECIMEN PREPARATION FOR TRIAXIAL TESTING

Scope

The purpose of this procedure is to prepare a loose specimen using the moist tamping preparation technique for triaxial testing.

Equipment

The preparation is undertaken using a split mould to allow preparation of loose specimens of 72 mm diameter and 149 mm height.

To enable placement of a specimen into the freezer without transfer of the entire triaxial base, a specially designed modular base platen system is used. The modular base consists of:

1) A “cradle” that mounts to the triaxial base with a recess
2) A base platen that fits tightly within the cradle recess
3) A drainage line for the base of the specimen exiting from the side of the base platen
4) Additional valves connected to the top and bottom drainage lines, to allow sealing the specimen at locations closer than the outer drainage control valves of the triaxial cell and removal of the sample for freezing.

The split mould and modular base are shown in Figure 1 and Figure 2, respectively. The modular base and top cap are shown in Figure 3 to Figure 4.

Figure 1: Split mould schematic view
Figure 2: Split mould internal (left) and external view (right)

Figure 3: Modular base (left) and lubricated end platens (right)

Figure 4: Modular base with lubricated end platens (left) and top cap with lubricated end platens (right)
Procedure

The following steps are undertaken to prepare the loose moist tamped specimens:

1) Porous stones, filter papers and layers of trimmed latex membrane lubricated with high vacuum silicone grease are placed at the top and bottom end caps.

2) A cylindrical split mould is placed on the triaxial base pedestal with a membrane held against the walls of the mould by suction provided from a vacuum pump.

3) The sample is tamped using the undercompaction technique proposed by Ladd 1978\(^1\) to promote a homogenous density along the specimen height. In this procedure, the sample is compacted in eight layers of equal thickness and varying masses.

4) Specimens are prepared tamping the material within the mould in eight layers using an under-compaction percentage of 10% for the first (bottom) layer and 0% for the final (top) layer (Figure 5).

5) Once the specimen is tamped, the top cap is placed and a suction of maximum 20 kPa is applied to the specimen with a vacuum pump to enable the specimen shape to be maintained during mould removal and test setup.

6) Initial specimen dimensions are taken using a digital calliper measuring both diameter and height at different locations.

7) The triaxial device is assembled and the cell filled with water.

The under-compaction percentage adopted for the tamping of the loose specimens is provided in Figure 5. Pictures of this procedure are provided in Figure 6 to Figure 7.

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Figure 5: Under-compaction percent used for tamping of the loose specimens
Figure 6: Split moulds with membrane under suction (left) and during specimen preparation with scarified layer prior tamping of next layer (right)

Figure 7: Tamped specimen prior placement of top cap (left) and with top cap after removal of split mould (right)
GAPMW 3.1.2 – MOIST TAMPER DENSE SPECIMEN PREPARATION FOR TRIAXIAL TESTING

Scope
The purpose of this procedure is to prepare a dense specimen, while avoiding the application of significant compaction stresses that may lead to an overconsolidated specimen after subsequent consolidation in a triaxial cell. The specimen is compacted by combining drop height compaction with gentle vibration of the mould.

Equipment
The compaction mould is designed to prepare the specimen in 8 layers, each with a height of 18 mm. Specimens are prepared to an approximate height of 144 mm and diameter of 63 mm.

A suction top cap typically used for undertaking extension triaxial testing is used in this procedure. The suction cap is used to limit the rotation of the top cap during shearing, thus forcing shearing to occur vertically. This allows shearing to continue to high strains even after shear bands develop in dense specimens.

The compaction mould developed for this process is schematically illustrated in Figure 1 and shown in Figure 2 to Figure 6.

Figure 1: Tamper schematic view
Figure 2: View of different components of compactor: mould base platen with the inner sleeve (left), outer sleeve (middle) and adjustable height tamper with top platen to allow controlling the height (right)

Figure 3: Mould base platen with sandwich of paper filter, latex membrane and paper filter at its bottom

Figure 4: Tamper with top platen to allow controlling the tamping height
Figure 5: Tamper dismantled with various spacers

Figure 6: Tamper mounted with screws to allow dropping height control
Procedures

The following steps are undertaken to prepare the dense specimens:

1) The sample is prepared at a moisture content such that vibration will induce additional densification (i.e. wetter than typical moist tamping to produce loose samples)

2) Compaction is undertaken in eight layers using the Ladd undercompaction technique (Ladd 1978) with an under-compaction percentage of 5% to 10% for the first (bottom) layer and 0% for the final (top) layer (Figure 7).

3) A sandwich of filter paper, latex membrane and filter paper is placed at the bottom of the mould to prevent the specimen from bonding to the mould, which could lead to damage of the specimen during subsequent extrusion

4) The inner sleeve is placed at the bottom of the mould

5) The outer sleeve encasing the inner sleeve is screwed to the bottom platen

6) The first layer is placed and gently levelled

7) The tamper is placed on top of the sample and tamping is provided by dropping the tamper from a height of approximately 2 cm or less, until compaction via drop height can no longer occur

8) The mould is then gently vibrated by providing horizontal manual rotations until the tamper is in contact with the edges of the outer mould, thus indicating that the target height has been achieved

9) If free standing water is present on the specimen surface, this is removed with a syringe

10) The first tamper spacer is unscrewed to allow the second layer to be tamped to its target height

11) Steps 6 to 10 are repeated until all layers have been compacted

12) The screws at the bottom of the compaction mould are removed and the inner sleeve housing the specimen taken out

13) The tamper’s spacers are reassembled, the inner sleeve containing the specimen is placed within the tamper and left for a couple of hours to allow the draining of water from the specimen, thus allowing the specimen to become slightly unsaturated

14) The tamper is than used to extrude the specimen and the specimen trimmed as required to its target height for the testing

15) Initial specimen dimensions are taken using a digital calliper measuring both diameter and height at different locations

16) Porous stones, filter papers and layers of lubricated trimmed latex membrane are placed at the top and bottom end caps

17) A latex membrane is placed around the sample sealed by O-rings

18) The triaxial device is assembled and the cell filled with water.

The typical under-compaction percentage adopted for the tamping of the dense specimens is provided in Figure 7. Pictures of this procedure are provided in Figure 8 to Figure 10.

Figure 7: Typical under-compaction percent used for tamping of the dense specimens

Figure 8: Water at surface of sample at vibration of mould (left) and specimen after compaction inside inner sleeve
Figure 9: Specimen on top of tamper during water draining stage (left) and water draining from specimen (right)

Figure 10: Specimen extruded using tamper (left) and sample on triaxial base platen (right)
Figure 11: Specimen with suction top cap assembled and inside cell
Scope

Triaxial testing involves the preparation of a cylindrical specimen of material, wrapped in an impervious membrane. A confining stress is then applied to the specimen, and the material allowed to come to equilibrium under the applied stress. The initial stress can either be isotropic (the same all around the specimen), or $K_0$, which typically involves a higher vertical stress than horizontal stress on the specimen.

The purpose of this procedure is to undertake strain controlled triaxial test of specimen prepared using the moist tamping technique. The specimens are prepared using either the moist tamped loose or dense preparation procedures. Tests are undertaken consolidating a specimen isotropically and sheared under drained or undrained strain control conditions.

Equipment

The tests were undertaken using a standard GDS triaxial device (Figure 1) with 50 kN digital load frame, 3 MPa 200 cc pressure volume controllers, submersible load cell, pore pressure transducer and linear variable displacement transducer.

Figure 1: Standard GDS triaxial device
**Procedure**

The test is undertaken using the following steps:

1) The specimen is prepared using either the moist tamped loose\(^1\) or dense\(^2\) preparation procedures.

2) The moist tamped loose specimen is flushed with CO\(_2\) for approximately 1 hour, followed by flushing with deaired deionised water imposing a differential head of approximately 5 kPa from the bottom to the top of the specimen. Flushing is carried out until bubbles are no longer observed leaving the top of the specimen. Flushing with CO\(_2\) and deaired deionised water is not carried out for the dense specimens as these specimens are prepared in a near-saturated condition.

3) The cell and back pressure are increased to promote saturation of the material by forcing air into solution. Ramping of the cell and back pressure is undertaken typically within a period of six hours. During this process, an approximate difference between cell and back pressure of 20 kPa is maintained, to prevent the specimen being subjected to significant effective stresses.

4) Once the target saturation back pressure is reached, and volume change is negligible, degree of saturation is assessed performing a B-value check. For this, the specimen drainage valves are closed, and an all-around pressure is applied to the specimen while monitoring and recording the pore pressure response at the base of the specimen. All tests undertaken in this study obtained a B-value of 0.95 or greater, which indicated that the pore pressure response of the specimen was 95% or greater than of the applied load, indicating a material of sufficient saturation for testing.

5) The specimen is consolidated to the target stress in one step, via two stages, one undrained loading stage and a final drained dissipation stage. In the first stage, the specimen drainage valves are closed, and an isotropic confining pressure is applied to the specimen until the pore pressure response is steady. In the second stage, the specimen drainage valves are opened to allow consolidation.

6) Once consolidation is complete, the specimen is sheared either drained or undrained depending on the desired test conditions. The specimen is generally sheared to a minimum of 20% axial strain, to enable critical state conditions to be inferred where possible.

7) After the test is completed, the specimen drainage valves are closed and the water in the cell is emptied.

8) The specimen void ratio is determined by measuring moisture content at the end of test, adopting the freezing method (Sladen and Handford, 1987\(^3\)) which involves carefully removing the specimen from the triaxial apparatus and freezing the specimen with the membrane, caps and drainage lines attached to prevent any water loss.

9) Area correction is applied based on the visually-observed shape of the deformed specimen at the end of shearing (i.e. right cylinder or parabola).

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\(^1\) GAPMW 3.1.1 Moist tamped loose sample preparation for triaxial testing

\(^2\) GAPMW 3.1.2 Moist tamped dense specimen preparation for triaxial testing

Figure 2: End of test typical deformed specimen to a parabola shape (left) and right cylinder shape (right)

Figure 3: Frozen specimen before removal of membrane and caps (left) and after (right)
GAPMW 3.2.4 – CONSTANT SHEAR DRAINED TEST WITH SERVO STRESS CONTROLLED

Scope

The purpose of this procedure is to provide the steps for undertaking constant shear drained (CSD) testing using a stress servo controller.

Equipment

A standard triaxial GDS device with an additional a servo controller is used to undertake the CSD collapse testing (Figure 1). The servo controller is a DigiRFM device manufactured by GDS which enables direct connection of the load cell and load frame (Figure 2). This direct linkage greatly increases the response time of the load frame. The DigiRFM allows via adjustment of the PID setting to achieve a maximum speed of the load frame of over 90 mm/min if the specified load suddenly reduces.

Figure 1: View of the GDS triaxial device
Figure 2: View of DigiRFM servo-controller mounted at the back of the load frame

Procedure

The test is undertaken using the following steps:

1) A specimen is prepared to its target density and consistency using the loose moist tamping preparation procedure.

2) A suction of maximum 20 kPa is applied to the specimen with a vacuum pump to enable the specimen shape to be maintained during test setup.

3) Initial specimen dimensions are taken using a digital calliper measuring both diameter and height at different specimen locations.

4) The triaxial device is assembled and the cell filled with water.

5) The specimen is flushed with CO₂ for approximately one hour.

6) The specimen is then flushed with water imposing a differential head of approximately 5 kPa from the bottom to the top of the specimen; flushing is carried out until bubbles are no longer observed to emerge from the pipe connected to the top of the specimen.

7) Back pressure saturation is undertaken over ~3 hours, maintaining a mean effective stress of 20 kPa.

8) Once the target saturation back pressure is reached, and volume change is negligible, a B-check is undertaken targeting a B value greater than 95%.

9) The specimen is then unloaded over ~3 hours to a cell pressure of 0 kPa and back pressure of -20 kPa.

10) The cell water is drained, the cell removed, and the specimen dimension taken using a digital calliper, to allow a more accurate measurement of specimen diameter for subsequent anisotropic consolidation.

11) The specimen is then reloaded following step 7.

12) The specimen is slowly consolidated anisotropically (i.e. confining and deviator stress increased) to its target K₀. The confining stress increase occurs at an approximate rate of 5 kPa per hour.

13) Once the target consolidation pressure is achieved, the specimen is left under the target anisotropic stress conditions for approximately 24 hours.
14) The CSD stage is then commenced by slowly increasing the back pressure at a rate of 15 kPa per hour. Test data are captured at intervals of one second, to provide stress conditions as close to failure as practicable.

15) Once failure occurs the specimen drainage valves are closed, and specimen void ratio determined by measuring its moisture content at the end of test, adopting the freezing method (Sladen and Handford, 1987\(^1\)).

The CSD stage is video recorded with sound, to capture the rapid failure that initiates when the stress conditions reach the relevant instability stress ratio for the specimen’s state.

The testing steps are provided in a diagram shown in Figure 3.

**Figure 3: CSD testing steps diagram**

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GAPMW 3.2.5 – CONSTANT SHEAR DRAINED TEST WITH DEAD-WEIGHT STRESS CONTROLLED

Scope
The purpose of this procedure is to provide the steps for undertaking constant shear drained (CSD) testing using a ‘dead-weight’ hanger system.

Equipment
A standard triaxial GDS device has been modified to undertake CSD collapse testing using dead-weights. The adjustments made to the standard triaxial device to allow CSD test to be undertaken are indicated in Figure 1. The system in use for a CSD test is shown in Figure 2.

Figure 1: Front and side view of triaxial device modified for CSD testing using a dead-weights hanger system
Figure 2: CSD triaxial during testing

Procedure

The test is undertaken using the following steps:

1) A specimen is prepared to its target density and consistency.

2) A suction of maximum 20 kPa is applied to the specimen with a vacuum pump to enable the specimen shape to be maintained during test setup.

3) Initial specimen dimensions are taken using a digital calliper measuring both diameter and height at different specimen locations.

4) The triaxial device is assembled and the cell filled with water.

5) The dead-weights hanger system is connected to the loading ram. Its vertical travel is initially controlled by using the triaxial cross-bar to gently lower the loading ram and hanger system down when necessary to “dock” to the specimen.

6) The specimen is flushed with CO₂ for approximately one hour.
7) The specimen is then flushed with water imposing a differential head of approximately 5 kPa from the bottom to the top of the specimen; flushing is carried out until bubbles are no longer observed to emerge from the pipe connected to the top of the specimen.

8) Back pressure saturation is undertaken over ~3 hours, maintaining an effective stress of 20 kPa. During this stage the clamp locking the dead-weights hanger system is unlocked and the weights are progressively added to prevent the cell pressure from lifting the hanger system. By keeping a dead-weight slightly higher than that required to balance the cell pressure, the hanger remains in a constant position resting on the cross bar.

9) Once the target saturation back pressure is reached and volume change is negligible, a B-check is undertaken targeting a B value greater than 95%.

10) The specimen is then unloaded over ~3 hours to a cell pressure of 0 kPa and back pressure of -20 kPa.

11) The cell water is drained, the cell removed, and the specimen dimension taken using a digital calliper, to allow a more accurate measurement of specimen diameter for subsequent anisotropic consolidation.

12) The specimen is then reloaded following step 8.

13) The specimen is slowly consolidated anisotropically (i.e. deviator stress increased) to its target anisotropic stress conditions by adding weights to the hanger system. The application of load to the specimen is regulated through use of the cross bar, to prevent any rapid loading occurring during this process. The deviator stress increase occurs at an approximate rate of 12 kPa per hour (i.e. approximately 4 kg of weight per hour assuming a specimen diameter of 65 mm). Owing to the manual loading requirement, the anisotropic consolidation is undertaken in stages, i.e. 10 hours of loading during daytime and 14 hours of standby, maintaining a constant stress overnight.

14) Once the target consolidation pressure is achieved, the specimen is left under $K_0$ consolidation for 24 hours.

15) The CSD stage is then commenced by slowly increasing the back pressure at a rate of 10 kPa per hour. Test data are captured at intervals of 1 second, to provide stress conditions as close to failure as practicable.

16) Once failure occurs the specimen drainage valves are closed, and specimen void ratio determined by measuring its moisture content at the end of test, adopting the freezing method.

The CSD stage is video recorded with sound, to capture the rapid failure that initiates when the stress conditions reach the relevant instability stress ratio for the specimen’s state.

The testing steps are provided in a diagram shown in Figure 3.
STEP 1. Specimen preparation

STEP 2. Suction applied to specimen to maintain its shape

STEP 3. Initial specimen dimensions taken

STEP 4 and 5. Assembling of triaxial device and specimen docking

STEP 6 and 7. CO₂ and water flushing

STEP 8. Back pressure saturation

STEP 9. B-Check

STEP 10. Unloading back pressure

STEP 11. Disassembling of triaxial cell and measure of new specimen dimensions for $K_0$ consolidation

STEP 12. Reloading back pressure

STEP 13. Anisotropic consolidation (15 kPa/hour)

STEP 14. Standby consolidation under $K_0$ for 24 hours

STEP 15. CSD stage increasing back pressure to 10 kPa/hour

STEP 16. Void ratio determination

Figure 3: CSD testing steps diagram
GAPMW 3.4.2 – SHEAR WAVE VELOCITY MEASUREMENT USING BENDER ELEMENTS FOR TRIAXIAL TEST OF SPECIMEN CONSOLIDATED ANISOTROPICALLY

Scope

The purpose of this procedure is to provide the steps for measuring the shear wave velocity \( (V_s) \) of a triaxial specimen consolidated anisotropically using bender elements. When \( V_s \) and the bulk density \( (\rho_b) \) of the specimen at the time of measurement are known, the small strain shear modulus \( (G_0) \) can be determined by the following equation:

\[
G_0 = \rho_b \times V_s^2
\]

The shear wave velocity is calculated by recording the time \( (t) \) required for the wave to travel through the specimen from the bottom through the top. Rather than the length of the specimen, the travel distance is defined as the length between the tip of the bender elements or tip-to-tip distance \( (L_{tt}) \). Therefore, the shear wave velocity is calculated by the following equation:

\[
V_s = \frac{L_{tt}}{t}
\]

Figure 1 shows an example of a transmitted and received signal using bender elements.

![Figure 1: Transmitted and received signals using bender element system](image)

Different criteria have been explored to select the point at which the arrival time \( (t) \) occurs in a bender element system such as (A) first deflection, (B) first bump maximum, (C) zero after first bump, and (D) major first peak as shown in Figure 2 (Lee and Santamaria, 2005).
Shear Wave Velocity Measurement using Bender Elements for Triaxial Test of Specimen Consolidated Anisotropically

Figure 2: Different first arrival points as described by Lee and Santamarina, 2005

**Equipment**

A GDS wave function generator and data acquisition device is added to a standard triaxial GDS equipment. The triaxial cell is equipped with a pair of caps that have bender elements protruding from the centre of the caps as shown in Figure 3.

![Figure 3: Set of caps with bender elements](image)

When a voltage excitation is sent to one bender element, the element physically bends laterally (hence the name) creating a wave that propagates through the porous medium (triaxial specimen). When the other element receives the signal, it generates an electrical response. The transmitted signal deteriorates as it travels through the specimen requiring the received signal to be amplified. A computer program developed by GDS is used to control several features such as the period, amplitude and waveform of the input signal, the triggering mechanism (e.g. manual or configured), the amplification factor of the received signal, and data storage. The three main variables stored in a single file are; time, input signal, received signal.

**Procedure**

The test is undertaken using the following steps:

1) A specimen is prepared in accordance to the loose moist tamped triaxial preparation procedure, with the following exemptions:
   a) The standard caps are replaced with a pair of caps with bender elements
   b) A connection ring for the cell is required at the base to allow access of the connection ports for the bender element caps
c) Installation of the bender elements caps requires proper alignment during the setup

2) A suction of maximum 20 kPa is applied to the specimen with a vacuum pump to enable the specimen shape to be maintained during test setup.

3) Initial specimen dimensions are taken using a digital calliper measuring both diameter and height at different specimen locations

4) The triaxial device is assembled and the cell filled with water.

5) The specimen is flushed with CO$_2$ for approximately one hour.

6) The specimen is then flushed with water imposing a differential head of approximately 5 kPa from the bottom to the top of the specimen; flushing is carried out until bubbles are no longer observed to emerge from the pipe connected to the top of the specimen.

7) Back pressure saturation is undertaken over ~3 hours, maintaining a mean effective stress of 20 kPa.

8) Once the target saturation back pressure is reached, and volume change is negligible, a B-check is undertaken targeting a $B$ value greater than 95%.

9) The specimen is then unloaded over ~3 hours to a cell pressure of 0 kPa and back pressure of -20 kPa.

10) The cell water is drained, the cell removed, and the specimen dimension taken using a digital calliper, to allow a more accurate measurement of specimen diameter for subsequent anisotropic consolidation.

11) The specimen is then reloaded following step 7.

12) Using the BE program, the following parameters must be defined:
   a) Specimen height
   b) Data sampling frequency and time
   c) Amplification factor or gain (auto)
   d) Input signal waveform (sinusoidal), period (varies) and amplitude (14V)
   e) Wave type: compressional wave (P) or shear wave (S)
   f) Trigger type (manual)

13) The input signal is sent by pressing the trigger button.

14) Several periods are used to determine a range with a good quality signal.

15) At least three signals with different periods are recorded individually

16) The height of the specimen at the time of measurement is recorded.

17) The specimen is consolidation under anisotropic conditions targeting a $K_0$ of 0.6.

18) The process is repeated as many times as required, typically at the end of each consolidation stage generally every approximately 100 kPa mean effective stress. Arrival time and thus shear wave velocity can be obtained using the GDS program or during the data process analysis.

19) At the end of testing, the deviatoric stress is reduced to near zero stress to achieve near isotropic conditions allowing drainage of the specimen during the process.
20) After achieving steady conditions, confining stresses are further reduced to a confining effective stress of 20 kPa at the same time the back pressure is reduced to zero allowing the specimen to drain.

21) Following the reduction of stresses to 20 kPa, the cell pressure is reduced to zero and the back pressure to -20 kPa.

22) After the specimen achieves steady conditions the drainage valves are closed, and the cell is disassembled while the sample is under suction.

23) The end of test sample dimensions is taken using a digital calliper measuring both diameter and height at different locations to allow its comparison with the specimen void ratio inferred from the end of test freezing method (Sladen and Handford, 1987\(^2\)).

24) The top cap with the bender element is carefully removed and replaced with a standard cap provided of drainage valves.

25) The specimen is flipped upside down and the bottom cap is also replaced with a standard cap of drainage valves.

26) The specimen void ratio is determined by measuring its moisture content at the end of test, adopting the freezing method which involves freezing the specimen with the membrane, replaced standard caps and drainage lines attached.

The specimen at step 10 (specimen measurement after saturation prior to \(K_0\) consolidation) and step 23 (end of test specimen measurement) is shown in Figure 4.

Figure 4: Specimen condition prior to $K_0$ consolidation (left) and at end of test (right)
GAPMW 4.1.1 – MOIST TAMPERED LOOSE SPECIMEN PREPARATION FOR DIRECT SIMPLE SHEAR TESTING

Scope
The purpose of this procedure is to prepare a loose specimen using the moist tamping preparation technique for direct simple shear (DSS) testing.

Equipment
The preparation was undertaken using a special DSS mould designed to allow preparation of loose specimen and a suction pump. This mould allows to undertaking preparation of a specimen while allowing the membrane to be neatly fixed on the DSS rings by application of suction.

The GDS specimen preparation mould and the DSS mould while suction is applied are shown in Figure 1.

Procedure
The specimen preparation is undertaken using the following steps:

1) The DSS is prepared with the rings with a latex membrane neatly fixed against the walls of the mould by applying suction.

2) The sample is placed inside the DSS and tamped to a known density in one layer while applying suction. A stainless steel ring is used to facilitate placement of the material inside the DSS while tamping to the height of the last DSS ring.

3) The DSS device is assembled and the top platen is lowered down using the computer-controlled software to a given bedding load of approximately 10 kPa.

4) The suction is removed, and the specimen preparation mould dissembled.

5) The DSS base is tightened via four screws located at each corner to the main device, the restrain arms to reduce specimen rotation during shear assembled and the test commenced.

The specimen preparation procedure is shown in Figure 2 to Figure 5.
Figure 2: Placement of loose sample in DSS mould with stainless steel ring used to facilitate material placement.

Figure 3: Tamped specimen outside DSS device (left) and fitted on the DSS base while still under suction (right).
Figure 4: Top DSS platen lowered down to specimen surface (left) and with specimen preparation mould disassembled (right)

Figure 5: DSS device assembled without (left) and with (right) restrain arms mounted
GAPMW 4.2.2 – CYCLIC DIRECT SIMPLE SHEAR TEST

Scope

Direct simple shear (DSS) testing involves preparation of a cylindrical specimen with a typical height to diameter ratio of about 0.4 within a membrane which is laterally constrained by a stack of low-friction metal rings. The material is vertically consolidated to the desired stress with or without an initial static shear stress (\(\alpha\), bias). Owing to the lateral restraint provided by the stack of rings, consolidation occurs under a \(K_0\) condition (i.e. zero lateral strain). Once consolidation is completed, the specimen is sheared cyclically by moving the lower platen horizontally while the top platen remains still. Following cyclic loading, the specimen is sheared monotonically provide an indication of post-cyclic strength. This may, in some instances, provide an assessment of post-liquefaction strength.

It should be noted that while DSS testing provides undrained strength parameters, the test itself is not undrained. Rather than restrict drainage, constant volume conditions are enforced via computer control of the test. Should the specimen contract, the top platen would begin to move downwards, reducing the height of the specimen. However, the computer control system prevents this from occurring by reducing the vertical stress to maintain a constant height. The excess pore pressures that would have developed within the specimen can then be inferred from the changes in vertical stress required to maintain constant height. This testing method has been shown to provide the same results as tests with enforced drainage conditions (Finn 1985\(^1\), Dyvik et al. 1987\(^2\)).

Equipment

Specimens were tested using a GDS electro-mechanical dynamic cyclic simple shear (EMDCSS) system shown in Figure 1.

Figure 1: GDS electro-mechanical DSS device

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The device is capable of carrying out DSS testing under monotonic and cyclic conditions. The GDS DSS base and top platens are specially designed to allow saturation to occur by applying a flow, generally from the bottom of the specimen to its top via a pump or a water reservoir.

**Procedure**

The test is undertaken using the following steps:

1. A specimen is prepared according to the loose tamping preparation procedure in a 100 mm diameter specimen.
2. The specimen is consolidated to the vertical effective stress for saturation of generally 15 kPa and water is flushed through the specimen from the base to the top.
3. For tests without bias, the specimen is consolidated to the target vertical effective stress in stages. For tests with a bias, the specimen is consolidated to the target vertical and horizontal effective stresses by ramping at a vertical stress rate of 10 ~ 25 kPa/hour.
4. The specimen is sheared cyclically by applying a sinusoidal cyclic stress at a loading frequency of 1 Hz.
5. Once the cyclic shear stage is completed, a post-cyclic monotonic shearing stage is undertaken. For testing with bias that during cyclic loading reached the maximum positive shear strain of the device, a “reverse” post-cyclic monotonic shear stage is undertaken – i.e. where post-cyclic shearing is in the opposite direction the bias application.
6. Once the test is completed, the DSS is dissembled, the specimen removed and dried in a 110°C oven for moisture content measurement.

The typical end of test specimen is provided in Figure 2.

![Figure 2: End of test specimen](image-url)