GEOTECHNICAL INVESTIGATION REPORT
NORTH BURNETT WASTE MANAGEMENT FACILITIES
BIGGENDEN WASTE TRANSFER STATION

Prepared By SQS
For:
Baker Rossow Consulting Engineers Pty Ltd

SQS Job No: S20C-0043
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1.0 INTRODUCTION

This report presents the result of a geotechnical site investigation carried out by AMB Geotech t/a SQS for the proposed infrastructure upgrades to the existing waste transfer station in Biggenden.

Based on Client supplied information, it is understood that the upgrade is to comprise the construction of a waste unloading ramp and associated earth retaining structure up to 2.4m in height. Also proposed is an upgrade to existing pavements and construction of new pavements to service the waste unloading facility, as is the construction of a waste water application area.

The request and approval of the site investigation was provided by Baker Rossow Consulting Engineers Pty Ltd representative Mr Ben Harvey, herein referred to as the “Client”.

Fieldwork was carried out on 15th and 16th January 2020.

2.0 SCOPE OF WORKS

The objective of this report as outlined in SQS’s Proposal dated 26 November 2019, was to assess the subsurface soils at the site to provide information, discussion and/or recommendations on the following:-

✓ Details of regional and local geology, groundwater conditions at time of drilling

✓ Engineering logs of the subsurface profile observed in the BH’s including any fill thickness, depths to natural soils, ground water depths and depths to rock if encountered.

✓ Foundation design parameters for high level and deep (pile) footing systems including:
  o Estimates of typical expected characteristic ground surface movements due to soil volume change potential (Site classification to AS 2870).
  o Allowable bearing pressure at appropriate pad footing depths including predicted settlement
    ▪ Ultimate shaft adhesion (piles)
    ▪ Ultimate axial load bearing capacity, predicted settlement and lateral resistance (piles)
    ▪ Constructability considerations (eg. Liner, excavation conditions)

✓ Design parameters for permanent retaining structures

✓ Suitability of in situ materials as backfill source and earthworks recommendations
3.0 METHODOLOGY

Fieldwork was carried out on 17 and 18 January 2020 and comprised the auger drilling of 8 Test Bore Holes (BH-BPT1 to BH-BPT8) using a truck mounted rotary drilling rig (Hydrapower Trekker) fitted with a 100mm diameter Tungsten Carbide drill bit.

The BH target depths ranged between 0.8m and 1.5m for BH’s pertinent to the construction/upgrade of pavement and waste water application area.

BH’s pertinent to the proposed retaining wall footprint (BH-BTP4 and BH-BTP5) had a target depth of 6.0m, but were discontinued at drilling refusal depth in bedrock a depth of 4.1m and 3.4m respectively.

An additional BH was drilled to a depth of 0.6m approximately 1.0m downslope of BH-BPT8 to enable in-situ assessment of permeability. The soil permeability test was carried out at a depth intervals of 0.15m to 0.6m using a Talsma-Hallam “CL26100 Well Permeameter”. The permeameter is commercially produced and constructed to meet Australian Standard AS/NZS1547:2012.

The BH locations were positioned as close as practical to the location as requested by the Client representative, with BH coordinates recorded using a handheld GPS to an accuracy of approximately 5m.

Bulk sampling of material likely to form the subgrade of new pavements was carried in natural material recovered from BH’s BTP2 and BPT3.

The approximate BH locations are presented on the Site Plan attached in Appendix A.

Photographs of each BH location are presented in Appendix D.

In situ field testing and sampling comprised the following:-

- Standard Penetration (SPT) testing.
- Bulk sampling using a 300mm diameter auger of material likely to form the subgrade of proposed new pavements.
- Dynamic Cone Penetrometer (DCP) testing.
- Pocket Penetrometer (PP) testing on disturbed clay based soil clods (auger tailings) where encountered.
- Undisturbed sampling of cohesive clay based soil using 50mm diameter steel tubes (U50).

The soil profile observed in each BH borehole, field test results and sample depths were logged in the field by an experienced geotechnical engineering scientist. The corresponding engineering logs are presented as Borehole Reports attached in Appendix B. All depth measurements denoted on the logs and test results are in reference to the existing ground surface level at time of drilling.
4.0 RESULTS

4.1 Subsurface Conditions and Regional Geology

The soil profile encountered within the BH’s drilled at this site is presented below with a more detailed description of the soil profile and field test results presented as Borehole Reports attached in Appendix A.

Retaining Wall (BH’s BTP4 and BTP5)

BTP 4

- **FILL (existing working platform)**
  - The existing working platform comprise an approximate 0.1m thick layer of dense siltstone derived silty gravel based material, underlain by an additional 0.1m thick layer of dense basaltic derived sandy gravel. The existing working platform is underlain by;

- **Uncontrolled FILL with waste**
  - Comprised of loose to very loose silty sand based with inclusions of refuse including copper, glass, plastic and steel. Grading to a silty sand and sandy silt based material with fibrous organic inclusions inferred as decomposing green waste through the depth range of 0.7 to 0.9m material.

- **Uncontrolled clean fill (possibly water affected natural soil)**
  - At a depth of approximately 0.9m, a distinct transition to a clay based soil of medium to high was observed and continues to a depth of approximately 2.3m. The material composition is relatively clean i.e. with no observable artificial contaminants, however, the consistency varies from an initial assessment of very stiff and moist for approximately 0.2m thickness and is underlain by weaker very moist to wet clay of stiff consistency for approximately 0.4m (depth range 1.1m-1.5m). Below 1.5m, consistency increases to very stiff and continues to 2.3m.
  - On the basis of irregularities in both moisture content and consistency, the aforementioned clay based soil between the depth range 0.9m to 2.3m is assessed as likely to be locally sourced clean fill, or potentially water affected natural soil. Either way, due to inconsistencies with both moisture variation and consistency, load bearing ability through this strata is expected to be irregular and not suitable for support of any significant structure.

- **Residual Soil (extremely weathered siltstone)**
  - Encountered at a depth of 2.3m, the material is comprised of a hard but friable sandy clay based soil of medium to high plasticity derived from the in-situ weathering of underlying rock. The residual clay continues to a depth of approximately 2.6m and is underlain by:-

- **Siltstone (undivided Gympie Group Formation)**
  - Encountered at a depth of approximately 2.6m, the siltstone is described as distinctly weathered and very low strength, increasing too low to medium strength from about 3.4m and further increasing to inferred medium to high strength or stronger denoted by drilling refusal encountered at 4.3m.
  - The weathered siltstone is considered to accord with published geology data (Department of Resource Industries Queensland. Australia 1:250 000 Geological Series – MARYBOROUGH – SHEET SG 56-6, 1st Edition 1992, refers) which indicates that the site is underlain by Permian aged undivided Gympie Group Formation comprising mudstone, siltstone, sandstone, limestone, chert, basaltic to andesitic flows and pyroclastics.
The siltstone is also exposed at the surface alongside the drainage channel associate with the existing pavement near BH-BTP2. Photo 4.1A and Photo 4.1B refer.

**Photo 4.1A – Exposed siltstone. Looking north. Drill rig on BH BTP2**

**Photo 4.1B- Close up photo of fractured siltstone.**

**BTP 5**

- **FILL (existing working platform)**
  - The existing working platform comprise an approximate 0.1m thick layer of dense siltstone derived silty gravel based material, underlain by an approximate 0.1m thick band of silty sand, further underlain by a 0.1m thick layer of dense basaltic derived sandy gravel. The existing working platform is underlain by;

- **Uncontrolled FILL with waste**
  - Encountered at a depth of 0.3m, the material comprises very stiff to hard sandy gravelly clay based material grading to stiff at a depth of 0.8m with an excess of coarse gravel and plastic bag inclusions. This material continues to a depth of about 1.3m before transitioning into an inferred soft silt based soil with an excess of plastic bag inclusions. The uncontrolled waste fill is underlain by;

- **Residual Soil (extremely weathered siltstone)**
  - Encountered at a depth of 1.4m, the material is comprised of a hard but friable sandy clay based soil of medium to high plasticity derived from the in-situ weathering of underlying rock. The residual clay continues to a depth of approximately 2.8 and is underlain by:-

- **Siltstone (undivided Gympie Group Formation)**
  - Encountered at a depth of approximately 2.8m, the siltstone is described as distinctly weathered and very low to low strength, increasing too low to medium strength from about 3.1m and further increasing to inferred medium to high strength or stronger denoted by drilling refusal encountered at 3.4m.
Pavement (BTP1, BTP2 and BTP3)

- **FILL - Pavement Material (Roadbase)**

The material exposed at the surface of BTP1, BTP2 and BTP3 comprised dense sandy gravel based material forming the unsealed pavement wearing course with the following approximate thicknesses.

- BTP1 = 300mm
- BTP2 = 150mm
- BTP3 = 100mm

- **Uncontrolled FILL with waste (BTP1 only)**

Encountered below the existing pavement gravel in BTP1, the material comprises a clay based soil of medium to high plasticity and very stiff consistency with glass, plastic and ceramic tile inclusions observed below depths of approximately 0.8m, continuing to natural ground surface encountered at approximately 1.2m.

Uncontrolled fill was not observed within the depth range of BH BTP2 and BTP3.

- **Residual soil – (BTP1 and BTP 3)**

**BTP1**

Encountered at depth of approximately 1.2m in BH-BTP1, the soil is described as a hard silty sandy clay based soil of medium plasticity and continues to the BH termination depth of 1.5m.

**BTP3**

Encountered at a depth of approximately 0.1m, the soil is described and a hard, sandy gravelly clay based soil of medium plasticity derived from the in-situ weathering of underlying siltstone which was observed at a depth of approximately 0.7m

- **Siltstone (undivided Gympie Group Formation) (BTP2 and BTP 3)**

Forming the natural pavement subgrade in BPT 1 at a depth of approximately 150mm and encountered at a depth of approximately 0.7m in BH BTP3, the siltstone is described as distinctly weathered and very low to low strength to the BH-BTP3 termination depth of 1.5m. In BH-BTP2, an increase too low to medium strength was observed at a depth of approximately 1.2m, continuing to the BH termination depth of 1.5m.
Efluent Application Area (BTP6, BTP7 and BTP8)

BPT6 and BPT7

The soil profile encountered in BTP6 and BTP7 was reasonably consistent between the BH’s with dominant soils comprising uncontrolled clay based fill of stiff to very stiff consistency underlain by a matrix of medium plasticity clay with loose sand, gravel and refuse including glass wire and steel continuing to the BH termination depths.

BTP 6 was terminated at a depth of 0.8m due to concerns with possible contamination of auger tailing with asbestos containing material after a small fragment (approximately 10mm wide) of fibro cement was recovered. The Bore Hole was immediately backfilled with auger tailings upon sighting the fragment.

BTP 7 was discontinued at a depth of 1.0m.

BTP8

The dominant soil type forming the soil profile encountered in BTP8 comprised natural, hard, medium to high plasticity sandy clay based soil to the BH termination depth of 1.5m. Noteworthy outliers include a thin scree of silty sand at the surface <50mm thickness supporting grass and rootlets, with embedded cobbles to 80mm diameter.

4.2 Groundwater

Active groundwater seepages were not encountered during the drilling of BH’s on this site. However, very moist to wet soil (clay based inferred fill) was encountered in BTP4 between the depth range 1.1m to 1.5m.

Seepages should not be discounted especially at the fill/natural soil interface, near to underground services (stormwater sewerage and the like) particularly after heavy rain.

4.3 Laboratory Test Results

Geotechnical laboratory testing was performed at SQS’s NATA accredited laboratory and included laboratory assessment of quality of materials, 4-day soaked California Bearing Ratio (CBR) and soil moisture content. Laboratory test results are summarized below in Table 4.3, with the corresponding laboratory Test Reports attached in Appendix C.
### Table 4.3: Quality of Materials Test Report Summary

<table>
<thead>
<tr>
<th>BH No.</th>
<th>Sample Depth (m)</th>
<th>Soil Type</th>
<th>CBR (%)</th>
<th>% Silt/Clay Fines</th>
<th>% Sand/gravel</th>
<th>Liquid Limit %</th>
<th>Plastic Limit %</th>
<th>Plasticity Index</th>
<th>% Soil Moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTP2</td>
<td>0.2-0.5</td>
<td>Disturbed weathered siltstone (silty clayey GRAVEL)</td>
<td>2.0</td>
<td>27</td>
<td>73</td>
<td>33</td>
<td>12</td>
<td>21</td>
<td>7.1</td>
</tr>
<tr>
<td>BTP3</td>
<td>0.2-0.5</td>
<td>Sandy gravelly CLAY (CI)</td>
<td>3.0</td>
<td>50</td>
<td>50</td>
<td>39</td>
<td>12</td>
<td>27</td>
<td>10.0</td>
</tr>
<tr>
<td>BTP4</td>
<td>1.3-1.5</td>
<td>Silty CLAY (CI-CH) Inferred FILL</td>
<td>-</td>
<td>86</td>
<td>14</td>
<td>58</td>
<td>13</td>
<td>45</td>
<td>*14.1</td>
</tr>
<tr>
<td>BTP5</td>
<td>1.5-1.95</td>
<td>Sandy CLAY (CI) Residual Soil</td>
<td>-</td>
<td>66</td>
<td>34</td>
<td>44</td>
<td>25</td>
<td>19</td>
<td>18.9</td>
</tr>
</tbody>
</table>

- Denotes Not Tested

CI = Medium Plasticity Clay
ML = Low Plasticity Silt

* Test anomaly with regard to soil moisture. Considered to not accord with field description of very moist to wet.

Quality of Materials Test results were found to support the visual and tactile assessment of materials carried out in the field with exception of soil moisture on Sample BTP4 1.3m-1.5m. Tested soil moisture does not accord with the field description of very moist to wet.

### 4.4 Soil Permeability

Soil permeability was assessed from the results of constant head permeability tests carried out in BH BTP8 between the depth interval of 0.15m and 0.6m. Under existing site conditions, in-situ constant head permeability testing and assessment of soil textures indicate the presence of medium to high plasticity clay based soil to the depth range of the BH with a very low permeability. The results are presented in Table 4.4.

### Table 4.4: Soil Permeability and Soil Category

<table>
<thead>
<tr>
<th>BH No.:</th>
<th>Depth Range of Test (m)</th>
<th>Soil Classification</th>
<th>Indicative Permeability $K_{sat}$, m/day as defined in AS/NZS 1547:2000, Table 5.1</th>
<th>Measured Permeability as $K_{sat}$, m/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTP8</td>
<td>0.15-0.6</td>
<td>Sandy CLAY</td>
<td>&lt;0.06</td>
<td>&lt;0.01 m/day</td>
</tr>
</tbody>
</table>

The provided permeability evaluation is based on existing site conditions and in-situ field test result at the time of the assessment. No allowance has been made for any subsequent earthworks on the site or variability with regard to underlying material composition or properties.
5.0 GEOTECHNICAL CONSIDERATIONS

5.1 Foundations

5.1.1 Characteristic Ground Surface Movement- Retaining Wall (BTP4 and BTP5)

Site classification as defined by Australian Standards AS2870-2011 Residential Slabs and Footings, relates to residential type construction and may not be directly applicable for this development, however, it provides a valuable tool for assessment of expected propensity of characteristic ground surface movements associated with normal seasonal moisture variations that can be considered in the design of an appropriate footing system.

In the absence of documentation, including compaction and construction records, and considering the encountered materials and contaminants, the existing fill on site is necessarily assessed as constituting uncontrolled non-structural fill, being unsuitable in its present state as a as a foundation for any significant structure or as a subgrade for pavements. On this basis, the site is necessarily classified as Class ‘P’ site in accordance with AS 2870 “Residential Slabs and Footings”.

It is impossible to accurately assess the long term settlement regime of the fill at this site. Considering the consistency and constituents of the uncontrolled waste fill, there will be ongoing settlement particularly where significant organic matter, voids or potential oversized inclusions persist. Potential further fill settlements will vary across the site and will largely depend on the thickness of the underlying fill and any applied loads from the proposed structures and pavements.

5.1.2 High Level Footings

Building support using shallow strip and pad footings and pavements using conventional design are unsuitable for the site in its present condition due to the presence of waste fill. The use of high level footings as a retaining wall support and a conventional pavement design where underlain by uncontrolled filling would require significant site treatment work comprising:

- Excavation of the existing fill material at the site to a depth necessary to expose a competent natural basement comprising clay based soil of at least very stiff consistency in combination with;
- Construction of an engineered fill platform using a combination of existing clean fill material from the site and/or select fill from an external source.

Further details are presented in Section 5.2.3 of this report.

5.1.3 Deep Footing Systems

Footing systems for the proposed retaining wall and any significant structure constructed over uncontrolled fill at this site could consider a bored foundation system founding into natural soil. The use of driven piles is not recommended due to the likelihood of insufficient penetration achievable into weathered rock to resist potential uplift forces due to reactive soils.
Bored pile construction must consider constraints and potential impacts with respect to possible obstructions within the waste fill and potential for significant variation to the natural ground and material consistency presented in Section 4.1 of this report.

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Allowable End Bearing $F_b$ (kPa)</th>
<th>Allowable Skin Friction $F_{m,s}$ (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siltstone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Extremely Low Strength</td>
<td>500</td>
<td>25</td>
</tr>
<tr>
<td>- Very Low to Low Strength</td>
<td>600</td>
<td>30</td>
</tr>
<tr>
<td>- Low to Medium strength</td>
<td>750</td>
<td>50</td>
</tr>
<tr>
<td>- Medium to high strength (below drilling refusal)</td>
<td>1,600</td>
<td>150</td>
</tr>
</tbody>
</table>

Allowable geotechnical values for end bearing and shaft adhesion for bored pile design provided in this table have been based on the geotechnical strength reduction factor ($\phi_{gb}$) for low redundancy, very high risk applications which is specified in Table 4.3.2(C) of AS2159-2009. The geotechnical strength reduction factor applicable for this site has been taken as 0.4.

Based on the results of the investigation, the natural clay based soils and clay based fill are considered likely to be reactive with regard to volume change potential with significant swell pressures likely. On this basis, shaft adhesion on bored piles within uncontrolled fill and natural clay based soil (to a depth of at least 3.0m $H_s$ zone) should be ignored, due to the potential for soils to shrink away from the pile shaft when dry. Piles should also be adequately reinforced over their full length to resist tensile forces which act in the upper 3.0m of pile shafts due to swelling soils or soil jacking, a heave phenomenon that can occur in highly reactive soils particularly where there is a relatively deep seasonal moisture content variation. Subject to the further assessment of swell pressure potential or unless the clay soil forming the pile shaft sidewall is isolated using appropriate permanent pile sleeves, piles constructed within the reactive clay strata should be founded into weathered rock below the 3.0 ($H_s$) zone and incorporate a minimum socket length of at least 1.5 times the thickness of $H_s$ zone (4.5m socket below 3.0m) to reduce pile movements associated with swelling of the upper clays. Uplift stress should also be considered as acting on the base of a pile cap or slab when assessing pile structural capacity. Reference should be made to AS 2159 – 2009 which provides design advice for piles in expansive clays.

Isolation of the pile shafts using permanent pile sleeves and underside of suspended slabs, pile caps and beams from the reactive using appropriate void formers (min 150 mm) could be considered to minimise the length of pile required to resist uplift forces.

Settlement of piled footings is expected to be in the order of 0.5% of the pile width.

**Lateral Capacity**

The lateral capacity of a pile is provided by the passive resistance of the surrounding soil. The soils to a depth of 1.5 times the pile diameter below the excavated natural surface or minimum 1.0m into natural soil for this site should be ignored in the assessment of lateral capacity. The lateral capacity of piles may be determined using various methods, and which generally require an estimation of the Young’s modulus (Es) of the founding stratum. A Young’s modulus of 30 MPa and 200MPa may be adopted for the very stiff to hard clay and very low strength or stronger siltstone respectively.
5.1.4 Footings General

To achieve the recommended design parameters, footing excavations must be dry and cleaned of any loose, disturbed or saturated materials prior to pouring concrete.

If footings cannot be poured on the same day as the excavations, a concrete blinding layer of at least 50mm thickness is recommended.

Foundation excavations should be inspected by an SQS engineering representative or suitably experienced geotechnical engineer prior to concrete pouring confirm that the actual founding conditions reflect the expected conditions presented in this report and that the design bearing capacities are achieved.

If any soil conditions encountered during the footing excavations are found to differ from those noted in the geotechnical investigation, SQS should be notified immediately, and an inspection of the footing excavations should be carried out to assess if changes to footing design are required.

All existing and proposed footings should found such that they are not adversely affected by any adjacent excavations, batter slopes, trenches, or retaining walls that are not designed to support building or fill loads.

To minimise the potential for any adverse interaction effects, footings should found at least below a plane extending 1 m horizontally from the base of trenches/batter slopes/excavations/retaining walls, then rising up at 1V:1H. This requirement is illustrated in the following diagram.

5.2 Earthworks

5.2.1 Excavation Conditions

Excavations to the borehole termination depth should be achievable using conventional earthmoving equipment (e.g. large tracked excavators).

If cast in place piles are adopted for structural foundations, excavations to the borehole termination depths should be within the drilling excavation limits of typical piling plant, or 12 to 20 tonne excavator fitted with rock tooth pendulum type augers (subject to limit of reach).
Drilling piles is not only dependent on the material characteristics but also the type (power and size) of the bored pile drilling rig, drilling teeth, size of pile, etc. It is recommended that a specialist drilling contractor be consulted to be able to manage the above conditions and materials encountered. The requirement for core barrels is considered likely for excavation below drilling refusal depths.

Construction/drilling difficulties should be expected within the waste fill (wire, or other potential obstructions). The likelihood of encountering ground conditions which will require the use of temporary or permanent liners is considered high.

Screw piles may have an application, but a constraint with respect to obstructions within the waste fill remains.

It is recommended that a specialist drilling contractor be consulted to be able to manage the above conditions and materials encountered.

5.2.2 Batter slopes

Temporary excavation batters (up to 3 m vertical height) without loads behind the crest could be formed at 1V:3H in uncontrolled fill and 1V:1H in natural the very stiff to hard clay based soils and weathered rock. Permanent batters should not exceed 1V:4H in uncontrolled fill or 1V:2H in natural very stiff to hard soils and weathered rock.

Permanent batters should be suitably protected from erosion by methods such as establishment of vegetation or protective matting, and surface drains behind the crest.

Flatter batters or temporary support systems may be required if significant groundwater seepage is encountered or if exposed faces are not protected from erosion by rainfall. Flatter batters may also be required in the uncontrolled fill, depending on the nature of the fill. A geotechnical engineer should inspect cuts during construction to confirm the stability of excavation batters. Cut batters should be assessed prior to the cut depth exceeding 1.5 m and at similar depth intervals thereafter.

Shoring will be required to enable safe personnel entry into trenches (with vertical sides) deeper than 1 m.

The above recommendations do not supersede any existing safety regulations or legislation applicable to excavations (e.g. limits on personnel entry into trenches).

5.2.3 Filling

General

Any filling proposed as part of the earthworks should be carried out with Level 1 supervision and testing in accordance with Australian Standard 3798-2007 *Guidelines on Earthworks for Commercial and Residential Developments*. It is recommended that general fill should:

- be compacted at moisture contents within the range of ±2% of optimum moisture content for Standard Compaction.
- have a maximum particle size of 100 mm
- be placed in loose layers not exceeding 300 mm loose thickness
- be compacted to not less than 98% of Standard Maximum Dry Density (MDD) for pavement/slab areas, or 95% for general fill and service trench backfill.

Any imported fill should be free from deleterious material, oversize (>100 mm size) particles and organic matter and have a minimum CBR of 10% and a maximum plasticity index of 15%.
In accordance with good construction practice, fill embankments should be ‘over built’ then trimmed back to the well compacted material.

Further details for control and testing of fill are given in Australian Standard AS 3798-2007.

**Excavate and Replace Fill Option**

It is envisaged that stripping depths to remove the existing waste fill beneath the proposed retaining wall alignment will range between 1.4m to 2.3m. The lateral extent of striping should extend beyond the pavement or structural footprint for an appropriate distance to achieve the maximum recommended permanent batter slopes.

Prior to the placement of fill materials, the stripped ground surface must be moisture conditioned to approximate optimum soil moisture for compaction (OMC) and compacted to at least 95% SMDD. Where the stripped ground surface will form the subgrade for new roads or duplicate as building platforms the exposed natural surface should be proof rolled under the supervision of SQS using a static vehicle with a tare of at least 10t. Any areas demonstrating excessive movement should be excavated to expose a competent subgrade that passes proof rolling prior to further compaction of the subgrade and the placement and compaction of controlled fill.

The existing clean granular fill materials are considered to be suitable for incorporation into the new fill platforms. The natural clays may present difficulties with handling, placement, and compaction if the appropriate moisture content is not achieved, particularly if the soils are overly moist. It is recommended that clay materials won from excavations are used in the lower sections of the fill profile and overlain by more sandy material to reduce the impact of seasonal shrink-swell movement and site classification to AS2870-2011.

Any imported fill should be of select quality having a CBR of at least 10%, a shrink swell index (Iss) of less than 1%, maximum plasticity index of 15% and a maximum stone size not exceeding 100mm to enable compaction.

Fill should be spread (under level 1 supervision) in even layers of not more than 300mm loose thickness and compacted to achieve a SMDD density ratio of not less than 98%, (AS1289.5.1.1 refers) generally, but 100% along pavement subgrades.

For engineered fill as specified, the allowable bearing capacity may be taken as 150kPa.

Assuming that the structural fill platform is constructed in accordance with the aforementioned guidelines, and final design levels approximate existing elevations, the design of high level strips, pads and raft slabs could consider an equivalent ‘Class ‘M’ site classification in accordance with AS2870-2011 with ‘ys’ estimated to be in within the range of 20mm to 40mm, subject to appropriate quality control testing and inspection during construction.

**5.3 Retaining Structures**

Design for temporary shoring and permanent basement walls could be carried out using a triangular pressure distribution applicable to the wall type (i.e. active pressures for a cantilever wall or ‘at rest’ pressures for a propped wall).

Suggested design parameters are presented in Table 5.3 below for horizontal backfill materials. Wall design will also need to consider groundwater pressures, construction and in-service surcharge loads behind walls, adjacent footing loads (if any), sloping ground behind walls, and backfill compaction stresses.

Positive permanent drainage must be installed behind all walls unless they are designed for development of full hydrostatic pressures.
Table 5.3: Retaining Structure Design Parameters.

<table>
<thead>
<tr>
<th>Retained Material</th>
<th>Unit Weight (t/m³)</th>
<th>Friction Angle (Degrees)</th>
<th>K_a (Cantilever Wall)</th>
<th>K_o (Non yielding wall)</th>
<th>K_p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncontrolled waste fill</td>
<td>1.7</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Select engineered fill (refer section 5.2.3)</td>
<td>1.9</td>
<td>34</td>
<td>0.28</td>
<td>0.44</td>
<td>3.54</td>
</tr>
<tr>
<td>Very stiff to hard Clay</td>
<td>2.0</td>
<td>32</td>
<td>0.31</td>
<td>0.47</td>
<td>3.25</td>
</tr>
<tr>
<td>Weathered siltstone (very low strength or stronger)</td>
<td>2.1</td>
<td>36</td>
<td>0.28</td>
<td>0.44</td>
<td>3.54</td>
</tr>
</tbody>
</table>

5.1 Pavement Design Parameters and Recommendations

5.1.1 Pavements on natural subgrade

Laboratory CBR testing on the disturbed and re-compacted siltstone and clay based soils recovered from BTP2 and BTP3 returned CBR values ranging between 2% and 3%.

Based on the investigation results and our previous experience, the results are considered to reflect expected values for such material and are considered appropriate for preliminary design.

Design parameters for pavements will depend on the subgrade materials present after earthworks and the type, depth and quality of any fill used to bring the site to design levels. Further subgrade evaluation including further DCP testing and further CBR testing should be undertaken during the construction stage.

5.1.2 Pavements on uncontrolled fill

Conventional pavement design on uncontrolled fill at this site is not recommended due to the potential for unacceptable settlement. Possible solutions are contained herein.

Solution 1: Rigid Pavement

Fully suspend a concrete slab to structural engineer’s detail on a deep pile footing system using preliminary design parameters as given in Table 5.1.3 of this report.

Solution 2: Flexible Pavement on Controlled Fill

Pavements constructed over controlled select fill platforms, constructed as described in Section 5.2.3 of this report, may be designed using the characteristic soaked CBR value of the fill obtained by appropriate testing. Or CBR = 10% for select fill as specified.
Solution 3: Reinforced and Thickened Unsealed Pavement over Uncontrolled Fill

Consideration could be given to applying a design CBR of 1% for waste fill and incorporating a subgrade reinforcement involving the use of a suitable geofabric as a treatment process to reduce the potential differential settlements beneath the proposed pavement to a potentially manageable level, however, with acceptance that the possibility of unacceptably large total and differential settlements remains and that deformation of roadways may occur, requiring regular maintenance involving topdressing and regrading not to be discounted.

5.2 Drainage

Site grades should shed water and prevent ponding. Subsurface drains adjacent to slabs and pavements are recommended.

Collection/cut-off drains should be installed up-slope of all excavations, and surface run-off should be prevented from entering excavations.
6.0 REPORT LIMITATIONS

This report has been prepared in accordance with generally accepted geotechnical assessment practices for the exclusive use of the Client relating to the construction of the proposed development. This report is not to be reproduced except in full including all appendices, attached reports etc.

Should you require any further information or clarification of the foregoing, please contact:-

Ray Hicks (RPEQ):-
Ph. (07) 4668 9351 – Mob. 0428 187 579.
Email: rayh@brandoneng.com or;

Mario Rubinic (Geoscientist) on:-
Ph. (07)4668 9716 – Mob. 0439 504 682
Email: Mario.Rubinic@sqs.net.au
Ray Hicks of this office by telephoning 07 4668 9351 during business hours.

Yours faithfully

SOUTH QLD SOILS PTY. LTD.

____________________
R.J. HICKS
RPEQ 1149
APPENDIX A

Site Plan
North

Legend
Approximate (BH) Location

Client
Baker Rosnow Pty Ltd

Project
Geotechnical Investigation

Job No
523C-00043

Project Location
Biggenden Waste Management Facility

Drawing Title:
Site Plan/ Borehole Locations
Rev A

Drawn By: M. Rubinic

Fieldwork Date:
17 and 18 January 2020
APPENDIX C

Laboratory Test Reports
### BORE HOLE REPORT

**CLIENT:** Baker Rossow Consulting Engineers Pty Ltd

**PROJECT:** Geotechnical Investigation – North Burnett Waste Management Facilities

**LOCATION:** Biggenden Waste Transfer Station

---

#### SOIL DESCRIPTION (AS 1726)

<table>
<thead>
<tr>
<th>Hole Depth (m)</th>
<th>Soil Code</th>
<th>Soil Name</th>
<th>Consistency / Density</th>
<th>FIELD TEST / SAMPLES</th>
<th>DCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>GW</td>
<td>FILL</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GW</td>
<td>Pave</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.3</td>
<td>CI-CH</td>
<td>Clay</td>
<td>VSt</td>
<td>0.3-0.6 D Bag</td>
<td>9</td>
</tr>
<tr>
<td>0.8</td>
<td>CI-CH</td>
<td>Uncontrolled FILL with waste</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>CI</td>
<td>Residual</td>
<td>VSt-H</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**0.0 (FILL-Pavement)**

- **GW (FILL):** Sandy GRAVEL (roadbase)
  - Dense. Fine to coarse grained basaltic gravel. Fine to coarse grained sand. Grey. Dry
- **GW (Pavement):** As above but gravel comprised of siltstone.

**0.3 (CI-CH):** CLAY

- **Very st iff. Medium to high plasticity with fine to medium grained sand. Mottled grey and brown. Moist.**

**0.8 (CI-CH):** As above with glass, plastic and ceramics/tile inclusions. Orange brown.

**1.2 (CI):** Silty sandy CLAY.

- **Very stiff to hard but friable. Fine to coarse grained sand. Pale grey. Moist.**

**1.5 (CI):** Bore Hole discontinued at 1.5m. Target depth achieved.

---

**ADDITIONAL NOTES (seepages, delays etc.)**

- Active seepage or free water not encountered at time of drilling.

---

**Termination Depth (m):** 1.5

---

**Hydropower Trekker**

Active seepage or free water not encountered at time of drilling.

---

**Drill Rig**

- Hydropower Trekker
- Drill Method
- Termination Depth (m): 1.5

---

**LOGGED BY:**

MR

---

**Legend:**

- D: Disturbed sample
- Bulk: Bulk disturbed sample
- SPT: Standard Penetration Test
- U50: Undisturbed 50mm Tube
- PP: Pocket Penetrometer
- DCP: Dynamic Cone Penetrometer
- Active seepage/water inflow
- Active seepage/water inflow, water level at date/time shown

---

**Hydropower Trekker**

Active seepage or free water not encountered at time of drilling.
### SOIL DESCRIPTION (AS 1726)

<table>
<thead>
<tr>
<th>Hole Depth (m)</th>
<th>Soil Origin</th>
<th>Soil Code</th>
<th>Soil Description</th>
<th>Consistency / Density</th>
<th>FIELD TEST / SAMPLES</th>
<th>DCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>FILL</td>
<td>GW</td>
<td>Sandy GRAVEL (roadbase)</td>
<td>D</td>
<td>0.00 – 0.10</td>
<td>Drill</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dense. Fine to coarse grained basaltic gravel. Fine to coarse grained sand. Grey. Dry</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.15</td>
<td>Sampled</td>
<td>MSt</td>
<td>SILTSTONE</td>
<td>Bulk Sample</td>
<td>0.10 – 0.20</td>
<td>Refusal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Distinctly to slightly weathered. Very low strength (Inferred fractured). Auger tailings comprised of silty and clayey gravel with gravel fragments being assessed as ranging between very low to high strength. Fines and highly weathered gravel can be remoulded with water to form a medium plasticity clay. Pale grey. Moist-Dry (Low moisture content)</td>
<td>DW-SW/VLS</td>
<td>0.2-0.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bulk Sample</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td></td>
<td></td>
<td></td>
<td>SW</td>
<td>0.20 – 0.30</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>LS-MS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td></td>
<td></td>
<td></td>
<td>SW</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>LS-MS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### ADDITIONAL NOTES (seepages, delays etc.)

- **Termination Depth (m)**: 1.5
- **Hydrapower Trekker**: Active seepage or free water not encountered at time of drilling.
- **Drill Rig**: BH located 1.0m east of the west edge of pavement.

**Legend:**
- D = Disturbed sample
- Bulk = Bulk disturbed sample
- SPT = Standard Penetration Test
- USO = Undisturbed 50mm Tube
- PP = Pocket Penetrometer
- DCP = Dynamic Cone Penetrometer

**Logged By:** MR
## BORE HOLE REPORT

**CLIENT:** Baker Rossow Consulting Engineers Pty Ltd

**PROJECT:** Geotechnical Investigation – North Burnett Waste Management Facilities

**LOCATION:** Biggenden Waste Transfer Station

**Excavation/Drill Date:** 16 Jan 2020

**Easting:** 405127

**Northing:** 7179303

**RL:** Accuracy +/- 5

**MAP Ref:** 56J

**BH No.:** BTP3

---

### SOIL DESCRIPTION (AS 1726)

<table>
<thead>
<tr>
<th>Hole Depth (m)</th>
<th>Soil Origin</th>
<th>Soil Code</th>
<th>Soil Code Description</th>
<th>Consistency / Density</th>
<th>FIELD TEST / SAMPLES</th>
<th>DCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>FILL</td>
<td>GW</td>
<td>Sandy GRAVEL (roadbase 50mm)</td>
<td>Dense. Fine to coarse grained basaltic gravel. Fine to coarse grained sand. Grey. Dry</td>
<td>0.00 – 0.50</td>
<td>20 blows for 80mm</td>
</tr>
<tr>
<td>0.1</td>
<td>Residual</td>
<td>CI</td>
<td>Sandy gravelly CLAY</td>
<td>Hard. Medium plasticity. Fine to coarse grained sand and gravel. Mottled yellow-brown, brown and grey. Moist to dry (low moisture content).</td>
<td>PP 0.1</td>
<td>+600kPa</td>
</tr>
<tr>
<td>0.1</td>
<td>Residual</td>
<td>CI</td>
<td>Bulk Sample</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.7</td>
<td>Gympie Group Formation</td>
<td>MST</td>
<td>BILSTONE</td>
<td>Distinctly weathered. Very low strength. Pale grey and pale brown.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td></td>
<td></td>
<td>Bore Hole discontinued at 1.5m. Target depth achieved.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**ADDITIONAL NOTES (seepages, delays etc.)**

**Hydrapower Trekker:**
Active seepage or free water not encountered at time of drilling.

**Drill Method:**
100mm TC Bit, Open hole auger

---

**Termination Depth (m):** 1.5
### SOIL DESCRIPTION (AS 1726)

<table>
<thead>
<tr>
<th>Hole Depth (m)</th>
<th>Soil Origin</th>
<th>Soil Code</th>
<th>Soil Code</th>
<th>Soil Description (AS 1726)</th>
<th>Consistency / Density</th>
<th>Field Test / Samples</th>
<th>DCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>FILL</td>
<td>GP</td>
<td>Silty GRAVEL (siltstone derived roadbase)</td>
<td>Dense. Fine to coarse grained gravel and sand with low to medium plasticity fines. Pale brown. Moist</td>
<td>D</td>
<td>0.00 – 0.10</td>
<td></td>
</tr>
<tr>
<td>0.1</td>
<td>GW</td>
<td>Silty GRAVEL (basaltic roadbed)</td>
<td>Dense. Fine to coarse grained angular gravel and sand. Trace low plasticity fines. Grey. Moist</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.35</td>
<td>SM</td>
<td>Silty SAND</td>
<td>Inferred loose to very loose (rapid penetration of auger). Fine to coarse grained sand. Low plasticity fines with waste fill including copper, glass plastic and steel. Dark grey. Moist.</td>
<td>L-VL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.7</td>
<td>SM/ML</td>
<td>As above. High component of pale grey silt with fibrous organics (mulch/decomposing green waste).</td>
<td></td>
<td>L-VL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.9</td>
<td>CH/CI</td>
<td>Sandy CLAY</td>
<td>Stiff to very stiff. Medium to high plasticity. Fine to coarse grained sand. Trace of fine to coarse grained angular gravel. Brown mottled grey and yellow brown. Moist.</td>
<td>St-VSt</td>
<td>PP 0.9</td>
<td>240 kPa</td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>CI-CH</td>
<td>Sandy CLAY</td>
<td>Stiff. Medium to high plasticity. Trace of fine grained sand. Mottled pale brown and grey. Very moist to wet (high moisture content)</td>
<td>St</td>
<td>PP 1.1</td>
<td>150 kPa</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>CH/CI</td>
<td>Sandy CLAY</td>
<td>Very stiff. Medium to high plasticity. Fine to coarse grained sand. Mottled pale brown and grey. Moist.</td>
<td>VSt</td>
<td>US0 1.5-2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>CI-CH</td>
<td>Sandy CLAY (extremely weathered siltstone)</td>
<td>Hard but friable. Medium to high plasticity. Fine to coarse grained sand with fine to coarse grained gravel. Mottled grey and grey brown.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>MSI</td>
<td>Siltstone</td>
<td>Distinctly weathered. Very low to low strength. Pale grey and pale brown.</td>
<td>DWVLS</td>
<td>SPT 3.0-3.05</td>
<td>5 blows for 50mm penetration then bouncing</td>
<td></td>
</tr>
<tr>
<td>3.4</td>
<td>MSI</td>
<td>Siltstone</td>
<td>Distinctly to slightly weathered. Low to medium strength. Slow drilling.</td>
<td>DWLS-MS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>MSI</td>
<td>Total drilling refusal on inferred medium to high strength siltstone.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### ADDITIONAL NOTES (seepages, delays etc.)

- **Active seepage/water inflow**
- **Active seepage or free water not encountered at time of drilling.**

**Termination Depth (m):** 4.1

**Logged By:** MR
### SOIL DESCRIPTION (AS 1726)

<table>
<thead>
<tr>
<th>Hole Depth (m)</th>
<th>Soil Type</th>
<th>Soil Code</th>
<th>Consistency / Density</th>
<th>FIELD TEST / SAMPLES</th>
<th>DCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>FILL</td>
<td>GP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.1</td>
<td>SM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2</td>
<td>GW</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.3</td>
<td>CI/CH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.8</td>
<td>ML</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1.3</td>
<td>ML</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>CI-CH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.8</td>
<td>MS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>MS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.4</td>
<td>MS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### ADDITIONAL NOTES (seepages, delays etc.)

- **Active seepage or free water not encountered at time of drilling.**

**Drill Rig**

- Hydrapower Trekker

**Drill Method**

- 100mm TC Bit
- Open face auger

**Termination Depth**

- 3.4

**Legend:**

- D: Disturbed sample
- Bulk: Bulk disturbed sample
- SPT: Standard Penetration Test
- U50: Undisturbed 50mm Tube
- PP: Pocket Penetrometer
- DCP: Dynamic Cone Penetrometer
- Active seepage/water inflow
- Water level at date/time shown

- **Logged By:** MR
BORE HOLE REPORT

CLIENT: Baker Rossow Consulting Engineers Pty Ltd
PROJECT: Geotechnical Investigation – North Burnett Waste Management Facilities
LOCATION: Biggenden Waste Transfer Station

Excavation/Drill Date: 17 / Jan / 2020
PAGE ...1...of...1.... SQS Job No: S20C-0043

Easting: 405194
Northing: 7179458

BH No. BTP6
RL: 5
MAP Ref: 56J

CLIENT: Baker Rossow Consulting Engineers Pty Ltd

PROJECT: Geotechnical Investigation – North Burnett Waste Management Facilities

LOCATION: Biggenden Waste Transfer Station

SOIL DESCRIPTION (AS 1726)

<table>
<thead>
<tr>
<th>Hole Depth (m)</th>
<th>Soil Code</th>
<th>Soil Code</th>
<th>Soil</th>
<th>Description</th>
<th>Consistency / Density</th>
<th>FIELD TEST / SAMPLES</th>
<th>DCP</th>
<th>RESULT</th>
<th>Test Depth Range (m)</th>
<th>Blows</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>CI-CH</td>
<td>Uncontrolled fill with waste</td>
<td>Sandy CLAY (supporting surface grass and rootlets)</td>
<td>St</td>
<td>PP 0.1</td>
<td>0.10</td>
<td>2</td>
<td>0.00 – 0.10</td>
<td>0.10 – 0.20</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Stiff. Medium to high plasticity. Fine to coarse grained sand. Mottled grey and brown. Moist to wet (rainfall occurred day previous to investigation)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2</td>
<td>CI-CH</td>
<td>Silt CLAY</td>
<td>Very stiff. Medium to high plasticity with fine sand. Pale grey mottled yellow brown. Moist</td>
<td>VSt</td>
<td>PP 0.3</td>
<td>0.20</td>
<td>6</td>
<td>0.20 – 0.30</td>
<td>0.30 – 0.40</td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>CI/GP</td>
<td>Matrix of friable medium plasticity stiff to very stiff CLAY (extremely weathered siltstone fill) and fine to coarse grained GRAVEL and loose to very loose SAND with refuse including glass, wire, steel. Possible asbestos at 0.8m (fibro cement sheet fragment)</td>
<td>St-VSt</td>
<td>L-VL</td>
<td>0.50</td>
<td>11</td>
<td>0.50 – 0.60</td>
<td>0.60 – 0.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.60 – 0.70</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.70 – 0.80</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.80 – 0.90</td>
<td>1</td>
<td></td>
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<tr>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.90 – 1.00</td>
<td>8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Drill Rig

Hydrapower Trekker

Drill Method

100mm TC Bit
Open hole auger

ADDITIONAL NOTES (seepages, delays etc.)

Active seepage or free water not encountered at time of drilling.

Termination Depth (m) 0.8

Drill Rig

Hydrapower Trekker

Active seepage/water inflow

Termination Depth (m) 0.8

Legend:

D = Disturbed sample
Bulk = Bulk disturbed sample
SPT = Standard Penetration Test
US50 = Undisturbed 50mm Tube
PP = Pocket Penetrometer
DCP = Dynamic Cone Penetrometer

Active seepage/water inflow

Logged By MR

SOUTH QLD SOILS
### BORE HOLE REPORT

**CLIENT:** Baker Rossow Consulting Engineers Pty Ltd  
**PROJECT:** Geotechnical Investigation – North Burnett Waste Management Facilities  
**LOCATION:** Biggenden Waste Transfer Station

**Excavation/Drill Date:** 17 Jan 2020

---

<table>
<thead>
<tr>
<th>Hole Depth (m)</th>
<th>Soil Code</th>
<th>Soil Code</th>
<th>Soil Description (AS 1726)</th>
</tr>
</thead>
</table>
| 0.0           | CI-CH     | Uncontrolled Fill with waste | Sandy CLAY (supporting surface grass and rootlets)  
Stiff. Medium to high plasticity. Fine to coarse grained sand. Mottled grey and brown. Moist to wet (rainfall occurred day previous to investigation) |
| 0.3           | CI-CH     | Uncontrolled Fill with waste | Silty CLAY  
Very stiff. Medium to high plasticity with fine sand. Trace of ceramic tile. Pale grey mottled yellow brown. Moist |
| 0.5           | CI/GP/SP  | Inferred loose SAND and GRAVEL with refuse including glass, wire, steel |
| 1.0           |           | Bore Hole discontinued at 1.0m. Target depth achieved |

**Drill Rig:** Hydrapower Trekker  
**Drill Method:** 100mm TC Bit, Open hole auger

**ADDITIONAL NOTES (seepages, delays etc.)**  
Active seepage or free water not encountered at time of drilling.

**Termination Depth (m):** 1.0

**Logged By:** MR

**LEGEND:**  
D = Disturbed sample  
B = Bulk disturbed sample  
SPT = Standard Penetration Test  
US = Undisturbed 50mm Tube  
PP = Pocket Penetrometer  
DCP = Dynamic Cone Penetrometer

Active seepage/water inflow  
Water level at date/time shown

---

**Easting:** 405174  
**Northing:** 7179458  
**RL:** Accuracy +/- 5  
**MAP Ref:** 56J  
**BH No.:** BTP7
## BORE HOLE REPORT

**CLIENT:** Baker Rossow Consulting Engineers Pty Ltd  
**PROJECT:** Geotechnical Investigation – North Burnett Waste Management Facilities  
**LOCATION:** Biggenden Waste Transfer Station  
**Easting:** 405097  
**Northing:** 7179276  
**BH No.:** BTP8

### SOIL DESCRIPTION (AS 1726)

<table>
<thead>
<tr>
<th>Hole Depth (m)</th>
<th>Soil Code</th>
<th>Soil Origin</th>
<th>Soils</th>
<th>Soil Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>CI-CH</td>
<td>Residual</td>
<td>Sandy Clay</td>
<td>(supporting surface grass and rootlets – thin scree of silty sand) Hard. Medium to high plasticity. Fine to coarse grained sand. Trace of cobbles to 80mm just below surface. Trace of fine rounded gravel sized ferruginous concretions and angular and sub-rounded gravel. Brown mottled grey and orange brown. Moist-Dry (low moisture content)</td>
</tr>
<tr>
<td>0.8</td>
<td>CI-CH</td>
<td>Residual</td>
<td>Sandy Clay</td>
<td>As above but coarse grained component (sand and gravel) decreasing.</td>
</tr>
</tbody>
</table>

### FIELD TEST / SAMPLES

<table>
<thead>
<tr>
<th>Test Depth Range (m)</th>
<th>Test Type &amp; Depth</th>
<th>RESULT</th>
<th>Blows</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 – 0.10</td>
<td>PP 0.1 +500kPa</td>
<td>0.00</td>
<td>11</td>
</tr>
<tr>
<td>0.10 – 0.20</td>
<td></td>
<td>0.10</td>
<td>14</td>
</tr>
<tr>
<td>0.20 – 0.30</td>
<td></td>
<td>0.20</td>
<td>20</td>
</tr>
</tbody>
</table>

**HOLE DISCONTINUED** at 1.5m. Target depth achieved.

### ADDITIONAL NOTES (seepages, delays etc.)

**Active seepage or free water not encountered at time of drilling.**

**Termination Depth (m):** 1.5

---

**Drill Rig:** Hydrapower Trekker  
**Drill Method:** 100mm TC Bit  
**Active seepage/water inflow:**  
**Logged By:** MR

---

**LEGEND:**  
- D: Disturbed sample  
- B: Bulk sample  
- SPT: Standard Penetration Test  
- USO: Undisturbed 50mm Tube  
- PP: Pocket Penetrometer  
- DCP: Dynamic Cone Penetrometer  
- Active seepage/water inflow:  
- Water level at date/time shown:
APPENDIX B

Bore Hole Reports
Material Test Report

Client: BAKER ROSSOW CONSULTING ENGINEERS
PO BOX 1382
TOOWOOMBA QLD 4350

Project: Biggebden Waste Transfer Station

Sample Details

Sample ID: S205-282
Test Request No: S20C-0043
Sampled By: Mario Rubinic
Sampling Method: AS1289.1.2.1 Clause 6.5.3
Date Sampled: 17/01/2020
Source: Insitu
Material: Insitu
Specification: All Purpose Grading
Material Description: Refer Log
Location: BTP 2, 0.2 0.5

Other Test Results

<table>
<thead>
<tr>
<th>Description</th>
<th>Method</th>
<th>Result</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample History</td>
<td>AS 1289.1.1</td>
<td>Oven-dried</td>
<td></td>
</tr>
<tr>
<td>Preparation</td>
<td>AS 1289.1.1</td>
<td>Dry Sieved</td>
<td></td>
</tr>
<tr>
<td>Linear Shrinkage (%)</td>
<td>AS 1289.3.4.1</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td>Mould Length (mm)</td>
<td></td>
<td>249.8</td>
<td></td>
</tr>
<tr>
<td>Crumbling</td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Curling</td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Cracking</td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Liquid Limit (%)</td>
<td>AS 1289.3.1.2</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Plastic Limit (%)</td>
<td>AS 1289.3.2.1</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Plasticity Index (%)</td>
<td>AS 1289.3.3.1</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Date Tested</td>
<td></td>
<td>22/01/2020</td>
<td></td>
</tr>
<tr>
<td>Moisture Content (%)</td>
<td>AS 1289.2.1.1</td>
<td>7.1</td>
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</tr>
<tr>
<td>Date Tested</td>
<td></td>
<td>22/01/2020</td>
<td></td>
</tr>
</tbody>
</table>

Particle Size Distribution

Method: AS 1289.3.6.1
Drying by: Oven
Date Tested: 21/01/2020
Note: Sample Washed

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.2mm</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>9.5mm</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>6.7mm</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>4.75mm</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>2.36mm</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>1.18mm</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>600µm</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>425µm</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>300µm</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>150µm</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>75µm</td>
<td>27</td>
<td></td>
</tr>
</tbody>
</table>

Chart

<table>
<thead>
<tr>
<th>% Passing</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>0</td>
</tr>
</tbody>
</table>

Comments

N/A

Form No: 18909, Report No: MAT:S205-282
© 2000-2018 QESTLab by SpectraQEST.com
California Bearing Ratio Test Report

Client: BAKER ROSSOW CONSULTING ENGINEERS
PO BOX 1382
TOOWOOMBA QLD 4350

Project: Biggebden Waste Transfer Station

Sample Details
Location: 
Sample ID: S205-282
Date Sampled: 17/01/2020
Sampled By: Mario Rubinic
Sampling Method: AS1289.1.2.1 Clause 6.5.3
Source: Insitu
Material: Sub-grade
Specification: All Purpose Grading
Sample Description: Siltstone
Tested By: Matthew Edwards
Date Tested: 24/01/2020
TRN: S20C-0043
Sample Location: BTP 2, 0.2 0.5

Test Results

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBR at 5.0mm (%)</td>
<td>2.0</td>
</tr>
<tr>
<td>Dry Density before Soaking (t/m³)</td>
<td>1.91</td>
</tr>
<tr>
<td>Moisture Content before Soaking (%)</td>
<td>11.6</td>
</tr>
<tr>
<td>Swell (%)</td>
<td>0.0</td>
</tr>
<tr>
<td>Moisture Content of Top 30mm (%)</td>
<td>16.6</td>
</tr>
<tr>
<td>Moisture Content of Remaining Depth (%)</td>
<td>15.2</td>
</tr>
</tbody>
</table>

Load vs Penetration

Comments
California Bearing Ratio Test Report

Client: BAKER ROSSOW CONSULTING ENGINEERS
PO BOX 1382
TOOWOOMBA QLD 4350

Project: Biggebden Waste Transfer Station

Sample Details
Location: S205-283
Sampled By: Mario Rubinic
Sample ID: S205-283
Date Sampled: 16/01/2020
Sampling Method: AS1289.1.2.1 Clause 6.5.3
Material: Sub-grade

Tested By: Matthew Edwards
Date Tested: 24/01/2020
Sample Description: Sandy Clay

Test Results

<table>
<thead>
<tr>
<th>Test</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBR at 2.5mm (%)</td>
<td>3.0</td>
</tr>
<tr>
<td>Dry Density before Soaking (t/m³):</td>
<td>1.78</td>
</tr>
<tr>
<td>Density Ratio before Soaking (%)</td>
<td>97.5</td>
</tr>
<tr>
<td>Moisture Content before Soaking (%)</td>
<td>15.3</td>
</tr>
<tr>
<td>Moisture Ratio before Soaking (%)</td>
<td>101.5</td>
</tr>
<tr>
<td>Dry Density after Soaking (t/m³):</td>
<td>1.77</td>
</tr>
<tr>
<td>Density Ratio after Soaking (%)</td>
<td>96.5</td>
</tr>
<tr>
<td>Swell (%)</td>
<td>0.5</td>
</tr>
<tr>
<td>Moisture Content of Top 30mm (%)</td>
<td>22.2</td>
</tr>
<tr>
<td>Moisture Content of Remaining Depth (%)</td>
<td>19.9</td>
</tr>
<tr>
<td>Compaction Hammer Used:</td>
<td>Standard</td>
</tr>
<tr>
<td>Performed:</td>
<td>AS 1289.5.1.1</td>
</tr>
<tr>
<td>Surcharge Mass (kg):</td>
<td>4.50</td>
</tr>
<tr>
<td>Period of Soaking (Days):</td>
<td>4</td>
</tr>
<tr>
<td>Retained on 19 mm Sieve (%):</td>
<td></td>
</tr>
<tr>
<td>CBR Moisture Content Method:</td>
<td>AS 1289.2.1.1</td>
</tr>
<tr>
<td>Sample Curing Time (h):</td>
<td>49</td>
</tr>
<tr>
<td>Plasticity Determination Method:</td>
<td>AS 1289.3.1.2</td>
</tr>
</tbody>
</table>

Comments

Form No: 18986, Report No: CBR:S205-283
© 2000-2018 QESTLab by SpectraQEST.com
# Material Test Report

**Client:**
BAKER ROSSOW CONSULTING ENGINEERS  
PO BOX 1382  
TOOWOOMBA QLD 4350

**Project:** Biggebden Waste Transfer Station

---

### Sample Details

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>S205-283</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Request No</td>
<td>S20C-0043</td>
</tr>
<tr>
<td>Sampled By</td>
<td>Mario Rubinic</td>
</tr>
<tr>
<td>Sampling Method</td>
<td>AS1289.1.2.1 Clause 6.5.3</td>
</tr>
<tr>
<td>Date Sampled</td>
<td>16/01/2020</td>
</tr>
<tr>
<td>Source</td>
<td>Insitu</td>
</tr>
<tr>
<td>Material</td>
<td>Insitu</td>
</tr>
<tr>
<td>Specification</td>
<td>All Purpose Grading</td>
</tr>
<tr>
<td>Material Description</td>
<td>Refer Log</td>
</tr>
<tr>
<td>Location</td>
<td>BTP 3, 0.2 - 0.5</td>
</tr>
</tbody>
</table>

### Particle Size Distribution

- **Method:** AS 1289.3.6.1
- **Drying by:** Oven
- **Date Tested:** 21/01/2020
- **Note:** Sample Washed

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5mm</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>6.7mm</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>4.75mm</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>2.36mm</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>1.18mm</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>600μm</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>425μm</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>300μm</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>150μm</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>75μm</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>

### Other Test Results

<table>
<thead>
<tr>
<th>Description</th>
<th>Method</th>
<th>Result</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample History</td>
<td>AS 1289.1.1</td>
<td>Oven-dried</td>
<td></td>
</tr>
<tr>
<td>Preparation</td>
<td>AS 1289.1.1</td>
<td>Dry Sieved</td>
<td></td>
</tr>
<tr>
<td>Linear Shrinkage (%)</td>
<td>AS 1289.3.4.1</td>
<td>11.0</td>
<td></td>
</tr>
<tr>
<td>Mould Length (mm)</td>
<td></td>
<td>249.9</td>
<td></td>
</tr>
<tr>
<td>Crumbling</td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Curling</td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Cracking</td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Liquid Limit (%)</td>
<td>AS 1289.3.1.2</td>
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<td></td>
</tr>
<tr>
<td>Plastic Limit (%)</td>
<td>AS 1289.3.2.1</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Plasticity Index (%)</td>
<td>AS 1289.3.3.1</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Date Tested</td>
<td></td>
<td>22/01/2020</td>
<td></td>
</tr>
<tr>
<td>Moisture Content (%)</td>
<td>AS 1289.2.1.1</td>
<td>10.0</td>
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</tr>
<tr>
<td>Date Tested</td>
<td></td>
<td>22/01/2020</td>
<td></td>
</tr>
</tbody>
</table>

### Chart

- Graph showing particle size distribution with % passing on the y-axis and sieve size on the x-axis.

### Comments

N/A
Material Test Report

Client: BAKER ROSSOW CONSULTING ENGINEERS
PO BOX 1382
TOOWOOMBA QLD 4350

Project: Biggebden Waste Transfer Station

Sample Details
Sample ID: S205-318
Test Request No: S20C-0043
Sampled By: Mario Rubinic
Sampling Method: AS1289.1.2.1 Clause 6.5.3
Date Sampled: 17/01/2020
Source: In situ
Material: In situ
Specification: All Purpose Grading
Material Description: Refer Log
Location: BTP 4, 1.3 - 1.5

Other Test Results

<table>
<thead>
<tr>
<th>Description</th>
<th>Method</th>
<th>Result</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample History</td>
<td>AS 1289.1.1</td>
<td>Oven-dried</td>
<td></td>
</tr>
<tr>
<td>Preparation</td>
<td>AS 1289.1.1</td>
<td>Dry Sieved</td>
<td></td>
</tr>
<tr>
<td>Linear Shrinkage (%)</td>
<td>AS 1289.3.4.1</td>
<td>13.0</td>
<td></td>
</tr>
<tr>
<td>Mould Length (mm)</td>
<td></td>
<td>250.2</td>
<td></td>
</tr>
<tr>
<td>Crumbling</td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Curling</td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Cracking</td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Liquid Limit (%)</td>
<td>AS 1289.3.1.2</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>Plastic Limit (%)</td>
<td>AS 1289.3.2.1</td>
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<tr>
<td>Plasticity Index (%)</td>
<td>AS 1289.3.3.1</td>
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<td></td>
</tr>
<tr>
<td>Date Tested</td>
<td></td>
<td>29/01/2020</td>
<td></td>
</tr>
<tr>
<td>Moisture Content (%)</td>
<td>AS 1289.2.1.1</td>
<td>14.1</td>
<td></td>
</tr>
<tr>
<td>Date Tested</td>
<td></td>
<td>22/01/2020</td>
<td></td>
</tr>
</tbody>
</table>

Particle Size Distribution
Method: AS 1289.3.6.1
Drying by: Oven
Date Tested: 23/01/2020
Note: Sample Washed

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.75mm</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>2.36mm</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>1.18mm</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td>600µm</td>
<td>97</td>
<td></td>
</tr>
<tr>
<td>425µm</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>300µm</td>
<td>93</td>
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</tr>
<tr>
<td>150µm</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td>75µm</td>
<td>86</td>
<td></td>
</tr>
</tbody>
</table>

Chart

Comments
N/A
Material Test Report

Client: BAKER ROSSOW CONSULTING ENGINEERS  
PO BOX 1382  
TOOWOOMBA QLD 4350  

Project: Biggebben Waste Transfer Station

Sample Details

Sample ID: S205-319  
Test Request No: S20C-0043  
Sampled By: Mario Rubinic  
Sampling Method: AS1289.1.2.1 Clause 6.5.3  
Date Sampled: 17/01/2020  
Source: Insitu  
Material: Insitu  
Specification: All Purpose Grading  
Material Description: Refer Log  
Location: BTP 5, 1.5 - 1.95

Particle Size Distribution

Method: AS 1289.3.6.1  
Drying by: Oven  
Date Tested: 23/01/2020  
Note: Sample Washed

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.75mm</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>2.36mm</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td>1.18mm</td>
<td>81</td>
<td></td>
</tr>
<tr>
<td>600µm</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>425µm</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>300µm</td>
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<td>150µm</td>
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<td>75µm</td>
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</table>

Other Test Results

<table>
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<tr>
<th>Description</th>
<th>Method</th>
<th>Result</th>
<th>Limits</th>
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<tbody>
<tr>
<td>Sample History</td>
<td>AS 1289.1.1</td>
<td>Oven-dried</td>
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<tr>
<td>Preparation</td>
<td>AS 1289.1.1</td>
<td>Dry Sieved</td>
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</tr>
<tr>
<td>Linear Shrinkage (%)</td>
<td>AS 1289.3.4.1</td>
<td>12.0</td>
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</tr>
<tr>
<td>Mould Length (mm)</td>
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<td>149.8</td>
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<tr>
<td>Crumbling</td>
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<tr>
<td>Curling</td>
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<tr>
<td>Cracking</td>
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<tr>
<td>Liquid Limit (%)</td>
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<td>Plastic Limit (%)</td>
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<td>Plasticity Index (%)</td>
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<tr>
<td>Date Tested</td>
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<td>29/01/2020</td>
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<tr>
<td>Moisture Content (%)</td>
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Chart

Comments

N/A
APPENDIX D

Site Photographs
<table>
<thead>
<tr>
<th>BTP1- 1 – Looking north</th>
<th>BTP1 – Looking south</th>
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<tbody>
<tr>
<td>BTP2 - Looking north</td>
<td>Looking north. Drill rig over BPT2. Exposed siltstone in side drain</td>
</tr>
<tr>
<td>BTP3 – Looking north</td>
<td>BTP3 – Looking east</td>
</tr>
</tbody>
</table>

Looking north. Drill rig over BPT2. Exposed siltstone in side drain
BTP4 – looking west/northwest

BTP5 – Looking north/northwest

BTP6 - Looking south

BTP7 - Looking north

BTP8 – Looking north. Permeameter over BTP8

BTP8 – Looking south. Permeameter to right side of middle tree