Geotechnical Investigation and Salinity Assessment
18-24 Allawah Street, Blacktown

Prepared for:

Great Western Pty Ltd

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1 Introduction

The following report outlines the findings of a combined preliminary site geotechnical investigation and site salinity assessment carried out for the properties located at 18 – 24 Allawah Street, Blacktown. The geotechnical investigation and salinity assessment has been undertaken by Witt Consulting at the request of Great Western Pty Ltd.

We understand that the subject sites are part of a parcel of land proposed for a high density residential development. We understand that the proposed development comprises of 137 units over six levels above ground level with a double level basement carpark. Construction of the lower level of the basement will require excavation works to approximately RL 46.6 m. This will result in a maximum excavation depth of approximately 10m in the north-eastern corner of the site.

The purpose of our geotechnical investigation was to:

- Assess the subsurface conditions at the site,
- Provide recommendations regarding the appropriate foundation system for the site including preliminary design parameters,
- Provide advice regarding temporary and permanent support of the excavation,
- Provide recommendations regarding vibration control during excavation in rock,
- Comment on the soil aggressivity to buried concrete, and
- Undertake a salinity assessment.

We understand that Blacktown Council have requested that a salinity report is submitted as part of the development application.

Our report has been undertaken in general accordance with the following documentation:

- AS 1726-1993 ‘Geotechnical Site Investigations’
- Site Investigations for Urban Salinity, Department of Land and Water Conservation, 2002
- Western Sydney Salinity Code of Practice, 2004 (WSROC), and

This report presents the findings of desktop analysis, visual site inspection, and the results of laboratory analysis of soil samples.
2 Scope of Works

Our scope of works for this investigation included the following:

- A review of soil landscape information using the Department of Environment & Heritages Soil Landscape Mapping web application eSPADE.
- Review of historical aerial imagery.
- A visual site inspection.
- Excavation of two (2) boreholes using a truck mounted auger to a depth of 6 m below ground level or refusal on rock (whichever is achieved first).
- Logging of geotechnical conditions encountered during drilling.
- Dynamic cone penetrometer (DCP) testing in a location adjacent to borehole locations.
- Collection of soil samples from boreholes for laboratory analysis of pH, electrical conductivity and sulfate content.
- Preparation of a report outlining the findings of the geotechnical site investigation and salinity assessment.

3 Site Location

The site is located at 18-24 Allawah Street, Blacktown. The site is currently occupied by four (4) residential lots identified as;

- SP 39266,
- Lot 196 of DP 13619,
- Lot 197 of DP 13619, and
- Lot 198 of DP 13619.

The approximate geographic coordinates at the site are 33°46'10.87"S and 150°54'4.12"E. A survey of the site provided to us by Great Western indicates that the site has an area of 4699 m². The site location is presented in Appendix A, and a survey plan of the existing site is presented in Appendix B.

The site is located within the Blacktown Local Government Area, Parish of Prospect, County of Cumberland.
4 Previous Site Investigations

Witt Consulting has not undertaken any previous geotechnical site investigation or salinity assessment at the site. We are not aware of any geotechnical site investigations or salinity assessments that may have undertaken for the site by others.

5 Site Features

The key site features as identified on the survey plan are;

- One & two storey brick villas located at 18 Allawah Street,
- A single storey weatherboard cottage and stand alone clad garage at 20 Allawah Street,
- A single storey weatherboard cottage, stand alone clad garage and metal shed at 22 Allawah Street, and
- A single storey weatherboard cottage and stand alone garage at 24 Allawah Street.

Additional features such as concrete hardstands, trees and services are presented on the Survey Plan.

6 Site Topography and Soil Surface

The ground surface at the site slopes gently downwards in a south westerly direction between RL 55.98 m and RL 52.85m at an approximate gradient of 3.34%.

Were the site is not occupied by structures or hardstands the ground surface is predominantly covered by grass.

7 Geology and Hydrology

7.1 Geology

The Penrith 1:100,000 Geological Map Sheet 9030, indicates that the site is located on Wianamatta Group Bringelly Shale.

Wianamatta Group Bringelly Shales in the area generally consist of shale, carbonaceous claystone, claystone, laminite, fine to medium grained lithic sandstone, rare coal and tuff.
An excerpt of the Penrith 1:100,000 Geological Mapping Sheet is included in Appendix C.

7.2 Soil Landscapes

The NSW Environment & Heritage eSPADE web application identifies the site to be in a region underlain by Blacktown (9030bt). The Blacktown soil landscape is characterised by:

**Landscape** – gently undulating rises on Wianamatta Group shales. Local relief to 30 m, slopes usually >5%. Broad rounded crests and ridges with gently inclined slopes. Cleared Eucalypt woodland and tall open-forest (dry sclerophyll forest).

**Soils** – shallow to moderately deep (>100 cm) hardsetting mottled texture contrast soils, red and brown podzolic soils (Dr3.21, Dr3.31, Db2.11, Db2.21) on crests grading to yellow podzolic soils (Dy2.11, Dy3.11) on lower slopes and in drainage lines.

**Limitations** – moderately reactive high plastic subsoil, low soil fertility, poor soil drainage, seasonal waterlogging.

The Blacktown soil landscape data sheet is presented in Appendix D.

7.3 Hydrology

A review of the Department of Primary Industries groundwater database indicated that there are not groundwater wells within 500 m of the site.

8 Salinity Potential

Planning and Natural Resource’s Salinity Potential in Western Sydney 2002 Map, indicates that the site is located predominantly on land with High Salinity potential. The Department of Infrastructure, Planning and Natural Resources defines zones of high salinity potential as ‘areas where soil, geology, topography and groundwater conditions predispose a site to salinity. These conditions are, scalding, salt efflorescence, vegetation dieback, salt tolerant plant species, waterlogging. These areas are most common in lower slopes and drainage systems where water accumulation is high.’
The Department of Planning and Natural Resource’s Salinity Potential in Western Sydney 2002 Map along with the site’s approximate location is attached in Appendix E.

9 Fieldwork

Witt Consulting undertook fieldwork in the 7th June 2017. Fieldwork included the following;

- A visual inspection of site conditions.
- The excavation of two (2) 100 mm diameter boreholes to refusal on rock.
- Dynamic cone penetrometer testing (DCP) adjacent to borehole locations.
- Collection of soil samples for laboratory analysis of pH, Electrical conductivity and sulfate content.

9.1 Visual Inspection

The weather during our inspection was wet. The Bureau of Meteorology’s nearest weather station at Seven Hills recorded 18 mm of rain on the day of the inspection.

The Department of Infrastructure, Planning and Natural Resources publication titled Salinity Indicator Plants, provides a list of common salinity indicators that suggest an area is experiencing the impacts of salinity. Indicators included;

- Damage to buildings including crumbling bricks and mortar,
- Evidence of salt crystals on brickwork,
- Bare patches of soil with or without salt crystals,
- Waterlogging,
- Soil puffiness,
- Black staining,
- Soil erosion,
- Efflorescence,
- Yellow, stunted, wilting or dead vegetation.

We did not observe significant evidence of the above salinity indicators.
9.2 Borehole Excavation

Two (2) boreholes were excavated using a 1 tonne, truck mounted, tungsten carbide tipped, Ø 100 mm solid flight auger. Boreholes were excavated to refusal on rock at approximately 6 m in both borehole locations. Auger refusal is achieved when the auger can no longer make significant vertical advancements.

Augered boreholes were excavated in locations that were clear of underground and overhead services, accessible by vehicle and not covered by hardstands. The borehole locations are presented on the site survey in Appendix B.

Borehole logs are presented in Appendix F.

9.3 Dynamic Cone Penetrometer Test

DCP tests were undertaken adjacent to each borehole location. DCP testing was carried out until DCP refusal was achieved. DCP refusal is achieved when the DCP rod bounces on rock or the number of blows to drive the DCP rod 100 mm exceeds 25.

The results of DCP testing are used to describe the consistency of cohesive soils. The consistency of the cohesive soil is based on the number of blows taken to drive the DCP rod. The results of DCP testing is included in the borehole logs presented in Appendix F.

9.4 Soil Sample Analysis

A total of twelve (12) soil samples were collected from the boreholes. The samples are numbered in the following format to indicate their collection location and depth at which that were sampled i.e. BH1-1 collected from borehole BH1 at a depth of 1 m.

All soil samples were collected from the auger spoil and were transferred into sterilised glass jars prepared by Australian Laboratory Services (ALS). All jars were filled to the rim to minimise headspace. The samples were then transferred to the laboratory. Chain of custody documentation was used to record and track the samples.

Soil samples were analysed by the laboratory to determine their Electrical conductivity, pH, and sulfate as SO₄. Detailed test reports are presented in Appendix G.
10 Subsurface Conditions

The subsurface conditions encountered in boreholes excavated at the site are presented in Table 10.1 below.

<table>
<thead>
<tr>
<th>Geotechnical Unit</th>
<th>Depth to Geotechnical Unit (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface RL</td>
<td>54.2 m AHD</td>
</tr>
<tr>
<td>Topsoil</td>
<td>0</td>
</tr>
<tr>
<td>Silty Clay - Stiff</td>
<td>0.1</td>
</tr>
<tr>
<td>Silty Clay – Very Stiff</td>
<td>1.1</td>
</tr>
<tr>
<td>Silty Clay - Hard</td>
<td>1.5</td>
</tr>
<tr>
<td>Shale (Extremely Low Strength, UCS ≈ 1 MPa)</td>
<td>2</td>
</tr>
<tr>
<td>Shale (Very Low Strength, UCS ≈ 5 MPa)</td>
<td>4.5</td>
</tr>
<tr>
<td>End Borehole</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 10.1 Summary of Subsurface Condition

Architectural drawings indicate that the maximum excavation depth will be approximately 10 m. We anticipate that the strength of the shale will increase with depth beyond 6 m. Further investigation would be required to determine the rock strength at greater depths.

All drilling spoil was dry. No groundwater seepage was observed during drilling.

11 Soil Sampling

11.1 Exposure Classification – Assessment Criteria

Table 4.8.1 of AS3600 – 2009 ‘Concrete Structures’ provides assessment criteria for concrete structures in contact with aggressive soils based on pH and sulfates (expressed as SO₄). Table 4.8.1 is presented in Figure 11.1 below.
11.2 Exposure Classification – Soil Sample Results

The silty clay soil and shale encountered at the site are considered low permeability soils, thus for exposure classification, soil condition B will be considered.

The results of pH and sulfate concentration of the soil samples collected from Borehole BH1 are presented in Table 11.2.1 below.

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Sample Depth (mm)</th>
<th>pH</th>
<th>Sulfate as SO₄ (mg/kg)</th>
<th>Exposure Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH1-0.1</td>
<td>100</td>
<td>7.7</td>
<td>570</td>
<td>A1</td>
</tr>
<tr>
<td>BH1-1</td>
<td>1000</td>
<td>7.1</td>
<td>960</td>
<td>A1</td>
</tr>
<tr>
<td>BH1-2</td>
<td>2000</td>
<td>5.6</td>
<td>1150</td>
<td>A1</td>
</tr>
<tr>
<td>BH1-3</td>
<td>3000</td>
<td>6.4</td>
<td>720</td>
<td>A1</td>
</tr>
<tr>
<td>BH1-4</td>
<td>4000</td>
<td>7.5</td>
<td>540</td>
<td>A1</td>
</tr>
<tr>
<td>BH1-5.5</td>
<td>5500</td>
<td>8.3</td>
<td>350</td>
<td>A1</td>
</tr>
</tbody>
</table>

Table 11.2.1 – Borehole B1 Soil Sample Analysis

The results of pH and sulfate concentration of the soil samples collected from Borehole BH2 are presented in Table 11.2.2 below.
<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Sample Depth (mm)</th>
<th>pH</th>
<th>Sulfate as SO₄ (mg/kg)</th>
<th>Exposure Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH2-0.5</td>
<td>500</td>
<td>7.7</td>
<td>350</td>
<td>A1</td>
</tr>
<tr>
<td>BH2-1</td>
<td>1000</td>
<td>6.5</td>
<td>750</td>
<td>A1</td>
</tr>
<tr>
<td>BH2-1.2</td>
<td>1200</td>
<td>8.8</td>
<td>230</td>
<td>A1</td>
</tr>
<tr>
<td>BH2-2</td>
<td>2000</td>
<td>9.1</td>
<td>140</td>
<td>A1</td>
</tr>
<tr>
<td>BH2-4</td>
<td>4000</td>
<td>9.3</td>
<td>230</td>
<td>A1</td>
</tr>
<tr>
<td>BH2-4.5</td>
<td>4500</td>
<td>9.0</td>
<td>180</td>
<td>A1</td>
</tr>
</tbody>
</table>

*Table 11.2.2 – Borehole B2 Soil Sample Analysis*

The results of analysis indicate that exposure classification for concrete structures in contact with the soil at the site is A1. The soil at the site is considered non-aggressive for concrete.

### 11.3 Electrical Conductivity – Assessment Criteria

Electrical conductivity is the fundamental criteria for assessing soil salinity. As salt separates into positively and negatively charged ions when dissolved in water, the electrical conductivity of the water increases as the amount of salt increases.

Electrical conductivity (EC₁:₅) of a soil is determined by mixing 1 part soil with 5 parts distilled or deionised water. After mixing the sample and allowing the sediments to settle, the electrical conductivity of the solution is tested. The electrical conductivity of the solution is used to assign the soil a salinity class.

The salinity ranges outlined in NSWEPA’s *Book 2 Dryland Salinity* are presented in Table 11.3 below.

<table>
<thead>
<tr>
<th>Salinity Class</th>
<th>Electrical Conductivity Range (ECₑ), dS/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-saline, 0</td>
<td>&lt; 2</td>
</tr>
<tr>
<td>Slightly saline, 1</td>
<td>2 - 4</td>
</tr>
<tr>
<td>Moderately saline, 2</td>
<td>4 - 8</td>
</tr>
<tr>
<td>Very saline, 3</td>
<td>8 – 16</td>
</tr>
<tr>
<td>Highly saline, 4</td>
<td>&gt; 16</td>
</tr>
</tbody>
</table>

*Table 11.3, Electrical conductivity Soil salinity classes, NSWEPA Book 2 Dryland Salinity.*
Table 4.8.2 AS3600 presented in Figure 11.3 below provides exposure classification strength and cover requirements concrete in contact with saline soils.

| TABLE 4.8.2  
STRENGTH AND COVER REQUIREMENTS FOR SALINE SOILS |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil electrical conductivity (EC&lt;sub&gt;e&lt;/sub&gt;)</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>4–8</td>
</tr>
<tr>
<td>8–16</td>
</tr>
<tr>
<td>&gt;16</td>
</tr>
</tbody>
</table>

NOTES:
1. EC<sub>e</sub> is saturated electrical conductivity in deciSiemens per metre.
2. Guidance on concrete in saline environments can be found in CCAA T56.

Figure 11.3 – Table 4.8.2 of AS3600 ‘Concrete Structures’

11.4 Electrical Conductivity – Soil Analysis Results

The results of field analysis are presented in Table 11.4.1 below. The result of EC<sub>1:5</sub> is multiplied by a factor of 7 to determine EC<sub>e</sub> when the soil tested is moderate clay.

<table>
<thead>
<tr>
<th>BH1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Depth (mm)</td>
</tr>
<tr>
<td>---------------------------------------</td>
</tr>
<tr>
<td>100</td>
</tr>
<tr>
<td>1000</td>
</tr>
<tr>
<td>2000</td>
</tr>
<tr>
<td>3000</td>
</tr>
<tr>
<td>4000</td>
</tr>
<tr>
<td>5500</td>
</tr>
</tbody>
</table>

Table 11.4.1, Electrical Conductivity Results for Samples Collected from Borehole BH1
### BH2

<table>
<thead>
<tr>
<th>Sample Depth (mm)</th>
<th>EC1:5 (dS/m)</th>
<th>EC_e (ds/m)</th>
<th>Salinity Class</th>
<th>Exposure Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>0.060</td>
<td>0.42</td>
<td>Non-Saline</td>
<td>A1</td>
</tr>
<tr>
<td>1000</td>
<td>0.081</td>
<td>0.567</td>
<td>Non-Saline</td>
<td>A1</td>
</tr>
<tr>
<td>1200</td>
<td>0.197</td>
<td>1.379</td>
<td>Non-Saline</td>
<td>A1</td>
</tr>
<tr>
<td>2000</td>
<td>0.168</td>
<td>1.176</td>
<td>Non-Saline</td>
<td>A1</td>
</tr>
<tr>
<td>4000</td>
<td>0.205</td>
<td>1.435</td>
<td>Non-Saline</td>
<td>A1</td>
</tr>
<tr>
<td>4500</td>
<td>0.221</td>
<td>1.547</td>
<td>Non-Saline</td>
<td>A1</td>
</tr>
</tbody>
</table>

*Table 11.4.2, Electrical Conductivity Results for Samples Collected from Borehole BH2*

### 11.5 Summary of Soil Sample Analysis.

The results of soil sample analysis indicate that the soils at the site are considered non-aggressive to concrete. The results of salinity analysis indicate that the exposure classification for concrete is A2.

### 12 Excavation and Support

Excavation works at the site will be undertaken in silty clay and shale. We anticipate that excavation in clay and shale with a UCS of < 2MPa could be undertaken using conventional excavation equipment.

We anticipate that excavation works in shale with a UCS >10 MPa could be undertaken using large (35 T) conventional excavation equipment with a ripping tyne or toothed bucket.

Care will be required to ensure that structures on adjacent properties are not damaged due to vibrations caused by excavation equipment. Should hydraulic rock hammers be required for excavation, methods that limit ground vibrations at adjacent structures to 10 mm/s should be adopted.

Temporary excavations in clay less than 1.5 m in height may be cut at a grade of 1.5H:1V. Excavations deeper than 1.5 m should be designed by Witt Consulting.
13 Potential Impacts on Development

The general impacts of salinity that have the potential to occur are;

- Damage to and subsequent reduction in the lifespan of buildings and associated infrastructure such as roads and underground services as a result of construction close to aggressive soils and groundwater. This may include;
  - Degradation of bricks, concrete, road base and curbing materials leading to expansion, cracking and strength losses,
  - Corrosion of reinforcement and loss of structural integrity,
  - Rising damp/falling damp,
  - Non-structural impacts such as salt staining and efflorescence on masonry.

- Degradation of drainage infrastructure by a rise in the groundwater level. Damage to pipes has the potential to exacerbate the problem by recharging shallow groundwater.

- Damage to or prevention of the cultivation of salt-sensitive vegetation in landscaped areas and gardens that may arise across the site due to salinity levels in the surface soils.

The construction stage and ongoing use of the proposed development has the potential to adversely affect salinity conditions on site and in surrounding areas by altering the hydrological cycle. Potential impacts include;

- A rise in the groundwater level due to increased water inputs associated with urban development such as irrigation and leaking pipes. Reduced infiltration due to the construction of hardstands across a significant portion of the site may offset the impacts of additional water inputs.

- Altered flow and drainage patterns which may result in increased water accumulation and associated salinity issues in areas with impeded flow, as a consequence of the construction of drainage lines, footings, roads etc.

- Interception of groundwater should local groundwater levels rise during prolonged periods of precipitation.

- Excavation and redistribution of moderately saline soil during excavation and filling operations around the site.

These impacts have the potential to lead to an increase in surface expressions of soil salinity and adversely affect downstream water quality.
14 Salinity Model

The results of testing indicate that the soils samples analysed by the laboratory are considered non-saline to moderately saline. It is our opinion that there is a low risk that the soils at the site will produce adverse salinity based impacts.

The materials encountered during our investigation were dry and no evidence of a groundwater table were observed at the site.

The main mechanisms by which salts could potentially be mobilised or the concentrations of salinity increased include but are not limited to, a rise in the groundwater table, or impedance of groundwater flow or subsurface water drainage.

15 Conclusion

Based on the results of our salinity investigation we do not anticipate that salinity will have a significant impact on the proposed development. Additionally, we do not anticipate that the proposed development will have a significant impact on salinity in adjacent sites. It is our opinion that a salinity management plan is not required for development at the site.

We recommend that the following general measures are implemented to reduce the impacts of salinity on the site;

- Trenching for underground services outside the basement footprint should be carried out in such a manner that there is a minimal rotation and vertical displacement of the original soil profile.
- Pipes used for stormwater drainage should be sealed to minimise the risk of leakage. Drainage, sewerage and water infrastructure is to be regularly maintained and repaired to prevent leakage.
- Concrete of suitable strength and reinforcement cover is to be used for drainage structures.
- Watering or irrigation practices are to be managed to avoid excessive infiltration and water logging.
- Drainage must not cause increased water logging adjacent to the roads.
- Appropriate construction materials should be selected to ensure that the integrity of structures in contact with the soils are not compromised due to acidity/alkalinity, or saline soils.

Should the materials observed during construction vary from those outlined in this report additional geotechnical advice must be sought.
Appendix A. Site Location
Disclaimer: This report has been generated by various sources and is provided for information purposes only. Spatial Services does not warrant or represent that the information is free from errors or omission, or that it is exhaustive. Spatial Services gives no warranty in relation to the information, especially material supplied by third parties. Spatial Services accepts no liability for loss, damage, or costs that you may incur relating to any use or reliance upon the information in this report.
Appendix B. Site Survey & Borehole Locations
Appendix C. Geological Mapping Sheet
Extract from Penrith 1:100,000 geological series sheets 9030

Approximate Site Location
Appendix D. Blacktown Soil Landscape Data Sheet
**Landscape**—gently undulating rises on Wianamatta Group shales. Local relief to 30 m, slopes usually >5%. Broad rounded crests and ridges with gently inclined slopes. Cleared Eucalypt woodland and tall open-forest (dry sclerophyll forest).

**Soils**—shallow to moderately deep (>100 cm) hardsetting mottled texture contrast soils, red and brown podzolic soils (Dr3.21, Dr3.31, Db2.11, Db2.21) on crests grading to yellow podzolic soils (Dy2.11, Dy3.11) on lower slopes and in drainage lines.

**Limitations**—localised seasonal waterlogging, localised water erosion hazard, moderately reactive highly plastic subsoil, localised surface movement potential.

**LOCATION**

Occurs extensively on the Cumberland Lowlands. Examples include Blacktown, Mount Druitt, Glossodia and Leppington.

Isolated examples are found at Bilpin on the Blue Mountains plateau surface and along the Silverdale Road south of Wallacia.

**LANDSCAPE**

**Geology**

Wianamatta Group—Ashfield Shale consisting of laminite and dark grey siltstone, Bringelly Shale which consists of shale with occasional calcareous claystone, laminite and infrequent coal, and Minchinbury Sandstone consisting of fine to medium-grained quartz lithic sandstone.
**Topography**

Gently undulating rises on Wianamatta Shale with local relief 10–30 m and slopes generally >5% but occasionally up to 10%. Crests and ridges are broad (200–600 m) and rounded with convex upper slopes grading into concave lower slopes. Outcrops of shale do not occur naturally on the surface. They may occur, however, where soils have been removed.

**Vegetation**

Almost completely cleared open-forest and open-woodland (dry sclerophyll forest). The original woodland and open-forest were dominated by *Eucalyptus tereticornis* (forest red gum), *E. crebra* (narrow-leaved ironbark), *E. moluccana* (grey box) and *E. maculata* (spotted gum) (Benson, 1981).

Further west near Penrith remnant stands of *E. punctata* (grey gum) occur. Between Liverpool and St Marys the dominant species are *E. globoidea* (white stringybark) and *E. fibrosa* (broad-leaved ironbark), with *E. longifolia* (woollybutt) as an understorey species. Individual trees or small stands of *E. sideroxylon* (mugga ironbark) are occasionally found on crests.

**Landuse**

The dominant landuses are intensive residential (Fairfield, Blacktown and Mt Druitt), horticulture and animal husbandry (Vineyard, Scheyville and Leppington) and light and heavy industry (Yennora and Moorebank).

**Existing Erosion**

No appreciable erosion occurs on this unit. Minor sheet and gully erosion may be found where surface vegetation is not maintained.

**Associated Soil Landscapes**

South Creek (sc) soil landscape occurs along drainage depressions. Picton (pn) soil landscape occurs on steeper south and southeast facing slopes. Small areas of Luddenham (lu) soil landscape may also occur.

---

**SOILS**

**Dominant Soil Materials**

**bt1—Friable brownish black loam.**

This is a friable brownish black loam to clay loam with moderately pedal subangular blocky structure and rough-faced porous ped fabric. This material occurs as topsoil (A horizon).

Peds are well defined subangular blocky and range in size from 2 mm to 20 mm. Surface condition is friable. Colour is brownish black (10YR 2/2) but can range from dark reddish brown (5YR 3/2) to dark yellowish brown (10YR 3/4). The pH varies from moderately acid (pH 5.5) to neutral (pH 7.0). Rounded iron indurated fine gravel-sized shale fragments and charcoal fragments are sometimes present. Roots are common.

**bt2—Hardsetting brown clay loam.**

This is a brown clay loam to silty clay loam which is hardsetting on exposure or when completely dried out. It has apedal massive to weakly pedal structure and slowly porous earthy fabric. It occurs as an A2 horizon.

Peds when present are weakly developed, subangular blocky and are rough faced and porous. They range in size between 20–50 mm. This material is water repellent when extremely dry.

Colour is dark brown (7.5YR 4/3) but can range from dark reddish brown (2.5YR 3/3) to dark brown (10YR 3/3). The pH varies from moderately acid (pH 5.0) to slightly acid (pH 6.5). Platy, iron indurated gravel-sized shale fragments are common. Charcoal fragments and roots are rarely present.

**bt3—Strongly pedal, mottled brown light clay.**

This is a brown light to medium clay with strongly pedal polyhedral or sub-angular to blocky structure and smooth-faced dense ped fabric. This material usually occurs as subsoil (B horizon).

Texture often increases with depth. Peds range in size from 5–20 mm. Colour is brown (7.5YR 4/6) but may range from reddish brown (2.5YR 4/6) to brown (10YR 4/6). Frequent red, yellow or grey mottles occur
often becoming more numerous with depth. The pH varies from strongly acid (pH 4.5) to slightly acid (pH 6.5). Fine to coarse gravel-sized shale fragments are common and often occur in stratified bands. Both roots and charcoal fragments are rare.

**bt4—Light grey plastic mottled clay.**

This is a plastic light grey silty clay to heavy clay with moderately pedal polyhedral to subangular blocky structure and smoothfaced dense ped fabric. This material usually occurs as deep subsoil above shale bedrock (B3 or C horizon).

Peds range in size from 2–20 mm. Colour is usually light grey (10YR 7/1) or, less commonly, greyish yellow (2.5YR 6/2). Red, yellow or grey mottles are common. The pH varies from strongly acid (pH 4.0) to moderately acid (pH 5.5). Strongly weathered ironstone concretions and rock fragments are common. Gravel-sized shale fragments and roots are occasionally present. Charcoal fragments are rare.

**Occurrence and Relationships**

**Crests.** On crests and ridges up to 30 cm of friable brownish black loam (**bt1**) overlies 10–20 cm of hardsetting brown clay loam (**bt2**) and up to 90 cm of strongly pedal, brown mottled light clay (**bt3**) [red podzolic soils (Dr 3.21, 3.11) and brown podzolic soils (Db 2.11)]. **bt1** is occasionally absent. Boundaries between the soil materials are usually clear. Total soil depth is <100 cm.

**Upper slopes and Midslopes.** Up to 30 cm of **bt1** overlies 10–20 cm of **bt2** and 20–50 cm of **bt5**. This in turn overlies up to 100 cm of a light grey plastic mottled clay (**bt4**) [red podzolic soils (Dr 3.21), brown podzolic soils (Db 2.21)]. Occasionally **bt1** is absent. The boundaries between the soil materials are usually clear. Total soil depth is <200 cm.

**Lower sideslopes.** Up to 30 cm of **bt1** overlies 10–30 cm of **bt2** and 40–100 cm of **bt3**. Below **bt3** there is usually >100 cm of **bt4** [yellow podzolic soils Dy 2.11, Dy 3.11]. The boundaries between the soil materials are clear. Total soil depth is >200 cm.

**LIMITATIONS TO DEVELOPMENT**

**Soil Limitations**

**bt1**  
Strongly acid  

**bt2**  
Hardsetting  
Low fertility  
Strongly acid  
High aluminium toxicity

**bt3**  
High shrink-swell (localised)  
Low wet strength  
Low permeability  
Low available water capacity  
Salinity (localised)  
Sodicity (localised)  
Very low fertility  
Very strongly acid  
Very high aluminium toxicity

**bt4**  
High shrink-swell (localised)  
Low wet strength  
Stoniness  
Low available water capacity  
Low permeability  
Salinity (localised)  
Sodicity (localised)  
Low fertility  
Strongly acid  
Very high aluminium toxicity  
High erodibility (localised)
Fertility
General fertility is low to moderate. Soil materials have low to moderate available water capacity, low CEC values, hardsetting surfaces (bt2), very low phosphorus and low to very low nitrogen levels. The subsoils (bt3, bt4) may be locally sodic with low permeability. When bt1 is present its higher organic matter content and moderate nitrogen levels result in higher general fertility.

Erodibility
Blacktown soil materials have moderate erodibility. The topsoils (bt1, bt2) are often hardsetting and they have high fine sand and silt content but they also have high to moderate organic matter content. The subsoils (bt3, bt4) are very low in organic matter. Where they are also highly dispersible and occasionally sodic the erodibility is high.

Erosion Hazard
The erosion hazard for non-concentrated flows is slight to moderate but ranges from low to very high. Calculated soil loss during the first twelve months of urban development for topsoil and exposed subsoil tends to be low (7–11 t/ha). Soil erosion hazard for concentrated flows is moderate to high.

Surface Movement Potential
The deep clay soils are moderately reactive. These are generally found on side-slopes and footslopes. Shallower soils on forests are slightly reactive.

Landscape Limitations
Seasonal waterlogging (localised), water erosion hazard (localised), surface movement potential (localised).

Urban Capability
High capability for urban development with appropriate foundation design.

Rural Capability
Small portions of this soil landscape which have not been urbanised are capable of sustaining regular cultivation and grazing.

Distribution diagram of the Blacktown soil landscape showing the occurrence and relationship of dominant soil materials.
Appendix E. Salinity Potential Map
Extract from DIPNR's Map of Salinity Potential in Western Sydney
Appendix F. Borehole Logs
Excavation Log

Client: Great Western  
Date commenced: 07 June 2017

Principal:  
Date completed: 07 June 2017

Project:  
Logged by: NK

Site location: 18-24 Allawah Street, Blacktown

Equipment type: Truck Mounted Auger

Date completed: 07 June 2017
Logged by: NK

Equipment type: Truck Mounted Auger

Excavation dimensions: 100 mm Diameter

R.L. surface: approx 54.2 m AHD

Vertical datum:
Horizontal datum:

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**Excavation Log**

**Client:** Great Western  
**Principal:**  
**Project:**  
**Site location:** 18-24 Allawah Street, Blacktown

**Equipment type:** Truck Mounted Auger  
**Excavation dimensions:** 100 mm Diameter

**R.L. surface:** approx 54.2 m AHD  
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**Northing:**  
**Vertical datum:**  
**Horizontal datum:**

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**Date commenced:** 07 June 2017  
**Date completed:** 07 June 2017  
**Logged by:** NK
## Excavation Log

**Client:** Great Western  
**Principal:**  
**Project:**  
**Site location:** 18-24 Allawah Street, Blacktown

**Equipment type:** Truck Mounted Auger  
**Excavation dimensions:** 100 mm Diameter

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**R.L. surface:** approx 54.2 m AHD

**Date commenced:** 07 June 2017  
**Date completed:** 07 June 2017  
**Logged by:** NK

**Structure and Additional Observations**

- **TOPSOIL:** brown
- **SILTY CLAY:** medium to high plasticity, light grey / orange brown / red mottle
- **SILTY CLAY:** medium to high plasticity, light brown / grey  
  light brown at 1.2 m
- **SILTY CLAY:** medium to high plasticity, light brown / grey mottle
- **SHALE:** extremely weathered, very low strength red brown / grey
- **SHALE:** weathered, very low strength, brown
- **SHALE:** weathered, low strength, dark brown  
  light brown at 4.5 m

...continued on next sheet
Excavation Log

Client: Great Western
Site location: 18-24 Allawah Street, Blacktown

Equipment type: Truck Mounted Auger
Excavation dimensions: 100 mm Diameter

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Date commenced: 07 June 2017
Date completed: 07 June 2017
Logged by: NK

Witt Consulting Pty Ltd
ABN 76 102 953 515
witt.com.au
Appendix G. Laboratory Analysis Results
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>
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<th>Signatories</th>
<th>Position</th>
<th>Accreditation Category</th>
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<td>Ankit Joshi</td>
<td>Inorganic Chemist</td>
<td>Sydney Inorganics, Smithfield, NSW</td>
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<tr>
<td>Celine Conceicao</td>
<td>Senior Spectroscopist</td>
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<tr>
<td>Edwandy Fadjar</td>
<td>Organic Coordinator</td>
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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 no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

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

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<td></td>
<td></td>
<td>µS/cm</td>
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<td>81</td>
<td>197</td>
<td>168</td>
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<tr>
<td>Electrical Conductivity @ 25°C</td>
<td>----</td>
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<td>60</td>
<td>81</td>
<td>197</td>
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<tr>
<td><strong>EA055: Moisture Content</strong></td>
<td></td>
<td></td>
<td>%</td>
<td>8.1</td>
<td>21.3</td>
<td>18.7</td>
<td>13.7</td>
<td>12.2</td>
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<tr>
<td>Moisture Content (dried @ 103°C)</td>
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<tr>
<td><strong>ED040: Sulfur as SO4 2-</strong></td>
<td>14808-79-8</td>
<td>100</td>
<td>mg/kg</td>
<td>350</td>
<td>350</td>
<td>750</td>
<td>230</td>
<td>140</td>
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## Analytical Results

**Sub-Matrix:** SOIL  
**Matrix:** SOIL

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<th>LOR</th>
<th>Unit</th>
<th>Result</th>
<th>Result</th>
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