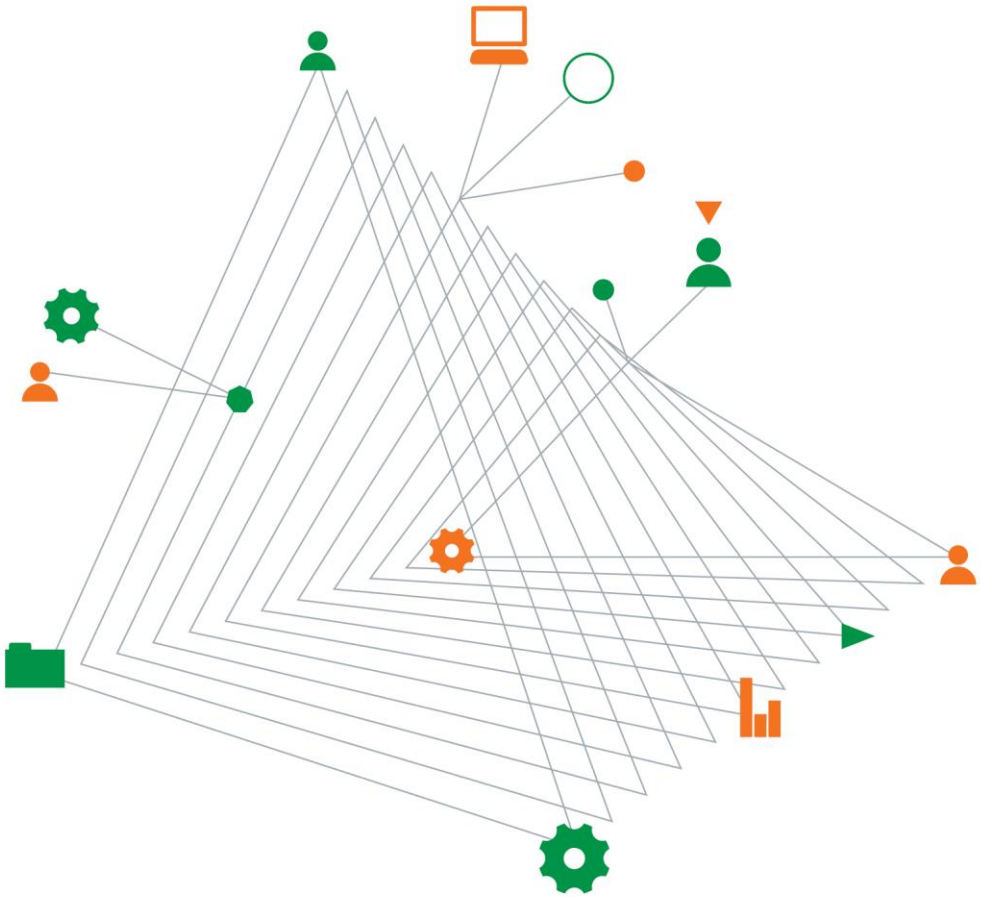
The University of Sydney

000-02 Darlington Road Terraces Rear Development

Geotechnical Investigation

27 March 2015



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000-02 Darlington Road Terraces Rear Development

Prepared for
The University of Sydney

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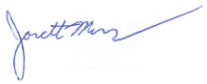

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Quality information

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1. Introduction

This report presents the results of a geotechnical site investigation carried out by Coffey Geotechnics Pty Ltd (Coffey) for the proposed student accommodation planned for the area located at the rear of the existing Darlington Road terraces study accommodation, as well as the reconditioning of the existing terraces (ref: Figure 1). The development is proposed at 00-02 Darlington Road within The University of Sydney – Darlington Campus. The work was commissioned by The University of Sydney and carried out in general accordance with our proposal (Ref: GEOTLCOV25176AA-AC, dated 1 October 2014).

An environmental Phase II investigation by Coffey Environments Australia Pty Ltd (Coffey Environments) was undertaken concurrently with the geotechnical investigation, and a summary of findings and recommendations is provided in a separate report.

The purpose of our geotechnical investigation was to obtain information on subsurface conditions as a basis for comments and recommendations on the following geotechnical aspects of the proposed development:

- Geotechnical model of subsurface conditions and four drafted long sections through the site using the boreholes and test pit information from this investigation as well as other available boreholes from the nearby Abercrombie site.
- Observed details on existing terrace building footing conditions and founding material.
- Observed groundwater levels.
- Foundation conditions for the rear building, suitable footing systems and foundation design parameters.
- Excavation conditions, temporary and permanent batter slopes, retention systems and retaining wall design parameters.
- Potential impact on adjoining structures.
- Earthquake design coefficient.

In conjunction with the preparation of this site investigation report Coffey has also carried out an Initial Geotechnical Site Assessment (ref GEOTLCOV25176AA-AB, dated 26 November 2014).

A Phase I Environmental Assessment undertaken by Sinclair Knight Merz (SKM) was provided to Coffey by The University of Sydney for review. The assessment covered the Abercrombie Street Economics Precinct Development and was dated 14 September 2010 which concluded the requirement for a Phase 2 Contamination Assessment.

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2. Proposed development

We understand that the student accommodation development will include the construction of up to four buildings up to three levels above ground. A basement level is planned for buildings ‘A’ and ‘B’. A finished floor level (FFL) for building ‘A’ is RL 36.2 m AHD and building ‘B’ is RL 36.2 m AHD and 33.2 m AHD. An underground stormwater system is planned for the development although the

location has yet to be chosen. The system is subdivided into three systems coordinating with the individual blocks.

The buildings will house up to approximately two-hundred students. Additionally the existing terraces will be reconditioned to house up to about one-hundred students. The single level structures at the rear of the existing terraces will be demolished. The design includes retaining one tree within the property site. Appendix C includes the latest drawings provided to Coffey for the proposed development, by Allen Jack + Cotter.

Generally excavation depths are estimated to be up to 3 m or near “one full level difference” at the rear of the existing terraces.

2.1. Phase I environmental site assessment (by others)

A Phase I Environmental Assessment undertaken by Sinclair Knight Merz (SKM) was provided to Coffey by The University of Sydney for review. The assessment covered the Abercrombie Street Economics Precinct Development and was dated 14 September 2010.

Some key information in the report for the subject property and area within the vicinity of the property included:

- Terraces fronting Darlington Lane were constructed pre-1930’s;
- A shed along the southern portion of Darlington Lane stored chemicals, these included fertilisers.
- A stockpile of fill materials along the southern portion of Darlington Lane was placed, this included soil, vegetation, timber, stone, glass and plastic.
- An area behind Building H07, University Garage which is on the south-western corner of Darlington Lane contained oil and fuel containers and staining on the ground surface was identified. It was noted that the ground surface slope may direct any spills in the area towards Darlington Lane and Codrington St. Stage 2 Investigation of building H07 was undertaken by Aecom in 2009 but the report was unavailable during the SKM Phase I assessment.
- SKM recommended that Stage 2 intrusive investigations be undertaken at the general site area to evaluate if any potential contamination is present prior to redeveloping areas.

3. Review of desk study information

Prior to the site investigation described later in this report, Coffey prepared an Initial Geotechnical Site Assessment (ref GEOTLCOV25176AA-AB, dated 26 November 2014). This desk study referenced previous Coffey geotechnical studies in the area, particularly the Abercrombie site to the south.

3.1. Coffey archives

Coffey conducted the geotechnical investigations and construction geotechnical services for the Abercrombie Precinct development, which borders the proposed development, approximately 5m to the south across Darlington Lane. Coffey has provided geotechnical investigations for the IXL garage south-west of the development. At these locations, the ground level dips toward the southeast with difference of elevation of about 12 m.

Based on these previous investigations, subsurface conditions in the locality include varying thicknesses of fill and residual soils over shale bedrock. The shale bedrock was encountered at 2.4 m

to 4.5 m below ground surface or RL 21.1 m AHD to RL 34.4 m AHD. The shale bedrock grades from extremely weathered to slightly weathered and very low to high strength with depth. Class III shale or better was encountered at 8.7 m to 11.6 m below ground surface or RL 14.1 m AHD to RL 21.8 m AHD.

Groundwater was encountered at about 2 m to 4 m below the ground surface or RL 22.9 m AHD to RL 30.3 m AHD, near the interface of soil and bedrock.

3.2. Desktop study preliminary geotechnical model

Based on our Initial Geotechnical Site Assessment (ref GEOTLCOV25176AA-AB, dated 26 November 2014) of existing information from near the site, including the Abercrombie building site immediately to the south, the following ground conditions were anticipated prior to carrying out the field investigation at the subject site:

- **Fill-Pavements**
    - Fill pavements/foundations associated with the existing development, includes asphalt, concrete and brick,
    - Indicative thickness up to 0.5 m, overlying;
- **Fill**
    - Fill associated with the existing development
    - Indicative thickness up to 1.0 m, overlying;
- **Residual Soil**
    - Clay, high plasticity, stiff to hard consistency
    - Indicative thickness 1 m to 6 m, overlying;
- **Bedrock - Class V and IV Shale**
    - Shale, extremely weathered grading to moderately weathered and very low to low strength with some high strength.
    - Indicative thickness 3 m to 9 m, overlying;
- **Bedrock - Class III or better Shale**
    - Shale, slightly weathered to fresh, medium to high strength.

4. Method of Investigation

4.1. Scope of fieldwork

The scope of works at the subject site included a ground investigation with on site testing and collection of materials for laboratory testing.

Fieldwork for the ground investigation was carried out as two stages of works:

- Borehole investigation with installation of standpipes; and,

- Test pit excavation investigation.

Locations of the boreholes and test pits are shown in Figure 2.

A Coffey Geotechnical Engineer observed the borehole investigation drilling and test pit excavations, undertook field testing, recorded test results, sampled soils and logged the encountered ground conditions. The borehole logs are presented as Appendix A together with test pit photographs and a set of Coffey Soil and Rock Description Explanation Sheets which describe the terms and symbols used.

4.2. Fieldwork – borehole investigation

Fieldwork, as the borehole investigation stage was carried out on 27 and 28 January 2015 and comprised the drilling of four boreholes (BH1 to BH4) to depths of 3.1 m to 5.1 m. Locations were selected by the structural engineer within the limits of the rear portion of the existing terraces. It rained throughout the borehole investigation. A rainfall of 116 mm was recorded at the Randwick Racecourse Station (approximately 4 km from the site) for this period.

The boreholes were hand augered for the upper 1 metre as a preventative measure of encountering utilities. The boreholes were then drilled using a 1-tonne track mounted XC ('Cross Country') drilling rig and were advanced using solid flight augers, a V drill bit and a Tungsten Carbide (TC) drill bit. Standard Penetration Tests (SPTs) were carried out during drilling in the soils and weathered rock to assess strength and obtain samples for logging and laboratory testing. Photographs of the samples collected from the drilling and SPTs are included as Appendix D.

Two standpipes were installed, at the termination depth in boreholes BH1 and BH4 for the purpose of groundwater monitoring.

4.3. Fieldwork – test pit excavation investigation

Test pit excavation investigation stage was carried out on 29 and 30 January 2015 and comprised six test pit excavations (TP1 to TP6) to depths of 0.8 m to 1.2 m. Locations were selected near the rear building terraces below existing concrete / pavers to carry out an assessment of the existing terrace footings and ground conditions. The proposed test pit locations were selected by the structural engineer, however prior to the works locations were revised based on existing subsurface utilities and access to the locations. Coffey, The University of Sydney and the structural engineer discussed and agreed upon the chosen relocated test pit locations.

Prior to excavations the concrete slab was cut or pavers were removed. For assessment of the existing footings and subsurface materials, the excavation was undertaken by hand with a shovel to the base of the footings and then subsequently hand augered to refusal. It rained on the 29 January 2015 during the test pit investigation. A rainfall of 17 mm was recorded at the Randwick Racecourse Station (approximately 4 km from the subject site) over this day.

During the test pit excavations field density / consistency testing were undertaken as the following:

- Pocket penetrometer tests in the clayey soils;
- Six dynamic cone penetration (DCP) tests, one in each of the test pits.

Sketches 1 to 6 (attached) include cross sections for each of the test pit areas. Photographs of the samples collected from the excavations are included as Appendix D.

5. Results of investigation

5.1. Site description

The site, approximately 200 m long and 30 m wide, is located at 00-02 Darlington Road, Darlington, NSW within The University of Sydney – Darlington Campus. It is bounded by Darlington Road to the north, open space and Codrington Street to the east, Darlington Lane to the south and the Darlington House H66 and Golden Grove Street to the west. The attached Figure 1 presents the site location plan.

Existing student accommodation, on the northern half of the site comprises two level terraces with one storey lean-to. These terraces have been listed as having local Heritage significance and a portion of the terraces are occupied by various faculties and student accommodation.

The proposed development is planned to be constructed to the rear of the existing student accommodation buildings (ref: Figure 1 and 2). The backyards consist of walkways / pavements and patios composed of concrete, asphalt and/or brick materials, as well as garden areas with trees, vegetation, mulch and topsoil. The southern boundary was bordered by timber or steel fencing. An area to the southeast of the subject site is grassed open space that has not been developed, although a section currently has electrical utilities under and above the ground surface.

The walkways / pavement in the backyards of the existing terraces are generally in fair condition with some cracking observed at some of the properties. A crack was observed along the pavement of Darlington Lane, running east to west.

The ground surface for the site area is between RL40 m Australian Height Datum (AHD) and RL30 m AHD and grades at about 5% towards the southeast.

5.2. Local geology and published groundwater information

The Sydney 1:100,000 Geological Series Sheet (9130 Edition 1 1983) indicates that the site is underlain by Ashfield Shale of the Wainamatta Group. Ashfield Shale typically consists of dark grey to black shale and laminate.

The Sydney 1:100,000 Soil Landscape Series Sheet (9130 Edition 1983) indicates that the site is underlain by residual “Blacktown” soils and notes that potential issues for development on this soil may include moderate reactivity, high plasticity subsoils.

The Botany Bay 1:25,000 Acid Sulfate Soil Risk Map (9130S3 Edition 2 1997) indicates that there is no known occurrence of acid sulfate soils at the site.

A search of groundwater bore licences was undertaken using the NSW Natural Resources Atlas (http://www.nratlas.nsw.gov.au). The results of the search indicated that there is one registered bore (GW110247) located approximately 200 m west of the site. The bore was installed in the year 2000 to a depth of 210 m below ground surface with a measured standing water level of 31 m below ground surface.

5.3. Subsurface conditions

For specific details at each borehole location references should be made to the attached borehole logs and core photos in Appendix A. In summary, the boreholes encountered a typical ground profile similar to the desk study predictions, comprising:

- **Fill – Pavements**: Concrete, Asphalt and Brick

  - Along walkways and patio areas
  - 0.05 m to 0.1 m thick, and / or;
- **Fill:** Clay, Silty Clay and Sandy Silt with Gravel
  - 0.5 m to 1 m deep,
  - With some porcelain and brick fragments, trace of rootlets,
  - some areas of topsoil associated with garden beds / planter areas; overlying
- **Residual Soil**: Silty Clay
  - 0.5 m to 1 m thick,
  - Typically of stiff consistency, although ranged from firm to very stiff consistency, medium plasticity; overlying
- **Weathered Bedrock** comprising:
  - Extremely weathered Shale, estimated as very low to low strength and can typically be remolded to a Silty Clay.

Infiltration of water was observed in two boreholes, BH1 and BH3. Groundwater was observed in two boreholes BH1 and BH4. It should be noted that water was not observed in BH2 and BH3 at termination of drilling and standpipe wells were not installed. A summary of infiltration levels and groundwater levels are recorded in Section 6.1.

5.4. Comparison to initial geotechnical model

In general the conditions encountered in the geotechnical investigation were consistent with our expectations set out in the initial geotechnical model. Some variations observed during the site investigation at the subject site included:

- Pavement layer was typically thinner; a maximum 0.1 m in thickness was measured.
- Areas of firm clays were assessed within the Residual Soil unit.

6. Geotechnical model

Using the subsurface information from the geotechnical investigation and the desk study (which reviewed adjacent Abercrombie geotechnical investigation), the ground conditions have been characterised into the geotechnical units presented in Table 1. Interpreted geotechnical sections through the site showing the inferred distribution of geotechnical units are presented in the Figures.

Table 1: Summary of Subsurface Conditions and Inferred Geotechnical Model

Geotechnical Unit	Material Description	Depth to Top of Unit from ground surface, m	Depth of Top of Unit, RL (m AHD) [(c)]	Unit Thickness, m
1a. Fill-Pavements [(b)]	Concrete, brick pavers or asphalt	0.0	35.0 to 38.8	0.05 to 0.1
1b. Fill [(b)]	Clay, Silty Clay and Sandy Silt with Gravel. With some porcelain and brick fragments and trace of rootlets.	0.0 to 0.1	34.9 to 38.75	0.5 to 1.0
2. Residual Soil	Silty Clay, Typically of stiff consistency, although ranged from firm to very stiff consistency, low to medium plasticity	0.5 to 1	32.6 to 38.1	1.1 to 2.3
3. Shale	Shale: • Extremely weathered • Very low to low strength • Assessed as Class V Shale[(a)]	1.6 to 3.0	32.0 to 35.0	Shale Refusal [(d)]

Notes on Table 3:

(a) Rock classified as sandstone in accordance with Pells et al (1998) “Foundations on Sandstone and Shale in the Sydney Region” Aust. Geomech. Jnl, Dec 1998.
(b) The fill may not be one uniform layer, but possibly at discrete locations with different thicknesses.
(c) RL inferred from plan provided (ref Appendix C).
(d) With TC bit refusal on 1-tonne drilling rig.

Groundwater seepage was typically encountered at the base of Fill and the Residual Soil / Shale interface. Seepage in shale typically occurs along sub-horizontal bedding planes and sub-vertical joints.

6.1. Standpipe groundwater well measurements and groundwater infiltrations

Two standpipe wells were installed after the completion of borehole drilling in BH1 and BH4. The standpipes were installed to refusal (or termination) depth of each borehole and Table 2 includes a summary of water readings from these standpipe wells as well as groundwater inflows during drilling.

Table 2: Summary of Groundwater Levels and Inflows

Borehole	Date of Measurement	Groundwater Inflow Depth (m) [(a)] During Drilling	Groundwater Depth (m) [(a)]	Groundwater Depth RL (m AHD) [(b)]
BH1	28/1/15 [(e)]	0.9 to 1.5	-	-
	30/1/15	-	2.4[c]	35.6
	6/2/15	-	3.2[d]	34.8
BH2	27/1/15 [(e)]	Not observed	(f)	(f)
BH3	28/1/15 [(e)]	0.7 to 3	(f)	(f)
BH4	27 to 28/1/15 [(e)]	Not observed	-	-
	30/1/15	-	2.4[c]	32.6
	6/2/15	-	4.2[d]	30.8

Notes on Table 2:

(a) Measured from existing ground surface.
(b) RL inferred from plan provided (ref Appendix C).
(c) Measured after drilling and prior to developing well.
(d) Water was removed from well on 30/1/15 prior to measuring.
(e) Date of drilling.
(f) Standpipe well not installed.

6.2. Laboratory testing

Soil samples were sent to our NATA registered Coffey laboratory where the following tests were carried out:

- Five soil Moisture Content tests; and,
- Two Atterberg Limits tests.

Laboratory test results are included as Appendix B.

6.3. Footing Observations

Test pits were carried out adjacent to the existing terrace buildings to observe a selection of the buildings footings. Test pit locations are shown on Figure 2.

The footings comprise cement mortered bricks, sandstone blocks or pavers founded at the base of the fill materials on the residual soil (Unit 2) or directly on the fill (Unit 1b). The footings extended to 0.1 m to 0.9 m below existing ground surface (i.e. below pavements). Table 3 includes a summary of the observed footings.

Table 3: Summary of Terrace Footing Details

Test Pit	Footing Type	Footing Condition	Footing Depth (m)	Footing Base, RL (m AHD) [a]	Footing Width (m)	Material at Base of Footing
TP1	Brick	Apparent good condition	0.75	38.1	0.08	Residual Soil (Silty Clay)
TP2	Brick	Apparent good condition	0.60	37.9	0.08	
TP3 [b]	Paver	Poor (separation observed between pavers)	0.10	36.8	0.2 [e]	
TP3 [C]	Sandstone Block	Apparent good condition	0.90	37.6	0.2 [e]	
TP4	Brick	Apparent good condition	0.80	35.7	0.08	
TP5	Brick	Apparent good condition	0.60	34.4	0.08	
TP6	Brick	Apparent good condition	0.5	32.6	0.08	

Notes on Table 3:

(a) RL inferred from plan provided (ref Appendix C).
(b) Along west portion of wall.
(c) Along north portion of wall.
(d) No footing exposed at base of wall running northwest to southeast. A sandstone block footing exposed at northern portion of excavation.
(e) Estimated width.

Sketches 1 to 6 include a more detailed description of dimensions and subsurface materials for each test pit location undertaken near the terrace footings.

7. Discussion and recommendations

7.1. Earthworks

7.1.1. Site Preparation

At the time of report preparation the terraces currently are occupied by tenants. Infrastructure, including the rear terraces and pavements will need to be demolished and removed from site. Existing vegetation, mulch and topsoil within the building footprints will need to be stripped.

Whilst the bulk excavation drawings are not available for review it is understood that up to one level of removal depth may be required from the front terraces to the proposed rear terraces.

To prepare these areas, we recommend the removal of Fill - Pavements (Unit 1a) and Fill (Unit 1b) under the proposed building footprints such that either stiff (or better) Residual Soil (Unit 2) or Shale (Unit 3) – is exposed. In some areas it may be necessary to place fill to raise the ground floor level. In this situation and in any other areas requiring fill to support structures we recommend:

- Fill have a moisture content +/- 2% of Optimum Moisture Content and be compacted to a minimum Dry Density Ratio of 98% Standard Maximum Dry Density (SMDD) in layers not exceeding 300 mm loose thickness.

- The Engineered Fill should be constructed under Level 1 geotechnical inspection and testing as defined in AS3798-2007.
- Maximum particle size of materials shall be 60 mm. If existing fill is used, cobble size materials shall be removed, as well as any non-durable materials, such as porcelain fragments, plastics, etc.

Consideration should be given to re-using existing site materials where appropriate. Topsoil and mulch has been observed around the garden beds and planter areas in some areas of the site and could potentially be re-used for landscaping purposes only. The Phase II environmental report by Coffey Environments shall be reviewed for the suitability of re-use of the mulch and topsoils. Pavement materials and Fill may be re-used as an engineered fill subject to the recommendations provided above.

7.1.2. Excavation

Excavation in Fill (Units 1a/1b), Residual Soil (Unit 2) and majority of Shale (Unit 3) should be possible using conventional earthmoving equipment such as tracked loaders and hydraulic excavators. Excavation through some parts of Unit 3 may require rock breakers, rippers and/or rock saws. Contractors should be provided with the borehole logs and be required to make their own assessment of the suitability and productivity of specific plant.

Selection of excavation methods should also consider the magnitude of vibrations generated and their potential impact on adjacent buildings, which are cultural heritage listed. Where reduction of construction induced vibration is required, measures such as rock saws should be considered.

7.2. Groundwater

Groundwater levels vary slightly across the site commensurate with topographic levels. Based on the site investigation fieldwork, standpipe groundwater monitoring results from the subject site and adjacent Abercrombie site (to the south) the following observations and deductions were made:

- Seepage of water was observed in BH1 and BH3 within the Residual Soil, i.e. near the soil / bedrock interface.
- Groundwater was observed in the Shale slightly below the Residual Soil, at RL 34.8 m AHD (3.2 m below ground surface) and RL 30.8 m AHD (4.2 m below ground surface) in boreholes BH1 and BH4, respectively.
- On the property to the south (Abercrombie site) groundwater was encountered RL 22.9 m AHD (2 m below ground surface) to RL 30.3 m AHD (4 m below ground surface), near the interface of soil and bedrock.
- Bulk excavation levels have not been provided at this time. However a finished floor level of near 33.2 m AHD has been given for the basement in Building B. The basement may intersect the groundwater table in this area.
- The lowering of the groundwater table in the vicinity of the proposed development is not expected to cause appreciable settlement of surrounding structures because proposed excavations are relatively shallow and groundwater levels are likely to be transient.
- Water seepage through excavation faces is likely to occur through defects in the heavily fractured rock or through fissures in the clay.

Groundwater levels can be expected to vary with seasonal conditions. Groundwater levels above those encountered during the investigation are likely to occur following periods of high rainfall.

If excavations are required below the groundwater table, such as for building 'B', the control of groundwater during construction could be managed by either lowering the groundwater level by sump and pump means or by constructing a cut off wall to reduce water seepage into the excavation.

Consideration of uplift pressures through the base of excavations will be required during construction should a cut off wall be used. This could be managed by providing temporary pressure relief boreholes around the perimeter of the excavation.

The design may require consideration for a fully tanked structure or a structure with a permanent subfloor drainage system. Based on the low inflow rates expected and area for proposed basement, permanent management of the groundwater should be capable using a permanent sub floor drainage system. For such a system, consideration of the following is recommended:

- Discharge of building basement water seepage into the stormwater system would require approval from City of Sydney Council. To obtain this approval it may be necessary to carry out testing of groundwater to assess potential contamination. Coffey Environments will provide a separate report with test results of the groundwater.
- Treatment of water seepage from the basement may be required before discharge to the stormwater system or re-use as irrigation in other areas across the Sydney University Campus.
- City of Sydney Council may stipulate a hydrogeological assessment of groundwater before granting approval to install a subfloor drainage system that will cause localised lowering of the groundwater table.
- A drainage system will require permanent maintenance of pumps and facilities.
- The consequence of failure of the subfloor drainage system on the proposed development.

The design decision of whether to construct a fully tanked basement or otherwise will also impact on construction methods. For a fully tanked system a secant pile wall or diaphragm wall should be considered. A tanked option would need to consider uplift pressure particularly during construction when downward loads are low. It may be necessary to pile the slab or provide other drainage or tie down measures to resist uplift.

7.3. Support Requirements

7.3.1. Temporary Cut Batters and Slope Stability Issues

Unsupported batter slopes for excavations should only be considered for excavation above the water table. A retention system will be required for excavations below groundwater or in situations where insufficient room is available to form temporary batters.

Excavations in the Fill, Residual Soils (Silty Clay) and Shale (Class V) may stand temporarily at relatively steep slopes and even vertically for short periods. However such batters will be of marginal stability and could suffer instability, particularly in wet weather.

We recommend the following maximum unsupported batter slopes for excavations above the water table, provided surcharge loads are kept well clear of the crest of batters:

- Fill (Units 1b) and Residual Soil (Unit 2)
    - 2 horizontal (H) : 1 vertical (V)

- Shale (Class V) (Unit 3)
    - 1.5H: 1V

If shallow vertical cuts suit construction works, temporary benching may be adopted with a maximum bench height of 1.2 m in Fill (Unit 1b) and Residual Soil (Unit 2). An experienced Engineering Geologist or Geotechnical Engineer can review exposed materials if a greater bench height is required.

7.3.2. Shoring

If there is insufficient room for unsupported batter slopes, some form of shoring will be required to support the excavations in soil and weathered shale. For this project shoring systems such as soldier piles with shotcrete infill panels or contiguous pile walls could be considered.

Where anchors are required these should be inclined downwards and installed into weathered rock. The use of temporary or permanent anchors under the adjoining streets and properties is likely to require owner's permission. Retaining walls/pile elements will have to be specifically sized and designed to support any adjacent structures or surcharge loads that lie within the excavation zone of influence.

Design parameters as provided in the following sections may be used for shoring design.

7.3.3. Retention Systems

The design of retention systems will need to consider the impact of excavating below groundwater. The selection of a suitable retention system depends on whether a fully tanked structure or a structure with a permanent subfloor drainage system is built.

For preliminary retaining wall design, we recommend the design parameters in Table 4.

Table 4: Recommended Design Parameters for Retaining Wall Design

Geotechnical Unit	Active Earth Pressure Coefficient (K_a)	At Rest Earth Pressure Coefficient (K_0)	Passive Earth Pressure Coefficient K_p	Bulk Density (kN/m^3)	Drained Cohesion c' (kPa)	Effective Friction ϕ' (^{o})	Elastic Modulus (MPa)
Unit 1 - Fill	0.4	0.5	2.5	20	0	25	3
Unit 2 – Residual Soil	0.4	0.5	2.5	20	5	25	20
Unit 3 – Shale (Class V)	0.33	0.5	3.0	23	25	30	100

The earth pressure coefficients in Table 4 assume horizontal ground surface at the crest and toe of the retaining wall. If this is not the case then the coefficient should be modified or surcharges added, as necessary. Lateral displacements of retaining walls designed assuming 'active' earth pressures could be up to 1% of the retained height. If such movements cannot be tolerated, or where ground anchors restrain retaining wall movement, then wall should be designed for higher earth pressure coefficients such as the K_o values given.

Where the walls are cantilevered or supported by a single row of anchors, retaining walls can be designed assuming a triangular earth pressure distribution.

For preliminary design of retaining walls, which are anchored or strutted at several levels, design can be based on the trapezoidal earth pressure distribution as shown in Table 5.

Table 5: Trapezoidal Pressure Distribution

Depth (m)	Horizontal Pressure (kPa)
0	$K.p_s$
0.25 H	$K\ (0.8.\gamma.H + p_s)$
0.75 H	$K\ (0.8.\gamma.H + p_s)$
H	$K.p_s$

Where:

K = Earth pressure coefficient which depends upon material type; whether movement needs to be limited as discussed above.

ps = Design surcharge pressure (kPa).

H = Thickness of layer being retained (m).

γ = Bulk unit weight (kN/m^3)

Hydrostatic pressures should be added to earth pressures unless walls can be provided with effective drainage, and pressures due to adjacent footings will also need to be taken into account. The above pressures assume level ground above the retaining wall. Surcharge loads should be added to earth pressures, as appropriate.

Retaining wall design involves complex soil structure interaction. Coffey has specialist capability on design of retaining walls and would be pleased to assist in refining preliminary design based on recommendations in this section.

7.3.4. Anchor Design

Temporary ground anchors may be required to support retention systems until permanent support can be provided. Ground anchors can be constructed by drilling and grouting based on the following allowable bond stresses shown in Table 6 below.

Table 6: Ultimate Bond Stresses for Anchors

Material	Ultimate Bond Stress (kPa)
Unit 2 - Residual Soil	50
Unit 3 - Class V Shale	75

Anchors should be checked for an anchor pullout failure mechanism assuming a 45^o failure cone in addition to bond strength.

We recommend anchor drill holes be cleaned and flushed prior to anchor and grout installation. Testing of temporary anchors is recommended by applying load increments up to 125% of the working load.

7.4. Foundations

Based on the brief by Taylor Thomson Whiting (NSW) Pty Ltd (TTW) the new buildings will consist of slab on ground with two suspended levels. It is understood that conventional pad or strip footings, piles to rock or combination of conventional footings and bored piles to rock will be utilised during site development. At this time building loads have not been provided.

The base of excavation for the majority of the proposed development will be located in residual soil, shale and engineered fill. It is recommended to excavate and re-compact some or all of the existing fill and any loose natural subgrade to reduce variability within the building footprints.

7.4.1. Shallow footings

If shallow footings are adopted, there is the potential for differential settlement due to varying foundation conditions. To avoid this all footings are founded in the same geotechnical unit. The following recommendations in Table 7 below are provided as a guide for strip or pad footing design.

Table 7: Shallow Strip or Pad Footing Bearing Pressures

Material	Serviceability End Bearing (kPa) (b)
Engineered Fill [(a)]	150
Unit 2 - Residual Soil, stiff consistency or better [(c)]	150
Unit 3 - Class V Shale	700

Notes on Table 7:

(a) as described in Section 7.1.1.
(b) Provided footings are founded greater than 600mm below the bulk excavation.
(c) Shall be assessed by a geotechnical engineer prior to concrete pour.

The use of allowable bearing pressures would be expected to result in settlement less than about 1% of footing width.

A geotechnical engineer should observe strip and pad footing excavations and assess the adequacy of the bearing stratum for the bearing pressures adopted.

7.4.2. Bored Piles

Potential issues associated with differential settlement can be avoided by the design of bored pile footings founded in rock. We recommend the geotechnical parameters provided in Table 8 be adopted.

Table 8: Recommended Pile Design Parameters

Geotechnical Unit	Ultimate Shaft Adhesion (kPa) [(a, d, e)]	Allowable Shaft Adhesion (kPa) [(a, d, e)]	Ultimate End Bearing Value (kPa) [(b, c, d)]	Serviceability End Bearing Value (kPa) [(b, c, d, f)]	Ultimate Lateral Yield Pressure, p_y, (kPa)	Young's Modulus (MPa)
1. Fill	-	-	-	-	-	-
2. Residual Soil	40	25	-	-	500	15
3. Shale (Class V)	75	40	3000	700	750	50

Notes on Table 8:

(a) Shaft adhesion in rock should only be adopted where piles have a minimum embedment of at least 2 pile diameters into the relevant stratum. Where piles are socketed in rock, shaft adhesion in soils to be ignored.

(b) To adopt the end bearing values piles should have a minimum embedment of 0.5 m into the relevant bearing stratum.

(c) Piles end bearing on fill or clay are not recommended.

(d) Ultimate shaft adhesion and end bearing pressure for shale in accordance with Pells et al (1998) "Foundations on Sandstone and Shale in the Sydney Region" Aust. Geomech. Jnl, Dec 1998.

(e) For uplift loads the tabulated shaft adhesion values should be multiplied by 0.7 in addition to the application of appropriate geotechnical strength reduction factors.

(f) Serviceability end bearing pressures quoted above are based on a footing settlement within 1% of the footing width as suggested by Pells et al (1998). Higher design values may be possible if appropriate assessment of footing performance is carried out. Serviceability should be assessed using the modulus value to check that settlements are within tolerable limits.

For limit state design a geotechnical reduction factor (Φg) is to be applied to the ultimate geotechnical pile capacity assessed using the ultimate shaft resistance and end bearing values shown in Table 8 to derive the design ultimate geotechnical pile capacity.

In accordance with AS2159-2009, Φg is dependent on assignment of an Average Risk Rating (ARR) which takes into account various geotechnical uncertainties, redundancy of the foundation system, construction supervision, and the quantity and type of pile testing. The assessment of Φg therefore depends on the structural design of the foundation system as well as the design and construction method, and testing (if any) to be employed by the designer and piling contractor. Where testing is undertaken, it may be possible to adopt a Φg value that leads to a more economical design.

To assist you with preliminary design, Coffey recommends a Φg value of 0.5 assuming some pile load testing and verification will be specified. However, once the pile designer has evaluated the ARR, this value could be revised and we recommend that Coffey review the resulting Φg.

The use of limit state design also requires that serviceability performance of the foundation system be assessed, including pile group interaction effects. Such assessment should be carried out by an experienced geotechnical professional using well-established and soundly based methods. The elastic modulus values given in Table 8 may be adopted for such assessment, but it should be recognised that the accuracy of settlement prediction is a function of construction methodology as well as the assessed values of material stiffness, both of which can involve considerable uncertainty. Therefore, the accuracy of settlement predictions may be no better than ± 50%. Where foundation settlement is critical to the performance of the structure, serviceability pile load testing should be carried out to confirm the design assumptions and/or assess prediction accuracy.

7.5. Earthquake design

We recommend that the site be classified as Class C_e in accordance with the site sub-soil classes defined in AS1170.4-2007 Part 4, Earthquake Actions in Australia. A hazard factor of 0.08 is recommended.

7.6. Recommendations for further assessments

Based on the proposed basements and depth to the groundwater table it is recommended that a hydrogeological study be carried out for the site. Currently information required and the type of system planned (i.e. fully tanked or drained) is not available. Coffey can carry out further studies at the site as required and when more information is made available.

Coffey services, such as the following (but not limited to) can be carried out as required:

- Design reviews, including review of foundation systems, retaining walls, etc.; and,
- Construction monitoring, including footing excavation inspections, groundwater monitoring and assessments of ground conditions.

8. LIMITATIONS

The geotechnical model and recommendations in this report are based on a limited number of boreholes and test pits. The engineering logs describe subsurface conditions only at the specific borehole locations. Ground conditions can vary over relatively close distances and a geotechnical engineer should be engaged at the construction stage to assess whether site conditions are consistent with design assumptions.

The attached document entitled “Important Information about your Coffey Report” presents additional information about the uses and limitations of this report.

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment.
Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

Figures

LEGEND

SITE BOUNDARY

20 0 20 40 60 80 100

Scale (metres) 1:2000

AERIAL IMAGE SOURCE: GOOGLE EARTH PRO 7.1.2
AERIAL IMAGE ©: SINCLAIR KNIGHT MERZ 2014

drawn	JM / AW
approved	-
date	26 / 02 / 15
scale	AS SHOWN
original size	A4

coffey

client: UNIVERSITY OF SYDNEY

project: 00-02 DARLINGTON ROAD TERRACES
00-02 DARLINGTON ROAD, DARLINGTON, NSW

title: SITE LOCATION PLAN

project no: GEOTLCOV25176AA-AF | figure no: FIGURE 1 | rev: B

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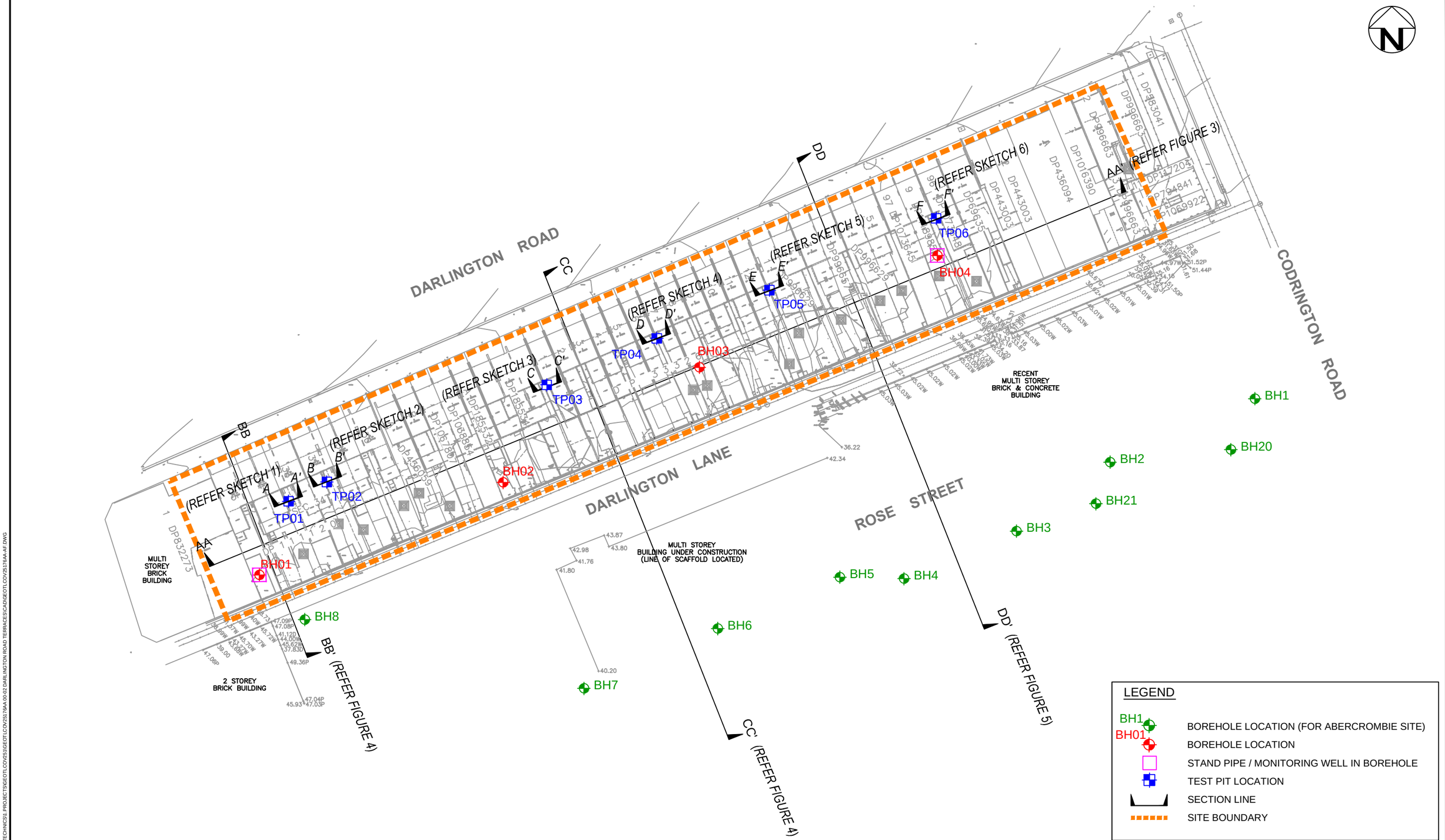

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	B	COLOUR TO UNITS, LEGEND EDITS	JM	-	26/03/15

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Scale (metres) 1:750

drawn	JM / AW
approved	-
date	26 / 02 / 15
scale	AS SHOWN
original size	A3

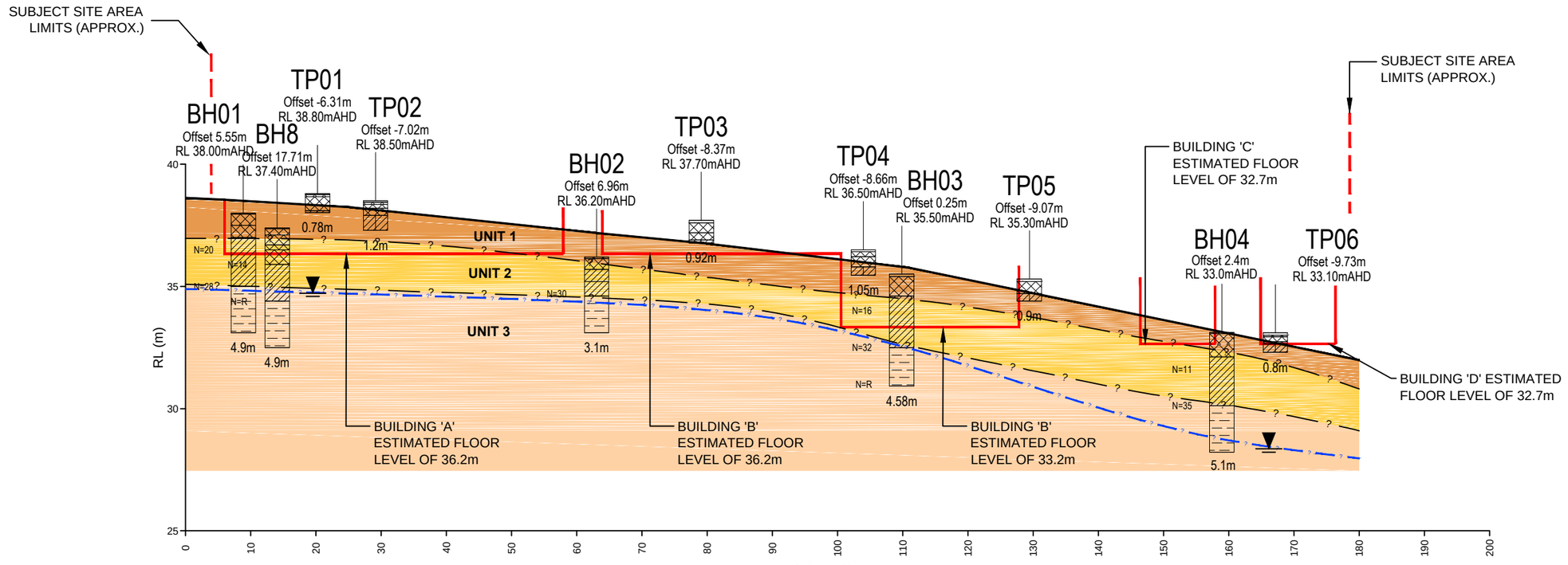
coffey

client: UNIVERSITY OF SYDNEY

project: 00-02 DARLINGTON ROAD TERRACES
00-02 DARLINGTON ROAD, DARLINGTON, NSW

title: INVESTIGATION LOCATION PLAN

project no: GEOTLCOV25176AA-AF | figure no: FIGURE 2 | rev: B



SECTION AA-AA'

NOTE:
REF: AJ&C DRAWINGS FOR DARLINGTON ROAD TERRACES, DATED 24/02/2015.
REF: MONTEATH & POWYS DETAIL SURVEY OF SYDNEY UNIVERSITY STUDENT ACCOMODATION, DARLINGTON ROAD, DARLINGTON, DATED 22/09/2014, SHEETS 1 TO 9.

LEGEND

- TOPSOIL
- FILL
- CLAY
- SHALE
- SILT
- CONCRETE
- SILTY CLAY
- ASPHALT
- N=17 STANDARD PENETRATION TEST RESULT
- APPROXIMATE GROUND SURFACE
- EXISTING GROUND LEVEL ALONG SECTION LINE (APPROX.)
- INTERPRETED GEOTECHNICAL UNIT BOUNDARY
- INTERPRETED GROUNDWATER TABLE
- UNIT 1 - FILL
- UNIT 2 - RESIDUAL SOIL
- UNIT 3 - SHALE (CLASS V)

revision

no.	description	drawn	approved	date
A	ORIGINAL ISSUE	JM	-	24/02/15
B	COLOUR TO UNITS, LEGEND EDITS	JM	-	26/03/15

Vertical Scale (metres) 1:200

Horizontal Scale (metres) 1:750

drawn	JM / AW
approved	-
date	26 / 02 / 15
scale	AS SHOWN
original size	A3

coffey

client: UNIVERSITY OF SYDNEY

project: 00-02 DARLINGTON ROAD TERRACES
00-02 DARLINGTON ROAD, DARLINGTON, NSW

title: SECTION AA-AA'

project no: GEOTLCOV25176AA-AF | figure no: FIGURE 3 | rev: B

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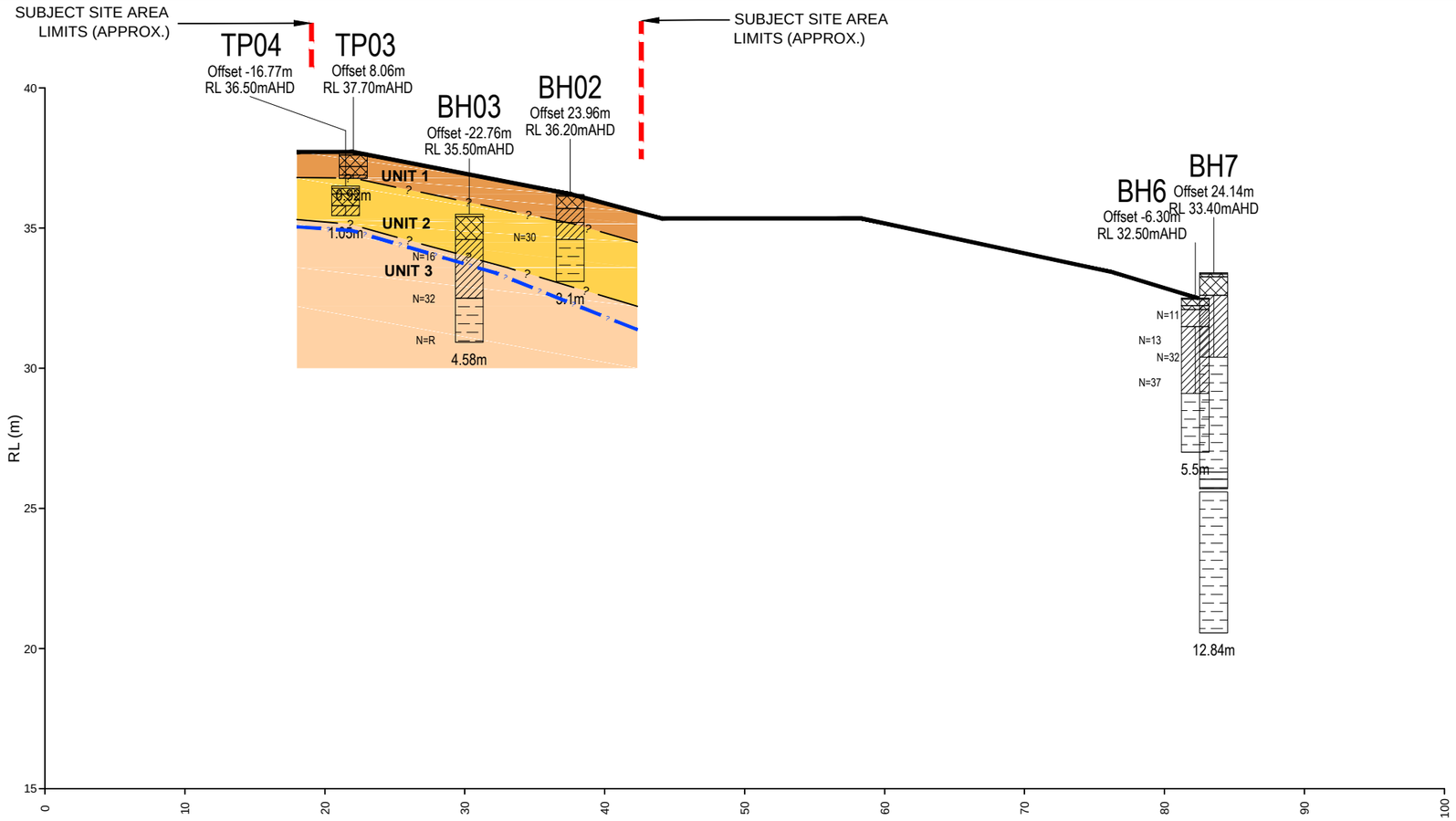
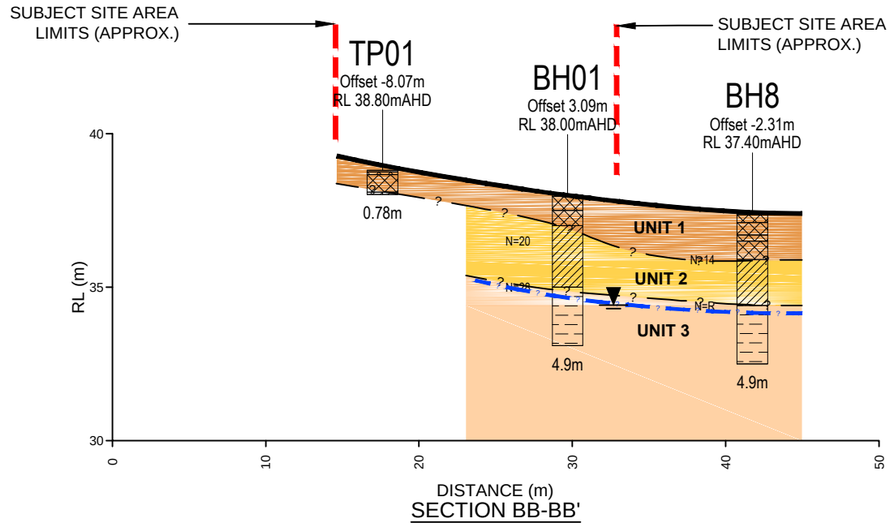


SECTION CC-CC'



SECTION BB-BB'

NOTE:
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REF: MONTEATH & POWYS DETAIL SURVEY OF SYDNEY UNIVERSITY STUDENT ACCOMODATION, DARLINGTON ROAD, DARLINGTON, DATED 22/09/2014, SHEETS 1 TO 9.

LEGEND

TOPSOIL	APPROXIMATE GROUND SURFACE
FILL	EXISTING GROUND LEVEL ALONG SECTION LINE (APPROX.)
CLAY	INTERPRETED GEOTECHNICAL UNIT BOUNDARY
SHALE	INTERPRETED GROUNDWATER TABLE
SILT	UNIT 1 - FILL
CONCRETE	UNIT 2 - RESIDUAL SOIL
SILTY CLAY	UNIT 3 - SHALE (CLASS V)
ASPHALT	
N=17 STANDARD PENETRATION TEST RESULT	

revision

no.	description	drawn	approved	date
A	ORIGINAL ISSUE	JM	-	24/02/15
B	COLOUR TO UNITS, LEGEND EDITS	JM	-	26/03/15

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Vertical Scale (metres) 1:200
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Horizontal Scale (metres) 1:400

drawn	JM / AW
approved	-
date	26 / 02 / 15
scale	AS SHOWN
original size	A3

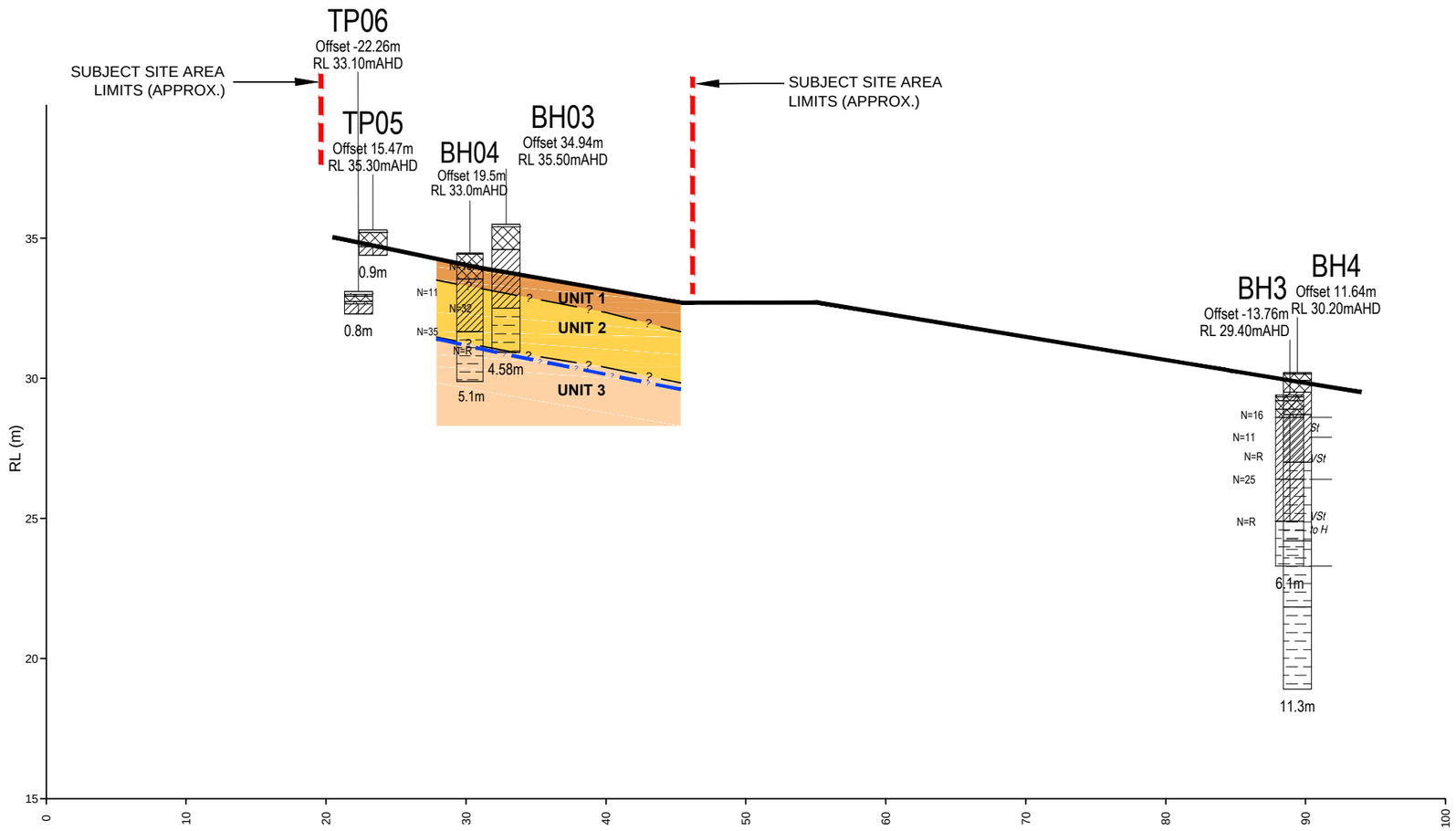
coffey

client: UNIVERSITY OF SYDNEY

project: 00-02 DARLINGTON ROAD TERRACES
00-02 DARLINGTON ROAD, DARLINGTON, NSW

title: SECTION BB-BB' AND SECTION CC-CC'

project no: GEOTLCOV25176AA-AF | figure no: FIGURE 4 | rev: B



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REF: MONTEATH & POWYS DETAIL SURVEY OF SYDNEY UNIVERSITY STUDENT ACCOMODATION, DARLINGTON ROAD, DARLINGTON, DATED 22/09/2014, SHEETS 1 TO 9.

LEGEND

TOPSOIL	APPROXIMATE GROUND SURFACE
FILL	EXISTING GROUND LEVEL ALONG SECTION LINE (APPROX.)
CLAY	INTERPRETED GEOTECHNICAL UNIT BOUNDARY
SHALE	INTERPRETED GROUNDWATER TABLE
SILT	UNIT 1 - FILL
CONCRETE	UNIT 2 - RESIDUAL SOIL
SILTY CLAY	UNIT 3 - SHALE (CLASS V)
ASPHALT	
N=17 STANDARD PENETRATION TEST RESULT	

revision

no.	description	drawn	approved	date
A	ORIGINAL ISSUE	JM	-	24/02/15
B	COLOUR TO UNITS, LEGEND EDITS	JM	-	26/03/15

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Vertical Scale (metres) 1:200

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Horizontal Scale (metres) 1:400

drawn	JM / AW
approved	-
date	26 / 02 / 15
scale	AS SHOWN
original size	A3

coffey

client: UNIVERSITY OF SYDNEY

project: 00-02 DARLINGTON ROAD TERRACES
00-02 DARLINGTON ROAD, DARLINGTON, NSW

title: SECTION DD-DD'

project no: GEOTLCOV25176AA-AF | figure no: FIGURE 5 | rev: B

Sketches

coffey

Computations Project No: GEOTLCOV25176AA Sheet 1 of 6

Client: University of Sydney Office: CHAT

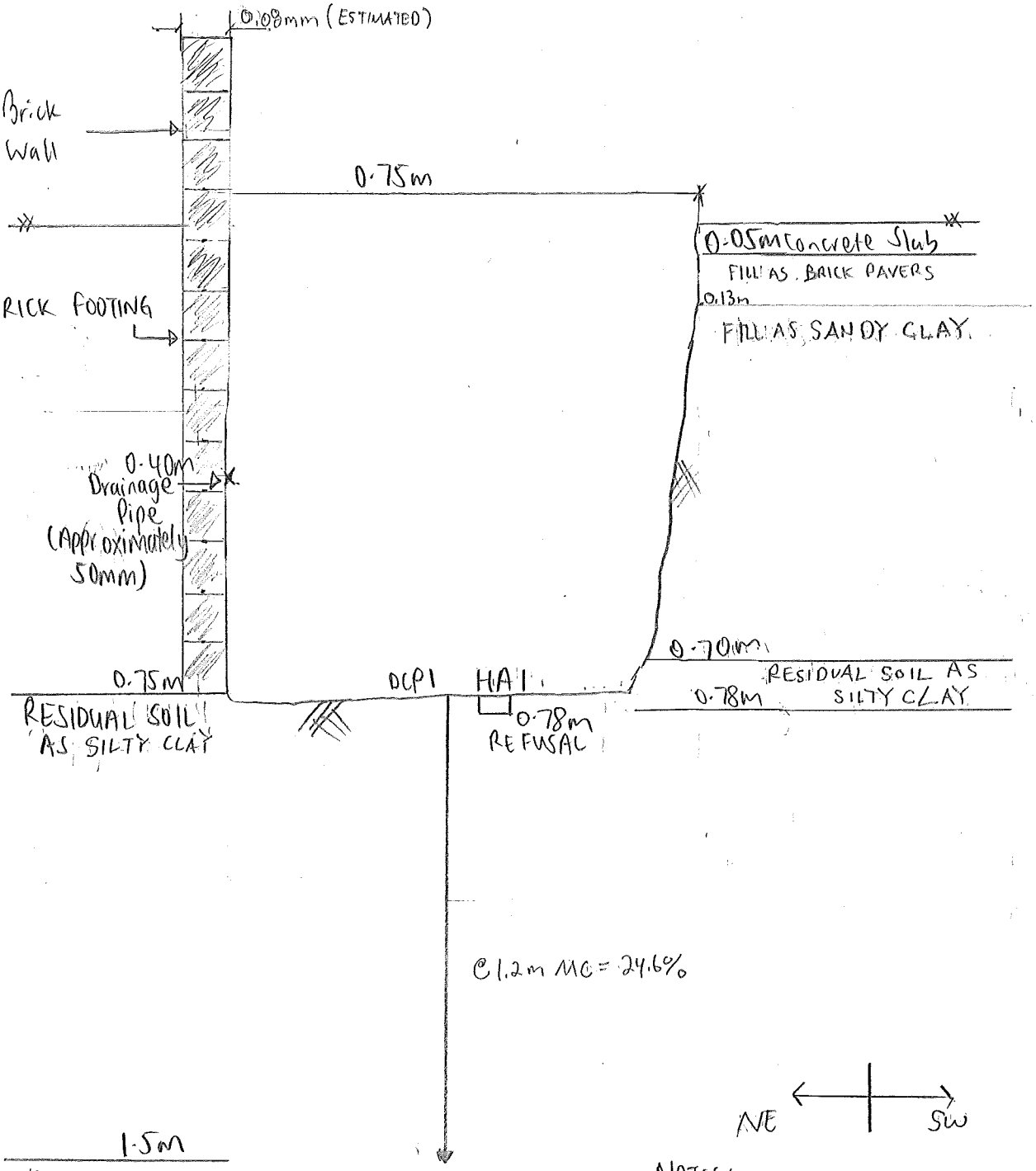
Principal: Date: 29/1/2015

Project: 00-02 Darlington Rd. Terraces By: SV

Location: Darlington, NSW Checked: JJM

SKETCH 1

TP1 - CROSS SECTION A-A'



LEGEND

HA - HAND AUGER
DCP - DYNAMIC CONE PENETROMETER
MLL - MEDIUM LIQUID LIMIT
HLL - HIGH LIQUID LIMIT
MC - MOISTURE CONTENT

SCALE 1:10

0 0.1m 0.2m 0.3m

NOTES:

1. DEPTHS MEASURED BELOW EXISTING GROUND SURFACE.
2. LOCATION EXTENTS ARE APPROXIMATE
3. REFERENCE FIGURE 1 FOR SECTION LOCATION
4. REFERENCE TEST PIT LOGS FOR MORE INFORMATION

64200/04-14

coffey

Computations Project No: GEOTLCOV25176AA Sheet 2 of 6

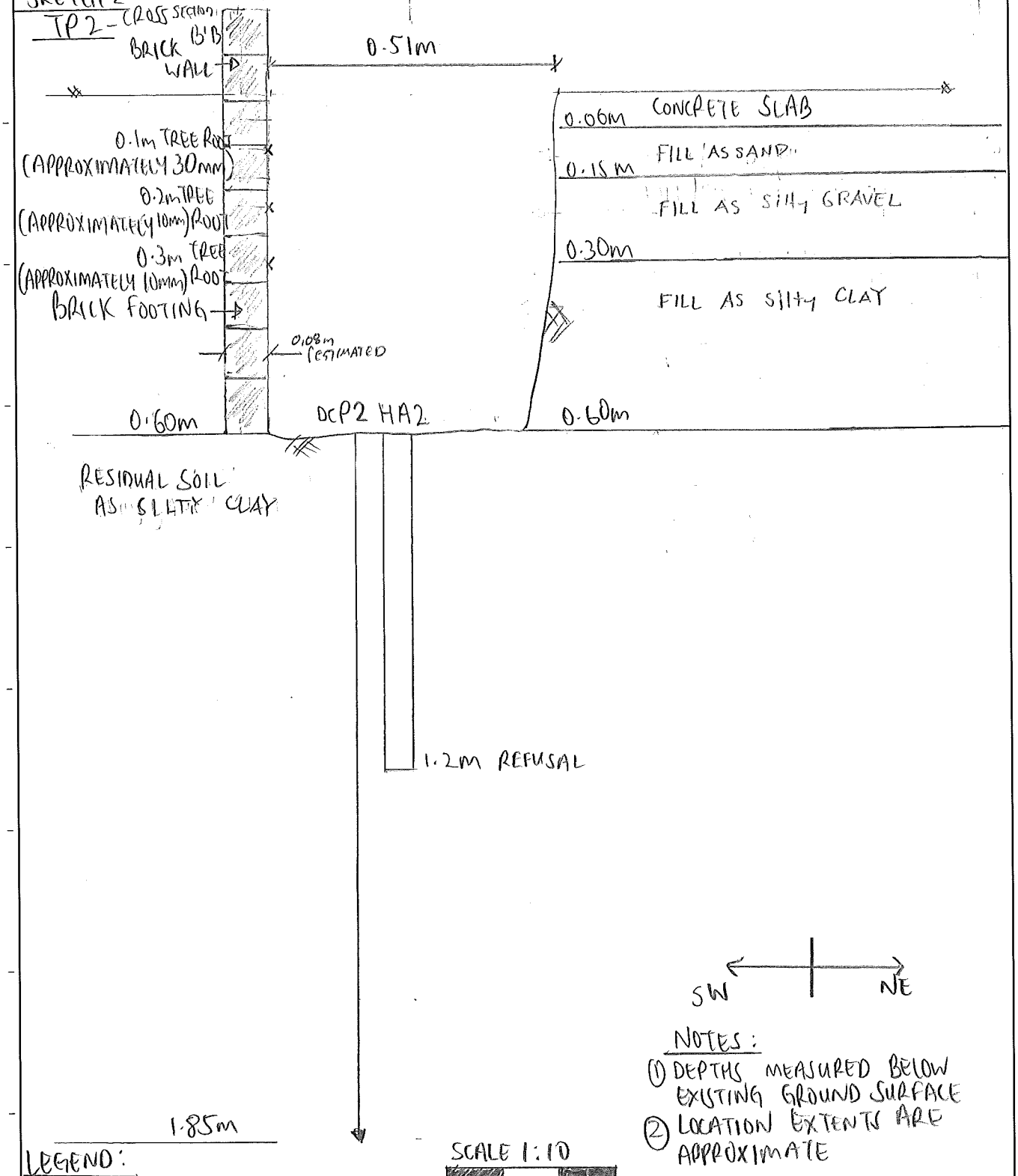
Client: University of Sydney Office: CHAT

Principal: Date: 29/1/2015

Project: 00-02 Darlington Rd. Terraces By: SV

Location: Darlington, NSW Checked: JJM

SKETCH 2



NOTES:
1. DEPTHS MEASURED BELOW EXISTING GROUND SURFACE
2. LOCATION EXTENTS ARE APPROXIMATE
3. REFERENCE FIGURE 1 FOR SECTION LOCATIONS.
4. REFERENCE TEST PIT LOGS FOR MORE INFORMATION

SCALE 1:10 0 0.1m 0.2m 0.3m

LEGEND:
HA - HAND AUGER
DCP - DYNAMIC CONE PENETROMETER
MLL - MEDIUM LIQUID LIMIT, HLL - HIGH LIQUID LIMIT

coffey

Computations Project No: GEOTLCOV25176AA Sheet 3 of 6

Client: University of Sydney Office: CHAT

Principal: Date: 29/1/2015

Project: 00-02 Darlington Rd. Terraces By: SV

Location: Darlington, NSW Checked: JJM

SKETCH 3

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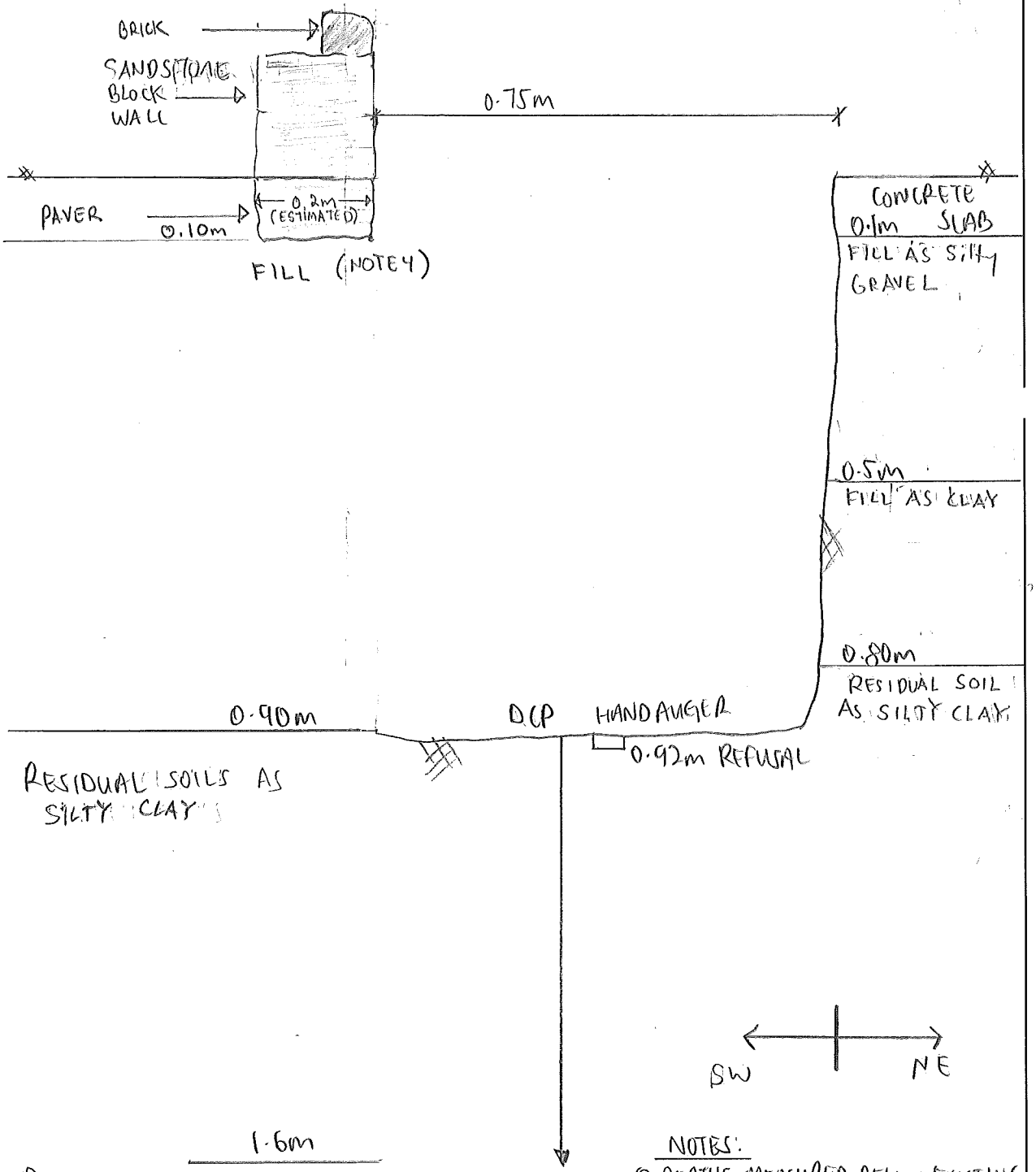

LEGEND

HA - HAND AUGER
DCP - DYNAMIC CONE PENETROMETER
MLL - MEDIUM LIQUID LIMIT
HLL - HIGH LIQUID LIMIT

SCALE 1:10

0m 0.1m 0.2m 0.3m

NOTES:

1. DEPTHS MEASURED BELOW EXISTING GROUND SURFACE
2. LOCATION EXTENTS ARE APPROXIMATE
3. REFERENCE FIGURE 1 FOR SECTION LOCATION
4. SANDSTONE BLOCK WALL

BLG - BELOW GROUND SURFACE ON NORTH SIDE OF PIT EXTENDS TO 0.9m BGS

64200/04-14

coffey

Computations Project No: GEOTLCOV25176AA Sheet 4 of 6

Client: University of Sydney Office: CMAT

Principal: Date: 29/1/2015

Project: 00-02 Darlington Rd - Terraces By: SV

Location: Darlington, NSW Checked: JJM

SKETCH 4

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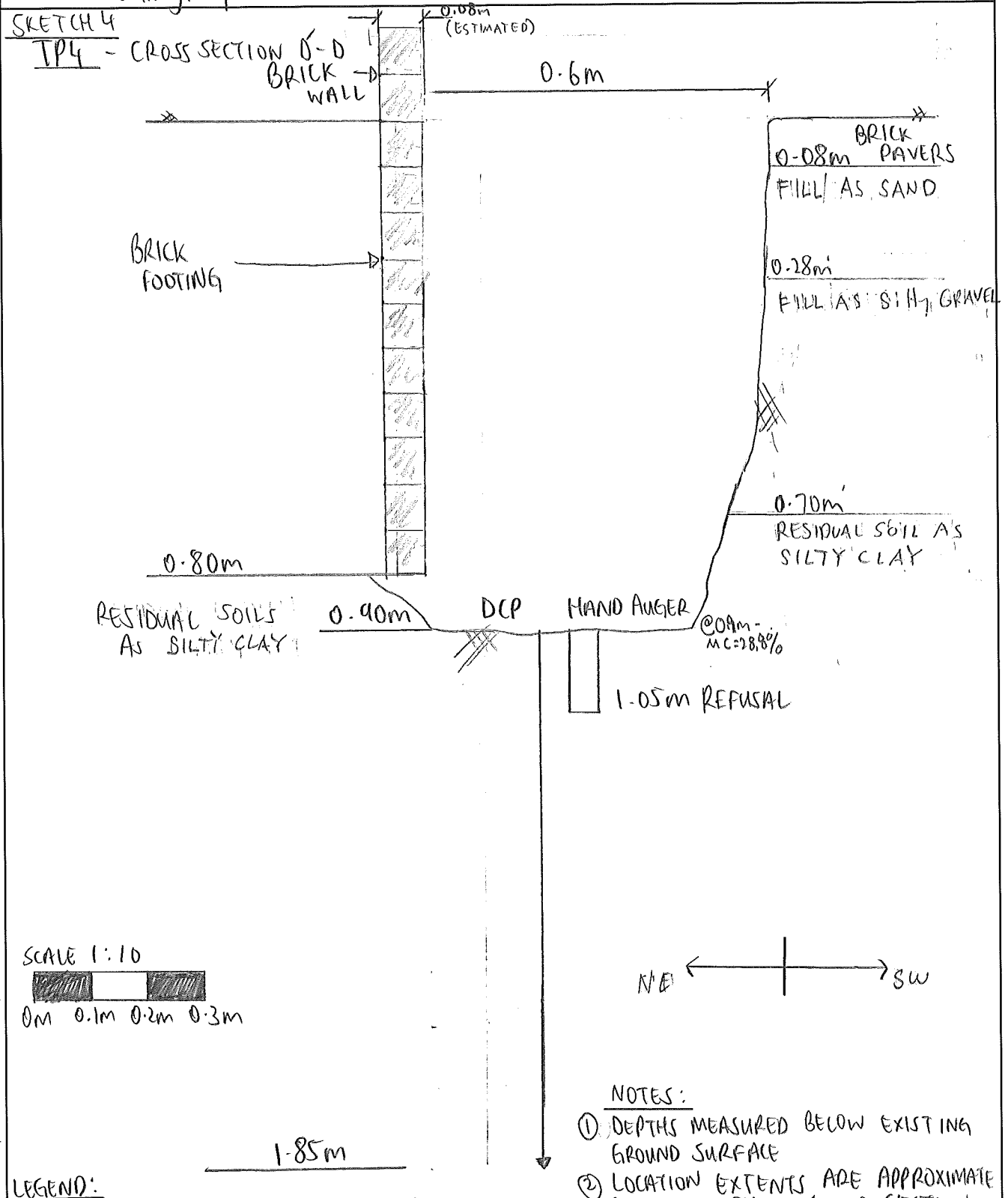


NOTES:

1. DEPTHS MEASURED BELOW EXISTING GROUND SURFACE
2. LOCATION EXTENTS ARE APPROXIMATE
3. REFERENCE FIGURE 1 FOR SECTION LOCATION
4. REFERENCE TEST PIT LOGS FOR MORE INFORMATION.

LEGEND:

HA - HAND AUGER, DCP - DYNAMIC CONE PENETROMETER
MLL - MEDIUM LIQUID LIMIT, HLL - HIGH LIQUID LIMIT
MC - MOISTURE CONTENT

coffey

Computations Project No: GEOTLCOV25176AA Sheet 5 of 6

Client: University of Sydney | Office: CHAT

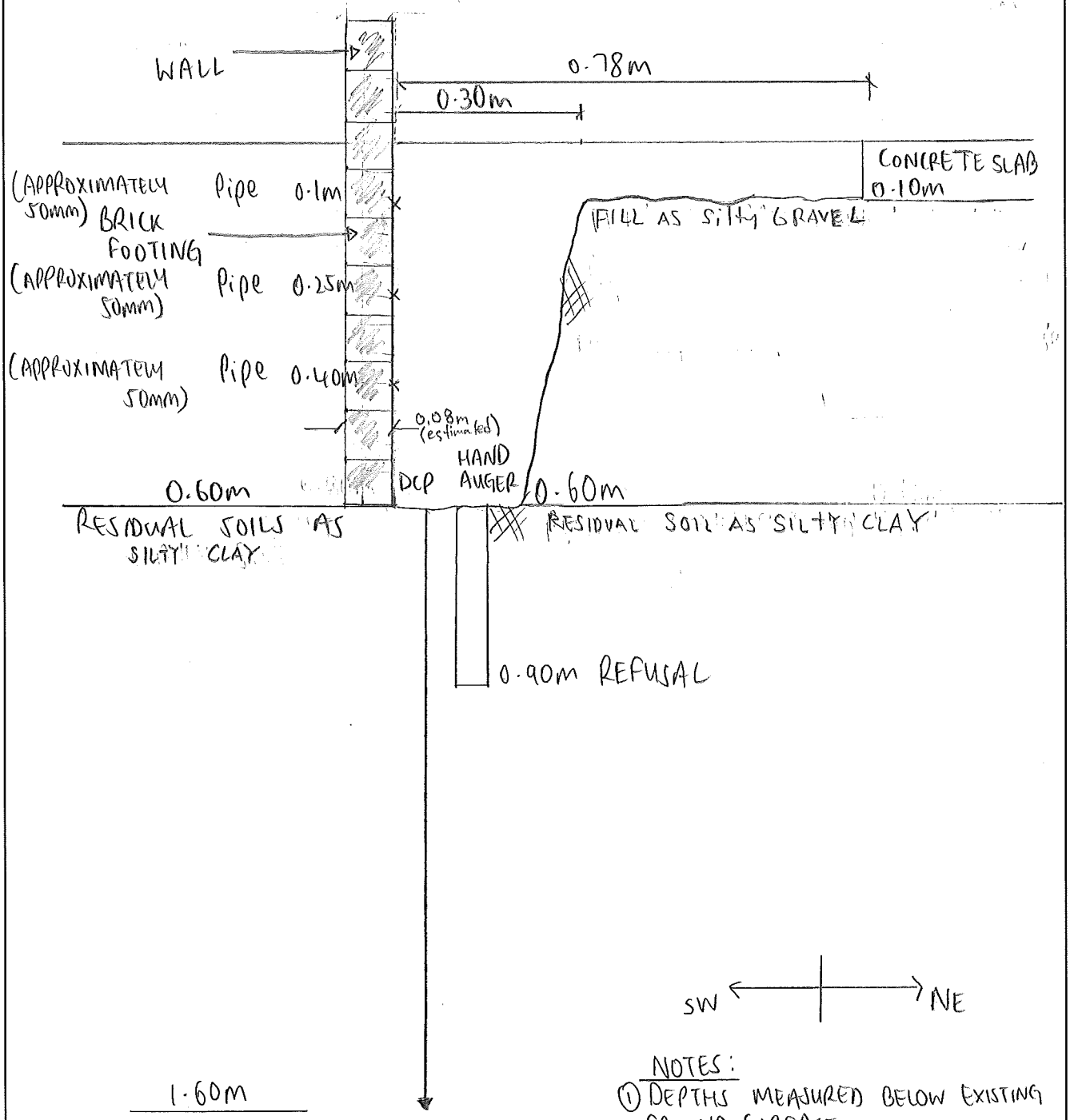
Principal: | Date: 29/1/2015

Project: 00-02 Darlington Rd. Terraces | By: SV

Location: Darlington, NSW | Checked: JJM

SKETCH 5

TP5 - CROSS SECTION E-E'



NOTES:

1. DEPTHS MEASURED BELOW EXISTING GROUND SURFACE.
2. LOCATION EXTENTS ARE APPROXIMATE
3. REFERENCE FIGURE 1 FOR SECTION LOCATIONS.
4. REFERENCE TEST PIT LOGS FOR MORE INFORMATION

LEGEND

HA - HAND AUGER
DCP - DYNAMIC CONE PENETROMETER
MLL - MEDIUM LIQUID LIMIT
HLL - HIGH LIQUID LIMIT

SCALE 1:10

0m 0.1m 0.2m 0.3m

64200/04-14

coffey

Computations

Project No: GEOTLCOV25176AA Sheet 6 of 6

Client: University of Sydney

Office: CHAT

Principal:

Date: 29/1/2015

Project: 00-02 Darlington Rd. Terraces

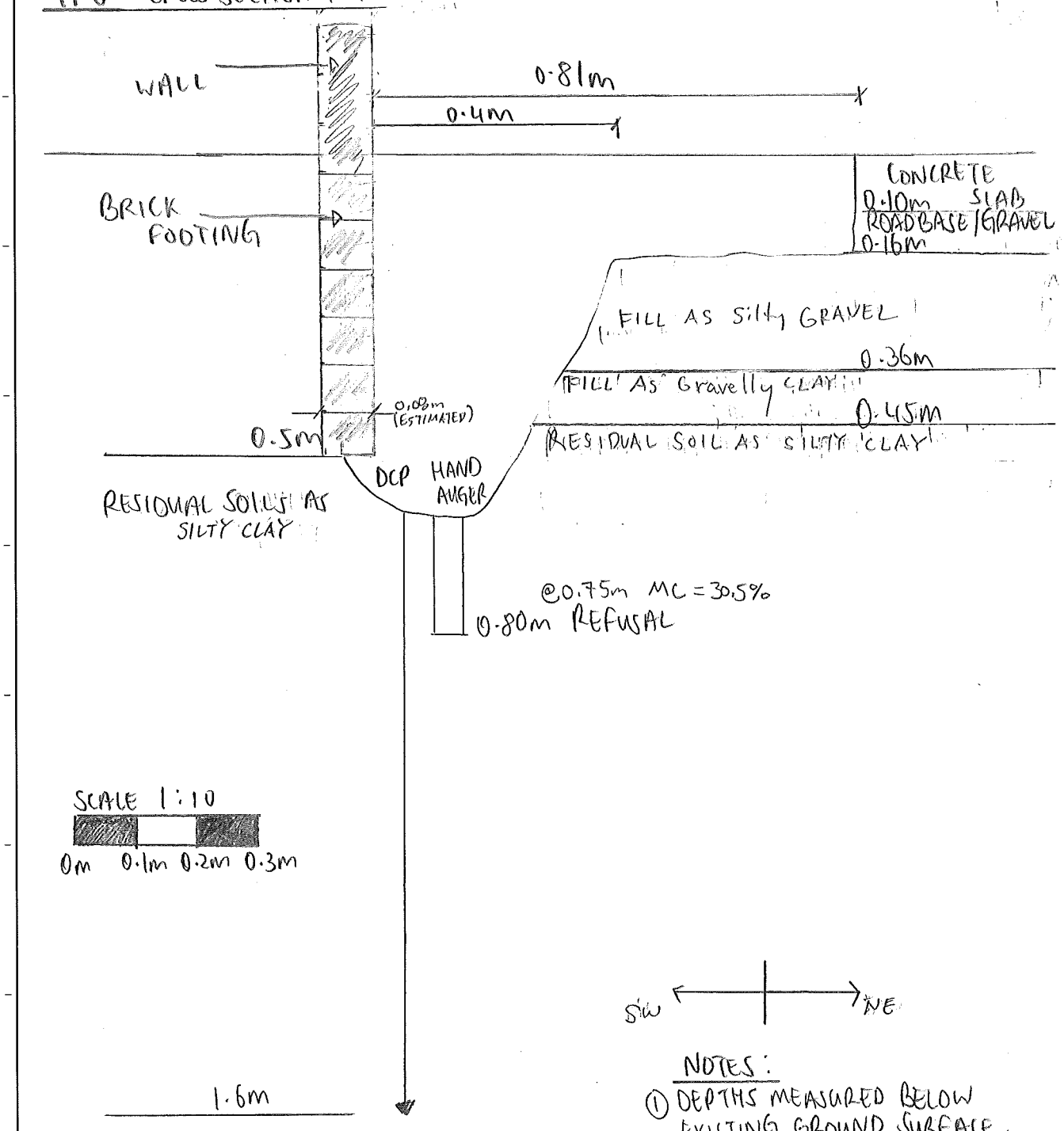
By: SV

Location: Darlington, NSW

Checked: JJM

SKETCH 6

TP6 - CROSS SECTION F-F'



LEGEND

HA - HAND AUGER
DCP - DYNAMIC CONE PENETROMETER
MLL - MEDIUM LIQUID LIMIT
HLL - HIGH LIQUID LIMIT

NOTES:

1. DEPTHS MEASURED BELOW EXISTING GROUND SURFACE.
2. LOCATION EXTENTS ARE APPROXIMATE.
3. REFERENCE FIGURE 1 FOR SECTIONS
4. REFERENCE TEST PIT LOGS FOR MORE INFORMATION

64200 / 04-14

Appendix A - Engineering Logs, Test Pit Photographs and Explanation Sheets

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Rock Description Explanation Sheet (1 of 2)

The descriptive terms used by Coffey are given below. They are broadly consistent with Australian Standard AS1726-1993.

DEFINITIONS: Rock substance, defect and mass are defined as follows:

Rock Substance	In engineering terms roch substance is any naturally occurring aggregate of minerals and organic material which cannot be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Effectively homogenous material, may be isotropic or anisotropic.
Defect	Discontinuity or break in the continuity of a substance or substances.
Mass	Any body of material which is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects.

SUBSTANCE DESCRIPTIVE TERMS:

ROCK NAME	Simple rock names are used rather than precise geological classification.
PARTICLE SIZE	Grain size terms for sandstone are:
Coarse grained	Mainly 0.6mm to 2mm
Medium grained	Mainly 0.2mm to 0.6mm
Fine grained	Mainly 0.06mm (just visible) to 0.2mm
FABRIC	Terms for layering of penetrative fabric (eg. bedding, cleavage etc.) are:
Massive	No layering or penetrative fabric.
Indistinct	Layering or fabric just visible. Little effect on properties.
Distinct	Layering or fabric is easily visible. Rock breaks more easily parallel to layering of fabric.

CLASSIFICATION OF WEATHERING PRODUCTS

Term	Abbreviation	Definition
Residual Soil	**RS**	Soil derived from the weathering of rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely Weathered Material	**XW**	Material is weathered to such an extent that it has soil properties, ie, it either disintegrates or can be remoulded in water. Original rock fabric still visible.
Highly Weathered Rock	**HW**	Rock strength is changed by weathering. The whole of the rock substance is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Some minerals are decomposed to clay minerals. Porosity may be increased by leaching or may be decreased due to the deposition of minerals in pores.
Moderately Weathered Rock	**MW**	The whole of the rock substance is discoloured, usually by iron staining or bleaching , to the extent that the colour of the fresh rock is no longer recognisable.
Slightly Weathered Rock	**SW**	Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance (usually by limonite) has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance.
Fresh Rock	**FR**	Rock substance unaffected by weathering.

Notes on Weathering:

1. AS1726 suggests the term "Distinctly Weathered" (DW) to cover the range of substance weathering conditions between XW and SW. For projects where it is not practical to delineate between HW and MW or it is judged that there is no advantage in making such a distinction. DW may be used with the definition given in AS1726.
2. Where physical and chemical changes were caused by hot gasses and liquids associated with igneous rocks, the term "altered" may be substituted for "weathering" to give the abbreviations XA, HA, MA, SA and DA.

ROCK SUBSTANCE STRENGTH TERMS

Term	Abbrev-iation	Point Load Index, I_S50 (MPa)	Field Guide
Very Low	**VL**	Less than 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; pieces up to 30mm thick can be broken by finger pressure.
Low	**L**	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show with firm bows of a pick point; has a dull sound under hammer. Pieces of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	**M**	0.3 to 1.0	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High	**H**	1 to 3	A piece of core 150mm long by 50mm can not be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High	**VH**	3 to 10	Hand specimen breaks after more than one blow of a pick; rock rings under hammer.
Extremely High	**EH**	More than 10	Specimen requires many blows with geological pick to break; rock rings under hammer.

Notes on Rock Substance Strength:

1. In anisotropic rocks the field guide to strength applies to the strength perpendicular to the anisotropy. High strength anisotropic rocks may break readily parallel to the planar anisotropy.
2. The term "extremely low" is not used as a rock substance strength term. While the term is used in AS1726-1993, the field guide therein makes it clear that materials in that strength range are soils in engineering terms.
3. The unconfined compressive strength for isotropic rocks (and anisotropic rocks which fall across the planar anisotropy) is typically 10 to 25 times the point load index (Is50). The ratio may vary for different rock types. Lower strength rocks often have lower ratios than higher strength rocks.

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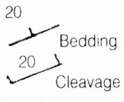
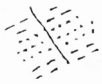
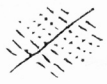
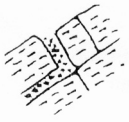
Rock Description Explanation Sheet (2 of 2)

COMMON DEFECTS IN ROCK MASSES

Term	Definition	Diagram	Map Symbol	Graphic Log (Note 1)
Parting	A surface or crack across which the rock has little or no tensile strength. Parallel or sub parallel to layering (eg bedding) or a planar anisotropy in the rock substance (eg, cleavage). May be open or closed.			
Joint	A surface or crack across which the rock has little or no tensile strength. but which is not parallel or sub parallel to layering or planar anisotropy in the rock substance. May be open or closed.			
Sheared Zone (Note 3)	Zone of rock substance with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge shaped blocks.			
Sheared Surface (Note 3)	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.			
Crushed Seam (Note 3)	Seam with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock substance which may be more weathered than the host rock. The seam has soil properties.			
Infilled Seam	Seam of soil substance usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1mm thick may be described as veneer or coating on joint surface.			
Extremely Weathered Seam	Seam of soil substance, often with gradational boundaries. Formad by weathering of the rock substance in place.			

Notes on Defects:

1. Usually borehole logs show the true dip of defects and face sketches and sections the apparent dip.
2. Partings and joints are not usually shown on the graphic log unless considered significant.
3. Sheared zones, sheared surfaces and crushed seams are faults in geological terms.

DEFECT SHAPE TERMS

Planar	The defect does not vary in orientation
Curved	The defect has a gradual change in orientation
Undulating	The defect has a wavy surface
Stepped	The defect has one or more well defined steps
Irregular	The defect has many sharp changes of orientation

Note: The assessment of defect shape is partly influenced by the scale of the observation.

ROUGHNESS TERMS

Slickensided	Grooved or striated surface, usually polished
Polished	Shiny smooth surface
Smooth	Smooth to touch. Few or no surface irregularities
Rough	Many small surface irregularities (amplitude generally less than 1mm). Feels like fine to coarse sand paper.
Very Rough	Many large surface irregularities (amplitude generally more than 1mm). Feels like, or coarser than very coarse sand paper.

COATING TERMS

Clean	No visible coating
Stained	No visible coating but surfaces are discoloured
Veneer	A visible coating of soil or mineral, too thin to measure; may be patchy
Coating	A visible coating up to 1mm thick. Thicker soil material is usually described using appropriate defect terms (eg, infilled seam). Thicker rock strength material is usually described as a vein.

BLOCK SHAPE TERMS

Blocky	Approximately equidimensional
Tabular	Thickness much less than length or width
Columnar	Height much greate than cross section

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Soil Description Explanation Sheet (1 of 2)

DEFINITION:

In engineering terms soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

CLASSIFICATION SYMBOL & SOIL NAME

Soils are described in accordance with the Unified Soil Classification (UCS) as shown in the table on Sheet 2.

PARTICLE SIZE DESCRIPTIVE TERMS

NAME	SUBDIVISION	SIZE
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 μm to 2.36 mm
	medium	200 μm to 600 μm
	fine	75 μm to 200 μm

MOISTURE CONDITION

Dry Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.

Moist Soil feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.

Wet As for moist but with free water forming on hands when handled.

CONSISTENCY OF COHESIVE SOILS

TERM	UNDRAINED STRENGTH s_u (kPa)	FIELD GUIDE
Very Soft	<12	A finger can be pushed well into the soil with little effort.
Soft	12 - 25	A finger can be pushed into the soil to about 25mm depth.
Firm	25 - 50	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 - 100	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 - 200	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	>200	The surface of the soil can be marked only with the thumbnail.
Friable	–	Crumbles or powders when scraped by thumbnail.

DENSITY OF GRANULAR SOILS

TERM	DENSITY INDEX (%)
Very loose	Less than 15
Loose	15 - 35
Medium Dense	35 - 65
Dense	65 - 85
Very Dense	Greater than 85

MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	PROPORTION OF MINOR COMPONENT IN:
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: <5% Fine grained soils: <15%
With some	Presence easily detected by feel or eye, soil properties little different to general properties of primary component.	Coarse grained soils: 5 - 12% Fine grained soils: 15 - 30%

SOIL STRUCTURE

ZONING		CEMENTING	
Layers	Continuous across exposure or sample.	Weakly cemented	Easily broken up by hand in air or water.
Lenses	Discontinuous layers of lenticular shape.	Moderately cemented	Effort is required to break up the soil by hand in air or water.
Pockets	Irregular inclusions of different material.		

GEOLOGICAL ORIGIN

WEATHERED IN PLACE SOILS

Extremely weathered material — Structure and fabric of parent rock visible.

Residual soil — Structure and fabric of parent rock not visible.

TRANSPORTED SOILS

Aeolian soil — Deposited by wind.

Alluvial soil — Deposited by streams and rivers.

Colluvial soil — Deposited on slopes (transported downslope by gravity).

Fill — Man made deposit. Fill may be significantly more variable between tested locations than naturally occurring soils.

Lacustrine soil — Deposited by lakes.

Marine soil — Deposited in ocean basins, bays, beaches and estuaries.

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Soil Description Explanation Sheet (2 of 2)

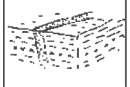
SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60 mm and basing fractions on estimated mass)							USC	PRIMARY NAME
COARSE GRAIINED SOILS More than 50% of materials less than 63 mm is larger than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.0 mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.			GW	GRAVEL
				Predominantly one size or a range of sizes with more intermediate sizes missing.			GP	GRAVEL
			GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)			GM	SILTY GRAVEL
				Plastic fines (for identification procedures see CL below)			GC	CLAYEY GRAVEL
		SANDS More than half of coarse fraction is smaller than 2.0 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate sizes			SW	SAND
				Predominantly one size or a range of sizes with some intermediate sizes missing.			SP	SAND
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).			SM	SILTY SAND
				Plastic fines (for identification procedures see CL below).			SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% of material less than 63 mm is smaller than 0.075 mm			IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm.					
		SILTS & CLAYS Liquid limit less than 50	**DRY STRENGTH**	**DILATANCY**	**TOUGHNESS**			
			None to Low	Quick to slow	None		ML	SILT
			Medium to High	None	Medium		CL	CLAY
			Low to medium	Slow to very slow	Low		OL	ORGANIC SILT
		SILTS & CLAYS Liquid limit greater than 50	Low to medium	Slow to very slow	Low to medium		MH	SILT
			High	None	High		CH	CLAY
			Medium to High	None	Low to medium		OH	ORGANIC CLAY
HIGHLY ORGANIC SOILS			Readily identified by colour, odour, spongy feel and frequently by fibrous texture.				Pt	PEAT

• Low plasticity – Liquid Limit W_L less than 35%. • Medium plasticity – W_L between 35% and 50%.

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM
PARTING	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed.	
JOINT	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2 m in length.	
SHEARED ZONE	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.	
SHEARED SURFACE	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect.	

TERM	DEFINITION	DIAGRAM
SOFTENED ZONE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
TUBE	Tubular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter	
TUBE CAST	Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases the soil which makes up the tube cast is cemented.	
INFILLED SEAM	Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open joints.	

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Engineering Log - Borehole

Borehole ID.	**BH01**
sheet:	1 of 1
project no.	**GEOTLCOV25176AA**
client:	***University of Sydney***
date started:	***28 Jan 2015***
principal:	
date completed:	***28 Jan 2015***
project:	***00-02 Darlington Road Terraces***
logged by:	***SV***
location:	***00-02 Darlington Road, Darlington, NSW***
checked by:	***AH***

position: E: 332538; N: 6248336 (MGA94) surface elevation: 38.00 m (AHD) angle from horizontal: 90°

drill model: XC - Cross Country, Track mounted hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA			E	38				**TOPSOIL: Sandy SILT**: low liquid limit, dark grey, fine to medium grained sand, trace rootlets, organic odour.	D - M			**TOPSOIL**
			E					**FILL: Sandy SILT**: low liquid limit, dark grey mottled pale white, medium to coarse grained sand.				**FILL** 0.2m: Photo Ionisation Detector (PID) = 5.5ppm 0.5m: PID = 0.0ppm
		▶	E	37	1.0		CL	**FILL: CLAY**: low plasticity, pale brown, mottled orange-brown, trace of gravel, trace of sand, fine to medium grained, becoming pale brown.	M			**RESIDUAL SOIL** 1.0m: PID = 0.0ppm
AD/V		▶	E SPT 4, 8, 12 N=20					**Silty CLAY**: medium plasticity, pale brown to orange-brown, mottled pale grey and red-brown, trace of ironstone gravel, sub-rounded.	D - M	St	✕	1.5m: PID = 0.0ppm
				36	2.0							
		▽ 06/02/15	SPT 2, 10, 18 N=28	35	3.0			**SHALE**: pale brown to orange-brown, mottled pale grey and red-brown, extremely weathered, estimated very low strength, can be remoulded to silty clay. 3.5 m: estimated low strength			✕	**WEATHERED BEDROCK** 3.5 m: V bit refusal
AD/T				34	4.0							
				33	5.0			Borehole BH01 terminated at 4.9 m Refusal				4.9 m: TC bit refusal
				32	6.0							
				31	7.0							

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method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
DT diatube
HA hand auger

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Borehole

Borehole ID.	**BH02**
sheet:	1 of 1
project no.	**GEOTLCOV25176AA**
client:	***University of Sydney***
date started:	***27 Jan 2015***
principal:	
date completed:	***27 Jan 2015***
project:	***00-02 Darlington Road Terraces***
logged by:	***SV***
location:	***00-02 Darlington Road, Darlington, NSW***
checked by:	***AH***

position: E: 332589; N: 6248355 (MGA94) | surface elevation: 36.20 m (AHD) | angle from horizontal: 90°

drill model: XC - Cross Country, Track mounted | hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA		Not Encountered	E	36				**FILL: CONCRETE SLAB**: 60mm.	M			**CONCRETE SLAB**
			E					**FILL: Silty CLAY**: medium plasticity, orange-brown, grey.				**FILL** 0.2m: Photo Ionisation Detector (PID) = 0.5ppm
							Cl	**Silty CLAY**: medium plasticity, pale grey to pale brown, trace subangular gravel.		F to St		**RESIDUAL SOIL** 0.5m: PID = 0.5ppm 1.0m: PID = 0.9ppm
AD/V			D + E	35	1.0							1.5m: PID = 2.2ppm
			E SPT 10, 15, 15 N=30					**SHALE**: pale grey mottled red-brown, extremely weathered, estimated very low strength, can be remouolded to silty clay.				**WEATHERED BEDROCK**
				34	2.0			2.3 m: estimated low strength				2.3 m: V bit refusal
AD/T					3.0							
				33				Borehole BH02 terminated at 3.1 m Refusal				3.1 m: TC bit refusal
					4.0							
				32								
					5.0							
				31								
					6.0							
				30								
					7.0							
				29								

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- DT diatube
- HA hand auger

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Borehole

Borehole ID.	**BH03**
sheet:	1 of 1
project no.	**GEOTLCOV25176AA**
client:	***University of Sydney***
date started:	**28 Jan 2015**
principal:	
date completed:	**28 Jan 2015**
project:	***00-02 Darlington Road Terraces***
logged by:	**SV**
location:	***00-02 Darlington Road, Darlington, NSW***
checked by:	**AH**

position: E: 332630; N: 6248379 (MGA94) surface elevation: 35.50 m (AHD) angle from horizontal: 90°

drill model: XC - Cross Country, Track mounted hole diameter : 100 mm

drilling information						material substance						
method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description **SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA			D + E					**CONCRETE SLAB**: 90mm.	M			**CONCRETE SLAB**
HA			E	35				**FILL: Silty CLAY**: low plasticity, dark grey, with some gravel, angular to sub-angular, pale white and dark grey, trace sand, medium to coarse grained, presence of organic odour. 0.5 m: with cobble-sized brick fragments, red-brown, glass fragments, ceramic and Porcelain fragments (up to 70mm)	M to W			**FILL** 0.2m: Photo Ionisation Detector (PID) = 3.7ppm 0.5m: PID = 6.1ppm
HA			E		1.0		CL	**Silty CLAY**: medium plasticity, pale grey.				**RESIDUAL SOIL** 1.0m: PID = 5.3ppm
HA			E	34				1.5 m: becoming pale grey, mottled orange-brown		St		1.5m: PID = 3.3ppm
HA			SPT 2, 5, 11 N=16		2.0							
AD/V				33								
AD/V			SPT 4, 12, 20 N=32		3.0			**SHALE**: pale grey, mottled red-brown, extremely weathered, estimated very low strength, can be remoulded to silty clay.				**WEATHERED BEDROCK**
AD/V				32				3.8 m: estimated low strength				3.8 m: V bit refusal
AD/T					4.0							
AD/T			SPT 25 N=R	31								4.58 m: TC bit refusal
					5.0			Borehole BH03 terminated at 4.58 m Refusal				
				30								
					6.0							
				29								
					7.0							
				28								

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- DT diatube
- HA hand auger

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Engineering Log - Borehole

Borehole ID.	**BH04**
sheet:	1 of 1
project no.	**GEOTLCOV25176AA**
client:	***University of Sydney***
date started:	***27 Jan 2015***
principal:	
date completed:	***28 Jan 2015***
project:	***00-02 Darlington Road Terraces***
logged by:	***SV***
location:	***00-02 Darlington Road, Darlington, NSW***
checked by:	***AH***

position: E: 332679; N: 332679 (MGA94) surface elevation: 33.00 m (AHD) angle from horizontal: 90°

drill model: XC - Cross Country, Track mounted hole diameter : 100 mm

drilling information						material substance							
method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description **SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA			E	33				**CONCRETE SLAB**: 60mm.	M to W			**CONCRETE SLAB**
								FILL: CLAY: high plasticity, dark grey, trace of gravel, angular, fine grained, pale white.				**FILL** 0.2m: Photo Ionisation Detector (PID) = 10.5ppm 0.5m: PID = 2.1ppm
			D + E									
			E	32	1.0		CL	**Silty CLAY**: medium plasticity, pale brown to orange red-brown.		VSt		**RESIDUAL SOIL** 1.0m: PID = 3.1ppm
			E						D			
			SPT 2, 4, 7 N=11	31	2.0			1.5 m: becoming pale grey, with red-brown iron staining				1.5m: PID = 0.5ppm
AD/V				30	3.0			**SHALE**: pale grey mottled red-brown, extremely weathered, estimated very low strength, can be remoulded to silty clay.				**WEATHERED BEDROCK**
			SPT 7, 16, 19 N=35									
		06/02/15		29	4.0			4.4 m: estimated low strength 4.5 m: becoming dark grey				4.4 m: V bit refusal
AD/T				28	5.0							
								Borehole BH04 terminated at 5.10 m Refusal				5.1 m: TC bit refusal
				27	6.0							
				26	7.0							

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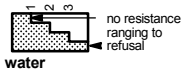
method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- DT diatube
- HA hand auger

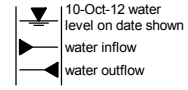
* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration



water



samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remoulded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Piezometer Installation Log

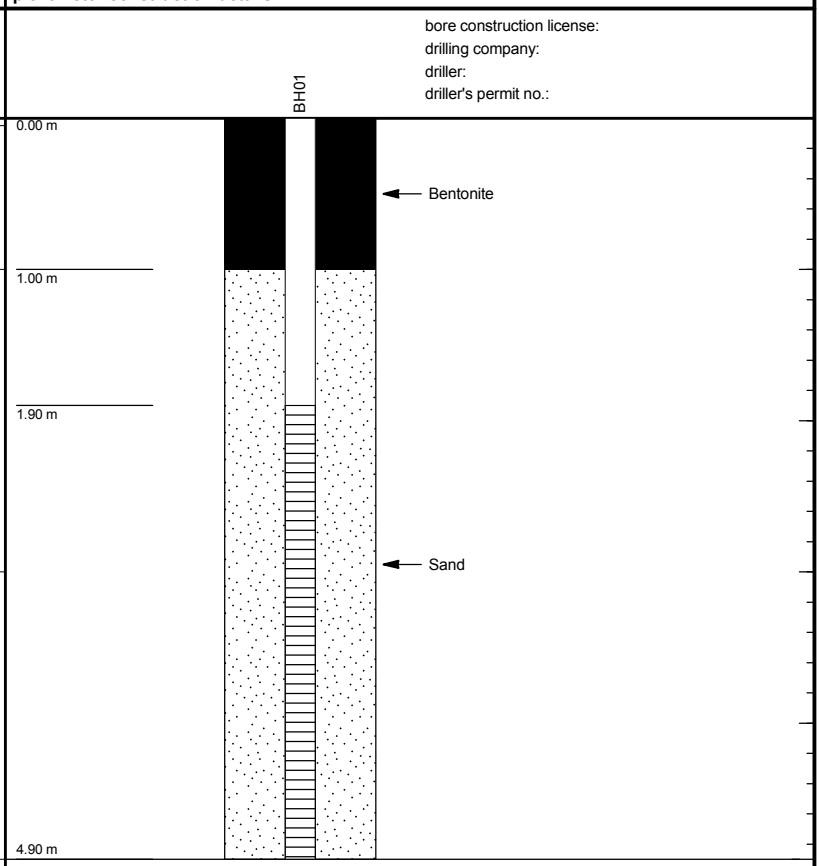
Hole ID.	**BH01**
sheet:	1 of 1
project no.	**GEOTLCOV25176AA**
client:	***University of Sydney***
date started:	**28 Jan 2015**
principal:	
date completed:	**28 Jan 2015**
project:	***00-02 Darlington Road Terraces***
logged by:	**SV**
location:	***00-02 Darlington Road, Darlington, NSW***
checked by:	**AH**

position: E: 332538; N: 6248336 (MGA94) surface elevation: 38.00 m (AHD) angle from horizontal: 90°

equipment type: XC - Cross Country, Track mounted hole diameter : 100 mm

drilling information | **material substance** | **piezometer construction details**

method & support	water	RL (m)	depth (m)	graphic log	material name
HA		38			TOPSOIL: Sandy SILT
					FILL: Sandy SILT
					FILL: CLAY
		37	1		Silty CLAY
ADV		36	2		
		35	3		SHALE
	06/02/15				
AD/T		34	4		
		33	5		Borehole BH01 terminated at 4.90 m Refusal
		32	6		
		31	7		



method & support
see engineering log for details

water
- 10-Oct-12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
- core recovered (graphic symbols indicate material)
- no core recovered

ID	type	stick up & RL	tip depth & RL	install. date	water level
BH01	standpipe piezo.		4.90 m 33.10 m AHD		

Piezometer Installation Log

Hole ID.	***BH04***
sheet:	1 of 1
project no.	***GEOTLCOV25176AA***
client:	***University of Sydney***
date started:	***27 Jan 2015***
principal:	
date completed:	***28 Jan 2015***
project:	***00-02 Darlington Road Terraces***
logged by:	***SV***
location:	***00-02 Darlington Road, Darlington, NSW***
checked by:	***AH***

position: E: 332679; N: 332679 (MGA94) surface elevation: 33.00 m (AHD) angle from horizontal: 90°

equipment type: XC - Cross Country, Track mounted hole diameter : 100 mm

drilling information | **material substance** | **piezometer construction details**

method & support	water	RL (m)	depth (m)	graphic log	material name
HA		33	0		CONCRETE SLAB
					FILL: CLAY
		32	1		Silty CLAY
		31	2		
AD/V		30	3		SHALE
	06/02/15	29	4		
AD/T		28	5		
		27	6		Borehole BH04 terminated at 5.10 m Refusal
		26	7		

bore construction license:
drilling company:
driller:
driller's permit no.:

1

Bentonite

1.00 m

2.10 m

Sand

5.10 m

5.10 m

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method & support
see engineering log for details

water
- 10-Oct-12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
- core recovered (graphic symbols indicate material)
- no core recovered

ID	type	stick up & RL	tip depth & RL	install. date	water level
1	standpipe		5.10 m 27.90 m AHD	30/01/2015	

coffey

Engineering Log - Excavation

Excavation ID.	***TP01***
sheet:	1 of 1
project no.	***GEOTLCOV25176AA***
client:	***University of Sydney***
date excavated:	***29 Jan 2015***
principal:	
date completed:	***29 Jan 2015***
project:	***00-02 Darlington Road Terraces***
logged by:	***SV***
location:	***00-02 Darlington Road, Darlington, NSW***
checked by:	***AH***

position: E: 332545; N: 6248351 (MGA94) | surface elevation: 38.80 m (AHD) | pit orientation: 310° | DCP id.:

equipment type: Concrete Cutter/Shovel | excavation method: Hand Excavation and Hand Auger | excavation dimensions: 0.9 m long 0.8 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	DCP (blows/100 mm) 2 4 6 8 10	structure and additional observations
HA	N		Not Observed	E	38.5	0.5			**CONCRETE SLAB**: 50mm.	D				**CONCRETE SLAB**
									FILL: BRICK PAVERS					**FILL**
				E					**FILL: Sandy CLAY**: low plasticity, pale brown to dark brown, sand is medium to coarse grained, trace limestone gravel, angular, pale white, some broken porcelain pots.					0.2m: Photo Ionisation Detector (PID) = 0.0ppm
														0.6m: PID = 0.0ppm
								CL	**Silty CLAY**: medium to high plasticity, dark brown to dark grey.		St			**RESIDUAL SOIL**
					38.0	1.0			Test pit TP01 terminated at 0.78 m Target depth					
					37.5	1.5								
					37.0									

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear peak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TP1 (1 of 2)

TP1 (2 of 2)

drawn	SV	coffey	client:	University of Sydney
approved	JJM		project:	00-02 Darlington Road Terraces 00-02 Darlington Road, Darlington, NSW
date	24-Feb-15			
scale	NTS		title:	Test Pit Photographs - TP1
original size	A4		project no: GEOTLCOV25176AA	figure no: FIGURE 1

Engineering Log - Excavation

Excavation ID.	***TP02***		
sheet:	1 of 1		
project no.	***GEOTLCOV25176AA***		
client:	***University of Sydney***	date excavated:	***29 Jan 2015***
principal:		date completed:	***29 Jan 2015***
project:	***00-02 Darlington Road Terraces***	logged by:	***SV***
location:	***00-02 Darlington Road, Darlington, NSW***	checked by:	***AH***

position: E: 332552; N: 6248355 (MGA94) | surface elevation: 38.50 m (AHD) | pit orientation: 310° | DCP id.:

equipment type: Concrete Cutter/Shovel | excavation method: Hand Excavation and Hand Auger | excavation dimensions: 0.7 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	DCP (blows/100 mm) 2 4 6 8 10	structure and additional observations
HA	N		Not Observed	E	38.5				**CONCRETE SLAB**: 50mm.	D				**CONCRETE SLAB**
									FILL: SAND: coarse grained, pale green to pale grey, trace ironstone gravel, angular, dark grey.					**FILL**
									FILL: Silty GRAVEL: fine to coarse grained, angular, pale brown, with some cobble sized brick fragments, with some tree roots.					0.2m: Photo Ionisation Detector (PID) = 16.2ppm
				E					**FILL: Silty CLAY**: medium plasticity, dark grey, mottled orange-brown, trace brick fragments.	D to M				0.4m: PID = 0.0ppm
					38.0	0.5		CL	**Silty CLAY**: medium plasticity, orange-brown, mottled pale grey.	M	S to F			**RESIDUAL SOIL**
				D	37.5	1.0			Test pit TP02 terminated at 1.2 m Target depth					
					37.0	1.5								

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear peak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TP02 (1 of 2)

TP02 (2 of 2)

drawn	SV	coffey	client:	University of Sydney
approved	JJM		project:	00-02 Darlington Road Terraces 00-02 Darlington Road, Darlington, NSW
date	24-Feb-15		title:	Test Pit Photographs - TP2
scale	NTS		project no: GEOTLCOV25176AA	figure no: FIGURE 2
original size	A4			

coffey

Engineering Log - Excavation

Excavation ID.	***TP03***
sheet:	1 of 1
project no.	***GEOTLCOV25176AA***
client:	***University of Sydney***
date excavated:	***29 Jan 2015***
principal:	
date completed:	***29 Jan 2015***
project:	***00-02 Darlington Road Terraces***
logged by:	***SV***
location:	***00-02 Darlington Road, Darlington, NSW***
checked by:	***AH***

position: E: 332598; N: 6248375 (MGA94) surface elevation: 37.70 m (AHD) pit orientation: 310° DCP id.:

equipment type: Concrete Cutter/Shovel excavation method: Hand Excavation and Hand Auger excavation dimensions: 0.8 m long 0.8 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	DCP (blows/100 mm) 2 4 6 8 10	structure and additional observations
HA	N		Not Observed	E	37.5	0.5			**CONCRETE SLAB**: 100mm.	D				**CONCRETE SLAB**
									FILL: Silty GRAVEL: fine to coarse grained, sub-angular to angular, with some brick and porcelain fragments, with some tree roots.					**FILL**
				D E	37.0				**FILL: CLAY**: medium plasticity, dark grey, with some pale white sub-rounded to sub-angular gravel, trace of brick fragments.					0.35m: Photo Ionisation Detector (PID) = 0.0ppm 0.6m: PID = 0.0ppm
								CL	**Silty CLAY**: medium plasticity, dark grey to dark brown.		St			**RESIDUAL SOIL**
					36.5	1.0			Test pit TP03 terminated at 0.92 m Target depth					
					36.0	1.5								

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear peak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

TP03 (1 of 2)

TP03 (2 of 2)

drawn	SV	coffey	client:	University of Sydney
approved	JJM		project:	00-02 Darlington Road Terraces 00-02 Darlington Road, Darlington, NSW
date	24-Feb-15		title:	Test Pit Photographs - TP3
scale	NTS		project no: GEOTLCOV25176AA	figure no: FIGURE 3
original size	A4			

coffey

Engineering Log - Excavation

Excavation ID.	***TP04***
sheet:	1 of 1
project no.	***GEOTLCOV25176AA***
client:	***University of Sydney***
date excavated:	***29 Jan 2015***
principal:	
date completed:	***29 Jan 2015***
project:	***00-02 Darlington Road Terraces***
logged by:	***SV***
location:	***00-02 Darlington Road, Darlington, NSW***
checked by:	***AH***

position: E: 332621; N: 6248385 (MGA94) surface elevation: 36.50 m (AHD) pit orientation: 310° DCP id.:

equipment type: Shovel excavation method: Hand Excavation and Hand Auger excavation dimensions: 0.9 m long 0.6 m wide

excavation information | **material substance**

method	support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	DCP (blows/ 100 mm) 2 4 6 8 10	structure and additional observations
HA	N		Not Observed	E	36.5				**BRICK PAVERS**: 80mm.	M				**BRICK PAVERS**
									FILL: SAND: coarse grained, pale green-brown.					**FILL**
				E										0.2m: Photo Ionisation Detector (PID) = 0.0ppm
									FILL: Silty GRAVEL: fine to coarse grained, sub-angular to angular, pale grey to dark brown, trace of medium plasticity clay, dark grey, with some brick fragments, trace ironstone gravel.	D				0.4m: PID = 0.0ppm
					36.0	0.5								
								CL	**Silty CLAY**: medium plasticity, dark brown to dark grey.	M	F to St			**RESIDUAL SOIL**
				D	35.5	1.0								
									Test pit TP04 terminated at 1.05 m Target depth					
					35.0	1.5								

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear peak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TP04 (1 of 2)

TP04 (2 of 2)

drawn	SV	coffey	client:	University of Sydney
approved	JJM		project:	00-02 Darlington Road Terraces 00-02 Darlington Road, Darlington, NSW
date	24-Feb-15		title:	Test Pit Photographs - TP4
scale	NTS		project no: GEOTLCOV25176AA	figure no: FIGURE 4
original size	A4			

coffey

Engineering Log - Excavation

Excavation ID.	***TP05***
sheet:	1 of 1
project no.	***GEOTLCOV25176AA***
client:	***University of Sydney***
date excavated:	***29 Jan 2015***
principal:	
date completed:	***29 Jan 2015***
project:	***00-02 Darlington Road Terraces***
logged by:	***SV***
location:	***00-02 Darlington Road, Darlington, NSW***
checked by:	***AH***

position: E: 332644; N: 6248395 (MGA94) | surface elevation: 35.30 m (AHD) | pit orientation: 310° | DCP id.:

equipment type: Concrete Cutter/Shovel | excavation method: Hand Excavation and Hand Auger | excavation dimensions: 0.7 m long 0.8 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	DCP (blows/100 mm) 2 4 6 8 10	structure and additional observations
	N		Not Observed	E	35.0	0.5			**CONCRETE SLAB**: 100mm.	D				**CONCRETE SLAB**
				E					**FILL: Silty GRAVEL**: fine to coarse grained, angular, pale brown to orange brown, with some coarse grained sand, trace low to medium plasticity clay, trace of brick fragments, trace of cobbles of limestone.					**FILL** 0.2m: Photo Ionisation Detector (PID) = 0.0ppm 0.4m: PID = 0.0ppm
HA					34.5			CL	**Silty CLAY**: medium plasticity, dark grey to dark brown.	D to M	St			**RESIDUAL SOIL**
					34.0	1.0 1.5			Test pit TP05 terminated at 0.9 m Target depth					
					33.5									

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear peak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TP05 (1 of 2)

TP05 (2 of 2)

drawn	SV	coffey	client:	University of Sydney
approved	JJM		project:	00-02 Darlington Road Terraces 00-02 Darlington Road, Darlington, NSW
date	24-Feb-15		title:	Test Pit Photographs - TP5
scale	NTS		project no: GEOTLCOV25176AA	figure no: FIGURE 5
original size	A4			

coffey

Engineering Log - Excavation

Excavation ID.	***TP06***
sheet:	1 of 1
project no.	***GEOTLCOV25176AA***
client:	***University of Sydney***
date excavated:	***29 Jan 2015***
principal:	
date completed:	***29 Jan 2015***
project:	***00-02 Darlington Road Terraces***
logged by:	***SV***
location:	***00-02 Darlington Road, Darlington, NSW***
checked by:	***AH***

position: E: 332679; N: 6248410 (MGA94) surface elevation: 33.10 m (AHD) pit orientation: 310° DCP id.:

equipment type: Concrete Cutter/Shovel excavation method: Hand Excavation and Hand Auger excavation dimensions: 0.6 m long 0.8 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	DCP (blows/100 mm) 2 4 6 8 10	structure and additional observations
	N		Not Observed		33.0				**CONCRETE SLAB**: 100mm.	D				**CONCRETE SLAB**
				E					**FILL: GRAVEL**					**FILL**
									FILL: Silty GRAVEL: fine to coarse grained, angular, pale brown to dark brown, gravel is composed of concrete fragments, with some brick fragments, with some cobbles of concrete.					0.2m: Photo Ionisation Detector (PID) = 0.0ppm
				E					**FILL: Gravelly CLAY**: medium plasticity, pale white, gravel is angular to sub-angular, presence of organic odour.					0.4m: PID = 0.0ppm
HA					32.5	0.5		CL	**Silty CLAY**: medium plasticity, pale brown to brown.	D to M	F to St			**RESIDUAL SOIL**
				D										
					32.0	1.0			Test pit TP06 terminated at 0.8 m Target depth					
					31.5	1.5								

LIBRARY - STANDARD COFFEY.GLB Log COF EXCAVATION + PSP/DCP BH LOGS - COPY.GPJ <<DrawingFile>> 24/02/2015 19:53

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear peak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TP06 (1 of 2)

TP06 (2 of 2)

drawn	SV	coffey	client:	University of Sydney
approved	JJM		project:	00-02 Darlington Road Terraces 00-02 Darlington Road, Darlington, NSW
date	24-Feb-15			
scale	NTS		title:	Test Pit Photographs - TP6
original size	A4		project no: GEOTLCOV25176AA	figure no: FIGURE 6

Appendix B - Geotechnical Laboratory Test Certificates

Artarmon, Sydney Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
47 - 49 Carlotta Street
Artarmon SYDNEY NSW 2064

Phone: +61 2 9437 0137

Report No: ARTA15S-00065-1
Issue No: 1

Material Test Report

Client:	Coffey Geotechnics Pty Ltd (Chatswood) PO Box 5275 West Chatswood NSW 1515
Principal:	UNIVERSITY OF SYDNEY
Project No.:	INFOARTA01314AA
Project Name:	GEOTLCOV25176AA - 00-02 DARLINGTON RD TERRACES
Lot No.:	TRN:

Accredited for compliance with ISO/IEC 17025.

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

Approved Signatory: Garry Collins
(Specialised Testing Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 10/02/2015

Sample Details

Sample ID:	ARTA15S-00065
Client Sample:	BH1
Date Sampled:	03/02/2015
Source:	Ex Job Site
Material:	Subgrade
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	Darlington Lane, Darlington NSW
Sample Location:	BH1 (1.50 to 1.95m)

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	17.5	
Date Tested		3/02/2015	

Comments

N/A

Artarmon, Sydney Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
47 - 49 Carlotta Street
Artarmon SYDNEY NSW 2064

Phone: +61 2 9437 0137

Report No: ARTA15S-00066-1
Issue No: 1

Material Test Report

Client:	Coffey Geotechnics Pty Ltd (Chatswood) PO Box 5275 West Chatswood NSW 1515
Principal:	UNIVERSITY OF SYDNEY
Project No.:	INFOARTA01314AA
Project Name:	GEOTLCOV25176AA - 00-02 DARLINGTON RD TERRACES
Lot No.:	TRN:

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025.

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

Approved Signatory: Garry Collins
(Specialised Testing Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 10/02/2015

Sample Details

Sample ID:	ARTA15S-00066
Client Sample:	BH1
Date Sampled:	03/02/2015
Source:	Ex Job Site
Material:	Subgrade
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	Darlington Lane, Darlington NSW
Sample Location:	BH1 (3.00 to 3.45m)

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Air-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	7.5	
Mould Length (mm)		254.3	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	37	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	21	
Plasticity Index (%)	AS 1289.3.3.1	16	
Date Tested		8/02/2015	

Comments

N/A

Artarmon, Sydney Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
47 - 49 Carlotta Street
Artarmon SYDNEY NSW 2064

Phone: +61 2 9437 0137

Report No: ARTA15S-00067-1
Issue No: 1

Material Test Report

Client:	Coffey Geotechnics Pty Ltd (Chatswood) PO Box 5275 West Chatswood NSW 1515
Principal:	UNIVERSITY OF SYDNEY
Project No.:	INFOARTA01314AA
Project Name:	GEOTLCOV25176AA - 00-02 DARLINGTON RD TERRACES
Lot No.:	TRN:

Accredited for compliance with ISO/IEC 17025.

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

Approved Signatory: Garry Collins
(Specialised Testing Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 10/02/2015

Sample Details

Sample ID:	ARTA15S-00067
Client Sample:	BH3
Date Sampled:	03/02/2015
Source:	Ex Job Site
Material:	Subgrade
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	Darlington Lane, Darlington NSW
Sample Location:	BH3 (1.50 to 1.95m)

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	22.0	
Date Tested		3/02/2015	

Comments

N/A

Artarmon, Sydney Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
47 - 49 Carlotta Street
Artarmon SYDNEY NSW 2064

Phone: +61 2 9437 0137

Report No: ARTA15S-00068-1
Issue No: 1

Material Test Report

Client:	Coffey Geotechnics Pty Ltd (Chatswood) PO Box 5275 West Chatswood NSW 1515
Principal:	UNIVERSITY OF SYDNEY
Project No.:	INFOARTA01314AA
Project Name:	GEOTLCOV25176AA - 00-02 DARLINGTON RD TERRACES
Lot No.:	TRN:

Accredited for compliance with ISO/IEC 17025.

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

Approved Signatory: Garry Collins
(Specialised Testing Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 10/02/2015

Sample Details

Sample ID:	ARTA15S-00068
Client Sample:	BH4
Date Sampled:	03/02/2015
Source:	Ex Job Site
Material:	Subgrade
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	Darlington Lane, Darlington NSW
Sample Location:	BH4 (1.50 to 1.95m)

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Air-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	9.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	43	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	21	
Plasticity Index (%)	AS 1289.3.3.1	22	
Date Tested		8/02/2015	

Comments

N/A

Artarmon, Sydney Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
47 - 49 Carlotta Street
Artarmon SYDNEY NSW 2064

Phone: +61 2 9437 0137

Report No: ARTA15S-00069-1
Issue No: 1

Material Test Report

Client:	Coffey Geotechnics Pty Ltd (Chatswood) PO Box 5275 West Chatswood NSW 1515
Principal:	UNIVERSITY OF SYDNEY
Project No.:	INFOARTA01314AA
Project Name:	GEOTLCOV25176AA - 00-02 DARLINGTON RD TERRACES
Lot No.:	TRN:

Accredited for compliance with ISO/IEC 17025.

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

Approved Signatory: Garry Collins
(Specialised Testing Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 10/02/2015

Sample Details

Sample ID:	ARTA15S-00069
Client Sample:	TP2
Date Sampled:	03/02/2015
Source:	Ex Job Site
Material:	Subgrade
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	Darlington Lane, Darlington NSW
Sample Location:	TP2 (1.2m)

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	24.6	
Date Tested		3/02/2015	

Comments

N/A

Artarmon, Sydney Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
47 - 49 Carlotta Street
Artarmon SYDNEY NSW 2064

Phone: +61 2 9437 0137

Report No: ARTA15S-00070-1
Issue No: 1

Material Test Report

Client:	Coffey Geotechnics Pty Ltd (Chatswood) PO Box 5275 West Chatswood NSW 1515
Principal:	UNIVERSITY OF SYDNEY
Project No.:	INFOARTA01314AA
Project Name:	GEOTLCOV25176AA - 00-02 DARLINGTON RD TERRACES
Lot No.:	TRN:

Accredited for compliance with ISO/IEC 17025.

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

Approved Signatory: Garry Collins
(Specialised Testing Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 10/02/2015

Sample Details

Sample ID:	ARTA15S-00070
Client Sample:	TP4
Date Sampled:	03/02/2015
Source:	Ex Job Site
Material:	Subgrade
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	Darlington Lane, Darlington NSW
Sample Location:	TP4 (0.9m)

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	28.8	
Date Tested		3/02/2015	

Comments

N/A

Artarmon, Sydney Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
47 - 49 Carlotta Street
Artarmon SYDNEY NSW 2064

Phone: +61 2 9437 0137

Report No: ARTA15S-00071-1
Issue No: 1

Material Test Report

Client:	Coffey Geotechnics Pty Ltd (Chatswood) PO Box 5275 West Chatswood NSW 1515
Principal:	UNIVERSITY OF SYDNEY
Project No.:	INFOARTA01314AA
Project Name:	GEOTLCOV25176AA - 00-02 DARLINGTON RD TERRACES
Lot No.:	TRN:

Accredited for compliance with ISO/IEC 17025.

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

Approved Signatory: Garry Collins
(Specialised Testing Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 10/02/2015

Sample Details

Sample ID:	ARTA15S-00071
Client Sample:	TP6
Date Sampled:	03/02/2015
Source:	Ex Job Site
Material:	Subgrade
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	Darlington Lane, Darlington NSW
Sample Location:	TP6 (0.75m)

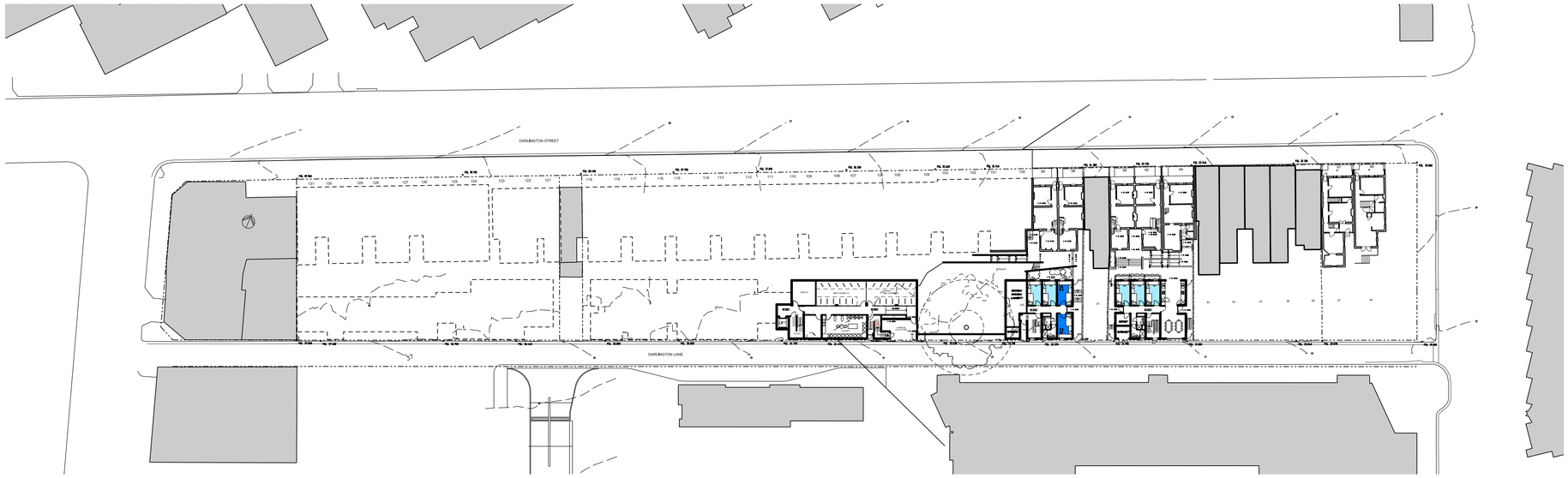
Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	30.5	
Date Tested		3/02/2015	

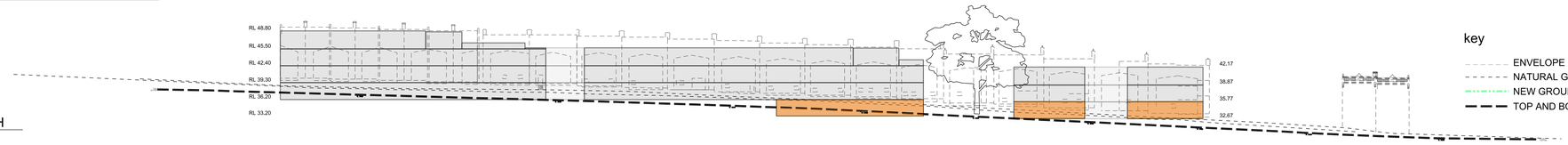
Comments

N/A

Appendix C - Drawings Provided for Darlington Terraces



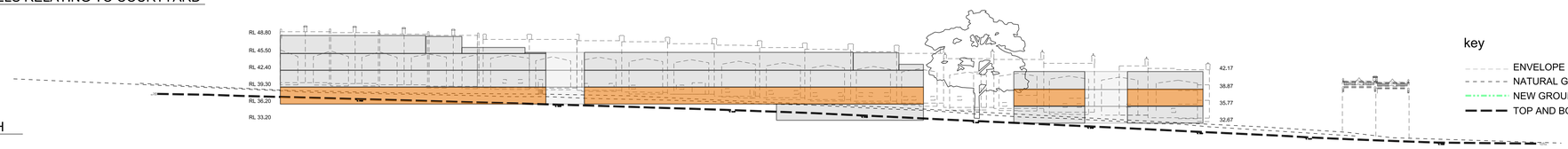
4 SITE PLAN 1 - LEVELS RELATING TO LANE
1:500



3 ELEVATION SOUTH
1:500

key
ENVELOPE OF TERRACES ON DARLINGTON STREET
NATURAL GROUND LINE THROUGH COURTYARD
NEW GROUND LINE THROUGH COURTYARD
TOP AND BOTTOM OF KERB ON DARLINGTON LANE

2 SITE PLAN 2 - LEVELS RELATING TO COURTYARD
1:500



1 ELEVATION SOUTH
1:500

key
ENVELOPE OF TERRACES ON DARLINGTON STREET
NATURAL GROUND LINE THROUGH COURTYARD
NEW GROUND LINE THROUGH COURTYARD
TOP AND BOTTOM OF KERB ON DARLINGTON LANE

Revisions

No	Date	Description	Ver	App'd
01	07.11.14	ISSUE FOR COORDINATION		
02	24.02.15	PRELIMINARY ISSUE		

Revisions

No	Date	Description	Ver	App'd

Nominated Architects: Michael Heenan 5264, Peter Ireland 6661

Key

Client
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79 Myrtle Street Chippendale NSW 2008 AUSTRALIA
ph +61 2 9311 8222 fx +61 2 9311 8200 ABN 53 003 782 250

Project
DARLINGTON TERRACES

Proj No.

NORTH

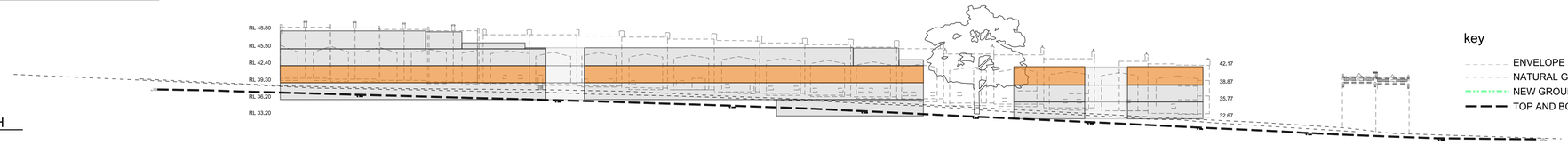
Drawing Title
SITE PLANS
LANE + COURTYARD

Drawing Status
NOT FOR CONSTRUCTION

Scale	Drawing No	Issue
1:500	DA1001	02

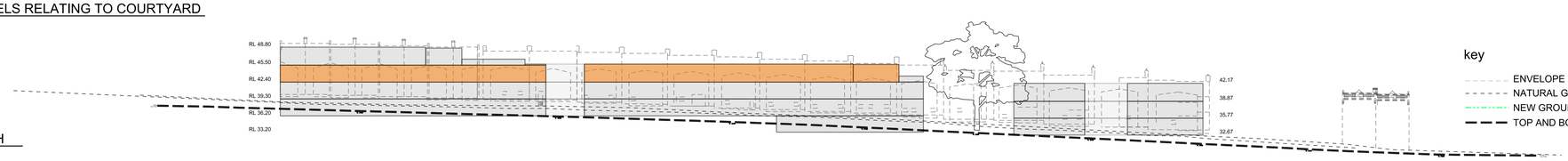
A1

4 SITE PLAN 1 - LEVELS RELATING TO LANE
1:500



3 ELEVATION SOUTH
1:500

2 SITE PLAN 2 - LEVELS RELATING TO COURTYARD
1:500



1 ELEVATION SOUTH
1:500

Revisions				Revisions			
No	Date	Description	Ver App'd	No	Date	Description	Ver App'd
01	07 11 14	ISSUE FOR COORDINATION					
02	24 02 15	PRELIMINARY ISSUE					

Nominated Architects: Michael Heenan 5264, Peter Ireland 6661

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Project
DARLINGTON TERRACES

Proj No.

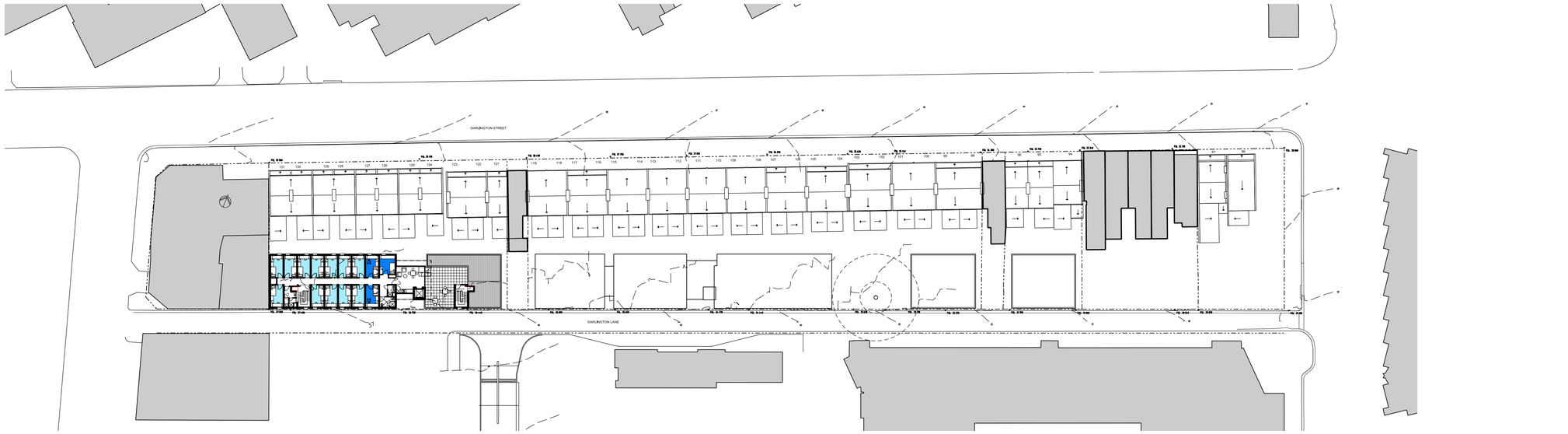
NORTH

Drawing Title
SITE PLANS

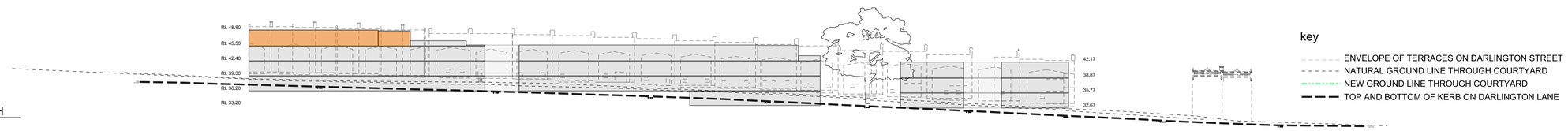
Drawing Status
NOT FOR CONSTRUCTION

Scale 1:500 | Drawing No DA1002 | Issue 02

A1



2 SITE PLAN 5
1:500



1 ELEVATION SOUTH
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Revisions				Revisions			
No	Date	Description	Ver App'd	No	Date	Description	Ver App'd
01	24 02 15	PRELIMINARY ISSUE					

Nominated Architects: Michael Heenan 5264, Peter Ireland 6661

Key

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Project
DARLINGTON TERRACES

Proj No.

NORTH

Drawing Title
SITE PLANS
LEVEL 05

Drawing Status
NOT FOR CONSTRUCTION

Scale	Drawing No	Issue
1:500	DA1003	01

A1

DARLINGTON STREET

FGL 39.960

FGL 39.170

FGL 38.490

131 130 129 128 127 126 125 124 123 122 121 119 118

N

FFL 36.200

LAUNDRY

BIKE PARKING 24

LIFT

GARBAGE

SWITCH

GARBAGE COLLECTION

FFL 36.200

FGL 36.780

FGL 36.810

FGL 37.560

FGL 37.400

FGL 36.750

FGL 36.020

FGL 36.440

FFL 36.280

FGL 35.890

RL 38.320

RL 38.510

RL 38.470

RL 37.900

RL 38.000

RL 37.540

RL 37.300

RL 37.100

RL 36.700

RL 36.350

RL 36.000

37

36

DARLINGTON LANE

Revisions					Revisions				
No	Date	Description	Ver	App'd	No	Date	Description	Ver	App'd
01	07.11.14	ISSUE FOR COORDINATION							
02	24.02.15	PRELIMINARY ISSUE							

Nominated Architects: Michael Heenan 5264, Peter Ireland 6661

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Project
DARLINGTON TERRACES

Proj No.

NORTH

Drawing Title
FLOOR PLAN
BUILDING 'A' - L2

Drawing Status
NOT FOR CONSTRUCTION

Scale
1:100

Drawing No
DA2102

Issue
02

A1

DARLINGTON STREET

FGL 38.490 FGL 37.750 FGL 37.010 FGL 36.330 FGL 35.620

119 118 117 116 115 114 113 112 111 110 109 108 107 106 105 104 103 102

SWITCH?

BIKE PARKING 24

BIKE PARKING 24

FFL 33.200

FFL 33.200

1:8 RAMP

LIFT

STORE?

LAUNDRY

??

RL 33.720

RL 33.847

GARBAGE COLLECTION

RL 33.690

RL 33.900

RL 34.000

RL 33.840

RL 33.500

FGL 35.890 FGL 35.650 FGL 34.770 FGL 34.440 FGL 33.630

DARLINGTON LANE

Revisions				
No	Date	Description	Ver	App'd
01	07.11.14	ISSUE FOR COORDINATION		
02	24.02.15	PRELIMINARY ISSUE		

Revisions				
No	Date	Description	Ver	App'd

Nominated Architects: Michael Heenan 5264, Peter Ireland 6661

Key

Client
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79 Myrtle Street Chippendale NSW 2008 AUSTRALIA
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Project
DARLINGTON TERRACES

Proj No.

NORTH

Drawing Title
FLOOR PLAN BUILDING 'B' - L1

Drawing Status
NOT FOR CONSTRUCTION

Scale 1:100 | Drawing No DA2111 | Issue 02

A1

DARLINGTON STREET

FGL 35.620 | FGL 35.140 | FGL 34.300 | FGL 33.730 | FGL 3

104 | 103 | 102 | 101 | 100 | 99 | 98 | 96 | 95 | 94 | 87 | 86

RL 34 690 | RL 34 690 | RL 34 130 | RL 33 760 | RL 33 600

RL 34 720 | RL 34 280 | RL 34 340 | RL 34 260 | RL 33 690 | RL 33 540 | RL 33 570 (RL 33 360) | RL 33 420 | RL 33 230

RL 34 490 | RL 33 460 | RL 33 080 | RL 33 080

RL 32 640 | RL 32 640

RL 33 400 | RL 33 230 | RL 32 500 | RL 32 520 | RL 32 520

COMMON/ KITCHEN/ LAUNDRY?

FFL 32.670 | FFL 32.670

COMMS?

GARBAGE? | GARBAGE?

RL 33 720 | RL 33 690 | RL 33 500 | RL 32 640 | RL 32 300

FGL 33.630 | FGL 33.130 | FGL 32.370 | FGL 31.790 | FGL 31.0 | FGL 29.870

DARLINGTON LANE

Revisions					Revisions				
No	Date	Description	Ver	App'd	No	Date	Description	Ver	App'd
01	07.11.14	ISSUE FOR COORDINATION							
02	24.02.15	PRELIMINARY ISSUE							

Nominated Architects: Michael Heenan 5264, Peter Ireland 6661

Key

Client: CIS - THE UNIVERSITY OF SYDNEY

Consultants

Architect: AJ+C Allen Jack+Cottier
79 Myrtle Street Chippendale NSW 2008 AUSTRALIA
ph +61 2 9311 8222 fx +61 2 9311 8200 ABN 53 003 782 250

Project: DARLINGTON TERRACES

Proj No.

NORTH

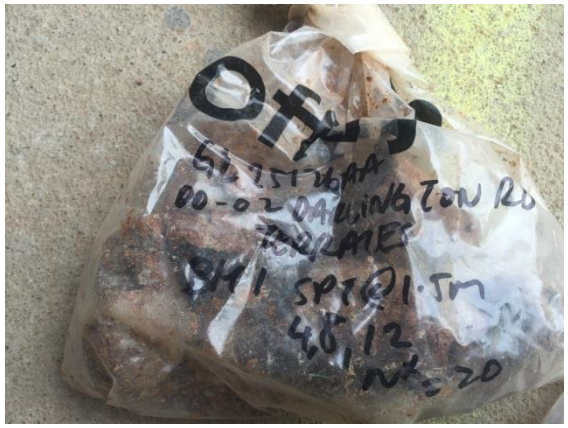
Drawing Title: FLOOR PLAN BUILDING 'C'/'D' - L1

Drawing Status: NOT FOR CONSTRUCTION

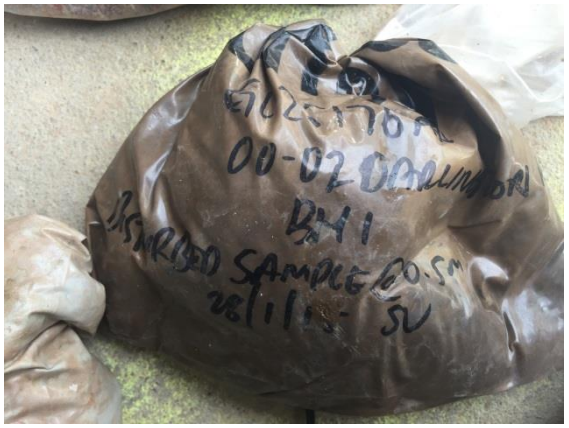
Scale: 1:100 | Drawing No: DA2121 | Issue: 02

A1

Appendix D - Borehole and Test Pit Sample Photographs

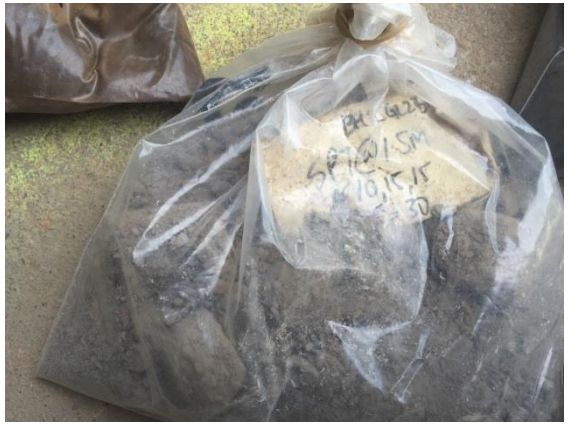


BH1 – 1.5m (IMG_3054.JPG)



BH1 – 0.5m (IMG_3055.JPG)

BH2 – 1.0m (IMG_3057.JPG)

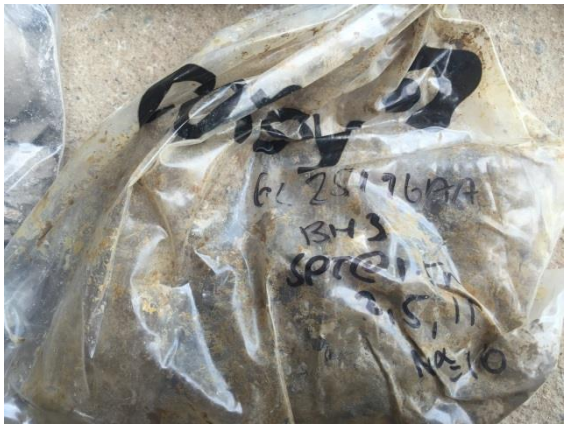


BH2 – 1.5m (IMG_3053.JPG)

BH3 – 4.5m (IMG_3049.JPG)

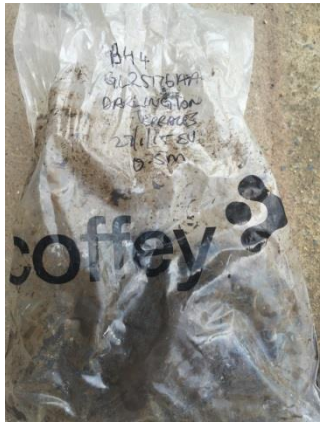
BH3 – 3.0m (IMG_3050.JPG)

BH3 – 2.0m (IMG_3051.JPG)



BH3 – 1.5m (IMG_3052.JPG)

BH4 – 3.0m (IMG_3048.JPG)



BH4 – 0.5m (IMG_3060.JPG)

TP2 – 0.2m (IMG_3047.JPG)

TP3 – 0.6m (IMG_3046.JPG)

TP4 – 0.9m (IMG_3044.JPG)

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