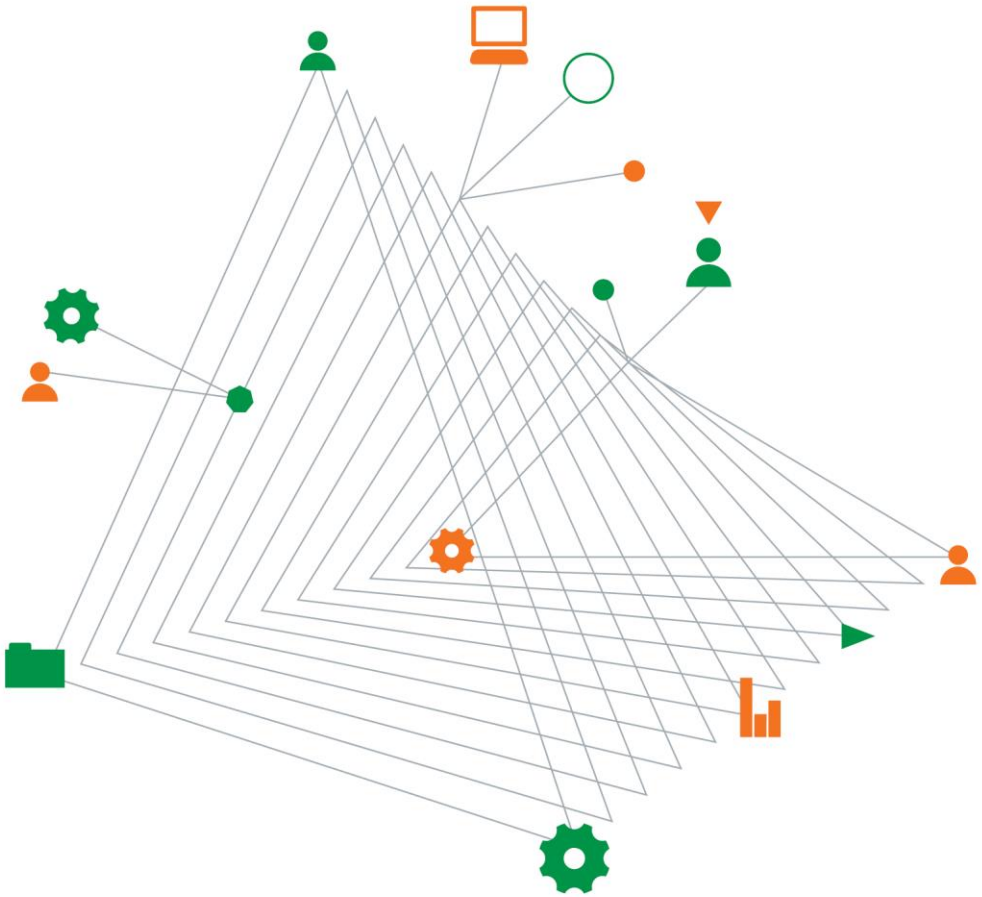
Lend Lease Building Pty Limited

Darling Square - South East Plot

Geotechnical assessment for SSDA 9

17 February 2016



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Darling Square - South East Plot

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For and on behalf of Coffey

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Quality information

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v6	Revised overview of proposed development	17/02/2016	AP	PKW	AP

Distribution

Report Status	No. of copies	Format	Distributed to	Date
v6 final	1	PDF	Jessica Paterson/Alex King	17/02/2016

Table of contents

Tables

Figures

Appendices

1. Introduction

This geotechnical report has been prepared by Coffey Geotechnics Pty Ltd (Coffey) to support a State Significant Development (SSD) Development Application (DA) submitted to the Minister for Planning pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Application (referred to as SSDA 9) follows the approval of a staged SSD DA (SSDA 2) in December 2013. SSDA 2 sets out a Concept Proposal for a new mixed use residential neighbourhood at Haymarket referred to as "Darling Square", previously known as "The Haymarket". Darling Square forms part of the Sydney International Convention, Exhibition and Entertainment precinct (SICEEP) Project, which will deliver Australia's global city with new world class convention, exhibition and entertainment facilities and support the NSW Government's goal to "make NSW number one again".

More specifically this subsequent DA seeks approval for mixed use development within the South East development plot of Darling Square and associated public domain works. The DA has been prepared and structured to be consistent with the Concept Proposal DA.

This report presents a summary of geotechnical site constraints relating to the future development of the South East Plot based on earlier investigation reports by Coffey.

2. Overview of proposed development

The proposal relates to a detailed ('Stage 2') DA for a mixed use residential development in the South East Plot of Darling Square together with associated public domain works. The Darling Square Site is to be developed for a mix of residential and non-residential uses, including but not limited to residential buildings, commercial, retail, community and open space. The South East Plot is one of six development plots identified within the approved Concept Proposal.

Under the Concept Proposal, the South East Plot is planned to accommodate a mixed use podium and three residential buildings (SE1, SE2, and SE3) above and within the podium structure. More specifically, this SSD DA seeks approval for the following components of the development:

- Demolition of existing site improvements, including the existing Sydney Entertainment Centre (SEC);
- Associated tree removal and planting;
- Construction and use of a predominantly 5 storey mixed use podium, including:
  - retail floor space and residential lobbies;
  - above ground parking;
  - residential apartments; and
  - communal facilities.
- Construction and use of three residential buildings above podium;
- Public domain improvements adjacent to the site;
- Provision of vehicle access to the development from Harbour Street;
- Landscaping works to the podium roof level; and
- Extension and augmentation of physical infrastructure / utilities as required.

3. Background

The NSW Government considers that a precinct-wide renewal and expansion of the existing convention, exhibition and entertainment centre facilities at Darling Harbour is required, and is committed to Sydney reclaiming its position on centre stage for hosting world-class events with the creation of SICEEP.

Following an extensive and rigorous Expressions of Interest and Request for Proposals process, a consortium comprising AEG Ogden, Lend Lease, Capella Capital and Spotless was announced by the NSW Government in December 2012 as the preferred proponent to transform Darling Harbour and create SICEEP.

Key features of the Preferred Master Plan include:

- Delivering world-class convention, exhibition and entertainment facilities, including:
  - Up to 40,000m^2 exhibition space;
  - Over 8,000m^2 of meeting rooms space, across 40 rooms;
  - Overall convention space capacity for more than 12,000 people;
  - A ballroom capable of accommodating 2,000 people; and
  - A premium, red-carpet entertainment facility with a capacity of 8,000 persons.
- Providing a hotel complex at the northern end of the precinct.
- A vibrant and authentic new neighbourhood at the southern end of the precinct, now called ‘Darling Square’, including apartments, student accommodation, shops, cafes and restaurants.
- Renewed and upgraded public domain that has been increased by a hectare, including an outdoor event space for up to 27,000 people at an expanded Tumbalong Park; and
- Improved pedestrian connections linking to the proposed Ultimo Pedestrian Network drawing people between Central, Chinatown and Cockle Bay Wharf as well as east-west between Ultimo/Pyrmont and the City.

On 21 March 2013 a critical step in realising the NSW Government’s vision for the SICEEP Project was made, with the lodgement of the first two SSD DAs with the (now) Department of Planning and Environment. The key components of these proposals are outlined below.

3.1. Public private partnership SSD DA (SSD 12_5752)

The Public-Private Partnership (PPP) SSD DA (SSDA 1) includes the core facilities of the SICEEP Project, comprising the new, integrated and world-class convention, exhibition and entertainment facilities along with ancillary commercial premises and public domain upgrades. SSDA1 was approved on 22 August 2013.

3.2. Concept Proposal (SSD 13_5878)

The Concept Proposal SSD DA (SSDA 2) establishes the vision and planning and development framework which will be the basis for the consent authority to assess detailed development proposals within the Darling Square Site. SSDA2 was approved on 5 December 2013. The Stage 1 Concept Proposal approved the following key components and development parameters:

- Indicative staging of demolition and development of future development plots;
- Land uses across the site including residential and non-residential uses;
- Street and laneway layouts and pedestrian routes;
- Open spaces and through-site links;
- Six separate development plots, development plot sizes and separation, building envelopes, building separation, building depths, building alignments, and benchmarks for natural ventilation and solar access provisions;
- A maximum total gross floor area (non-residential and residential GFA)
- Above ground car parking including public car parking;
- Residential car parking rates;
- Design guidelines to guide future development and the public domain; and
- A remediation strategy.

The Concept Proposal was modified on 26 November 2015 to increase the amount of non-residential GFA. This minor increase in GFA was allocated to the approved North-West Plot building to meet tenant requirements. In addition to the approval of SSDA2, the following approvals have been granted for various stages of Darling Square site:

- Darling Drive (part) development plot (SSDA3) for the construction and use of a residential building (student accommodation) and the provision of associated public domain works approved on 7 May 2014;
- North-West development plot (SSDA4) for the construction and use of a mixed use commercial development and public car park building and associated public domain works approved on 7 May 2014; and
- South-West development plot (SSDA5) – construction and use of a mixed use residential development and associated public domain works approved on 21 May 2014.
- North-East development plot (SSDA7) – construction and use of a mixed use residential development and associated public domain works approved on 16 April 2014.

Approval was also granted on 15 June 2014 for SSDA6 which includes the construction and use of the International Convention Centre (ICC) Hotel and provision of public domain works. Approval was also granted for SSDA8 on 16 October 2015 which comprised the ICC Hotel fitout, external lighting and subdivision

This report has been prepared to support a detailed Stage 2 SSD DA for mixed use development and associated public domain works within Darling Square (SSDA 9), consistent with the Concept Proposal (SSDA 2).

4. Site Description

The SICEEP Site is located within Darling Harbour. Darling Harbour is a 60 hectare waterfront precinct on the south-western edge of the Sydney Central Business District that provides for a mix of functions including recreational, tourist, entertainment and business.

With an area of approximately 20 hectares, the SICEEP Site is generally bound by the light rail Line to the west, Harbourside shopping centre and Cockle Bay to the north, Darling Quarter, the Chinese Garden and Harbour Street to the east, and Hay Street to the south (refer to **Figure 1**). The Darling Square Site is:

- located in the south of the SICEEP Site, within the northern portion of the suburb of Haymarket;
- bounded by the Powerhouse Museum to the west, the Pier Street overpass and Little Pier Street to the north, Harbour Street to the east, and Hay Street to the south; and
- irregular in shape and occupies an area of approximately 37,700m^2.

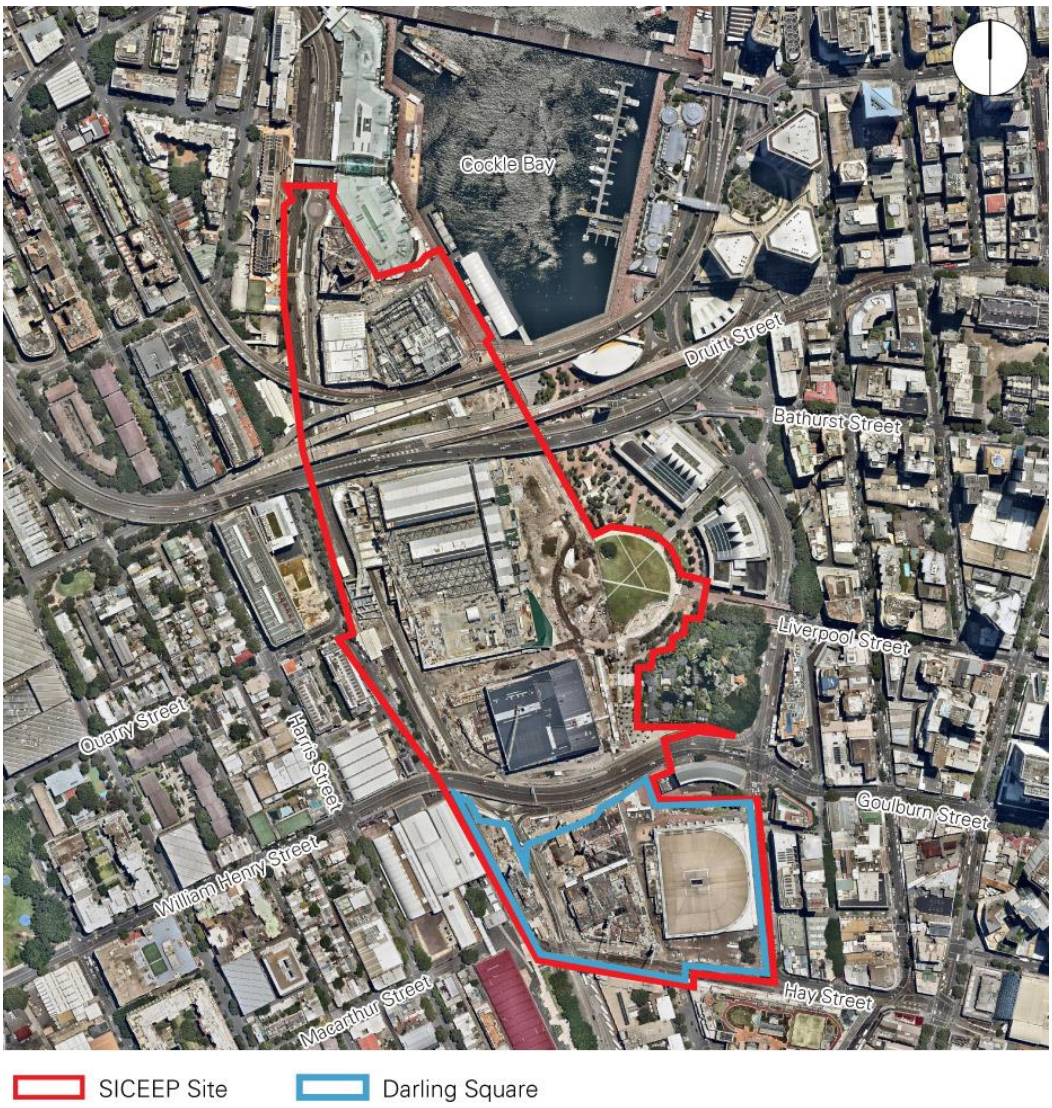


Figure 1 - Aerial Photograph of the SICEEP Site

The Concept Proposal DA provides for six (6) separate development plots within the Darling Square Site (refer to **Figure 2**):

1. North Plot;
2. North East Plot;
3. South East Plot;
4. South West Plot;
5. North West Plot; and
6. Western Plot (Darling Drive).

The Application Site area relates to the South East Plot and surrounds as detailed within the architectural and landscape plans submitted in support of the DA.

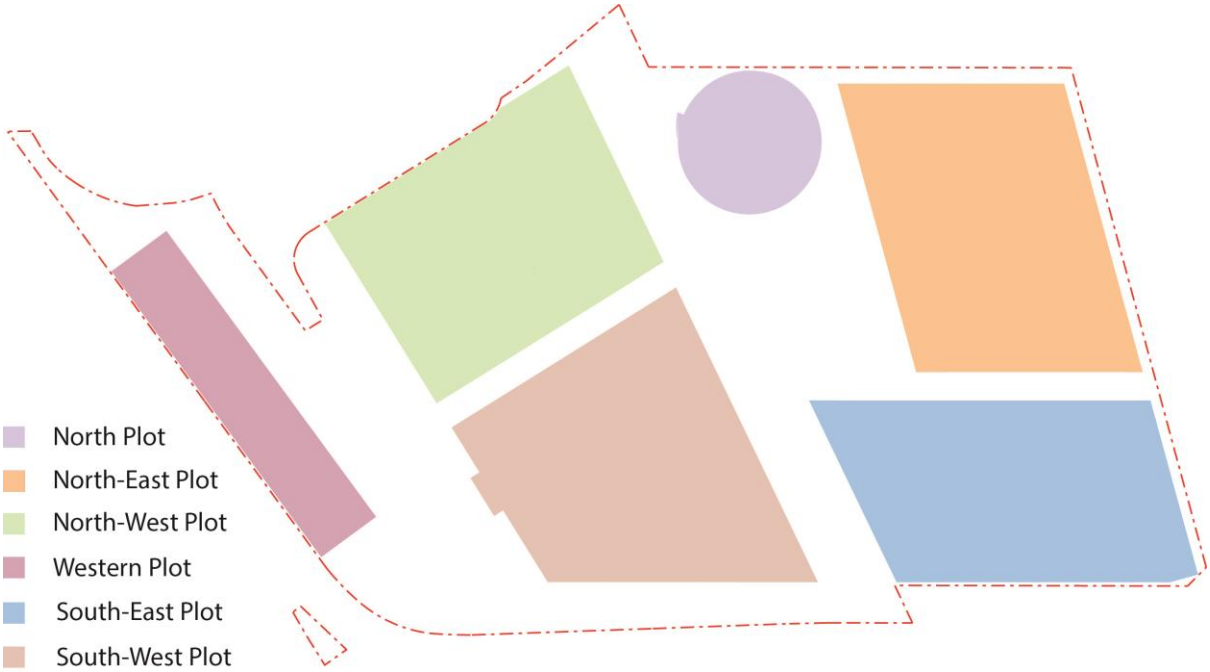


Figure 2 - Concept Proposal Development Plots

5. Planning Approvals Strategy

The SICEEP project has resulted in the lodgement of numerous SSD DAs for the various components of the redevelopment project. Future applications will continue to be lodged in accordance with the Concept Proposal SSD DA for the remaining development plots of Darling Square Site.

6. Geotechnical Model

Coffey has previously completed a Preliminary Geotechnical Assessment to support a Stage 1 Development Application (SSDA2) for the overall Haymarket (Darling Square) Precinct development (refer report ref: GEOTLCOV24303AG-AD, dated 6 March 2013). Additional geotechnical investigations were carried out in 2014 and a geotechnical report has been prepared for the South East Plot (refer report ref: GEOTLCOV24303AG-BN, dated 2 October 2014) which is presented as Appendix A of this report.

Based on the results of our latest geotechnical investigation, the geotechnical constraints for the development of the SE Plot are expected to broadly comprise those associated with the following subsurface features:

- variable fill in terms of nature and thickness, including a suspected buried dam (discussed below);
- an igneous dyke intrusion (and associated dyke affected zone) within the sandstone bedrock, striking northwest/southeast and running through the SE plot;
- an in-filled palaeochannel, incised into the Sandstone bedrock along the north side of the SE plot, with the deepest part of the channel inferred to have a similar location and orientation as the dyke;
- presence of localised sub-vertical shearing and joint swarms with likely NNE strikes; and
- high groundwater levels.

The material infilling the palaeochannel incised in the sandstone bedrock comprises man-made fill and alluvium / estuarine deposits. Based on the available borehole information, an overview of the respective subsurface strata is presented in our geotechnical investigation report (refer Appendix A). The SE plot is located on the southern side of the in-filled palaeochannel resulting in a variable bedrock profile with depth to bedrock typically increasing towards the northern plot boundary (and dyke location) as shown on the inferred top of rock contour plan included as Figure 7 of Appendix A.

The inferred location of the igneous dyke through the site is also shown in Figures 1 and 2 of Appendix A. Our report describes the inherent variability of igneous dykes and demonstrates that although at this site the approximate orientation and location of the dyke is relatively well understood, the nature of the dyke rock – and the sandstone bedrock adjacent to it – is expected to be non-uniform. Dykes can thicken and thin, deviate and kink, split apart and recombine, and may exhibit other irregularities governed by the original host rock structure.

Pile foundations within the dyke zone will be impacted by the dyke and affected sandstone adjacent to the dyke. Our discussion and recommendations on foundation design and mitigation measures is presented in sections 7.3 and 7.4 of Appendix A. The site is located between the GPO Fault Zone to the west, and the Martin Place Joint Swarm to the east, and localised shearing and joint swarms may be present within the site.

A buried dam wall is thought to have been built through the SE plot in the early 19th century. Information from Casey and Lowe report titled "*Non Indigenous Archaeological Assessment and Impact Statement*", dated March 2013, suggests the dam is orientated approximately northeast/southwest from the corner of Harbour Street and Factory Street to the corner of Hay Street and Quay Street. The report states on page 16 that the dam wall "*may have a stone face or skin on the western side, retaining the formed earth, timber and rubble stone core. The top of the embankment may have a stone capping*". Casey and Lowe have undertaken additional archaeological investigation at the site in 2014. Reference should be made to their findings to assist in mitigating the impact of the development on the dam wall.

Table 1 below presents a summary of the depths of occurrence and thickness of each geotechnical unit of relevance to the SE plot area based on the findings of previous investigations by Coffey and others.

Table 1 - Depth of occurrence and thickness of geotechnical units

Unit	Material / Origin	Depth to Top of Unit (m)	Thickness of Unit (m)	Elevation at Top of Unit (mAHD)
1	Fill	0	2 to 4.5	2.7 to 3.3
2A	Estuarine Deposits	2 to 3	nil to 2	0 to 1
2B	Alluvium	3.8 to 4.5	nil to 5.5	-1.5 to -0.5
3	Residual Soil	7 to 9	nil to 1.5	-6 to -4
4A	Class V/IV Sandstone	8 to 13	0.5 to 2	-5 to -10
4B	Class III Sandstone	10 to 13	2 to 3	-7 to -11
4C	Class II Sandstone	13.5 to 16	Not Proven	-13 to -10.5
5	Igneous Dyke	12 to 16	3.5 to 7 wide, depth not proven	-13 to -9

Groundwater levels are expected to vary between 0 m AHD and 1.0 m AHD, about 2 m to 3 m below existing ground level, although higher groundwater levels may occur due to tidal variations and high and persistent rainfall periods.

The site is located in a region with low seismic hazard, and has been classified as sub-soil class C_e with a Seismic Hazard Factor (Z) of 0.08.

7. Conclusion

Based on the findings of our geotechnical assessment, and experience on similar projects, the proposed developments associated with the South East Plot are considered feasible from a geotechnical perspective. The proposed developments should present a low risk to surrounding structures provided appropriate additional site investigation, design assessments, and construction monitoring normally associated with this type of development are carried out and on the assumption that a piled footing design is adopted to transfer the building loads to the underlying bedrock.

For advice pertaining to the above identified geotechnical site constraints for the proposed development, reference should be made to the relevant parts of our Geotechnical Assessment Report (ref: GEOTLCOV24303AG-BN, dated 2 October 2014) attached as Appendix A.

The following two pages contain important information about the uses and limitations of this report.

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.

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.

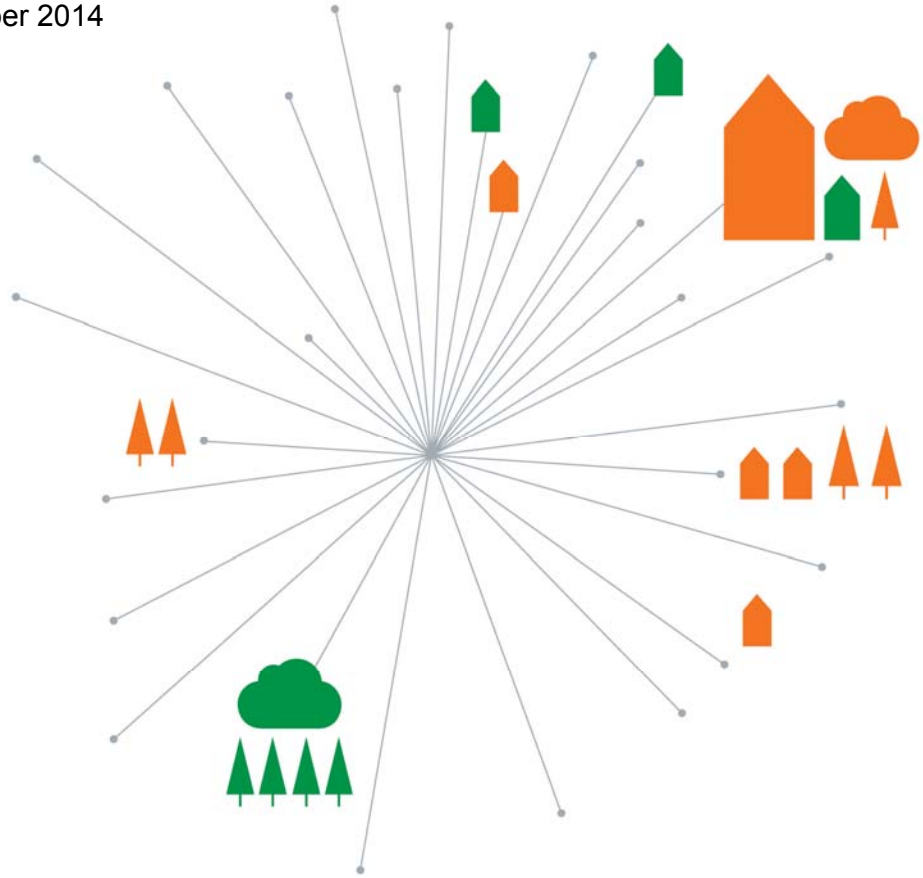
Appendix A - Geotechnical investigation report (ref. GEOTLCOV24303AG-BN, dated 2 October 2014)

Lend Lease Building Pty Limited

Sydney International Convention Exhibition and Entertainment Precinct (SICEEP) "The Haymarket"

South East Plot
Geotechnical Investigation Report

2 October 2014



Pour trust
into your
foundations
and you
can build
anything

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Sydney International Convention Exhibition and Entertainment Precinct (SICEEP) "The Haymarket"

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Table of contents

Tables

Figures

Appendices

1 Introduction

This report presents the results of a geotechnical investigation for the proposed South East (SE) plot of The Haymarket Development. Coffey Geotechnics Pty Ltd (Coffey) was commissioned by Lend Lease Building Pty Limited (Lend Lease) to carry out the investigation under Professional Services Agreement 163389 – PS 0008 and did so in general accordance with the following three proposals.

- Ref. GEOTLCOV24303AG-AU, dated 31 March 2014.
- Ref. GEOTLCOV24303AG-BE, dated 17 June 2014.
- Ref. GEOTLCOV24303AG-BT, dated 1 September 2014.

Coffey understands that The Haymarket site is to be developed for a mix of residential and non-residential uses, including, but not limited to residential buildings, commercial, retail, community and open space. The South East Plot is one of six development plots within the Haymarket Site.

The purpose of the geotechnical investigation was to provide further targeted information on sub surface conditions as a basis for providing an updated geotechnical model and recommendations for design and construction.

2 Project overview

The redevelopment of the South East Plot is understood to include:

- Demolition of the existing Sydney Entertainment Centre building;
- Construction and use of a five storey mixed use podium across the South East Plot, including:
  - Retail and residential lobbies on Ground Level;
  - Above ground parking; and
  - Residential apartments.
- Construction and use of three residential towers above the podium:
  - SE1 along the south side of the plot, to an approximate height of 97m above existing surface levels.
  - SE2 along the north side of the plot, to an approximate height of 33m above existing surface levels.
  - SE3 along the east side of the plot, to an approximate height of 65m above existing surface levels.
- Public domain improvements, including:
  - a new north-south pedestrian connection (known as the Boulevard) eventually linking Quay Street to Darling Harbour;
  - a new east-west pedestrian laneway (Little Hay Street) north of the SE Plot linking Harbour Street to the Boulevard; and
  - Upgrade of Hay Street (part) to provide for a pedestrian share way.
- Extension and augmentation of physical infrastructure / utilities as required.

3 Previous geotechnical investigations

Coffey has extensive existing geotechnical information within the site and immediate environs. This includes site investigations carried out by Coffey and information gathered by others for previous projects. Borehole data from the references listed in Table 3.1 was used to assess the geotechnical/geological conditions of the site.

Table 3.1: Results of previous investigations used in preparation of this report

Ref No.	Description of Previous Project
R1	Department of Main Roads, "North Western Expressway Project", 1971*
R2	Coffey & Partners Pty Ltd, "Haymarket Redevelopment – Report on Preliminary Foundation Investigation", May 1978 (S6063-AA)
R3	Coffey & Partners Pty Ltd, "Haymarket Redevelopment – Parking Station Foundation Investigation", July 1979 (S6269-AB)
R4	Coffey & Partners Pty Ltd, "Proposed Haymarket Carpark – Additional Foundation Investigation", June 1980 (S6269/2-AA)
R5	Arup Geotechnics, " Darling Harbour Redevelopment – Site Investigation Report", November 1984
R6	Coffey & Partners Pty Ltd, " Darling Harbour Development Maritime Structures Geotechnical Investigation Zones 1 to 6" May 1985 (S7559/1-AE)*
R7	Coffey & Partners Pty Ltd, " Darling Harbour Development Project Convention Centre – Geotechnical Investigation" June 1985 (S7559/3-AD)
R8	Arup Geotechnics, " Darling Harbour Development Western Boulevard – Site Investigation Report", December 1985
R9	Coffey & Partners Pty Ltd, " Darling Harbour Light Monorail Geotechnical Investigation", May 1986 (S7769/1-AG)
R10	Coffey & Partners Pty Ltd, "Studio City Development – Geotechnical investigation", July 1988 (S8283/1-AH)
R11	City of Sydney, City Engineer's Department, "William Henry Street Bridge – Eastern Approach", July 1967
R12	Coffey Geosciences Pty Ltd, " Geotechnical Investigation Proposed Multi-storey Development – Bullecourt Place, Ultimo", December 2001 (S21012/1-AS)
R13	Arup Geotechnics, "Darling Harbour Development – Western Boulevard Sewer Tunnel", December 1985
R14	Coffey & Partners Pty Ltd, "Merino Central Two Project, Pyrmont – Geotechnical Investigation", November 1986 (S7960/1-AC)
R15	Jeffery and Katauskas Pty Ltd, "Geotechnical Investigation Proposed Refurbishment of Woolstores", April 1986
R16	Arup Geotechnics, "Darling Harbour Development – Pier Street, Harbour/Day Streets" April 1986
R17	Coffey Geotechnics Pty Ltd, "Sydney International Convention and Entertainment Centre – Geotechnical Investigation Report", August 2011 (GEOTLCOV24303AA-AE)
R18	Coffey Geotechnics Pty Ltd, "Proposed Sydney International Convention, Exhibition and Entertainment Precinct (SICEEP)", May 2012 (GEOTLCOV24303AC-AD)

R19	Coffey Environments Pty Ltd, "Supplementary Site Investigation – Sydney International Conference, Exhibition and Entertainment Precinct, Darling Harbour" August 2012 (GEOTLCOV24303AD-AA)
R20	Coffey Environments Pty Ltd, "Supplementary Site Investigation: Factual Report – Sydney International Conference, Exhibition and Entertainment Precinct, Darling Harbour" January 2013 (GEOTLCOV24303AF_R0-01a)

4 Method of investigation

Fieldwork for the geotechnical investigation for the South East Plot comprised:

- Drilling 3 inclined cored boreholes (SE-BH1 to SE-BH3) into bedrock to drill lengths ranging from 17.2m to 25.6m; and
- Drilling 2 vertical cored boreholes (SE-BH4 and SE-BH5) into bedrock to respective depths of 18.8m and 20m below current surface levels.

4.1 Borehole drilling

SE-BH2 was drilled within the existing Qantas Credit Union Arena (QCUA) building using a small difficult access drilling rig with a low mast due to restricted headroom and access required through pedestrian doors.

SE-BH1, SE-BH3, SE-BH4 and SE-BH5 were drilled around the perimeter of the Entertainment Centre using a larger, track mounted, drilling rig.

No space was found within QCUA to drill SE-BH1 within the proposed SE2 tower footprint. It was instead drilled from the back of house area, inclined towards the tower footprint. This borehole was terminated at 17.2m due to rig instability on sloping ground.

SE-BH3 was drilled as an inclined borehole to assess the presence of any sub-vertical defects in the rock. SE-BH4 and SE-BH5 were drilled at a 3m offset from the assumed igneous dyke location to assess foundation conditions either side of the dyke. Boreholes SE-BH2 and SE-BH4 intersected the dyke.

Each borehole was started using solid flight augers with a tungsten carbide (TC) drill bit. Boreholes were continued to bedrock by washboring using a casing advancer. Rock coring was carried out in all boreholes using the NMLC or NQ wireline coring techniques.

Standard Penetration Tests (SPT) were typically carried out at 1.5m intervals in soils at the vertical borehole locations (SE-BH4 and SE-BH5). SPTs are not possible during inclined borehole drilling.

A Coffey Geotechnical Engineer recorded testing and sampling, boxed and photographed the rock core and logged the soil and rock materials encountered. Groundwater inflows and soil moisture observations were recorded during auger drilling. Observations of drill fluid return/loss were recorded during wash boring and core drilling.

The boreholes were backfilled with cuttings and capped with about 200mm thick concrete flush with the ground surface.

The borehole locations and reduced levels were measured by the project surveyor and are recorded on the borehole logs. The borehole locations are shown on Figures 1 and 2.

4.2 Laboratory testing

Soil and Rock samples obtained during fieldwork were taken to our laboratory. The following tests were carried out on selected samples.

- Point Load Strength Index tests at approximately 1m intervals on rock core
- 1 x Unconfined Compressive Strength (UCS) test on rock core.

5 Results of investigation

5.1 Borehole drilling

The results of the borehole drilling are presented in the Engineering Borehole Logs in Appendix A. The Point Load Strength Index Test results are presented on the borehole logs. The results of the geotechnical investigation are primarily presented as an updated geotechnical model in Section 6 and the attached figures.

Additional to the borehole logs, Photo 1 shows some of the fill profile in an archaeological excavation on the south side of the QCUA near R2-5 borehole location. The excavation was not logged.

Photograph 1: Archaeological Excavation at approximate R2-5 location

5.2 Laboratory testing

The result of the UCS test on the rock core sample from SE-BH3 was 34.8 MPa at a depth interval of 15.1m to 15.4m. The UCS testing is in general agreement with the Point Load Strength Index Test results, showing medium to high strength sandstone bedrock. The UCS laboratory test report sheet is presented in Appendix B.

6 Updated geotechnical model

Based on this geotechnical investigation carried out by Coffey and the previous geotechnical investigations by Coffey and others, the geotechnical constraints for developments within the South East Plot are expected to broadly comprise those associated with the following main subsurface features:

- Variable fill in terms of nature and thickness;
- An igneous dyke intrusion (and associated dyke affected zone) within the sandstone bedrock, striking northwest/southeast and running through the SE Plot;
- An in-filled palaeochannel, incised into the Sandstone bedrock along the north side of the SE plot, with the deepest part of the channel inferred to have a similar location and orientation as the dyke; and
- High groundwater levels.

The material infilling the palaeochannel that has been incised in the Sandstone bedrock comprises man-made fill, estuarine deposits and alluvium.

A dam wall is thought to have been built in the early 19 century below the proposed NE plot. Information from a supplied report titled "*Non Indigenous Archaeological Assessment and Impact Statement*", Casey and Lowe, March 2013, suggests the dam alignment is orientated approximately northeast/southwest from the intersection of Harbour Street and Factory Street to the intersection of Hay Street and Quay Street. The approximate alignment is shown on Figure 1, reproduced from the supplied DHL Haymarket Archaeological Investigation plan, dated 10 June 2014. The report indicates the dam wall "*may have a stone face or skin on the western side, retaining the formed earth, timber and rubble stone core. The top of the embankment may have a stone capping*". From our discussion with the archaeologist on site on 2 October 2014, we understand that high plasticity clay was observed between approximately RL 0 m AHD and RL -0.6m AHD in the trench shown in Photo 1.

The fill is underlain by estuarine sediments and alluvial back-swamp deposits, which have been deposited predominantly in a south-north direction consistent with the historic shape of the bay, with relatively uniform thickness across the SE Plot. Beneath these estuarine deposits, alluvial deposits with variable thickness were encountered. The alluvial deposits comprise a mixture of clayey sand, sandy clay, and clay, which varies from loose to medium dense or firm to very stiff consistency. A second layer of estuarine deposits was observed below the alluvium in the lowest part of the palaeochannel in the north east corner of the plot. These deposits comprised soft sandy clay and very loose clayey sand. Residual soil was observed below the alluvium at R17-BH11 and R17-BH17 and comprised clayey sand or sandy clay in a loose to medium dense or very stiff condition.

Sandstone bedrock and the igneous dyke occur at depth beneath the SE Plot. An irregular top of rock profile is anticipated, with the depth to rock increasing from the southern side to the northern side of the SE Plot, towards the centreline of the inferred palaeochannel and the igneous dyke location. It should be noted that the buried bedrock surface is likely to take shape as a series of sub-horizontal benches and sub-vertical cliff lines, in a similar fashion to the variations in level that can be observed

on the Sydney harbour foreshores. The difference in rock level is expected to be about 6 m across the width of the proposed building footprint.

The sandstone bedrock is classified based on the Sydney rock classification system given in the footnote of Table 6.1 below. There are five classes of Sandstone (I to V), based on strength, fracturing, and amount of defects such as sheared zones and clay seams. Class I Sandstone is the best quality while Class V Sandstone represents the lowest quality sandstone in the classification system.

Based on the previous information and current geotechnical investigation carried out by Coffey, we have inferred subsurface contours for the following material layers:

- Base of fill/top of alluvial deposits (Figure 6)
- Top of extremely weathered/highly weathered sandstone bedrock - Class V/Class IV Sandstone (Figure 7)

The observed base of fill level across the SE plot varies between -1.4m AHD and +1.5m AHD.

Top of Class III sandstone levels are expected to range from -7 m to -11 m AHD across the SE plot. The interpretation Class III and Class II Sandstone levels may be highly irregular due to the igneous dyke passing though the SE Plot and near vertical jointing downgrading the Pell's classification of the cored rock.

Three cross sections have been drawn through the site and are presented as Figures 3 to 5. The location of the section lines is shown on Figures 1 and 2.

Based on the borehole information, an overview of the subsurface strata is presented in Table 6.1.

Table 6.1: Overview of subsurface conditions and geotechnical units

Unit	Material Description	Depth to Top of Unit (m)	Thickness of Unit (m)	Elevation at Top of Unit (mAHD)
1	**Fill** – comprising heterogeneous mixtures of sand, sandy gravel, clay and sandy clay/silt with cobbles and occasional boulder sized rock fragments. Concrete and Asphalt materials were encountered at shallow depths at most of the borehole locations. The density/consistency of the fill is variable, and may range from loose to dense or very soft to stiff. Due to its variability and likely non-uniform placement procedure, it would be classified as "uncontrolled fill".	0	2 to 4.5	2.7 to 3.3
2A	**Alluvium and Estuarine Deposits** – comprising clayey sands and clays with trace shell layers and organic matter. These materials range from very loose to medium dense or very soft to firm in consistency.	2 to 3	nil to 2	0 to 1
2B	**Alluvium** - this unit may comprise alluvial soil as well as transported colluvial soil derived from the neighbouring buried slope of the eroded Cockle Creek banks. This unit comprises sandy clay of firm to very stiff consistency with interspersed layers of loose medium dense sand and clayey sand.	3.8 to 4.5	3 to 5.5	-1.5 to -0.5
3	**Residual Soil** – derived from weathering of the underlying sandstone rock, and generally comprising clayey sand or sandy clay having stiff to very stiff consistency. In some places, however, this unit is relatively thin or absent due to the geological erosion process.	7 to 9	nil to 1.5m	-6 to -4
4A	**Bedrock** – comprising Sandstone ranging from extremely weathered to fresh with low to medium strength shale bands (up to 1.2m thick). This unit has been subdivided based on strength, fracturing, and defects in accordance with Pells et al (1998) as follows: • 4A – Class V and Class IV Sandstone • 4B – Class III Sandstone • 4C – Class II Sandstone or better Class V Sandstone is extremely low to low strength with significant amounts of defects while Class II Sandstone or better is generally medium and high rock strength with limited defects.	8 to 13	0.5 to 2	-5 to -10
4B		10 to 13	2 to 3	-7 to -11
4C		13.5 to 16	not proven	-13 to -10.5
5	**Igneous dyke –** Typically comprising extremely weathered pale grey to pale green grey dolerite with stiff clay properties. Poorer quality fractured / weathered sandstone may be anticipated either side of the dyke.	12 to 16	3.5 to 7 wide, depth not proven	-13 to -9

Note: Rock classified in accordance with Pells et al (1998) "Foundations on Sandstone and Shale in the Sydney Region" Aust. Geomech. Jnl, Dec 1998.

6.1 Igneous dyke

The igneous dyke (known as the “Great Sydney Dyke”) runs diagonally across the north side of the SE Plot, striking north-west south-east (refer to Figure 1 and 2). Figure 5 presents a cross section perpendicular to the dyke at Tower SE3 location. From the borehole information gathered in both the SE and NW plots the dyke appears to be sub-vertical, ranging from approximately 3.5 m to 7 m in thickness and comprises typically extremely weathered pale grey to pale green grey dolerite with stiff clay properties.

SE-BH2, SE-BH4 and R2-BH2 were drilled into the dyke. They encountered extremely weathered dolerite to -16 m AHD, -13 m AHD and -20 m AHD respectively, underlain by highly weathered to slightly weathered dolerite of high to very high strength. Boreholes drilled in the Great Sydney Dyke elsewhere have indicated depths of up to -24 m AHD before dolerite rock of better quality was encountered. R17-BH16 encountered fresh dolerite at -33.5 m AHD. NW-BH1 encountered what would appear to be a smaller ‘stringer’ dyke (an off-shoot of the main dyke) weathered to a grey clay and separated from the main dyke by sandstone bedrock. On the basis of the borehole information the dyke appears to deviate laterally from its general strike trend line.

The intrusion of the dyke has altered and sheared the sandstone bedrock around it. Boreholes drilled in both the NW plot and SE plot indicate that deeper weathering, sheared and brecciated zones with closely spaced fracturing and variable rock strength should be expected within several meters either side of the dyke.

These features reflect the inherent variability of igneous dykes and demonstrate that although at this site the approximate orientation and location of the dyke is relatively well understood, the nature of the dyke rock – and the sandstone bedrock adjacent to it – is expected to be non-uniform. These observations demonstrate how dykes can thicken and thin, deviate and kink, split apart and recombine, and may exhibit other irregularities governed by the original host rock structure.

Information gathered from an internet web search (source: development application documents for City West Cable Tunnel project) indicates that previous excavations in the vicinity of corner of Thomas Street and Hay Street encountered highly permeable dyke material and adjacent sandstone. The seepage flow was highly saline, with iron, manganese and sulphate. These documents suggest it is likely that the dyke zone is connected to water in the Darling Harbour sediments.

6.2 Fault and shear zones

In addition to the dyke, shear zones and isolated joints sub parallel to the GPO fault zone are also inferred to be present within the site. The known location of the main GPO fault zone extends from Circular Quay to the intersection of Bathurst Street and Harbour Street (i.e. about 400m north of site) with an approximate strike of NNE. A possible projection of the GPO fault zone through the Haymarket site is shown on Figure 1. The SE Plot is located to the east of the projection of the known GPO Fault zone and to the west of the Martin Place Joint Swarm.

An inferred zone for the possible presence of isolated joints/shear zones is indicated on Figure 1.

7 Discussion and recommendations

7.1 Filling and compaction

Fill encountered at the site is variable and could be classified as “uncontrolled fill” according to AS2870 – Residential Slabs and Footings, 2011. Where slabs or pavements are to be founded on structural fill, all existing fill should be removed and replaced with structural fill. The removal of all existing fill material would expose poorer Unit 2A materials and is therefore not recommended.

Prior to placement of new fill, the exposed surface should be proof rolled using a static roller weighing at least 8 tonnes. Granular bridging layer and geogrid may also be required if wet and/or heaving conditions occur.

Table 7.1 presents compaction requirements for typical earthworks situations. Further assessment for potential settlements will be required with the appropriate material parameters for the compacted fill.

Table 7.1: Earthwork specifications for typical situations

Application	Depth Profile	Minimum Compaction Relative to Standard Maximum Dry Density (SMDD)	Moisture Content Relative to Standard Optimum Moisture Content (SOMC)
Beneath Building Footings & Raft Slabs	Upper 1m below footing base	98%	±2%
	More than 1m below footing base	95%	±2%
Pavements	Upper 0.3m below pavement layer	100%	±2%
	0.3m to 1m below pavement layer	95%	±2%
	More than 1m below pavement layer	95% for new fill 95% for upper 0.3m of existing fill	±2%

7.2 Excavations

Based on the architectural concept and structural drawings supplied by Lend Lease, the proposed development will not have deep basements and therefore significant excavations are not currently anticipated. Smaller excavations of up to 3m depth below existing surface levels are expected for the construction of pile caps and ground slabs. Such excavations are expected to be within Unit 1 Fill and Unit 2 Alluvium/Estuarine Deposits. The proposed buildings are generally expected to be founded on piles.

7.2.1 Excavation batter slopes

Stability of excavations in Unit 1 Fill will be influenced by the presence of underlying low strength Unit 2 soils (even if Unit 1 fill is replaced by Engineered Fill) and groundwater. As a result there will be a significant risk of excavation instability if relatively steep temporary batter slopes are adopted without site specific investigation and geotechnical input during both design and construction. For preliminary design we recommend the following temporary batters and shoring:

- Above the groundwater table, excavations in Unit 1 or Engineered Fill: flatter than 2H:1V; and
- Below the groundwater table or into Unit 2 soils: adopt shoring.

Instability due to bottom heave is not anticipated for excavations shallower than 3m. However, further assessment should be carried out for deeper excavations if proposed.

7.2.2 Excavation support requirements

Depending on project requirements for a sufficiently watertight, and/or stiff retention system the following options could be considered.

- Driven sheet piles;
- Contiguous pile wall; or
- Secant pile wall.

For a sheet piled wall, overlapping or interlocking sheets would be vibrated or driven into the ground around the proposed excavation perimeter. The steel sheet piles could be used to provide formwork for the permanent walls for the superstructure, but this would preclude their recovery. Sheet piles would likely be installed within the alluvium. However, if sheet piles have to extend into the weathered bedrock, it is likely that the sheet pile will refuse on the weathered bedrock and groundwater seepage should be expected to occur through the clutches and toe of the wall.

Contiguous pile walls may be practicable where the proposed excavation does not extend below the groundwater level.

Secant piling involves drilling “soft” (mass concrete) piles using low strength concrete and overlapping “hard” (reinforced structural concrete) to form minimum 75mm to 150mm overlaps. The required overlap is a function of the depth of piling and construction tolerance. The interlocks between “soft” and “hard” piles provide a seal to limit groundwater inflow. Unless bored carefully, secant piles can deviate off vertical centre during installation creating gaps between the piles resulting in groundwater seepage and ground loss.

For the preliminary design of retaining walls the parameters in Table 7.2 may be adopted.

Table 7.2: Preliminary retaining wall design parameters

Unit	Description	Bulk Unit Weight (kN/m^3)	Effective Cohesion (kPa)	Friction Angle (degree)
1	Fill	20	0	30 to 35
2	Alluvium/Estuarine	18	0	26
3 & 5A	Residual Soil/weathered dyke	20	5	28
4a	Class V and IV Sandstone	21	30	35

Retaining walls should be designed for appropriate hydrostatic and surcharge loads.

Where cantilevered walls are not practicable, lateral stability could be provided by anchors installed progressively as the excavation proceeds. Where installation of anchors is not practicable, internal strutting or bracing may be required to provide lateral stability.

Excavations associated with installation of utilities are expected to be relatively shallow. Where it is not practicable to adopt temporary batters as recommended in Section 7.2.1 above due to land take restrictions, or where excavations are below standing groundwater levels; lateral excavation support should be provided using a temporary shoring box, internal strutting or similar.

7.2.3 Groundwater conditions

Groundwater levels are expected to vary between 0 m AHD and 1.5m AHD. Where excavations are proposed to extend below standing groundwater levels, extensive dewatering of the alluvial soils is not desirable as this could lead to consolidation settlement of the fill and alluvium and may need special permits to discharge off site. Cut-off walls will be required during excavation works and the final walls should be designed as tanked to maintain standing groundwater levels and prevent groundwater ingress.

Where excavations for the purpose of utilities, remediation and archaeological works are to extend below standing groundwater levels, localised dewatering will be required. Where inflow rates are relatively low and cohesive soils are encountered, sump and pump techniques may be practicable. However, where higher inflow rates occur, installation and operation of drilled wells or jetted spear points around the excavation perimeter would be required.

The detailed assessment and design of groundwater management is beyond the scope of this report and should be addressed by a hydrogeological investigation. Coffey has conducted such a hydrogeological investigation for the adjacent Stormwater Amplification Project (Ref. GEOTLCOV24303AG-BU, dated 17 September 2014.

7.2.4 Excavation induced ground movements

Excavation induced ground movements may be significant given the site ground conditions. Walls retaining soil strength material may laterally deflect up to 1% of the retained height, depending on the stiffness of the retaining wall system. Lateral deflections may be limited to typically 0.3% to 0.5% of the retained height using appropriate design and construction techniques.

The potentially damaging effects of stress redistribution in the vicinity of excavations should be assessed as part of the detailed design. Lateral displacements of retaining walls due to stress redistribution may also result in settlement. For preliminary assessment of impacts we recommend that potential settlement be assumed to be equal to predicted lateral displacements. Typically,

ground movements (lateral displacement and settlement) are greatest at the excavation face and decrease to negligible values at a distance of up to 3 times the excavation depth. Dilapidation surveys of adjacent structures within this distance of the excavation should be carried out prior to construction. Close coordination with geotechnical engineers will be required during design and construction stages to assess possible movements and mitigation measures.

For preliminary impact assessment purposes the above guidelines on displacements may be used. If such movements cannot be tolerated for sensitive features, then retaining walls should be designed for higher earth pressures. Depending on the specific retention system, basement excavation details and the nature of adjacent structures, a more detailed analysis will be required. Coffey has specialist capability in applying numerical modelling techniques to the estimation of ground movements.

7.3 Building foundations

7.3.1 Expected arrangements and issues

The SE plot redevelopment is understood to comprise construction of a mixed use podium and three residential towers above and within the podium structure. Proposed roof levels are shown on Figure 2.

Based on the nature of subsurface conditions; comprising a variable thickness of fill and alluvial/estuarine soils, we expect that footings for this development may comprise cased bored piles or continuous flight auger (CFA) piles socketed into the underlying sandstone bedrock.

Stress relief effects due to the palaeochannel formation process are likely to have caused opening and weathering of defects (bedding planes and joints). Therefore, poor foundation conditions may occur near the current rock surface level. Significant joints and clay seams may be encountered and these may affect bearing capacity, settlement and required socket lengths of pile foundations.

Difficulties in construction of deep piles for the Entertainment Centre have been reported (e.g. Malcom D.J., 1997) when the dyke is in contact with recent marine and alluvial sediments. An indurated sandstone or ironstone capping layer at the boundary of recent sediments and the underlying, lower strength, dyke could pose construction difficulties for driven piles. Possible difficulties to cased bored and CFA piling include drilling in very strong Dolerite/altered Sandstone (i.e. Sandstone could be significantly altered to a distance of several meters on either side of dyke), ironstone bands, collapse of dyke material and management of groundwater.

Geotechnical verification during construction will be required to mitigate the risks associated with the potentially complex foundation conditions in the vicinity of the dyke (as mentioned in previous sections, the igneous dyke may thin, thicken, sidestep or branch). Through our discussions with Lend Lease, we understand that column loads will be supported on reinforced beams spanning the dyke and founded on the adjacent sandstone. Depending on the proximity of the footings and the condition of the sandstone which may have been adversely affected by the dyke material, it may be necessary to reduce rock design parameters.

7.3.2 Design parameters for footings and piled foundation

Design end bearing pressures and shaft adhesion for piled foundations are provided in Table 7.3 for both Limit State and Working Stress design methods. Where Limit State design parameters are used, a geotechnical strength reduction factor Φ_g of 0.6 should be applied and the Serviceability Limit State deflections should be checked using the elastic properties presented in Table 7.3.

If piles are required to resist uplift, the shaft adhesion values in Table 7.3 should be reduced by a factor of 0.7, in addition to adopting a Φ_g value of 0.6.

The allowable end bearing pressures provided in Table 7.3 are based on a settlement criterion of up to 1% of the pile diameter. Ultimate capacities (for better quality rocks) are significantly higher, however, can only be mobilised under large settlements. Use of limit state design of piles using ultimate capacities, appropriate reduction factors and settlement calculations is likely to allow higher load capacities to be adopted.

Table 7.3: Design parameters for footings and piled foundation

Unit	Working Stress Design Values[1,2]		Limit State Design Values[1]		
	Allowable End Bearing Pressures (MPa) [3]	Allowable Shaft Adhesion[3,4] (kPa)	Ultimate End Bearing (MPa) [3]	Ultimate Shaft Adhesion[3,4] (kPa)	Elastic Modulus (MPa)
3 / 5 (Residual Soil / Weathered Dyke)	-	-	-	60	40
4a (Class V and IV Sandstone)	1 to 3.5	75 to 150	3 to 10	150 to 250	125
4b (Class III Sandstone)	5 to 6	500 to 600	20 to 40	800 to 1,000	1000
4c (Class II Sandstone or better)	8 to 12	800 to 1,200	60 to 120	1,500 to 2,000	1500

(1) Structure specific assessments should be carried out to assess design values, particularly if the values at the upper end of the ranges provided are to be adopted.

(2) These values are based on Pells et al. (1998), for presumptive settlement limits of up to 1% footing width or pile diameter. Higher design values may be possible based on first principle engineering design (refer to limit state design values) and appropriate settlement and differential settlement assessment.

(3) Design values for specific structures should be selected from within the ranges provided in the table depending on factors such as rock quality, particularly rock strength. Lower values than the ranges provided in the table may apply for shear / fracture affected zones adjacent to the dyke. Appropriate values should be confirmed by additional investigation and with construction stage verification by a geotechnical engineer.

(4) Shaft Adhesion should be ignored for pad or strip footings.

7.3.3 Constructability of piles

The type of pile construction will depend on the capability of construction plant for rock penetration. CFA piles can be constructed with sockets in Class III or II Sandstone using high capacity piling rigs with special rock drilling bits. However, the availability of construction plant capable of penetrating into Class II Sandstone is more limited, with associated cost and time implications.

Bored piles can be constructed with sockets into all classes of sandstone using rock drilling buckets, coring and impact tools. Please note that the rock classification has been primarily conducted for the purpose of foundation design and not for the purpose of excavatibility. Harder rock layers may exist at any level within the sandstone bedrock. Piling contractors should inspect the rock cores and make their own assessment on drillability of the rock.

Temporary casing may be required during bored pile construction to avoid the collapse of soil material above the rock into bored holes.

A 2 m thickness of concrete was encountered at a depth of 2.8m in SE-BH3. Concrete was also encountered at 1 m and 10 m depth in SE-BH1. There are likely to be buried slabs, shallow footings,

pile caps and piles left in the ground from previous developments of the site. The previous dam wall (see Section 6) of unknown construction and condition is thought to run through the SE plot at the approximate location shown on Figures 1 and 2 and may contain buried rock fill. These structures may cause refusal and/or slow progress during piling works.

7.3.4 Construction platform for piling

Piling platforms will need to be constructed on Unit 1 Fill. The platform design should be assessed using the BRE method. Existing backfilled excavations and inconsistency in the fill may cause localised softer zones. Localised testing and/or proof rolling of the subgrade should be observed by a geotechnical engineer prior to construction of the platform.

7.4 Contingency planning

Subsurface conditions at the site are expected to be highly variable in terms of unit thickness/material type and consistency. The dyke is anticipated to be variable in nature with poor engineering properties. Further shear zones may be encountered within the bedrock.

Based on the expected variable nature of subsurface conditions, some form of contingency planning is recommended should adverse conditions be encountered such as soft soils and/or higher groundwater levels than those observed during site investigations.

Contingency planning should include allowance for items such as:

- Importation of granular fill for construction of access roads and temporary working platforms for heavy plant such as cranes and piling rigs;
- Removal and replacement of existing fill where required;
- Shoring and dewatering of excavations where groundwater / soft saturated soils are encountered;
- Permissions for discharge of water to stormwater where dewatering is required; and
- Redesign of footings/piled foundation to accommodate variable ground conditions associated with features such as the Great Sydney Dyke or the GPO fault zone joint swarm.

Coffey considers predrilling of pile locations to be a prudent measure for Lend Lease to manage the risk associated with poor geotechnical conditions, which may result in foundation redesigns.

7.5 Soil aggressivity

Based on the chemical test results from the site wide investigations and previous investigations, the soil can be classified as “non-aggressive” to “mildly aggressive” conditions for buried concrete and steel structural elements according to AS 2159-2009. However, a number of chemical test results from previous investigations would classify as “mildly aggressive” to “severely aggressive” based on resistivity values.

Acid sulphate soils have been encountered at the Haymarket site. Reference should be made to the Acid Sulphate Soils Management Plan (Ref. ENAURHOD04498AA-RO3), prepared by Coffey.

7.6 Seismic design

In review of AS1170.4-2007, we recommend the following be adopted for seismic design:

- Seismic Hazard Factor (Z) 0.08
- Sub-Soil Class C_e

8 Limitations

The geotechnical model and recommendations in this report are based on the available boreholes from the current and past investigations. The engineering logs describe subsurface conditions only at the specific borehole locations. Ground condition 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” provides additional information on the uses and limitations of this report.

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.

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

POSSIBLE GPO FAULT ZONE PROJECTED FROM AVAILABLE GEOLOGICAL MAPS

POSSIBLE ISOLATED JOINTS OR SHEAR ZONES SUB PARRALLEL TO MAIN GPO FAULT ZONE AND MARTIN PLACE JOINT SWARM

POSSIBLE PREVIOUS DAM LOCATION

LEGEND

- PROPOSED BOREHOLE LOCATION
- PREVIOUS BOREHOLE LOCATION
- BOREHOLE LOCATION - 2014
- BOREHOLE WELL LOCATION - 2014
- CONE PENETRATION TEST LOCATION - 2014
- PAVEMENT BOREHOLE LOCATION
- GPO FAULT ZONE
- INFERRED EXTENT OF ALTERED ZONE
- INFERRED DYKE LOCATION
- SECTION LINE
- PROPOSED ROOF LEVELS (RL + 16.50)

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

Scale (metres) 1:1000

drawn	RC / AW
approved	-
date	02 / 10 / 14
scale	AS SHOWN
original size	A3

coffey

client: LEND LEASE (HAYMARKET) PTY LIMITED

project: SYDNEY INTERNATIONAL CONVENTION EXHIBITION AND ENTERTAINMENT PRECINCT (SICEEP) "THE HAYMARKET'

title: SITE LOCATION PLAN

project no: GEOTLCOV24303AG-BN | figure no: FIGURE 1 | rev: A

PLOT DATE: 2/10/2014 2:30:57 PM DWG FILE: F:\GEOTECH\NCS\LPROJECTS\GEOTLCOV24\GEOTLCOV24303AG LEND LEASE - THE HAYMARKET\8. FIGURES\GEOTLCOV24303AG-BN.DWG

NE-BH5
RL +52.00
NE-BH3
R17-BH15
R9-HR49
SW-BH6
PBH6
RL +27.50
SE-2
55°
SE-BH1
RL +15.00
R20-BH121
30°
SE-BH2
RL +15.00
SE-3
R17-BH16
SE-2'
SE-BH5
SW-BH3
SW-BH5
R20-BH126
SE-BH4
RL +16.50
R17-BH13
R2-2
R2-5
SE-1
SE-BH3
R20-BH119
R17-BH11
R17-BH17
CPT3
SW-BH4
CPT5
GW3
R2-4
CPT4
CPT2
CPT1
SE-1'
GW2
R9-HY45
GW1
POSSIBLE PREVIOUS DAM LOCATION
R10-43
R10-42

LEGEND

- PROPOSED BOREHOLE LOCATION
- PREVIOUS BOREHOLE LOCATION
- BOREHOLE LOCATION - 2014
- BOREHOLE WELL LOCATION - 2014
- CONE PENETRATION TEST LOCATION - 2014
- PAVEMENT BOREHOLE LOCATION
- GPO FAULT ZONE
- INFERRED EXTENT OF ALTERED ZONE
- INFERRED DYKE LOCATION
- SECTION LINE
- RL + 16.50 PROPOSED ROOF LEVELS

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

N

5 0 5 15 25

Scale (metres) 1:500

drawn	RC / AW
approved	-
date	02 / 10 / 14
scale	AS SHOWN
original size	A3

coffey

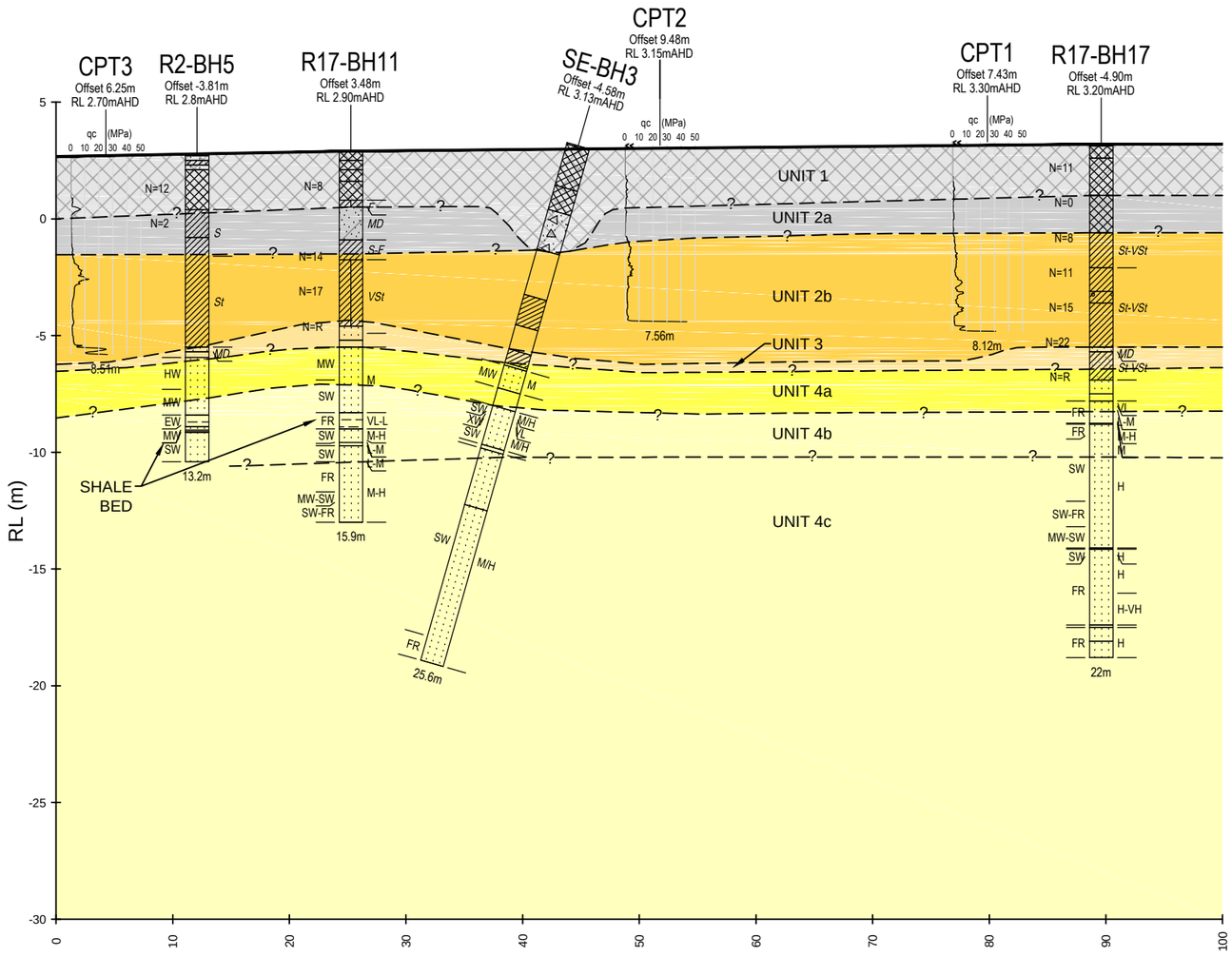
client: LEND LEASE (HAYMARKET) PTY LIMITED

project: SYDNEY INTERNATIONAL CONVENTION EXHIBITION AND ENTERTAINMENT PRECINCT (SICEEP) "THE HAYMARKET'

title: SE PLOT BOREHOLE LOCATION PLAN

project no: GEOTLCOV24303AG-BN | figure no: FIGURE 2 | rev: A

PLOT DATE: 2/10/2014 2:32:40 PM DWG FILE: F:\GEOTECHNICS\1.PROJECTS\GEOTLCOV24\GEOTLCOV24303AG LEND LEASE - THE HAYMARKET\8. FIGURES\GEOTLCOV24303AG-BN.DWG



SECTION SE-1-SE-1'

LEGEND

- FILL
- CLAYEY SAND
- SANDSTONE
- SHALE
- CLAY
- SANDY CLAY
- SAND
- SILTY CLAY
- SILTY SAND
- DOLERITE
- CLAYEY SILT
- SILT
- GRAVELLY SILT
- GRAVELLY SAND
- GRAVEL
- GRAVELLY CLAY
- INTERBEDDED SHALE & SANDSTONE
- DOLERITE
- INTERLAMINATED SILTSTONE & SANDSTONE
- CONCRETE
- ASPHALT
- NO CORE
- IV — ROCK CLASSIFICATION (PELLS ET AL, 1998)
- DX — WEATHERING (SEE EXPLANATION SHEETS)
- WATER LEVEL
- N*=17 — STANDARD PENETRATION TEST RESULT

PROJECT UNITS

UNIT 1	FILL
UNIT 2a	ESTUARINE DEPOSITS
UNIT 2b	ALLUVIUM
UNIT 3	RESIDUAL SOIL
UNIT 4a	CLASS V / IV SANDSTONE
UNIT 4b	CLASS III SANDSTONE
UNIT 4c	CLASS II SANDSTONE

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

NOTE: 2 x VERTICAL EXAGGERATION

Horizontal Scale (metres) 1:500

Vertical Scale (metres) 1:250

drawn	RC / AW
approved	-
date	02 / 10 / 14
scale	AS SHOWN
original size	A3

coffey

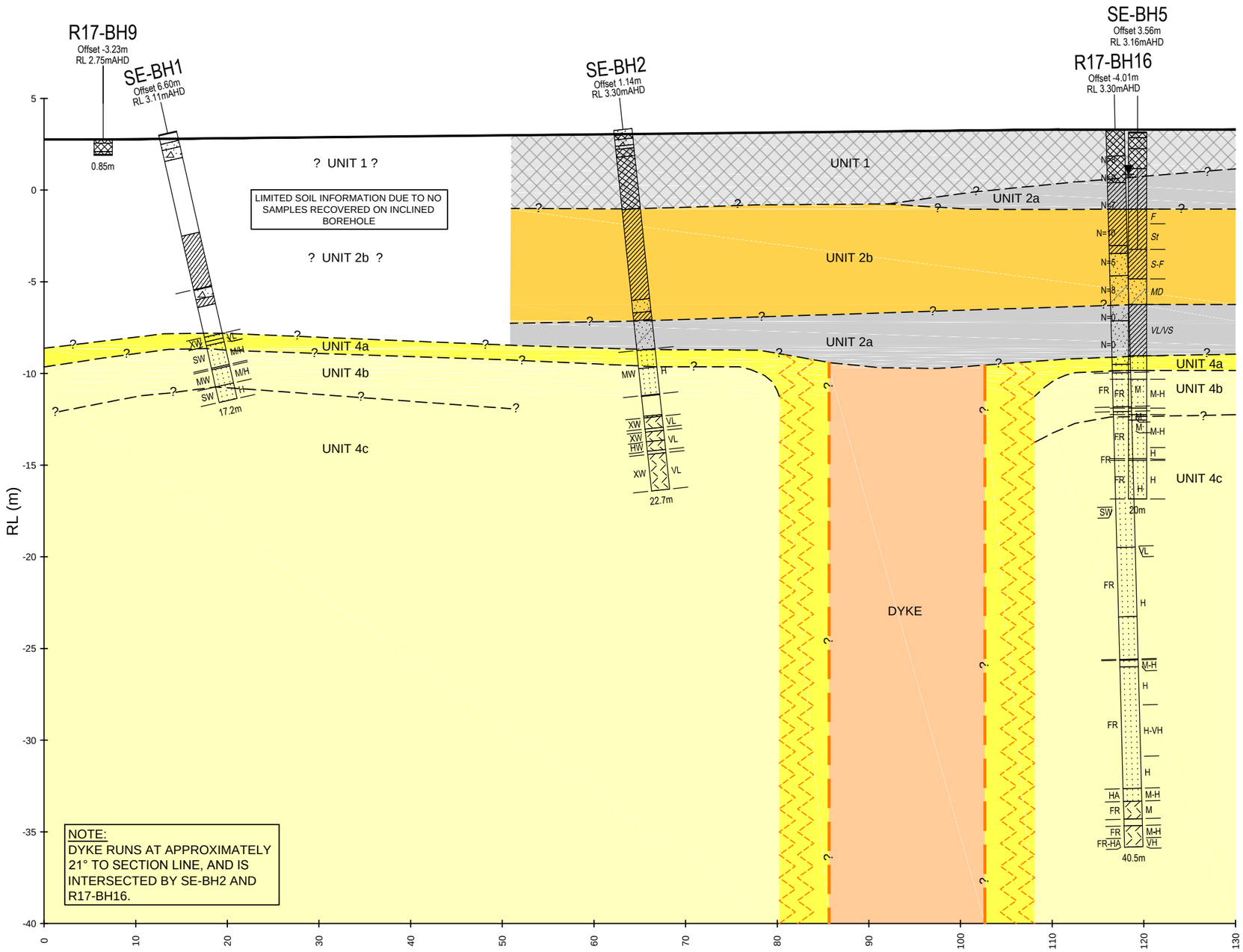
client: LEND LEASE (HAYMARKET) PTY LIMITED

project: SYDNEY INTERNATIONAL CONVENTION EXHIBITION AND ENTERTAINMENT PRECINCT (SICEEP) "THE HAYMARKET'

title: SUBSURFACE SECTION SE-1

project no: GEOTLCOV24303AG-BN | figure no: FIGURE 3 | rev: A

PLOT DATE: 2/10/2014 2:22:38 PM DWG FILE: F:\GEOTECHNICS\1.PROJECTS\GEOTLCOV243\GEOTLCOV24303AG LEND LEASE - THE HAYMARKET\8. FIGURES\GEOTLCOV24303AG-BN.DWG



SECTION SE-2-SE-2'

LEGEND

- FILL
- CLAYEY SAND
- SANDSTONE
- SHALE
- CLAY
- SANDY CLAY
- SAND
- SILTY CLAY
- SILTY SAND
- DOLERITE
- CLAYEY SILT
- SILT
- GRAVELLY SILT
- GRAVELLY SAND
- GRAVEL
- GRAVELLY CLAY
- INTERBEDDED SHALE & SANDSTONE
- DOLERITE
- INTERLAMINATED SILTSTONE & SANDSTONE
- CONCRETE
- ASPHALT
- NO CORE
- IV — ROCK CLASSIFICATION (PELLS ET AL, 1998)
- DX — WEATHERING (SEE EXPLANATION SHEETS)
- WATER LEVEL
- N*=17 — STANDARD PENETRATION TEST RESULT

PROJECT UNITS

UNIT 1	FILL
UNIT 2a	ESTUARINE DEPOSITS
UNIT 2b	ALLUVIUM
UNIT 3	RESIDUAL SOIL
UNIT 4a	CLASS V / IV SANDSTONE
UNIT 4b	CLASS III SANDSTONE
UNIT 4c	CLASS II SANDSTONE
UNIT 5	IGNEOUS DYKE

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

NOTE: 2 x VERTICAL EXAGGERATION

Horizontal Scale (metres) 1:500

Vertical Scale (metres) 1:250

drawn	RC / AW
approved	-
date	02 / 10 / 14
scale	AS SHOWN
original size	A3

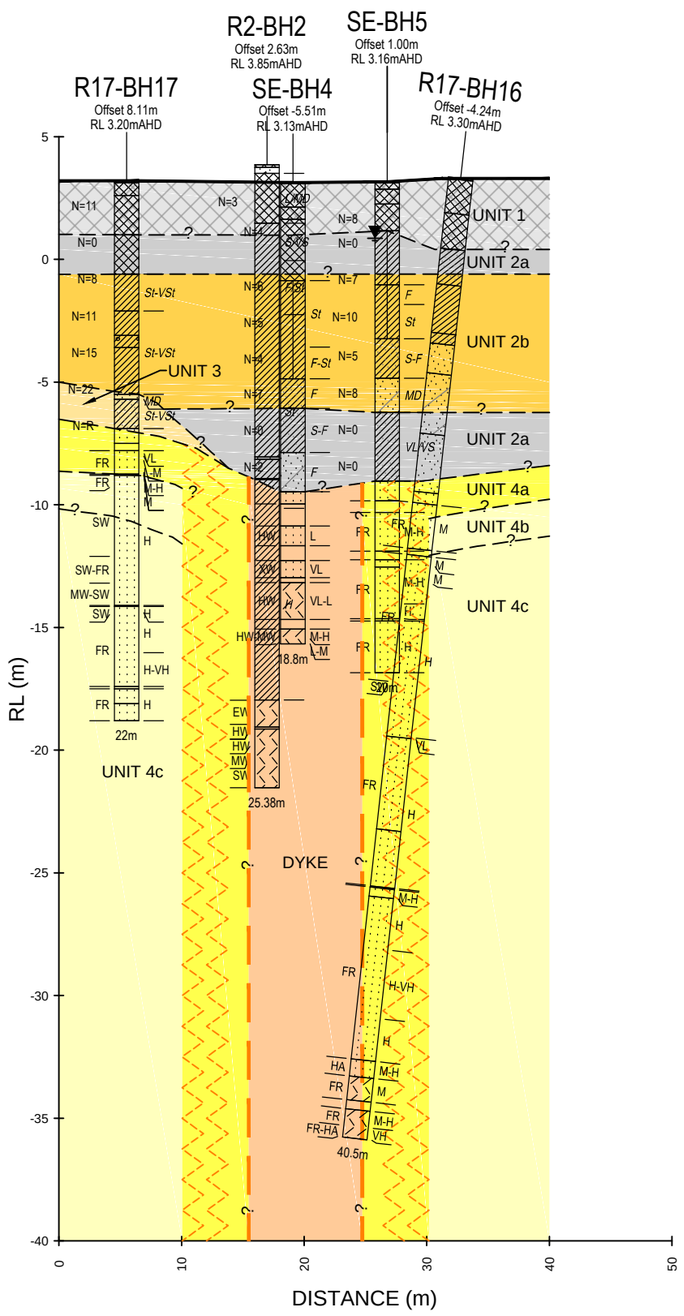
coffey

client: LEND LEASE (HAYMARKET) PTY LIMITED

project: SYDNEY INTERNATIONAL CONVENTION EXHIBITION AND ENTERTAINMENT PRECINCT (SICEEP) "THE HAYMARKET'

title: SUBSURFACE SECTION SE-2

project no: GEOTLCOV24303AG-BN | figure no: FIGURE 4 | rev: A



SECTION SE-3-SE-3'

LEGEND

- FILL
- CLAYEY SAND
- SANDSTONE
- SHALE
- CLAY
- SANDY CLAY
- SAND
- SILTY CLAY
- SILTY SAND
- DOLERITE
- CLAYEY SILT
- SILT
- GRAVELLY SILT
- GRAVELLY SAND
- GRAVEL
- GRAVELLY CLAY
- INTERBEDDED SHALE & SANDSTONE
- DOLERITE
- INTERLAMINATED SILTSTONE & SANDSTONE
- CONCRETE
- ASPHALT
- NO CORE
- IV — ROCK CLASSIFICATION (PELLS ET AL, 1998)
- DX — WEATHERING (SEE EXPLANATION SHEETS)
- WATER LEVEL
- N*=17 — STANDARD PENETRATION TEST RESULT

PROJECT UNITS

UNIT 1	FILL
UNIT 2a	ESTUARINE DEPOSITS
UNIT 2b	ALLUVIUM
UNIT 3	RESIDUAL SOIL
UNIT 4a	CLASS V / IV SANDSTONE
UNIT 4b	CLASS III SANDSTONE
UNIT 4c	CLASS II SANDSTONE
UNIT 5	IGNEOUS DYKE

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

NOTE: 2 x VERTICAL EXAGGERATION

Horizontal Scale (metres) 1:500

Vertical Scale (metres) 1:250

drawn	RC / AW
approved	-
date	02 / 10 / 14
scale	AS SHOWN
original size	A3

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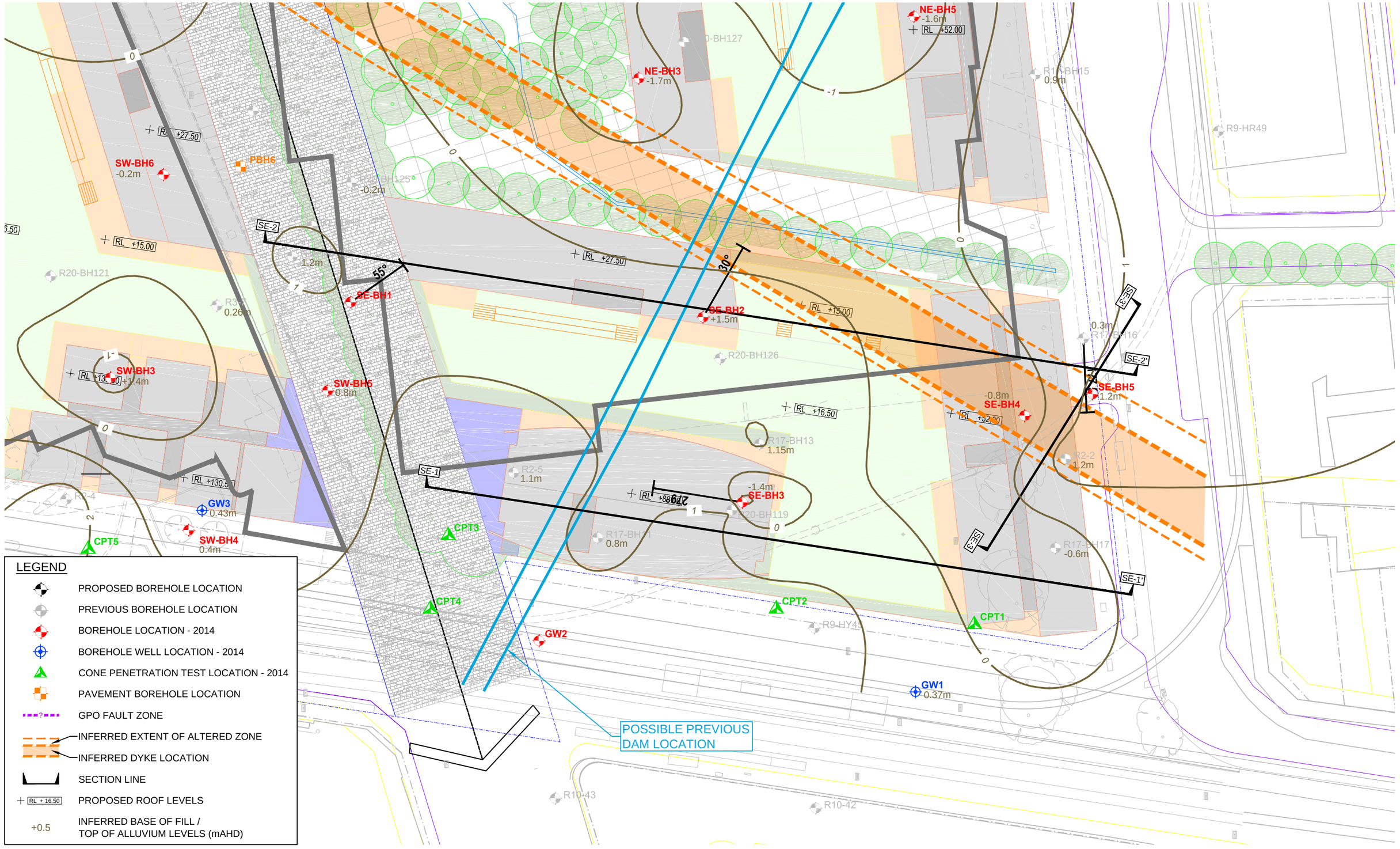
client: LEND LEASE (HAYMARKET) PTY LIMITED

project: SYDNEY INTERNATIONAL CONVENTION EXHIBITION AND ENTERTAINMENT PRECINCT (SICEEP) "THE HAYMARKET'

title: SUBSURFACE SECTION SE-3

project no: GEOTLCOV24303AG-BN | figure no: FIGURE 5 | rev: A



LEGEND

- PROPOSED BOREHOLE LOCATION
- PREVIOUS BOREHOLE LOCATION
- BOREHOLE LOCATION - 2014
- BOREHOLE WELL LOCATION - 2014
- CONE PENETRATION TEST LOCATION - 2014
- PAVEMENT BOREHOLE LOCATION
- GPO FAULT ZONE
- INFERRED EXTENT OF ALTERED ZONE
- INFERRED DYKE LOCATION
- SECTION LINE
- RL + 16.50 PROPOSED ROOF LEVELS
- +0.5 INFERRED BASE OF FILL / TOP OF ALLUVIUM LEVELS (mAHD)

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

N

5 0 5 15 25

Scale (metres) 1:500

drawn	RC / AW
approved	-
date	02 / 10 / 14
scale	AS SHOWN
original size	A3

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client: LEND LEASE (HAYMARKET) PTY LIMITED

project: SYDNEY INTERNATIONAL CONVENTION EXHIBITION AND ENTERTAINMENT PRECINCT (SICEEP) "THE HAYMARKET'

title: INFERRED BASE OF FILL / TOP OF ALLUVIUM CONTOUR PLAN

project no: GEOTLCOV24303AG-BN | figure no: FIGURE 6 | rev: A

PLOT DATE: 2/10/2014 2:33:20 PM DWG FILE: F:\GEOTECHNICS\1.PROJECTS\GEOTLCOV24\GEOTLCOV24303AG LEND LEASE - THE HAYMARKET\8. FIGURES\GEOTLCOV24303AG-BN.DWG

NOTE:

ROCK SURFACE IS LIKELY TO BE IRREGULAR WITH POTENIAL CLIFFS, STEPS AND BENCHES, AND SHOULD NOT BE INTERPRETED AS SMOOTH CHANGES BETWEEN BOREHOLES.

LEGEND

- PROPOSED BOREHOLE LOCATION
- PREVIOUS BOREHOLE LOCATION
- BOREHOLE LOCATION - 2014
- BOREHOLE WELL LOCATION - 2014
- CONE PENETRATION TEST LOCATION - 2014
- PAVEMENT BOREHOLE LOCATION
- GPO FAULT ZONE
- INFERRED EXTENT OF ALTERED ZONE
- INFERRED DYKE LOCATION
- SECTION LINE
- RL + 16.50 PROPOSED ROOF LEVELS
- -7.0m INFERRED TOP OF ROCK LEVELS (mAHD)

POSSIBLE PREVIOUS DAM LOCATION

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

Scale (metres) 1:500

drawn	RC / AW
approved	-
date	02 / 10 / 14
scale	AS SHOWN
original size	A3

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client: LEND LEASE (HAYMARKET) PTY LIMITED

project: SYDNEY INTERNATIONAL CONVENTION EXHIBITION AND ENTERTAINMENT PRECINCT (SICEEP) "THE HAYMARKET'

title: INFERRED TOP OF CLASS V/IV SANDSTONE CONTOUR PLAN

project no: GEOTLCOV24303AG-BN | figure no: FIGURE 7 | rev: A

Appendix A - Engineering borehole logs, core photographs and explanation sheets

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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 GRAINED 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 2.36 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 2.36 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%. • High plasticity – w_L greater than 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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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 rock 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, $I_{s(50)}$ (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 $I_{s(50)}$. The ratio may vary for different rock types. Lower strength rocks often have lower ratios than higher strength rocks.

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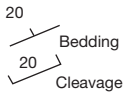
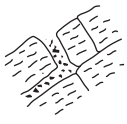
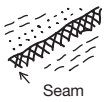
Rock Description Explanation Sheet (2 of 2)

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.			 (Note 2)
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.			 (Note 2)
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.			

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

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.

72710 / 07-06

coffey

Engineering Log - Borehole

Borehole ID.	***SE-BH1***
sheet:	1 of 4
project no.	***GEOTLCOV24303AG***
client:	***Lend Lease Pty Ltd***
date started:	***22 Sep 2014***
principal:	
date completed:	***23 Sep 2014***
project:	***SICEEP - The Haymarket Redevelopment***
logged by:	***RC/IG/VG***
location:	***2 Darling Drive, Haymarket, NSW***
checked by:	***DMH***

position: E: 333724; N: 6249833 (Datum Not Specified) surface elevation: 3.11 m (AHD) angle from horizontal: 58°

drill model: Drillcat, Track mounted hole diameter : 76 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
AD/T				3				**FILL: ASPHALT**: 50mm.	D			**FILL**
								FILL: Sandy GRAVEL: medium grained, dark grey, with some silt. (Road base).				
								FILL: Clayey SAND: medium to coarse grained, brown, with some medium grained sandstone gravel.				
				2	1.0			**FILL: CONCRETE**: 700mm.				
								FILL: SANDSTONE FILL AND BOULDERS				
				1	2.0							
					3.0			No information due to washboring on inclined borehole				
W				0	4.0							
				-1	5.0							
				-2	6.0		CH	**Sandy CLAY**: high plasticity, pale grey mottled red-brown, sand is fine to medium grained, grey and brown.				**ALLUVIUM**
				-3	7.0							

CDF_0_9_04BB.GLB Log COF BOREHOLE: NON CORED GEOTLCOV24303AG_GINT MASTER.GPJ <<DrawingFile>> 01/10/2014 13:09

method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- DT diatube
- RR rock roller/tricone
- HWG HWG core barrel (76.2mm)
- * 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

coffey

Engineering Log - Borehole

Borehole ID.	***SE-BH1***
sheet:	2 of 4
project no.	***GEOTLCOV24303AG***
client: ***Lend Lease Pty Ltd***	date started: ***22 Sep 2014***
principal:	date completed: ***23 Sep 2014***
project: ***SICEEP - The Haymarket Redevelopment***	logged by: ***RC/IG/VG***
location: ***2 Darling Drive, Haymarket, NSW***	checked by: ***DMH***

position: E: 333724; N: 6249833 (Datum Not Specified) surface elevation: 3.11 m (AHD) angle from horizontal: 58°

drill model: Drillcat, Track mounted hole diameter : 76 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
W				-4 9.0 -5			CH	**Sandy CLAY**: high plasticity, pale grey mottled red-brown, sand is fine to medium grained, grey and brown. *(continued)*				**ALLUVIUM**
				-6 10.0 11.0 -7 12.0 13.0 -8 14.0 -9 15.0 -10				Borehole SE-BH1 continued as cored hole				

CDF_0_9_04BB.GLB Log COF BOREHOLE: NON CORED GEOTLCOV24303AG_GINT MASTER.GPJ <<DrawingFile>> 01/10/2014 13:09

method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- DT diatube
- RR rock roller/tricone
- HWG HWG core barrel (76.2mm)

* 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

coffey

Engineering Log - Cored Borehole

Borehole ID.	***SE-BH1***
sheet:	3 of 4
project no.	***GEOTLCOV24303AG***
client: ***Lend Lease Pty Ltd***	date started: ***22 Sep 2014***
principal:	date completed: ***23 Sep 2014***
project: ***SICEEP - The Haymarket Redevelopment***	logged by: ***RC/IG/VG***
location: ***2 Darling Drive, Haymarket, NSW***	checked by: ***DMH***

position: E: 333724; N: 6249833 (Datum Not Specified) surface elevation: 3.11 m (AHD) angle from horizontal: 58°

drill model: Drillcat, Track mounted drilling fluid: hole diameter : 76 mm

drilling information				material substance					rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		-4									
			9.0								
		-5			start coring at 9.95m						
NMLC			10.0		**CLAY**: high plasticity, mottled brown and red, very stiff to hard.						
					CONCRETE				0%		
		-6			**CLAY**: high plasticity, mottled brown and red, very stiff to hard.						
			11.0		**NO CORE:** 1.90 m						
		-7	12.0						0%		
		-8	13.0		**SANDSTONE**: medium to coarse grained, brown, grey.	XW					XW SM, 300mm
					NO CORE: 0.25 m						
					SANDSTONE: medium to coarse grained, grey, indistinct cross bedding.	SW		a=1.42 d=1.35	22%		PT, 0 - 30°, CU, RO, SN JT, 75°, CU, RO, SN PT, 45°, UN, RO, SN PT, 45°, PL, RO, SN
		-9	14.0								PT, 40°, PL, RO, CN PT, 40°, PL, VR, CN Fracture Zone PT, 40°, PL, RO, CN PT, 40 - 45°, PL, RO, SN
								a=1.32 d=1.24	69%		
			15.0		**NO CORE:** 0.10 m						PT, 40 - 45°, CU, RO, SN PT, 35°, PL, VR, CN PT, 50°, PL, VR, CN PT, 10 - 50°, UN, RO, CN PT, 40°, PL, VR, SN
		-10			**SANDSTONE**: medium to coarse grained, brown, yellow brown, grey, massive.	MW		a=1.40 d=1.66	71%		PT, 40°, PL, VR, SN PT, 0 - 40°, UN, VR, SN PT, 10 - 30°, CU, VR, SN

CDF_0_9_04BB.GLB Log COF BOREHOLE: CORED GEOTLCOV24303AG_GINT MASTER.GPJ <<DrawingFile>> 01/10/2014 13:10

method & support
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test
- DT diatube
- RR rock roller/tricone
- HWG HWG core barrel (76.2mm)

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

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

core run & RQD
- barrel withdrawn
- RQD = Rock Quality Designation (%)

weathering & alteration*
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

strength
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

defect type
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CS crushed seam
- SM seam
- DB drilling break

planarity
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

roughness
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

coating
- CN clean
- SN stain
- VN veneer
- CO coating

coffey

Engineering Log - Cored Borehole

Borehole ID.	***SE-BH1***
sheet:	4 of 4
project no.	***GEOTLCOV24303AG***
client: ***Lend Lease Pty Ltd***	date started: ***22 Sep 2014***
principal:	date completed: ***23 Sep 2014***
project: ***SICEEP - The Haymarket Redevelopment***	logged by: ***RC/IG/VG***
location: ***2 Darling Drive, Haymarket, NSW***	checked by: ***DMH***

position: E: 333724; N: 6249833 (Datum Not Specified) surface elevation: 3.11 m (AHD) angle from horizontal: 58°

drill model: Drillcat, Track mounted drilling fluid: hole diameter : 76 mm

drilling information				material substance						rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NMLC		-11				MW					PT, 25°, PL, RO, Sand CO, 1mm SM, 25°, PL, RO, Sand CO, 5mm PT, 25°, PL, RO, Sand CO, 1mm PT, 25°, PL, RO, Sand CO, 1mm PT, 45°, PL, RO, Sand CO, 1mm
					SANDSTONE: medium to coarse grained, pale brown and grey, indistinctly cross bedded at 40°-65°.	SW		a=1.69 d=1.86	87%		
			17.0					a=2.70 d=2.64			PT, 45°, PL, RO, Sand CO, 1mm
		-12	18.0		Borehole SE-BH1 terminated at 17.20 m						
		-13	19.0								
		-14	20.0								
		-15	21.0								
		-16	22.0								
		-17	23.0								

CDF_0_9_04BB.GLB Log COF BOREHOLE: CORED GEOTLCOV24303AG_GINT MASTER.GPJ <<DrawingFile>> 01/10/2014 13:10

method & support
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test
- DT diatube
- RR rock roller/tricone
- HWG HWG core barrel (76.2mm)

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

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

core run & RQD
- barrel withdrawn

RQD = Rock Quality Designation (%)

weathering & alteration*
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

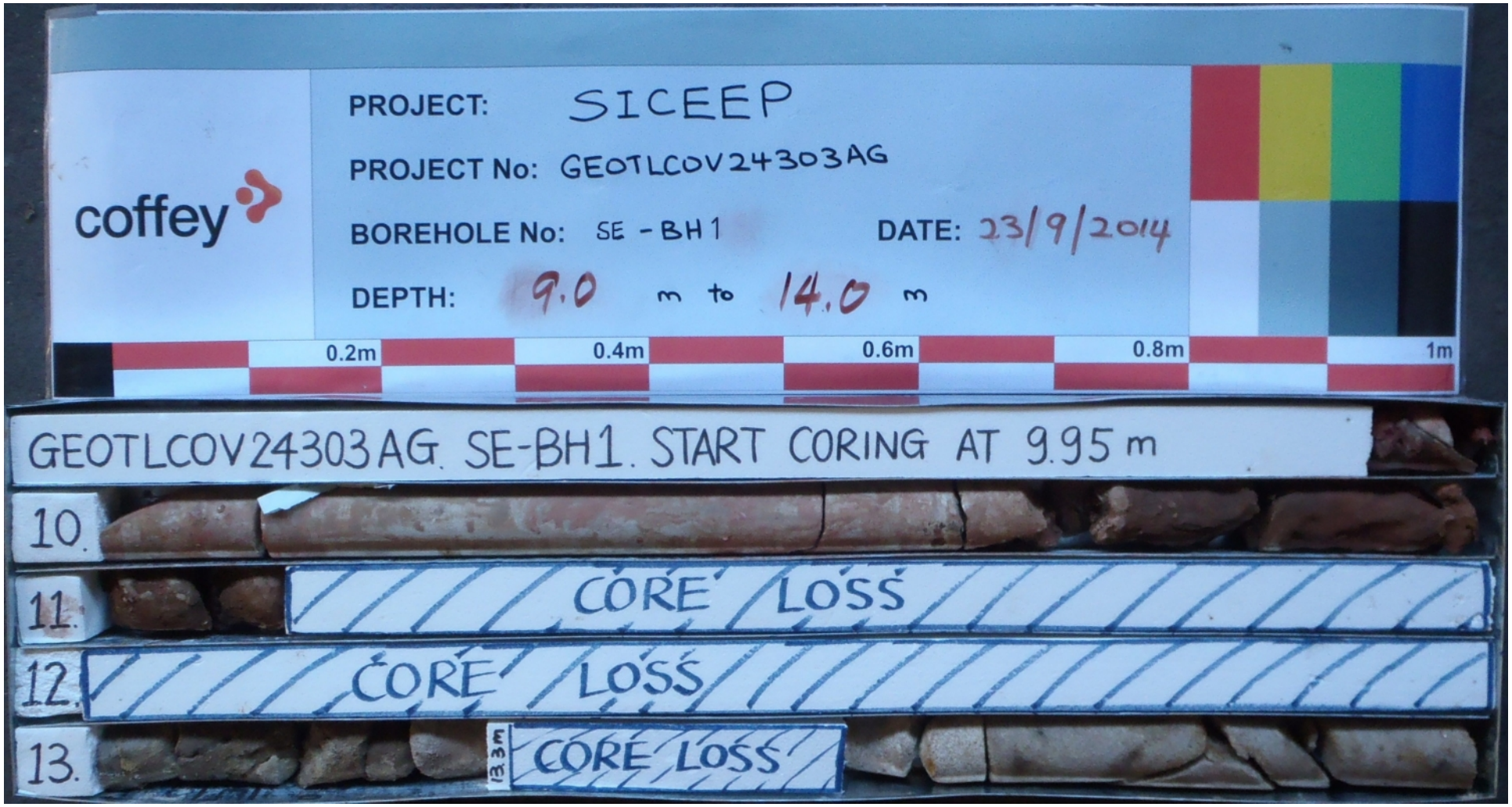
strength
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

defect type
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CS crushed seam
- SM seam
- DB drilling break

roughness
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

planarity
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

coating
- CN clean
- SN stain
- VN veneer
- CO coating



PointID : SE-BH1 Depth Range: 9.95 - 14.00 m

drawn	**RC**
approved	**PKW**
date	**29/09/2014**
scale	**N.T.S.**
original size	**A4**

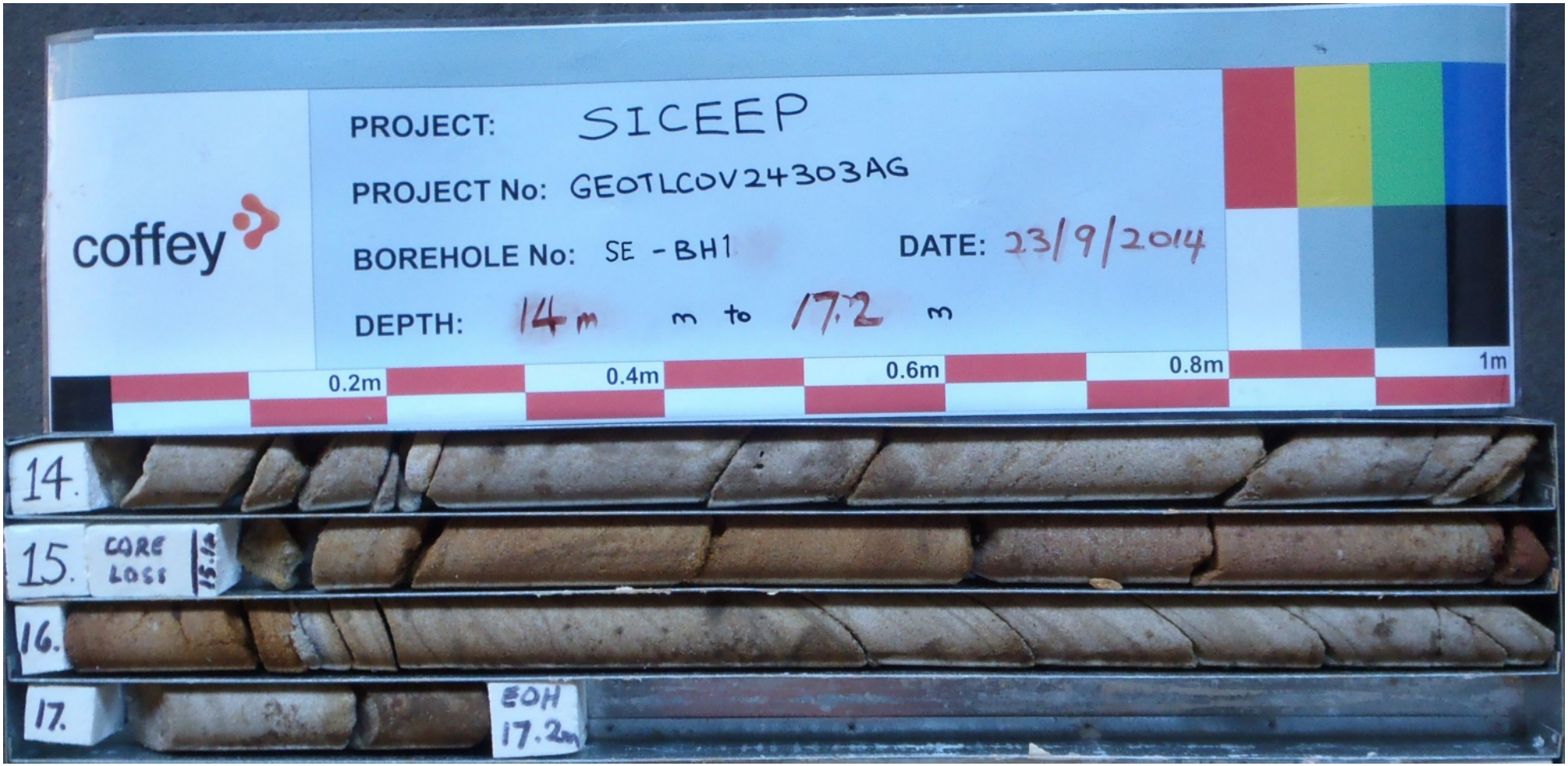
coffey

client: Lend Lease Pty Ltd

project: SICEEP - The Haymarket Redevelopment
2 Darling Drive, Haymarket, NSW

title: **CORE PHOTOGRAPH**
SE-BH1

project no: GEOTLCOV24303AG | fig no: **1** | rev:



PointID : SE-BH1 Depth Range: 14.00 - 17.20 m

drawn	RC
approved	PKW
date	29/09/2014
scale	N.T.S.
original size	A4

coffey

client: Lend Lease Pty Ltd

project: SICEEP - The Haymarket Redevelopment
2 Darling Drive, Haymarket, NSW

title: **CORE PHOTOGRAPH**
SE-BH1

project no: GEOTLCOV24303AG | fig no: **2** | rev:

coffey

Engineering Log - Borehole

Borehole ID.	***SE-BH2***
sheet:	1 of 4
project no.	***GEOTLCOV24303AG***
client:	***Lend Lease Pty Ltd***
date started:	***28 Aug 2014***
principal:	
date completed:	***02 Sep 2014***
project:	***SICEEP - The Haymarket Redevelopment***
logged by:	***HT***
location:	***2 Darling Drive, Haymarket, NSW***
checked by:	***PKW***

position: E: 333774; N: 6249831 (Datum Not Specified) surface elevation: 3.30 m (AHD) angle from horizontal: 60° towards 030°

drill model: XC, Track mounted casing diameter : HW

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)	structure and additional observations
DT, HW casing, W				3				**CONCRETE**: grey.				**FILL**
								FILL: Gravelly SAND: medium to coarse grained, black, fine grained angular gravel.				
								CONCRETE: grey.				
				2	1.0			**FILL: BOULDER**: brown.				
								FILL: Gravelly SAND: medium to coarse grained, grey, fine grained angular gravel. 1.30m: Becoming dark grey				
				1	2.0			**FILL: Clayey SAND**: fine to medium grained, brown.				
				0	3.0							
					4.0							
				-1	5.0		CL	**CLAY**: low plasticity, brown, trace fine to medium grained sand.				**ALLUVIUM**
				-2	6.0							
					7.0			7.0m: Becoming grey				
				-3								

CDF_0_9_04BB.GLB Log COF BOREHOLE: NON CORED GEOTLCOV24303AG_GINT MASTER.GPJ <<DrawingFile>> 01/10/2014 13:09

method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- DT diatube
- RR rock roller/tricone
- HWG HWG core barrel (76.2mm)

* 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/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

coffey

Engineering Log - Borehole

Borehole ID.	**SE-BH2**
sheet:	2 of 4
project no.	**GEOTLCOV24303AG**
client:	**Lend Lease Pty Ltd**
date started:	**28 Aug 2014**
principal:	
date completed:	**02 Sep 2014**
project:	**SICEEP - The Haymarket Redevelopment**
logged by:	**HT**
location:	**2 Darling Drive, Haymarket, NSW**
checked by:	**PKW**

position: E: 333774; N: 6249831 (Datum Not Specified) surface elevation: 3.30 m (AHD) angle from horizontal: 60° towards 030°

drill model: XC, Track mounted casing diameter : HW

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
W				-4	9.0		CL	**CLAY**: low plasticity, brown, trace fine to medium grained sand. *(continued)*				**ALLUVIUM**
				-5	10.0							
				-6	11.0		SC	**Clayey SAND**: fine to medium grained, red-brown.				
				-7	12.0		CL	**CLAY**: low plasticity, brown, trace fine grained sand.				
				-8	13.0		SC	**Clayey SAND**: fine to medium grained, dark grey-black, medium plasticity clay. 12.5m: Becoming brown				
				-9	14.0			Borehole SE-BH2 continued as cored hole				
				-10	15.0							

CDF_0_9_04BB.GLB Log COF BOREHOLE: NON CORED GEOTLCOV24303AG_GINT MASTER.GPJ <<DrawingFile>> 01/10/2014 13:09

method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- DT diatube
- RR rock roller/tricone
- HWG HWG core barrel (76.2mm)

* 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
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VS	very soft
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F	firm
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H	hard
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VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey

Engineering Log - Cored Borehole

Borehole ID.	***SE-BH2***
sheet:	3 of 4
project no.	***GEOTLCOV24303AG***
client: ***Lend Lease Pty Ltd***	date started: ***28 Aug 2014***
principal:	date completed: ***02 Sep 2014***
project: ***SICEEP - The Haymarket Redevelopment***	logged by: ***HT***
location: ***2 Darling Drive, Haymarket, NSW***	checked by: ***PKW***

position: E: 333774; N: 6249831 (Datum Not Specified) surface elevation: 3.30 m (AHD) angle from horizontal: 60° towards 030°

drill model: XC, Track mounted drilling fluid: casing diameter : HW

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		-4	9.0								
		-5	10.0								
		-6	11.0								
		-7	12.0								
		-8	13.0		start coring at 13.85m						
NMLC		-9	14.0		**SANDSTONE**: medium to coarse grained, orange-brown, indistinct cross bedding. 14.3m: Becoming pale grey	MW	O X	a=1.23 d=0.50 a=1.63 d=1.38	75%		JT, 30°, IR, VR, CN JT, 0 - 5°, IR, VR, VN PT, 40°, PL, RO, VN PT, 40°, PL, RO, VN JT, 65°, ST, VR, VN PT, 40°, PL, RO, VN CS, 40°, 30 mm PT, 40°, PL, RO, VN JT, 20 - 40°, UN, RO, VN
		-10	15.0		**SANDSTONE**: medium to coarse grained, pale grey, distinct cross bedding.		X	a=4.13 d=2.84			JT, 30°, ST, RO, VN CS, 40°, Clayey sand, 20 mm JT, 30°, PL, RO, VN

CDF_0_9_04BB.GLB Log COF BOREHOLE: CORED GEOTLCOV24303AG_GINT MASTER.GPJ <<DrawingFile>> 01/10/2014 13:10

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
SPT standard penetration test
DT diatube
RR rock roller/tricone
HWG HWG core barrel (76.2mm)

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

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

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
DW distinctly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SZ shear zone
SS shear surface
CS crushed seam
SM seam
DB drilling break

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
SL slickensided
POL polished
SO smooth
RO rough
VR very rough

coating
CN clean
SN stain
VN veneer
CO coating

coffey

Engineering Log - Cored Borehole

Borehole ID.	***SE-BH2***
sheet:	4 of 4
project no.	***GEOTLCOV24303AG***
client: ***Lend Lease Pty Ltd***	date started: ***28 Aug 2014***
principal:	date completed: ***02 Sep 2014***
project: ***SICEEP - The Haymarket Redevelopment***	logged by: ***HT***
location: ***2 Darling Drive, Haymarket, NSW***	checked by: ***PKW***

position: E: 333774; N: 6249831 (Datum Not Specified) surface elevation: 3.30 m (AHD) angle from horizontal: 60° towards 030°

drill model: XC, Track mounted drilling fluid: casing diameter : HW

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NMLC		-11			**SANDSTONE**: medium to coarse grained, pale grey, distinct cross bedding. *(continued)*	MW	X O	a=1.98 d=3.36	19%		JT, 20°, ST, RO, VN PT, 40°, PL, RO, VN JT, 40°, PL, RO, VN JT, 20°, PL, RO, VN SM, Clayey sand, 5 mm JT, 20°, PL, RO, VN SZ, 170 mm
		-12	17.0		**CLAY (CH)**: high plasticity, pale grey. **NO CORE:** 1.25 m				0%		
			18.0		**CLAY (CH)**: high plasticity, pale grey.						
		-13			**DOLERITE**: white-pale grey.	XW			0%		
			19.0		**NO CORE:** 0.20 m						
					DOLERITE: white-pale grey.	XW			0%		
		-14	20.0		**DOLERITE**: pale grey.	HW			0%		
					NO CORE: 0.20 m						
			21.0		**DOLERITE**: pale grey, remoulds into GRAVEL: medium to coarse grained, some fine to coarse grained sand and clay.	XW			0%		
		-15									
		-16	22.0						0%		
			23.0		Borehole SE-BH2 terminated at 22.70 m						
		-17									

CDF_0_9_04BB.GLB Log COF BOREHOLE: CORED GEOTLCOV24303AG_GINT MASTER.GPJ <<DrawingFile>> 01/10/2014 13:10

method & support
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test
- DT diatube
- RR rock roller/tricone
- HWG HWG core barrel (76.2mm)

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

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

core run & RQD
- barrel withdrawn

RQD = Rock Quality Designation (%)

weathering & alteration*
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

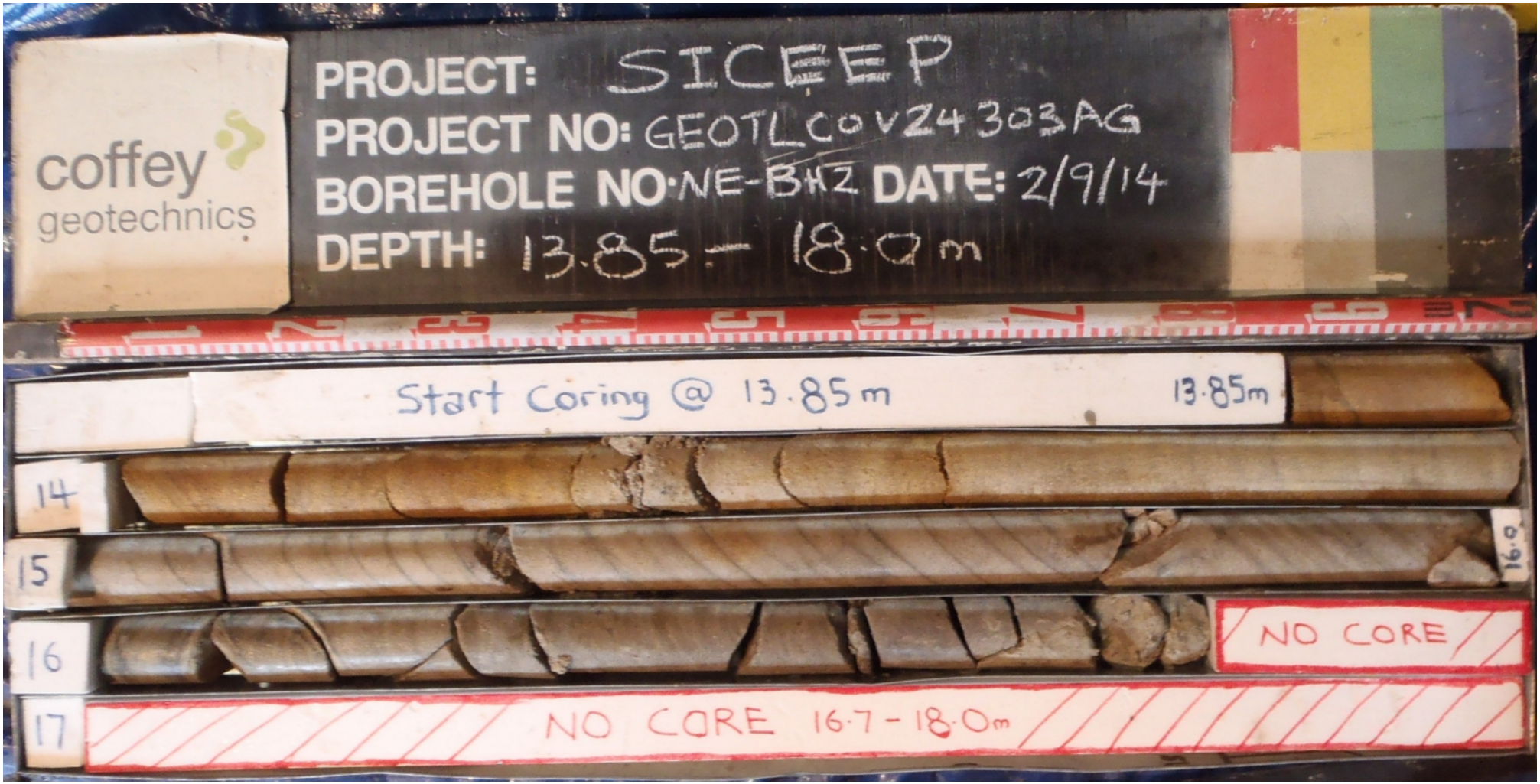
strength
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

defect type
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CS crushed seam
- SM seam
- DB drilling break

roughness
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

planarity
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

coating
- CN clean
- SN stain
- VN veneer
- CO coating



PointID : SE-BH2 Depth Range: 13.85 - 18.00 m

drawn	RC
approved	PKW
date	29/09/2014
scale	N.T.S.
original size	A4

coffey

client: Lend Lease Pty Ltd

project: SICEEP - The Haymarket Redevelopment
2 Darling Drive, Haymarket, NSW

title: **CORE PHOTOGRAPH**
SE-BH2

project no: GEOTLCOV24303AG | fig no: **3** | rev:

PointID : SE-BH2 Depth Range: 18.00 - 22.70 m

drawn	**RC**
approved	**PKW**
date	**29/09/2014**
scale	**N.T.S.**
original size	**A4**

coffey

client: Lend Lease Pty Ltd

project: SICEEP - The Haymarket Redevelopment
2 Darling Drive, Haymarket, NSW

title: **CORE PHOTOGRAPH**
SE-BH2

project no: GEOTLCOV24303AG | fig no: **4** | rev:

coffey

Engineering Log - Borehole

Borehole ID.	***SE-BH3***
sheet:	1 of 5
project no.	***GEOTLCOV24303AG***
client:	***Lend Lease Pty Ltd***
date started:	***29 May 2014***
principal:	
date completed:	***29 May 2014***
project:	***SICEEP - The Haymarket Redevelopment***
logged by:	***IG/AF***
location:	***2 Darling Drive, Haymarket, NSW***
checked by:	***PKW***

position: E: 333780; N: 6249805 (Datum Not Specified) surface elevation: 3.13 m (AHD) angle from horizontal: 60° towards 279°

drill model: Drillcat, Track mounted hole diameter : 76 mm

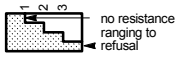
drilling information						material substance						
method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description **SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T				3				**FILL: BRICK PAVERS**: 75mm thickness.	M			**PAVEMENT**
								FILL: Silty SAND: fine to medium grained, dark grey, with some medium grained sub angular gravel.				**FILL**
				2	1.0							
				1	2.0			**FILL: SAND**: fine to medium grained, dark grey, brown, with some silts and fine to medium grained gravel.	W			
HQ					3.0							
				0	4.0			Borehole SE-BH3 continued as cored hole				
				-1	5.0							
				-2	6.0							
				-3	7.0							

CDF_0_9_04BB.GLB Log COF BOREHOLE: NON CORED GEOTLCOV24303AG_GINT MASTER.GPJ <<DrawingFile>> 01/10/2014 13:09

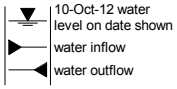
method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- DT diatube
- RR rock roller/tricone
- HWG HWG core barrel (76.2mm)
- * bit shown by suffix
- e.g. AD/T
- B blank bit
- T TC bit
- V V bit

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/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 - Cored Borehole

Borehole ID.	***SE-BH3***
sheet:	2 of 5
project no.	***GEOTLCOV24303AG***
client: ***Lend Lease Pty Ltd***	date started: ***29 May 2014***
principal:	date completed: ***29 May 2014***
project: ***SICEEP - The Haymarket Redevelopment***	logged by: ***IG/AF***
location: ***2 Darling Drive, Haymarket, NSW***	checked by: ***PKW***

position: E: 333780; N: 6249805 (Datum Not Specified) surface elevation: 3.13 m (AHD) angle from horizontal: 60° towards 279°

drill model: Drillcat, Track mounted drilling fluid: hole diameter : 76 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		3									
			1.0								
		2									
			2.0								
		1									
			3.0		start coring at 3.30m						
NQ		0	4.0		**CONCRETE**: 1.95m.			a=0.48 d=0.50 a=0.28 d=0.28	0%		
		-1	5.0		**NO CORE:** 2.25 m						
		-2	6.0								
		-3	7.0		**CLAY**: High plasticity, pale grey, mottled orange brown, red.				0%		

method & support
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test
- DT diatube
- RR rock roller/tricone
- HWG HWG core barrel (76.2mm)

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

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

core run & RQD
- barrel withdrawn

RQD = Rock Quality Designation (%)

weathering & alteration*
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

strength
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

defect type
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CS crushed seam
- SM seam
- DB drilling break

roughness
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

planarity
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

coating
- CN clean
- SN stain
- VN veneer
- CO coating

coffey

Engineering Log - Cored Borehole

Borehole ID.	***SE-BH3***
sheet:	3 of 5
project no.	***GEOTLCOV24303AG***
client: ***Lend Lease Pty Ltd***	date started: ***29 May 2014***
principal:	date completed: ***29 May 2014***
project: ***SICEEP - The Haymarket Redevelopment***	logged by: ***IG/AF***
location: ***2 Darling Drive, Haymarket, NSW***	checked by: ***PKW***

position: E: 333780; N: 6249805 (Datum Not Specified) surface elevation: 3.13 m (AHD) angle from horizontal: 60° towards 279°

drill model: Drillcat, Track mounted drilling fluid: hole diameter : 76 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NQ		-4			**CLAY**: High plasticity, pale grey, mottled orange brown, red. *(continued)*				0%		
			9.0		**NO CORE:** 1.20 m						
		-5									
			10.0		**CLAY**: High plasticity, grey, mottled red brown.				33%		
		-6									
			11.0		**NO CORE:** 0.12 m						
					SANDSTONE: coarse grained, pale grey, orange brown, distinctly cross bedded at 10° to 30°.	MW	X O	a=0.25 d=0.53			
		-7									
			12.0		**NO CORE:** 0.88 m						
		-8									
			13.0		**SANDSTONE**: coarse grained, pale grey, orange brown, indistinctly cross bedded at 10° to 30°.	SW XW SW		a=0.96 d=0.90	62%		JT, 20°, PL, RO, CN SM, Clayey sand, 70 mm PT, 10°, PL, RO, Silty sand VN
		-9	14.0					a=1.23 d=1.33			JT, 60°, PL, RO, CN PT, 5°, PL, RO, Silty sand CO JT, 20°, CU, RO, CN JT, 45°, CU, RO, Fe VN
			15.0		**NO CORE:** 0.18 m						PT, 0°, PL, RO, CN SZ, 70 mm
		-10			**SANDSTONE**: coarse grained, pale grey, orange brown, indistinctly cross bedded at 10° to 30°.	SW		a=0.47 d=0.56	87%		JT, 40°, PL, RO, Clayey sand CO JT, 40°, PL, RO, Clayey sand CO JT, 45°, PL, RO, Clayey sand CO

Defects are:PT, 10 - 40°, PL, RO, CN, unless otherwise described

CDF_0_9_04BB.GLB Log COF BOREHOLE: CORED GEOTLCOV24303AG_GINT MASTER.GPJ <<DrawingFile>> 01/10/2014 13:10

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
SPT standard penetration test
DT diatube
RR rock roller/tricone
HWG HWG core barrel (76.2mm)

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

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

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
DW distinctly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SZ shear zone
SS shear surface
CS crushed seam
SM seam
DB drilling break

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
SL slickensided
POL polished
SO smooth
RO rough
VR very rough

coating
CN clean
SN stain
VN veneer
CO coating

Engineering Log - Cored Borehole

Borehole ID.	***SE-BH3***
sheet:	4 of 5
project no.	***GEOTLCOV24303AG***
client: ***Lend Lease Pty Ltd***	date started: ***29 May 2014***
principal:	date completed: ***29 May 2014***
project: ***SICEEP - The Haymarket Redevelopment***	logged by: ***IG/AF***
location: ***2 Darling Drive, Haymarket, NSW***	checked by: ***PKW***

position: E: 333780; N: 6249805 (Datum Not Specified) surface elevation: 3.13 m (AHD) angle from horizontal: 60° towards 279°

drill model: Drillcat, Track mounted drilling fluid: hole diameter : 76 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NQ		-11			**SANDSTONE**: coarse grained, pale grey, orange brown, indistinctly cross bedded at 10° to 30°. *(continued)*	SW					PT, 5°, PL, RO, Clayey sand CO
			17.0					a=1.34 d=1.49	87%		
		-12									
			18.0		**SANDSTONE**: coarse grained, pale grey, grey, distinctly cross bedded at 10° to 20°.			a=2.59 d=2.35			
		-13									
			19.0					a=1.56 d=1.26			SM, Clayey sand, 10 mm
		-14							88%		
			20.0					a=1.61 d=1.34			JT, 30°, CU, RO, CN
		-15						a=1.71 d=1.66			20.8m: becoming indistinctly cross bedded at 10° to 50° JT, 15 - 50°, IR, RO, CN JT, 15 - 50°, IR, RO, CN
			21.0								
			22.0					a=2.20 d=1.61			
		-16							88%		
			23.0					a=2.09 d=2.32			
		-17									SZ, IR, RO, CN, 50 mm
								a=2.51			

Defects are: PT, 10 - 40°, PL, RO, CN, unless otherwise described

CDF_0_9_04BB.GLB Log COF BOREHOLE: CORED GEOTLCOV24303AG_GINT MASTER.GPJ <<DrawingFile>> 01/10/2014 13:10

method & support
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test
- DT diatube
- RR rock roller/tricone
- HWG HWG core barrel (76.2mm)

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

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

core run & RQD
- barrel withdrawn

RQD = Rock Quality Designation (%)

weathering & alteration*
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

strength
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

defect type
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CS crushed seam
- SM seam
- DB drilling break

roughness
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

planarity
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

coating
- CN clean
- SN stain
- VN veneer
- CO coating

coffey

Engineering Log - Cored Borehole

Borehole ID.	***SE-BH3***
sheet:	5 of 5
project no.	***GEOTLCOV24303AG***
client: ***Lend Lease Pty Ltd***	date started: ***29 May 2014***
principal:	date completed: ***29 May 2014***
project: ***SICEEP - The Haymarket Redevelopment***	logged by: ***IG/AF***
location: ***2 Darling Drive, Haymarket, NSW***	checked by: ***PKW***

position: E: 333780; N: 6249805 (Datum Not Specified) surface elevation: 3.13 m (AHD) angle from horizontal: 60° towards 279°

drill model: Drillcat, Track mounted drilling fluid: hole diameter : 76 mm

drilling information				material substance					rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NQ		-18			**SANDSTONE**: coarse grained, pale grey, grey, distinctly cross bedded at 10° to 20°. *(continued)*	SW		d=2.04			
						FR			89%		
		-19	25.0					a=2.81 d=2.95			
					Borehole SE-BH3 terminated at 25.60 m						
		-20	26.0								
			27.0								
		-21	28.0								
		-22	29.0								
			30.0								
		-23	31.0								
		-24									

CDF_0_9_04BB.GLB Log COF BOREHOLE: CORED GEOTLCOV24303AG_GINT MASTER.GPJ <<DrawingFile>> 01/10/2014 13:10

method & support
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test
- DT diatube
- RR rock roller/tricone
- HWG HWG core barrel (76.2mm)

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

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

core run & RQD
- barrel withdrawn

RQD = Rock Quality Designation (%)

weathering & alteration*
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

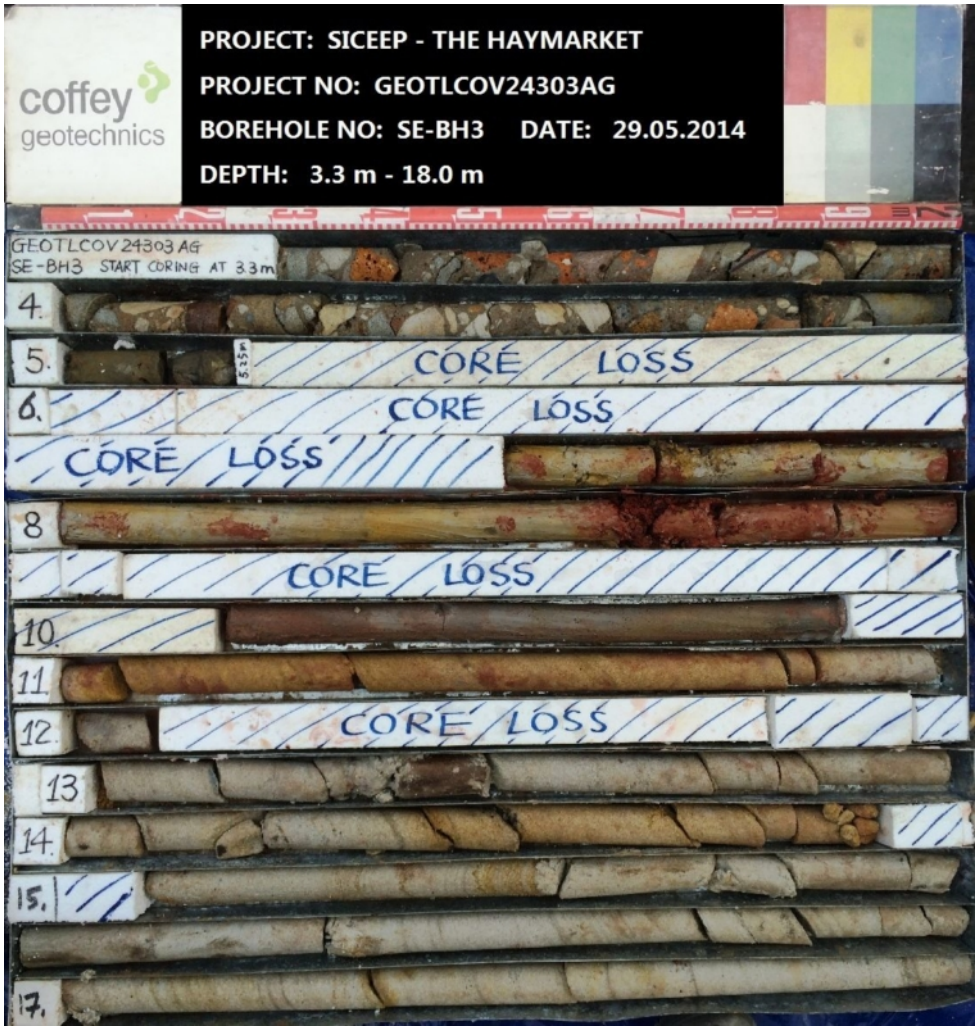
strength
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

defect type
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CS crushed seam
- SM seam
- DB drilling break

roughness
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

planarity
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

coating
- CN clean
- SN stain
- VN veneer
- CO coating



PointID : SE-BH3 Depth Range: 3.30 - 18.00 m

drawn	**RC**
approved	**PKW**
date	**29/09/2014**
scale	**N.T.S.**
original size	**A4**

coffey

client: Lend Lease Pty Ltd

project: SICEEP - The Haymarket Redevelopment
2 Darling Drive, Haymarket, NSW

title: **CORE PHOTOGRAPH**
SE-BH3

project no: GEOTLCOV24303AG | fig no: **5** | rev:

coffey

Engineering Log - Borehole

Borehole ID.	***SE-BH4***
sheet:	1 of 4
project no.	***GEOTLCOV24303AG***
client: ***Lend Lease Pty Ltd***	date started: ***20 Aug 2014***
principal:	date completed: ***21 Aug 2014***
project: ***SICEEP - The Haymarket Redevelopment***	logged by: ***AO***
location: ***2 Darling Drive, Haymarket, NSW***	checked by: ***PKW***

position: E: 333820; N: 6249817 (Datum Not Specified) surface elevation: 3.13 m (AHD) angle from horizontal: 90°

drill model: Drillcat, Track mounted hole diameter : 76 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
AD/V				3				**PAVERS**: 50mm.	M			**FILL**
								FILL: Gravelly SAND: fine to coarse grained, dark brown to black, gravel is fine to coarse grained, sub-angular.				
				2	1.0			**FILL: Silty SAND**: fine to coarse grained, orange, (appears to be crushed sandstone).				
N								**FILL: Sandy CLAY**: low plasticity, pale green grey, sand is medium grained, with some fine to coarse gravel.				
			SPT 3, 2, 2 N=4	1	2.0							
								sandstone fragment	W			
				0	3.0							
					4.0		CH	**Silty CLAY**: high plasticity, pale grey, red, trace of fine to medium grained gravel.	M	St		**ALLUVIUM**
			SPT 2, 2, 4 N=6	-1								
W				-2	5.0							
			SPT 2, 2, 3 N=5	-3	6.0							
										F - St		
			SPT 1, 2, 2 N=4	-4	7.0							only 50mm of sample recovered in SPT

CDF_0_9_04BB.GLB Log COF BOREHOLE: NON CORED GEOTLCOV24303AG_GINT MASTER.GPJ <<DrawingFile>> 01/10/2014 13:09

method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- DT diatube
- RR rock roller/tricone
- HWG HWG core barrel (76.2mm)

* 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/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

coffey

Engineering Log - Borehole

Borehole ID.	**SE-BH4**
sheet:	2 of 4
project no.	**GEOTLCOV24303AG**
client:	**Lend Lease Pty Ltd**
date started:	**20 Aug 2014**
principal:	
date completed:	**21 Aug 2014**
project:	**SICEEP - The Haymarket Redevelopment**
logged by:	**AO**
location:	**2 Darling Drive, Haymarket, NSW**
checked by:	**PKW**

position: E: 333820; N: 6249817 (Datum Not Specified) surface elevation: 3.13 m (AHD) angle from horizontal: 90°

drill model: Drillcat, Track mounted hole diameter : 76 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
W			SPT 2, 3, 4 N=7	-5	9.0		CL	**Sandy CLAY**: low plasticity, pale grey, with some black veins, sand is fine to medium grained.	M	F		**ALLUVIUM**
			SPT 0, 0, 0 N=0	-6 / -7	10.0		CL	**Sandy CLAY**: low plasticity, dark grey to black, sand is fine to medium grained, with approximately 40% organic matter.	W	S		**ESTUARINE DEPOSITS** SPT sunk under hammer weight
			SPT 0, 1, 1 N=2	-8 / -9	11.0 12.0		SC / CL	**Clayey SAND / Sandy CLAY**: sand is fine to medium grained, grey, with a trace of black organic matter, low pasticity clay. clay is low plasticity, grey, with a trace of organic matter.				
					13.0			**SANDSTONE**: pale yellow, extremely weathered.				**WEATHERED BEDROCK** colour change to pale yellow noted in drilling fluid
				-10 / -11 / -12	14.0 15.0			Borehole SE-BH4 continued as cored hole				

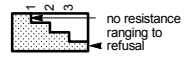
CDF_0_9_04BB.GLB Log COF BOREHOLE: NON CORED GEOTLCOV24303AG_GINT MASTER.GPJ <<DrawingFile>> 01/10/2014 13:09

method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- DT diatube
- RR rock roller/tricone
- HWG HWG core barrel (76.2mm)

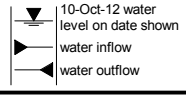
* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

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/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

coffey

Engineering Log - Cored Borehole

Borehole ID.	***SE-BH4***
sheet:	3 of 4
project no.	***GEOTLCOV24303AG***
client: ***Lend Lease Pty Ltd***	date started: ***20 Aug 2014***
principal:	date completed: ***21 Aug 2014***
project: ***SICEEP - The Haymarket Redevelopment***	logged by: ***AO***
location: ***2 Darling Drive, Haymarket, NSW***	checked by: ***PKW***

position: E: 333820; N: 6249817 (Datum Not Specified) surface elevation: 3.13 m (AHD) angle from horizontal: 90°

drill model: Drillcat, Track mounted drilling fluid: hole diameter : 76 mm

drilling information				material substance					rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		-5									
		-6	9.0								
		-7	10.0								
		-8	11.0								
		-9	12.0								
			13.0		start coring at 13.10m						
NQ		-10			**NO CORE:** 0.90 m						
		-11	14.0		**SANDSTONE**: fine to medium grained, orange brown.	HW		a=0.35 d=0.24	0%		SM, 50 mm SM, 100 mm SM, 50 mm SM XW, 50 mm Highly Fractured Zone
		-12	15.0		**NO CORE:** 0.60 m			a=0.08 d=0.07			
					SANDSTONE: fine to medium grained, orange brown.	XW			13%		JT, 40 - 60°, PL, SO, VN SM XW, 20 mm Highly Fractured Zone

CDF_0_9_04BB.GLB Log COF BOREHOLE: CORED GEOTLCOV24303AG_GINT MASTER.GPJ <<DrawingFile>> 01/10/2014 13:10

method & support
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test
- DT diatube
- RR rock roller/tricone
- HWG HWG core barrel (76.2mm)

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

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

core run & RQD
- barrel withdrawn

RQD = Rock Quality Designation (%)

weathering & alteration*
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

strength
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

defect type
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CS crushed seam
- SM seam
- DB drilling break

planarity
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

roughness
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

coating
- CN clean
- SN stain
- VN veneer
- CO coating

coffey

Engineering Log - Cored Borehole

Borehole ID.	***SE-BH4***
sheet:	4 of 4
project no.	***GEOTLCOV24303AG***
client: ***Lend Lease Pty Ltd***	date started: ***20 Aug 2014***
principal:	date completed: ***21 Aug 2014***
project: ***SICEEP - The Haymarket Redevelopment***	logged by: ***AO***
location: ***2 Darling Drive, Haymarket, NSW***	checked by: ***PKW***

position: E: 333820; N: 6249817 (Datum Not Specified) surface elevation: 3.13 m (AHD) angle from horizontal: 90°

drill model: Drillcat, Track mounted drilling fluid: hole diameter : 76 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NQ		-13			**NO CORE:** 0.20 m						
			17.0		**DOLERITE**: pale blue grey.	HW	O	a=0.11 d=0.17	48%		Highly Fractured Zone
		-14					O	d=0.18			JT, 80°, PL, SO, VN
			18.0		**NO CORE:** 0.40 m						Highly Fractured Zone
		-15			**DOLERITE**: blue grey, with pale grey flecks.	HW - MW			0%		Highly Fractured Zone
					Borehole SE-BH4 terminated at 18.80 m						
		-16	19.0								
			20.0								
		-17									
			21.0								
		-18									
			22.0								
		-19									
			23.0								
		-20									

Defects are: JT, 40 - 60°, PL, SO, VN, unless otherwise described

method & support
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
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- H high
- VH very high
- EH extremely high

defect type
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CS crushed seam
- SM seam
- DB drilling break

roughness
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- POL polished
- SO smooth
- RO rough
- VR very rough

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- CU curved
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coating
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- VN veneer
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