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LendLease Building Pty Limited
Locked Bag 1
Millers Point NSW 2000

Project 72505.14
20 August 2019
72505.14.R.006.Rev3
PMM/PG

Attention: Silvie Pappas
cc: John Gillen

Email: silvie.pappas@lendlease.com
john.gillen@lendlease.com

Proposed IASB Addition (SSD-10339)
Randwick Campus Redevelopment
Hospital Road, Randwick

As part of the Randwick Campus Redevelopment, Douglas Partners Pty Ltd (DP) has prepared contamination related reports for the Acute Services Building (ASB) project (Stage 1), as approved under the State Significant Development (SSD) 9113, as listed below.

- *Detailed Site Investigation Report* (DSI, reference R.001.Rev2, dated 21 February 2019) which includes an assessment of the suitability of Stage 1 of the campus redevelopment for the proposed ASB from a contamination perspective, and relates to both Stage 1 and Stage 2 of the Randwick Campus Redevelopment;
- *Remediation Action Plan* (RAP, reference R.002.Rev4, dated 27 February 2019) which includes advice to remove and/or mitigate potential environmental risks posed by contamination during earthworks such that the Stage 1 site can be rendered suitable for the proposed development. The RAP relates to the Stage 1 ASB works.

The IASB Addition component of the Randwick Campus Redevelopment sits adjoining and to the east of Stage 1. The core elements of the IASB Addition are as follows:

- UNSW Eastern Extension (base building only);
- Associated modifications within the ASB;
- Lowering of Hospital Road; and
- Landscaping.

Douglas Partners considers that the DSI is applicable to the proposed development as it includes three boreholes and one groundwater monitoring well within Hospital Road, in the vicinity of the proposed IASB Addition. Testing on soil samples recovered from these bores did not identify any contaminants at concentrations exceeding the adopted health-based investigation and screening levels for a commercial / industrial form of land use, which is considered appropriate for the land use scenario described above. It is likely that the footprint of the proposed IASB Addition will have similar sub-surface conditions to that encountered in the three boreholes, as there is minimal encroachment into the existing hospital grounds to the east of Hospital Road.

Groundwater samples collected from the monitoring well within Hospital Road did not identify contaminants within groundwater that would preclude development of the ASB and/or IASB Addition.

It is understood that the ground intrusive works associated with the IASB Addition will essentially comprise bulk excavation to lower Hospital Road and Delivery Drive, piling and footings, then limited landscaping. These works can be appropriately managed by adopting the procedures outlined in the RAP, particularly:

- Section 9.4.2 in terms of the assessment of fill soils proposed to remain within the IASB Addition;
- Section 10 for the assessment of soils for re-use or waste classification for off-site disposal, and management of hazardous building materials;
- Section 12 for the management of unexpected finds; and
- Section 13 for the validation of remediation and imported materials.

The RAP has been amended to incorporate the IASB Addition (Rev 5).

The proposed development is declared to be an SSDA as a "hospital" in accordance with Clause 14 of Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (SRD SEPP) Part 4, Division 4.7 of the EP&A Act which establishes an assessment framework for SSDAs. The remediation works for the IASB Addition as part of the Randwick Campus Redevelopment are considered ancillary to the ASB development in accordance with Clause 4.4.1 of the *Managing Land Contamination Planning Guidelines, SEPP 55 - Remediation of Land*, and is not proposed to be carried out independently of that development. These works are therefore considered to be Category 2 works not needing consent.

The IASB Addition site can be made suitable for the proposed development, subject to the implementation of the amended RAP, in order to satisfy SEPP55.

We trust that this letter meets with your requirements. Please do not hesitate in contacting the undersigned if you have any further queries.

Yours faithfully
Douglas Partners Pty Ltd

Paula Maurici
Associate

Reviewed by

Paul Gorman
Principal

Attachment: About this Report

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

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Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

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Fax (02) 9809 4095

Memorandum

To	Lendlease Building Pty Ltd	Danny Finn Anja Niewolik	danny.finn@lendlease.com anja.niewolik@lendlease.com	
From	Joel Huang		**Date**	20 Jul 2018
Subject	Lateral Surcharge Load Analysis Randwick Campus Redevelopment		**Project No.** **Doc. No.**	72505.13 R.003.Rev0

As requested by Lendlease Building Pty Ltd (Lendlease), Douglas Partners Pty Ltd (DP) carried out a geotechnical analysis to estimate the additional lateral surcharge pressure on the shoring wall for the proposed basement of the Acute Services Building (ASB). The additional lateral surcharge will be imposed by the outrigger loads of a mobile crane to be set up on Hospital Road to assist the construction of the new patient link bridge between the ASB and the existing hospital building.

Based on the preliminary crane setup plan and specification sheet prepared by Borger Cranes (Project Ref: POW Hosp, Rev 1 dated 1 June 2018), provided to DP by Lendlease on 12 July 2018, it is understood that:

- A GMK6400 mobile crane with up to 400 tonne capacity will be used on Hospital Road;
- The outriggers of the crane are spaced at 8.5 m in the transverse direction and 8.7 m in the longitudinal direction;
- A 3 m x 2 m bearing pad will be placed under each outrigger and will result in maximum bearing pressures of 148 kPa for the front two outriggers and 180 kPa for the rear two outriggers;
- The distance between the outer edge of the bearing pad and the proposed shoring wall is not provided. For the purpose of the analysis, DP has assumed that the nearest edge of any bearing pad will have a minimum 2.5 m clearance from the shoring wall of ASB.

Based on the structural drawings of the proposed shoring wall (Ref: Issue B, dated 28 June 2018) prepared by Enstruct Group Pty Ltd (Enstruct), it is understood that a maximum retaining height of approximately 10.5 m will be required at the location of this mobile crane setup.

The horizontal surcharge analysis was carried out using the method of Merlin G Spangler and Richard L Handy (Handy-Spangler Method) of Iowa State University. The results indicated that at the most critical section (i.e. the vertical plane perpendicular to the shoring wall and across the centre of the rear outriggers), the additional horizontal pressure will have a maximum of 24 kPa at 1.7 m depth. The distribution of the additional horizontal pressure down the full depth of the shoring wall is shown in the attached output.

The structural engineer / shoring wall designer must review this information and confirm that the shoring wall has the capacity to withstand the additional surcharge loads due to the mobile crane loading.

A working platform assessment should be carried out by DP to confirm that the ground conditions can support the proposed crane loads.

We trust that this satisfies your present requirements. Please do not hesitate to contact the undersigned if you have any queries.

Yours faithfully,

Douglas Partners Pty Ltd

Reviewed by

Joel Huang
Associate

Fiona MacGregor
Principal

Limitations:

Douglas Partners Pty Ltd has prepared this memorandum for the Randwick Campus Redevelopment project at the site bound by Hospital Road and High, Magill and Botany Streets, Randwick. The work was carried out under a professional services agreement with Lendlease Building Pty Ltd (Contract No. 258723-512, dated 3 May 2018). This memorandum is provided for the exclusive use of Lendlease Building Pty Ltd for this project only and for the purposes as described in the report. It should not be used for other projects or by a third party. Any party relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

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Attachments: About This Report
Analysis Output
Mobile Crane Setup Plan and Specification

About this Report

Douglas Partners

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SPANGLER

Horizontal Pressures on Vertical Walls due to Footing Loads

Using the method of Merlin G **Spangler** and Richard L **Handy**, Iowa State University

Ver 2.0 SRJ Sep 2014

Data can be entered in yellow cells only

Details of Footings

Ftg	x_1	y_1	x_2	y_2	z_f	p
1	2.5	2.8	4.5	5.8	0	180
2	2.5	-5.8	4.5	-2.8	0	148
3	11	2.8	13	5.8	0	180
4	11	-5.8	13	-2.8	0	148

x_1, y_1 Coordinates of bottom left corner (m)

x_2, y_2 Coordinates of top right corner (m)

z_f Base depth of footing (m)

p Pressure of Footing (kPa)

Calculation Depth (m): 10.5 m

Sections for Calculations

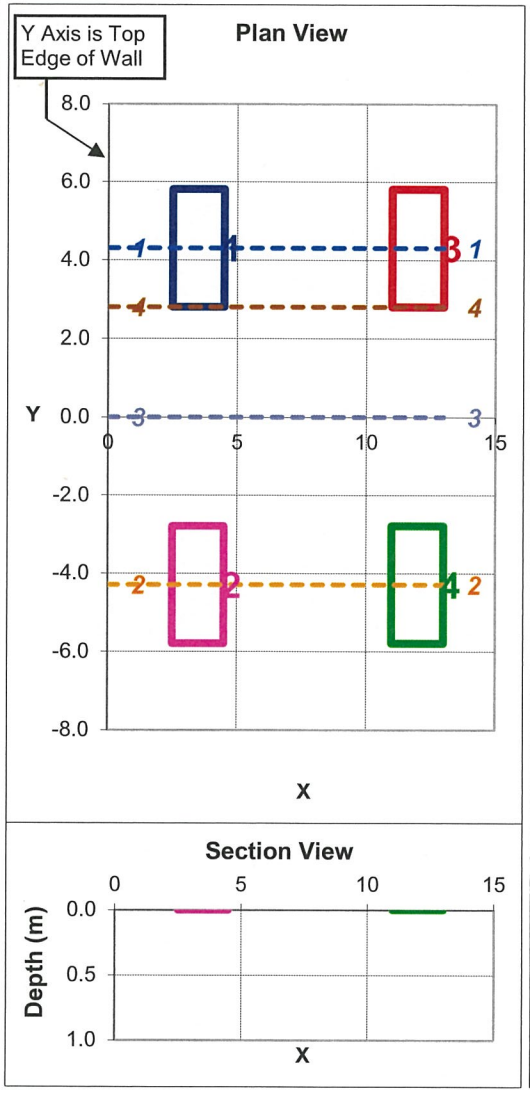
Sect	y_s		Max h_z	at Depth of
1	4.3	→	24.0 kPa	1.68 m
2	-4.3	→	20.0 kPa	1.68 m
3	0	→	9.5 kPa	2.94 m
4	2.8	→	19.2 kPa	1.89 m

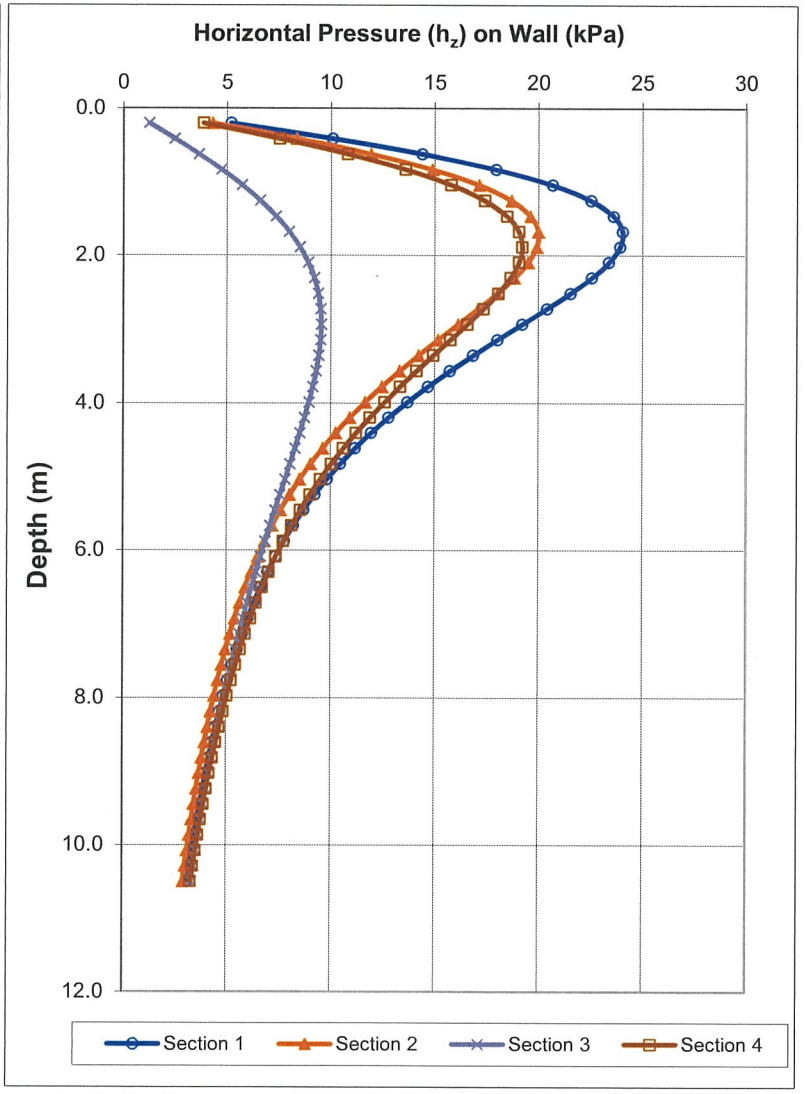
Project No: 72505.13

Project: PoW Hospital Randwick

Location: Section SR11

Client: Lendlease

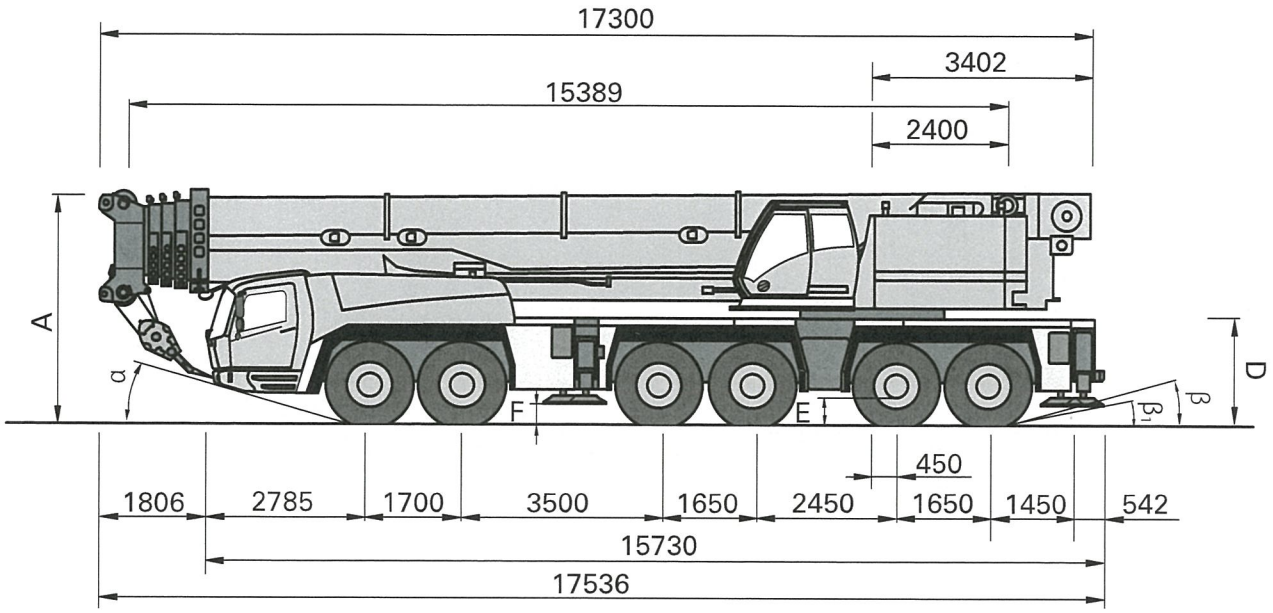


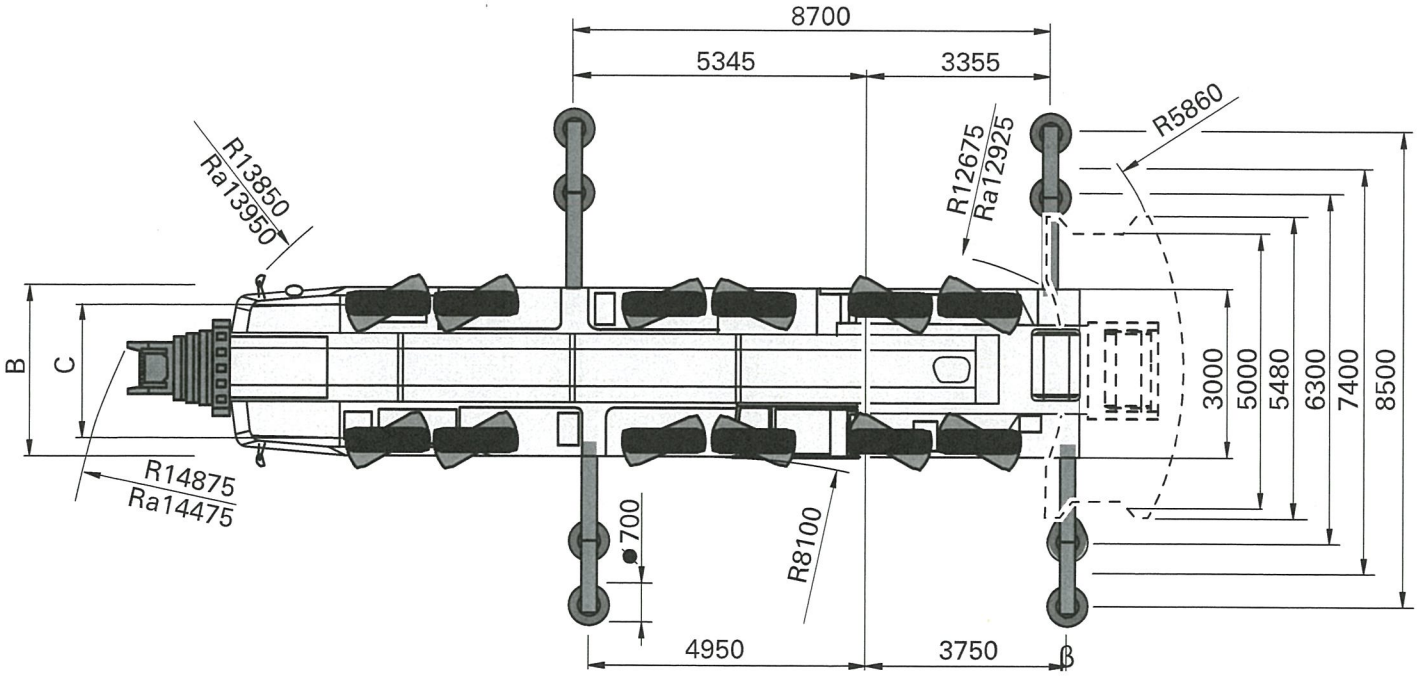


Notes: The horizontal pressures are surcharges due to Footing Loads only and do not include earth pressures

Douglas Partners
Geotechnics / Environment / Groundwater

Dimensions • Abmessungen • Encombrement
Dimensiones • Dimensioni • Размеры



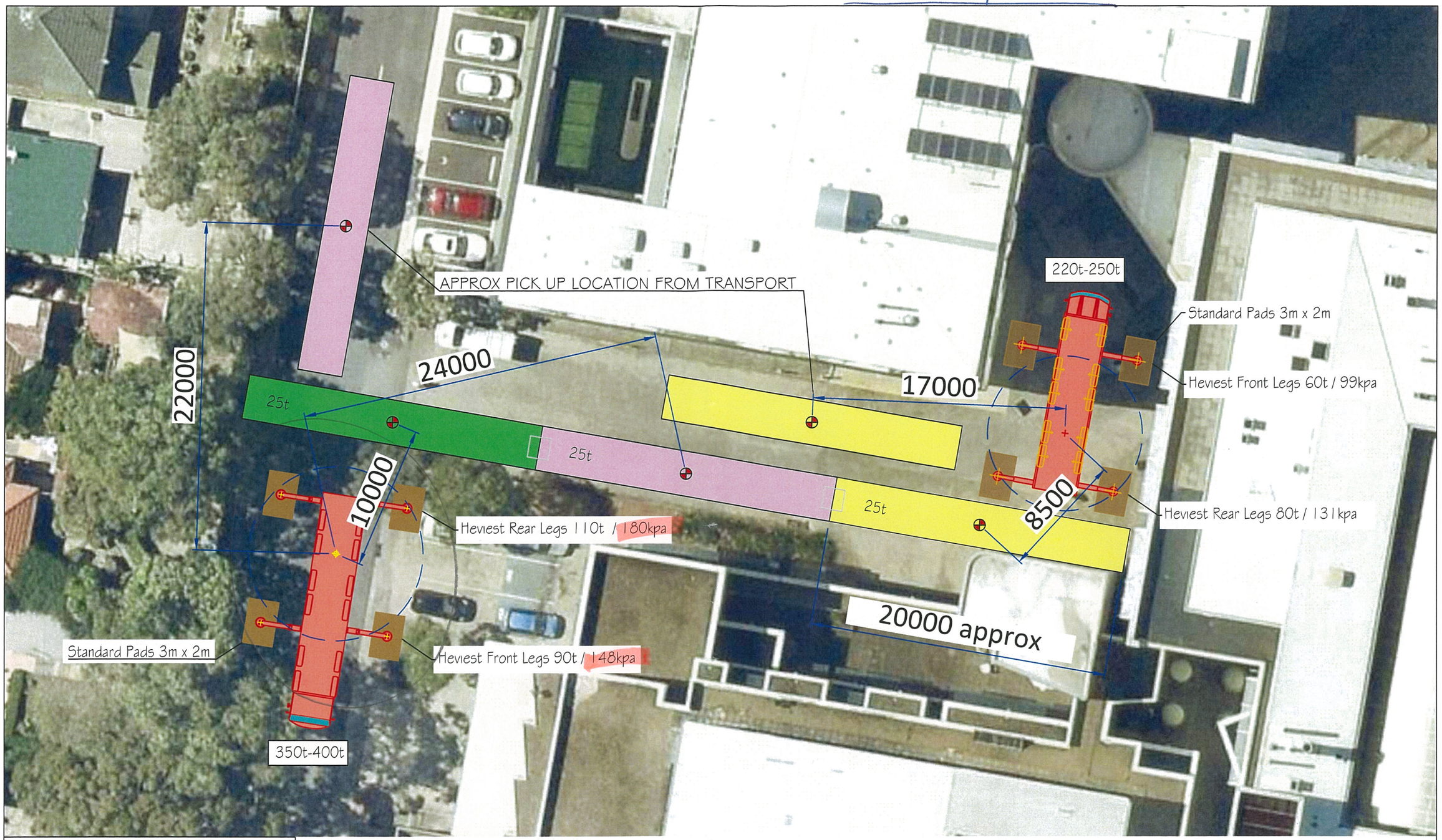


Ra = Radius all wheels steered • Radius allradgelenkt • Rayon toutes les roues directrices • Radio de giro con todas las ruedas giradas • Raggio di curva con tutte le ruote sterzate • Радиус поворота при управлении всеми колесами

	A	A 130 mm**	B	C	D	E	F	α	β	β_1
14.00 R25	3956	3826	2970	2570	1815	400	209	14	11	8
16.00 R25	4000	3870	2975	2510	1865	450	260	16	13	10
20.5 R25	4000	3870	3070	2530	1865	450	260	16	13	10

** *Lowered • Abgesenkt • Surbaissée • Rebaja • Abbassato • Сниженный*

PoW Hospital 72505.13.



PROJECT DETAILS			
CLIENT	Lend Lease		
PROJECT	Randwick Campus (POW Hosp)		
SITE	Randwick		
LIFT DESCRIPTION	Link Bridges		
DRAWN BY	PW		
PAGE	1 OF 1	DATE	1.6.18
REVISION	1	A3 SCALE	1:250

BORGER CRANES
A NEW STRENGTH IN LIFTING
Ph: (02)9832 1044 Fax: (02)9832 1033

PRELIMINARY CRANE PLAN WITH OUTRIGGER LOADS FOR LINK BRIDGE INSTALL. FOR DISCUSSION PURPOSES ONLY.

Maximum Wind Speed During Lift: 10m/s (36km/hr)

This Drawing Has Been Prepared For The Sole Use Of BORGER CRANES. It Is Loaned To The Recipient For His Confidential Use Only. Reproduction Or Distribution Shall Not Be Performed Without The Express Written Consent Of BORGER CRANES

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Fax (02) 9809 4095

Memorandum

To	Lendlease Building Pty Ltd	Danny Finn Elliot Hicks	danny.finn@lendlease.com elliot.hicks@lendlease.com
From	Peter Valenti	**Date**	01 Aug 2018
Subject	Retention of Hospital Road – Pile Wall Capping Beam Randwick Campus Redevelopment (RCR)	**Project No.** **Doc. No.**	72505.13 R.005.Rev0

As requested by Lendlease Building Pty Ltd (Lendlease), Douglas Partners Pty Ltd (DP) has reviewed the proposed pile capping beam arrangement for the perimeter shoring wall along Hospital Road and provides geotechnical advice to consider for design and construction.

It is understood from the attached architectural drawings by BVN Pty Ltd that edge of the capping beam is setback approximately 0.3 – 0.8 m inside the site boundary, with the base of the capping beam about 0.7 – 1.0 m below the adjacent Hospital Road level. Once the capping beam is constructed, the bulk excavation will be backfilled up to the existing Hospital Road level with a new footpath to replace the current garden bed.

It is understood from the attached survey drawings by CMS Surveyors Pty Ltd that a 0.5 – 1.0 m wide garden bed with large trees extends along the site boundary, followed by Hospital Road.

It is understood from Lendlease that at least 0.2 m of additional width or space is required beyond the capping beam to accommodate form work for the concrete pour. Therefore, the proposed excavation will be setback up to 0.6 m from the site boundary in some parts, encroach the site boundary at other parts.

Numerous buried utilities are known to extend below the garden bed and Hospital Road and these may be sensitive to significant ground movement. Hospital Road is trafficked by light and heavy vehicles and will also be subjected to significant surcharge loads from a 350 - 400 tonne mobile crane for construction of the proposed patient bridge.

DP completed a geotechnical report (Ref: 72505.13.R.001.Rev0, dated June 2018), which included boreholes along the Hospital Road. Extracts from DP's geotechnical report including a borehole location plan, together with one cross-section showing a summary of the subsurface conditions along the site boundary are attached.

Within the proposed depths of excavation for the capping beam, the subsurface conditions are expected to include predominantly sandy filling underlain by loose and medium dense natural sand extending to the top of bedrock, which is about 3.5 – 5 m deep. Groundwater seepage or 'stormwater runoff' is expected below the proposed excavation depths, near the top of bedrock.

Based on the above information, it is anticipated that temporary batter slopes of about 1:1 (H:V) may be achieved 'at-best', with near-vertical cuts required in some parts along the site boundary.

As per DP's geotechnical report and previous correspondence (Ref: Aconex Mail No. DP-CAN-12 dated 29 May 2018), temporary batter slopes that are steeper than 1.5:1 (H:V) in filling and natural sand are likely to have a reduced factor of safety for stability, particularly if subjected to surcharge loads. Some slumping of material may occur for steeper batter slopes and this may result in loss of material beyond the site boundary.

It is recommended that some form of excavation support be implemented due to the proximity of the excavation to the site boundary.

Injections of the ground with cement or chemicals to permeate and strengthen the ground may be used to retain soils, either temporarily or permanently. Options for soil stabilisation of the in-situ sands and filling include:

- Jet Grouting – involving the use of high pressures to inject a fluid grout into the soil and mix it into the subject layer, forming a composite cement-soil structure;
- Permeation Grouting - involving the use of low pressures to inject micro-fine cement into an existing sandy soil matrix. (Mainly only applicable for clean, poorly graded sands);
- Sodium-Silicate Chemical Grouting – often used to stabilise granular soils with the aim of increasing strength and retarding water seepage. The process involves filling voids in a soil matrix with the fluid chemical which sets or cures to alter the mechanical properties of the soil mass. The rate of chemical injection and set time are usually such that the soil particles are not significantly displaced by the process.

Given the proprietary nature of both cementitious and chemical stabilisation methods, it will be necessary to seek the appropriate assurances with respect to the long-term performance, durability and integrity of the product from the specialist contractor.

It is recommended that the suitability of any grouting or chemical stabilisation scheme be assessed on the basis of a trial at the site to account for the soil chemistry and particle size distribution.

Alternatively, excavation support including timber plywood panels with walers and internal props may be considered. Sand bags (20 kg) stacked against high-density polyethylene (HDPE) plastic sheeting might also be suitable, depending on the slope, gap and height of the batter. This support system should be constructed in short, hit-and miss panels to reduce the risk of larger, global instability failure. This support system, however, has a greater risk for ground movement to occur compared to the other support systems as the construction method requires bulk excavation prior to the installation of the support system. This approach would need to be closely monitored during construction, with a contingency plan including immediate backfilling of any localised slumping. It is recommended that a construction trial be carried out to determine whether this support system is feasible at this site.

As per DP's geotechnical report, precise survey monitoring of the shoring system should be carried out prior to and during excavation given that the existing nearby structures are likely to be sensitive to differential movement, particularly if footings are founded in sand.

A range of factors are associated with the shoring systems recommended above, including, but not limited to, the ease of construction, quality of workmanship, time and cost. These factors should be assessed to choose the most appropriate shoring system for the RCR.

We trust that this satisfies your present requirements. Please do not hesitate to contact the undersigned if you have any queries.

Yours faithfully,

Douglas Partners Pty Ltd

Reviewed by

Peter Valenti
Associate

Michael J Thom
Principal

Limitations:

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Attachments: About This Report
Drawings

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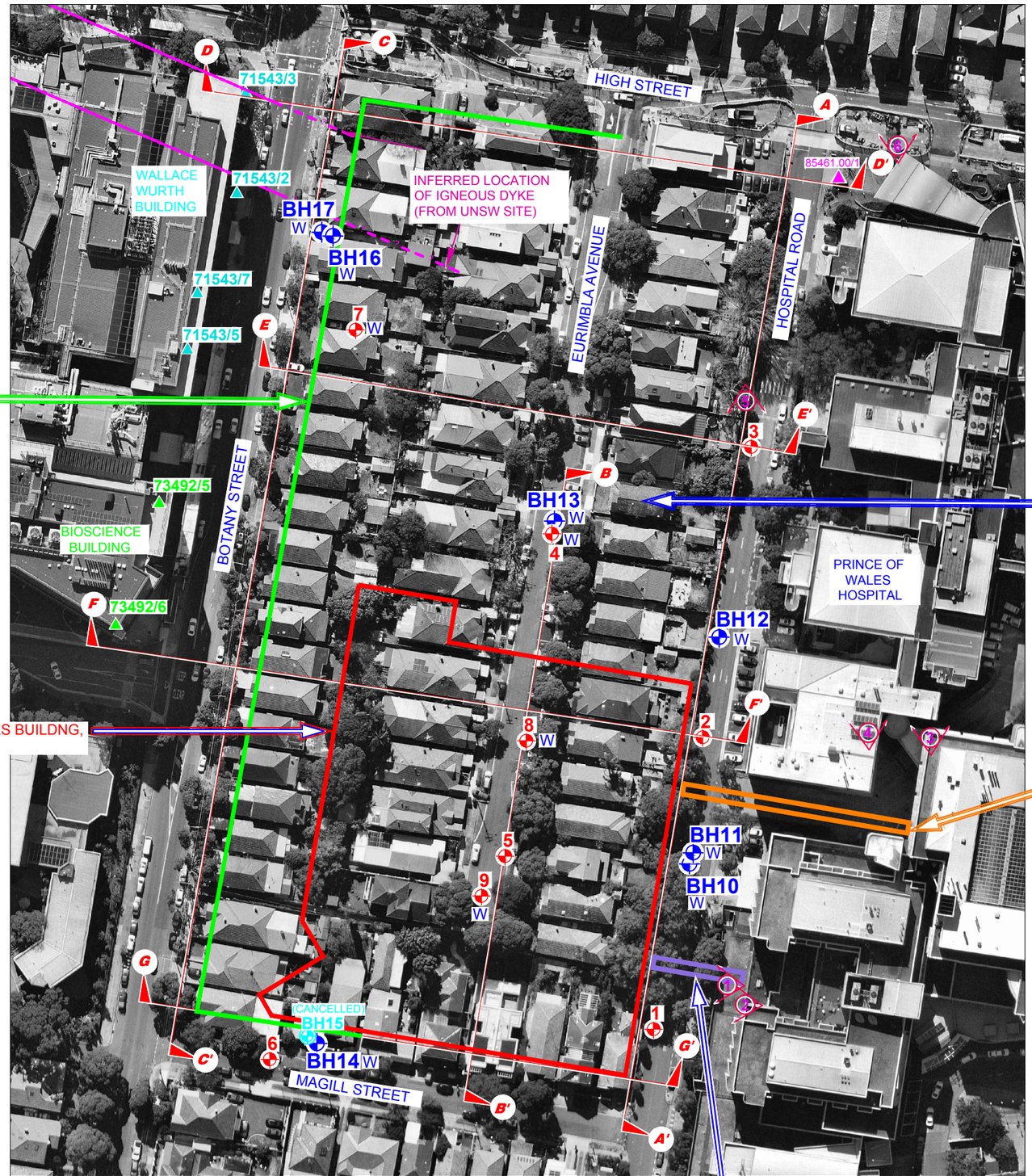
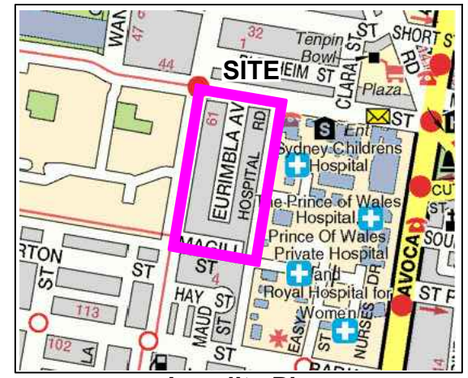
The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.





Locality Plan

NOTE:
1: Base image from Nearmap.com (Dated 6.8.2017)

0 5 10 20 30 40 50 75 100 125m

1:1250 @ A3

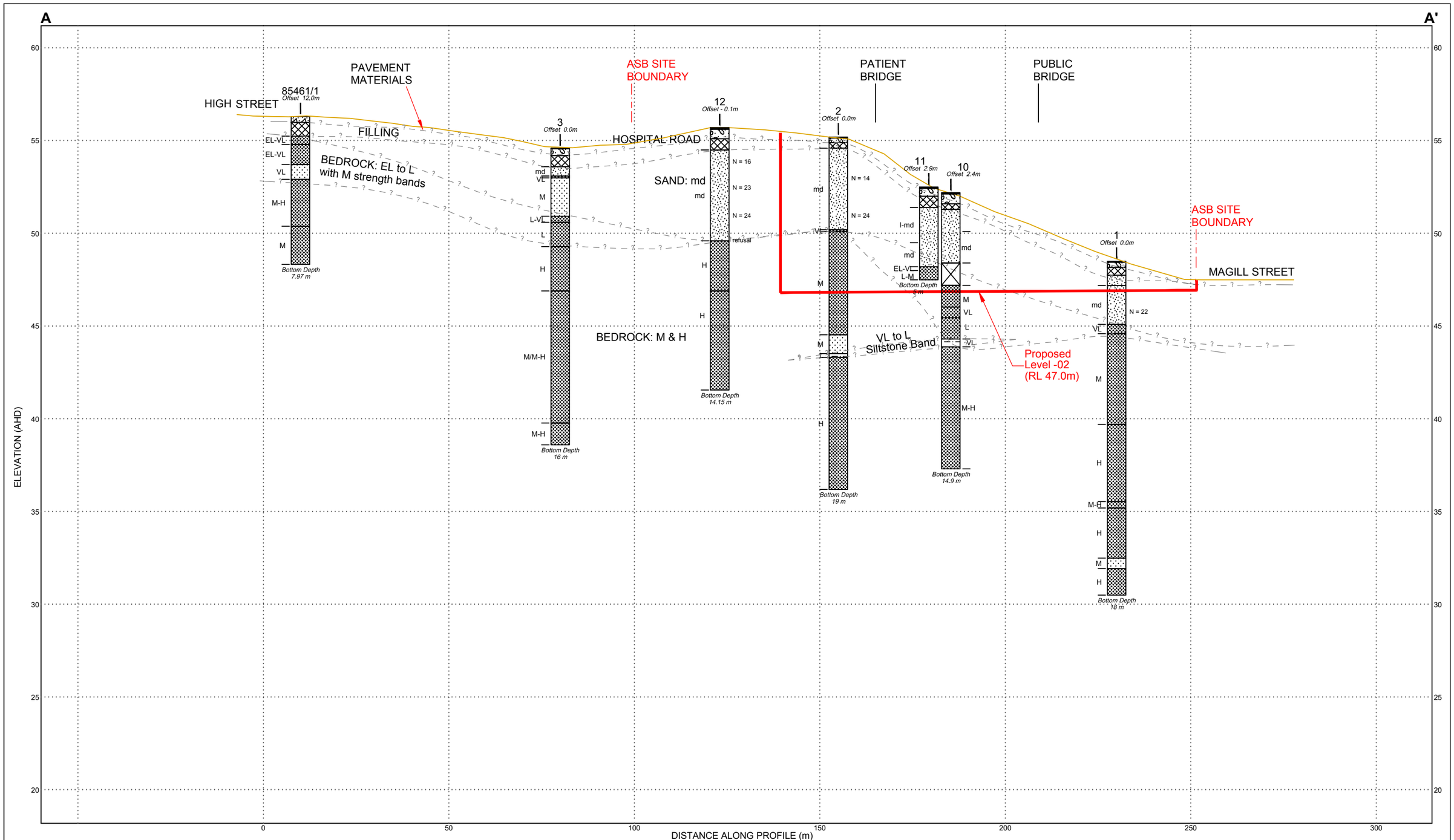
LEGEND

- Previous borehole (UNSW Wallace Wurth Building, Proj. 71543, 2010)
- Previous borehole (UNSW Bioscience Building Proj. 73492, 2013)
- Previous borehole (Prince of Wales Hospital Proj. 85461.00, 2016)
- Previous borehole (Proj. 72505.11, Feb 2018)
- Current borehole
- W Groundwater monitoring well
- A A' Interpreted geotechnical Cross Section
- 1 Photo number with direction of view

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Lendlease Building Pty Ltd		TITLE: **Locations of Previous and Current Boreholes** **Randwick Campus Redevelopment** **Hospital Road and High, Magill and Botany Streets, RANDWICK**
OFFICE: Sydney	DRAWN BY: PSCH	
SCALE: 1:1250 @ A3	DATE: 17.5.2018	

PROJECT No: 72505.13
DRAWING No: 1
REVISION: 0



LEGEND

- Asphaltic Concrete
- Roadbase
- Filling
- Sand
- Sandstone coarse grained
- Sandstone fine grained
- Siltstone
- Concrete

NOTE:

1. Subsurface conditions are accurate at borehole locations. Variations in subsurface conditions may occur between test locations.
2. Interpreted strata boundaries are approximate and should be used as a guide only.
3. Summary logs only. Should be read in conjunction with detailed logs.

ROCK STRENGTH
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High

SOIL CONSISTENCY
vs - very soft
s - soft
f - firm
st - stiff
vst - very stiff
h - hard
vl - very loose
l - loose
md - medium dense
d - dense
vd - very dense

TESTS / OTHER
N - Standard penetration test value
Water level
Inferred Geology

Horizontal Scale (metres) 0 20

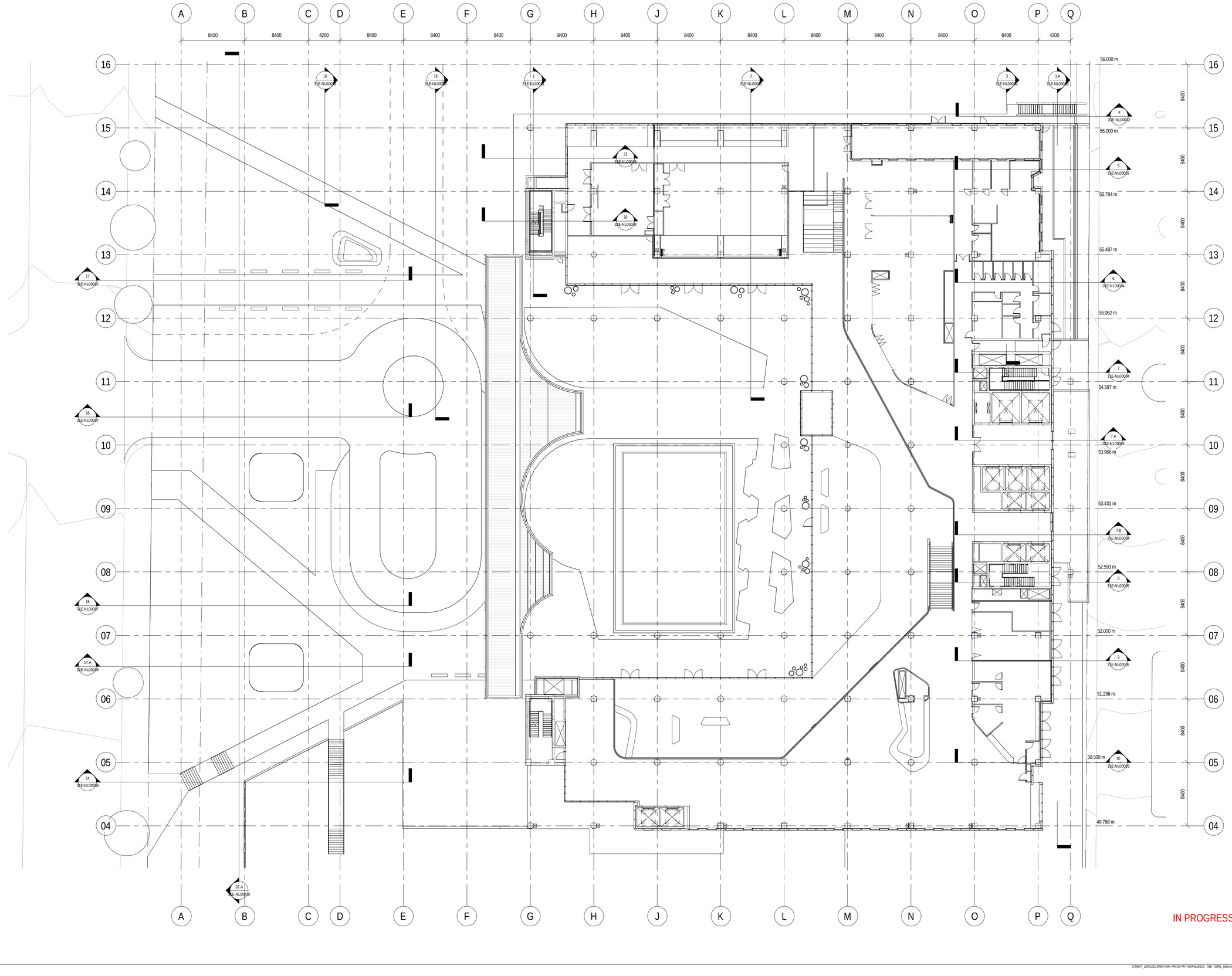
Vertical Exaggeration = 5.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Lendlease Building Pty Ltd		
OFFICE: Sydney	DRAWN BY: LJH	
SCALE: 1:1000 (H) 1:200 (V) @ A3	DATE: 17.5.2018	

TITLE: **Interpreted Geotechnical Cross Section A-A'**
Randwick Campus Redevelopment
Hospital Road and High, Magill and Botany Streets, RANDWICK

PROJECT No:	72505.13
DRAWING No:	2
REVISION:	0



IN PROGRESS

BVN TERROIR

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ISSUE	DATE	FOR
A	05/06/18	FOR INFORMATION

PROJECT MANAGEMENT
PWC

CIVIL AND STRUCTURAL ENGINEERING
ENSTRUCT GROUP

MECHANICAL ENGINEERING
LEHR CONSULTANTS INTERNATIONAL

ELECTRICAL ENGINEERING
WOOD & GRIEVE ENGINEERS

HYDRAULIC ENGINEERING
ACDR CONSULTANTS

CONSTRUCTION MANAGER
lendlease

CLIENT

NSW GOVERNMENT Health Infrastructure

HEALTH INFRASTRUCTURE
CLIENT NUMBER

130487
PROJECT

RANDWICK CAMPUS REDEVELOPMENT

BARKER ST
RANDWICK NSW 2031
AUSTRALIA

BVN PROJECT NUMBER

s1606008
DRAWING KEY

TRUE NORTH PROJECT NORTH

GRAPHIC SCALE
0 2000 5000

SCALE

1 : 200@B1 DO NOT SCALE

STATUS

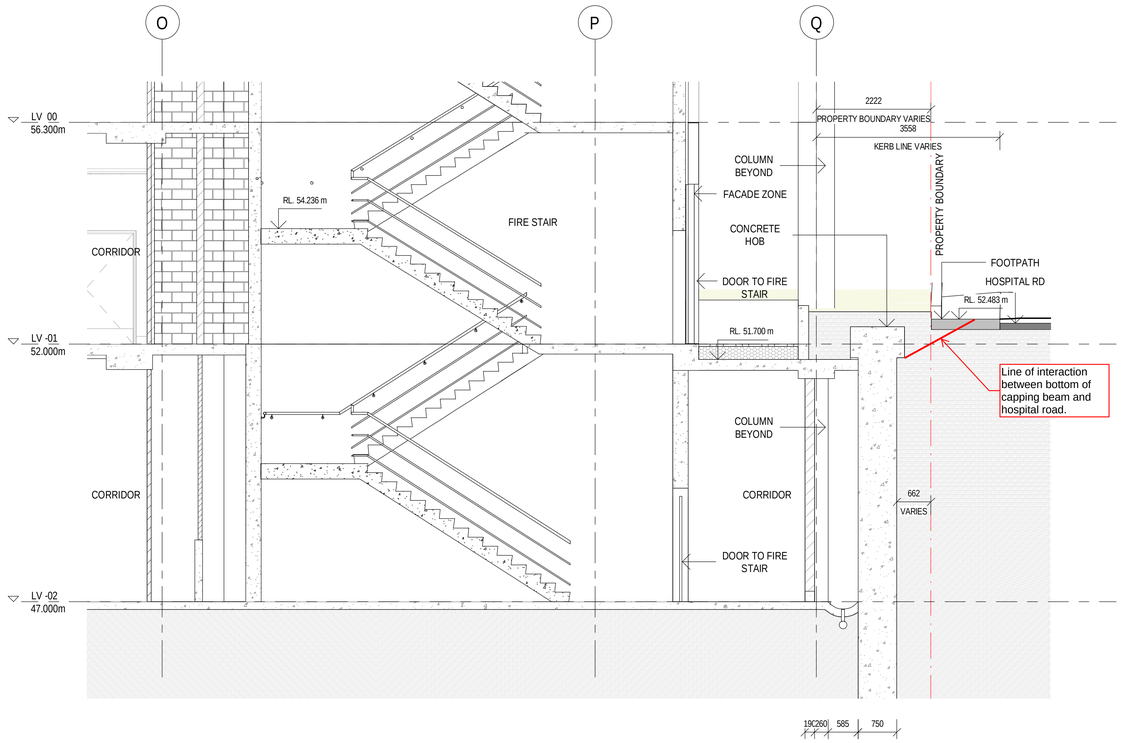
DESIGN DEVELOPMENT
DRAWING

HOSPITAL - LEVEL 00 SITE SECTIONS REFERENCE PLAN

RCR-BVN-ARC-50-DRW-31A-0000001

ISSUE
A

C:\REVIT_LOCAL2018\RCR-BVN-ARC-50-RVT-00M-NL00101 - ASB - CORE_amount.rvt 15/06/2018 4:56:52 PM



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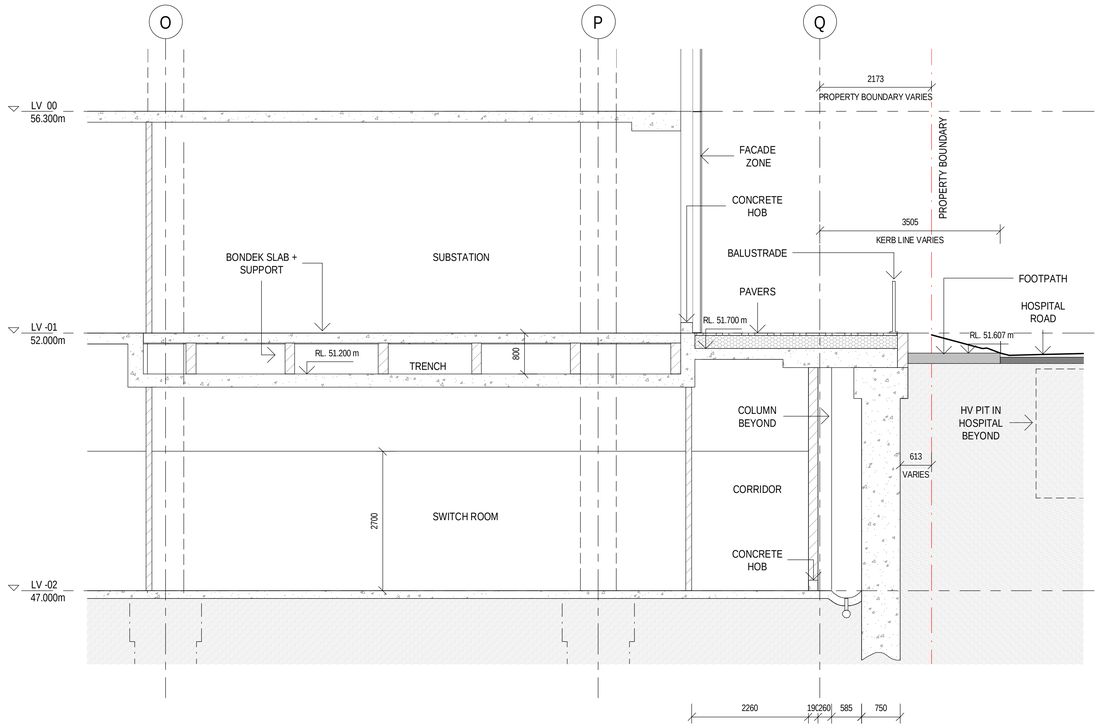

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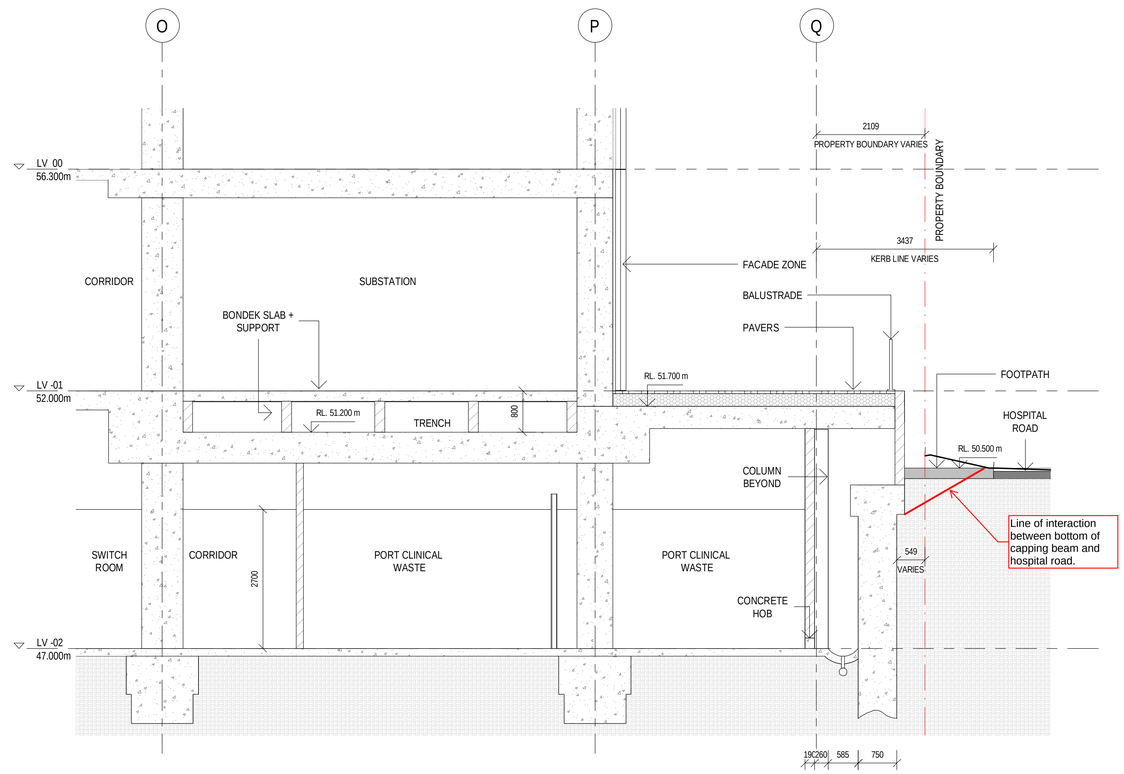

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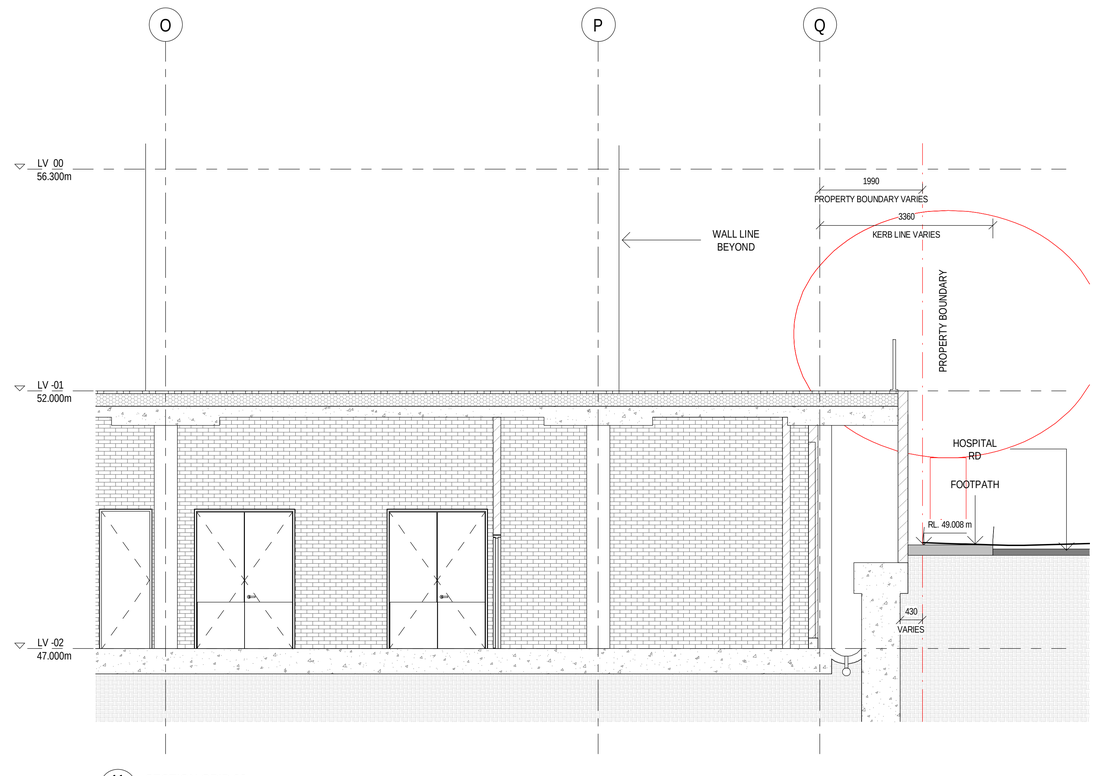

11 SECTION GRID 03
31A-B1000001 1 : 50

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A	05/09/18	FOR INFORMATION
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WOOD & GRIEVE ENGINEERS

HYDRAULIC ENGINEERING
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CONSTRUCTION MANAGER
lendlease

CLIENT

NSW GOVERNMENT Health Infrastructure

HEALTH INFRASTRUCTURE
CLIENT NUMBER

130487
PROJECT

RANDWICK CAMPUS REDEVELOPMENT

BARKER ST
RANDWICK NSW 2031
AUSTRALIA
BVN PROJECT NUMBER

s1606008
DRAWING KEY

TRUE NORTH PROJECT NORTH

GRAPHIC SCALE
0 2000 5000
SCALE

1 : 50@B1 DO NOT SCALE
STATUS

DESIGN DEVELOPMENT
DRAWING

HOSPITAL - SITE SECTIONS

RCR-BVN-ARC-50-DRW-31E-NL00005
ISSUE B

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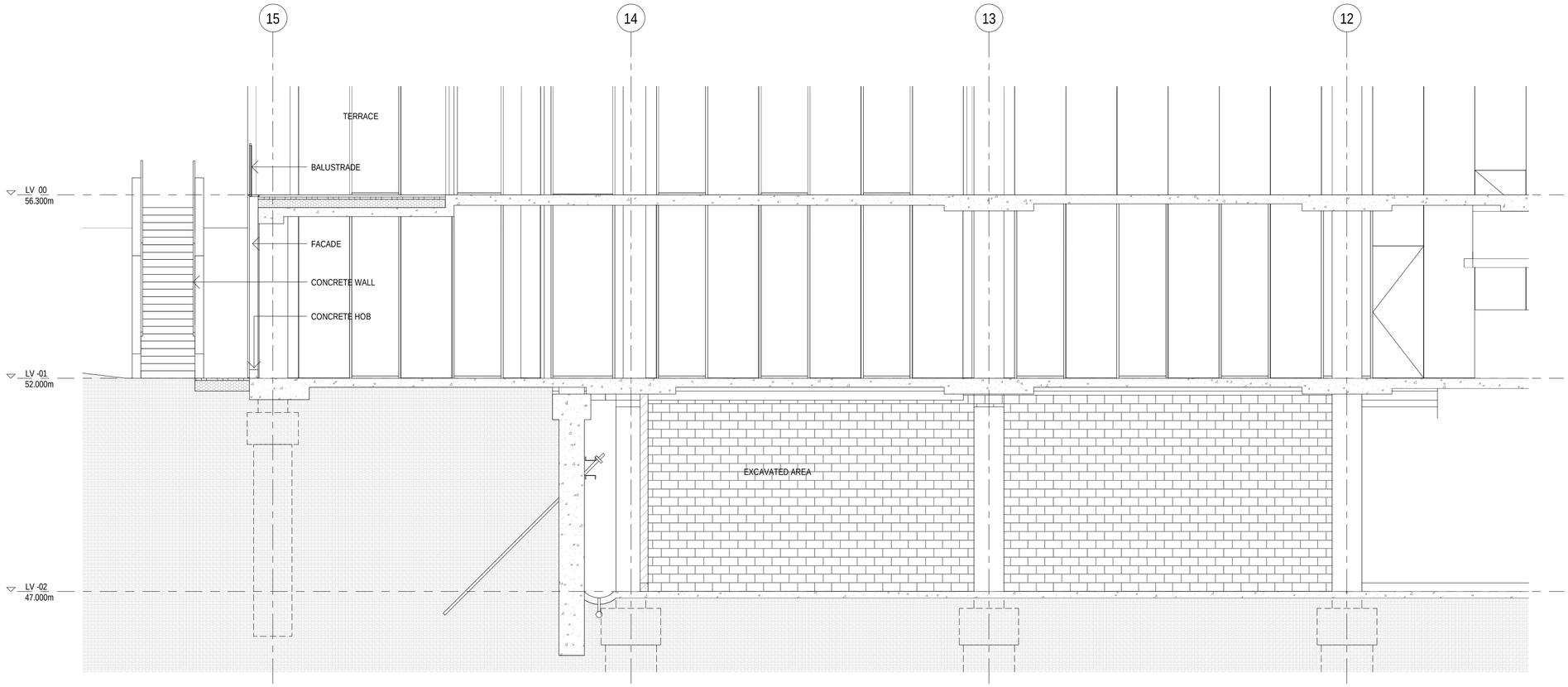

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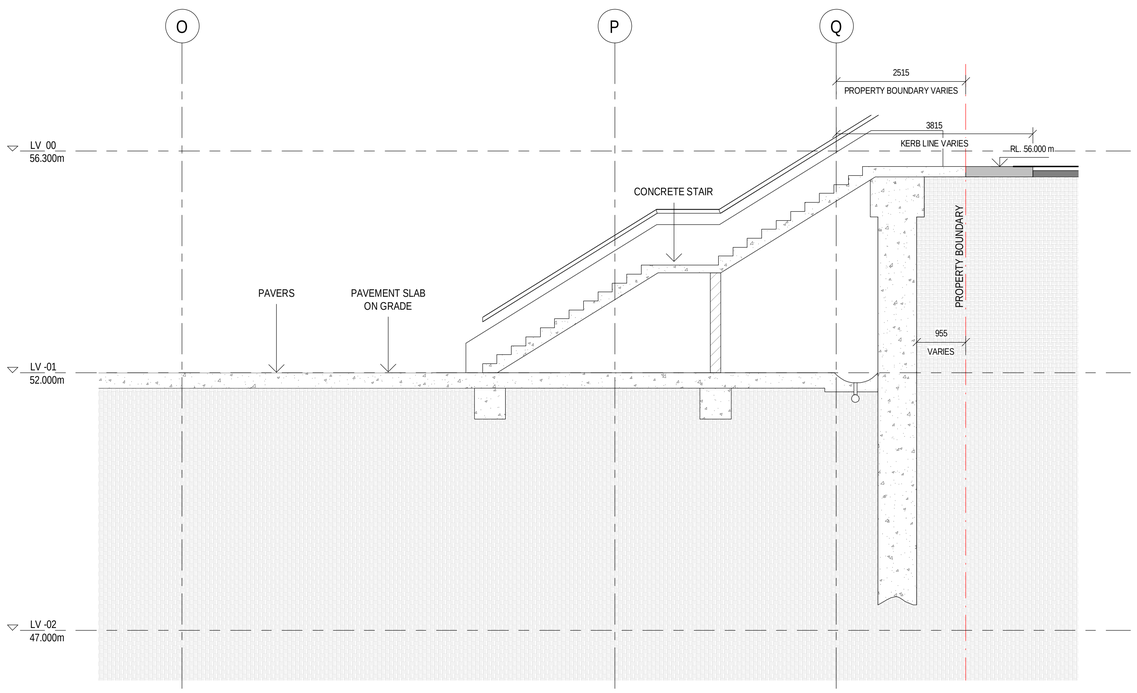

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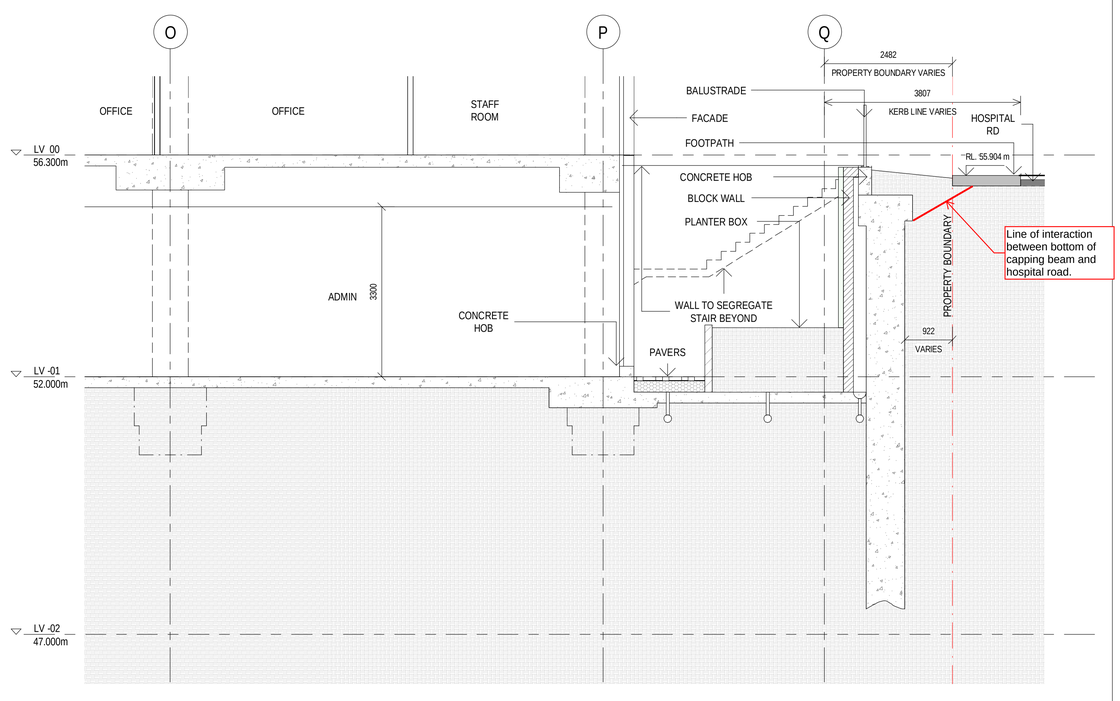

5 SECTION GRID 14
31A-0000001 1 : 50

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B	15/06/18	FOR INFORMATION

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WOOD & GRIEVE ENGINEERS

HYDRAULIC ENGINEERING
ACDR CONSULTANTS

CONSTRUCTION MANAGER
lendlease

CLIENT

NSW GOVERNMENT Health Infrastructure

HEALTH INFRASTRUCTURE
CLIENT NUMBER

130487
PROJECT

RANDWICK CAMPUS REDEVELOPMENT

BARKER ST
RANDWICK NSW 2031
AUSTRALIA

BVN PROJECT NUMBER

s1606008
DRAWING KEY

TRUE NORTH PROJECT NORTH

GRAPHIC SCALE
0 2000 5000

SCALE

1 : 50@B1 DO NOT SCALE

STATUS

DESIGN DEVELOPMENT
DRAWING

HOSPITAL - SITE SECTIONS

RCR-BVN-ARC-50-DRW-31E-NL00002

ISSUE B

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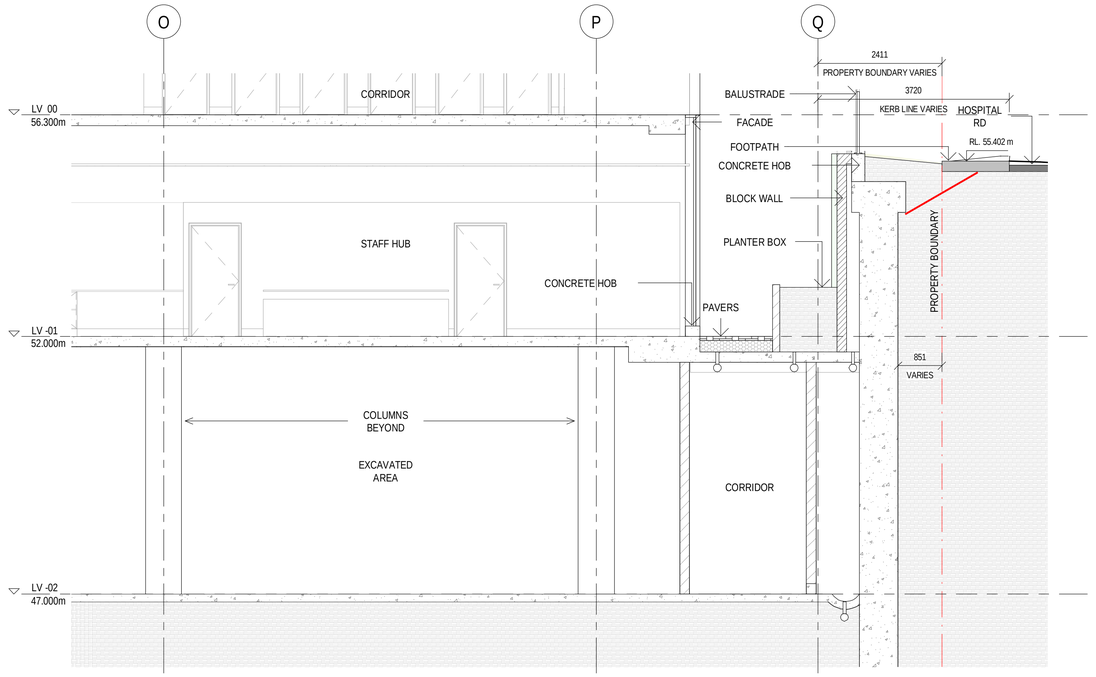

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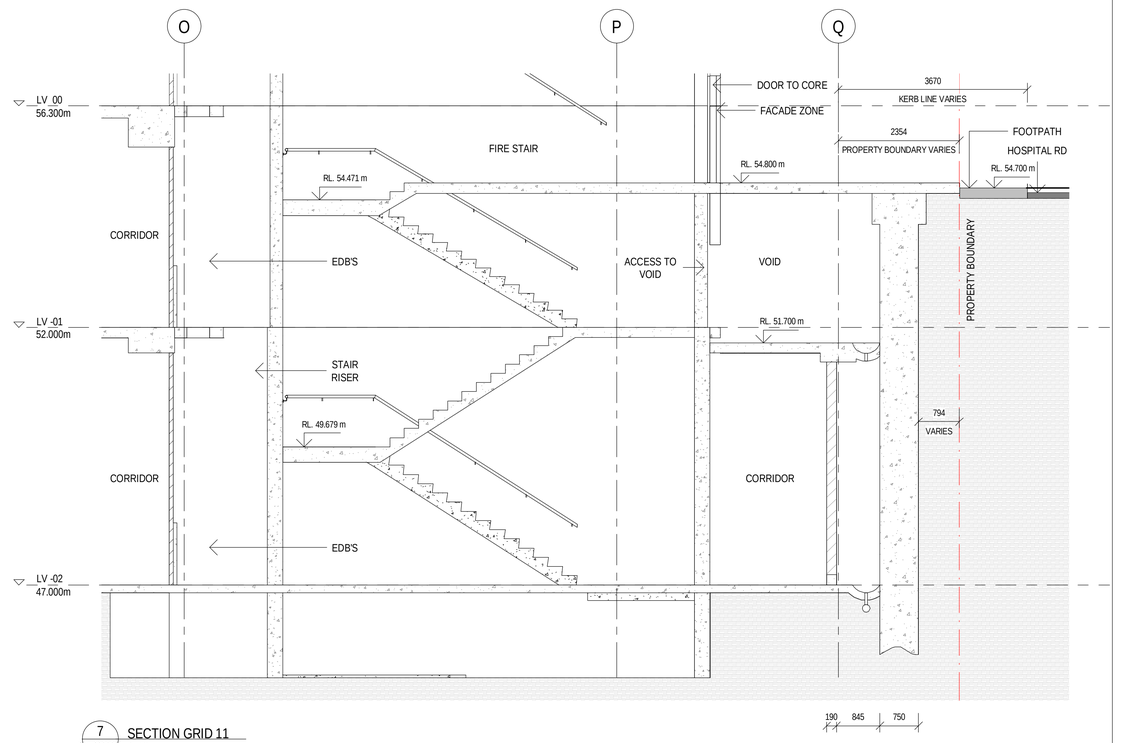

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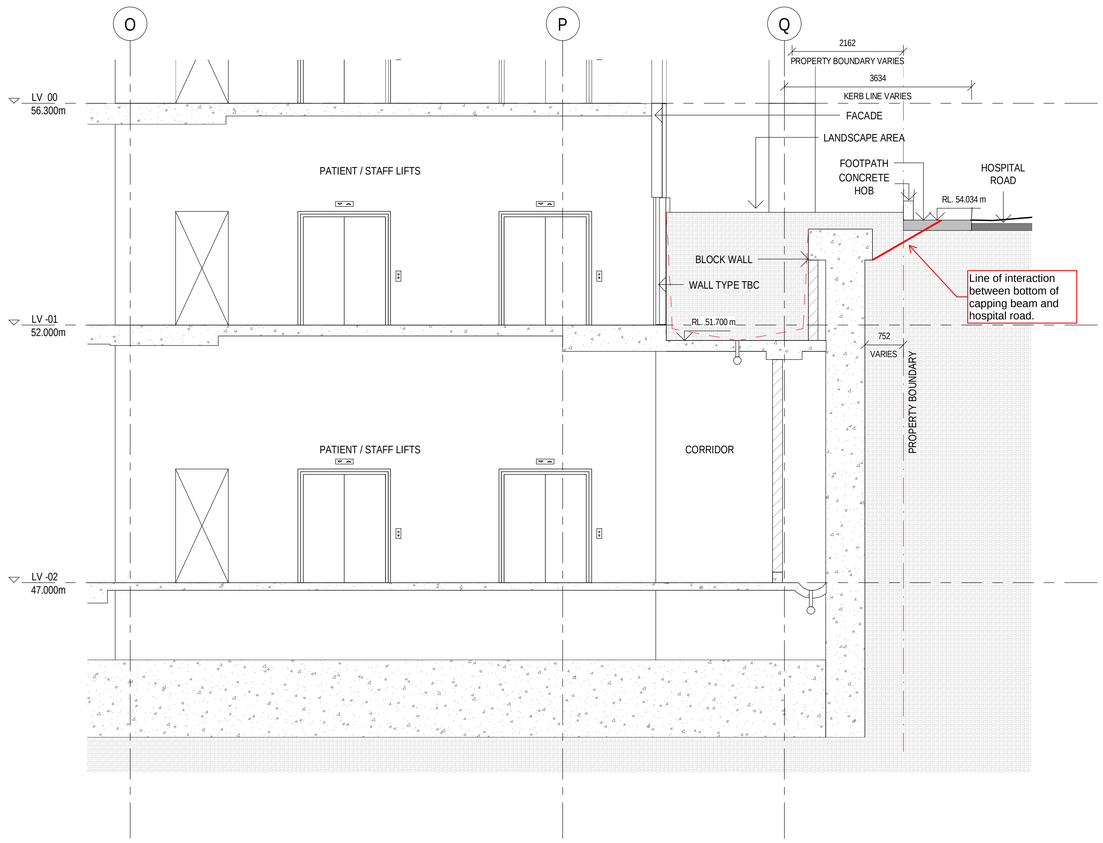

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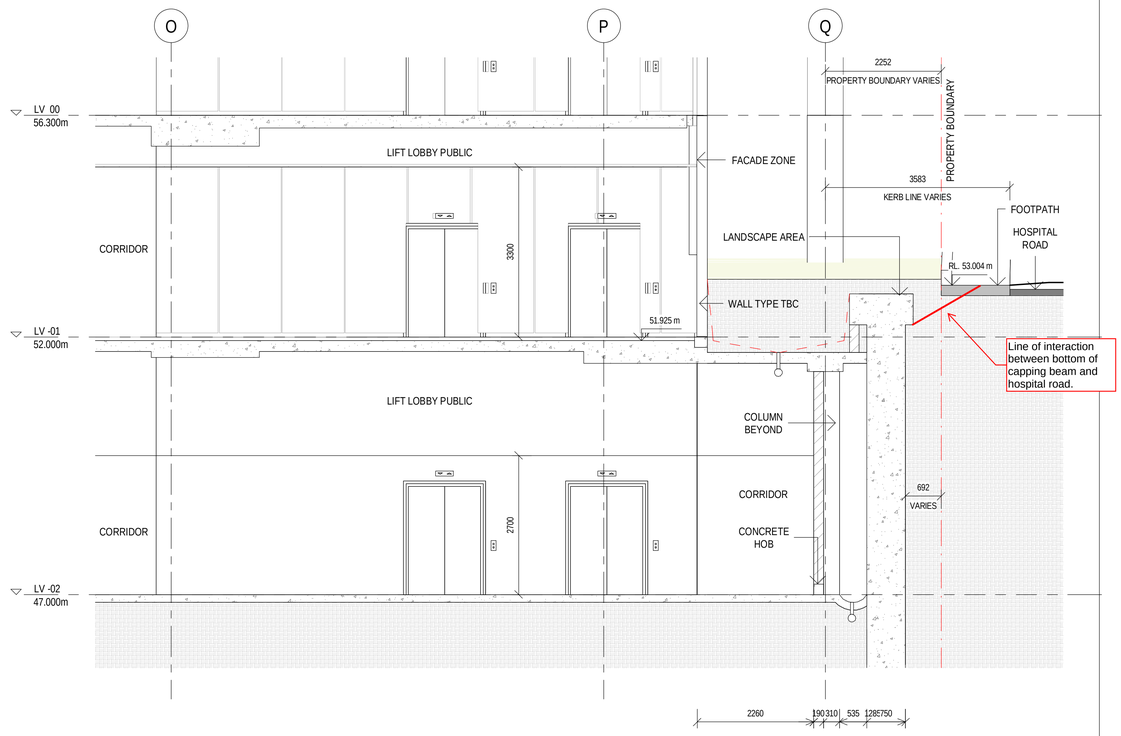

7.B SECTION GRID 09
31A-0000001 1 : 50

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ISSUE	DATE	FOR
A	05/06/18	FOR INFORMATION
B	15/06/18	FOR INFORMATION

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CLIENT
NSW GOVERNMENT Health Infrastructure

HEALTH INFRASTRUCTURE
CLIENT NUMBER

130487
PROJECT

RANDWICK CAMPUS REDEVELOPMENT

BARKER ST
RANDWICK NSW 2031
AUSTRALIA
BVN PROJECT NUMBER

s1606008
DRAWING KEY

TRUE NORTH PROJECT NORTH

GRAPHIC SCALE
0 2000 5000
SCALE

1 : 50@B1 DO NOT SCALE
STATUS

DESIGN DEVELOPMENT
DRAWING

HOSPITAL - SITE SECTIONS

RCR-BVN-ARC-50-DRW-
31E-NL00004
ISSUE
B

A3

APPROX TRUE NORTH
MGA NORTH

NOTES:

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- EXCEPT WHERE SHOWN BY DIMENSION LOCATION OF DETAIL WITH RESPECT TO BOUNDARIES IS INDICATIVE ONLY.
- CRITICAL SPOT LEVELS SHOULD BE CONFIRMED WITH SURVEYOR.
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LEGEND

CL = CENTRELINE
CON = CONCRETE
FCE = FENCE
GF = GUTTER FLOW
SGN = SIGN
TKB = TOP OF KERB
TR = TREE (DIA-SPR-HT.)

EDGE OF CAPPING BEAM PER DESIGN PLAN RCR-ENS-STR-50-DRW-002-00[J] - BUILDING 50 - SITE RETENTION GENERAL ARRANGEMENT.DWG

GRIDS PER DESIGN PLAN RCR-ENS-STR-50-DRW-002-00[J] - BUILDING 50 - SITE RETENTION GENERAL ARRANGEMENT.DWG. GRIDS ALIGNED TO SOUTH WESTERN CORNER OF SITE AND BOTANY RD STREET ALIGNMENT.

SEE SHEET 2

NO. 35
NO. 33
NO. 31
NO. 29

× 54.70 POOL
× 54.71 POOL
× 54.67 PAV
× 54.99 PAV

DESIGN LOCATION OF PIERS

EDGE OF CAPPING BEAM (SEE LEGEND)

55.92 FCE
0.450
1,668m
55.57 TKB
55.39 GF
56.06 FCE
0.490
1,719m
55.77 TKB
55.53 GF
55.85 SGN
56.06 FCE
0.530
1,743m
55.79 TKB
55.65 GF
0.575
1,802m
56.04 FCE
55.70 GF
0.595
1,841m
55.79 T

GARDEN
CONCRETE KERB & GUTTER
GARDE

HOSPITAL ROAD

BOUNDARY LINE

13 14 15 16 17

× 55.55
× 55.49 CL
× 55.70 CL
× 55.78 CL
× 55.82 CL

55.24 GF
55.55 GF
55.70 GF

0 1 2 3 4 5 6 7 8 9 10

SCALE 1:100

1	INITIAL ISSUE	18/07/2018

PLAN SHOWING RELATIONSHIP OF PROPOSED RETENTION WALL WITH BOUNDARY AND PARTIAL DETAIL HOSPITAL ROAD, RANDWICK REDEV. PRECINCT RANDWICK, NSW 2031

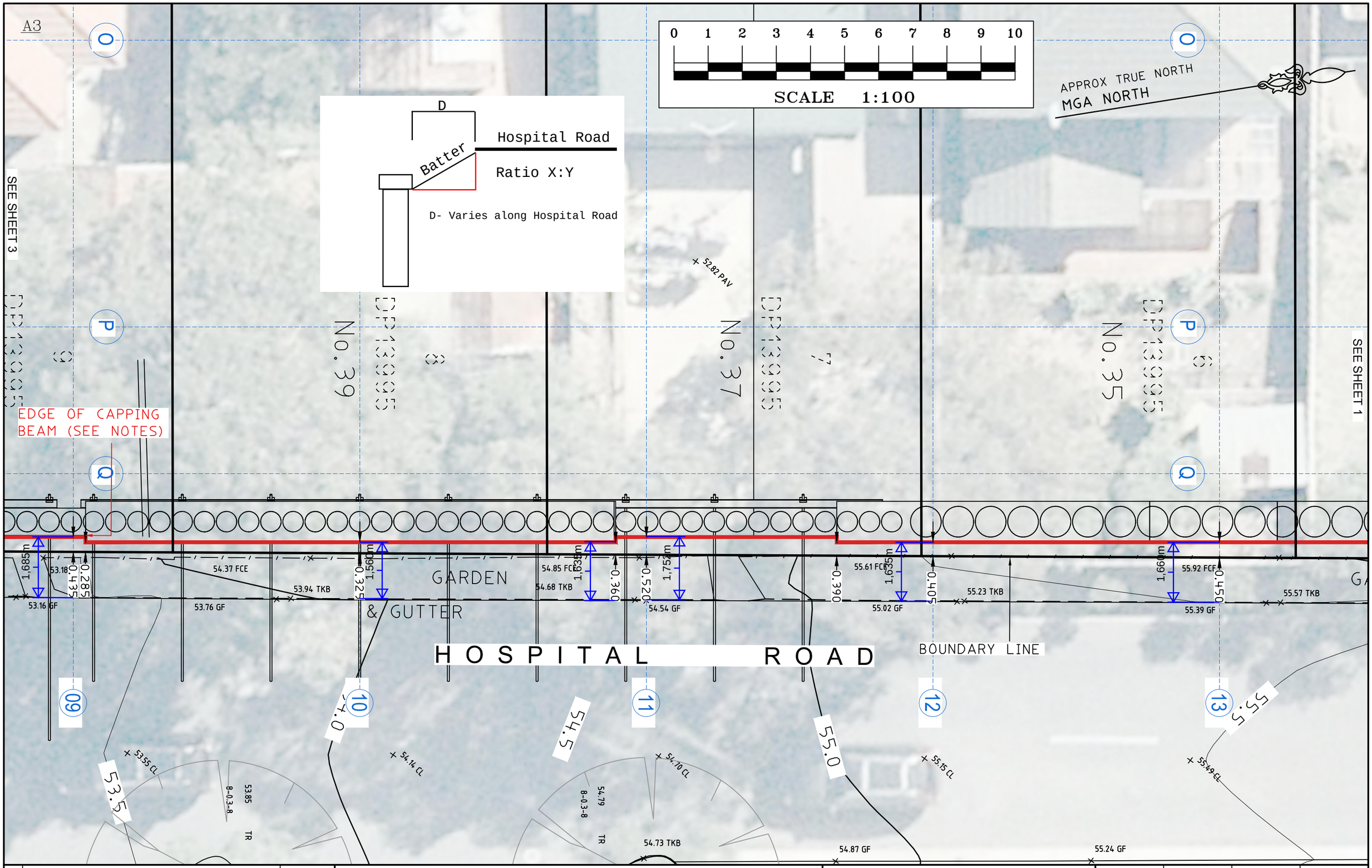
C.M.S. Surveyors Pty. Ltd.
A.C.N 096 240 201
PO Box 463 Dee Why NSW 2099
2/99A South Creek Road, Dee Why NSW 2099
Phone: (02) 9971 4802 Fax: (02) 9971 4822
E-mail: info@cmssurveyors.com.au

SURVEYED	DRAWN	CHECKED	APPROVED
TC/CL	CL	DR	CL

SURVEY INSTRUCTION	SCALE	DATE OF SURVEY
17729	1:100	JUNE 2018-JULY 2018

DRAWING NAME	SHEET	ISSUE
17729 RetentionWall	1 OF 4	1

CAD FILE
17729-RCR-CMS-ST-50-DWG-RetentionWall.dwg



1	INITIAL ISSUE	18/07/2018

PLAN SHOWING RELATIONSHIP OF PROPOSED RETENTION WALL WITH BOUNDARY AND PARTIAL DETAIL HOSPITAL ROAD, RANDWICK REDEV. PRECINCT RANDWICK, NSW 2031

C.M.S. Surveyors Pty. Ltd.
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2/99A South Creek Road, Dee Why NSW 2099
Phone: (02) 9971 4802 Fax: (02) 9971 4822
E-mail: info@cmssurveyors.com.au

SURVEYED	DRAWN	CHECKED	APPROVED
TC/CL	CL	DR	CL

SURVEY INSTRUCTION	SCALE	DATE OF SURVEY
17729	1:100	JUNE 2018-JULY 2018

DRAWING NAME	SHEET	ISSUE
17729 RetentionWall	2 OF 4	1

CAD FILE
17729-RCR-CMS-ST-50-DWG-RetentionWall.dwg

A3

0 1 2 3 4 5 6 7 8 9 10

SCALE 1:100

APPROX TRUE NORTH
MGA NORTH

No. 47

No. 45

No. 43

No. 41

SEE SHEET 4

SEE SHEET 2

EDGE OF CAPPING BEAM (SEE NOTES)

4.981 CON

50.22 CON

52.60 CON

50.83 FCE
50.26 TKB
1.390m
0.115
50.78 GF

51.39 FCE
50.98 TKB
1.429m
0.155
0.160
51.56 GF

52.25 FCE
51.74 TKB
0.350
52.55 SGN
1.641m
52.42 GF

52.51 FCE
52.57 TKB
0.395

53.29 TKB
1.080m
53.18
0.435
0.285
1.529m
53.16 GF

BOUNDARY LINE

CONCRETE KERB

HOSPITAL ROAD

50.76 CL

51.46 CL

52.18 CL

52.89 CL

53.55 CL

50.5
51.0
51.5
52.0
52.5
53.5

1	INITIAL ISSUE	18/07/2018

PLAN SHOWING RELATIONSHIP OF PROPOSED RETENTION WALL WITH BOUNDARY AND PARTIAL DETAIL HOSPITAL ROAD, RANDWICK REDEV. PRECINCT RANDWICK, NSW 2031

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A.C.N 096 240 201
PO Box 463 Dee Why NSW 2099
2/99A South Creek Road, Dee Why NSW 2099
Phone: (02) 9971 4802 Fax: (02) 9971 4822
E-mail: info@cmssurveyors.com.au

SURVEYED	DRAWN	CHECKED	APPROVED
TC/CL	CL	DR	CL

SURVEY INSTRUCTION	SCALE	DATE OF SURVEY
17729	1:100	JUNE 2018-JULY 2018

DRAWING NAME	SHEET	ISSUE
17729 RetentionWall	3 OF 4	1

CAD FILE
17729-RCR-CMS-ST-50-DWG-RetentionWall.dwg

A3

0 1 2 3 4 5 6 7 8 9 10

SCALE 1:100

APPROX TRUE NORTH
MGA NORTH

No.12

No.14

No.47

SEE SHEET 4

EDGE OF CAPPING BEAM (SEE NOTES)

47.13 PAV

47.25 CON

49.81 CON

49.06 FCE

50.00 FCE

50.83 FCE

51.39 FCE

47.44 TKB

48.14 TKB

48.28 FCE

48.30 SGN

48.64 SGN

48.88 TKB

49.41 SGN

49.55 TKB

50.26 TKB

47.97 GF

48.71 GF

49.38 GF

50.08 GF

50.78 GF

1.256m

0.120 (OVER BDY)

0.110 (OVER BDY)

1.281m

0.020 (OVER BDY)

0.070

1.389m

0.115

GARDEN

CONCRETE KERB & GUTTER

BOUNDARY LINE

6-0.45-10 TR 49.13

6-0.45-10 TR 49.77

9-0.3-10 TR 49.19

01 02 03 04 05

P Q

47.44 CL

48.04 CL

48.69

49.38 CL

50.07 CL

47.5

48.0

48.5

49.0

49.5

50.0

50.5

HOSPITAL ROAD

1	INITIAL ISSUE	18/07/2018

PLAN SHOWING RELATIONSHIP OF PROPOSED RETENTION WALL WITH BOUNDARY AND PARTIAL DETAIL HOSPITAL ROAD, RANDWICK REDEV. PRECINCT RANDWICK, NSW 2031

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SURVEY INSTRUCTION	SCALE	DATE OF SURVEY
17729	1:100	JUNE 2018-JULY 2018

DRAWING NAME	SHEET	ISSUE
17729 RetentionWall	4 OF 4	1

CAD FILE
17729-RCR-CMS-ST-50-DWG-RetentionWall.dwg

Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Supplementary Geotechnical Investigation

Randwick Campus Redevelopment
Hospital Road and High, Magill and Botany Streets,
Randwick

Prepared for
Lendlease Building Pty Ltd

Project 72505.13
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Executive Summary

This report consolidates the results of a recently completed preliminary geotechnical investigation (Ref: Report 72505.11.R.001.Rev2, dated February 2018) and this supplementary geotechnical investigation undertaken for the proposed Randwick Campus Redevelopment at the site bound by Hospital Road, and High, Magill and Botany Streets, Randwick. The purpose of the investigation was to further assess the subsurface conditions and to undertake groundwater monitoring across the site to provide comments for detailed design and planning purposes. This report supersedes any previous geotechnical reports for this project.

It is understood that the redevelopment includes:

- A new multi-storey Acute Services Building (ASB), about 125 m by 150 m in area, with basement Level -02 extending to RL 47.0 m. This basement will require excavation to depths of up to 8 m. Localised, deeper excavations to approximate depths of 2 – 3 m below basement Level -02 are required for core stairs and lift pits;
- A patient bridge and a public bridge over Hospital Road linking the new ASB to the existing Hospital Campus; and
- Diversion of sewer and stormwater services around the perimeter of the ASB site and the future development site (Stage 2). The sewer will extend below the stormwater system, with sewer invert levels ranging from RL 44.7 m at Chainage 0 m at Magill Street to RL 49.9 m at Chainage 320 m at High Street; and
- A future expansion area (Stage 2), located immediately north of the ASB and extending up to High Street.

The investigations included a desktop study of previous rock-cored boreholes in proximity to the site and regional mapping, drilling of 16 boreholes across the site (where access was readily available to drilling rigs), installation of 11 groundwater monitoring wells to monitor the groundwater levels, permeability tests in soil and rock, and laboratory tests for geotechnical purposes.

The subsurface conditions generally include sandy filling and ripped sandstone filling of variable thickness, overlying loose and medium dense, non-plastic sand and Hawkesbury Sandstone bedrock. The bedrock surface is expected to dip down towards the south and west. The rock is initially extremely low to low strength and generally becomes more consistent medium and high strength sandstone with depth. Some extremely low to low strength siltstone and laminite bands were interbedded within the stronger sandstone.

Based on measurements of groundwater within boreholes and monitoring wells, stormwater runoff seepage is expected at the soil and rock interface and within bedrock along rock joints and extremely/highly weathered bedrock bands, which lie above the proposed ASB Level -02 (RL 47.0 m), and the sewer/stormwater diversions, at the northern end of the ASB site and beyond to the north. The stormwater runoff seepage level should be expected to rise by about 0.1 – 0.2 m over the top of rock following rainfall. It is noted that rainfall events are considered to be the source of stormwater runoff seepage, with ‘sinks’ including gardens or nature strips located upslope of the site.

At the southern (i.e. lower-lying) end of the site, a transient water table, which stores the stormwater runoff seepage that flows downslope after rainfall events, is expected at about RL 42.6 – 43.0 m within

sand below the proposed ASB Level -02 (RL 47.0 m) and the sewer diversion invert level (RL 44.7 m). The water table should be expected to rise by about 1 m following rainfall.

Based on the site topography, published mapping and subsurface conditions encountered to date, acid sulphate soils and saline soils are unlikely to be geotechnical issues at this site.

For the ASB basement, a secant pile shoring wall embedded into bedrock is recommended to cut-off stormwater runoff seepage. Alternatively, a contiguous pile wall, with the gaps between the piles plugged with dry-pack grout upon excavation to retain soil, together with a drainage plenum around the site perimeter for collection and subsequent discharge of stormwater runoff seepage is also considered to be a feasible retaining system for the ASB basement, as proposed by Enstruct Group Pty Ltd, the structural engineers for this project.

The current basement design includes a drained basement with a contiguous pile shoring wall and plugged pile gaps. A drained basement is considered to be a feasible construction method for the proposed basement. Alternatively, a tanked basement comprising water-tight walls and floors would eliminate the requirement for permanent dewatering of stormwater runoff seepage and approval from regulatory authorities.

Based on the current information on groundwater monitoring, rainfall data, rock contours, and permeability testing at this site, stormwater inflow to the basement excavation is estimated to be in the order of 3,000 – 30,000 L/day or 1.1 – 11 ML/year. The volume of stormwater ingress will ultimately depend on the soil permeability, rock fracturing, the amount of ground surface infiltration compared to surface run-off, and prevailing weather conditions. Greater volumes of stormwater ingress to the basement may also be experienced if leaking stormwater systems are present in the surrounding sandy soils or heavy continuous rainfall is experienced. Consideration should be given to whether a dewatering licence from a regulatory authority is required for this site.

For the drained ASB basement and the sewer/stormwater diversions, any immediate lowering of stormwater runoff seepage, through weep holes/spitter pipes in the ASB basement walls or between the shoring systems in the service diversions, is expected to be within local historical fluctuations. The proposed development levels are also above the water table located at the southern end of the site, and therefore, there is no requirement to lower the water table. Therefore, the affects of drawdown (i.e. additional soil stresses causing vertical settlement of the ground surface and nearby structures) is not expected to be an issue with dewatering for a drained basement or drained service trenches/pits.

It is expected that a combination of shallow pad or strip footings and deep pile footings bearing in medium strength (or stronger) bedrock will be required to support the heavily-loaded building columns. The footing design should consider the presence of extremely low to low strength laminite bands. To reduce the potential risk of differential settlement between footings, all footings should be founded below ‘weak’ laminite/siltstone bands or not within five pile diameters (where piles are used) or 1.5 times the minimum footing dimension (where pads are used) above the ‘weak’ rock. Beyond the ASB basement excavation, it may be possible to support lightly-loaded structures on shallow, pad or strip footings bearing on loose to medium dense sand.

A preliminary flexible pavement thickness design was undertaken, resulting in a minimum pavement thickness of 300 mm.

The excavations for the sewer and stormwater diversions have similar geotechnical issues to the ASB basement to consider for construction. All material above medium strength rock will require some form of temporary support by a combination of batters, sheet pile walls, shoring boxes and/or contiguous pile walls. The choice of excavation support along the services alignment will change to satisfy the proposed depth of excavation, the size of the trench/shaft and the subsurface conditions in that area.

For detailed design, further geotechnical investigation including rock-cored boreholes is recommended to further characterise the subsurface conditions where data-gaps exist at the ASB and two bridges. Groundwater monitoring should also continue until construction begins to assess the response of stormwater seepage levels to rainfall events. Further investigation should occur when site access is more readily available to drilling rigs (i.e. post-demolition of existing buildings).

Table of Contents

Page

1. Introduction 1
2. Previous Investigations 2
   - 2.1 Hospital Precinct 2
   - 2.2 Within University Of New South Wales 2
     - 2.2.1 Wallace Wurth Building 2
   - 2.3 Bioscience Building 3
3. Site Description 3
4. Regional Geology 5
5. Field Work Methods 5
6. Field Work Results 7
   - 6.1 Site Walkover 7
   - 6.2 Boreholes 8
   - 6.3 Groundwater 9
     - 6.3.1 Groundwater Monitoring 9
     - 6.3.2 Falling-Head Tests 10
7. Laboratory Testing 11
   - 7.1 Physical Soil Properties 11
   - 7.2 Chemical Soil Properties 11
   - 7.3 Rock Strength Testing 12
8. Proposed Development 12
9. Comments 13
   - 9.1 Geological Model 13
   - 9.2 Dilapidation Surveys 15
   - 9.3 Excavation Conditions 15
     - 9.3.1 Groundwater and Dewatering 16
     - 9.3.2 Disposal of Excavated Materials 18
     - 9.3.3 Ground Vibrations 18
   - 9.4 Working Platforms 19
   - 9.5 Excavation Support 19
     - 9.5.1 Sewer and Stormwater Diversions 19
     - 9.5.2 Batter Slopes 21
     - 9.5.3 Retaining Wall Types 21

9.5.4 Retaining Wall Design 22
9.5.5 Ground Anchors 23
9.5.6 Excavation Induced Ground Movements (Stress Relief) 24
9.6 Survey Monitoring During Excavation 25
9.7 Foundations 25
9.7.1 Site Classification 25
9.7.2 Footings 26
9.7.3 Sewer Diversion 28
9.7.4 Stormwater Diversion 28
9.7.5 Slabs on Grade 28
9.8 Soil Aggressivity 29
9.9 Seismic Design 29
9.10 Subgrade Preparation 29
9.11 Pavements 30
9.11.1 General 30
9.11.2 Pavement Thickness Design 31
9.11.3 Drainage 32
9.12 Stormwater Management Systems 33
9.13 Further Investigation 33
10. References 33
11. Limitations 34

Appendices

Appendix A: About this Report
Appendix B: Drawings 1 to 8
Appendix C: Results of Previous Investigations
Appendix D: Site Photographs
Appendix E: Results of Current Investigation
Appendix F: Results of Laboratory Testing – Physical Properties
Appendix G: Results of Laboratory Testing – Chemical Properties
Appendix H: Well Logs
Appendix I: Results of Groundwater Monitoring and Rainfall Data
Appendix J: Results of Falling-Head Permeability Tests

Report on Supplementary Geotechnical Investigation
Randwick Campus Redevelopment
Hospital Road and High, Magill and Botany Streets, Randwick

1. Introduction

This report presents the results of a supplementary geotechnical investigation undertaken by Douglas Partners Pty Ltd (DP) for the proposed Randwick Campus Redevelopment at Hospital Road and High, Magill and Botany Streets, Randwick. The investigation was undertaken in accordance with DP's proposal (SYD180227.P.002.Rev0, dated 28 March 2018) and a professional services agreement with Lendlease Building Pty Ltd (LLB). The investigation was carried out in consultation with LLB, Health Infrastructure (HI), the project managers for the planning phase (Aurecon) and the design phase (Price Waterhouse Coopers), and the structural engineers Enstruct Group Pty Ltd (Enstruct). This report supersedes any previous geotechnical reports for this project.

It is understood that the redevelopment includes:

- A new multi-storey Acute Services Building (ASB), about 125 m by 150 m in area, with basement Level -02 extending to RL 47.0 m. This basement will require excavation to depths of up to 8 m. Localised, deeper excavations to approximate depths of 2 – 3 m below basement Level -02 are required for core stairs and lift pits;
- A patient bridge and a public bridge over Hospital Road linking the new ASB to the existing Hospital Campus;
- Diversion of sewer and stormwater services around the perimeter of the ASB site and the future development site (Stage 2). The sewer will extend below the stormwater system, with sewer invert levels ranging from RL 49.6 m (near High Street) to RL 44.4 m (near Magill Street); and
- A future expansion area (Stage 2), located immediately north of the ASB and extending up to High Street. No details of this future development are known at this stage.

The investigation included a desktop study of previous rock-cored boreholes in proximity to the site and regional mapping, together with the drilling of 16 boreholes across the site (where access was readily available to drilling rigs), installation of 11 groundwater monitoring wells to monitor the groundwater levels, permeability tests in soil and rock, and laboratory tests for geotechnical purposes.

Details of the field work methods and results are provided in this report, together with comments on geotechnical issues for planning and design of the ASB site, and the diversion of the sewer/stormwater services.

The first part of this geotechnical investigation was conducted in conjunction with a preliminary site (contamination) investigation, for which the results were reported separately in DP's Report on Preliminary Geotechnical Investigation (DP Project 72505.11.R.001.Rev2, dated 8 February 2018), and Report on Preliminary Site (Contamination) Investigation (DP Project 72505.12.R.001.Rev1, dated 30 November 2017), respectively. DP also completed a factual, Report on Survey of Buried Services (DP Project 72505.11.R.002.Rev0, dated 17 November 2017), which included locating, exposing and surveying a number of buried services around the ASB site.

2. Previous Investigations

DP has previously carried out a number of geotechnical investigations within the adjacent Randwick Hospital's Campus (the Hospital Precinct) and the University of New South Wales (UNSW), Kensington Campus. The approximate locations of the previous boreholes are shown on Drawing 1 in Appendix B. The results of previous boreholes including photographs of rock core samples are provided in Appendix C, and are also included in interpreted geotechnical cross sections in Appendix B.

It should be noted that the same borehole numbers have been used in the various investigations over the years. Therefore, to distinguish the borehole numbers, the project number for previous investigations is shown next to the corresponding previous borehole number on all drawings.

The results of the nearby boreholes of relevance to the proposed redevelopment are summarised below.

2.1 Hospital Precinct

On the eastern side of the proposed redevelopment, one rock-cored borehole (BH85461.00/1) was drilled to about 8 m depth at the intersection of High Street and Hospital Road (Ref: DP Project 85461.00, dated 8 August 2016).

The subsurface conditions encountered in the previous borehole BH85461.00/1 included gravelly clayey sand filling with some sandstone cobbles to 1.1 m depth, overlying extremely low and very low strength sandstone, grading to medium strength sandstone below 3.4 m (RL 52.9 m) and continuing to 8 m (RL 48.3 m). The rock discontinuities were predominantly along bedding planes dipping up to 10° below the horizontal and are clean or clay coated, with an occasional 45° or 90° joint. No free groundwater was observed whilst augering to 1.6 m depth.

Results of laboratory testing on a sample of gravelly clayey sand filling from BH85461.00/1 at depths of 0.4 - 0.5 m indicated that the filling was of low plasticity, with a plasticity index of 10% and a field moisture content of 15.7%, which was within 2% of the plastic limit of 17%.

2.2 Within University Of New South Wales

On the western side of the proposed redevelopment, DP has previously completed two geotechnical investigations within UNSW for the Wallace Wurth Building (Ref: DP Project 71543.00, dated 19 March 2010) and the Bioscience Building (Ref: DP Project 73492.00, dated 28 June 2013). The results of these investigations are summarised below.

2.2.1 Wallace Wurth Building

At the Wallace Wurth Building, four boreholes (BH71543.00/2, BH71543.00/3, BH71543.00/5 and BH71543.00/7) were drilled to depths of about 8.4 m to 18.3 m within the campus along the Botany Street frontage.

The subsurface conditions encountered in the previous boreholes can be summarised as predominantly sandy filling with occasional building rubble to depths of 0.7 – 3 m, overlying medium dense sand then extremely low/very low strength sandstone (or an igneous dyke in BH3) at depths of 3.2 – 5.3 m (about RL 50.5 – RL 53 m). Medium and high strength sandstone was intersected below about RL 50 – RL 51 m and continued to the base of the boreholes, except at BH71543.00/2 and BH71543.00/3, where an igneous intrusion was intersected.

The igneous dyke in BH71543.00/2 and BH71543.00/3 included highly variable strength material, ranging from extremely low/very low strength, extremely weathered rock to very high strength, fresh stained rock. The igneous dyke and the surrounding sandstone rock was typically highly fractured and fractured. The dyke is expected to strike east: south-east, and therefore, may extend across Botany Street into the north-western corner of the proposed future redevelopment site. The inferred strike of the two dykes is shown on Drawing 1 in Appendix B.

In March 2010, groundwater was measured within a monitoring well within BH71543.00/3 at a depth of 4.9 m (RL 51.3 m), which was within the bedrock profile.

It is understood from historical aerial photographs, that immediately west of the Wallace Wurth Building, clay-like material from the more widespread igneous intrusions was quarried and later backfilled. Subsequently, that area was redeveloped to house the current Lowy Cancer Research Facility. DP was involved with pressure grouting of the fractured sandstone for that project to reduce groundwater ingress to the basement.

2.3 Bioscience Building

At the Bioscience Building, two boreholes (BH73492/5 and BH73492/6) were drilled in June 2013 to depths of 8.0 m and 9.6 m within the campus close to the Botany Street frontage.

The subsurface conditions encountered in the previous boreholes can be summarised as sandy filling to depths of 0.5 – 3.4 m, overlying loose and medium dense sand, then extremely low/very low strength sandstone at depths of 6.2 m (RL 48.9 m) and 4.8 m (RL 48.0 m), respectively. Consistent high strength, slightly fractured and unbroken sandstone was intersected below 6.5 m (RL 48.6 m) and 4.9 m (RL 47.9 m), and continued to the base of the boreholes.

In June 2013, groundwater was measured in BH73492/6 during drilling at a depth of 4.0 m (RL 48.8 m), which was 0.8 m above the bedrock surface, within the sand profile.

3. Site Description

The proposed redevelopment site (i.e. The ASB and future expansion area) is a rectangular area of approximately 125 m by 260 m or about 3.3 hectares and is bordered by High Street, Magill Street, Hospital Road and Botany Street to the north, south, east and west, respectively. The site is currently occupied by 92 residential lots, large trees and Eurimbla Avenue. The proposed ASB is located on the southern half of the larger site and is approximately 125 m by 150 m in area. Within the surrounding footpaths and road pavements, numerous utilities are below ground, with a main stormwater pipeline extending into existing residential lots. The site location is shown in Figure 1 below.

The ground surface to the west of Eurimbla Avenue generally slopes down towards the south and south-east, with the ground surface to the east of Eurimbla Avenue sloping down towards the south and west. Reduced levels range between RL 55.5 m at the north-western corner (i.e. Botany/High Street intersection) and RL 46.5 m at the south-eastern corner (i.e. Hospital Road/Magill Street intersection) relative to Australian Height Datum (AHD). The general site topography with 2 m contour lines is shown in Figure 1 below.

The Hospital Precinct is located to the east of Hospital Road and accommodates a number of health facilities including the Prince of Wales Hospital, Sydney Children's Hospital, Royal Hospital for Women, Mental Health facilities as well as Research and Education facilities. The buildings along Hospital Road are generally less than 10-storeys high. A multi-level car park with the lowest basement car park level at about RL 44.2 m is located off Hospital Road, near the intersection of Francis Martin Drive.

The UNSW Kensington Campus is located to the west of Botany Street and includes multi-storey buildings along Botany Street. The Wallace Wurth and Bioscience Buildings are understood to have lower ground floor levels at about RL 53.5 and 53.0 m, respectively.

Residential properties are located further north and south of High and Magill Streets, respectively.

Figure 1: Site Location and Topography with 2 m Contours

4. Regional Geology

Reference to the Sydney 1:100 000 Series Geological Sheet indicates that the site is underlain by fine to medium grained sand (shown in yellow in Figure 2). Hawkesbury Sandstone comprising medium to coarse grained quartz sandstone with minor shale and laminite bands (shown in blue in Figure 2) is present in areas to the north-east, south-east and south-west of the site. The current investigation confirmed the presence of sand and Hawkesbury Sandstone with minor laminite bands.

Figure 2: Regional Geology (Source: Sydney 1:100 000 Series Geological Sheet)

The site is located well beyond the Western Sydney area, and therefore, there is no potential for saline soils to exist.

The Acid Sulphate Soils Map (Sheet ASS_007) sourced from the Randwick Local Environment Plan 2012 indicates that the site is located in an area which is not known to have acid sulphate soils.

5. Field Work Methods

The preliminary and supplementary field investigations included:

- A Site Walkover:
  - An experienced geotechnical engineer inspected the site to map the locations of rock outcrops and other site features.
- Scanning for Services:
  - Review of Dial-Before-You-Dig (DBYD) service plans, together with a services and survey plan provided by the client to assist with identifying the location of underground and overhead services; and

- Scanning for services using a ground penetrating radar and an electromagnetic scanner to set out all boreholes a safe distance away from underground services.

- Pot-Holing:
  - All boreholes were firstly pot-holed using non-destructive drilling (NDD) methods (i.e. vacuum and water) or with a hand auger to confirm that the proposed borehole locations were unaffected by buried services.

- Drilling of Boreholes:
  - 16 boreholes (BH11 to 14, 16 and 17) were drilled to depths of between 3.8 m and 20.5 m, and were located within the existing road pavements, except for BH7, 14, 16 and 17, which were located within residential properties (refer to Drawing 1 in Appendix B for borehole locations).

    Borehole 15, which was proposed adjacent BH14 within a residential property, was cancelled due to the presence of buried services and restricted access for a drill rig;
  - The boreholes were drilled through the filling and soil to the top of weathered rock with drilling rigs using solid flight auger and rotary/washbore drilling (i.e. with circulating drilling fluid) techniques;
  - Standard penetration tests (SPTs) were undertaken below the depths of NDD or hand augering at approximate 1.5 m depth intervals to assess the compaction of filling, the strength of the soils/weathered rock and to collect samples for tactile assessment and laboratory testing;
  - Observation of any groundwater whilst augering the boreholes;
  - 13 out of 16 boreholes were continued into the bedrock using diamond core drilling techniques to recover 50 mm diameter (NMLC-size) rock core samples for logging and strength testing;
  - Point load (axial) strength testing at approximately 1 m depth intervals on the rock core; and
  - Logging of the boreholes and co-ordination of the field work by a geotechnical engineer.

- Groundwater Monitoring Wells:
  - 11 groundwater monitoring wells were installed within boreholes BH4, 7, 8, 9, 10, 11, 12, 13, 14, 16 and 17. Seven of the 11 wells (BH8, 9, 11, 12, 13, 14 and 16) were installed to depths directly below the soil/rock interface to allow groundwater monitoring and permeability testing within the sand profile. The other four wells were installed with the slotted screen sections confined within the bedrock to allow groundwater monitoring and permeability testing within the underlying bedrock.

    Three wells were installed within previously drilled boreholes BH4, 8 and 9 in Eurimbla Avenue. These boreholes were re-drilled to the appropriate depths to allow the installation of wells.

    Wells included 50 mm diameter, machine-slotted polyvinyl chloride (PVC) pipes over the subsurface section of interest, with non-slotted PVC pipes above, and end caps at the top and bottom. The annulus was backfilled with gravel over the slotted section, with bentonite plugs constructed above and/or below the slotted section to confine the well to the appropriate subsurface material. A lockable steel cover plate was set in concrete at the ground surface to minimise vandalism and disturbance of monitoring equipment. The specific details of the well construction are provided in the remarks section on the

corresponding borehole log and are also shown schematically in well logs in Appendix H; and

- The stormwater runoff seepage level was measured within the well at BH7 well within the previous investigation period in October 2017 following purging of drilling fluid and any influent groundwater.

  Data loggers were recently installed within the 10 wells to measure the groundwater level throughout the supplementary investigation period.

- Permeability Testing:
  - Falling-head permeability tests were undertaken within 10 wells using water data-loggers. The permeability tests within BH8, 9, 11, 12, 13, 14 and 16 targeted the soil permeability and tests within BH4, 10, and 17 targeted the rock permeability.
- Reinstatement:
  - All boreholes located within the existing road pavements were reinstated with stabilised sand, roadbase gravel and cold-mix asphalt at the ground surface (except at well locations); and
  - All excess spoil was removed and disposed of off-site.
- Surveying:
  - The ground surface level at the borehole locations were measured using a high-precision global positioning system, with horizontal positioning of boreholes referenced to the Map Grid of Australia 1994 (MGA94), Zone 56 datum, with vertical positioning relative to AHD, The accuracy of the vertical and horizontal measurements with the high-precision global positioning system is less than 0.1 m.
- Photographing:
  - Colour photographs were taken of the rock core samples collected from the boreholes as well as the rock outcrops and site features located in proximity to the redevelopment area.

It is noted that six boreholes were previously omitted from the scope of works due to the presence of closely-spaced in-ground and overhead services along roadways, as well as the current light-rail construction works along High Street. Randwick City Council (RCC) requested via email dated 11 September 2017 that no groundwater monitoring wells be installed within road pavements. For the supplementary investigation, RCC insisted via phone conversation that groundwater monitoring wells must not be installed with Botany Street.

The locations of the boreholes are shown on Drawing 1 in Appendix B.

6. Field Work Results

6.1 Site Walkover

Photographs of rock outcrops and site features are provided in Photo plates 1 to 3 in Appendix D. The approximate location and direction of the photographs are shown on Drawing 1 in Appendix B.

Along the east side of Hospital Road, near BH10, an existing multi-level car park has a localised rock fall along steeply inclined rock joints, directly above a 0.3 m to 0.9 m thick layer of weathered siltstone. Medium strength sandstone with significant calcite staining, which is a sign of stormwater runoff seepage, was also evident along part of a rock face at Level B4 of the car park (refer to photographs 1 and 2). It is likely that stormwater runoff seepage along adverse rock defects, combined with the 'weak' siltstone has contributed to the rock fall.

Within the driveway of a delivery dock, a vertical cutting up to about 2 m high exposed medium to high strength sandstone (refer to photographs 3 and 4). It is noted that these rock outcrops are located relatively close to the eastern end of the proposed patient bridge.

The existing asphaltic concrete (AC) pavement surfaces around the site perimeter appear to be in relatively good condition, though some cracking and patches of reinstated AC is present in Botany Street, and some crocodile cracking of the AC is present along the wheel paths near borehole BH2 on Hospital Road (refer to photograph 5). Medium strength sandstone was also exposed about 1 m below the High Street pavement within a cutting for the Light Rail Project (refer to photograph 6).

6.2 Boreholes

Details of the subsurface conditions encountered in boreholes BH1 to BH14, 16 and 17 are provided in the respective borehole logs in Appendix E, together with notes defining classification methods and descriptive terms. Photographs of the rock cores are also presented opposite to the relevant borehole logs in Appendix E.

The subsurface profile encountered in boreholes BH1 to BH14, 16 and 17 is summarised as follows:

- PAVEMENT: A 30 – 90 mm thick asphaltic concrete surfacing overlying roadbase gravel to depths of between 0.2 m and 0.6 m in BH1 to BH6, BH8 to BH13;
- FILLING: Sandy filling and/or ripped sandstone in all boreholes to depths of between 0.2 m and 2.3 m;
- SAND: Loose and medium dense sand in all boreholes to depths of between 1.5 m and 6.9 m. Dense clayey sand (possibly extremely low strength sandstone) was encountered in BH6 below a depth of 5.2 m. A 0.5 m thick band of stiff silty clay/clay was encountered in BH9 below a depth of 5.5 m;
- BEDROCK: In all boreholes, the top of bedrock ranged between depths of 1.5 m (RL 53.1 m) and 6.9 m (RL 40.7 m).

  The upper rock profile included variably extremely low to low strength sandstone, except for BH12, which had sand overlying high strength sandstone. Core loss of 1.2 m below a depth of 3.8 m occurred in BH10, possibly indicating very low strength rock.

  More consistent medium and high strength sandstone was encountered in all boreholes at depths ranging between 3.9 m (RL 44.6 m) and 8.8 m (RL 38.8 m). Some very low and low strength siltstone and laminite bands were interbedded within the sandstone in BH1, BH2, BH5, BH6, BH8, BH9 and BH10; and

  The rock discontinuities are predominantly along bedding planes dipping between 0° and 20° below the horizontal with the occasional rock joint dipping between 30° and 70°.

6.3 Groundwater

6.3.1 Groundwater Monitoring

Groundwater was measured in three boreholes whilst auger drilling. No groundwater was observed during auger drilling in the other 13 boreholes. The use of water for rotary/washbore drilling and rock coring purposes precluded any further observation of groundwater.

The results of the groundwater levels measured with a tape-measure during auger drilling, and following purging of residual water from drilling or falling head tests within groundwater monitoring wells are provided in Table 1. The top of rock depths/levels are also provided for comparison.

Table 1: Summary of Tape-Measured Groundwater Level Measurements (Vs. Top of Rock)

Bore	Groundwater During Drilling	Groundwater in Well (Post-Purging of Residual Water from Drilling and Tests)				Approximate Depth (& RL) to Top of Rock (m (& m AHD))
	Approximate Depth (& RL) (m (& m AHD))	Date	Approximate Depth (& RL) (m (& m AHD))	Date	Approximate Depth (& RL) (m (& m AHD))	
BH1	-	No Well	No Well	No Well	No Well	3.4 (45.1)
BH2	-	No Well	No Well	No Well	No Well	5.0 (50.2)
BH3	-	No Well	No Well	No Well	No Well	1.5 (53.1)
BH4	-	10.5.18	3.6 (48.3)	17.5.18	3.7 (48.2)	3.5 (48.4)
BH5	-	No Well	No Well	No Well	No Well	4.6 (44.8)
BH6	5.0 (42.6)	No Well	No Well	No Well	No Well	6.9 (40.7)
BH7	-	13.10.17	5.1 (49.5)	17.5.18	Not Accessed	3.9 (50.7)
BH8	-	10.5.18	Dry	17.5.18	Not Accessed	2.6 (47.9)
BH9	5.5 (43.7)	10.5.18	**5.1 (44.1)**	17.5.18	**5.2 (44.0)**	6.0 (43.2)
BH10	-	10.5.18	4.7 (47.5)	17.5.18	4.9 (47.3)	3.8 (48.4)
BH11	-	10.5.18	5.0 (47.5)	17.5.18	4.8 (47.7)	4.3 (48.2)
BH12	-	10.5.18	6.3 (49.4)	17.5.18	6.1 (49.6)	6.1 (49.6)
BH13	-	10.5.18	Dry	17.5.18	3.5 (48.5)	3.2 (48.8)
BH14	4.5 (43.0)	10.5.18	**4.5 (43.0)**	17.5.18	**4.7 (42.8)**	6.6 (40.9)
BH16	-	10.5.18	4.2 (51.0)	17.5.18	4.1 (51.1)	4.1 (51.1)
BH17	-	10.5.18	5.1 (50.1)	17.5.18	5.0 (50.2)	4.4 (50.8)

Notes: **Bold** indicates that the measured groundwater level is above the top of rock

The results of the groundwater levels measured by electronic data-loggers during the monitoring period of 1 May to 17 May 2018 are provided in Appendix I. The results are plotted against rainfall data from a nearby station located at Randwick Street, Randwick (Station No. 66052, operated by the Bureau of Meteorology). Labels are shown at the respective time on the graphs where the data-loggers were manually handled for tests during the monitoring period (i.e. to identify false readings).

The groundwater levels were generally stable over the monitoring period between 1 May 2018 and 17 May 2018. In BH9 and BH14, the water level was about 0.9 m and 2 m above the top of rock, or 3 m and 4 m below the proposed basement Level -02 (RL 47.0), respectively. In the other wells, the water levels were close to or below the top of rock, and above Level -02.

Rainfall data from a closer station at Randwick Racecourse (Station No. 66073) excludes records for May 2018 (i.e. during the groundwater monitoring period). Historical data from this station indicates that April 2018 recorded 45 mm of rainfall, which is relatively low compared to previous months.

Rainfall data measured at both rainfall stations are provided in Appendix I. It is noted that a total of 31 mm of rainfall was measured at the Randwick Street Station (No. 66052) during the monitoring period of 1 May to 17 May 2018. The rainfall does not appear to have a significant effect on the stormwater runoff seepage levels, except at BH10 where the stormwater runoff seepage level increased by about 0.1 m (in the sandstone profile), and at BH11 where seepage levels increased by 0.2 m and 0.6 m (close to the top of rock level) during rainfall. Boreholes BH10 and 11 are located a few metres away from each other within the steepest section of Hospital Road, and the site. Based on the contour mapping in Figure 1, together with the steeply dipping rock contours, the area near BH10 and 11 may act as a drainage path, where greater volumes of stormwater runoff seepage is experienced compared to other areas at the site.

6.3.2 Falling-Head Tests

The permeability tests within BH8, 9, 11, 12, 13, 14 and 16 targeted the soil permeability and tests within BH4, 10, and 17 targeted the rock permeability. The detailed results of the in situ falling head tests are provided in Appendix J and are summarised in Table 2.

Table 2: Results of Falling Head Tests

Well Location	Hydraulic Conductivity (m/sec)			
	Sand		Sandstone	
	Test 1	Test 2	Test 1	Test 2
BH4	-	-	1.7×10^{-7}	1.7×10^{-7}
BH8	8.9×10^{-7}	Inaccessible	-	-
BH9	6.5×10^{-6}	8.9×10^{-6}	-	-
BH10	-	-	5.7×10^{-8}	6.0×10^{-8}
BH11	1.7×10^{-7}	2.1×10^{-7}	-	-
BH12	3.0×10^{-7}	3.2×10^{-7}	-	-
BH13	8.7×10^{-6}	1.1×10^{-5}	-	-
BH14	3.1×10^{-5}	4.9×10^{-5}	-	-
BH16	2.1×10^{-7}	4.1×10^{-7}	-	-

Well Location	Hydraulic Conductivity (m/sec)			
	Sand		Sandstone	
	Test 1	Test 2	Test 1	Test 2
BH17	-	-	1.1×10^{-6}	1.2×10^{-6}

7. Laboratory Testing

7.1 Physical Soil Properties

The detailed laboratory test results of the physical properties are included in Appendix F.

Six soil samples were tested in DP's National Association of Testing Authorities (NATA) accredited laboratory to assess a range of physical properties including the field moisture content, soil plasticity, California Bearing Ratio (CBR), maximum dry density and optimum moisture content at Standard compaction. The laboratory test results are summarised in Table 3 below.

Table 3: Laboratory Results of Physical Soil Properties

Borehole	Depth (m)	Material	W_F (%)	W_P (%)	W_L (%)	PI (%)	CBR (%)	MDD (t/m^3)	OMC (%)
BH1	1.0 – 1.1	Sand	3.6	NO	NO	NP	-	-	-
BH2	0.3 – 0.4	Sand Filling	7.3	NO	NO	NP	-	-	-
BH3	0.4 – 0.5	Sand Filling	4.5	NO	NO	NP	-	-	-
BH4	2.5 – 2.95	Sand	4.9	NO	NO	NP	-	-	-
BH4	0.75 – 1.3	Sand Filling with some Sandstone Gravel	4.9	-	-	-	25	1.68	12.5
BH5	2.95 – 4.0	Sand	-	-	-	-	9	1.66	16.0

Notes: W_F = Field Moisture Content; W_P = Plastic Limit; W_L = Liquid Limit; PI = Plasticity Index; CBR = California Bearing Ratio; MDD = Maximum Dry Density; NO = Not Observed; NP = Non-Plastic

Five particle size distribution (PSD) tests were also carried out in DP's laboratory on natural soil samples to assess the soil grading and to estimate the soil permeability using empirical methods. The results of the PSD tests indicate that the natural soil is fine to medium grained sand, with either 0%, with trace of (0 – 5%), or with some (5 – 12%) silt or clay content. An estimate of the sand permeability using empirical methods is described in Section 9.3.1 of this report.

7.2 Chemical Soil Properties

Ten soil samples were tested at an external NATA-accredited laboratory to assess the soil aggressivity (pH, chloride, sulphate content and electrical conductivity) to buried concrete and steel elements. The detailed laboratory test results of chemical properties are included in Appendix G and are summarised in Table 4 below.

Table 4: Summary of Laboratory Chemical Soil Analysis

Borehole	Depth (m)	Material	pH	Chloride (mg/kg)	Sulphate (mg/kg)	Electrical Conductivity (µS/cm)
BH1	0.5 – 0.6	Sand Filling	8.2	<10	<10	59
BH2	4.0 – 4.45	Sand	8.5	<10	10	20
BH3	1.3 – 1.4	Sand	8.0	<10	28	41
BH4	2.5 – 2.95	Sand	7.7	<10	22	20
BH8	2.5 – 2.66	Sand/Weathered Sandstone	11.6	<10	66	730
BH9	5.5 – 5.95	Clay	5.2	10	29	34
BH12	6.0 – 6.1	Sand	6.9	<10	<10	22
BH13	3.0 – 3.2	Sand	5.4	<10	<10	12
BH14	3.5 – 3.95	Sand	6.3	<10	<10	10
BH14	6.3 – 6.5	Silty Sand	5.4	<10	34	38

The results of the chemical soil analysis are discussed further in Section 9.8 of this report.

7.3 Rock Strength Testing

Selected samples of the rock core were tested to determine the Point Load Strength Index (Is_{50}) values for classification of the rock strength. The test results are shown on the borehole logs at the appropriate depths. The $Is_{(50)}$ values for the tested rock cores ranged from less than 0.1 MPa to 3.6 MPa, corresponding to a rock classification from very low to very high strength. The unconfined compressive strength (UCS) of the rock is inferred to range between about 1 MPa and 72 MPa using a typical correlation ratio of 20:1 for UCS:$Is_{(50)}$ in Hawkesbury Sandstone.

8. Proposed Development

It is understood that the proposed Randwick Campus Redevelopment will include:

- Demolition of existing buildings to allow for the construction of a new multi-storey Acute Services Building (ASB), about 125 m by 150 m in area, with basement Level -02 extending to RL 47 m. This will require excavation to depths of up to 8 m, with the deepest part of the excavation being at the northern end. Localised, deeper excavations to approximate depths of 1 – 3 m below basement Level -02 are required for core stairs and lift pits. Working column loads are understood to be up to 15,000 kN. The current basement design includes a drained basement with a contiguous pile shoring wall;
- A patient bridge and a public bridge over Hospital Road linking the new ASB to the existing Hospital Campus;

- Diversion of sewer and stormwater services within a 6.8 m wide easement along High, Botany and Magill Streets.

  The sewer will extend below the stormwater system, with sewer invert levels ranging from RL 44.7 m at Chainage 0 m at Magill Street to RL 49.9 m at Chainage 320 m at High Street. The depths to invert levels range between 2.8 m and 7.3 m below ground surface. It is understood that vertical shafts, approximately 6 m by 3 m in area for launch shafts and 3 m by 3 m for receiving shafts, will be constructed for micro-tunnelling and pipe-jacking for the sewer. The sewer pipe diameter ranges between 300 mm to 450 mm;

  The stormwater system will include two box culverts, 2.4 m by 3.0 m in cross-sectional area extending from Chainage 0 - 213 m (i.e. from Eurimbla Avenue to about Grid 15 of ASB Site Plan on Botany Street). Smaller pipes and box culverts of various sizes will extend north and south of Grid 15 and into the new ASB. The depths to invert levels range between 3.9 m and 5.3 m at Chainages 0 – 81 m, reducing from 5.3 m to 1.5 m deep at Chainages 81 - 426 m;
- A future expansion area (Stage 2), located immediately north of the ASB and extending up to High Street. No details of this future development are known at this stage. However, it is likely that the future development may include multi-storey buildings, new internal roads and utilities. Relatively deep basement excavations are also expected, similar to the currently proposed ASB.

The approximate locations of the above proposed development features are shown on Drawing 1 in Appendix B.

9. Comments

9.1 Geological Model

A summary of the subsurface conditions encountered across the site are shown in seven geotechnical cross-sections A - A' to G - G' in Drawings 2 to 8 in Appendix B, with the proposed levels for the ASB basement, and the sewer/stormwater diversion invert levels also shown (indicative only). It is noted that the previous boreholes within UNSW are 25 – 30 m to the west of the Botany Street site boundary. Therefore, the previous borehole information within UNSW is indicative only of possible ground conditions in this site area. Further investigation is recommended near Botany Street (and other areas) to confirm the ground conditions within the site boundary once site access is available.

The site is expected to be underlain by sandy filling and ripped sandstone filling of variable thickness, overlying predominantly medium dense (and some loose) sand extending to the top of Hawkesbury Sandstone bedrock. Based on the site topography, published mapping and subsurface conditions encountered to date, acid sulphate soils and saline soils are unlikely to be geotechnical issues at this site.

The bedrock surface is expected to dip down towards the south and west. The rock is initially extremely low to low strength (except at BH12) and generally becomes more consistent medium and high strength sandstone with depth. Some extremely low to low strength siltstone and laminite bands were interbedded within the stronger sandstone within the central and eastern areas of the ASB. The design of heavily-loaded foundation piles should consider these 'weaker' bands of rock.

The Hawkesbury Sandstone is generally cut by two main sets of steeply dipping joints trending north:north-east and east:south-east. These main sets of rock joints are likely to be near-parallel to excavation faces for the proposed ASB basement.

An igneous dyke including highly variable strength rock, with a fractured host-rock around the dyke may extend east: south-east from UNSW into the proposed future redevelopment site near the intersection of Botany and High Streets. Drawing 1 in Appendix B shows the inferred alignment of the dyke. The dyke was not intersected by the closest rock-cored borehole BH17. The dyke may still be present in this area and further investigation using inclined boreholes would be more useful in intersecting the dyke.

A summary of the geotechnical model for boreholes BH1 to BH14, BH16 and BH17 are provided in Table 5.

Table 5: Summary of Geotechnical Model

Borehole	Ground Surface RL (m AHD)	Approximate Depth (& RL)[1] to Top of Various Material (m (& m AHD))		
		Natural Sand	EL to L [2]	M & H [2]
BH1	48.5	0.8 (47.7)	3.4 (45.1)	3.9 (44.6)
BH2 *	55.2	0.6 (54.6)	5.0 (50.2)	5.1 (50.1)
BH3	54.6	1.0 (53.6)	1.5 (53.1)	5.3 (49.3)
BH4	51.9	0.8 (51.1)	3.5 (48.4)	4.2 (47.7)
BH5 *	49.4	0.4 (49.0)	4.6 (44.8)	5.9 (43.5)
BH6	47.6	2.3 (45.3)	6.9 (40.7)	8.8 (38.8)
BH7	54.6	0.2 (54.4)	3.9 (50.7)	5.1 (49.5)
BH8 *	50.5	0.6 (49.5)	2.6 (47.9)	3.2 (47.3)
BH9 *	49.2	0.4 (48.8)	6.0 (43.2)	7.8 (41.4)
BH10 *	52.2	0.9 (51.3)	3.8 (48.4)	7.9 (44.3)
BH11	52.5	1.1 (51.4)	4.3 (48.2)	Shallow Borehole
BH12	55.7	1.2 (54.5)	-	6.1 (49.6)
BH13	52.0	0.9 (51.1)	3.2 (48.8)	Shallow Borehole
BH14	47.5	1.1 (46.4)	6.6 (40.9)	8.8 (38.7)
BH16	55.2	0.6 (54.6)	4.1 (51.1)	Shallow Borehole
BH17	55.2	0.6 (54.6)	4.4 (50.8)	5.1 (50.1)

Notes: 1 Numbers in parentheses are the Reduced Level (to AHD) for the top of the stratum.

2 Some bands of lower and higher strength rock may be present.

EL to L = Extremely Low to Low Strength Rock

M & H = Medium and High Strength Rock

* Extremely low to low strength laminite/siltstone bands intersected within 'higher' strength rock

Based on measurements of groundwater within previous and current boreholes and monitoring wells, stormwater runoff seepage is expected at the soil and rock interface and within bedrock along rock joints and extremely/highly weathered bedrock bands. The stormwater seepage levels generally dip down towards the south with the site topography, and lie above the proposed ASB Level -02 (RL 47.0 m), and the sewer/stormwater diversions at the northern end of the ASB site and beyond to the north. It is noted that rainfall events are considered to be the major source of groundwater seepage, with 'sinks' formed by gardens or nature strips located further upslope of the site.

At the southern (i.e. lower-lying) end of the site, a water table within the sand stores the stormwater runoff seepage, which flows downslope after rainfall events. The water table is expected at about RL 42.6 – 43.0 m within sand below the proposed ASB Level -02 (RL 47.0 m) and sewer diversion invert levels (RL 44.7 m).

The levels of stormwater runoff seepage at the soil/rock interface and of the lower-lying water table should be expected to fluctuate with variations in climate. For design, based on groundwater monitoring data to date and DP's experience in the area, the level of stormwater runoff seepage over top of bedrock and the lower-lying water table within the sand may periodically rise by about 0.1 - 0.2 m and 1 m, respectively, following extended periods of rainfall.

The stormwater runoff seepage is expected to flow downslope over the bedrock surface towards the south and west. Based on the contour lines shown in Figure 1 of this report, a natural drainage channel may extend north-south near the alignment of Eurimbla Avenue. Larger volumes of stormwater runoff seepage may also occur on the steep section of Hospital Road near BH10/11.

Given the very dry weather experienced before and throughout the investigation period, on-going groundwater monitoring to further assess the potential fluctuation of stormwater runoff seepage and the lower-lying water table is recommended until construction begins.

9.2 Dilapidation Surveys

It is recommended that dilapidation (building condition) reports be prepared for adjacent structures and infrastructure located within about 15 m from the site boundaries, prior to commencing demolition and excavation work on the site. Dilapidation reports are undertaken to document any existing defects, so that any potential claims for damage from third parties due to construction related activities can be accurately assessed.

9.3 Excavation Conditions

The bedrock surface is expected to dip down towards the south and west. Excavations for the ASB basement are likely to intersect pavements, filling, natural soil and bedrock of variable strength.

Excavations for the proposed sewer shafts/pits are likely to intersect filling, natural soil and bedrock of variable strength, except at the southern end of Botany Street and along Magill Street, where pits are expected to be entirely in sandy filling and sand.

Excavation of soil and extremely low to very low strength bedrock should be readily achieved using conventional earthmoving equipment, such as tracked excavators with bucket attachments.

Removal of low strength or stronger bedrock will require relatively large excavators fitted with hydraulic rock hammers and rotary rock saws. Excavation of existing pavements is also likely to require similar plant and equipment. For productive excavation of low strength or stronger rock within large areas, ripping of rock with large dozers should be considered.

9.3.1 Groundwater and Dewatering

Based on the groundwater data available at this stage, stormwater runoff seepage is expected at the soil and rock interface, and within bedrock along rock joints and extremely/highly weathered bedrock bands, all of which lie above the proposed ASB basement and services diversions for most of the site. At the southern (i.e. lower-lying) end of the site, a water table is expected within sand below the proposed basement excavation depths.

Therefore, a secant pile shoring wall embedded into bedrock is recommended to cut-off the flow of stormwater runoff seepage into the basement. Alternatively, a contiguous pile wall, with the gaps between the piles plugged with dry-pack grout upon excavation to retain soil, together with a drainage plenum around the site perimeter for collection and subsequent discharge of groundwater is considered to be a feasible retaining system, as proposed by Enstruct. Further discussion of secant and contiguous pile shoring walls is provided in Section 9.5.2. Although the current basement design includes contiguous pile shoring walls, comments on secant pile shoring walls are still provided as an alternative shoring solution.

A tanked basement comprising water-tight walls and floors would eliminate the requirement for permanent dewatering and approval from regulatory authorities. Alternatively, a drained basement is also suitable.

For the drained ASB basement and the sewer/stormwater diversions, any immediate lowering of stormwater runoff seepage, through weep holes/spitter pipes in the ASB basement walls or between the shoring systems in the service diversions, is expected to be within local historical fluctuations. The proposed development levels are also above the water table located at the southern end of the site, and consequently, there is no requirement to lower the water table. Therefore, the affects of drawdown (i.e. additional soil stresses causing vertical settlement of the ground surface and nearby structures) is not expected to be an issue with dewatering for a drained basement or drained service trenches/pits.

Dewatering during excavation for the ASB basement and stormwater/sewer diversions should be managed through sump and pump techniques.

9.3.1.1 Stormwater Ingress

Based on the results of five particle size distribution tests on natural sand and using Hazen's equation to predict the soil permeability or hydraulic conductivity (k), the sand has an average 'k' value of 2.6×10^{-4} m/s.

Based on the results of the of 13 falling-head tests in natural sand, the sand has an average 'k' value of 9.1×10^{-6} m/s.

These 'k' values represent a soil of relatively high permeability, and within the typical range of permeability for fine to medium grained sand with varying inclusions of silt and clay. It is noted that the

hydraulic conductivity of sandy soil is highly dependent upon the grain size, the soil density, the amount of silt and clay content (i.e. fine particles less than 0.075 mm diameter) and the degree of saturation over the full depth of the sand profile.

The permeability of bedrock depends on the primary permeability of the rock, which considers the rock mass, and the secondary permeability of the rock, which is governed by the frequency and aperture (i.e. tightness, open or tight) of the rock joints or discontinuities. Based on the results of six in situ falling head tests within bedrock, the bedrock has an average 'k' value of 4.6 x 10^{-7} m/sec. If open joints or igneous dykes with a fractured host-rock are intersected then the secondary permeability of the rock would be expected to be greater than the estimate provided. The permeability of the bedrock can be most accurately measured during the bulk excavation stage of construction.

Based on the current information on groundwater monitoring, rainfall data, rock contours, and permeability testing at this site, stormwater inflow to the:

- ASB basement excavation is estimated to be in the order of order of 3,000 – 30,000 L/day or 1.1 – 11 ML/year;
- ASB Courtyard is not expected to occur, given the courtyard is located at the same level as the ASB basement. Stormwater runoff seepage is expected to be collected further upslope of the courtyard within the basement drainage system, drainage blanket and natural sand below the basement slab.

The volume of stormwater ingress will ultimately depend on the soil permeability, rock fracturing, the amount of ground surface infiltration compared to surface run-off, and prevailing weather conditions. Greater volumes of stormwater ingress to the basement may also be experienced if leaking stormwater systems are present in the surrounding sandy soils or heavy continuous rainfall is experienced. Consideration should be given to whether a dewatering licence from a regulatory authority is required for this site.

A drainage blanket including a free-draining, single-sized (typically 20 mm), durable crushed rock should be constructed below the Level-02 basement slab. The thickness of the drainage blanket (typically 100 – 150 mm thick) will ultimately depend on the granular material adopted, and should be designed by the civil or hydraulic engineers. By way of example, a 100 mm thick drainage blanket is appropriate for the estimated rate of groundwater ingress to the basement. This assumes use of a free-draining granular material with a permeability of 1 x 10^{-2} m/s.

9.3.1.2 Disposal of Groundwater

The potential to dewater and dispose stormwater runoff seepage off-site into Randwick City Council's (Council) stormwater system will depend on the contamination status of the groundwater and other groundwater properties. Contamination testing on stormwater runoff seepage has not been completed by DP to date, and this should be completed with further soil/groundwater contamination assessments. In the absence of Council criteria for disposal of groundwater to the local stormwater system, DP proposes the following stormwater quality assessment criteria from Australian and New Zealand guidelines for fresh and marine water quality, Australian and New Zealand Conservation Council & Agriculture, and Resource Management Council of Australia and New Zealand (ANZECC/ARMCANZ (2000):

- Conductivity (µs/cm) 125-2200;

- pH 6.5-8.5;
- Dissolved Oxygen (% saturation) 85-110;
- Turbidity (NTU) 11.6-50; and
- Suspended solids (mg/L) <40.

Reference should be made to the contamination assessment reports by DP for further advice and recommendations in relation to the contamination status of soil and groundwater and remedial works.

9.3.2 Disposal of Excavated Materials

All excavated materials will need to be disposed of in accordance with the provisions of the current legislation and guidelines including "Waste Classification Guidelines" - 2014, New South Wales Environment Protection Authority (NSW EPA). This includes filling and natural materials that may be removed from the site.

Reference should be made to DP's Report on Preliminary Site (Contamination) Investigation (DP Project 72505.12, dated 8 February 2018) for preliminary guidance on the off-site disposal of excavated materials.

9.3.3 Ground Vibrations

Vibrations may be induced by a large number of site activities, including demolition of existing structures, excavation, driving sheet piles, piling and compaction works. Hence, particular care to avoid damaging adjacent buildings or structures will be required.

The level of acceptable vibration is site-specific and is dependent on various factors including the type of building structure (e.g. reinforced concrete, brick, etc.), its structural condition, the frequency range of vibrations produced by the construction equipment, the natural frequency of the building and the vibration transmitting medium.

The Australian Standard AS 2187.2 - 1993 "Explosives Code" recommends a maximum peak particle velocity (PPV) of 10 mm/sec to avoid structural damage to houses and low-rise residential or commercial buildings. Ground vibration arising from excavation plant is of a continuous nature, as opposed to transient nature such as with blasting events. More stringent vibration limits should generally apply for excavation plant than for blasting. It is suggested that vector sum peak particle velocity (VSPPV) be initially limited to 8 mm/sec at the foundation level of adjacent buildings for this site. The presence of medical equipment within existing facilities may warrant more stringent vibration limits for their operation. Utility owners may also request a vibration limit to protect their buried asset.

It should also be noted that human perception of vibrations is much greater than that of buildings and consequently vibration levels considered insignificant for buildings may disturb humans.

Where vibrations are a concern for the operation of plant at the site, consideration should be given to vibration trials at the commencement of work, which may indicate minimum set-backs from existing buildings or sensitive areas for specific plant, and possibly the requirement for continuous vibration monitoring.

9.4 Working Platforms

Working platforms may be required where heavy loads such as from large piling rigs or outrigger cranes are anticipated during construction, particularly in areas where poorly compacted filling and loose sand is present. Such platforms typically require the use of additional layers of durable, high strength crushed rock or similar.

It is noted that failures of working platforms occur most frequently in the vicinity of poorly backfilled trenches and excavations. As these weaker ground conditions are localised, they may not be identified by borehole testing. It is therefore recommended that working platforms be proof-rolled using a 10 tonne roller (or similar) in the presence of a geotechnical engineer to detect any soft spots for remediation. Existing excavations within working platforms should be suitably backfilled to reduce the potential for working platform failures.

9.5 Excavation Support

9.5.1 Sewer and Stormwater Diversions

9.5.1.1 General

The excavations for the sewer and stormwater diversions have similar geotechnical issues to the ASB basement to consider for construction. All material above medium strength rock will require some form of temporary support by a combination of batters, sheet pile walls, shoring boxes and/or contiguous pile walls. The choice of excavation support along the services alignment will change to satisfy the proposed depth of excavation, the size of the trench/shaft and the subsurface conditions in that area.

Where space permits, temporary batters may be constructed behind the top of the shoring system to reduce the depth of shoring. The contractor must be diligent to install the shoring as close as possible and embed them into weathered bedrock to reduce the potential for sand loss.

Installation of struts/walers and/or ground anchors are likely to be required to provide additional lateral support, and will depend upon the shoring system adopted. The position of lateral support within the shoring will require careful design and planning to allow plant and materials to be lowered into the excavations.

Further comments on batter slopes and retaining wall design are provided in Sections 9.5.3, 9.5.4 and 9.5.5 of this report.

Saw cutting followed by rock hammering of medium strength or stronger rock would be required to achieve the proposed invert levels in the northern sections. Where required, geotechnical inspection of the excavation face at every 1.5 m vertical drop is required to assess if any adverse rock joints are present and whether any further stabilisation (i.e. rock bolts) is required.

Where movement sensitive structures are located in close proximity to the excavation (i.e. above a 2:1 H:V zone of influence extending up from the top of rock or the base of the excavation, whichever is shallower), ground vibration trials should be undertaken at commencement of installing sheet piles

(Refer to Section 9.3.3 of this report), together with survey monitoring throughout the excavation (Refer to Section 9.6).

For detailed design of shoring systems, slope stability assessments using a software package called SlopeW is recommended to assess the global stability of the excavation, with any surcharge loading from plant and materials at the ground surface also considered.

Unless shoring systems are designed to withstand lateral loads other than those applied by the retained soils, the excavated soil should be stockpiled beyond a 2:1 H:V zone of influence extending up from the top of rock or the base of the excavation, whichever is shallower.

9.5.1.2 Sewer Diversion

At the launch and receiving shafts for the sewer, steel sheet piles driven to refusal in weathered bedrock may be adopted. A steel shoring box will also be required to support any underlying extremely low to low strength rock (expected to be 1 – 2 m thick in some sections), as this material cannot be relied upon to remain unsupported.

Alternatively, a contiguous pile wall embedded into at least medium strength bedrock below the proposed invert levels may be adopted for excavation support of the shafts to reduce the risk of sand loss and disturbance of the surrounding ground. Struts and walers are likely to be required to provide additional lateral support. The pile wall toe may be terminated in at least medium strength bedrock at a level above the proposed invert levels, however an anchored waler near the pile toe would be required to restrain the pile toe. The gaps between the piles should be plugged with dry-pack grout during excavation to retain soil. It is recommended that weep holes/spitter pipes be installed at regular vertical and horizontal spacing through the plugged gaps in the contiguous pile wall to prevent the build-up of hydrostatic pressure behind the wall, unless the shoring wall is designed to resist full hydrostatic pressure. The advantage of this shoring system is that it may be incorporated to provide permanent support and allow future access for maintenance to the sewer.

The proposed micro-tunnelling for the sewer along High Street and the central and northern end of Botany Street (i.e. north of about Chainage 80 m), is expected to intersect predominantly medium and high strength, slightly fractured sandstone. An igneous dyke including highly variable, extremely low to medium strength rock may also be intersected near the intersections of Botany and High Streets (i.e. between Chainage 250 m and 280 m), though a dyke has not been confirmed by boreholes to date.

At the southern end of Botany Street and along Magill Street (i.e. south of about Chainage 80 m), the proposed sewer is expected to be entirely within loose to medium dense sand. Driven sheet piles or steel shoring boxes may be considered to support excavations within sand above the water table, with temporary batters constructed behind the shoring to reduce the height of shoring.

9.5.1.3 Stormwater Diversion

For the proposed stormwater diversion, construction of an open trench is required for the installation of two box culverts. The use of steel sheet piles driven to refusal in weathered bedrock or installation of steel shoring boxes, with temporary batters constructed above/behind the shoring to reduce the height of shoring are recommended to support excavations. Struts and walers or installation of ground anchors are likely to be required to provide additional lateral support to sheet pile walls.

The initial 1 – 2 m thick, extremely low to low strength rock, will also require temporary support. Therefore, lowering of the shoring box or installation of a second shoring box will be required during construction. Where space permits, temporary batters may be sufficient where the proposed depths of excavation are less than 3 m deep.

9.5.2 Batter Slopes

Vertical excavations in filling and natural sand are not expected to be stable for any extended period of time. Therefore, both temporary and permanent shoring support will be required for proposed excavations.

Where there is sufficient space, maximum temporary and permanent batters of 1.5H:1V and 2H:1V, respectively, are suggested for cuts less than 3 m high in filling and natural sand above the water table as well as the zone of stormwater runoff seepage, and where not subjected to surcharge loads. If vegetation and maintenance of permanent batters is proposed, a flatter permanent batter of 3H:1V is suggested. Erosion control should also be provided for permanent batters and this may simply include a layer of geofabric covered by grass.

Excavations in consistent medium and high strength sandstone can be cut vertically and remain unsupported provided there are no adversely oriented joints, faults or other defects in the rock mass.

During construction of the ASB basement, lift cores/stairs and service diversion shafts and/or trenches, exposed excavation faces should be inspected at regular 1.5 m depth intervals by an experienced geotechnical engineer to assess whether there is any further stabilisation requirements, such as reducing the steepness of a batter, installation of ground anchors or shotcrete protection.

9.5.3 Retaining Wall Types

Due to the presence of sand, stormwater runoff seepage at the soil and rock interface and possibly rising stormwater runoff seepage levels above bedrock during extended wet periods, a secant pile shoring wall comprising interlocking Continuous Flight Auger (CFA) piles or CFA piles with jet grouted columns in between piles is recommended as this shoring system can generally provide an effective seal to minimise sand loss and water inflow from behind the wall, and if adequately supported, minimise lateral deflections. The pile wall can be incorporated into the vertical load carrying footing system and can generally form part of the basement structure.

Alternatively, a contiguous pile wall, with the gaps between the piles plugged with dry-pack grout during excavation to retain soil, together with a drainage plenum around the site perimeter for collection and subsequent discharge of groundwater is considered to be a feasible retaining system, as proposed by Enstruct. It is recommended that weep holes/spitter pipes be installed at regular vertical and horizontal spacing through the plugged gaps in the contiguous pile wall to prevent the build-up of hydrostatic pressure behind the wall.

It will be necessary to ensure that gaps between contiguous piles are generally limited to less than 50 mm to minimise the risk of sand loss from behind the wall. Some groundwater ingress between piles should also be expected during construction. Any gaps between the contiguous piles should be progressively plugged as the excavation proceeds (at every 1.5 m depth of excavation) to prevent such sand loss. The gaps in between the piles are typically filled with dry-packed grout, however,

shotcrete or grout injection may be required where the wall is designed to form part of the basement structure.

The shoring piles can be terminated in consistent medium strength (or stronger) rock above the bulk excavation level, and this would most likely require lateral restraint of the pile toe using steel beams and ground anchors.

Given the presence of sands overlying bedrock, together with the proximity of adjacent structures and utilities, particular care will be required by the piling contractor to avoid "decompression" of the upper sands. Decompression involves the drilling auger drawing in the surrounding soils, usually due to a sudden decrease in the rate of penetration. Decompression can lead to settlement of the ground surface and damage to existing structures founded within sand. For this and other reasons, only experienced piling contractors with suitable high-powered drilling rigs should be considered for this project.

For temporary support of localised excavations such as lift pits or service trenches, sheet pile walls or steel trench boxes may be appropriate, provided no vibration or movement sensitive structures are located in close proximity to the excavation.

9.5.4 Retaining Wall Design

As a preliminary guide, recommended bulk density and earth pressure co-efficients for the design of cantilevered walls or walls with one row of ground anchors are provided in Table 6. Active earth pressure coefficients (K_a) may be used where some wall movement is acceptable. “At rest” earth pressure coefficients (K_o) should be used where wall movement is to be minimised such as close to structures, or where the wall is propped or braced prior to excavation. A triangular earth pressure distribution should be adopted for cantilevered walls or walls with one row of anchors.

Table 6: Earth Pressure Coefficients and Bulk Unit Weights

Material	Active Earth Pressure Coefficient (K_a)		At Rest Earth Pressure Coefficient (K_o)	Bulk Unit Weight γ (kN/m^3)
	Short Term / Temporary	Long Term / Permanent		
Filling / Sand	0.3	0.4	0.5	20
Variable Extremely Low to Low Strength Rock	0.1	0.15	0.2	22
Medium Strength (or stronger) Sandstone	0	0	0	24

The above earth pressure coefficients assume a level ground surface behind the top of the wall. Additional allowances should be made for the effects of building or structure loads on the wall, as well as any short-term surcharges such as construction plant or vehicles operating behind the top of the wall.

Where more than one row of temporary anchors is used, it is recommended that shoring design is based on a rectangular earth pressure distribution. Where there are no movement sensitive structures or services in close proximity to the excavation, the maximum pressure (kPa) could be calculated

using 4H (where H equals the depth to the bulk excavation level or to the top of medium strength sandstone, whichever is shallower). Where the wall movement is to be minimised, the maximum pressure could be calculated using 5H.

Passive lateral resistance for piles embedded in rock below the base of the excavation may be based on an ultimate passive lateral pressure provided in Table 7. A factor of safety must be applied to the ultimate values to limit wall movement that is required to mobilise the full passive resistance. Passive resistance should be assumed to start at least 0.5 m below bulk excavation level due to disturbance and fracturing of the rock and toe drains.

Table 7: Ultimate Passive Lateral Co-efficient and Pressures for Embedded Retaining Wall Piles

Material	Ultimate Passive Lateral Co-efficient and Pressures
Sand	$K_p = 3$
Variable Extremely Low to Very Low Strength Rock	400 kPa
Low to Medium Strength (or Stronger) Sandstone	2,000 kPa

If a water-tight retaining wall system is used to provide a tanked basement without drainage measures, the retaining walls should be designed for full hydrostatic pressures.

Detailed design of shoring should preferably be carried out using WALLAP, FLAC or other computer analysis programs capable of modelling the proposed excavation and anchoring sequence and potential movements of the wall.

9.5.5 Ground Anchors

Temporary ground anchors may be required to restrict wall movements during the construction phase, with permanent support of retaining walls anticipated to be provided by the final ASB structure.

As a preliminary guide, ground anchors are typically inclined at about 10° below the horizontal, have a free length equal to or greater than the height of the anchor above the base of the excavation and have a minimum free length of 3 m. A minimum bond length of 3 m should also be used.

For anchors in sands, the bond length design is dependent upon the overburden soil pressure, which depends upon the depth of the anchor below ground and the unit weight of the soil. The design of temporary ground anchors bonded into natural sands below at least 2 m depth may be carried out using an allowable bond stress of 25 kPa at the grout-sand interface. Secondary-grouted anchors could be used in the natural sand to increase the anchor capacity. This technique involves installing a conventionally-grouted anchor and then, once cured, injecting grout into the anchor at a higher pressure to crack the primary grout and densify the surrounding materials. This technique is fairly specialised and only experienced contractors should be engaged for the design and installation of secondary-grouted anchors.

For ground anchors within bedrock, the bond length can be designed on the basis of the maximum allowable bond stresses provided in Table 8.

Table 8: Maximum Allowable Bond Stresses for Ground Anchors

Material	Working Bond Stress
Variable Very Low to Low Strength Rock	150 kPa
Medium Strength Sandstone	500 kPa
High Strength Sandstone	1000 kPa

After installation, anchors should be proof stressed to 125% of their nominal working load and locked-off no higher than 85% of the Working Load. Periodic checks should also be carried out throughout the construction phase to ensure that the lock-off load is maintained and not lost due to creep effects or other causes. Proof stressing should also be carried out at intervals after installation to ensure that the load is maintained in the anchors and not lost due to creep effects.

The parameters given above for ground anchors in sand and in Table 8 for ground anchors in rock assume that anchor holes are clean and adequately flushed, with grouting and other installation procedures carried out carefully and in accordance with normal ground anchoring practice.

Where vertical anchors are required (i.e. for crane tower pads, lift shafts etc.), anchor design should also consider cone pull-out failure mechanism within the surrounding rock.

If ground anchors extend into adjacent properties then permission from the property owners for their installation will be required.

It is anticipated that the building will restrain the basement excavation over the long term and therefore ground anchors are expected to be temporary only. The use of permanent anchors, if required, would generally need careful attention to corrosion protection. Further advice on design and specification should be sought if permanent anchors are to be employed at this site.

9.5.6 Excavation Induced Ground Movements (Stress Relief)

Locked in stresses are present in rock. During excavation, these stresses will be released, which will result in lateral movement, typically along existing sub-horizontal bedding planes. These lateral movements may cause cracking of adjacent buildings and services and may also cause increases in the loads on any anchors used to provide lateral restraint to the shoring walls.

It is anticipated that the proposed excavation for the ASB basement may intersect up to 3 m of medium strength (or stronger) bedrock. For excavations within medium strength (or stronger) bedrock, some stress relief movement of medium strength (or stronger) bedrock in the cut face should be expected. Any re-entrant corners within the perimeter of the excavation are likely to be move more than the straight sides of the excavation. The top mid-section of each excavation face is likely to move inwards in the order of 0.5 mm to 1.0 mm per metre depth of excavation within medium and high strength rock. The amount of stress relief is also related to the length of the excavation. Most of the stress-relief movement is expected to be complete once bulk level has been reached.

For example, considering the ground conditions encountered in geotechnical cross sections, for a 3 m deep vertical and unsupported excavation in medium strength (or stronger) bedrock, about 25 m long, lateral movement in the order of 2 - 3 mm should be expected. At the ground surface, this movement is expected to reduce away from the excavation at an initial rate of 0.5 mm/m to 1 mm/m, possibly

giving rise to some differential strain and possible cracking of structures founded on bedrock in the near vicinity of the excavation.

Consideration should be given to the locations of internal columns, connections with perimeter walls and other design issues so that future rock stress relief movements as a result of "creep" or from reactivation of earlier movement as a result of subsequent adjacent excavations (i.e. basements for the future expansion area to the north) does not affect the new structure. For preliminary design purposes, a 10 mm gap between the proposed excavation face and the new structure should be allowed to account for such rock stress relief movement. A heavy-duty compressible material (to be approved by the structural engineer) between perimeter shoring walls and the building buttresses may be used to allow the transfer of loads.

9.6 Survey Monitoring During Excavation

The use of instrumentation to monitor existing adjacent roads/footpaths, buildings and structure movements will be important for this development as the existing structures are likely to be sensitive to differential foundation movement.

Precise survey points should be established on existing roads, buildings and structures adjacent to the proposed basement and services diversion excavations as well as on the shoring wall capping beam, prior to the commencement of any excavation works. Monitoring should be undertaken to an accuracy of at least ± 1 mm and should be continued throughout the construction phase until excavation faces are permanently supported by the new building structure, or in the case of the services diversion, until backfilled and completed.

Survey readings must be taken prior to commencement of any excavation works to provide baseline readings. The frequency of survey monitoring should be at every 1.5 m drop in excavation or at least weekly.

A "trigger" or alarm level appropriate for the shoring system and based on expected movement, should be adopted for survey monitoring of existing buildings and the proposed shoring wall. A monitoring plan should be developed that includes trigger levels, hold points and actions by responsible parties, at which time the builder would be obliged to seek further advice from structural and geotechnical engineers.

9.7 Foundations

9.7.1 Site Classification

Based on the depth of sandy filling within some of the boreholes, the site has a site classification of 'Class P' in accordance with AS 2870 - 2011 "Residential slabs and footings". Design of footings for Class P sites should be based on engineering principles. Provided all footings are designed to be founded beneath the filling on natural sand or bedrock, a 'Class A' site classification would be appropriate.

9.7.2 Footings

Excavations are likely to intersect pavements, filling, natural sand and bedrock of variable strength. It is anticipated that excavations for basement Level -02 will expose bedrock and sand at the northern and southern ends, respectively.

Therefore a combination of shallow pad or strip footings and deep pile footings bearing in bedrock will be required to support the heavily-loaded building columns. Where a deeper sand profile exists, suitable footings may include concrete or grout-injected CFA piles or bored piles drilled under a drilling mud or by using temporary or sacrificial casing to construct pile footings down to bedrock.

It is noted that extremely low to low strength laminite/siltstone bands were encountered in BH2, 5, 8, 9, and 10 within the medium and high strength sandstone. To reduce the potential risk of differential settlement between footings, all footings should be founded below 'weak' laminite/siltstone bands or not within five pile diameters (where piles are used) or 1.5 times the minimum footing dimension (where pads are used) above the 'weak' rock.

It is understood that CFA piles are the preferred foundation system. Given that construction of CFA piles involves a blind drilling technique, additional rock-cored boreholes should be carried out across the site, where data-gaps exist and where 'weak' laminite bands have been encountered to confirm their level and thickness.

Beyond the ASB basement excavation, it may be possible to support lightly-loaded structures on shallow, pad or strip footings bearing on loose to medium dense sand. The design of shallow footings founded in sand is dependent upon the size of the footing, the depth of footing embedment, the friction angle of the founding material as well as the depth to the water table.

By way of example, a 0.5 m by 0.5 m pad footing or a 0.5 m wide strip footing, embedded 1 m deep, founded in loose to medium dense sand, with a water table at least twice the minimum footing width below the base of the footing, may be designed for a maximum allowable bearing pressure of 250 kPa. Reduced bearing pressures will apply in cases where footings are founded close to the water table. Therefore, targeted investigations of subsurface conditions are recommended where shallow footings in sand are proposed. Typically, footings designed on the basis of an allowable bearing pressure can be expected to settle up to 1% of the minimum footing dimension.

For the design of pad, strip or pile footings founded in bedrock, reference should be made to Table 9 for appropriate design parameters. Parameters for both the working stress and limit-state design approaches have been provided.

Table 9: Design Parameters for Footings

Material Description	Allowable End Bearing Pressure (kPa)		Ultimate End Bearing Pressure [3] (kPa)		Young's Modulus E (MPa)
	End Bearing [5]	Shaft Adhesion[1,2]	End Bearing [5]	Shaft Adhesion[1,2]	
Medium Strength Sandstone	3,500	300	20,000	800	500
Medium to High Strength (or stronger) Sandstone [4]	6,000	500	60,000	1,500	1,000

Notes:
1. Shaft adhesion applies only for the design of rock socketed piles of adequate sidewall roughness.
2. Where piles are also required to resist uplift, it is suggested that the adhesion values be reduced by 50%.
3. Ultimate values occur at large settlements, typically >5% of the minimum footing dimension.
4. Additional rock-cored boreholes together with spoon testing of 50% of pad footings are required to confirm medium to high strength sandstone.
5. Extremely low to low strength laminite bands should be absent within 5 pile diameters and 1.5 times the minimum pad/strip footing dimension below the footing base.

An appropriate geotechnical strength reduction factor ($Ø_g$) should be selected using the procedure outlined in AS 2159 – 2009 "Piling design and installation" if using the limit-state design approach. As the calculation of $Ø_g$ should be carried out by the pile designer, given the variables, which are unknown at this early stage.

Footings founded at a high-level, within a 45° zone of influence line extending up from the base of any adjacent excavation or retaining wall should be designed using a reduced allowable end bearing pressure of 1,000 kPa and 2,000 kPa for consistent medium and high strength sandstone, respectively.

The settlement of footings is dependent upon the foundation conditions and applied loads. The settlement of footings may be estimated on the basis of the values of elastic (Young's) modulus given in Table 9 for the various rock strengths.

The foundation design parameters presented in Table 9 assume that the foundation excavations are clean and free of loose debris, with pile sockets (i.e. shafts) free of smear and adequately rough prior to concrete placement.

Spoon testing of 50% of shallow pad/strip footings designed on the basis of an allowable bearing pressure of 6,000 kPa is recommended to confirm the absence of 'weak' clay or rock bands directly beneath the footings. Spoon testing should be carried out to 1.5 times the minimum footing dimension or to a maximum depth of 2 m. Further borehole investigation is also required to confirm the presence of high strength sandstone across the building footprint.

All foundation excavations should be inspected by an experienced geotechnical professional prior to pouring of concrete to confirm that the material is suitable for the design parameters adopted. It is noted that CFA piles are a proprietary product that involves a 'blind' drilling technique and therefore

the piling contractor should certify the installation of CFA piles. For CFA piles, DP can observe the piling resistance, and correlate pile depths with rock strength data from nearby boreholes.

9.7.3 Sewer Diversion

For the sewer launch shafts, the design of slabs or pad footings founded in the base of the shafts on bedrock may be designed using the geotechnical design parameters provided in Table 9 of Section 9.7.2. A thrust block in bedrock may be designed using the ultimate lateral pressure provided in Table 7 of Section 9.5.4, and if ground anchors are required to tie-down the thrust block, refer to Section 9.5.5.

9.7.4 Stormwater Diversion

It is recommended that the bearing pressure of the subgrade be confirmed at the time of construction, given the design of shallow footings founded in sand is dependent upon the size of the footing, the depth of footing embedment, the friction angle of the founding material as well as the depth to the water table.

By way of example, a 375 mm diameter pipe (i.e. one of the smaller sizes of stormwater pipes proposed), embedded at least 0.9 m deep, founded in loose to medium dense sand, with a water table at least twice the minimum footing width below the base of the footing, may be designed for an allowable bearing pressure of 200 kPa. For the same diameter pipe and foundation material, embedded 0.6 m below surface, an allowable bearing pressure of 150 kPa would apply. Greater bearing pressures will generally apply for larger size pipes/box culverts and where pipe invert levels are embedded deeper below ground surface, and remain at least twice the minimum footing width above water table.

Dynamic penetrometer tests should be carried at subgrade level within the services trenches to confirm the foundation material satisfies the design bearing pressure.

9.7.5 Slabs on Grade

It is anticipated that slabs-on-grade may be adopted for most of the basement floors. The existing filling in the south-western corner of the site is assumed to be uncontrolled in the absence of compaction records and should be removed and replaced as engineered filling in accordance with Section 9.10.

Preferably, all slab foundations should be supported on strata of uniform strength/stiffness to reduce differential settlements, however this will depend on the loads and the settlement tolerances. Slabs founded on bedrock should be designed for a modulus of subgrade reaction of 50 kPa/mm.

Design of slabs founded on engineered granular filling or at least medium dense sand could be based on a modulus of subgrade reaction of 2 - 3 kPa/mm for engineered granular filling and/or loose sand.

It is noted that the modulus of subgrade reaction is dependent on the size of the area subject to loading and the foundation material. The above recommended modulus of subgrade reaction values are based on a slab 10 m x 10 m in area with a uniform pressure of 10 kPa founded on either very low

strength sandstone or a 0.6 m thick layer of engineered filling overlying loose sand (as encountered in BH6 and 14).

9.8 Soil Aggressivity

Based on the results of the chemical analysis and with reference to Tables 6.4.2(C) and 6.5.2(C) of AS 2159 – 2009 "Piling design and installation", the nine soil samples tested from BH1 to BH7, BH12 and BH14/3.5 – 3.95 m have a 'non-aggressive' exposure classification with respect to buried concrete and steel elements, assuming 'Soil Conditions B' (i.e. all soils above groundwater).

Four soil samples tested from BH8, BH9 and BH13 have a 'mild' exposure classification with respect to buried concrete and steel elements, assuming 'Soil Conditions B' (i.e. all soils above groundwater).

One soil sample tested from BH14/6.3 – 6.5 m, which is below the water table, has a 'moderate' exposure classification with respect to buried concrete and steel elements, assuming 'Soil Conditions A' (i.e. high permeability soils which are in groundwater).

9.9 Seismic Design

In accordance with AS 1170 - 2007 "Structural Design Actions, Part 4: Earthquake Actions in Australia" a hazard factor (Z) of 0.08 and a site subsoil Class C_e (shallow soil site) on the basis of the soil/rock profile is considered to be appropriate for the site.

If all of the building footings are socketed into low strength (or stronger) rock then it would be permissible to treat the site as a site subsoil Class Be (rock). However the seismic impact of the soils above the rock on the retaining walls must be considered. Pad footings must be embedded entirely within rock to provide lateral resistance to deformation under cyclic loading. At the Magill Street end of the site, the low strength or stronger bedrock is approximately 6 - 7 m below the finished floor level of RL 47.0m.

Based on the subsurface profile encountered in the previous and current investigations, the proposed future expansion area is likely to have a site subsoil Class Ce (shallow soil site). The north-eastern corner of the proposed future expansion area (Stage 2) may have a Site Sub-soil Class Be (rock) in accordance with AS 1170.4, given that less than 3 m deep of soil or rock with a compressive strength of less than 1 MPa exists in two boreholes (BH1/85461.00 and BH3/72505.11) along Hospital Road.

9.10 Subgrade Preparation

From a geotechnical perspective, the existing filling and natural sand are likely to be suitable for re-use as engineered filling on site provided oversize material (i.e. particles greater than 100 mm) and any deleterious material is removed. The suitability of re-using site-won filling and natural soil should also be considered from a contamination perspective (refer to DP's preliminary contamination report).

Subgrade preparation measures for future pavements or slabs on grade should include:

- Removal of any filling to a maximum depth of 0.6 m below design subgrade level or to the top of natural soil or bedrock, whichever is shallower;
- Proof rolling the exposed surface using a minimum 10-tonne roller in non-vibration mode. The subgrade should be rolled a minimum of six times with the last two passes observed by an experienced geotechnical engineer to detect any soft spots. Any loose/soft areas identified during proof rolling should be removed as directed by the geotechnical engineer;
- Placement of engineered filling in loose layer thicknesses of 200-300 mm (dependent upon compaction equipment used) and compacted to a minimum dry density ratio of 98% (for slabs on grade) and 100% (for pavements) relative to Standard compaction and with moisture contents maintained within 2% of Standard optimum moisture content. New filling should be free of oversize particles (>100 mm) and deleterious material. The use of a readily compacted material such as medium to high strength, ripped sandstone or dense graded basecourse (DGB) material would generally be appropriate. Such materials are likely to have a CBR value of at least 10%; and
- Density testing in accordance with AS 3798 - 2007 “Guidelines for earthworks for commercial and residential developments” should be undertaken to at least a Level 2 standard to verify the above compaction criteria is achieved.

For the sewer/stormwater diversions, an earthworks specification is typically provided by the utility owner, such as Sydney Water or Randwick City Council. The specification nominates the material type to be used and the compaction to be achieved.

9.11 Pavements

9.11.1 General

It is understood that asphaltic concrete (i.e. flexible) and concrete (rigid) pavements will be adopted beyond and within the ASB site perimeter, respectively.

It is anticipated that the bulk levels will expose variable strength sandstone and predominantly medium dense sand (with some loose sand) at the northern and southern ends, respectively (refer to Drawing 2 in Appendix B).

The CBR tests indicated that the sand and sand filling with sandstone gravel had a CBR of 8% and 25%, respectively. The higher CBR for the sandy filling is most likely attributed to the gravels inclusions in the samples tested.

Subject to the subgrade preparation outlined in Section 9.10, the design of pavements on sandy subgrade or on weathered rock may be based on a CBR value of 8%. These CBR values assume all pavements are protected by adequate surface and subsoil drainage to minimise the risk of water infiltration and softening of pavement materials.

Control joints should be provided in rigid concrete slabs at the soil and rock interface to reduce the effects of differential movement and possible cracking of the slabs at these locations.

Based on a CBR value of 8% for sand and provided subgrade preparation is carried out in accordance with Section 9.10, a Young's elastic modulus of 60 MPa for short term loading and 25 MPa for long term loading is appropriate for pavement design in accordance with "Industrial Floors and Pavements" 1999.

9.11.2 Pavement Thickness Design

A pavement thickness design for the asphaltic concrete pavements beyond the site perimeter was carried out using design traffic loadings provided by Enstruct as follows:

- A 25 year design life;
- An equivalent standard axle (ESA) loading of 5 x 10^5;
- A growth factor of 3% (which is included in the ESA provided); and
- Heavy vehicles including a 26 tonne medium bulk/general deliveries truck and a Type OSV5-12 (30 tonne portable crane with 20 tonne axle load) may use the pavement once per week.

A mechanistic pavement analysis, based on the methods outlined in "Austroads" - 2012 and using the CIRCLY analysis program, was adopted for the assessment of pavement thicknesses. Presumptive parameters that were adopted for the analysis are outlined in Table 10.

Table 10: Pavement Design Thickness

Layer	Material	Minimum Compaction
AC layer	E=2000 MPa, $V_{bitumen}$=10%	Dependant on mix design
Base	E=350 MPa	Minimum dry density ratio of 100% (modified) compaction
Sub-Base	E = 150 MPa	Minimum dry density ratio of 100% (modified) compaction
Subgrade	Soaked CBR=8%	Site preparation as per Section 9.10 of this report.
Subgrade replacement (if required)	Soaked CBR ≥ 8%; Granular	Minimum dry density ratio of 100% (Standard) compaction or 80% density index

The materials used for construction should meet the requirements in Table 10, or allowance made for further analysis based on the actual materials used. All pavement materials and associated construction and drainage works should also meet the requirements of Austroads 2012.

It is noted that long term pavement performance is often dictated by construction stage works, and therefore that careful attention should be made to adopting appropriate construction processes, including quality controls, inspections and testing, to ensure that the subgrade is suitably prepared, and pavement is constructed in accordance with all requirements.

The pavement thickness design also assumed:

- A 95% project reliability; and
- An ESA of 5 x 10^5 includes heavy vehicles at a frequency of once per week given Austroads 2012 Table 12.2: Indicative heavy vehicle axle group volumes for lightly trafficked urban streets indicates that an ESA of 5 x 10^5 allows for 6% use by heavy vehicles.

The analysis indicates the pavement design thicknesses given in Table 11.

Table 11: Pavement Design Thickness

Material	Minimum Thickness (mm)
AC layer	25
Base	120
Sub-base	140
Total pavement thickness	285

Early results of the analysis indicate that a pavement design with a 40 mm AC layer over unbound granular materials would result in failure by asphalt fatigue before the design life is achieved. The AC layer thickness was therefore reduced to 25 mm, to reduce the development of tensile strains within the layer. It is common practice, however, for flexible pavements to be constructed with a minimum 40 mm thick AC layer. Therefore, a total pavement thickness of 300 mm, including a minimum 40 mm thick AC layer is recommended.

For the pavement design thicknesses given above, the life of the pavement was governed by fatigue failure of the AC, rather than rutting of the subgrade. The pavement life could potentially therefore be extended in the future by replacement of the upper AC, rather than the larger scale pavement rectification works that would be required by a pavement design governed by a subgrade failure (or the failure of other, deeper bound pavement layers, in the case of alternative designs).

It would generally be appropriate for the client and the Council (for Council operated roads) to assess whether the above uncertainty and maintenance considerations are considered acceptable.

9.11.3 Drainage

The pavement thickness design is based on pavement performance at equilibrium conditions. Water within the pavement and upper subgrade materials will reduce pavement performance, and allowance must be made for appropriate surface and subsurface drainage to maintain and protect the pavement and subgrade, in order to achieve the pavement design life.

It is recommended that the subsurface drain should generally extend to at least 0.5 m below subgrade level on both sides of the road pavement. Such drainage could potentially be integrated with other drainage works, such as bedding for stormwater lines.

If a final AC layer is not placed immediately following pavement construction, it is suggested that diversion mounds and appropriate temporary drainage measures be provided to prevent excessive water flows running into the pavement (as may occur where the ‘lip’ of permanent kerbing and drainage measures acts as a dam to water movement). Such infiltration may result in premature pot-holing and pavement failure.

9.12 Stormwater Management Systems

Given the depth to bedrock and the highly permeable sandy soils expected to overlie bedrock, the use of absorption systems may be appropriate for stormwater management. As a preliminary guide, the invert levels of stormwater tanks should be at least 2 m above any impermeable layers such as bedrock or a water table to allow absorption into sandy soil.

9.13 Further Investigation

To fill-in data-gaps, it will be necessary to undertake additional rock-cored boreholes along the Botany Street side of the ASB site and at the proposed two bridges to confirm the presence of consistent medium strength (or stronger) rock for foundation design, particularly given that CFA piles will be adopted for shoring and foundation piles, and that 'weak' laminite bands were encountered within higher strength sandstone. Further investigation should occur once site access is more readily available to drilling rigs.

The findings of a further geotechnical investigation may indicate that additional in situ testing, targeting geological features or areas specific to the proposed development, may be required.

Further monitoring of the levels of stormwater runoff seepage and the water table using existing water data-loggers is recommended throughout the detailed design phase until construction begins, particularly due to the relatively dry weather conditions experienced throughout the monitoring period.

Given the known presence of an igneous dyke near the intersection of Botany and High Streets (i.e. near the north-western corner of the future expansion area), the boreholes in this area should extend well below proposed excavation and foundation levels in that area, with possible consideration of an inclined borehole to increase the probability of intersecting a dyke, if present. The presence of a dyke can also lead to highly fractured bedrock and greater volumes of groundwater ingress through rock joints into deep excavations.

10. References

1. Department of Mineral Resources, Geological Survey of New South Wales, "Geology of the Sydney 1:100,000 Sheet 9130", 1983;
2. Randwick Local Environment Plan 2012, Acid Sulphate Soils Map (Sheet ASS_007);
3. NSW Environment Protection Authority, "Waste Classification Guidelines" 2014;
4. Standards Australia, AS 2187.2 - 1993 "Explosives – Storage, Transport and Use";
5. Standards Australia, AS 2870 - 2011 "Residential Slabs and Footings";
6. Standards Australia, AS 2159 – 2009 "Piling Design and Installation";
7. Standards Australia, AS 1170 - 2007 "Structural Design Actions, Part 4: Earthquake Actions in Australia";
8. Standards Australia, AS 3798 - 2007 "Guidelines on Earthworks for Commercial and Residential Developments";

9. Cement and Concrete Association of Australia, “Industrial Floors and Pavements” Second Edition 1999;
10. Austroads Ltd, “Guide to Pavement Technology Part 2: Pavement Structural Design” 2012;
11. ANZECC & ARMCANZ 2000, National water quality management strategy. Australian and New Zealand guidelines for fresh and marine water quality, Australian and New Zealand Conservation Council & Agriculture, and Resource Management Council of Australia and New Zealand (ANZECC 2000);
12. Pells, P.J., Mostyn, G. and Walker, B.F. "Foundations on Sandstone and Shale in the Sydney Region". Australian Geomechanics Journal, Vol. No. 33 Part 3, Dec. 1998;
13. Pells, P.J., Douglas, D.J., B., Thorne, C. and McMahon, B.K. "Design Loadings for Foundations on Shale and Sandstone in the Sydney Region". Australian Geomechanics Journal, Vol. 3, 1978; and
14. Walker, B.F. and Pells, P.J.N. "The Construction of Bored Piles Socketed into Shale and Sandstone". Australian Geomechanics Journal, Vol. No. 33 Part 3, Dec. 1998.

11. Limitations

Douglas Partners Pty Ltd has prepared this report for the Randwick Campus Redevelopment project at the site bound by Hospital Road and High, Magill and Botany Streets, Randwick in accordance with DP’s proposal (SYD180227.P.002.Rev0, dated 28 March 2018). The work was carried out under a professional services agreement with Lendlease Building Pty Ltd (Contract No. 258723-512, dated 3 May 2018). This report is provided for the exclusive use of Lendlease Building Pty Ltd for this project only and for the purposes as described in the report. It should not be used for other projects or by a third party. Any party relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP’s field testing has been completed.

DP’s advice is based upon the conditions encountered during this investigation and previous investigations at this site. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Appendix A

About this Report

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

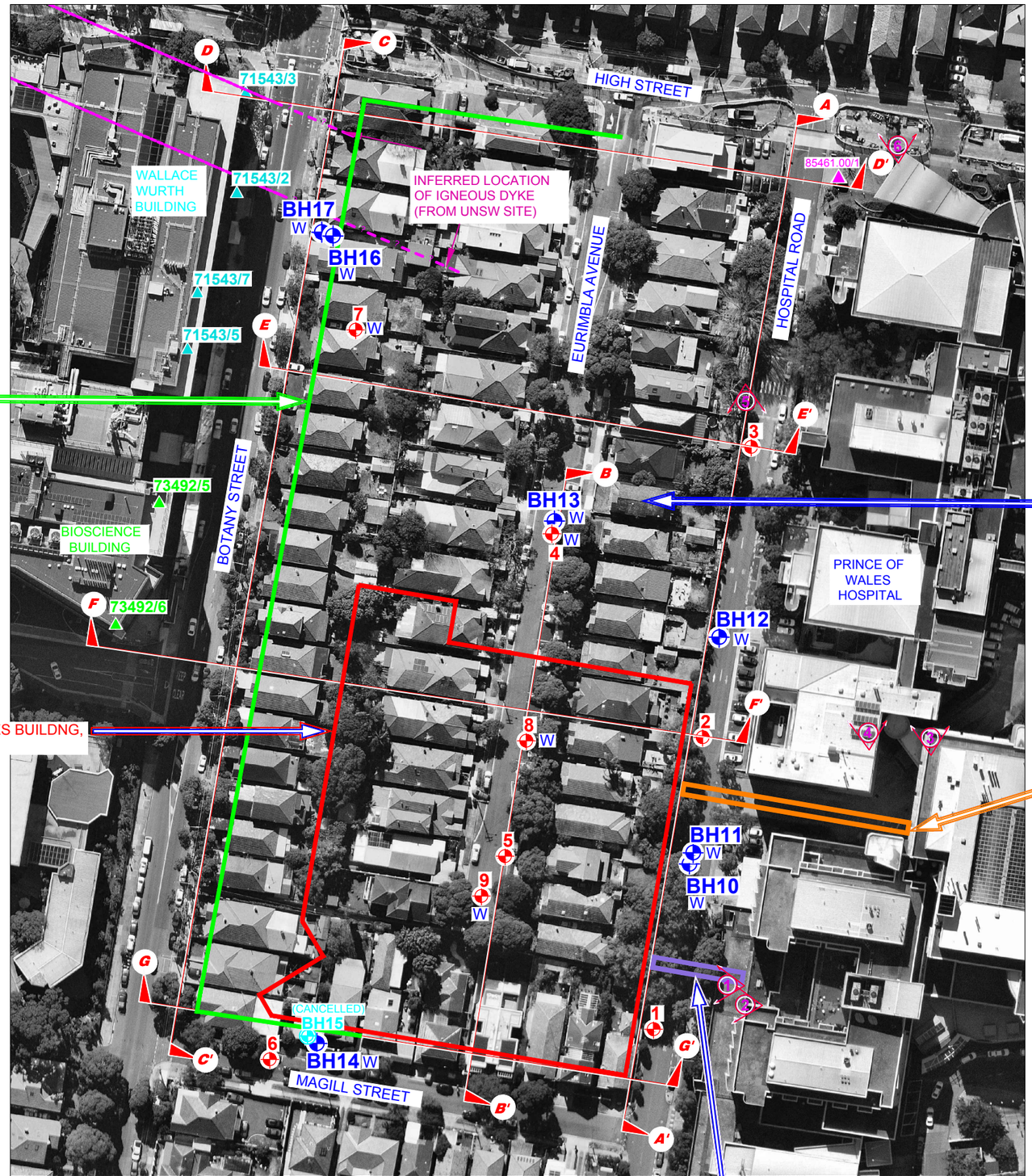
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

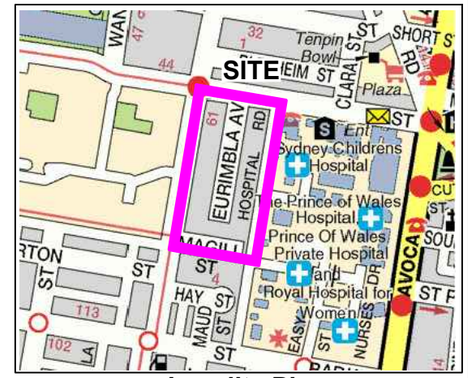
Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

Drawings 1 to 8





Locality Plan

NOTE:
1: Base image from Nearmap.com (Dated 6.8.2017)

0 5 10 20 30 40 50 75 100 125m

1:1250 @ A3

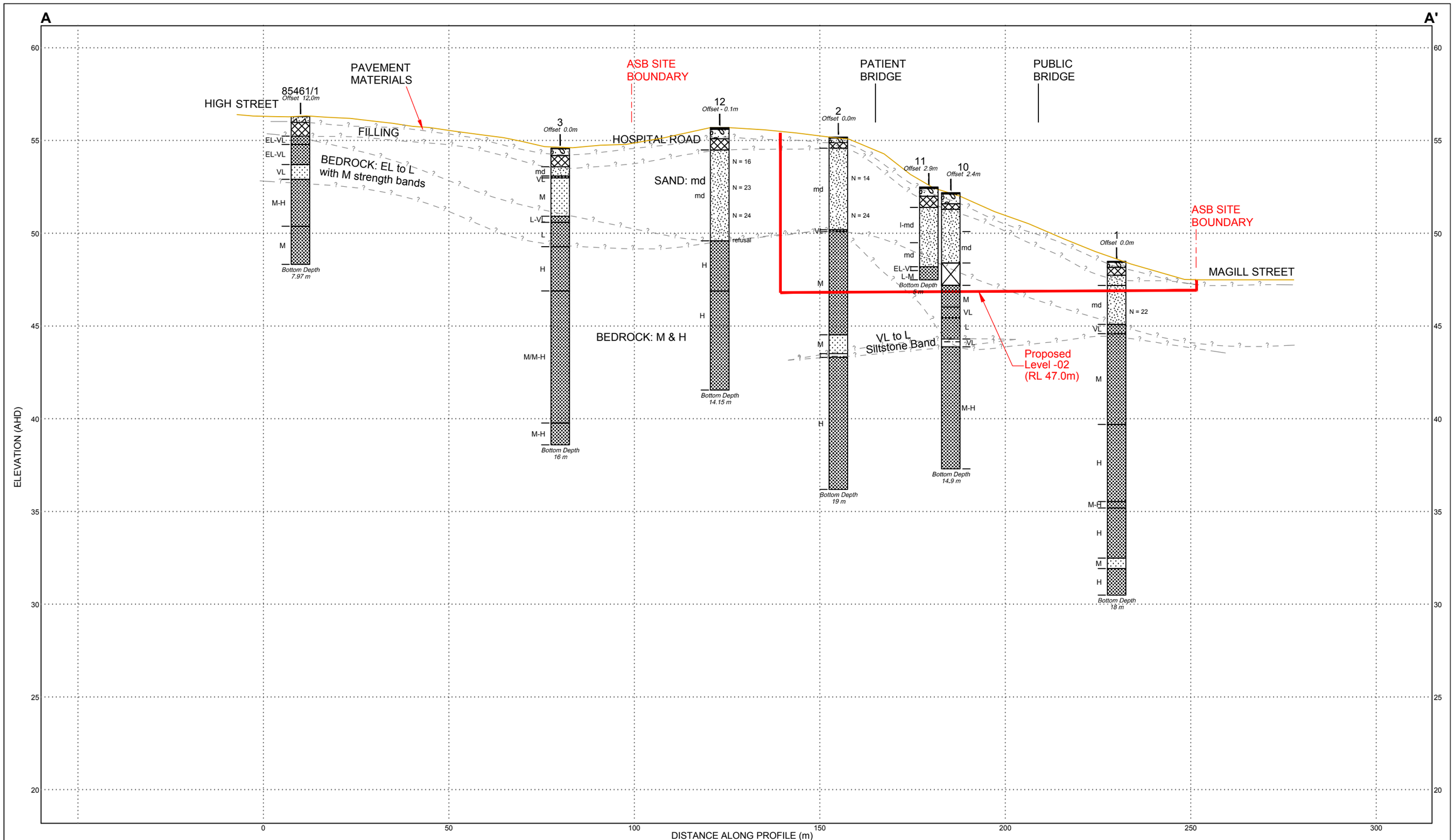
LEGEND

- Previous borehole (UNSW Wallace Wurth Building, Proj. 71543, 2010)
- Previous borehole (UNSW Bioscience Building Proj. 73492, 2013)
- Previous borehole (Prince of Wales Hospital Proj. 85461.00, 2016)
- Previous borehole (Proj. 72505.11, Feb 2018)
- Current borehole
- W Groundwater monitoring well
- A A' Interpreted geotechnical Cross Section
- 1 Photo number with direction of view

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Lendlease Building Pty Ltd		TITLE: **Locations of Previous and Current Boreholes** **Randwick Campus Redevelopment** **Hospital Road and High, Magill and Botany Streets, RANDWICK**
OFFICE: Sydney	DRAWN BY: PSCH	
SCALE: 1:1250 @ A3	DATE: 17.5.2018	

PROJECT No: 72505.13
DRAWING No: 1
REVISION: 0



LEGEND

- Asphaltic Concrete
- Roadbase
- Filling
- Sand
- Sandstone coarse grained
- Sandstone fine grained
- Siltstone
- Concrete

NOTE:

1. Subsurface conditions are accurate at borehole locations. Variations in subsurface conditions may occur between test locations.
2. Interpreted strata boundaries are approximate and should be used as a guide only.
3. Summary logs only. Should be read in conjunction with detailed logs.

ROCK STRENGTH
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High

SOIL CONSISTENCY
vs - very soft
s - soft
f - firm
st - stiff
vst - very stiff
h - hard
vl - very loose
l - loose
md - medium dense
d - dense
vd - very dense

TESTS / OTHER
N - Standard penetration test value
Water level
Inferred Geology

Horizontal Scale (metres) 0 20

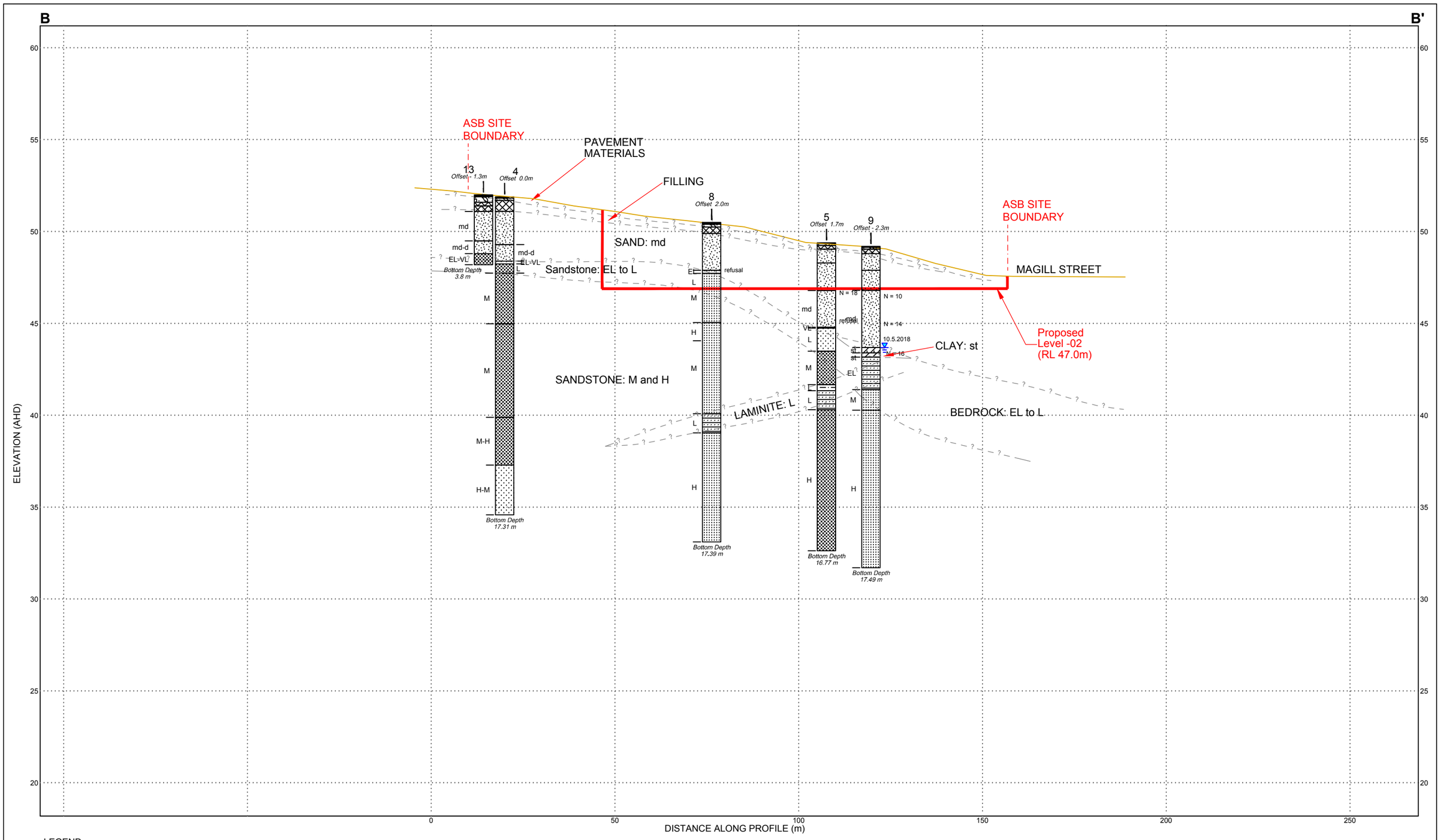
Vertical Exaggeration = 5.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Lendlease Building Pty Ltd		
OFFICE: Sydney	DRAWN BY: LJH	
SCALE: 1:1000 (H) 1:200 (V) @ A3	DATE: 17.5.2018	

TITLE: **Interpreted Geotechnical Cross Section A-A'**
Randwick Campus Redevelopment
Hospital Road and High, Magill and Botany Streets, RANDWICK

PROJECT No:	72505.13
DRAWING No:	2
REVISION:	0



LEGEND

- Asphaltic Concrete
- Roadbase
- Filling
- Sand
- Sandstone fine grained
- Sandstone coarse grained
- Siltstone
- Laminite
- Sandstone
- Silty Clay
- Clay

NOTE:

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vd - very dense

TESTS / OTHER
N - Standard penetration test value
- Water level
- ? — - - Inferred Geology

Horizontal Scale (metres) 0 20

Vertical Exaggeration = 5.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Lendlease Building Pty Ltd		TITLE: **Interpreted Geotechnical Cross Section B-B'**	PROJECT No: 72505.13
OFFICE: Sydney	DRAWN BY: LJH	**Randwick Campus Redevelopment**	DRAWING No: 3
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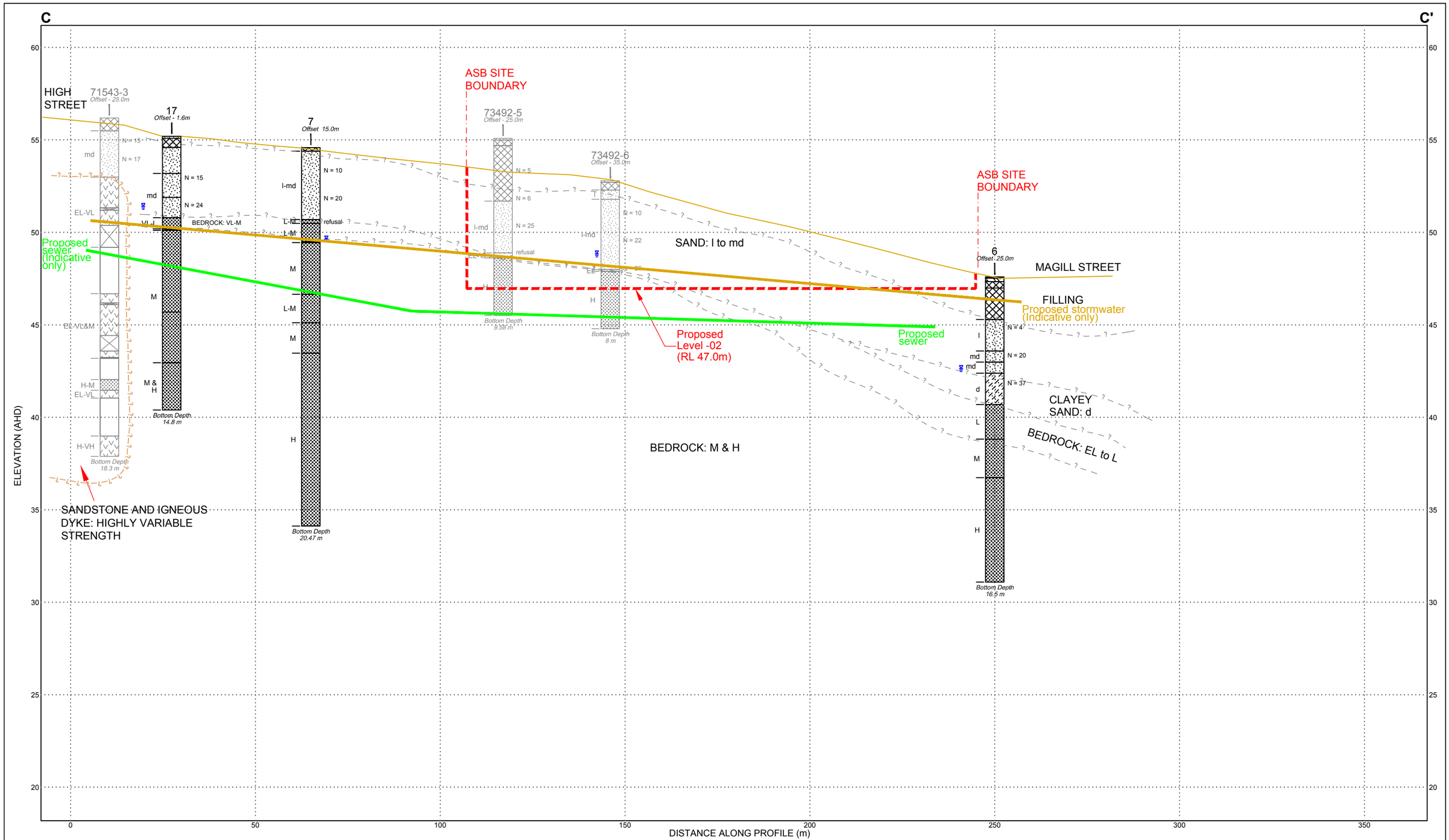

LEGEND

Core Loss
Asphaltic Concrete
Bricks
Clayey Sand
Concrete
Dyke
Blank = Rotary Drilling
Filling
Roadbase
Sand
Sandstone coarse
Sandstone fine

NOTE:

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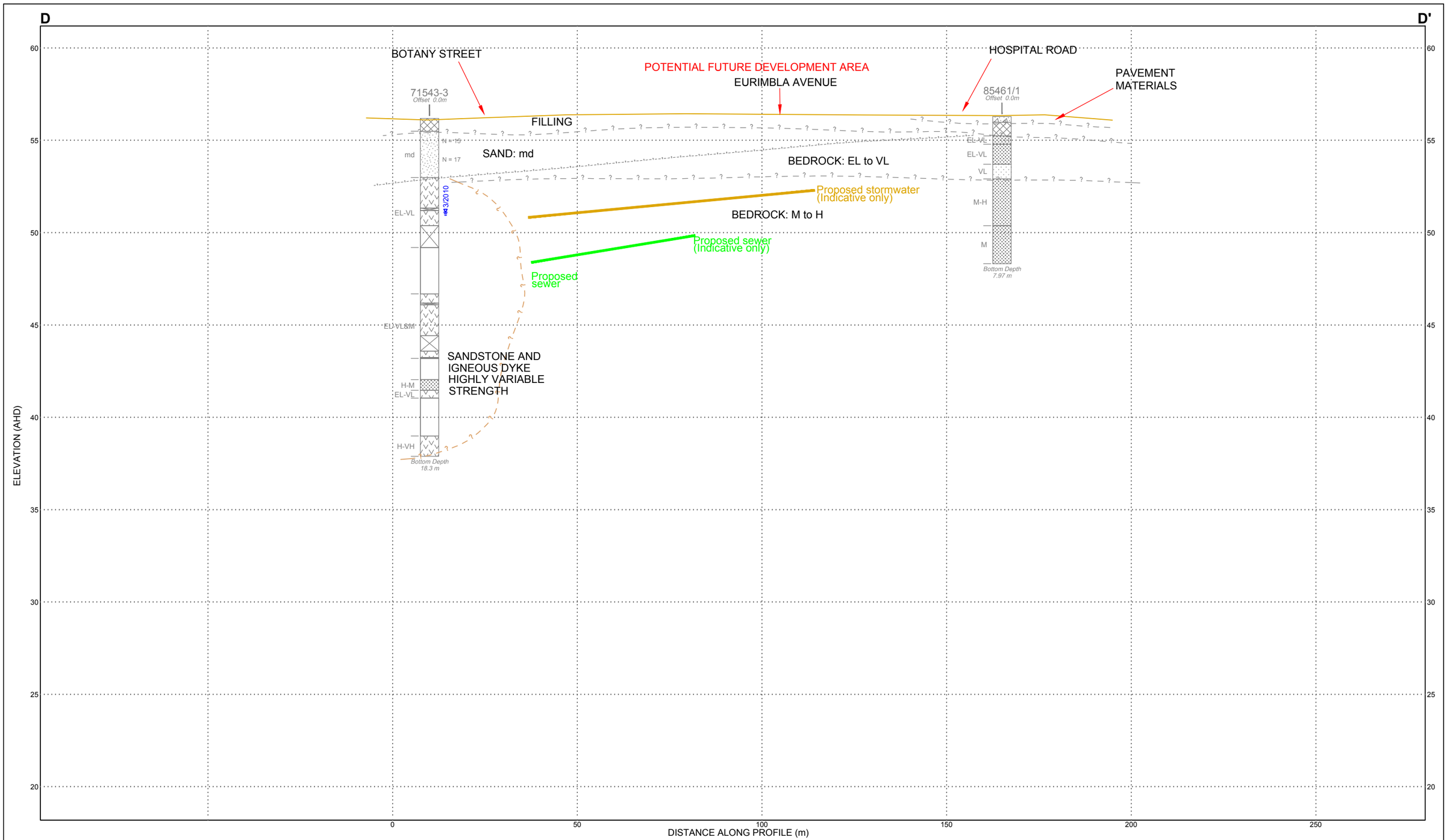
TESTS / OTHER
N - Standard penetration test value
▽ - Water level
– ? — – - Inferred Geology

Horizontal Scale (metres) 0 20
Vertical Exaggeration = 5.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Lendlease Building Pty Ltd		TITLE: **Interpreted Geotechical Cross Section C-C'**	PROJECT No: 72505.13
OFFICE: Sydney	DRAWN BY: LJH	**Randwick Campus Redevelopment**	DRAWING No: 4
SCALE: 1:1000 (H) 1:200 (V) @ A3	DATE: 17.5.2018	**Hospital Road and High, Magill and Botany Streets, RANDWICK**	REVISION: 0



LEGEND

- Core Loss
- Concrete
- Dyke
- Blank Lithology = Rotary Drilling
- Filling
- Sand
- Sandstone coarse grained
- Sandstone fine grained

NOTE:

1. Subsurface conditions are accurate at borehole locations. Variations in subsurface conditions may occur between test locations.
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d - dense
vd - very dense

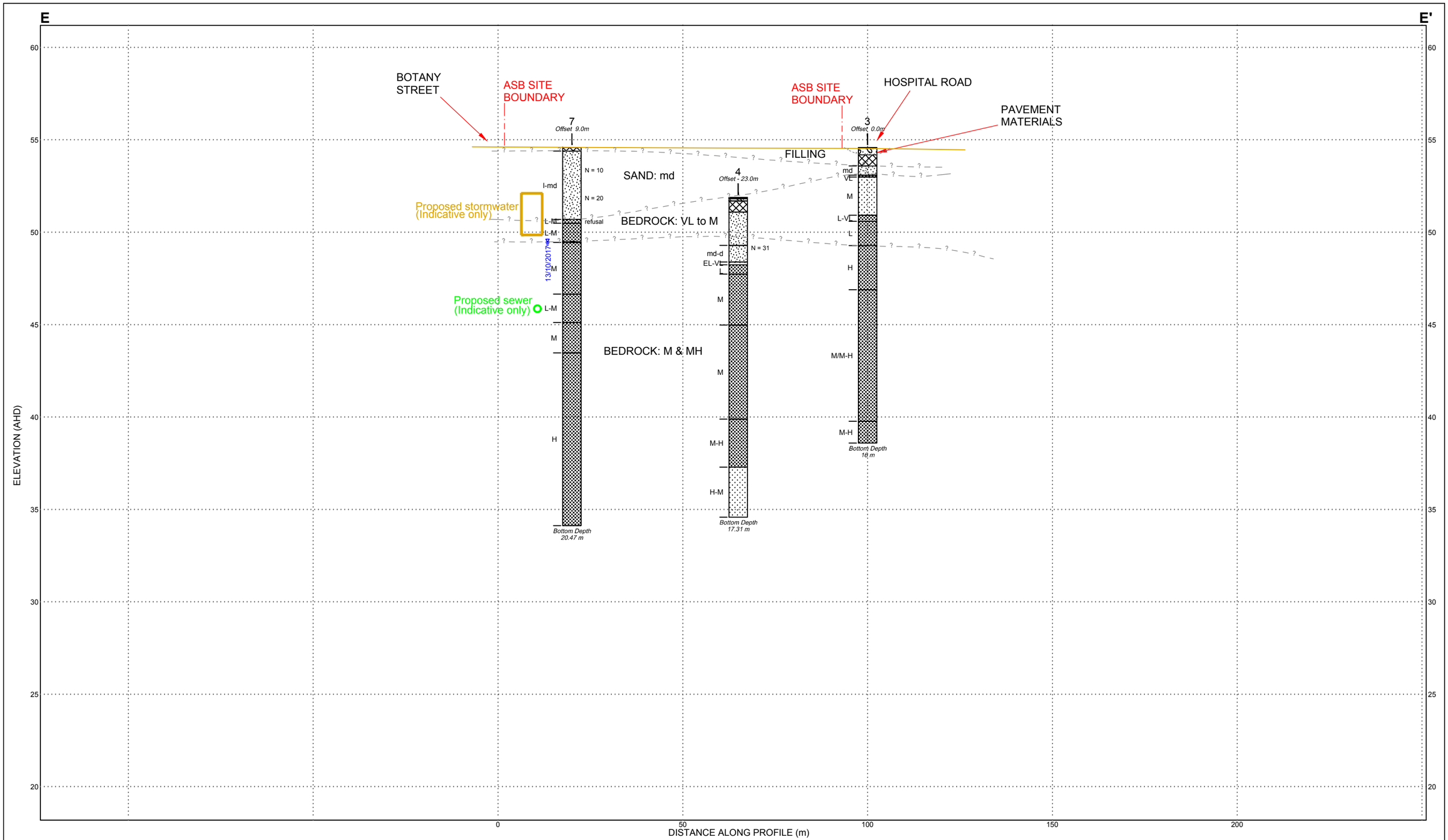
TESTS / OTHER
N - Standard penetration test value
Water level
Inferred Geology

Horizontal Scale (metres) 0 20

Vertical Exaggeration = 5.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Lendlease Building Pty Ltd		TITLE: **Interpreted Geotechnical Cross Section D-D'**	PROJECT No: 72505.13
OFFICE: Sydney	DRAWN BY: LJH	**Randwick Campus Redevelopment**	DRAWING No: 5
SCALE: 1:1000 (H) 1:200 (V) @ A3	DATE: 17.5.2018	**Hospital Road and High, Magill and Botany Streets, RANDWICK**	REVISION: 0



LEGEND

- Core Loss
- Asphaltic Concrete
- Filling
- Roadbase
- Sand
- Sandstone coarse grained
- Sandstone fine grained

NOTE:

1. Subsurface conditions are accurate at borehole locations. Variations in subsurface conditions may occur between test locations.
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TESTS / OTHER
N - Standard penetration test value
- Water level
- Inferred Geology

Horizontal Scale (metres) 0 20

Vertical Exaggeration = 5.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Lendlease Building Pty Ltd		TITLE: **Interpreted Geotechnical Cross Section E-E'**
OFFICE: Sydney	DRAWN BY: LJH	**Randwick Campus Redevelopment**
SCALE: 1:1000 (H) 1:200 (V) @ A3	DATE: 17.5.2018	**Hospital Road and High, Magill and Botany Streets, RANDWICK**

PROJECT No:	72505.13
DRAWING No:	6
REVISION:	0

F

F'

BOTANY STREET

UNSW

ASB SITE BOUNDARY

73492-6
Offset 0.0m

HOSPITAL ROAD

PAVEMENT MATERIALS

ASB SITE BOUNDARY

2
Offset 0.0m

FILLING

N = 10

N = 22

N = 26

3/2013

Proposed stormwater (Indicative only)

SAND: l and md

8
Offset 8.0m

N = 14

N = 24

BEDROCK: EL & VL

7,10/10mm refusal

Proposed sewer (Indicative only)

BEDROCK: L

Proposed Level -02 (RL 47.0m)

BEDROCK: M & H

LAMINITE: L

Bottom Depth 8 m

Bottom Depth 17.39 m

Bottom Depth 19 m

ELEVATION (AHD)

DISTANCE ALONG PROFILE (m)

LEGEND

- Asphaltic Concrete
- Roadbase
- Filling
- Sand
- Sandstone coarse grained
- Sandstone fine grained
- Siltstone
- Bricks
- Laminite

NOTE:

1. Subsurface conditions are accurate at borehole locations. Variations in subsurface conditions may occur between test locations.
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vst - very stiff
h - hard
vl - very loose
l - loose
md - medium dense
d - dense
vd - very dense

TESTS / OTHER
N - Standard penetration test value
- Water level
- Inferred Geology

Horizontal Scale (metres)

Vertical Exaggeration = 5.0

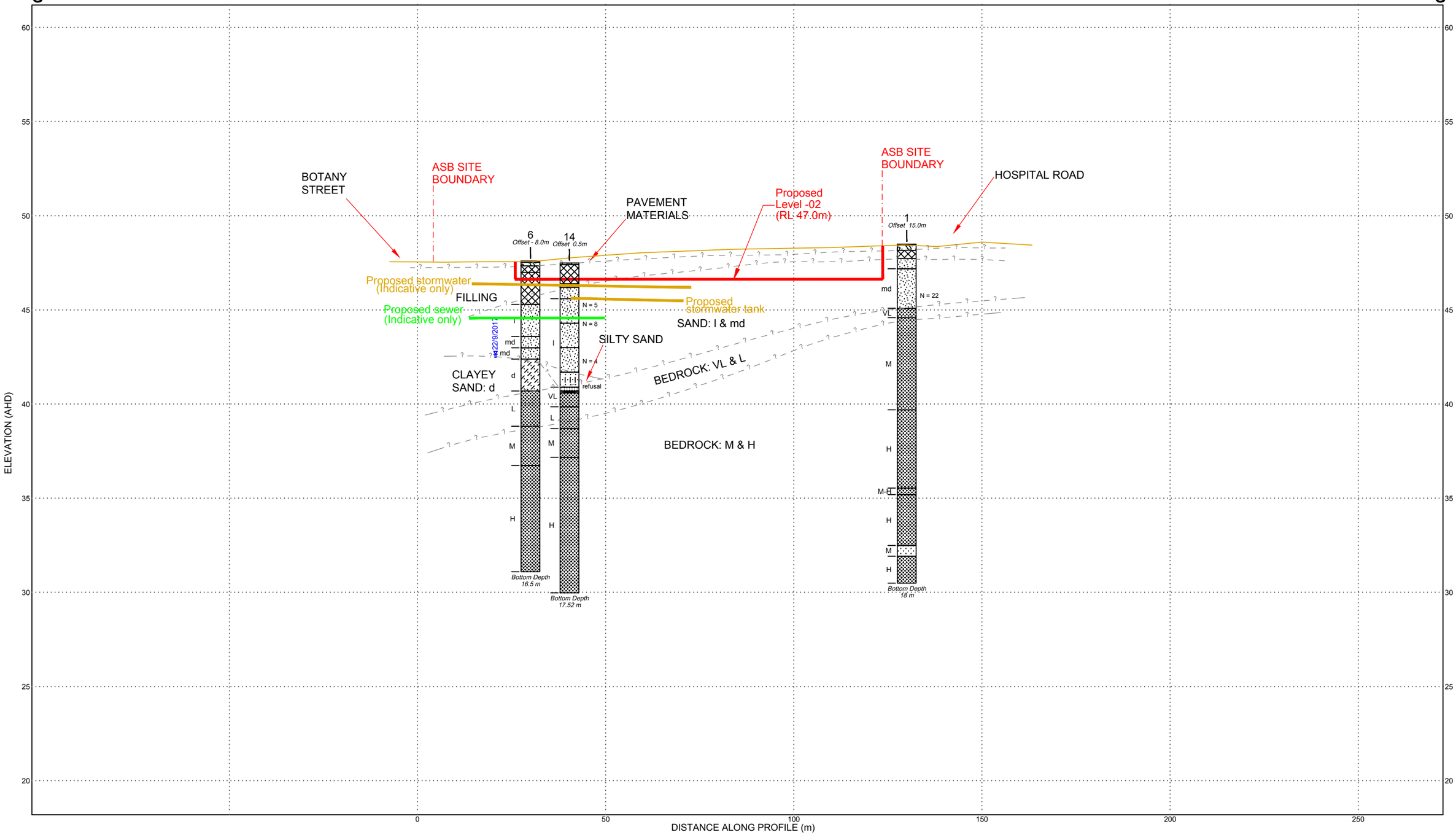
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Lendlease Building Pty Ltd		TITLE: **Interpreted Geotechnical Cross Section F-F'**
OFFICE: Sydney	DRAWN BY: LJH	**Randwick Campus Redevelopment**
SCALE: 1:1000 (H) 1:200 (V) @ A3	DATE: 17.5.2018	**Hospital Road and High, Magill and Botany Streets, RANDWICK**

PROJECT No: 72505.13
DRAWING No: 7
REVISION: 0

G

G'



LEGEND

- Asphaltic Concrete
- Roadbase
- Filling
- Sand
- Sandstone coarse grained
- Sandstone fine grained
- Clayey Sand
- Silty Sand

NOTE:

1. Subsurface conditions are accurate at borehole locations. Variations in subsurface conditions may occur between test locations.
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d - dense
vd - very dense

TESTS / OTHER
N - Standard penetration test value
- Water level
- Inferred Geology

0 20
Horizontal Scale (metres)

Vertical Exaggeration = 5.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Lendlease Building Pty Ltd		TITLE: **Interpreted Geotechnical Cross Section G-G'**	PROJECT No: 72505.13
OFFICE: Sydney	DRAWN BY: LJH	**Randwick Campus Redevelopment**	DRAWING No: 8
SCALE: 1:1000 (H) 1:200 (V) @ A3	DATE: 17.5.2018	**Hospital Road and High, Magill and Botany Streets, RANDWICK**	REVISION: 0

Appendix C

Results of Previous Investigations

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Site Infrastructure Investigation
LOCATION: Prince of Wales Hospital, Randwick

SURFACE LEVEL: 56.3 AHD^
EASTING: 337123.2
NORTHING: 6245657.1
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 85461.00
DATE: 26/5/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
56	0.31	CONCRETE SLAB										
		FILLING - apparently moderately compacted, orange-brown and grey, gravelly clayey sand filling with a trace of sandstone cobbles, damp						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°	E			
55	1.05	SANDSTONE - extremely low and very low strength, orange-brown and purple, medium to coarse grained sandstone with some iron-cemented bands							E			
	1.5	SANDSTONE - extremely low and very low strength, extremely then highly weathered, slightly fractured, red-brown, orange-brown and grey medium to coarse grained sandstone with some iron-cemented bands - very fine grained sandstone/siltstone below 2.3m						2.06m: B0°, cly, 10mm 2.12m: B0°, cly, 30mm 2.26m: B0°, cly, 30mm	C	100	76	PL(A) = 0.04
54	2.58							2.67 & 2.78m: B0°, cly vn, fe stn				PL(A) = 0.08 PL(A) = 0.09
53	3.38	SANDSTONE - very low strength, moderately weathered, slightly fractured, pink-grey and pale grey fine to medium grained sandstone with up to 15% siltstone laminations						3.28m: B0°, cly, 20mm 3.3-3.36m: J90°, pl, ro, cly vn 3.37m: B0°, cly, 20mm 3.7m: B5°, cly vn	C	100	96	PL(A) = 0.08 PL(A) = 0.6
52		SANDSTONE - medium and high strength, slightly then moderately weathered, slightly fractured, pale grey, grey and purple-brown, medium to coarse grained sandstone with some extremely low strength, extremely weathered bands and some iron-cemented bands						4.31m: Ds, 150mm 4.57 & 4.74m: B5°, cly vn				PL(A) = 1.2
51								5.11 & 5.37m: B5°, cly vn 5.14 & 5.44m: B0°, cly, 10mm 5.45-5.52m: J45°, ir, ro 5.68m: B5°, cln				PL(A) = 0.4
50	5.91	SANDSTONE - medium strength, fresh, slightly fractured, pale grey, medium to coarse grained sandstone with some extremely low strength bands						6.11m: B0°, cly, 15mm 6.26m: B0°, cly vn	C	100	89	PL(A) = 0.6
49								7.18m: B0°, cly vn				PL(A) = 0.7
48	7.97	Bore discontinued at 7.97m - target depth reached						7.89 & 7.91m: B5°, cly vn				
47												

RIG: Bobcat **DRILLER:** GM **LOGGED:** MP **CASING:** HW to 1.5m

TYPE OF BORING: Diacore to 0.31m; NDD to 1.05m; Solid flight auger to 1.55m; NMLC-Coring to 7.97m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: NDD = Non destructive suction drilling. ^Surface level provided by LTS Lockley Pty Ltd

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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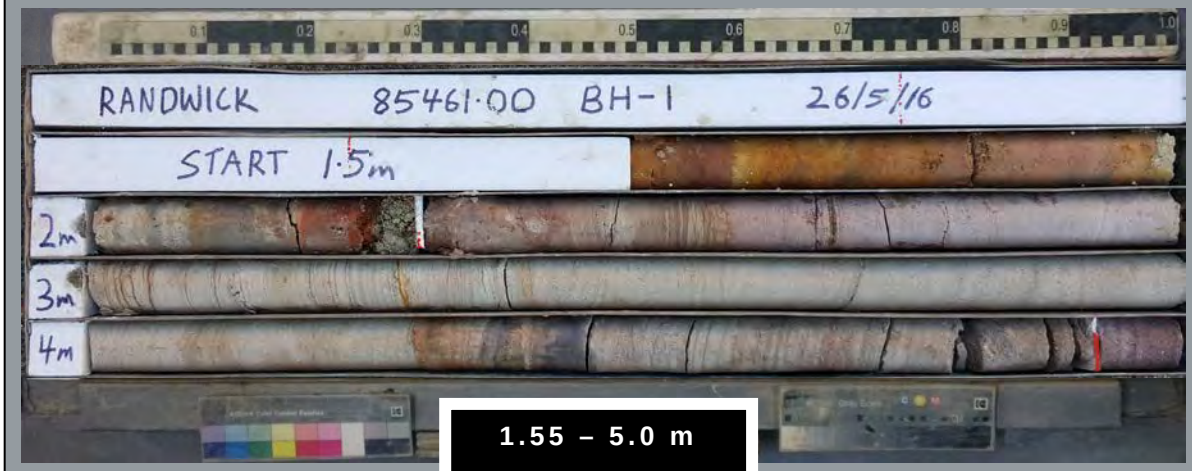
DOUGLAS PARTNERS PTY LTD

SITE INFRASTRUCTURE INVESTIGATION - RANDWICK

BORE 1 PROJECT 85461.00 MAY 2016

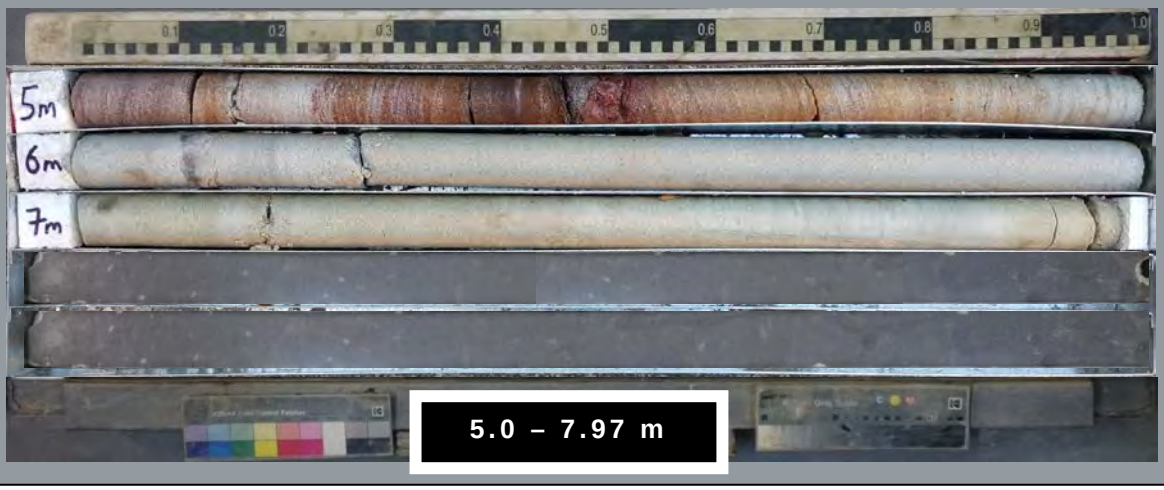


1.55 – 5.0 m

DOUGLAS PARTNERS PTY LTD

SITE INFRASTRUCTURE INVESTIGATION - RANDWICK

BORE 1 PROJECT 85461.00 MAY 2016



5.0 – 7.97 m

BOREHOLE LOG

CLIENT: Bovis Lend Lease
PROJECT: Wallace Wurth Redevelopment
LOCATION: Cnr High & Botany St, UNSW, Kensington

SURFACE LEVEL: 55.8 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 60°/0

BORE No: 2
PROJECT No: 71543
DATE: 01 Feb 10
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
56	0.1	FILLING - dark grey, fine grained, silty sand filling with some rootlets (topsoil)							A			
		FILLING - dark grey brown, fine to medium grained, sand filling with a trace of gravel, humid							A			
									A			
									A/E			
57	1 1.0	FILLING - light grey, fine to medium grained, sand filling with a trace of concrete fragments							A			
									A/E			
	1.8	SAND - orange and light grey, fine to medium grained sand, moist										
58	2											
									A/E			
	3											
	3.5	SAND - orange brown, medium grained sand, moist							A			
59	4							Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10° or joints				
	4.3	SANDSTONE - extremely low and very low strength, extremely to highly weathered, light grey then light grey brown, medium to coarse grained sandstone with extremely low strength, igneous rock inclusions										
	4.65							4.65m: CORE LOSS: 100mm				
60	5							4.75-4.85m: dyke	C	92	0	PL(A) = 0.7MPa
61	6							6.33-7.25m: dyke				
	6.52	SANDSTONE - medium then high to very high strength, highly and slightly weathered, highly fractured to fractured, grey and brown, medium to coarse grained sandstone with extremely low strength, igneous rock inclusions (cooked sandstone)						6.53-7.25m: highly fractured to fractured sandstone (dyke) in subvertical joints	C	100	0	
62	7							7.2m: CORE LOSS: 480mm				
	7.2							7.68-7.78m: fragmented in 0.02m intervals	C	62	0	PL(A) = 1.9MPa
63	8							7.88-8.13m: J, subvertical, rough 8.05-8.08m: clay band				PL(A) = 4.9MPa
	8.4	IGNEOUS ROCK & SANDSTONE extremely low and very low strength, extremely and highly weathered, grey and orange brown, medium to coarse grained sandstone with frequent igneous rock intrusions. Some high strength fractured bands						8.13m: J75°, rough 8.28-8.31m: clay band 8.31m: J, subvertical, ironstained 8.4m: CORE LOSS: 1050mm	C	34	0	
	9							9.45-9.65m: fragmented to 0.02m intervals				PL(A) = 1.3MPa

RIG: Bobcat **DRILLER:** Steve S **LOGGED:** SI **CASING:** HW to 2.6m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 4.65m; NMLC-Coring to 14.4m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed to 14.4m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U$_x$	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep
		▼	Water level

CHECKED
Initials: STE
Date: 17/3/10

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BOREHOLE LOG

CLIENT: Bovis Lend Lease
PROJECT: Wallace Wurth Redevelopment
LOCATION: Cnr High & Botany St, UNSW, Kensington

SURFACE LEVEL: 55.8 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 60°/0

BORE No: 2
PROJECT No: 71543
DATE: 01 Feb 10
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
65	10.0	IGNEOUS ROCK & SANDSTONE - extremely low and very low strength, extremely and highly weathered, grey and orange brown, medium to coarse grained sandstone with frequent igneous rock intrusions. Some high strength fractured bands *(continued)*						10m: CORE LOSS: 450mm 10.45-10.6m: fragmented to 0.01m intervals	C	50	0	
66	10.9							10.9m: CORE LOSS: 1100mm	C	19	0	
67	12.0	SANDSTONE - alternate bands of very low and medium to high strength, highly and moderately to slightly weathered, fragmented to slightly fractured, light grey and brown, coarse grained sandstone with bands of igneous rock intrusions						12.0-12.25m: fragmented 12.3m: J80°, healed 12.37m: J20°, ironstained 12.43m: J15°, ironstained 12.47-12.6m: very low strength band 12.64m: J70°, healed 12.8m: J65°, ironstained 12.92m: B0°, very low strength band 13.13m: J80°, healed 13.29m: J65°, ironstained very low strength band	C	88	0	PL(A) = 1.7MPa
68	13.56											
	14.35							13.4m: J30°, ironstained very low strength band 13.48-13.56m: fragmented in 0.02mm intervals 13.56m: CORE LOSS: 200mm 13.76m: J60°, ironstained 13.76-13.92m: fragmented 14m: J85° 14.15m: J70°, ironstained, clay band 14.25m: J50°, ironstained 14.3-14.4m: fragmented 14.35m: CORE LOSS: 50mm				
69	14.4	Bore discontinued at 14.4m										
70	15											
71	16											
72	17											
	18											
	19											

RIG: Bobcat **DRILLER:** Steve S **LOGGED:** SI **CASING:** HW to 2.6m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 4.65m; NMLC-Coring to 14.4m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed to 14.4m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep
		▽	Water level

CHECKED
Initials: STE
Date: 17/3/10

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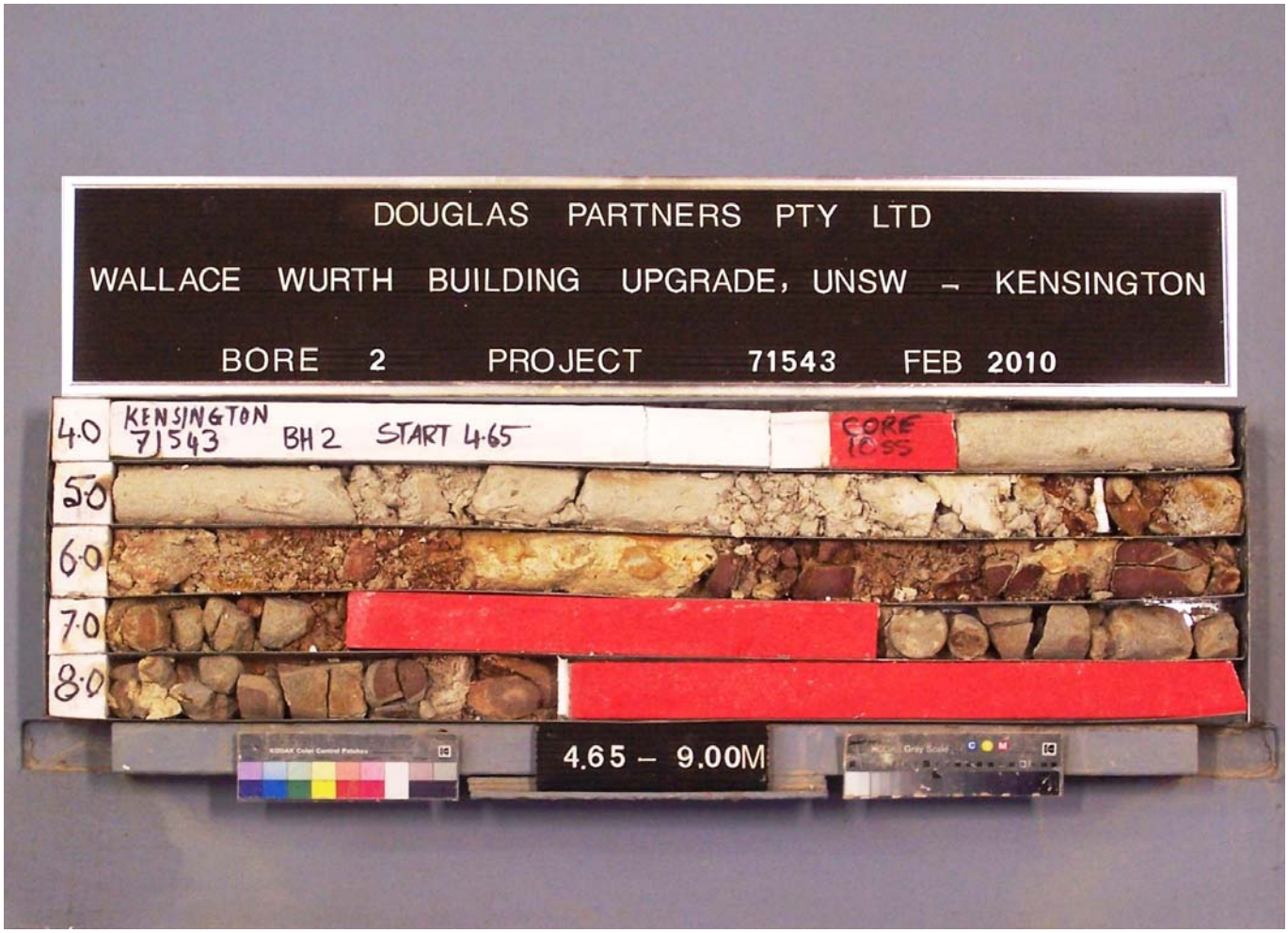
DOUGLAS PARTNERS PTY LTD
WALLACE WURTH BUILDING UPGRADE, UNSW – KENSINGTON
BORE 2 PROJECT 71543 FEB 2010
4.0
KENSINGTON 71543 BH2 START 4.65
CORE LOSS
5.0
6.0
7.0
8.0
4.65 – 9.00M

DOUGLAS PARTNERS PTY LTD
WALLACE WURTH BUILDING UPGRADE, UNSW – KENSINGTON
BORE 2 PROJECT 71543 FEB 2010
9.0
10.0
12
13.
9.00 – 14.00M

DOUGLAS PARTNERS PTY LTD
WALLACE WURTH BUILDING UPGRADE, UNSW - KENSINGTON
BORE 2 PROJECT 71543 FEB 2010
U.N.S.W. KENSINGTON - 71543 B/H. 2. @ 60° START 12.25m.
14
END OF HOLE 14.4m
14.00 - 14.40M

BOREHOLE LOG

CLIENT: Bovis Lend Lease
PROJECT: Wallace Wurth Redevelopment
LOCATION: Cnr High & Botany St, UNSW, Kensington

SURFACE LEVEL: 56.2 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 71543
DATE: 3-8 Feb 2010
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
56	0.0	FILLING - dark brown, sand filling							A			
									A			
	0.7	SAND - medium dense, light brown, fine to medium grained sand										
55	1								S			4,6,9 N = 15
54	2	- yellow below 2.2m							S			3,6,11 N = 17
									A			
53	3							Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping at 0°-10° or joints				
	3.2	IGNEOUS ROCK (DYKE) - extremely low to very low strength, extremely to highly weathered, light grey to red brown, igneous rock (dyke)										
52	4								C	90	0	
	4.86					05-03-10		4.86m: CORE LOSS: 140mm				
51	5											
	5.8							5.8m: CORE LOSS: 1200mm	C	40	0	
50	6											
	7.0	ROTARY DRILLING						7.0-9.5m: rotary drilling in extremely weathered dyke	R			
49	7											
48	8											
47	9											
	9.5	IGNEOUS ROCK - description next page						9.7-9.95m: fragmented into 0.05mm intervals	C	83	0	PL(A) = 0.8MPa

RIG: Bobcat **DRILLER:** Steve S **LOGGED:** SI **CASING:** HW to 3.6m

TYPE OF BORING: Solid flight auger to 3.6m; NMLC-Coring to 7.0m; Rotary to 9.5m; NMLC-Coring to 13.0m; Rotary to 14.5m; NMLC-Coring to 15.15m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Groundwater well installed to 18.0m. Water measured in well at 4.9m on 5/3/10

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep
		⫢	Water level

CHECKED
Initials: STE
Date: 17/3/10

Douglas Partners
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BOREHOLE LOG

CLIENT: Bovis Lend Lease
PROJECT: Wallace Wurth Redevelopment
LOCATION: Cnr High & Botany St, UNSW, Kensington

SURFACE LEVEL: 56.2 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 71543
DATE: 3-8 Feb 2010
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
46	10.0	IGNEOUS ROCK (DYKE) - extremely low to very low and medium strength, extremely to highly weathered, fractured, light grey brown to red brown, igneous rock with medium strength sandstone bands						10m: CORE LOSS: 100mm 10.6m: J70°, clay band 11.2-11.6m: fragmented in 0.02mm intervals	C	69	0	PL(A) = 0.6MPa
45	11											
	11.77							11.77m: CORE LOSS: 830mm				
44	12											PL(A) = 0.5MPa
	12.95							12.6-12.8m: fragmented in 0.02 to 0.05mm intervals 12.8-12.95m: clay band 12.95m: CORE LOSS: 50mm				
43	13 13.0	ROTARY DRILLING						13.0-14.15m: rotary drilling to weathered rock	R			
	14											
42	14.15	SANDSTONE - high then medium strength, highly to moderately weathered, fractured, red brown, coarse grained sandstone (cooked sandstone)						14.23m: J10°, 30mm clay 14.23-14.43m: (x4) B0°-5°, ironstained				PL(A) = 2.1MPa
	14.73							14.59m: B0°, 20mm clay 14.74-14.8m: extremely low strength dyke	C	100	0	
	15							14.78-15.15m: extremely low strength dyke				
41	15.15	IGNEOUS ROCK (DYKE) - extremely low to very low strength, extremely weathered, light grey brown, igneous rock (dyke)										
		ROTARY DRILLING							R			
	16											
40												
	17											
39	17.2	IGNEOUS ROCK (DYKE) - high to very high strength, fresh stained, fractured to slightly fractured, light greenish grey and brown, igneous rock (dyke). Some medium strength bands						17.2m: J, subvertical, healed, ironstained 17.3m: J70°, healed, ironstained 17.4-17.6m: J, subvertical, partially healed, fragmented into 0.05mm intervals	C	100	63	PL(A) = 9.2MPa
	18											PL(A) = 3MPa
38	18.3	Bore discontinued at 18.3m						17.74m: J85°, partially healed 17.85m: J70° 18.07m: J65°, rough 18.21-18.3m: J75°, clay smear & fragmented into 0.03mm intervals				PL(A) = 0.7MPa
	19											
37												

RIG: Bobcat **DRILLER:** Steve S **LOGGED:** SI **CASING:** HW to 3.6m

TYPE OF BORING: Solid flight auger to 3.6m; NMLC-Coring to 7.0m; Rotary to 9.5m; NMLC-Coring to 13.0m; Rotary to 14.5m; NMLC-Coring to 15.15m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Groundwater well installed to 18.0m. Water measured in well at 4.9m on 5/3/10

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: STE
Date: 17/3/10

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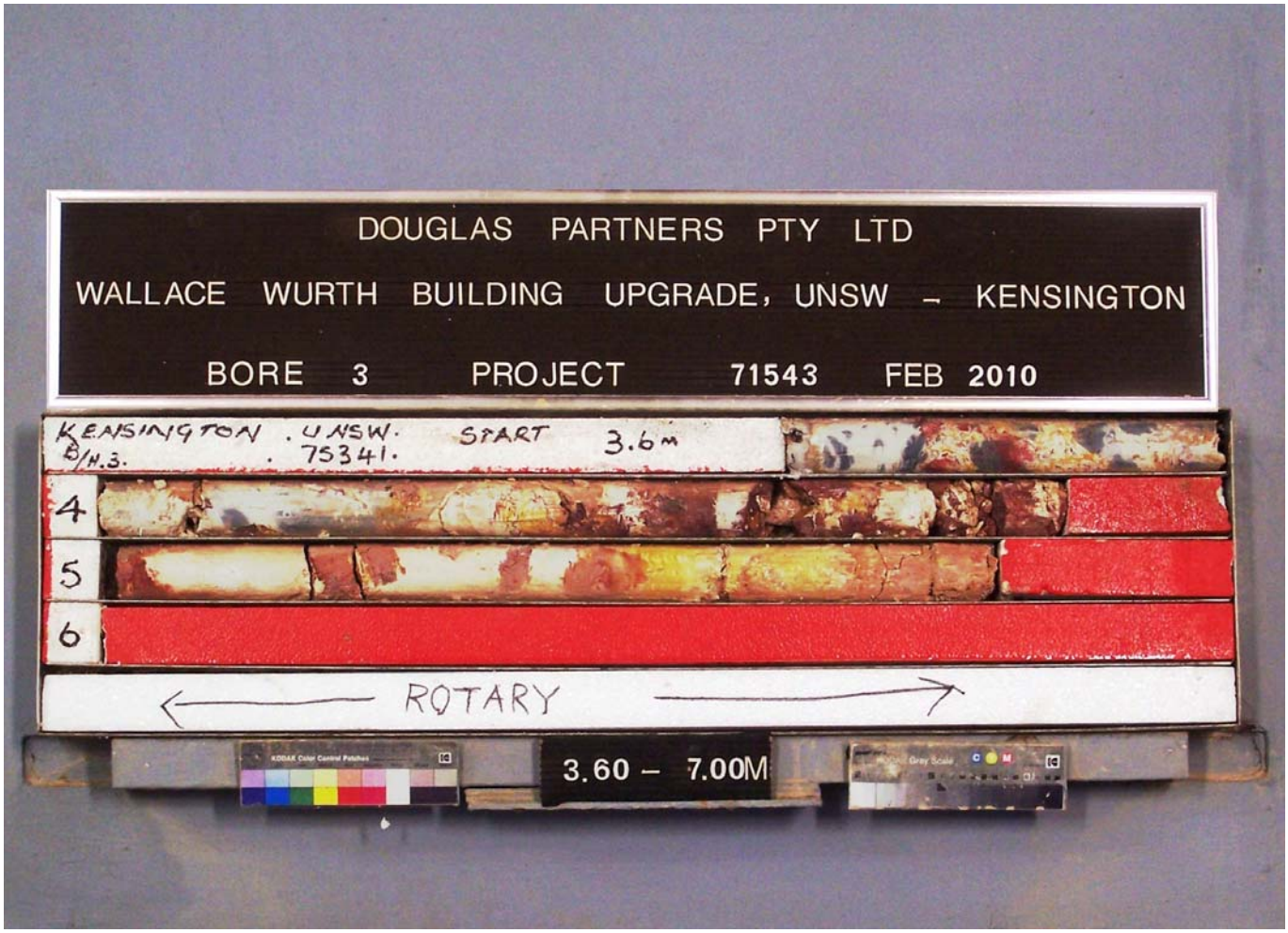
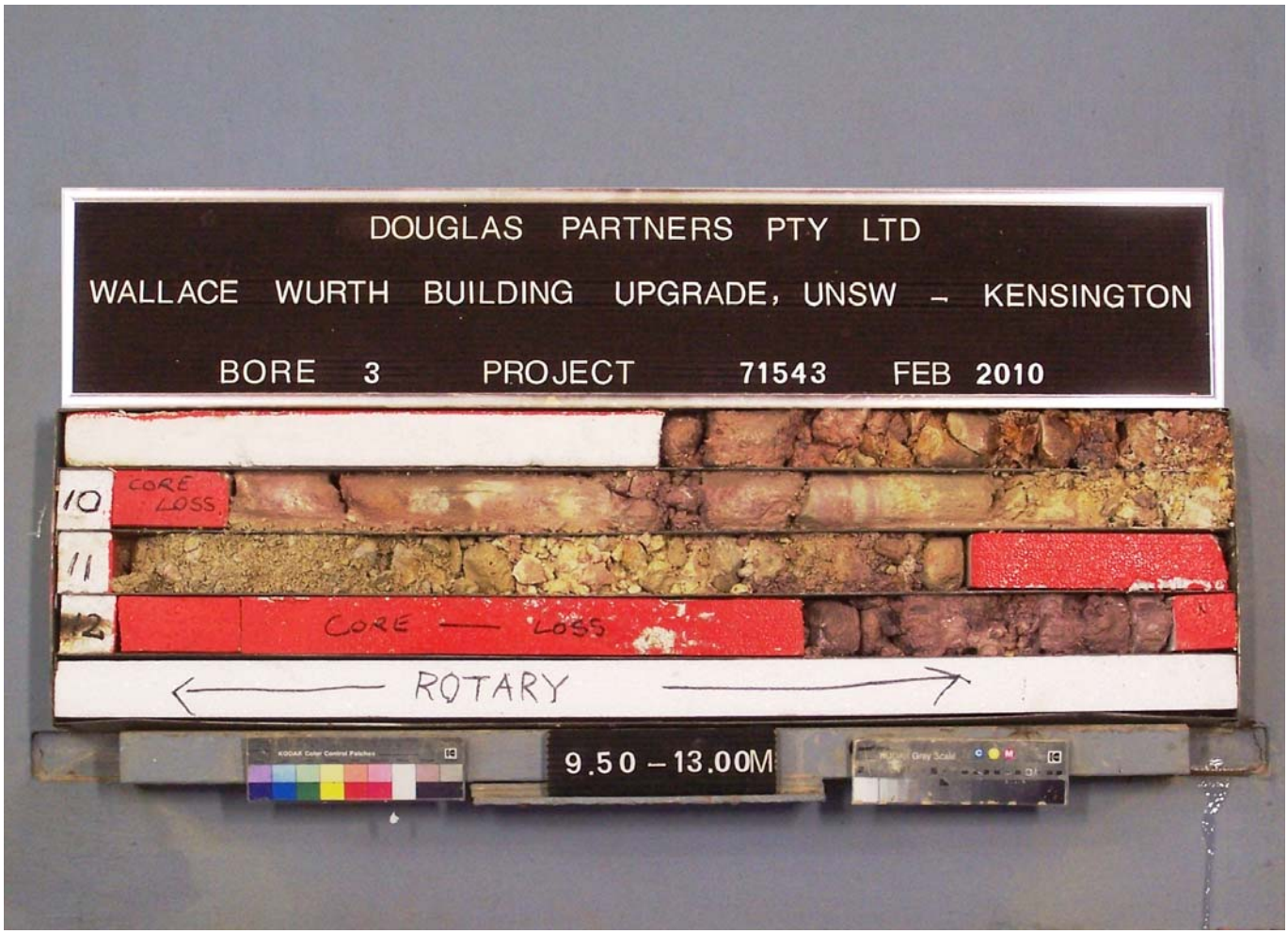

DOUGLAS PARTNERS PTY LTD
WALLACE WURTH BUILDING UPGRADE, UNSW – KENSINGTON
BORE 3 PROJECT 71543 FEB 2010
KENSINGTON . UNSW. START 3.6m
B/H.3. . 75341.
4
5
6
ROTARY
3.60 – 7.00M


DOUGLAS PARTNERS PTY LTD
WALLACE WURTH BUILDING UPGRADE, UNSW – KENSINGTON
BORE 3 PROJECT 71543 FEB 2010
10
CORE LOSS
11
12
CORE — LOSS
ROTARY
9.50 – 13.00M

DOUGLAS PARTNERS PTY LTD
WALLACE WURTH BUILDING UPGRADE, UNSW - KENSINGTON
BORE 3 PROJECT 71543 FEB 2010
14
15
ROTARY DRILLING
16
17
18
BH END @ 18.3 M
14.15 – 18.30M

BOREHOLE LOG

CLIENT: Bovis Lend Lease
PROJECT: Wallace Wurth Redevelopment
LOCATION: Cnr High & Botany St, UNSW, Kensington

SURFACE LEVEL: 55.9 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 71543
DATE: 01 Feb 10
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
55	0.2	FILLING - dark grey brown, fine grained, silty sand filling (topsoil) with some organic matter and a trace of concrete cobble and crushed sandstone fragments							A			
55	0.9	FILLING - brown, fine to medium grained, sand filling with some silt and gravel and a trace of slag and ceramic tile fragments, humid							A			
54	2.0	FILLING - light brown, medium grained, sand filling with some crushed sandstone							A			
54									A			
54									A			
54									A/E			
54									A/E			
54									S			3,8,8 N = 16
54		SAND - medium dense, orange and light grey, fine to medium grained sand, moist							A			
53									A/E A			
53									A S			6,10,12 N = 22
52												
51									S			9,10,13 N = 23
51								Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping at 0°-10°				
51	5.3	SANDSTONE - very low strength, orange brown, medium grained sandstone							S			20,20/25mm refusal
50	5.8	SANDSTONE - medium then high strength, slightly then moderately weathered, slightly fractured, light grey brown then red brown, medium to coarse grained sandstone						6.1m: B0°, ironstained 6.62m: B0°, 5mm sandy clay 6.65m: B0°, 10mm sandy clay 7.44 & 8.28m: (x2) B0°-5°, clay veneer	C	100	99	PL(A) = 0.5MPa PL(A) = 0.4MPa PL(A) = 1.1MPa PL(A) = 1.1MPa
47	8.8	Bore discontinued at 8.8m										

RIG: Bobcat **DRILLER:** Steve S **LOGGED:** SI **CASING:** HW to 5.8m

TYPE OF BORING: Solid flight auger to 5.5m; Rotary to 5.8m; NMLC-Coring to 8.8m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep
		▼	Water level

CHECKED
Initials: STE
Date: 17/3/10

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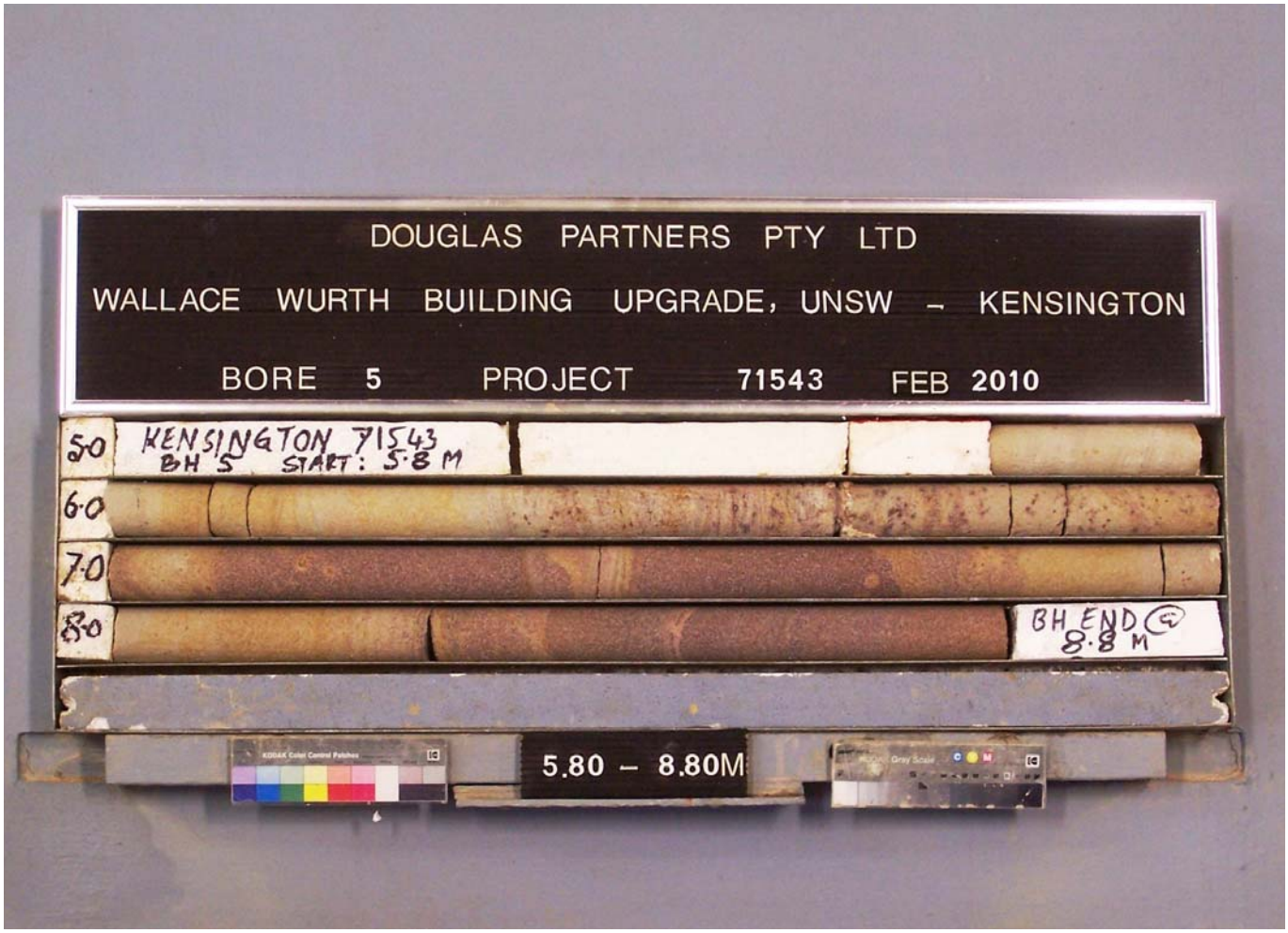
DOUGLAS PARTNERS PTY LTD
WALLACE WURTH BUILDING UPGRADE, UNSW - KENSINGTON
BORE 5 PROJECT 71543 FEB 2010
5.0
KENSINGTON 71543
BH 5 START: 5.8 M
6.0
7.0
8.0
BH END @ 8.8 M
5.80 - 8.80M

BOREHOLE LOG

CLIENT: Bovis Lend Lease
PROJECT: Wallace Wurth Redevelopment
LOCATION: Cnr High & Botany St, UNSW, Kensington

SURFACE LEVEL: 55.8 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 71543
DATE: 29 Jan 10
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
55	0.1	FILLING - brown, fine grained, silty sand filling (topsoil) with some gravel and rootlets							A			
	0.4	FILLING - brown sand and crushed sandstone filling, humid							A			
54	1	FILLING - light to dark brown, fine to medium grained sand filling, with a trace of gravel, humid to moist							A/E			
		1.3-1.45m: concrete fragments							A/E			
	1.5	FILLING - light brown, fine to medium grained sand with some sandstone gravel (possible natural)							A			
53	2								A			
									A			
									S			4,5,5 N = 10
	3								A			
52	3.0	SAND - medium dense, orange brown, medium grained sand, moist							A			
	4								A			
									S			11,15,20/10mm refusal
51	4.9	SANDSTONE - very low strength, light grey brown, medium grained sandstone						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping at 0°-10° or joints				
	5											
	5.2	SANDSTONE - medium strength, moderately weathered, fractured to slightly fractured, red brown, medium grained sandstone						5.42m: B5°, clay veneer 5.58m: B10°, 10mm sandy clay 5.63m: B5°, 50mm clay 5.68-8.35m: massive sandstone				PL(A) = 0.6MPa
50	5.68	SANDSTONE - medium then high strength, slightly weathered and fresh, unbroken, light grey and red brown, medium to coarse grained, massive sandstone										PL(A) = 0.8MPa
	6								C	100	97	
49	7											PL(A) = 0.9MPa
48	8											PL(A) = 1.4MPa
	8.35	Bore discontinued at 8.35m										
47	9											
46												

RIG: Bobcat **DRILLER:** Steve S **LOGGED:** SI **CASING:** HW to 5.0m

TYPE OF BORING: Solid flight auger to 5.2m; NMLC-Coring to 8.35m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U$_x$	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: STE
Date: 17/3/10

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DOUGLAS PARTNERS PTY LTD
WALLACE WURTH BUILDING UPGRADE, UNSW – KENSINGTON
BORE 7 PROJECT 71543 FEB 2010
NSW KENSINGTON
71543. B/H-7. START. 5.2
START
6
7
8
FIN 8.3 m.
5.20 – 8.30M

BOREHOLE LOG

CLIENT: The University of New South Wales
PROJECT: Proposed Building Upgrade
LOCATION: UNSW, Botany Road, Kensington

SURFACE LEVEL: 55.1 AHD^
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 73492
DATE: 7/6/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
			EW HW MW SW FS FR		Ex Low / Very Low / Low / Medium / High / Very High / Ex High		0.01 / 0.05 / 0.10 / 0.50 / 1.00	B - Bedding J - Joint S - Shear F - Fault				
55	0.1	CONCRETE							A/E			
	0.4	FILLING - yellow brown, sand and crushed sandstone filling, humid							E			
		FILLING - poorly compacted, brown, fine to medium grained sand filling with some sandstone gravel and a trace of organic matter, humid										
54	1								E			
		- with some brick fragments at 1.5m							E			
									S			5,3,2 N = 5
53	2								E			
									E			
									E			
52	3								S			2,2,4 N = 6
	3.4	SAND - loose becoming medium dense, yellow brown, fine to medium grained sand, humid										
51	4								E			
									S			5,10,15 N = 25
50	5											
49	6							Unless otherwise stated rock is fractured along rough planar bedding dipping at 0°-10°				
	6.2	SANDSTONE - extremely low then very low strength, light grey, fine to medium grained sandstone							S			10,35/150mm refusal
	6.47	SANDSTONE - high strength, slightly then moderately weathered, slightly fractured and unbroken, light grey and light purple brown, medium to coarse grained sandstone										PL(A) = 1.1
48	7							7.11m: B0, fe, cly co 1mm				PL(A) = 1.3
47	8								C	100	100	
								8.35m: B20, cly vn				PL(A) = 1.7
46	9	9.05m to 9.58m: fresh										PL(A) = 1.8
	9.58	Bore discontinued at 9.58m										

RIG: Terrier **DRILLER:** Tightsite **LOGGED:** SI/AG **CASING:** HQ to 6.3m

TYPE OF BORING: Diatube to 0.1m, hand auger to 1.5m, solid flight auger to 6.47m, NMLC-Coring to 9.58m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: ^Surface level interpolated from Dwg No K-FME-2013.0002, Rev A, 31.5.13.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

DOUGLAS PARTNERS PTY LTD

PROPOSED BUILDING UPGRADE, UNSW - KENSINGTON

BORE 5 PROJECT 73492 JUNE 2013

6.47 – 9.58m

BOREHOLE LOG

CLIENT: The University of New South Wales
PROJECT: Proposed Building Upgrade
LOCATION: UNSW, Botany Road, Kensington

SURFACE LEVEL: 52.8 AHD^
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 73492
DATE: 6/6/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	0.08	BRICK PAVING										
	0.5	FILLING - brown and yellow brown, fine to medium grained sand filling with a trace of gravel and rootlets, humid							D/E*			
52	1.0	SAND - apparently loose, yellow brown, fine to medium grained sand, humid							B			
		SAND - loose to medium dense becoming medium dense, yellow brown, fine to medium grained sand, humid							D/E			
51	2								D/E			
									E			
									S			3,3,7 N = 10
50	3								A			
									S			4,8,14 N = 22
49	4	- wet below 4.0m				06-06-13						
									S			4,6,20 N = 26
48	4.8 4.9	SANDSTONE - extremely low strength, light grey and orange brown, fine to medium grained sandstone										PL(A) = 1.1
		SANDSTONE - high strength, moderately then slightly weathered, slightly fractured and unbroken, light purple yellow brown and light grey, medium to coarse grained sandstone										PL(A) = 1.6
47	6								C	100	100	PL(A) = 1.4
46	7											PL(A) = 1.4
45								7.68m: B10, cly vn				
	8	8.0 Bore discontinued at 8.0m										
44	9											
43												

RIG: Terrier **DRILLER:** Tightsite **LOGGED:** SI/AG **CASING:** HQ to 4.9m

TYPE OF BORING: Vacuum excavation to 1.4m, solid flight auger to 4.9m, NMLC-Coring to 8.0m

WATER OBSERVATIONS: Free groundwater observed at 4.0m whilst augering

REMARKS: *Environmental sample duplicate BD2/050613, ^surface level interpolated from Dwg No K-FME-2013.0002, Rev A, 31.5.13.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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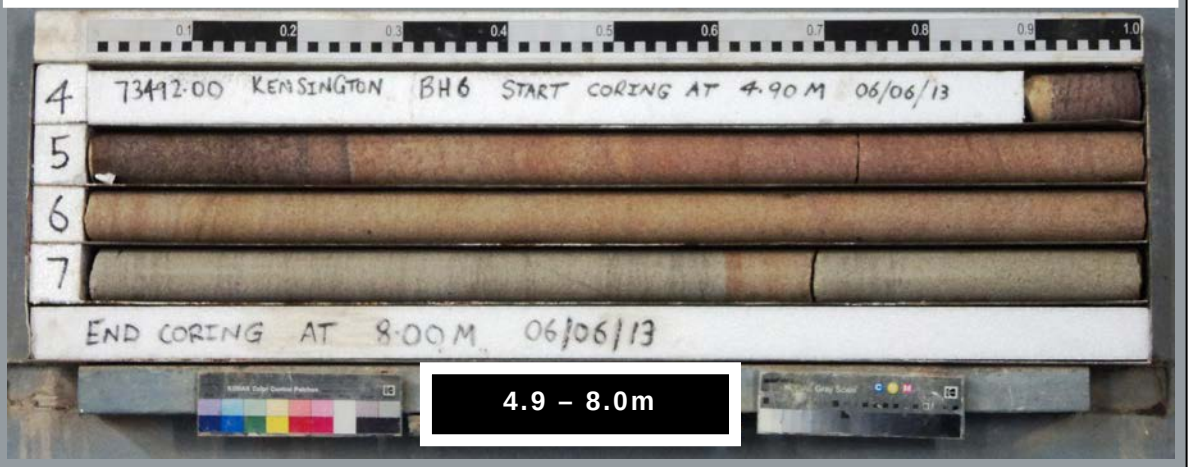
PROPOSED BUILDING UPGRADE, UNSW - KENSINGTON

BORE 6 PROJECT 73492 JUNE 2013



4.9 – 8.0m

Appendix D

Site Photographs

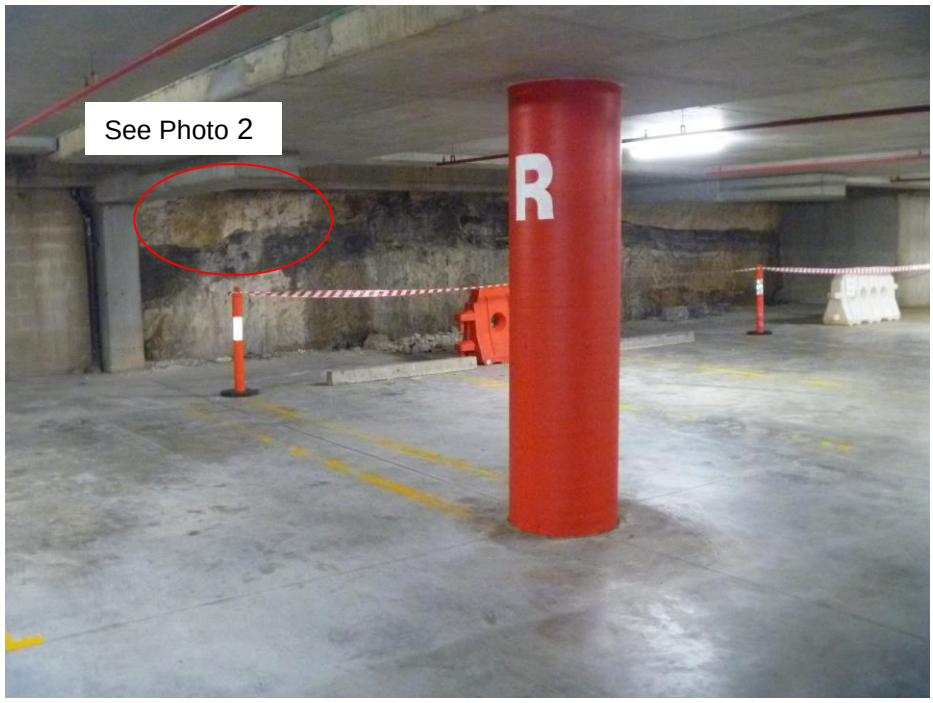


Photo 1 – Medium to high strength sandstone outcrop with 0.3 – 0.9 m thick siltstone band in Car Park Level B4. A rock fall has occurred.

Photo 2 – Calcite staining (i.e. sign of groundwater seepage) on sandstone cutting in Car Park Level B4. Circled area in Photo 1.

Douglas Partners Geotechnics / Environment / Groundwater	**RCR Project** **Hospital Road and High, Magill and Botany Streets,** **Randwick**	PROJECT: 72505.11 PLATE No: 1 REV: 1
	CLIENT: Health Infrastructure	DATE: 30-Nov-17

Photo 3 – Medium to high strength sandstone cutting, up to 2 m high.

Photo 4 – Medium to high strength sandstone cutting, up to 2 m high.

Douglas Partners Geotechnics / Environment / Groundwater	**RCR Project** **Hospital Road and High, Magill and Botany Streets,** **Randwick**	PROJECT: 72505.11 PLATE No: 2 REV: 1
	CLIENT: Health Infrastructure	DATE: 30-Nov-17

Photo 5 – Crocodile cracking along wheel paths in Hospital Road north-bound (near borehole BH2).

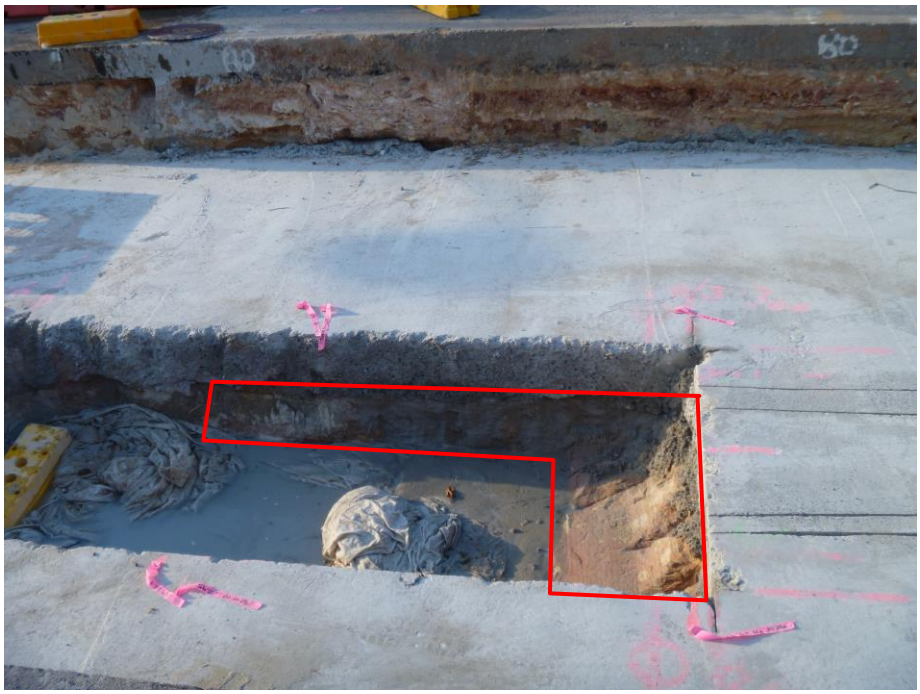


Photo 6 – Ripped sandstone filling over medium strength sandstone at about 1 m below High Street pavement.

Douglas Partners Geotechnics / Environment / Groundwater	**RCR Project** **Hospital Road and High, Magill and Botany Streets,** **Randwick**	PROJECT: 72505.11 PLATE No: 3 REV: 2
	CLIENT: Health Infrastructure	DATE: 30-Nov-17

Appendix E

Results of Current Investigation

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

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Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 2007. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approximate Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and longer sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

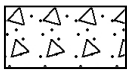
Symbols & Abbreviations

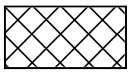
Graphic Symbols for Soil and Rock

General

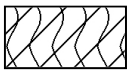
Asphalt

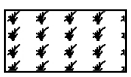
Road base

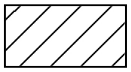

Concrete

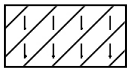

Filling

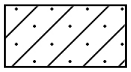
Soils


Topsoil

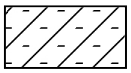

Peat

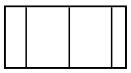

Clay

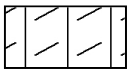

Silty clay

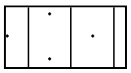

Sandy clay

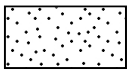
Gravelly clay

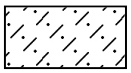

Shaly clay

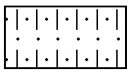

Silt


Clayey silt


Sandy silt

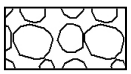

Sand

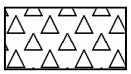

Clayey sand


Silty sand

Gravel

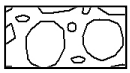
Sandy gravel


Cobbles, boulders

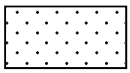

Talus

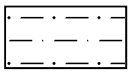
Sedimentary Rocks

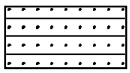
Boulder conglomerate

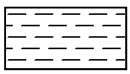

Conglomerate

Conglomeratic sandstone

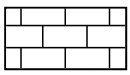

Sandstone


Siltstone

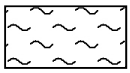

Laminite

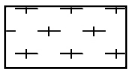

Mudstone, claystone, shale

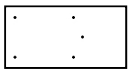
Coal


Limestone

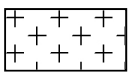
Metamorphic Rocks

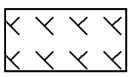

Slate, phyllite, schist

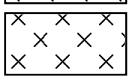

Gneiss

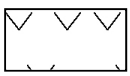

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia

Porphyry

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 48.5 AHD
EASTING: 337072.8
NORTHING: 6245429.4
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 72505.11
DATE: 18 - 19/9/2017
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
48	0.05	ASPHALTIC CONCRETE - typically <10mm diameter										
	0.33	ROADBASE - dark grey, angular, igneous gravel, typically <30mm diameter							A			
	0.75	FILLING - grey-brown medium to coarse grained sand filling with some fine to medium grained sandstone gravel							A			
47	1.3	0.7m: rootlets							A			
		SAND - pale grey, medium grained sand with some dark brown silty bands, damp, occasional rootlets										
46	2	SAND - medium dense, orange-brown, medium grained sand with a trace of clay, damp							S			9,12,10 N = 22
	3							Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 20°				
45	3.4	SANDSTONE - very low strength, light grey medium grained sandstone with some low strength bands										
	3.9	SANDSTONE - medium strength, slightly weathered then fresh, slightly fractured, light grey medium grained sandstone with some carbonaceous flecks						3.94m: J30°, ro, un, cln				PL(A) = 0.89
44	4							4.72m: J30°, he, un, fe stn				PL(A) = 0.4
	5	5.37-5.61m: very low strength band with dark grey siltstone laminations						5.31-5.43m: B (x3) 5°, ro, un, cbs, un 5.53m: Ds, 80mm 5.7m: Ds, 60mm	C	100	83	PL(A) = 0.09
43	6											
								6.65m: Ds, 10mm 6.77m: Ds, 20mm				PL(A) = 0.42
42	7											PL(A) = 0.71
	8							7.92m: B0°- 5°, ro, un, cly vn	C	100	99	PL(A) = 0.83
41	8.8	SANDSTONE - high strength, fresh, slightly fractured and unbroken, light grey medium and coarse grained sandstone. Typically indistinctly bedded										
	9							9.12m: J30°, ro, un, cln				PL(A) = 1.08
40												
39												

RIG: DT100 **DRILLER:** SS **LOGGED:** ARM/RMM **CASING:** HW to 2.5

TYPE OF BORING: Diatube to 0.05m; Non-destructive drilling to 1.6m; Solid flight auger (TC-bit) to 2.5m; Rotary to 3.9m; NMLC-Coring to 18.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Water loss at approximately 14.5m (~50%)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 48.5 AHD
EASTING: 337072.8
NORTHING: 6245429.4
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 72505.11
DATE: 18 - 19/9/2017
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
38		SANDSTONE - high strength, fresh, slightly fractured and unbroken, light grey medium and coarse grained sandstone. Typically indistinctly bedded *(continued)*										PL(A) = 1.32
	11							10.72m: B10°, ro, pl, cly vn				
37									C	100	100	PL(A) = 1.32
	12											
36												PL(A) = 3.34
	13 12.95	SANDSTONE - medium to high strength, fresh, light grey, medium and coarse grained sandstone with some fine quartz gravel bands and carbonaceous laminations										PL(A) = 0.96
35	13.3	SANDSTONE - high strength, fresh, slightly fractured, light grey, medium grained sandstone. Typically indistinctly bedded						13.65m: B5°, ro, un, cln				
	14											PL(A) = 1.86
34									C	100	95	
	15							15.16-15.31m: B (x3) 5°-10°, ro, un, cly vn				PL(A) = 2.33
33								15.53m: J30°, ro, un, cln				
	16 16.0	SANDSTONE - medium strength, fresh, light grey to grey fine to medium grained sandstone with some siltstone laminations										PL(A) = 0.66
32	16.57	SANDSTONE - high strength, fresh, slightly fractured, light grey, medium and coarse grained sandstone. Indistinctly bedded to massive										
	17								C	100	98	
31								17.23-17.28m: B (x2) 0°-5°, ro, un, cly vn				PL(A) = 1.54
	18 18.0	Bore discontinued at 18.0m - target depth reached										
30												
	19											
29												

RIG: DT100 **DRILLER:** SS **LOGGED:** ARM/RMM **CASING:** HW to 2.5

TYPE OF BORING: Diatube to 0.05m; Non-destructive drilling to 1.6m; Solid flight auger (TC-bit) to 2.5m; Rotary to 3.9m; NMLC-Coring to 18.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Water loss at approximately 14.5m (~50%)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

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BORE: 1 PROJECT: RANDWICK SEPTEMBER 2017

3.9m – 8.0m

BORE: 1 PROJECT: RANDWICK SEPTEMBER 2017

8.0m – 13.0m

BORE: 1 PROJECT: RANDWICK SEPTEMBER 2017

13.0m – 18.0m

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 55.2 AHD
EASTING: 337086
NORTHING: 6245508.3
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 72505.11
DATE: 18 - 20/9/2017
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
55	0.05	ASPHALTIC CONCRETE							A			
	0.3	ROADBASE - dark grey, sandy fine to medium grained igneous gravel roadbase (possibly recycled road surface)							A*			
	0.6	FILLING - grey-brown, fine to medium sand filling with trace fine gravel and glass fragments, damp							A			
54	1	SAND - medium dense, yellow-brown, medium grained sand, damp										
									A			
53	2	- with some dark brown silty sand bands to 2.0m							S			4,7,7 N = 14
52	3											
51	4							Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 20°	S			6,11,13 N = 24
50	5	5.0 5.1 SANDSTONE - very low strength, light yellow-brown, medium grained sandstone						5.18m: B0°- 5°, ro, un, fe stn 5.27m: B5°, ro, pl, cln				PL(A) = 0.43
		SANDSTONE - medium strength, slightly weathered, slightly fractured then unbroken, light yellow-brown medium grained sandstone. Typically indistinctly bedded with some distinct ironstained beds										PL(A) = 0.62
49	6								C	100	92	PL(A) = 0.71
48	7							>>				PL(A) = 0.67
47	8								C	100	100	PL(A) = 0.94
46	9	9.47-9.7m: ironstained cross bedding at 70°- 45°						9.47m: B5°, he, fe stn				PL(A) = 0.91

RIG: DT100 **DRILLER:** SS **LOGGED:** ARM/RMM **CASING:** HW to 2.5

TYPE OF BORING: Diatube to 0.05m; Non-destructive drilling to 1.9m; Solid flight auger (TC-bit) to 2.0m; Rotary to 5.1m; NMLC-Coring to 19.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *BD1/20170918 taken at 0.3m to 0.4m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 55.2 AHD
EASTING: 337086
NORTHING: 6245508.3
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 72505.11
DATE: 18 - 20/9/2017
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		SANDSTONE *(continued)*										
45	10.66	SANDSTONE - medium strength, fresh, slightly fractured, light grey medium and fine grained sandstone. Typically indistinctly bedded						10.63m: Ds, 30mm				PL(A) = 0.71
44	11							11.46m: B5°, ro, pl, cly vn	C	100	97	
	11.68	SILTSTONE - low strength, slightly weathered, dark grey siltstone with approximately 30% sandstone beds						11.69m: Ds, 10mm				PL(A) = 0.17
	11.88	SANDSTONE - high strength, fresh, unbroken, light grey to grey, medium and coarse grained sandstone. Typically indistinctly bedded and massive						11.87m: Ds, 10mm				PL(A) = 1.24
43	12											
42	13							13.48m: Ds, 30mm				PL(A) = 0.9
								13.68m: Ds, 20mm				
41	14											PL(A) = 1.22
									C	100	94	
40	15	15.34-15.8m: some distinct siltstone beds						15.09-15.28m: B (x4) 10°, pl, cly, 5mm				PL(A) = 1.29
								15.72m: B10°, pl, he				
39	16							15.76m: Ds, 20mm				PL(A) = 1.31
38	17											PL(A) = 1.52
								17.63m: Ds, 10mm	C	100	99	
37	18											PL(A) = 1.25
36	19 19.0	Bore discontinued at 19.0m - target depth reached										

RIG: DT100 **DRILLER:** SS **LOGGED:** ARM/RMM **CASING:** HW to 2.5

TYPE OF BORING: Diatube to 0.05m; Non-destructive drilling to 1.9m; Solid flight auger (TC-bit) to 2.0m; Rotary to 5.1m; NMLC-Coring to 19.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *BD1/20170918 taken at 0.3m to 0.4m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BORE: 2 PROJECT: RANDWICK SEPTEMBER 2017

5.1m – 9.0m

BORE: 2 PROJECT: RANDWICK SEPTEMBER 2017

9.0m – 14.0m

BORE: 2 PROJECT: RANDWICK SEPTEMBER 2017

14.0m – 19.0m

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 54.6 AHD
EASTING: 337098.7
NORTHING: 6245586
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 72505.11
DATE: 21-9-2017
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
54	0.03	ASPHALTIC CONCRETE - typically <10mm diameter							A/E			
	0.4	ROADBASE - dark grey, sandy gravel, igneous, angular, up to 30mm diameter, damp							A/E			
		FILLING - light brown to brown, fine to medium grained sand filling with traces of fine gravel, damp						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 20°	A/E			
53	1.0	- grey-brown with trace of earthenware fragments from 0.7m							A/E			
	1.5											
	1.6	SAND - apparently medium dense, yellow-brown medium grained sand, damp										
		SANDSTONE - very low strength, light yellow-brown, medium grained sandstone						1.87m: B0°, ro, un, fe stn 2.06-2.09m: B10°, ro, un, cly, 5mm 2.14m: B5°, ro, un, cly & organic material, 5mm 2.22m: Ds, 10mm 2.56-2.58m: B (x2) 5°, ro, un, fe stn 2.68m: B5°, ro, un, cly, 5mm 3.16m: B5°, pl, partially he, fe stn 3.52m: J30°, un, ti 3.68m: B5°, ro, un, fe stn 13.68m: Ds, 30mm 3.72m: J60°- 70°, ro, un, cln 3.85m: Ds, 10mm 3.9m: J60°- 70°, ro, un, cln 3.93m: Ds, 70mm 4.1m: Ds, 10mm 4.22-4.5m: B (x6) un, ti, fe stn, cly, 5-10mm 5.09m: Ds, 10mm 5.3m: Cs, 10mm 5.71m: B10°, ro, pl, fe stn 6.41m: Cs, 10mm 6.52m: Cs, 20mm	C	100	81	PL(A) = 0.32 PL(A) = 0.48 PL(A) = 0.12 PL(A) = 0.14 PL(A) = 0.26 PL(A) = 1.42 PL(A) = 0.08 PL(A) = 1.85
52	2											
		SANDSTONE - medium strength, slightly weathered, slightly fractured, light grey, medium grained sandstone with some ironstaining. Typically indistinctly bedded										
51	3											
	3.67	SANDSTONE - low and very low strength, moderately then slightly weathered, light grey and grey, fine and medium grained sandstone										
	4.0											
50		SANDSTONE - low strength, slightly weathered, slightly fractured, light grey, medium grained sandstone. Typically indistinctly bedded										
	5											
	5.31	SANDSTONE - high strength, slightly weathered then fresh, slightly fractured, light grey medium and coarse grained sandstone. Typically indistinctly bedded										
49	6											
		6.42m:-6.52m: very low strength band										
48		- distinctly bedded from 6.54m										
	7											
								7.14-7.53m: B (x9) 10°, ro, pl, cln or cbs stn	C	100	24	PL(A) = 1.33
47		- medium strength from 7.5m										
	7.7	SANDSTONE - medium then medium to high strength, fresh, slightly fractured to unbroken, light grey to grey, medium grained sandstone with some carbonaceous flecks. Typically massive						7.78m: B5°, ro, un, cln 7.93m: Ds, 20mm				PL(A) = 0.62
	8											PL(A) = 0.52
46								8.55m: B0°, ro, un, cly, 5mm	C	100	99	
	9											
45								9.32m: B0°, ro, un, cly, 5mm				PL(A) = 1.16

RIG: DT100 **DRILLER:** SS **LOGGED:** RMM **CASING:** HW to 1.6m

TYPE OF BORING: Solid flight auger (TC-bit) to 0.03m; Non-destructive drilling to 1.5m; Solid flight auger (TC-bit) to 1.6m; NMLC-Coring to 16.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 54.6 AHD
EASTING: 337098.7
NORTHING: 6245586
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 72505.11
DATE: 21-9-2017
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
44	11	SANDSTONE - medium then medium to high strength, fresh, slightly fractured to unbroken, light grey to grey, medium grained sandstone with some carbonaceous flecks. Typically massive *(continued)*						10.45m: B0°, ro, un, cln				PL(A) = 0.17
		10.36-10.5m: low strength band										PL(A) = 0.82
												PL(A) = 0.89
43									C	100	99	
	12							12.18-12.2m: B (x2) 0°-10°, pl, ro, cln				PL(A) = 1.16
42												
	13											PL(A) = 1.2
41												
	14											
40	14.82	SANDSTONE - medium to high strength, fresh, slightly fractured, light grey medium grained sandstone with some medium strength bands. Typically distinctly bedded						14.78m: Ds, 40mm	C	100	96	PL(A) = 1.09
	15											PL(A) = 1.21
39								15.67m: J30°- 40°, ro, un, cln				
	16	16.0 Bore discontinued at 16.0m - target depth reached						15.75-15.9m: B (x2) 10°, ro, pl, cln				PL(A) = 0.76
38												
	17											
37												
	18											
36												
	19											
35												

RIG: DT100 **DRILLER:** SS **LOGGED:** RMM **CASING:** HW to 1.6m

TYPE OF BORING: Solid flight auger (TC-bit) to 0.03m; Non-destructive drilling to 1.5m; Solid flight auger (TC-bit) to 1.6m; NMLC-Coring to 16.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BORE: 3 PROJECT: RANDWICK SEPTEMBER 2017

1.6m – 6.0m

BORE: 3 PROJECT: RANDWICK SEPTEMBER 2017

6.0m – 11.0m

BORE: 3 PROJECT: RANDWICK SEPTEMBER 2017

11.0m – 16.0m

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 51.9 AHD
EASTING: 337044.9
NORTHING: 6245563
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 72505.11
DATE: 19 - 21/9/2017
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
51	0.04	ASPHALTIC CONCRETE (typically <10mm diameter)							A			
	0.07											
	0.2	ASPHALTIC CONCRETE (typically <20mm diameter)							A			
	0.8	ROADBASE - dark grey, angular, igneous gravel typically 40-80mm diameter, slight hydrocarbon odour							A			
	1	FILLING - orange-brown, medium grained sand filling with some sandstone gravel and a trace of clay (ripped sandstone)							A			
50	2	SAND - pale yellow-brown, fine to medium grained sand, damp 2.2m: brown							A			
	2.6	SAND - medium dense to dense, orange, fine to medium sand with some clay, damp						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 20°	S			8,14,17 N = 31
49	3											
	3.5	SANDSTONE - extremely low to very low strength sandstone										
	3.65	SANDSTONE - low strength, slightly weathered, fractured to slightly fractured, pale brown, medium to coarse grained sandstone						3.75m: B0°, pl, ro, cln 4.12-4.14m: Ds, 20mm, cly	C	100	98	PL(A) = 0.22
48	4											
	4.15	SANDSTONE - medium strength, slightly weathered then fresh, slightly fractured and fractured, medium to coarse grained sandstone - limonite staining to 4.40m 5.5m: distinct irregular bedding dipping 15°- 20°										PL(A) = 0.76
47	5							5.21m: B0°, pl, ro, co, sandy clay, 5mm 5.23m: Ds, 15mm, cly				
								5.71m: B20°, pl, vn, co, 5mm sandy cly				PL(A) = 0.71
46	6							5.92m: B20°, pl, ro, stn, cly 5.96m: B20°, pl, ro, vn, cly 6.14m: B20°, pl, ro, vn, cly				
		6.4m: indistinct irregular bedding dipping 0°- 20°							C	100	99	PL(A) = 0.71
45	6.91	SANDSTONE - medium strength, fresh, slightly fractured and unbroken, pale grey, medium to coarse grained sandstone, massive, trace carbonaceous flecks										
44	7							7.63m: Ds, 15mm sandy clay				
	8											PL(A) = 0.66
43	9							>>	C	100	95	PL(A) = 0.95
42												PL(A) = 0.73

RIG: Bobcat **DRILLER:** GM **LOGGED:** ARM **CASING:** HW to 3.65m

TYPE OF BORING: Diatube to 0.08m; NDD to 1.7m; Solid flight auger (TC-bit) to 3.65m; NMLC-Coring to 17.31m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Well installed, blank to 4.0 m, screen to 7.0 m, gatic cover at surface, asphalt to 0.2 m, sand & cement to 3.0 m, bentonite to 3.8 m, sand to 7.0 m, bentonite to 8.0 m, NDD = Non-destructive drilling

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 51.9 AHD
EASTING: 337044.9
NORTHING: 6245563
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 72505.11
DATE: 19 - 21/9/2017
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
41	11	SANDSTONE - medium strength, fresh, slightly fractured and unbroken, pale grey, medium to coarse grained sandstone, massive, trace carbonaceous flecks *(continued)*						10.91-10.94m: Ds, 30mm, cly 11.03-11.06m: Ds, 30mm cly	C	100	95	PL(A) = 0.61
40	12	12.0 SANDSTONE - medium to high strength, fresh, slightly fractured to unbroken, pale grey, medium to coarse grained sandstone, indistinct bedding typically dipping 10°- 20°						12.42m: Ds, 10mm, sandy cly				PL(A) = 0.69
39	13								C	100	98	PL(A) = 1.1
38	14							13.29-13.31m: 20mm sandy cly 13.51-13.54m: Ds, 30mm, sandy cly				PL(A) = 0.91
37	15	14.6 SANDSTONE - high then medium strength, fresh, unbroken, pale grey, fine to medium grained sandstone, occasional carbonaceous laminations and flecks						14.59-14.64m: Ds, 50mm, sandy cly 14.83m: B0°- 5°, un, sm, vn, cbs				PL(A) = 1.33
36	16								C	100	94	PL(A) = 0.59
35	17	16.78-16.97m: siltstone clasts and laminations, slightly fractured						16.85m: B10°, un, sm, co, cly, 5-10mm 16.94-16.97m: Ds, 30mm, sandy cly				PL(A) = 0.76
34	18	17.31 Bore discontinued at 17.31m - target depth reached										
33	19											
32												

RIG: Bobcat **DRILLER:** GM **LOGGED:** ARM **CASING:** HW to 3.65m

TYPE OF BORING: Diatube to 0.08m; NDD to 1.7m; Solid flight auger (TC-bit) to 3.65m; NMLC-Coring to 17.31m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Well installed, blank to 4.0 m, screen to 7.0 m, gatic cover at surface, asphalt to 0.2 m, sand & cement to 3.0 m, bentonite to 3.8 m, sand to 7.0 m, bentonite to 8.0 m, NDD = Non-destructive drilling

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⊻	Water level	V	Shear vane (kPa)

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BORE: 4 PROJECT: RANDWICK SEPTEMBER 2017

3.65m – 8.0m

BORE: 4 PROJECT: RANDWICK SEPTEMBER 2017

8.0m – 13.0m

BORE: 4 **PROJECT: RANDWICK** **SEPTEMBER 2017**

13.0m – 17.31m

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 49.4 AHD
EASTING: 337032.3
NORTHING: 6245476.3
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 72505.11
DATE: 19 - 25/9/2017
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
49	0.05	ASPHALTIC CONCRETE (typically <10mm diameter)										
	0.15	ROADBASE - dark grey, angular, igneous gravel typically 40-80mm diameter, slight hydrocarbon odour							A			
	0.35	FILLING - pale grey and brown sandstone gravel and cobbles up to 100mm diameter (ripped sandstone)							A			
48	1.1	SAND - grey-brown, fine to medium grained sand with a trace of fine gravel, humid (possibly filling) 0.9m: becoming dark brown							A*			
47	2	SAND - dark brown, fine to coarse grained sand with some silt and a trace of fine gravel, damp (possibly filling)							A			
	2.6	SAND - medium dense, yellow-brown, fine to medium grained sand, damp							S			6,9,9 N = 18
46	3								B			
45	4							Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 20°	S			4,13,30/140mm refusal
	4.6	SANDSTONE - very low strength, orange-brown sandstone										
	4.65	SANDSTONE - low strength, slightly and moderately weathered, unbroken, orange-brown sandstone with some fine quartz gravel 4.77-5.15m: distinct ironstaining										PL(A) = 0.24
44	5											
	5.9	SANDSTONE - medium strength, fresh, slightly fractured, slightly fractured, pale grey, medium to coarse grained sandstone with trace of carbonaceous flecks						5.9m: B0°, pl, ro, co, sandy cly, 5mm	C	100	98	PL(A) = 0.48
43	6							6.45-6.56m: J 6.56m: B0°, pl, ro, cly vn				
42	7											PL(A) = 0.8
	7.72	SILTSTONE - low strength, fresh, slightly fractured to unbroken,						7.72m: B0°, pl, sm, cly vn				PL(A) = 0.15
	8.05	slightly fractured to unbroken, dark grey siltstone with 20% fine sand						8.05m: B5°, pl, sm, stn, sandy cly				
41	8	LAMINITE - low strength, fresh, slightly fractured to unbroken, dark grey siltstone interlaminated and interbedded with 30% pale grey, fine grained sandstone, horizontally bedded							C	100	100	
	9.09	8.27-8.38m: disturbed bedding, possible healed shear zone										PL(A) = 0.19
40	9							9.42m: Ds, 10mm, sandy cly				
		SANDSTONE - see next page										PL(A) = 1.2

RIG: Bobcat **DRILLER:** GM **LOGGED:** ARM **CASING:** HW to 4.65m

TYPE OF BORING: Diatube to 0.05m; Non-destructive drilling to 1.6m; Solid flight auger to 4.65m; NMLC-Coring to 16.77m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *BD1/20170919 replicate taken at 1.3m to 1.4m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 49.4 AHD
EASTING: 337032.3
NORTHING: 6245476.3
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 72505.11
DATE: 19 - 25/9/2017
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
39		SANDSTONE - high strength, fresh, unbroken then slightly fractured, medium to coarse grained sandstone *(continued)*							C	100	100	
38	11	10.94-11.22m: fine to medium grained 11.22m: distinct cross bedding typically dipping 20°						10.93m: B5°, pl, ro, cly co, 5mm				PL(A) = 0.79
37	12	12.07m: massive							C	100	100	PL(A) = 1.59
36	13							13.5m: B10°, pl, ro, cly vn				PL(A) = 1.18
35	14	14.2-14.4m: fine to medium grained 14.4m: massive						14.39m: B5°, pl, ro, cly co, 5mm				PL(A) = 1.45 PL(A) = 1.62
34	15	15.21m: indistinct irregular bedding dipping 0°- 20°						15.21m: B10°, pl, ro, cly vn 15.59m: Ds, sandy cly, 10mm	C	100	100	PL(A) = 1.76
33	16											PL(A) = 1.26
	16.77	Bore discontinued at 16.77m - target depth reached										PL(A) = 1.63
32	17											
31	18											
30	19											

RIG: Bobcat **DRILLER:** GM **LOGGED:** ARM **CASING:** HW to 4.65m

TYPE OF BORING: Diatube to 0.05m; Non-destructive drilling to 1.6m; Solid flight auger to 4.65m; NMLC-Coring to 16.77m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *BD1/20170919 replicate taken at 1.3m to 1.4m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BORE: 5 PROJECT: RANDWICK SEPTEMBER 2017

4.65m – 9.0m

BORE: 5 PROJECT: RANDWICK SEPTEMBER 2017

9.0m – 14.0m

BORE: 5 PROJECT: RANDWICK SEPTEMBER 2017

14.0m – 16.77m

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 47.6 AHD
EASTING: 336968.9
NORTHING: 6245421.4
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 72505.11
DATE: 19 - 22/9/2017
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Type	Core Rec. %	RQD %	Test Results & Comments
47	0.06	ASPHALTIC CONCRETE (typically <10mm diameter)		A			
	0.25	ROADBASE - dark grey/black, sandy gravel, angular, igneous (typically <40mm diameter)		A			
	0.6	FILLING - grey-brown, gravelly sand filling with a trace of clay, fine to medium igneous and sandstone gravel, damp		A			
46	1	FILLING - brown, medium sand filling with some fine sandstone gravel, cobbles and clay, damp (crushed sandstone)		A			
	2			A			
	2.3	SAND - loose, brown, fine to medium grained sand, damp		S			0,2,2 N = 4
45	3						
44	4						
	4.0	SAND - medium dense, fine to medium grained sand, damp		S			8,11,9 N = 20
43	4.6	SAND - medium dense, orange-brown, fine to medium grained sand with some clay, moist		A			
	5						
	5.2	CLAYEY SAND - very dense, grey-brown, clayey fine to medium grained sand, wet 5.5m: grey		A S			5,17,20 N = 37
42	6						
41	6.9	SANDSTONE - low strength, slightly weathered, fractured to slightly fractured, pale grey and orange, medium to coarse grained sandstone					PL(A) = 0.15
	7						
40	8			C	100	81	PL(A) = 0.12
39		8.61-8.66m: disturbed siltstone laminations					
	8.77	SANDSTONE - medium strength, fresh, slightly fractured, pale grey, medium to coarse grained sandstone, indistinct bedding typically dipping 10°- 20°					PL(A) = 0.77
	9			C	100	99	
38							PL(A) = 0.94

Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 20°

Discontinuities: B - Bedding, J - Joint, S - Shear, F - Fault

7.6-7.67m: Ds, 70mm, cly
7.82-7.86m: Ds, 40mm, cly
7.95-7.98m: Ds, 30mm, cly
8.36m: B20°, pl, ro, un, cly
8.43m: B20°, pl, ro, cly co, 7mm
8.56-8.63m: Ds, 70mm cly
8.75m: Ds, 15mm, sandy cly
9m: B20°, pl, ro, cly vn
9.06m: B10°, pl, ro, stn, cly

RIG: Bobcat **DRILLER:** GM **LOGGED:** ARM **CASING:** HW to 6.0m

TYPE OF BORING: Diatube to 0.06m; Non-destructive drilling to 1.5m; Solid flight auger (TC-bit) to 5.5m; Washbore to 6.88m; NMLC-Coring to 16.5m

WATER OBSERVATIONS: Free groundwater observed at 5.0m whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 47.6 AHD
EASTING: 336968.9
NORTHING: 6245421.4
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 72505.11
DATE: 19 - 22/9/2017
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
37		SANDSTONE - medium strength, fresh, slightly fractured, pale grey, medium to coarse grained sandstone, indistinct bedding typically dipping 10°- 20° *(continued)*						9.9m: B5°, pl, ro, cly vn 10.6m: Cs, 20mm cly	C	100	99	PL(A) = 1.6
	10.85											
36	11	SANDSTONE - high strength, fresh, unbroken, pale grey, medium to coarse grained sandstone, irregular bedding dipping 0°- 20°										
35	12							>>				PL(A) = 1.41
34	13								C	100	100	PL(A) = 1.95
	14											PL(A) = 1.41
33		14.56m: slightly fractured						14.56m: B20°, pl, ro, cly vn 14.65m: B15°, pl, ro, cly co, 3mm 15.13m: B15°, pl, ro, co, 5mm sandy cly 15.39m: B20°, pl, ro, cly stn				PL(A) = 1.37
32	15	15.55m: with some fine quartz gravel bands							C	100	93	
	16											PL(A) = 2.78
31		16.45-16.5m: siltstone band						16.18m: B20°, pl, vr, cly stn 16.45-16.49m: Cz, 30°-50°, cu, sm, 40mm, cly & siltstone				
	16.5	Bore discontinued at 16.5m - target depth reached										
30	17											
29	18											
28	19											

RIG: Bobcat **DRILLER:** GM **LOGGED:** ARM **CASING:** HW to 6.0m

TYPE OF BORING: Diatube to 0.06m; Non-destructive drilling to 1.5m; Solid flight auger (TC-bit) to 5.5m; Washbore to 6.88m; NMLC-Coring to 16.5m

WATER OBSERVATIONS: Free groundwater observed at 5.0m whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BORE: 6 PROJECT: RANDWICK SEPTEMBER 2017

6.9m – 11.0m

BORE: 6 PROJECT: RANDWICK SEPTEMBER 2017

11.0m – 16.0m

BORE: 6 PROJECT: RANDWICK SEPTEMBER 2017

16.0m – 16.5m

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 54.6 AHD
EASTING: 336990.5
NORTHING: 6245617.7
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 72505.11
DATE: 6-10-2017
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
54	0.2	FILLING - brown, fine to medium grained sand filling with traces of rootlets, humid							A/E			
		SAND - loose to medium dense becoming medium dense, yellow-brown mottled orange-brown fine to medium grained sand, damp							A/E			
53	1								A/E			
									S			4,5,5 N = 10
52	2								S			7,10,10 N = 20
51	3	3.5m: becoming orange-brown with traces of clay						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 20°				
	3.9	SANDSTONE - low to medium strength, orange-brown and grey medium to coarse grained sandstone							S			10/50mm refusal bouncing
50	4.1	SANDSTONE - low to medium strength, slightly weathered, slightly fractured, orange-brown and light grey, medium to coarse grained sandstone. Bedding typically indistinct and ironstained						4.32m: Cs, 10mm 4.77m: Cs, 5mm 4.91m: Cs, 20mm 4.95m: Cs, 15mm 5.09m: CORE LOSS: 50mm				PL(A) = 0.31 PL(A) = 0.35 PL(A) = 0.19
49	5.09 5.14	SANDSTONE - medium strength, slightly weathered, slightly fractured to unbroken, orange-brown and light grey, medium to coarse grained sandstone 5.14-5.7m: cross bedding at approximately 40°, bedding typically indistinct							C	98	97	PL(A) = 0.72 PL(A) = 0.75 PL(A) = 0.81
48	7	7.77-7.94m: extremely low to very low strength ironstained seam						7.77m: Ds, 170mm				PL(A) = 0.25
47	7.94	SANDSTONE - low to medium strength, slightly weathered, slightly fractured, light grey, medium grained sandstone. Bedding typically indistinct						8.26m: B0°- 10°, un, cly, 5mm 8.62m: B0°- 10°, ro, un, cly vn	C	100	92	PL(A) = 0.26 PL(A) = 0.17
46	9											
45	9.48	SANDSTONE - see next page						9.42m: Cs, 60mm				PL(A) = 0.48

RIG: DT100 **DRILLER:** RKE **LOGGED:** RMM **CASING:** HW to 4.0m; HQ to 4.1m

TYPE OF BORING: Solid flight auger (TC-bit) to 4.0m; Rotary to 4.1m; NMLC-Coring to 20.47m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Groundwater monitoring well installed (screen 4.0-20.47m; gravel 5.0-20.47m; bentonite 3.5-5.0m; backfill surface to 3.5m with concrete set gatic cover). Groundwater well purged >3 well volumes following installation

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⏚	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 54.6 AHD
EASTING: 336990.5
NORTHING: 6245617.7
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 72505.11
DATE: 6-10-2017
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
44	11	SANDSTONE - medium strength, slightly weathered to fresh, slightly fractured to unbroken, light grey medium to coarse grained sandstone. Massive with some siltstone flecking to indistinctly bedded with approximately 5% siltstone bands *(continued)*						10.46m: J15°- 20°, ro, un, cln	C	100	99	PL(A) = 0.84 PL(A) = 0.62
	11.12	SANDSTONE - high strength slightly weathered to fresh, slightly fractured to unbroken, light grey medium to coarse grained sandstone with some low and very high strength bands. Massive with some siltstone flecking, to indistinctly bedded with approximately 10% siltstone bands						11.11m: Ds, 10mm				PL(A) = 3.2
43	12								C	100	99	PL(A) = 1.37
42	13							12.44m: Ds, 20mm				PL(A) = 3.56
41		13.33-13.6m: fine grained band						13.3-13.31m: B (x2) 0°, ro, un, cbs vn 13.61m: Ds, 30mm				PL(A) = 1.9 PL(A) = 0.12
40	14								C	100	98	PL(A) = 1.86
	15							14.58m: B20°, pl, he				PL(A) = 1.13
39	16											PL(A) = 0.74
38								16.32m: J45°, ro, un, cln 16.32-16.34m: B (x2) 5°-10°, ro, un, cbs vn				PL(A) = 1.26
	17	16.95-18.05m: fine grained band with some carbonaceous laminations						17m: Ds, 10mm				PL(A) = 0.16
37								17.39m: B0°- 5°, ro, un, cbs vn 17.59m: B0°- 5°, ro, pl, cbs vn	C	100	97	PL(A) = 1.22
	18							17.9m: B0°- 5°, ro, pl, cbs vn 18.05m: Ds, 20mm				PL(A) = 1.46
36								18.39-18.45m: J30°-60°,un, he, cbs, 1mm 18.77m: Ds, 20mm				
	19							19.19m: B5°, ro, pl, cln				PL(A) = 1.39
35								19.77m: B0°- 5°, ro, un, cbs vn	C	100	100	

RIG: DT100 **DRILLER:** RKE **LOGGED:** RMM **CASING:** HW to 4.0m; HQ to 4.1m

TYPE OF BORING: Solid flight auger (TC-bit) to 4.0m; Rotary to 4.1m; NMLC-Coring to 20.47m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Groundwater monitoring well installed (screen 4.0-20.47m; gravel 5.0-20.47m; bentonite 3.5-5.0m; backfill surface to 3.5m with concrete set gatic cover). Groundwater well purged >3 well volumes following installation

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BORE: 7 PROJECT: RANDWICK OCTOBER 2017

4.1m – 8.0m

BORE: 7 PROJECT: RANDWICK OCTOBER 2017

8.0m – 13.0m

BORE: 7 PROJECT: RANDWICK OCTOBER 2017

13.0m – 18.0m

BORE: 7 PROJECT: RANDWICK OCTOBER 2017

18.0m – 20.47m

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 54.6 AHD
EASTING: 336990.5
NORTHING: 6245617.7
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 72505.11
DATE: 6-10-2017
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
34		SANDSTONE *(continued)*						20.24m: B5°, ro, pl, cln	C	100	100	PL(A) = 0.88
	20.47	Bore discontinued at 20.47m - target depth reached						20.42m: J20°, ro, un, cln				
33	21											
32	22											
31	23											
30	24											
29	25											
28	26											
27	27											
26	28											
25	29											

RIG: DT100 **DRILLER:** RKE **LOGGED:** RMM **CASING:** HW to 4.0m; HQ to 4.1m

TYPE OF BORING: Solid flight auger (TC-bit) to 4.0m; Rotary to 4.1m; NMLC-Coring to 20.47m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Groundwater monitoring well installed (screen 4.0-20.47m; gravel 5.0-20.47m; bentonite 3.5-5.0m; backfill surface to 3.5m with concrete set gatic cover). Groundwater well purged >3 well volumes following installation

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 50.5 AHD
EASTING: 337038.1
NORTHING: 6245507
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 72505.11
DATE: 23 - 24/1/2018
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
50	0.1	ASPHALTIC CONCRETE (typically <10mm diameter)										
	0.25	ROADBASE - dark grey, angular, igneous gravel typically 40-80mm diameter							A			
	0.6	FILLING - pale grey and brown sandstone gravel and cobbles up to 100mm diameter (ripped sandstone)							A*			
49	1	SAND - pale brown, medium grained sand with a trace of fine gravel, damp										
									A			
48	2							Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 20°				
	2.6	SANDSTONE - extremely low strength, orange-brown sandstone							S			7,10/10mm refusal
	2.77	SANDSTONE - low to medium strength, slightly weathered, fractured to slightly fractured, orange and grey, medium to coarse grained sandstone										PL(A) = 0.26
47	3								C	100	100	
								3.71m: B15°, vn, cly				PL(A) = 0.43
	4							4.15m: B10°, vn, cly				
46								4.38m: B20°, co, cly, 2mm				
								4.61m: B20°, co, sandy cly, 1mm				
	5							4.64m: B15°, co, cly, 2mm				PL(A) = 0.6
45	5.45	SANDSTONE - high then medium strength, fresh, slightly fractured to unbroken, pale grey, medium to coarse grained sandstone with a trace of carbonaceous flecks						4.72m: B0°, sm, co, cly, 3mm	C	100	95	
	6											PL(A) = 1.12
44		6.4-6.9m: red-brown iron staining										
								6.49m: B0-5°, cu, co, cly, 10mm				
	7							6.69-6.76m: J50°, un, ro, vn, fe				PL(A) = 0.69
43												
	8											PL(A) = 0.63
		8.1-8.55m: low strength band										
42								>>	C	100	100	PL(A) = 0.22
	9											PL(A) = 0.63
41												
												PL(A) = 1.03

RIG: Bobcat **DRILLER:** GM **LOGGED:** ARM **CASING:** HW to 2.5m; HQ to 2.7m

TYPE OF BORING: Diatube to 0.10m; Non-destructive drilling to 1.7m; Solid flight auger (TC-bit) to 2.77m; NMLC-Coring to 17.39m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Well installed, blank to 2.0 m, screen to 3.0 m, gatic cover at surface, asphalt to 0.2 m, sand & cement to 0.8 m, bentonite to 1.5 m, sand to 3.0 m, bentonite to 3.5 m, *BD1/20180123 replicate taken at 0.4m to 0.5m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BORE: 8 PROJECT: RANDWICK JANUARY 2018

2.77m – 7.0m

BORE: 8 PROJECT: RANDWICK JANUARY 2018

7.0m – 12.0m

BORE: 8 PROJECT: RANDWICK JANUARY 2018

12.0m – 17.0m

BORE: 8 PROJECT: RANDWICK JANUARY 2018

17.0m – 17.39m

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 50.5 AHD
EASTING: 337038.1
NORTHING: 6245507
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 72505.11
DATE: 23 - 24/1/2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
40	10.41	10.2-10.41m: with 25% siltstone clasts up to 20mm diameter, fragmented (possibly drilling induced)						10.14-10.41m: fg, 270mm 10.41m: B0°, sm, co, cly, 5mm	C	100	88	
		LAMINITE - low strength, fresh, slightly fractured, dark grey siltstone interlaminated and interbedded with 40% pale grey, fine grained sandstone						10.73m: J35°, sm, co, cly, 1mm 11.04m: J30°x2, sm, vn, cly				PL(A) = 0.18
39	11.45	SANDSTONE - high strength, fresh, slightly fractured to unbroken, pale grey, medium to coarse grained sandstone, massive						11.38-11.45m: J30-45°x3, sm, vn, cly 11.57m: B0°, vn, cly 11.78m: B0°, vn, cly	C	100	88	PL(A) = 2.23
38	12											PL(A) = 1.54
37	13	12.84-13.03m: with 50% carbonaceous laminations 13.03-13.21: fine to medium grained 13.21m: medium to coarse grained, irregular bedding dipping 10-20°						12.79m: Ds, 20mm, sandy cly 12.96m: Ds, 20mm, sandy cly 13.21m: B10°, vn, cly				PL(A) = 1.19
36	14							13.97m: Ds, 15mm, cly 14.38m: B20°, vn, cly	C	100	99	
35	15	14.8m: massive										PL(A) = 1.27
34	16	16.44m: irregular bedding dipping 10-20°						16.44m: B0-10°, cu, co, sandy cly, 10mm	C	100	99	PL(A) = 1.36
33	17											PL(A) = 1.57
	17.39	Bore discontinued at 17.39m - target depth reached						17.29m: B20°, vn, cly				
32	18											
31	19											

RIG: Bobcat **DRILLER:** GM **LOGGED:** ARM **CASING:** HW to 2.5m; HQ to 2.7m

TYPE OF BORING: Diatube to 0.10m; Non-destructive drilling to 1.7m; Solid flight auger (TC-bit) to 2.77m; NMLC-Coring to 17.39m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Well installed, blank to 2.0 m, screen to 3.0 m, gatic cover at surface, asphalt to 0.2 m, sand & cement to 0.8 m, bentonite to 1.5 m, sand to 3.0 m, bentonite to 3.5 m, *BD1/20180123 replicate taken at 0.4m to 0.5m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 49.2 AHD
EASTING: 337026.2
NORTHING: 6245465.1
DIP/AZIMUTH: 90°/--

BORE No: 9
PROJECT No: 72505.11
DATE: 23 - 25/1/2018
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
49	0.05	ASPHALTIC CONCRETE (typically <10mm diameter)							A			
	0.15	ROADBASE - dark grey, angular, igneous gravel typically 40-80mm diameter										
	0.4	FILLING - pale grey and brown sandstone gravel and cobbles up to 150mm diameter (ripped sandstone)							A			
48	1											
	1.3	SAND - dark grey, slightly silty fine to medium grained sand with a trace of rootlets, humid							A			
		SAND - pale grey, medium grained sand, damp										
47	2	2.2-2.4m: dark brown, silty band							A			
	2.4	SAND - medium dense, yellow-brown, fine to medium grained sand, damp							S			3,5,5 N = 10
46	3											
45	4								S			5,7,7 N = 14
44	5	5.0m: becoming clayey										
	5.5	SILTY CLAY - stiff, orange-brown and grey, silty clay with some fine sand, Mc>PL						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 20°	S			3,7,9 N = 16
	5.8											
43	6											
	6.03	CLAY - stiff, grey, clay with some silt, high plasticity, Mc~PL						6.03-6.10m: Cs, 70mm				pp = 450
		LAMINITE - extremely low strength, extremely weathered, interbedded then interlaminated pale grey sandstone and dark grey siltstone (soil like properties)										pp = 350
42	7	6.2-6.5m: Distinct orange iron staining							C	100	28	pp = 550-600 PL(A) = 0.05 pp = 450-600
	7.8	SANDSTONE - medium strength, fresh, slightly fractured, pale grey, medium to coarse grained sandstone, irregular bedding dipping 10-20°						7.8m: B5°, sm, co, cly, 2mm				PL(A) = 0.6
41	8	8.5-8.56m: 50% fine siltstone laminations										
	8.92	SANDSTONE - high strength, fresh, slightly fractured to unbroken, pale grey, medium to coarse grained sandstone, irregular bedding dipping 10-20°						8.9m: Ds, 20mm, cly	C	100	98	PL(A) = 1.11
40	9							9.54m: B20°, vn, cly 9.7m: B20°, vn, cly				PL(A) = 1.04

RIG: Bobcat **DRILLER:** GM **LOGGED:** ARM **CASING:** HW to 4.0m; HQ to 6.0m

TYPE OF BORING: Diatube to 0.10m; NDD to 1.6m; Solid flight auger (TC-bit) to 4.0 m; Rotary to 6.03 m; NMLC-Coring to 17.49m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Well installed, blank to 1.5 m, screen to 6.5 m, gatic cover at surface, asphalt to 0.2 m, sand & cement to 0.8 m, bentonite to 1.3 m, sand to 6.5 m, bentonite to 7.5 m, NDD = Non-Destructive Drilling

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

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BORE: 9 PROJECT: RANDWICK JANUARY 2018

6.03m – 10.0m

BORE: 9 PROJECT: RANDWICK JANUARY 2018

10.0m – 15.0m

BORE: 9 PROJECT: RANDWICK JANUARY 2018

15.0m – 17.49m

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 52.2 AHD
EASTING: 337082
NORTHING: 6245474
DIP/AZIMUTH: 90°/--

BORE No: 10
PROJECT No: 72505.13
DATE: 2-5-2018
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
52	0.07	ASPHALTIC CONCRETE							D			
		ROADBASE: dark grey, sand fine to coarse igneous gravel, damp (typically <30 mm diameter)										
	0.6	FILLING: brown medium to coarse sandy filling with some silt, damp							D			
	0.9	SAND: brown, medium sand with trace silt, damp										
51	1											
		2.1 m: medium dense							S			3,6,10 N = 16
50	2											
49	3								S			10,20/20 refusal
	3.8	Possibly very low strength rock						3.8m: CORE LOSS: 1200mm	C	0	0	Core Loss
48	4											
47	5											PL(A) = 0.48
	5.0	SANDSTONE: medium strength, moderately weathered, slightly fractured, red/brown, medium grained sandstone						5.67m: B0°, pl, ro, cly vn	C	100	99	
46	6											PL(A) = 0.08
	6.3	SANDSTONE: very low strength, slightly weathered, slightly fractured, grey-brown, medium grained sandstone						6.3m: B0° pl, ro, cly vn 6.37-6.72m: J15-30° he, un, fe stn 6.41m: J30° pl, ro, cnn 6.61m: Cs, 50 mm				
	6.75	SANDSTONE: low strength, fresh stained, slightly fractured, light grey, fine to medium grained sandstone, some carbonaceuos flakes, typically indistinct bedding						6.89m: J30° pl, ro, cly co	C	100	96	PL(A) = 0.15
45	7											
	7.89	SILTSTONE: very low strength, slightly weathered, unbroken, dark grey siltstone with sandstone laminations (20%)						7.89-8.31m: B0-5°, pl, ro, cly 5mm				PL(A) = 0.05
44	8											
	8.32	SANDSTONE: medium and medium to high strength, fresh, slightly fractured to unbroken, light grey, fine to medium grained sandstone										PL(A) = 0.85
43	9								C	100	99	PL(A) = 0.48
								9.54-9.71m: B(x2) 5° pl, ro, cln 9.55m: B5° pl, sm, cln				

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** HW to 4.0 m

TYPE OF BORING: Diatube to 0.1 m, Non-destructive drilling to 1.9 m, solid flight auger (TC-bit) to 3.8 m, NMLC coring to 14.9 m

WATER OBSERVATIONS: No free ground water observed whilst augering, 20% water loss from 3.8-6.0 m, 50% water loss from 11.0-11.5 m

REMARKS: Well installed, blank to 4.3 m, screen to 7.3 m, gatic cover at surface, asphalt to 0.2 m, sand & cement to 3.3 m, bentonite to 4.3 m, sand to 7.6, bentonite to 8.5 m, sand to 14.9 m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 52.2 AHD
EASTING: 337082
NORTHING: 6245474
DIP/AZIMUTH: 90°/--

BORE No: 10
PROJECT No: 72505.13
DATE: 2-5-2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
42		SANDSTONE: medium and medium to high strength, fresh, slightly fractured to unbroken, light grey, fine to medium grained sandstone *(continued)*						9.71m: B5° pl, sm, cln				
		10.47-12.9 m: cross bedding typically 5-15°						10.37m: B5° pl, sm, cln 10.47m: Cs, 30 mm 10.47-10.51m: Ds, 40 mm	C	100	99	PL(A) = 0.3 PL(A) = 0.47
41	11											
40	12							11.96-12.03m: J60° pl, ro, cln	C	100	96	PL(A) = 0.98
39	13							12.86-12.90m: Cs, 40 mm				
38	14								C	100	100	PL(A) = 1.08 PL(A) = 0.5
	14.9	Bore discontinued at 14.9m Target depth reached										
37	15											
36	16											
35	17											
34	18											
33	19											

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** HW to 4.0 m

TYPE OF BORING: Diatube to 0.1 m, Non-destructive drilling to 1.9 m, solid flight auger (TC-bit) to 3.8 m, NMLC coring to 14.9 m

WATER OBSERVATIONS: No free ground water observed whilst augering, 20% water loss from 3.8-6.0 m, 50% water loss from 11.0-11.5 m

REMARKS: Well installed, blank to 4.3 m, screen to 7.3 m, gatic cover at surface, asphalt to 0.2 m, sand & cement to 3.3 m, bentonite to 4.3 m, sand to 7.6, bentonite to 8.5 m, sand to 14.9 m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

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BORE: 10 PROJECT: RANDWICK APRIL 2018

3.80 – 8.00 m

BORE: 10 PROJECT: RANDWICK APRIL 2018

8.00 – 13.00 m

BORE: 10 **PROJECT: RANDWICK** **APRIL 2018**

13.00 – 14.90 m

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 52.5 AHD
EASTING: 337083
NORTHING: 6245477
DIP/AZIMUTH: 90°/--

BORE No: 11
PROJECT No: 72505.13
DATE: 1-5-2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
52	0.07	ASPHALTIC CONCRETE							A			
	0.5	ROADBASE: dark grey, sandy fine to coarse igneous gravel, damp, gravels (typically <30mm diameter)							A			
		FILLING: brown, medium to coarse sand filling, with some silt, damp										
51	1.1	SAND: loose to medium dense, yellow brown medium sand, with some dark brown silty sand bands, damp							S			3,2,3 N = 5
50	3	3.0 m: medium dense							S			4,5,7 N = 12
49	4								S			9,15,5/20 refusal Bouncing
48	4.3	SANDSTONE: extremely low to very low strength, light red-brown, medium grained sandstone, damp										
	5.0	4.5m to 5.0m: low to medium strength										
		Bore discontinued at 5.0m Limit of investigation										
47	6											
46	7											
45	8											
44	9											
43												

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** HW to 5.0 m

TYPE OF BORING: Diatube to 0.07 m, Non-destructive drilling to 1.6 m, Solid flight auger (TC-bit) to 2.0 m, Rotary to 5.0 m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Rotary refusal at 4.5 m, PCD bit to 5.0 m; Well installed, blank to 2.0 m, screen to 5.0 m, gatic cover at surface, concrete to 0.2 m, sand & cement to 1.3 m, bentonite to 2.1 m, sand to 5.0

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 55.7 AHD
EASTING: 337090
NORTHING: 6245535
DIP/AZIMUTH: 90°/--

BORE No: 12
PROJECT No: 72505.13
DATE: 30-4-2018
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	0.09	ASPHALTIC CONCRETE							D			
		ROADBASE: dark grey, sandy fine to coarse grain igneous gravel, damp										
	0.6	FILLING: brown, medium to coarse sand filling, with some silt, damp							D			
55	1	0.8-1.2m: with some roots.										
	1.2	SAND: medium dense, yellow brown, medium sand with trace of silt, damp							S			2,7,9 N = 16
54	2											
53	3								S			5,10,13 N = 23
52	4											
51	5								S			6,11,13 N = 24
50	6								S			11/110 refusal
	6.1	SANDSTONE: high strength, slightly weathered becoming fresh, slightly fractured to unbroken, pale grey, medium to coarse grained sandstone, some iron staining										PL(A) = 2.42
49	7								C	100	100	PL(A) = 2.29
48	8							7.44m: B5°, pl, ro, cly 5mm 7.6m: Ds, 50mm				
47	8.8	SANDSTONE: high strength, fresh, unbroken, pale grey, medium grained sandstone										PL(A) = 1.24
	9								C	100	100	
46												PL(A) = 1.9

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** HW to 5.5 m

TYPE OF BORING: Diatube to 0.09 m, NDD to 1.5 m, Solid flight auger (TC-bit) to 4.0 m, Rotary to 6.1 m, HQ-Coring to 14.15 m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Well installed, blank to 3.8 m, screen to 6.8 m, gatic cover at surface, concrete to 0.2 m, sand & cement to 2.0 m, bentonite to 3.0 m, sand to 6.8 m, bentonite to 7.8 m, sand to 14.15 m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 55.7 AHD
EASTING: 337090
NORTHING: 6245535
DIP/AZIMUTH: 90°/--

BORE No: 12
PROJECT No: 72505.13
DATE: 30-4-2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
45	11	SANDSTONE: high strength, fresh, unbroken, pale grey, medium grained sandstone *(continued)*							C	100	100	PL(A) = 2.54
												PL(A) = 0.93
44	12								C	100	100	PL(A) = 1.33
									C	100	100	
43	13								C	100	100	
42	14	13.57m: becoming slightly fractured						13.57m: B5° pl, ro, cly vn				PL(A) = 1.2
												PL(A) = 1.04
	14.15	Bore discontinued at 14.15m Target depth reached										
41	15											
40	16											
39	17											
38	18											
37	19											
36												

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** HW to 5.5 m

TYPE OF BORING: Diatube to 0.09 m, NDD to 1.5 m, Solid flight auger (TC-bit) to 4.0 m, Rotary to 6.1 m, HQ-Coring to 14.15 m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Well installed, blank to 3.8 m, screen to 6.8 m, gatic cover at surface, concrete to 0.2 m, sand & cement to 2.0 m, bentonite to 3.0 m, sand to 6.8 m, bentonite to 7.8 m, sand to 14.15 m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 52.0 AHD
EASTING: 337045
NORTHING: 6245565
DIP/AZIMUTH: 90°/--

BORE No: 13
PROJECT No: 72505.13
DATE: 3-5-2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
52	0.05	ASPHALT: (typically <10 mm diameter)										
	0.11	ASPHALT: (typically <20 mm diameter)										
	0.4	ROADBASE: dark grey, angular igneous gravels (30-80 mm)										
	0.6	FILLING: grey-brown, ripped sandstone filling, (40-80mm)										
51	0.9	FILLING: orange brown, medium sandy gravel filling with some coarse sandstone gravel, damp										
	1	SAND: medium dense, pale yellow, medium sand, damp							S			2,6,9 N = 15
50	2											
	2.5	SAND: medium dense to dense, brown orange, fine to medium sand with some silt, damp							D			
49	3								S			14,8/80 refusal
	3.2	SANDSTONE: extremely low to very low strength, orange brown sandstone										
	3.8	Bore discontinued at 3.8m Limit of investigation										
48	4											
47	5											
46	6											
45	7											
44	8											
43	9											

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** Uncased

TYPE OF BORING: Diatube to 0.15 m, Non-destructive drilling to 1.6 m, solid flight auge (TC-bit) to 3.8 m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Well installed, blank to 1.3 m, screen to 3.8 m, gatic cover at surface, asphalt to 0.2 m, sand & cement to 0.4 m, bentonite to 1.0 m, sand to 3.8 m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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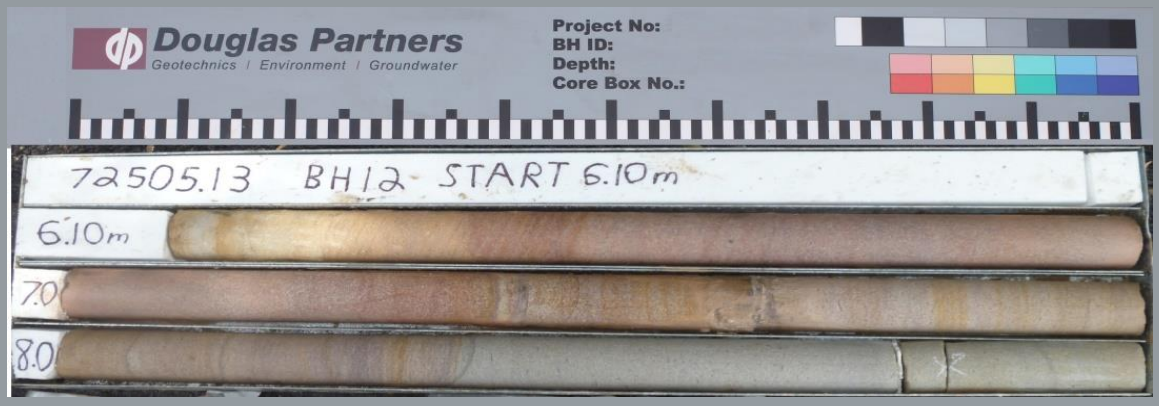
BORE: 12 PROJECT: RANDWICK APRIL 2018



6.10 – 9.00 m

BORE: 12 PROJECT: RANDWICK APRIL 2018

9.00– 13.00 m

BORE: 12 **PROJECT: RANDWICK** **APRIL 2018**

13.00 – 14.15 m

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 47.5 AHD
EASTING: 336983
NORTHING: 6245427
DIP/AZIMUTH: 90°/--

BORE No: 14
PROJECT No: 72505.13
DATE: 4-5-2018
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
47	0.09	CONCRETE SLAB							A			
		FILLING: light brown and brown, fine to medium sand filling with a trace of clay and gravel, damp							A			
	1								A			
	1.1	SILTY SAND: dark brown, fine to medium silty sand with some clay and a trace of rootlets, moist										
46	1.3	SAND: yellow, fine to medium sand, moist							A			
	1.9	SAND: loose, orange brown, fine to medium sand with a trace of clay, moist							S			2,2,3 N = 5
45	2											
	3											
	3.2	SAND: loose, pale brown/grey, fine to medium sand, moist							S			3,3,5 N = 8
44	4											
	4.5	SAND: loose, brown, fine to medium sand, saturated										
43	5								S			2,2,2 N = 4
	5.8	SILTY SAND: apparently loose, dark grey, fine to medium silty sand with trace of clay, saturated							E			
42	6								A			
	6.6	SANDSTONE: very low to low strength, grey-brown sandstone							S			8/100mm Bouncing
	6.9							6.8m: CORE LOSS: 100mm				
	7	SANDSTONE: very low strength, highly weathered, slightly fractured, pale grey and orange, medium to coarse grained sandstone with some medium strength, iron cemented bands						6.9m: Ds, 160mm 7.17m: B0°, pl, ro, cly, co 7.44m: Ds, 200mm				PL(A) = 0.03
41	7.64	SANDSTONE: low strength, slightly and moderately weathered, slightly fractured, pale grey and orange-brown, medium to coarse grained sandstone							C	95	69	PL(A) = 0.14
40	8							8.59m: Ds, 70mm 8.71m: B0°, pl, ro, cly, 5mm 8.91m: Cs, 10mm				
	8.8	SANDSTONE: medium strength, fresh, slightly fractured, pale grey, medium to coarse grained sandstone							C	100	95	
39	9							9.76m: B10°, pl, ro, cln				PL(A) = 0.5
38												

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** HW to 6.6 m

TYPE OF BORING: Diatube to 0.09 m, Hand Auger to 1.7 m, Solid flight auger (TC-bit) to 3.0 m, Rotary to 6.8 m, NMLC-Coring to 17.52

WATER OBSERVATIONS: Ground water observed at 4.5 m, 100% water loss from 10.7 m

REMARKS: Well installed, blank to 2.0 m, screen to 7.5 m, gatic cover at surface, concrete to 0.2 m, sand & cement to 1.0 m, bentonite to 1.5 m, sand to 7.5 m, bentonite to 8.5 m, sand to 17.5 m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 47.5 AHD
EASTING: 336983
NORTHING: 6245427
DIP/AZIMUTH: 90°/--

BORE No: 14
PROJECT No: 72505.13
DATE: 4-5-2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
37		SANDSTONE: as above						9.99m: B0-10°, cu, ro, cly, co 10m: B0-10°, cu, ro, cly, co 10.32m: Ds, 20mm 10.68m: Fg, 30mm				
	10.32	SANDSTONE: high strength, fresh, unbroken, pale grey, medium to coarse grained sandstone							C	100	95	PL(A) = 1.6
36	11											PL(A) = 0.48
35	12											PL(A) = 1.6
34	13								C	100	99	
		13.6-15.4m: slightly fractured						13.67m: B10°, pl, ro, cly, vn 13.86m: Cs, 10mm				PL(A) = 1.3
33	14							14.51m: Ds, 20mm				PL(A) = 1.2
32	15							15.24m: B10°,pl, ro, cly, co 15.37m: B10°,pl, ro, cly, co				PL(A) = 2
31	16								C	100	100	
	17											PL(A) = 1.34
30	17.52	Bore discontinued at 17.52m Target depth reached										PL(A) = 1.6
29	18											
28	19											

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** HW to 6.6 m

TYPE OF BORING: Diatube to 0.09 m, Hand Auger to 1.7 m, Solid flight auger (TC-bit) to 3.0 m, Rotary to 6.8 m, NMLC-Coring to 17.52

WATER OBSERVATIONS: Ground water observed at 4.5 m, 100% water loss from 10.7 m

REMARKS: Well installed, blank to 2.0 m, screen to 7.5 m, gatic cover at surface, concrete to 0.2 m, sand & cement to 1.0 m, bentonite to 1.5 m, sand to 7.5 m, bentonite to 8.5 m, sand to 17.5 m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BORE: 14 PROJECT: RANDWICK MAY 2018

6.80 – 11.00 m

BORE: 14 PROJECT: RANDWICK MAY 2018

11.00 – 16.00 m

BORE: 14 PROJECT: RANDWICK MAY 2018

16.00 – 17.52 m

BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 55.2 AHD
EASTING: 336986
NORTHING: 6245643
DIP/AZIMUTH: 90°/--

BORE No: 16
PROJECT No: 72505.13
DATE: 8-5-2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
55	0.12	CONCRETE SLAB										
		FILLING: brown, fine to medium sand filling with some silt and trace of igneous gravel, humid										
	0.55	SAND: yellow, fine to medium sand, damp										
54	1											
53	2											
	2.0	SAND: medium dense, yellow, fine to medium sand, damp							S			4,9,11 N = 20
52	3											
	3.2	SAND: medium dense, brown, fine to medium sand with trace of clay, damp							S			7,9,20 N = 29
51	4											
	4.1	SANDSTONE: very low strength, orange-brown and light grey, medium to coarse grained sandstone							S			6/30, Bouncing
	4.7	Bore discontinued at 4.7m Limit of investigation										
50	5											
49	6											
48	7											
47	8											
46	9											

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** HW to 4.0 m

TYPE OF BORING: Diatube to 0.12 m, Non-destructive drilling to 1.8 m, solid flight auger (TC-bit) to 2.0 m, Rotary to 4.7 m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Well installed, blank to 2.1 m, screen to 4.7 m, gatic cover at surface, concrete to 0.2 m, sand & cement to 1.2 m, bentonite to 2.0 m, sand to 4.7 m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 55.2 AHD
EASTING: 336983
NORTHING: 6245644
DIP/AZIMUTH: 90°/--

BORE No: 17
PROJECT No: 72505.13
DATE: 8-5-2018
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
55	0.11	CONCRETE SLAB										
		FILLING: brown, fine to medium sand filling with some silt and trace of igneous and sandstone gravel, humid										
	0.6											
54	1	SAND: yellow-brown, fine to medium sand, damp										
	2.0											
53	2	SAND: medium dense yellow-brown fine to medium sand, damp							S			4,6,9 N = 15
	3											
52	3.3											
		SAND: medium dense, brown, fine to medium sand with trace of clay, damp							S			9,10,14 N = 24
51	4											
	4.4											
		SANDSTONE: very low to low strength, orange-brown and light grey, medium to coarse grained sandstone										
	5											
50	5.08	SANDSTONE: medium strength, slightly weathered, slightly fractured, light grey and red-brown, medium to coarse grained sandstone						5m: CORE LOSS: 80mm 5.13m: J25° pl, ro, cln	C	90	83	PL(A) = 0.6
	6							6.05m: J20° pl, ro, fe, stn				PL(A) = 0.8
49												
	7								C	100	100	
48								7.54-7.57m: B5-10°, he, cu, ro, fe, stn x2				PL(A) = 1.1
	8							7.92-8.05m: B0-10°, pl, ro, fe, stn x3 8m: J30°, pl, ro 8.31m: Ds, 110mm				
47												PL(A) = 0.5
	9											
46												
	9.5	SANDSTONE (see over page)						9.32-9.50 m: B0-10°, un, ro fe, stn x5 9.36m: Cs, 20mm	C	100	90	PL(A) = 0.5

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** HW to 4.5 m

TYPE OF BORING: Diatube to 0.11 m, Non-destructive drilling to 1.8 m, Auger to 2.0 m, Rotary to 5.0 m, NMLC Coring to 14.80 m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Well installed, blank to 5.1 m, screen to 9.6 m, gatic cover at surface, concrete to 0.2 m, sand & cement to 1.5 m, sand to 4.0 m, bentonite to 5.0 m, sand to 10.0 m, bentonite to 11.0 m, sand to 15.0 m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 55.2 AHD
EASTING: 336983
NORTHING: 6245644
DIP/AZIMUTH: 90°/--

BORE No: 17
PROJECT No: 72505.13
DATE: 8-5-2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
45		SANDSTONE: medium strength, fresh, slightly fractured to unbroken, light grey, fine to medium grained sandstone with some low strength bands, cross bedding at 10-15° *(continued)*										PL(A) = 0.8
44	11							10.69m: Ds, 10mm	C	100	90	PL(A) = 0.12
43	12							11.99-12.09m: J60°, pl, ro, cln				PL(A) = 0.39
	12.24	SANDSTONE: medium and high strength, fresh, unbroken, light grey, medium grained sandstone						12.41m: J20°, pl, ro, cln				PL(A) = 1.38
42	13								C	100	100	PL(A) = 0.69
41	14											
	14.8	Bore discontinued at 14.8m Target depth reached										PL(A) = 1.16
40	15											
39	16											
38	17											
37	18											
36	19											

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** HW to 4.5 m

TYPE OF BORING: Diatube to 0.11 m, Non-destructive drilling to 1.8 m, Auger to 2.0 m, Rotary to 5.0 m, NMLC Coring to 14.80 m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Well installed, blank to 5.1 m, screen to 9.6 m, gatic cover at surface, concrete to 0.2 m, sand & cement to 1.5 m, sand to 4.0 m, bentonite to 5.0 m, sand to 10.0 m, bentonite to 11.0 m, sand to 15.0 m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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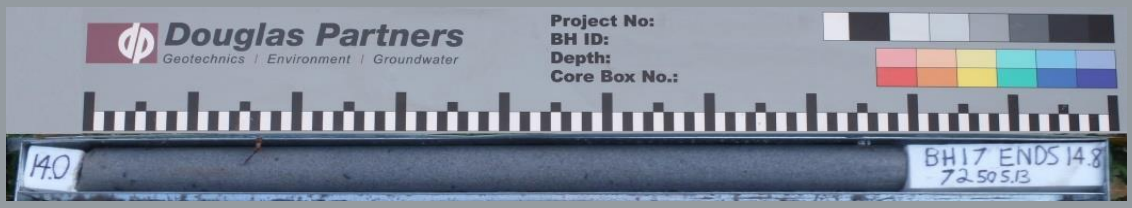
BORE: 17 PROJECT: RANDWICK MAY 2018

5.00 – 9.00 m

BORE: 17 PROJECT: RANDWICK MAY 2018

9.00 – 14.00 m

BORE: 17 PROJECT: RANDWICK MAY 2018



14.00 – 14.80 m

Appendix F

Results of Laboratory Testing – Physical Properties

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
Fax: (02) 9809 0666
Email: mark.matthews@douglaspartners.com.au

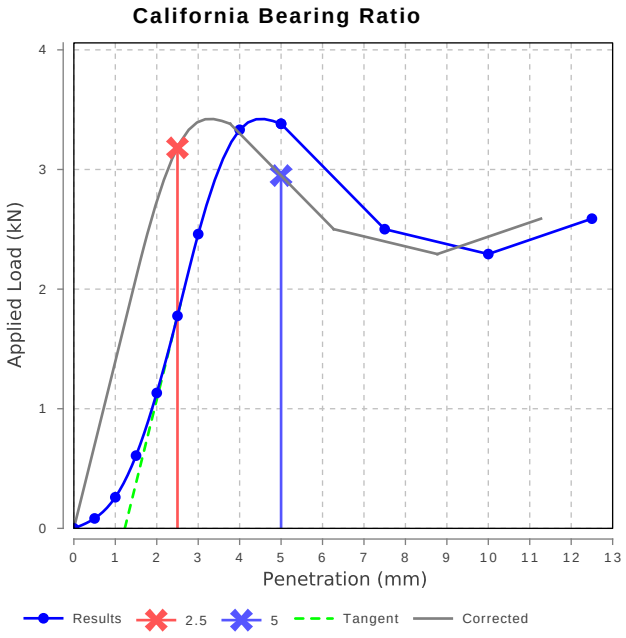
Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Mark Matthews
NATA Accredited Laboratory Number: 828

Report Number: **72505.11-1**
Issue Number: 1
Date Issued: 04/10/2017
Client: Health Infrastructure (ABN 89600377397)
PO Box 1060, North Sydney NSW 2059
Contact: Simon Brender
Project Number: 72505.11
Project Name: Randwick Campus Redevelopment
Project Location: Bound by High, Magill, Hospital and Botany Street, Randwick
Work Request: 1626
Sample Number: 17-1626A
Date Sampled: 18/09/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **BH4 (0.75-1.3m)**
Material: Filling - Orange brown sand filling with some sandstone gravel and a trace of clay

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**25**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m^3)	1.68		
Optimum Moisture Content (%)	12.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	101.0		
Dry Density after Soaking (t/m^3)	1.68		
Field Moisture Content (%)	4.9		
Moisture Content at Placement (%)	12.5		
Moisture Content Top 30mm (%)	16.2		
Moisture Content Rest of Sample (%)	16.2		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	1		



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
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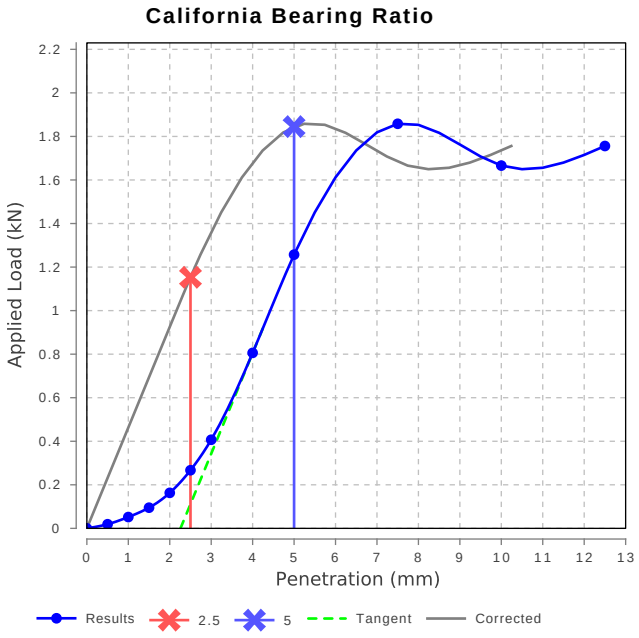
Email: mark.matthews@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Mark Matthews
NATA Accredited Laboratory Number: 828

Report Number:	**72505.11-2**
Issue Number:	2 - *This version supercedes all previous issues*
Date Issued:	23/10/2017
Client:	Health Infrastructure (ABN 89600377397)
	PO Box 1060, North Sydney NSW 2059
Contact:	Simon Brender
Project Number:	72505.11
Project Name:	Randwick Campus Redevelopment
Project Location:	Bound by High, Magill, Hospital and Botany Street, Randwick
Work Request:	1712
Sample Number:	17-1712A
Date Sampled:	18/09/2017
Sampling Method:	Sampled by Engineering Department
Sample Location:	**BH5 (2.95-4.0m)**
Material:	SAND - medium dense, yellow-brown, fine to medium grained sand

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**9**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m^3)	1.66		
Optimum Moisture Content (%)	16.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.5		
Dry Density after Soaking (t/m^3)	1.66		
Field Moisture Content (%)	2.2		
Moisture Content at Placement (%)	16.2		
Moisture Content Top 30mm (%)	17.3		
Moisture Content Rest of Sample (%)	15.5		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
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Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Mark Matthews
NATA Accredited Laboratory Number: 828

Report Number: **72505.11-1**
Issue Number: 1
Date Issued: 04/10/2017
Client: Health Infrastructure (ABN 89600377397)
PO Box 1060, North Sydney NSW 2059
Contact: Simon Brender
Project Number: 72505.11
Project Name: Randwick Campus Redevelopment
Project Location: Bound by High, Magill, Hospital and Botany Street, Randwick
Work Request: 1626
Sample Number: 17-1626B
Date Sampled: 18/09/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **BH1 (1.0-1.1m)**
Material: Sand - Pale grey sand with some dark brown silty bands

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	Not Obtainable		
Plastic Limit (%)	Not Obtainable		
Plasticity Index (%)	**Non Plastic**		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
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Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Mark Matthews
NATA Accredited Laboratory Number: 828

Report Number: **72505.11-1**
Issue Number: 1
Date Issued: 04/10/2017
Client: Health Infrastructure (ABN 89600377397)
PO Box 1060, North Sydney NSW 2059
Contact: Simon Brender
Project Number: 72505.11
Project Name: Randwick Campus Redevelopment
Project Location: Bound by High, Magill, Hospital and Botany Street, Randwick
Work Request: 1626
Sample Number: 17-1626C
Date Sampled: 18/09/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **BH2 (0.3-0.4m)**
Material: Roadbase - Dark grey sandy igneous gravel roadbase

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	Not Obtainable		
Plastic Limit (%)	Not Obtainable		
Plasticity Index (%)	**Non Plastic**		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
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96 Hermitage Road West Ryde NSW 2114
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Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Mark Matthews
NATA Accredited Laboratory Number: 828

Report Number: **72505.11-1**
Issue Number: 1
Date Issued: 04/10/2017
Client: Health Infrastructure (ABN 89600377397)
PO Box 1060, North Sydney NSW 2059
Contact: Simon Brender
Project Number: 72505.11
Project Name: Randwick Campus Redevelopment
Project Location: Bound by High, Magill, Hospital and Botany Street, Randwick
Work Request: 1626
Sample Number: 17-1626D
Date Sampled: 18/09/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **BH3 (0.4-0.5m)**
Material: Filling - Light brown to brown sand filling with traces of gravel

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	Not Obtainable		
Plastic Limit (%)	Not Obtainable		
Plasticity Index (%)	**Non Plastic**		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
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Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Mark Matthews
NATA Accredited Laboratory Number: 828

Report Number: **72505.11-1**
Issue Number: 1
Date Issued: 04/10/2017
Client: Health Infrastructure (ABN 89600377397)
PO Box 1060, North Sydney NSW 2059
Contact: Simon Brender
Project Number: 72505.11
Project Name: Randwick Campus Redevelopment
Project Location: Bound by High, Magill, Hospital and Botany Street, Randwick
Work Request: 1626
Sample Number: 17-1626E
Date Sampled: 18/09/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **BH4 (2.5-2.95m)**
Material: Sand - Orange sand with some clay

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	Not Obtainable		
Plastic Limit (%)	Not Obtainable		
Plasticity Index (%)	**Non Plastic**		

Material Test Report

Report Number: **72505.11-1**
Issue Number: 1
Date Issued: 04/10/2017
Client: Health Infrastructure (ABN 89600377397)
PO Box 1060, North Sydney NSW 2059
Contact: Simon Brender
Project Number: 72505.11
Project Name: Randwick Campus Redevelopment
Project Location: Bound by High, Magill, Hospital and Botany Street, Randwick
Work Request: 1626

Douglas Partners
Geotechnics / Environment / Groundwater
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Approved Signatory: Mark Matthews
NATA Accredited Laboratory Number: 828

Moisture Content AS 1289 2.1.1			
Sample Number	Sample Location	Moisture Content	Material
17-1626B	BH1 (1.0-1.1m)	3.6 %	Sand - Pale grey sand with some dark brown silty bands
17-1626C	BH2 (0.3-0.4m)	7.3 %	Roadbase - Dark grey sandy igneous gravel roadbase
17-1626D	BH3 (0.4-0.5m)	4.5 %	Filling - Light brown to brown sand filling with traces of gravel
17-1626E	BH4 (2.5-2.95m)	4.9 %	Sand - Orange sand with some clay

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
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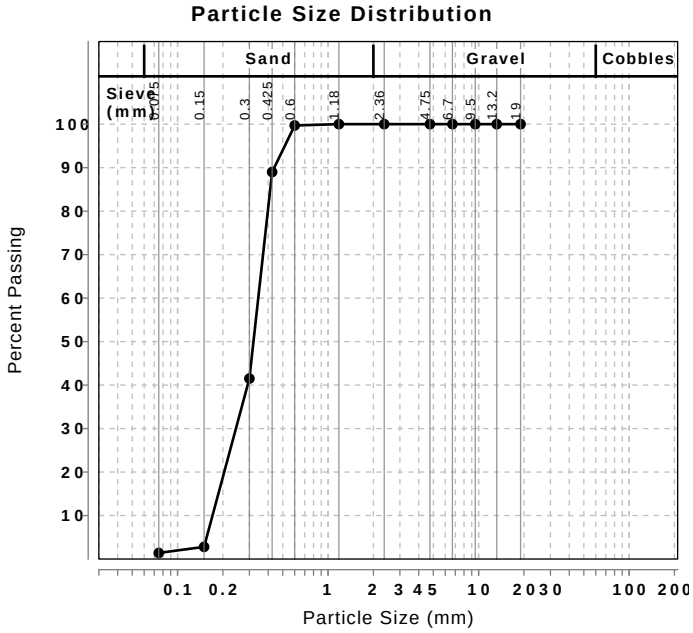
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Lujia Wu
dp-lujia.wu

NATA Accredited Laboratory Number: 828

Report Number:	**72505.13-1**
Issue Number:	2 - *This version supercedes all previous issues*
Date Issued:	22/05/2018
Client:	LendLease Building Pty Limited
	Locked Bag 1, Millers Point NSW 2000
Contact:	Elliot Hicks
Project Number:	72505.13
Project Name:	Randwick Campus Redevelopment
Project Location:	Bound by High, Magill, Hospital and Botany Street, Randwick
Work Request:	3020
Sample Number:	18-3020A
Date Sampled:	04/05/2018
Sampling Method:	Sampled by Engineering Department
Sample Location:	**BH10 (2.1 to 2.55m)**
Material:	Brown fine to medium sand with trace of silt

Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
19 mm	**100**		
13.2 mm	**100**		
9.5 mm	**100**		
6.7 mm	**100**		
4.75 mm	**100**		
2.36 mm	**100**		
1.18 mm	**100**		
0.6 mm	**100**		
0.425 mm	**89**		
0.3 mm	**42**		
0.15 mm	**3**		
0.075 mm	**1**		



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
Fax: (02) 9809 0666
Email: lujia.wu@douglaspartners.com.au

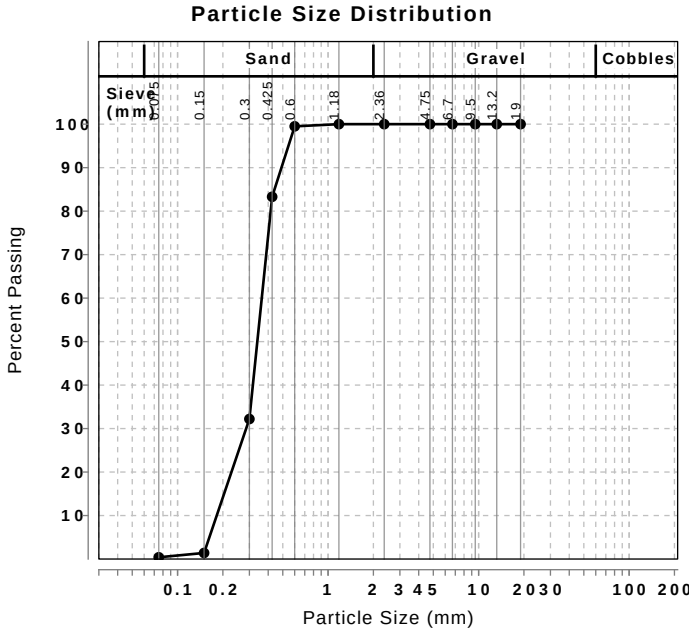
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Lujia Wu
dp-lujia.wu

NATA Accredited Laboratory Number: 828

Report Number: **72505.13-1**
Issue Number: 2 - *This version supercedes all previous issues*
Date Issued: 22/05/2018
Client: LendLease Building Pty Limited
Locked Bag 1, Millers Point NSW 2000
Contact: Elliot Hicks
Project Number: 72505.13
Project Name: Randwick Campus Redevelopment
Project Location: Bound by High, Magill, Hospital and Botany Street, Randwick
Work Request: 3020
Sample Number: 18-3020B
Date Sampled: 04/05/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **BH11 (3.0 to 3.45m)**
Material: Yellow brown fine to medium sand

Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
19 mm	**100**		
13.2 mm	**100**		
9.5 mm	**100**		
6.7 mm	**100**		
4.75 mm	**100**		
2.36 mm	**100**		
1.18 mm	**100**		
0.6 mm	**100**		
0.425 mm	**83**		
0.3 mm	**32**		
0.15 mm	**1**		
0.075 mm	**0**		



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
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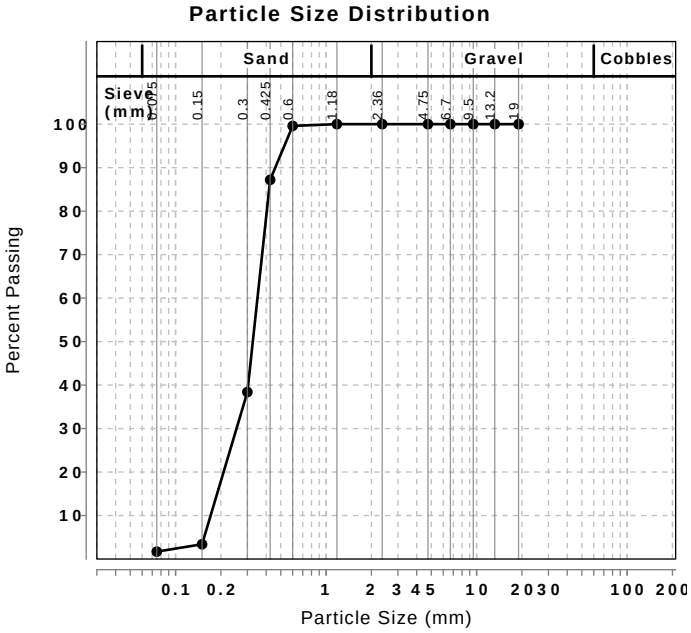
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Lujia Wu
dp-lujia.wu

NATA Accredited Laboratory Number: 828

Report Number: **72505.13-1**
Issue Number: 2 - *This version supercedes all previous issues*
Date Issued: 22/05/2018
Client: LendLease Building Pty Limited
Locked Bag 1, Millers Point NSW 2000
Contact: Elliot Hicks
Project Number: 72505.13
Project Name: Randwick Campus Redevelopment
Project Location: Bound by High, Magill, Hospital and Botany Street, Randwick
Work Request: 3020
Sample Number: 18-3020C
Date Sampled: 04/05/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **BH12 (4.5 to 4.95m)**
Material: Yellow brown fine to medium sand with trace of silt

Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
19 mm	**100**		
13.2 mm	**100**		
9.5 mm	**100**		
6.7 mm	**100**		
4.75 mm	**100**		
2.36 mm	**100**		
1.18 mm	**100**		
0.6 mm	**100**		
0.425 mm	**87**		
0.3 mm	**38**		
0.15 mm	**3**		
0.075 mm	**2**		



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
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Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Lujia Wu
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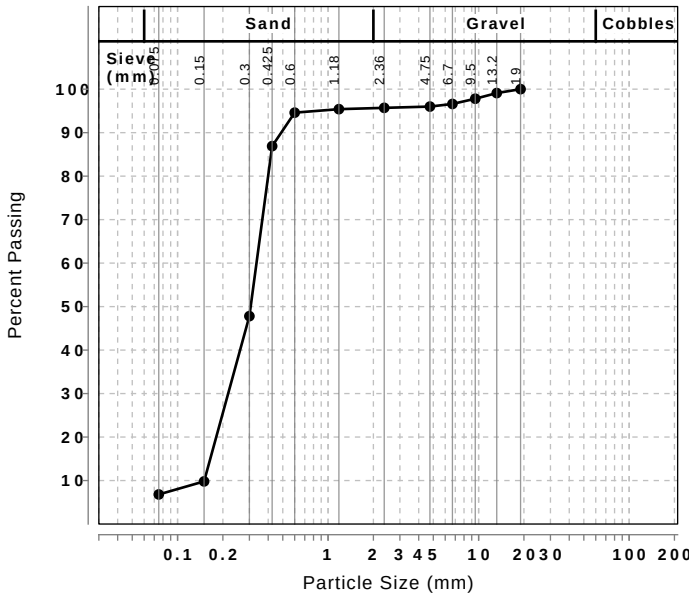
NATA Accredited Laboratory Number: 828

Report Number: **72505.13-1**
Issue Number: 2 - *This version supercedes all previous issues*
Date Issued: 22/05/2018
Client: LendLease Building Pty Limited
Locked Bag 1, Millers Point NSW 2000
Contact: Elliot Hicks
Project Number: 72505.13
Project Name: Randwick Campus Redevelopment
Project Location: Bound by High, Magill, Hospital and Botany Street, Randwick
Work Request: 3020
Sample Number: 18-3020D
Date Sampled: 04/05/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **BH13 (2.8 to 3.0m)**
Material: Brown orange fine to medium sand with some silt

Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
19 mm	**100**		
13.2 mm	**99**		
9.5 mm	**98**		
6.7 mm	**97**		
4.75 mm	**96**		
2.36 mm	**96**		
1.18 mm	**95**		
0.6 mm	**95**		
0.425 mm	**87**		
0.3 mm	**48**		
0.15 mm	**10**		
0.075 mm	**7**		

Particle Size Distribution



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
Fax: (02) 9809 0666
Email: lujia.wu@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

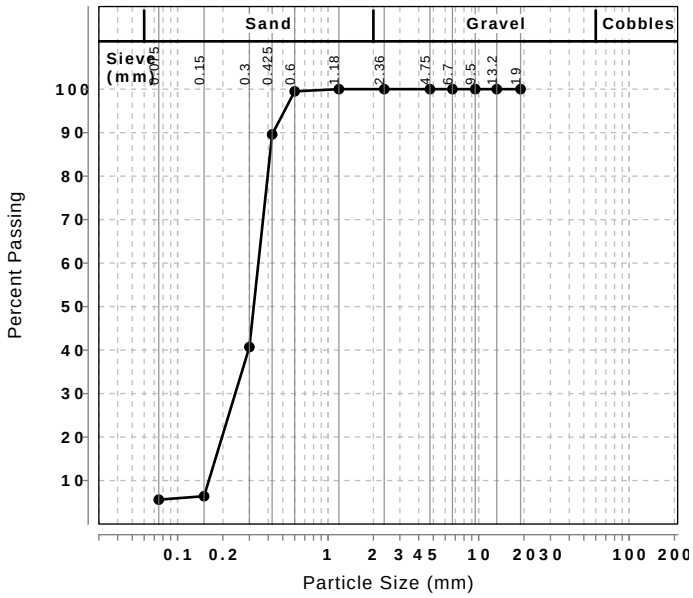
Approved Signatory: Lujia Wu
dp-lujia.wu

NATA Accredited Laboratory Number: 828

Report Number: **72505.13-1**
Issue Number: 2 - *This version supercedes all previous issues*
Date Issued: 22/05/2018
Client: LendLease Building Pty Limited
Locked Bag 1, Millers Point NSW 2000
Contact: Elliot Hicks
Project Number: 72505.13
Project Name: Randwick Campus Redevelopment
Project Location: Bound by High, Magill, Hospital and Botany Street, Randwick
Work Request: 3020
Sample Number: 18-3020E
Date Sampled: 04/05/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **BH14 (2.0 to 2.45m)**
Material: Orange brown fine to medium sand with some clay

Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
19 mm	**100**		
13.2 mm	**100**		
9.5 mm	**100**		
6.7 mm	**100**		
4.75 mm	**100**		
2.36 mm	**100**		
1.18 mm	**100**		
0.6 mm	**100**		
0.425 mm	**90**		
0.3 mm	**41**		
0.15 mm	**6**		
0.075 mm	**6**		

Particle Size Distribution



Appendix G

Results of Laboratory Testing – Chemical Properties

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 176263

Client Details

Client	Douglas Partners Pty Ltd
Attention	Peter Valenti
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**72505.11, RCR Project**
Number of Samples	4 samples
Date samples received	22/09/2017
Date completed instructions received	22/09/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	29/09/2017
Date of Issue	28/09/2017

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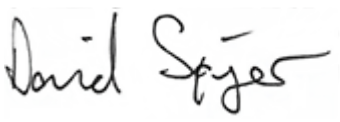
Results Approved By
Nick Sarlamis, Inorganics Supervisor

Authorised By



David Springer, General Manager

Misc Inorg - Soil					
Our Reference		176263-1	176263-2	176263-3	176263-4
Your Reference	UNITS	BH1	BH2	BH3	BH4
Depth		0.5-0.6	4.0-4.45	1.3-1.4	2.5-2.95
Date Sampled		18/09/2017	18/09/2017	21/09/2017	21/09/2017
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	25/09/2017	25/09/2017	25/09/2017	25/09/2017
Date analysed	-	25/09/2017	25/09/2017	25/09/2017	25/09/2017
pH 1:5 soil:water	pH Units	8.2	8.5	8.0	7.7
Electrical Conductivity 1:5 soil:water	µS/cm	59	20	41	20
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	<10	10	28	22

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			25/09/2017	1	25/09/2017	25/09/2017		25/09/2017	[NT]
Date analysed	-			25/09/2017	1	25/09/2017	25/09/2017		25/09/2017	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	8.2	8.6	5	102	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	59	72	20	101	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	<10	0	96	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	20	67	105	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 184350

Client Details

Client	Douglas Partners Pty Ltd
Attention	Peter Valenti
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**72505.11, RCR Project**
Number of Samples	2 Soil
Date samples received	01/02/2018
Date completed instructions received	01/02/2018

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	06/02/2018
Date of Issue	06/02/2018

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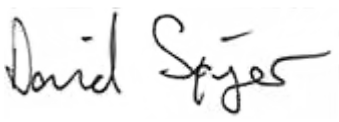
Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By



David Springer, General Manager

Misc Inorg - Soil			
Our Reference		184350-1	184350-2
Your Reference	UNITS	BH8	BH9
Depth		2.5-2.66	5.5-5.95
Date Sampled		24/01/2018	25/01/2018
Type of sample		Soil	Soil
Date prepared	-	02/02/2018	02/02/2018
Date analysed	-	02/02/2018	02/02/2018
pH 1:5 soil:water	pH Units	11.6	5.2
Electrical Conductivity 1:5 soil:water	µS/cm	730	34
Chloride, Cl 1:5 soil:water	mg/kg	<10	10
Sulphate, SO4 1:5 soil:water	mg/kg	66	29

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			02/02/2018	[NT]	[NT]	[NT]	[NT]	02/02/2018	[NT]
Date analysed	-			02/02/2018	[NT]	[NT]	[NT]	[NT]	02/02/2018	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	100	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	100	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	95	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	97	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

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12 Ashley St Chatswood NSW 2067
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customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 191062

Client Details

Client	Douglas Partners Pty Ltd
Attention	Peter Valenti
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**72505.13, RCR Project**
Number of Samples	4 Soil
Date samples received	08/05/2018
Date completed instructions received	08/05/2018

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	15/05/2018
Date of Issue	14/05/2018

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Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Jacinta Hurst, Laboratory Manager

Misc Inorg - Soil					
Our Reference		191062-1	191062-2	191062-3	191062-4
Your Reference	UNITS	BH14	BH12	BH13	BH14
Depth		6.3-6.5	6.0-6.1	3.0-3.2	3.5-3.95
Date Sampled		04/05/2018	30/04/2018	03/05/2018	04/05/2018
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	11/05/2018	11/05/2018	11/05/2018	11/05/2018
Date analysed	-	11/05/2018	11/05/2018	11/05/2018	11/05/2018
pH 1:5 soil:water	pH Units	5.4	6.9	5.4	6.3
Electrical Conductivity 1:5 soil:water	µS/cm	38	22	12	10
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	34	<10	<10	<10
Resistivity in soil*	ohm m	260	450	810	970

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			11/05/2018	1	11/05/2018	11/05/2018		11/05/2018	[NT]
Date analysed	-			11/05/2018	1	11/05/2018	11/05/2018		11/05/2018	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	5.4	5.5	2	102	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	38	33	14	94	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	<10	0	87	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	34	35	3	91	[NT]
Resistivity in soil*	ohm m	1	Inorg-002	<1	1	260	300	14	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Appendix H

Groundwater Well Logs

WELL LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 51.9 AHD
EASTING: 337044.9
NORTHING: 6245563
DIP/AZIMUTH: 90°/--

BORE No: 4 (72505.11)
PROJECT No: 72505.13
DATE: 19 - 21/9/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
51.9	0.04	ASPHALTIC CONCRETE (typically <10mm diameter)		A	0.07				Gatic Cover
51.8	0.07	ASPHALTIC CONCRETE (typically <20mm diameter)		A	0.15				
51.7	0.2	ROADBASE - dark grey, angular, igneous gravel typically 40-80mm diameter, slight hydrocarbon odour		A	0.5				
51.1	0.8	FILLING - orange-brown, medium grained sand filling with some sandstone gravel and a trace of clay (ripped sandstone)		A	0.6				
50.9	1			A	0.9				
50.8				A	1.0				
50.5				A	1.4				
50.3	1.6			A	1.6				
50.1	1.8			A	1.9				
50	2			A	2.0				Backfill
49.9				A	2.5				
49.8	2.6	SAND - pale yellow-brown, fine to medium grained sand, damp		S			8,14,17 N = 31		
49.3	3	2.2m: brown		S	2.95				
49.1	3.5			S	3.5				
49.1	3.65	SAND - medium dense to dense, orange, fine to medium sand with some clay, damp		S	3.65				Bentonite
48.9	4			C	3.9		PL(A) = 0.22		
48.8	4.15	SANDSTONE - extremely low to very low strength sandstone		C	4.15				
48.3	4.65			C	4.65				
48.1	4.85			C	4.85				
47.9	5	SANDSTONE - low strength, slightly weathered, fractured to slightly fractured, pale brown, medium to coarse grained sandstone		C	4.95		PL(A) = 0.76		
47.6	5.29			C	5.29				Gravel Screen 4-7m
47.4	5.5			C	5.5				
47.1	5.8			C	5.8				
46.9	6	SANDSTONE - medium strength, slightly weathered then fresh, slightly fractured and fractured, medium to coarse grained sandstone		C	5.93		PL(A) = 0.71		
46.6	6.3			C	6.3				
46.3	6.6			C	6.6				
46.1	6.8			C	6.8				
45.9	6.91	- limonite staining to 4.40m		C	6.95		PL(A) = 0.71		
45.9	7	5.5m: distinct irregular bedding dipping 15°- 20°		C	7				Bentonite
45.8		6.4m: indistinct irregular bedding dipping 0°- 20°		C	7.2				
45.6	7.4			C	7.4				
45.4	7.6			C	7.6				
45.1	7.8			C	7.8				
44.9	8	SANDSTONE - medium strength, fresh, slightly fractured and unbroken, pale grey, medium to coarse grained sandstone, massive, trace carbonaceous flecks		C	7.95		PL(A) = 0.66		
44.6	8.3			C	8.38				
44.4	8.5			C	8.5				
44.1	8.8			C	8.8				
43.9	8.95			C	8.95		PL(A) = 0.95		
43.6	9.3			C	9.3				
43.4	9.5			C	9.5				
43.1	9.8			C	9.8				
42.9	9.95			C	9.95		PL(A) = 0.73		
42.6	10.3			C	10.3				
42.4	10.5			C	10.5				
42.1	10.8			C	10.8				
41.9	10.88			C	10.88		PL(A) = 0.61		
41.8	11			C	11				
41.6	11.3			C	11.3				
41.5				C	11.39				
41.3	11.6			C	11.6				
41.1	11.8			C	11.8				
40.9	11.95			C	11.95		PL(A) = 0.69		
40.8	12	SANDSTONE - medium to high strength, fresh, slightly fractured to unbroken, pale grey, medium to coarse grained sandstone, indistinct bedding typically dipping 10°- 20°		C	12				Backfill
40.6	12.3			C	12.3				
40.4	12.5			C	12.5				
40.1	12.8			C	12.8				
39.9	12.95			C	12.95		PL(A) = 1.1		
39.6	13.3			C	13.3				
39.4	13.5			C	13.5				
39.1	13.8			C	13.8				
38.9	13.95			C	13.95		PL(A) = 0.91		
38.8	14			C	14				
38.6	14.3			C	14.3				
38.5				C	14.37				
38.3	14.6	SANDSTONE - high then medium strength, fresh, unbroken, pale grey, fine to medium grained sandstone, occasional carbonaceous laminations and flecks		C	14.6				
38.1	14.8			C	14.8				
37.9	15			C	14.95		PL(A) = 1.33		
37.6	15.3			C	15.3				
37.4	15.5			C	15.5				
37.1	15.8			C	15.8				
36.9	15.93			C	15.93		PL(A) = 0.59		
36.8	16			C	16				
36.6	16.3			C	16.3				
36.4	16.5			C	16.5				
36.1	16.8			C	16.8				
35.9	17	16.78-16.97m: siltstone clasts and laminations, slightly fractured		C	17				
35.8	17.04			C	17.04		PL(A) = 0.76		
35.6	17.31	Bore discontinued at 17.31m		C	17.31				
34.9	18	- target depth reached							

RIG: Bobcat **DRILLER:** GM **LOGGED:** ARM **CASING:** HW to 3.65m

TYPE OF BORING: Diatube to 0.08m; NDD to 1.7m; Solid flight auger (TC-bit) to 3.65m; NMLC-Coring to 17.31m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

WELL LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 50.5 AHD
EASTING: 337038.1
NORTHING: 6245507
DIP/AZIMUTH: 90°/--

BORE No: 8 (72505.11)
PROJECT No: 72505.13
DATE: 23 - 24/1/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
50.4	0.1	ASPHALTIC CONCRETE (typically <10mm diameter)							Gatic Cover
50.25	0.25			A	0.4				Backfill
50.1	0.6	ROADBASE - dark grey, angular, igneous gravel typically 40-80mm diameter		A*	0.5				
					0.6				
49.5	1	FILLING - pale grey and brown sandstone gravel and cobbles up to 100mm diameter (ripped sandstone)			0.7				Bentonite
				A	1.6				
49	1.7	SAND - pale brown, medium grained sand with a trace of fine gravel, damp							
48.4	2								Gravel Screen 2-3m
	2.6			S	2.5		7,10/10mm refusal		
48.23	2.66				2.66				
48	2.77	SANDSTONE - extremely low strength, orange-brown sandstone			2.77		PL(A) = 0.26		
	3			C	2.95				Bentonite
47.4		SANDSTONE - low to medium strength, slightly weathered, fractured to slightly fractured, orange and grey, medium to coarse grained sandstone			3.88		PL(A) = 0.43		
47	4				3.91				
46.4					4.95		PL(A) = 0.6		
	5			C					
45.55	5.45								
		SANDSTONE - high then medium strength, fresh, slightly fractured to unbroken, pale grey, medium to coarse grained sandstone with a trace of carbonaceous flecks			5.95		PL(A) = 1.12		
44.4	6	6.4-6.9m: red-brown iron staining							
					6.89		PL(A) = 0.69		
43.5	7				6.95				
					7.95		PL(A) = 0.63		
43	8	8.1-8.55m: low strength band		C	8.41		PL(A) = 0.22		
42.4					8.95		PL(A) = 0.63		
	9								
41.5					9.93		PL(A) = 1.03		
	10				9.95				
40.09	10.41	10.2-10.41m: with 25% siltstone clasts up to 20mm diameter, fragmented (possibly drilling induced)							Backfill
40	11	LAMINITE - low strength, fresh, slightly fractured, dark grey siltstone interlaminated and interbedded with 40% pale grey, fine grained sandstone			10.95		PL(A) = 0.18		
39.05	11.45			C					
39	12	SANDSTONE - high strength, fresh, slightly fractured to unbroken, pale grey, medium to coarse grained sandstone, massive			11.95		PL(A) = 2.23		
					12.75		PL(A) = 1.54		
38	13	12.84-13.03m: with 50% carbonaceous laminations 13.03-13.21: fine to medium grained			12.92				
37.5		13.21m: medium to coarse grained, irregular bedding dipping 10-20°			13.85		PL(A) = 1.19		
37	14			C					
36.5		14.8m: massive			14.95		PL(A) = 1.27		
	15								
35.5					15.89		PL(A) = 1.36		
35	16				15.95				
34.5		16.44m: irregular bedding dipping 10-20°		C					
34	17				16.95		PL(A) = 1.57		
33.11	17.39				17.39				
		Bore discontinued at 17.39m - target depth reached							
32.5	18								

RIG: Bobcat **DRILLER:** GM **LOGGED:** ARM **CASING:** HW to 2.5m; HQ to 2.7m

TYPE OF BORING: Diatube to 0.10m; Non-destructive drilling to 1.7m; Solid flight auger (TC-bit) to 2.77m; NMLC-Coring to 17.39m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

Douglas Partners
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WELL LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 49.2 AHD
EASTING: 337026.2
NORTHING: 6245465.1
DIP/AZIMUTH: 90°/--

BORE No: 9 (72505.11)
PROJECT No: 72505.13
DATE: 23 - 25/1/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
49	0.05	ASPHALTIC CONCRETE (typically <10mm diameter)		A	0.15				Gatic Cover
	0.15				0.2				Backfill
	0.4	ROADBASE - dark grey, angular, igneous gravel typically 40-80mm diameter		A	0.6				
48	1				0.7				1 Bentonite
	1.3	FILLING - pale grey and brown sandstone gravel and cobbles up to 150mm diameter (ripped sandstone)		A	1.4				
47	2				1.5				2
		SAND - dark grey, slightly silty fine to medium grained sand with a trace of rootlets, humid		A	1.9				
	2.4				2.0				
		SAND - pale grey, medium grained sand, damp		S	2.5		3,5,5 N = 10		
46	3	2.2-2.4m: dark brown, silty band			2.95				3
		SAND - medium dense, yellow-brown, fine to medium grained sand, damp							
45	4			S	4.0		5,7,7 N = 14		4 Gravel Screen 1.5-6.5m
					4.45				
44	5	5.0m: becoming clayey							5
	5.5			S	5.5		3,7,9 N = 16		
	5.8	SILTY CLAY - stiff, orange-brown and grey, silty clay with some fine sand, Mc>PL			5.95		pp = 450		
43	6				6.03		pp = 350		6
	6.03	CLAY - stiff, grey, clay with some silt, high plasticity, Mc~PL			6.1				
					6.4		pp = 550-600		
42	7	LAMINITE - extremely low strength, extremely weathered, interbedded then interlaminated pale grey sandstone and dark grey siltstone (soil like properties)		C	6.8		PL(A) = 0.05		7 Bentonite
					6.95		pp = 450-600		
	7.8	6.2-6.5m: Distinct orange iron staining			7.1				
41	8				7.95		PL(A) = 0.6		8
		SANDSTONE - medium strength, fresh, slightly fractured, pale grey, medium to coarse grained sandstone, irregular bedding dipping 10-20°			8.49				
	8.92				8.95		PL(A) = 1.11		
40	9	8.5-8.56m: 50% fine siltstone laminations							9
		SANDSTONE - high strength, fresh, slightly fractured to unbroken, pale grey, medium to coarse grained sandstone, irregular bedding dipping 10-20°		C	9.95		PL(A) = 1.04		
39	10								10
					10.9		PL(A) = 1.12		
38	11								11
					11.56				
	12				11.92		PL(A) = 0.9		12
37									Backfill
		12.48-12.58m: grey, fine to medium grained							
	13	12.58-13.48m: massive		C	12.95		PL(A) = 1.72		13
36									
	14				13.9		PL(A) = 1.38		14
35									
					14.59				
	15				14.95		PL(A) = 1.85		15
34									
	16			C	15.95		PL(A) = 1.4		16
33		16.23-17.27m: with some quartz gravel bands and carbonaceous laminations							
	17				16.95		PL(A) = 1.01		17
32									
	17.49	17.27m: massive			17.38		PL(A) = 1.13		
		Bore discontinued at 17.49m - target depth reached			17.49				
31	18								18

RIG: Bobcat **DRILLER:** GM **LOGGED:** ARM **CASING:** HW to 4.0m; HQ to 6.0m

TYPE OF BORING: Diatube to 0.10m; NDD to 1.6m; Solid flight auger (TC-bit) to 4.0 m; Rotary to 6.03 m; NMLC-Coring to 17.49m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

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WELL LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 52.2 AHD
EASTING: 337082
NORTHING: 6245474
DIP/AZIMUTH: 90°/--

BORE No: 10
PROJECT No: 72505.13
DATE: 2-5-2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
52	0.07	ASPHALTIC CONCRETE		D	0.1				Gatic Cover
					0.2				
	0.6	ROADBASE: dark grey, sand fine to coarse igneous gravel, damp (typically <30 mm diameter)		D	0.6				
	0.9	FILLING: brown medium to coarse sandy filling with some silt, damp			0.7				
51	1	SAND: brown, medium sand with some silt, damp							1
									Backfill
50	2	2.1 m: medium dense		S	2.1		3,6,10 N = 16		2
					2.55				
49	3								3
				S	3.6		10,20/20 refusal		
	3.8	Possibly very low strength rock			3.8				Bentonite
48	4			C			Core Loss		4
47	5	5.0 SANDSTONE: medium strength, moderately weathered, slightly fractured, red/brown, medium grained sandstone			5.0				5
					5.13		PL(A) = 0.48		
				C					
46	6								6
	6.3	SANDSTONE: very low strength, slightly weathered, slightly fractured, grey-brown, medium grained sandstone			6.21		PL(A) = 0.08		Gravel Screen 4.3-7.3m
	6.75				6.63				
45	7	SANDSTONE: low strength, fresh stained, slightly fractured, light grey, fine to medium grained sandstone, some carbonaceuos flakes, typically indistinct bedding			7.09		PL(A) = 0.15		7
				C					
44	7.89								
	8	SILTSTONE: very low strength, slightly weathered, unbroken, dark grey siltstone with sandstone laminations (20%)			8.15		PL(A) = 0.05		8
	8.32				8.7		PL(A) = 0.85		Bentonite
		SANDSTONE: medium and medium to high strength, fresh, slightly fractured to unbroken, light grey, fine to medium grained sandstone			8.72				
43	9				9.23		PL(A) = 0.48		9
42	10			C					10
		10.47-12.9 m: cross bedding typically 5-15°			10.59		PL(A) = 0.3		
41	11								11
					11.65		PL(A) = 0.47		Backfill
					11.79				
40	12			C					12
					12.78		PL(A) = 0.98		
39	13				12.9				13
38	14			C	13.95		PL(A) = 1.08		14
					14.76		PL(A) = 0.5		
37	14.9	Bore discontinued at 14.9m Target depth reached			14.9				15
	15								

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** HW to 4.0 m

TYPE OF BORING: Diatube to 0.1 m, Non-destructive drilling to 1.9 m, solid flight auger (TC-bit) to 3.8 m, NMLC coring to 14.9 m

WATER OBSERVATIONS: No free ground water observed whilst augering, 20% water loss from 3.8-6.0 m, 50% water loss from 11.0-11.5 m

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

WELL LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 52.5 AHD
EASTING: 337083
NORTHING: 6245477
DIP/AZIMUTH: 90°/--

BORE No: 11
PROJECT No: 72505.13
DATE: 1-5-2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
52	0.07	ASPHALTIC CONCRETE							Gatic Cover
		ROADBASE: dark grey, sandy fine to coarse igneous gravel, damp, gravels (typically <30mm diameter)		A	0.1 0.2				
	0.5	FILLING: brown, medium to coarse sand filling, with some silt, damp		A	0.5 0.6				Backfill
51	1.1	SAND: loose to medium dense, yellow brown medium sand, with some dark brown silty sand bands, damp							Bentonite
				S	2.0		3,2,3 N = 5		
					2.45				
50		3.0 m: medium dense		S	3.0		4,5,7 N = 12		
					3.45				Screen 2-5m Gravel
49				S	4.0		9,15,5/20 refusal Bouncing		
	4.3	SANDSTONE: extremely low to very low strength, light brown/ red-brown, medium grained sandstone, damp 4.5m to 5.0m: low to medium strength			4.45				
48	5.0	Bore discontinued at 5.0m Limit of investigation							
47									

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** HW to 5.0 m

TYPE OF BORING: Diatube to 0.07 m, Non-destructive drilling to 1.6 m, Solid flight auger (TC-bit) to 2.0 m, Rotary to 5.0 m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

WELL LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 55.7 AHD
EASTING: 337090
NORTHING: 6245535
DIP/AZIMUTH: 90°/--

BORE No: 12
PROJECT No: 72505.13
DATE: 30-4-2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
55.61	0.09	ASPHALTIC CONCRETE		D	0.1				Gatic Cover
					0.2				
55.1	0.6	ROADBASE: dark grey, sandy fine to coarse grain igneous gravel, damp		D	0.8				
54.9	0.8	FILLING: brown, medium to coarse sand filling, with some silt, damp			0.9				Backfill
54.5	1.2	0.8-1.2 m: with some roots.							
		SAND: medium dense, yellow brown, medium sand, damp			1.6				
				S			2,7,9 N = 16		
					2.05				
									Bentonite
					3.0				
				S			5,10,13 N = 23		
					3.45				
					4.5				
				S			6,11,13 N = 24		
					4.95				Gravel
									Screen 3.8-6.8m
				S	6.0		11/110 refusal		
49.61	6.1	SANDSTONE: high strength, slightly weathered becoming fresh, slightly fractured, pale grey, medium to coarse grained sandstone, some iron stained bedding			6.1				
					6.11				
					7.0		PL(A) = 2.42		
				C			PL(A) = 2.29		Bentonite
47.61	8.8	SANDSTONE: high strength, fresh, unbroken, pale grey, medium grained sandstone			8.79		PL(A) = 1.24		
					8.8				
		9.40-9.45 m: bedding typically 10-20°			9.81		PL(A) = 1.9		
				C					
					10.72		PL(A) = 2.54		Backfill
					11.48		PL(A) = 0.93		
					11.81				
				C	12.06		PL(A) = 1.33		
					12.27				
				C	12.55				
				C					
42.61	13.57	13.57-14.15 m: becoming slightly fractured			13.71		PL(A) = 1.2		
42.41	13.76	13.66-13.76 m: bedding typically 5 - 10°			14.0		PL(A) = 1.04		
41.61	14.15	Bore discontinued at 14.15m Target depth reached			14.15				

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** HW to 5.5 m

TYPE OF BORING: Diatube to 0.09 m, NDD to 1.5 m, Solid flight auger (TC-bit) to 4.0 m, Rotary to 6.1 m, HQ Coring to 14.15 m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

WELL LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 52.0 AHD
EASTING: 337045
NORTHING: 6245565
DIP/AZIMUTH: 90°/--

BORE No: 13
PROJECT No: 72505.13
DATE: 3-5-2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
52	0.05	ASPHALTIC CONCRETE: (typically <10 mm diameter)							Gatic Cover
	0.11	ASPHALTIC CONCRETE: (typically <20 mm diameter)							
		ROADBASE: dark grey, angular igneous gravels, (typically 30-80 mm diameter)							Backfill
	0.4								
	0.6	FILLING: grey-brown, ripped sandstone filling, (typically 40-80mm diameter)							Bentonite
	0.9	FILLING: orange brown, medium sandy gravel filling with some coarse sandstone gravel, damp							
51	1	SAND: medium dense, pale yellow, medium sand, damp							1
					1.8				
50	2			S			2,6,9 N = 15		2
					2.25				Gravel
	2.5	SAND: medium dense to dense, brown orange, fine to medium sand with some silt, damp							Screen 1.3-3.8m
					2.8				
49	3			D					3
					3.0				
				S			14,8/80 refusal		
	3.2	SANDSTONE: extremely low to very low strength, orange brown sandstone			3.2				
	3.8	Bore discontinued at 3.8m Limit of investigation							
48	4								4
47	5								5

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** Uncased

TYPE OF BORING: Diatube to 0.15 m, Non-destructive drilling to 1.6 m, solid flight auge (TC-bit) to 3.8 m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⊻	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

WELL LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 47.5 AHD
EASTING: 336983
NORTHING: 6245427
DIP/AZIMUTH: 90°/--

BORE No: 14
PROJECT No: 72505.13
DATE: 4-5-2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
47.5	0.09	CONCRETE SLAB		A	0.1				Gatic Cover
				A	0.2				
		FILLING: light brown and brown, fine to medium sand filling with a trace of clay and gravel, damp			0.3				Backfill
					0.4				
	1.1			A	0.9				
	1.3	SILTY SAND: dark brown, fine to medium silty sand with some clay and a trace of rootlets, moist			1.0				Bentonite
				A	1.6				
	1.9	SAND: yellow, fine to medium sand, moist			1.7				
				S	2.0		2,2,3 N = 5		
		SAND: loose, orange brown, fine to medium sand with a trace of clay, moist			2.45				
					3.0		3,3,5 N = 8		
	3.2	SAND: loose, pale brown/grey, fine to medium sand, moist		S	3.45				
	4.5	SAND: loose, brown, fine to medium sand, saturated							Gravel Screen 2-7.5m
				S	5.0		2,2,2 N = 4		
					5.45				
	5.8	SILTY SAND: apparently loose, dark grey, fine to medium silty sand with trace of clay, saturated (slight hydrocarbon odour)		E	6.1				
				A	6.3				
	6.6			S	6.5		8/100mm Bouncing		
	6.9	SANDSTONE: very low to low strength, grey-brown sandstone			6.6				
					6.8		PL(A) = 0.03		
	7.64	SANDSTONE: very low strength, highly weathered, slightly fractured, pale grey and orange, medium to coarse grained sandstone with some medium strength, iron cemented bands		C	7.17				
					8.14		PL(A) = 0.14		Bentonite
	8.8	SANDSTONE: low strength, slightly and moderately weathered, slightly fractured, pale grey and orange-brown, medium to coarse grained sandstone			8.8				
		SANDSTONE: medium strength, fresh, slightly fractured, pale grey, medium to coarse grained sandstone, bedding typically 0-10°			9.83		PL(A) = 0.5		
	10.32	SANDSTONE: as above		C	10.73		PL(A) = 1.6		
		SANDSTONE: high strength, fresh, unbroken, pale grey, medium to coarse grained sandstone, bedding typically 0-10°			11.71		PL(A) = 0.48		
					11.8				
					12.24		PL(A) = 1.6		
				C					Backfill
		13.6-15.4 m: slightly fractured			13.67		PL(A) = 1.3		
					14.45				
					14.61		PL(A) = 1.2		
				C	15.78		PL(A) = 2		
					16.86		PL(A) = 1.34		
	17.52	Bore discontinued at 17.52m			17.49		PL(A) = 1.6		
		Target depth reached			17.52				

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** HW to 6.6 m

TYPE OF BORING: Diatube to 0.09 m, Hand Auger to 1.7 m, Solid flight auger (TC-bit) to 3.0 m, Rotary to 6.8 m, NMLC-Coring to 17.52

WATER OBSERVATIONS: Ground water observed at 4.5 m, 100% water loss from 10.7 m

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

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WELL LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 55.2 AHD
EASTING: 336986
NORTHING: 6245643
DIP/AZIMUTH: 90°/--

BORE No: 16
PROJECT No: 72505.13
DATE: 8-5-2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
55	0.12	CONCRETE SLAB							Gatic Cover
		FILLING: brown, fine to medium sand filling with some silt and trace of igneous gravel, humid							
	0.55	SAND: yellow, fine to medium sand, damp							Backfill
54	1								1
									Bentonite
	2.0	SAND: medium dense, yellow, fine to medium sand, damp		S	2.0 2.45		4,9,11 N = 20		2
53	3								3
52	3.2	SAND: medium dense, brown, fine to medium sand with trace of clay, damp		S	3.5 3.95		7,9,20 N = 29		Gravel Screen 2.1-4.7m
	4.1	SANDSTONE: very low strength, orange-brown and light grey, medium to coarse grained sandstone		S	4.1 4.15		6/30, Bouncing		4
51	4.7	Bore discontinued at 4.7m Limit of investigation							
50	5								5

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** HW to 4.0 m

TYPE OF BORING: Diatube to 0.12 m, Non-destructive drilling to 1.8 m, solid flight auger (TC-bit) to 2.0 m, Rotary to 4.7 m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

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WELL LOG

CLIENT: LendLease Building Pty Ltd
PROJECT: Randwick Campus Redevelopment
LOCATION: Hospital Road and High, Magill and Botany Streets, Randwick

SURFACE LEVEL: 55.2 AHD
EASTING: 336983
NORTHING: 6245644
DIP/AZIMUTH: 90°/--

BORE No: 17
PROJECT No: 72505.13
DATE: 8-5-2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
55	0.11	CONCRETE SLAB							Gatic Cover
	0.6	FILLING: brown, fine to medium sand filling with some silt and trave of igneous and sandstone gravel, humid							
54	1	SAND: yellow-brown, fine to medium sand, damp							
53	2.0	SAND: medium dense yellow-brown fine to medium sand, damp		S	2.0 2.45		4,6,9 N = 15		Backfill
52	3.3	SAND: medium dense, brown, fine to medium sand with trace of clay, damp		S	3.5 3.95		9,10,14 N = 24		
51	4.4	SANDSTONE: very low to low strength, orange-brown and light grey, medium to coarse grained sandstone							Bentonite
50	5.08	SANDSTONE: medium strength, slightly weathered, slightly fractured, light grey and red-brown, medium to coarse grained sandstone, bedding typically 0-10°		C	5.0 5.79 5.8 6.71 7.86 8.8 8.88 9.34		PL(A) = 0.6 PL(A) = 0.8 PL(A) = 1.1 PL(A) = 0.5 PL(A) = 0.5		Gravel Screen 5.1-9.6m
49	9.5	SANDSTONE: medium strength, fresh, slightly fractured to unbroken, light grey sandstone with some low strength bands, bedding typically 10-15° with some cross bedding		C	10.0 11.0 11.85 11.95		PL(A) = 0.8 PL(A) = 0.12 PL(A) = 0.39		Bentonite
43	12.24	SANDSTONE (see over page) SANDSTONE: medium and high strength, fresh, unbroken, light grey and grey sandstone		C	12.37 13.44		PL(A) = 1.38 PL(A) = 0.69		Backfill
		13.4-13.8: Bedding typically 5-10°							
40	14.8	Bore discontinued at 14.8m Target depth reached			14.76 14.8		PL(A) = 1.16		

RIG: Han Jin 8D **DRILLER:** BG Drilling **LOGGED:** JAP **CASING:** HW to 4.5 m

TYPE OF BORING: Diatube to 0.11 m, Non-destructive drilling to 1.8 m, Auger to 2.0 m, Rotary to 5.0 m, NMLC Coring to 14.80 m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

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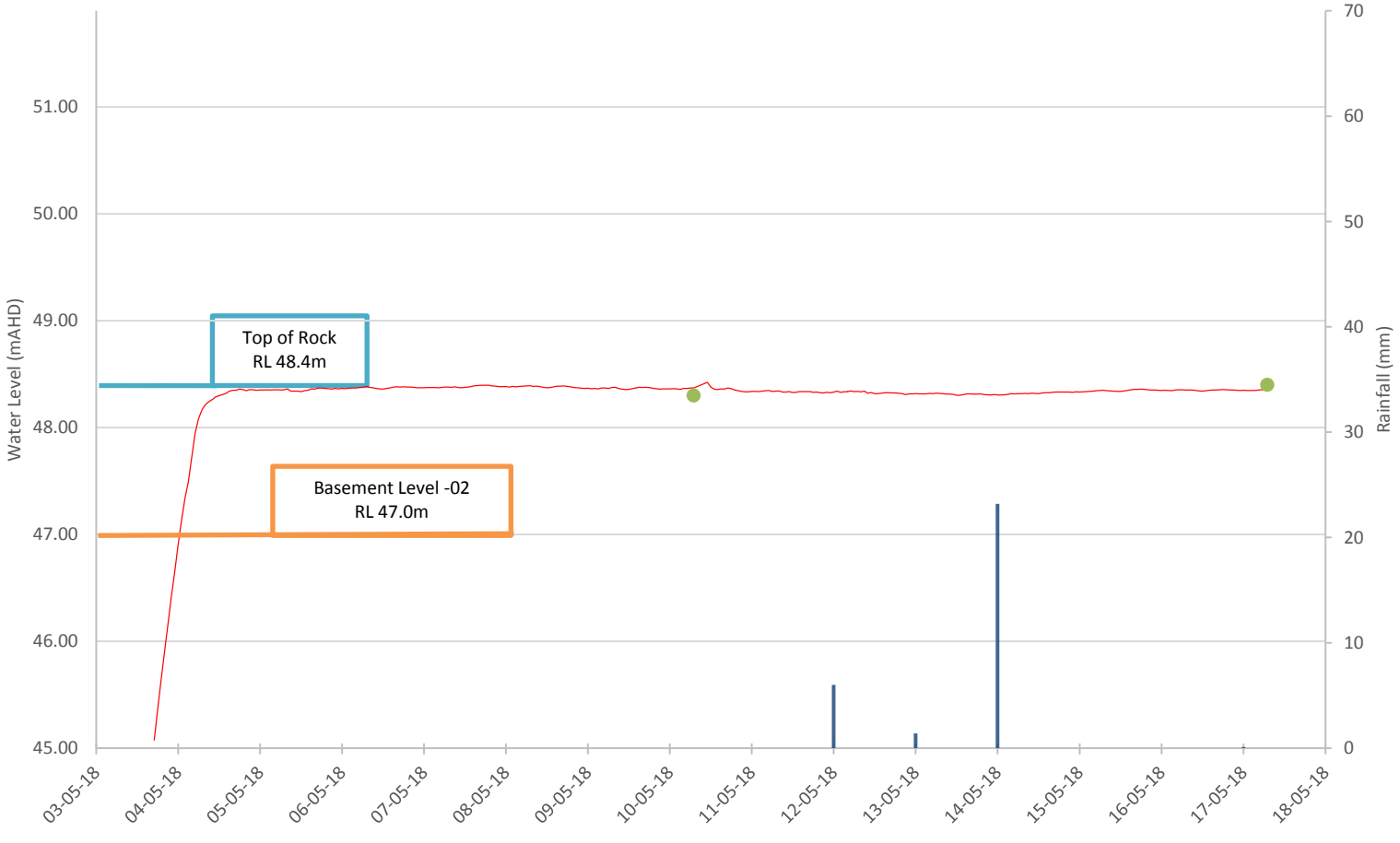
Appendix I

Results of Groundwater Monitoring

BH4



Note: Reading Interval = 1 hour

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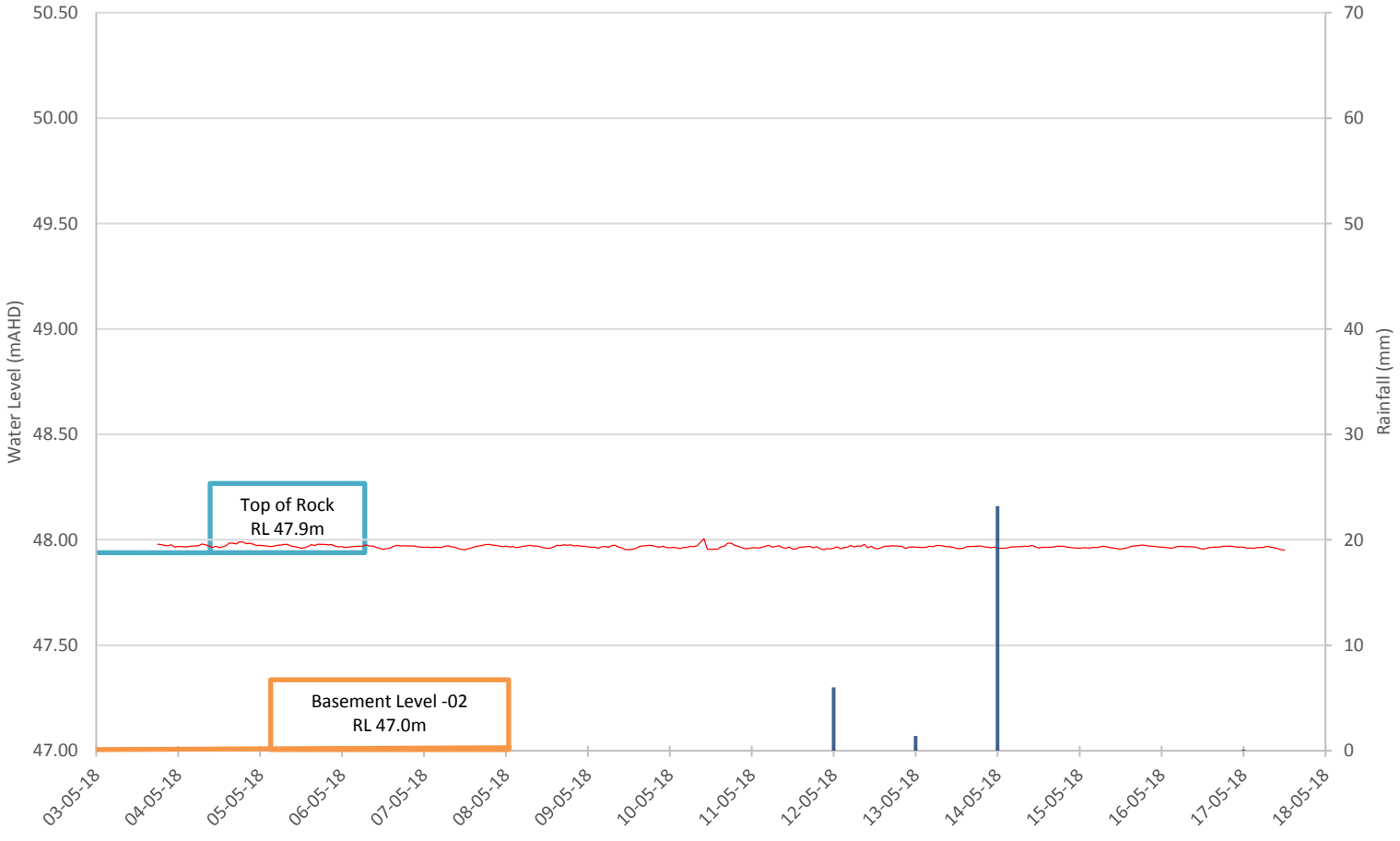
Geotechnics / Environment / Groundwater

Water Level
Manual Levels
Rainfall data

Date:	From:	Drawn:
23-05-18	03-05-18	JAP
Project:	**To:**	**Checked:**
72505.13	17-05-18	LJH

BH8



Note: Reading Interval = 1 hour

Douglas Partners
Geotechnics / Environment / Groundwater

Water Level
Manual Levels
Rainfall data

Date:	From:	Drawn:
23-05-18	03-05-18	JAP
Project:	**To:**	**Checked:**
72505.13	17-05-18	LJH

BH9

Note: Reading Interval = 1 hour

Douglas Partners
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Water Level
Manual Levels
Rainfall data

Date:	From:	Drawn:
23-05-18	03-05-18	JAP
Project:	**To:**	**Checked:**
72505.13	17-05-18	LJH

BH10

Note: Reading Interval = 1 hour

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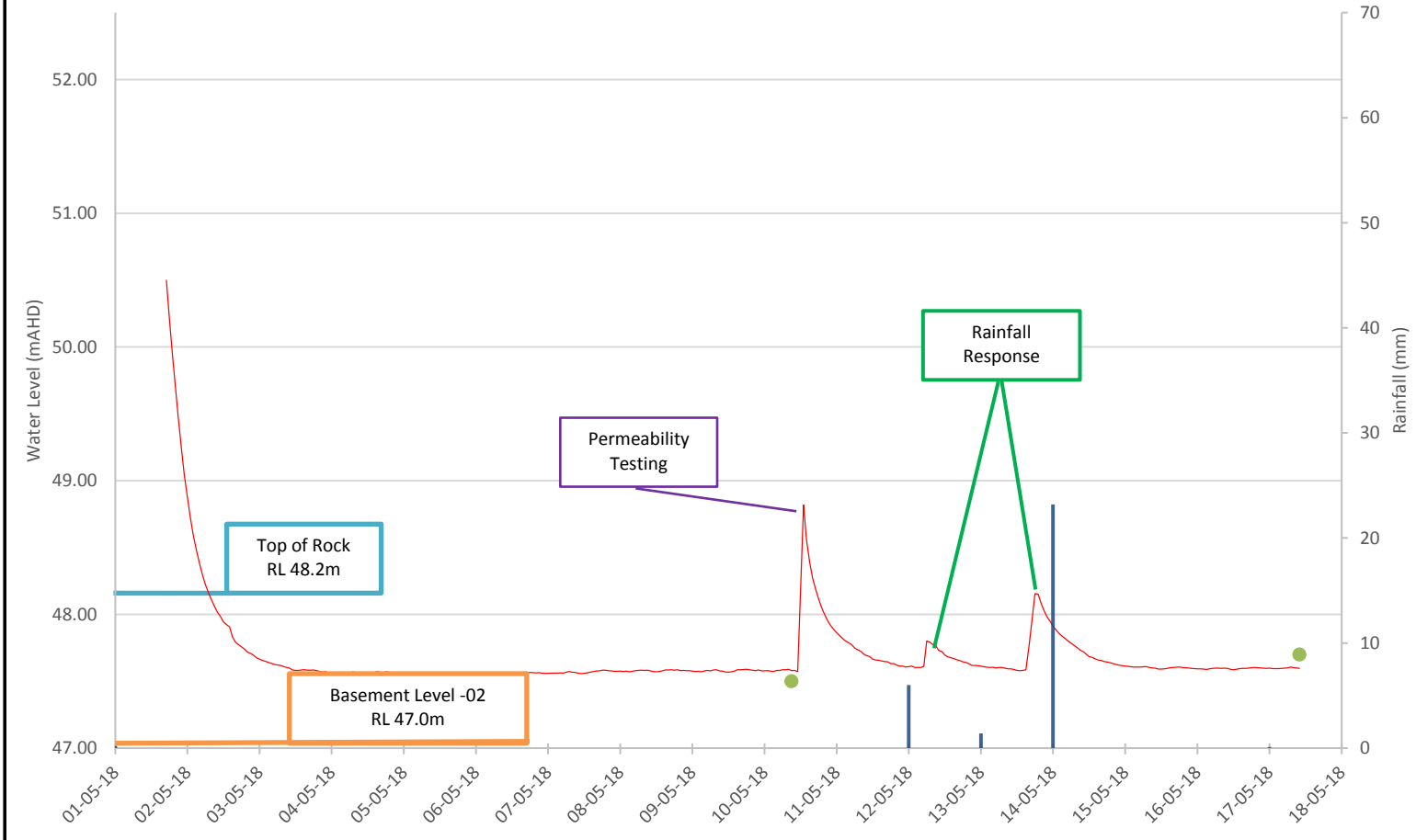
Water Level
Manual Levels
Rainfall data

Date:	From:	Drawn:
23-05-18	02-05-18	JAP
Project:	**To:**	**Checked:**
72505.13	17-05-18	LJH

BH11



Note: Reading Interval = 1 hour

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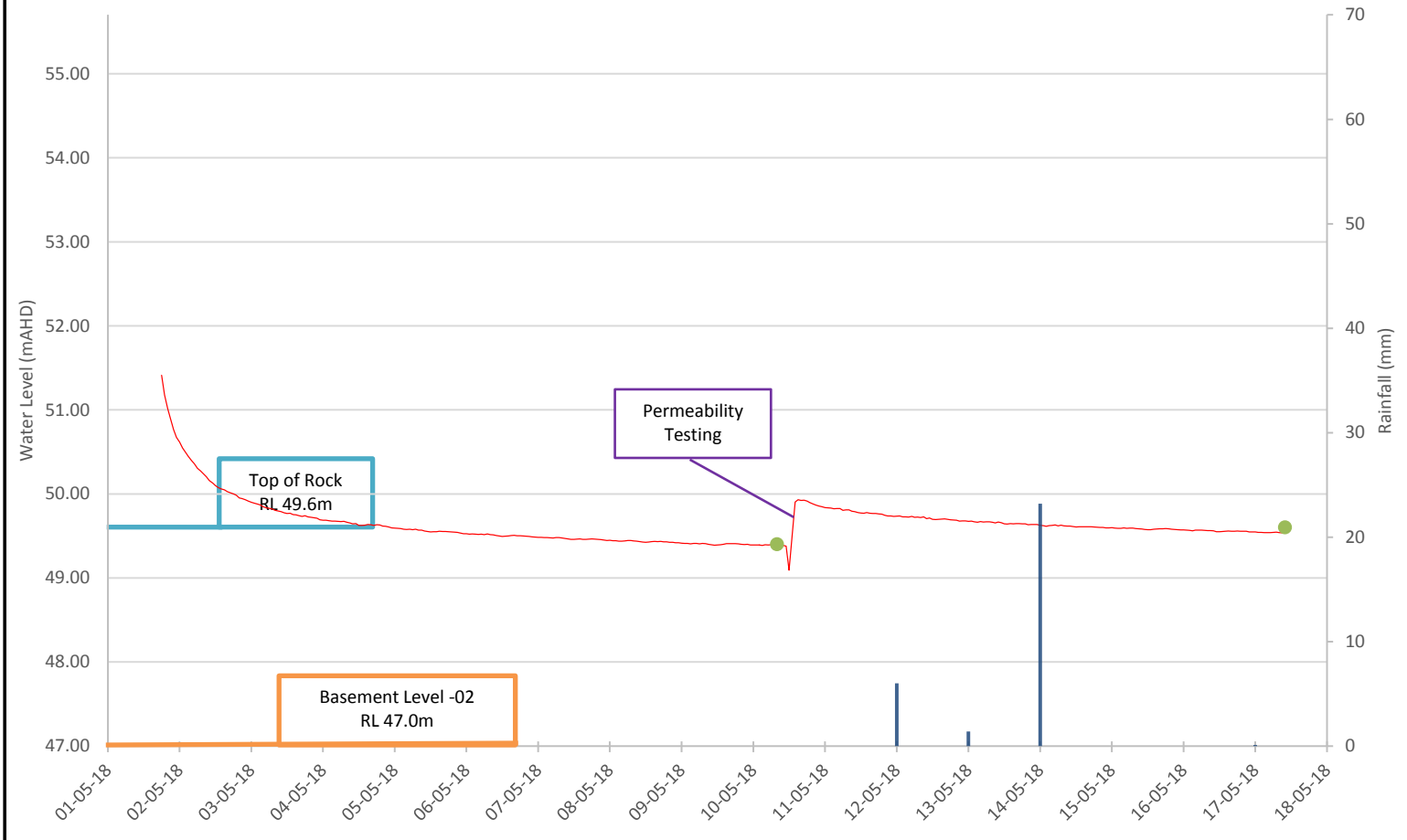
Water Level
Manual Levels
Rainfall data

Date:	From:	Drawn:
23-05-18	01-05-18	JAP
Project:	**To:**	**Checked:**
72505.13	17-05-18	LJH

BH12



Note: Reading Interval = 1 hour

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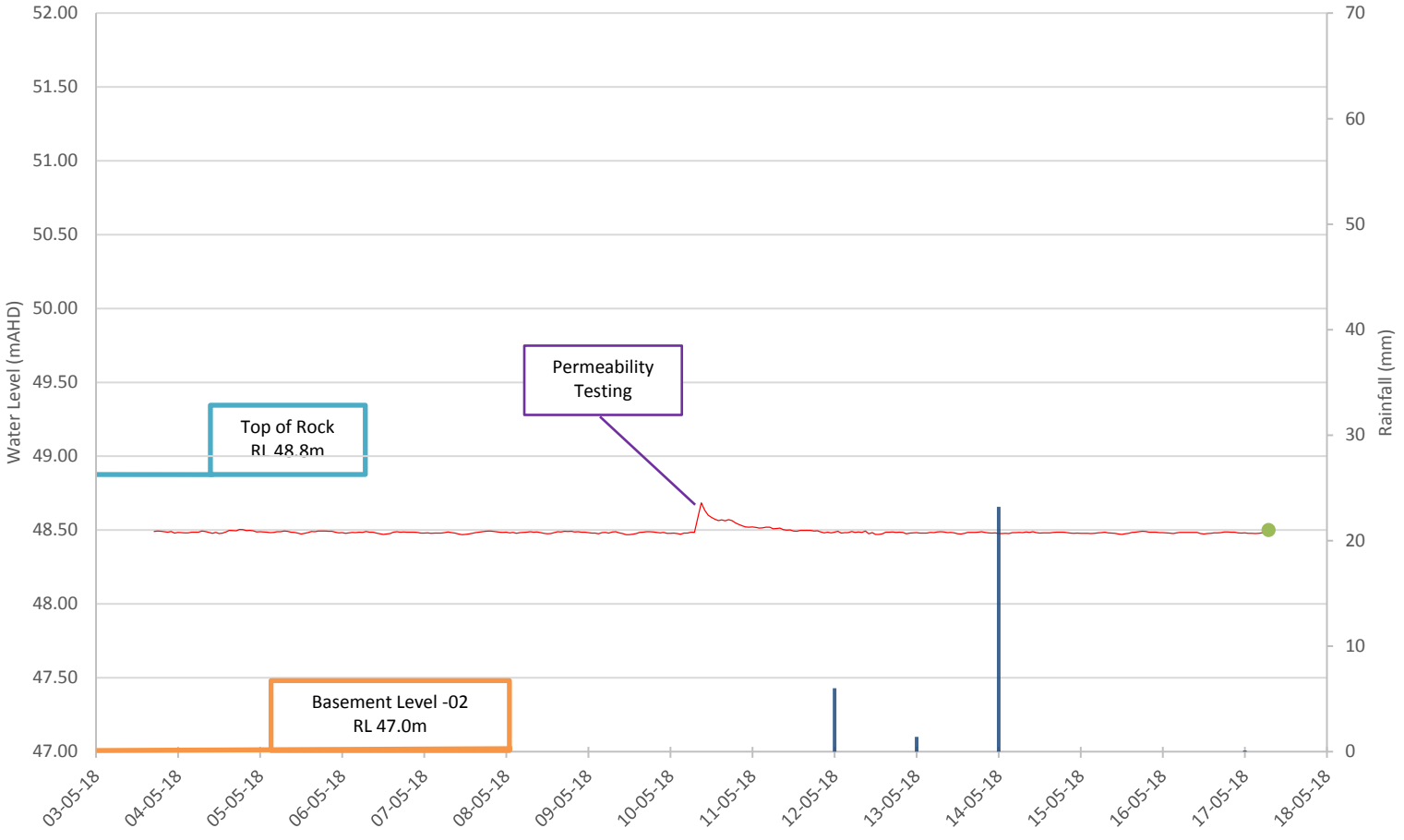
Water Level
Manual Levels
Rainfall data

Date:	From:	Drawn:
23-05-18	01-05-18	JAP
Project:	**To:**	**Checked:**
72505.13	17-05-18	LJH

BH13



Note: Reading Interval = 1 hour

Douglas Partners
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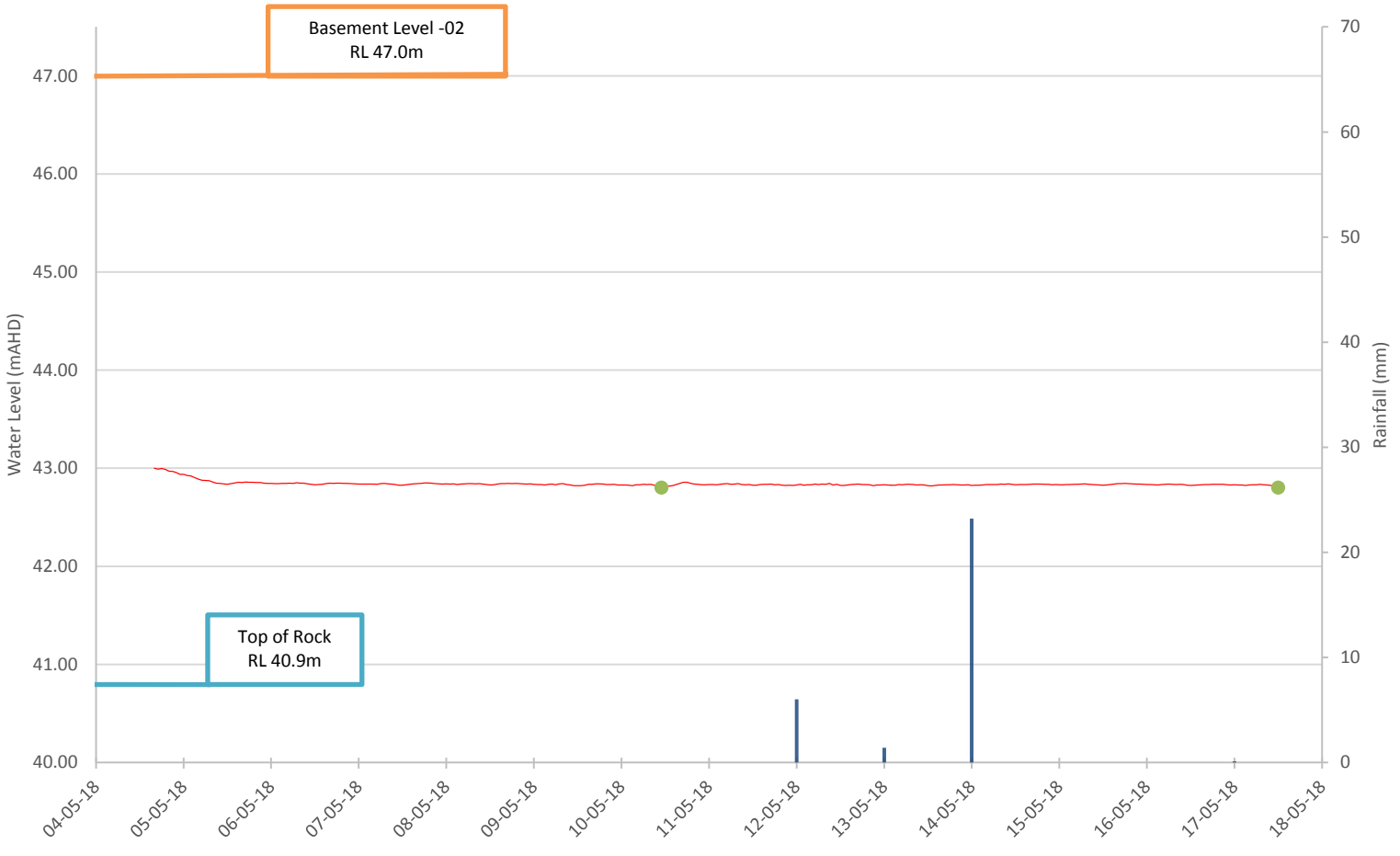
Water Level
Manual Levels
Rainfall data

Date:	From:	Drawn:
23-05-18	03-05-18	JAP
Project:	**To:**	**Checked:**
72505.13	17-05-18	LJH

BH14



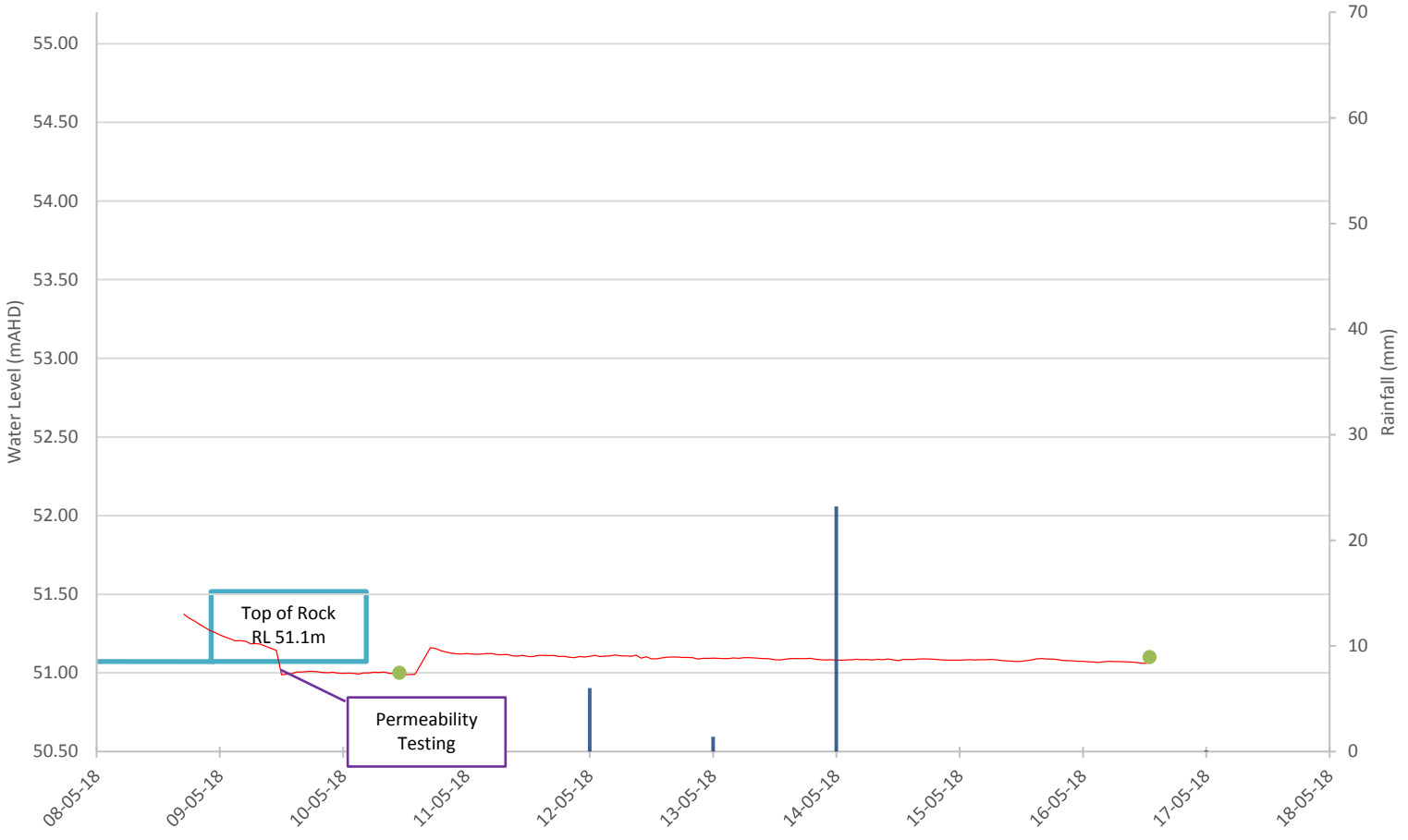
Note: Reading Interval = 1 hour

Douglas Partners
Geotechnics / Environment / Groundwater

Water Level
Manual Levels
Rainfall data

Date:	From:	Drawn:
23-05-18	04-05-18	JAP
Project:	**To:**	**Checked:**
72505.13	17-05-18	LJH

BH16



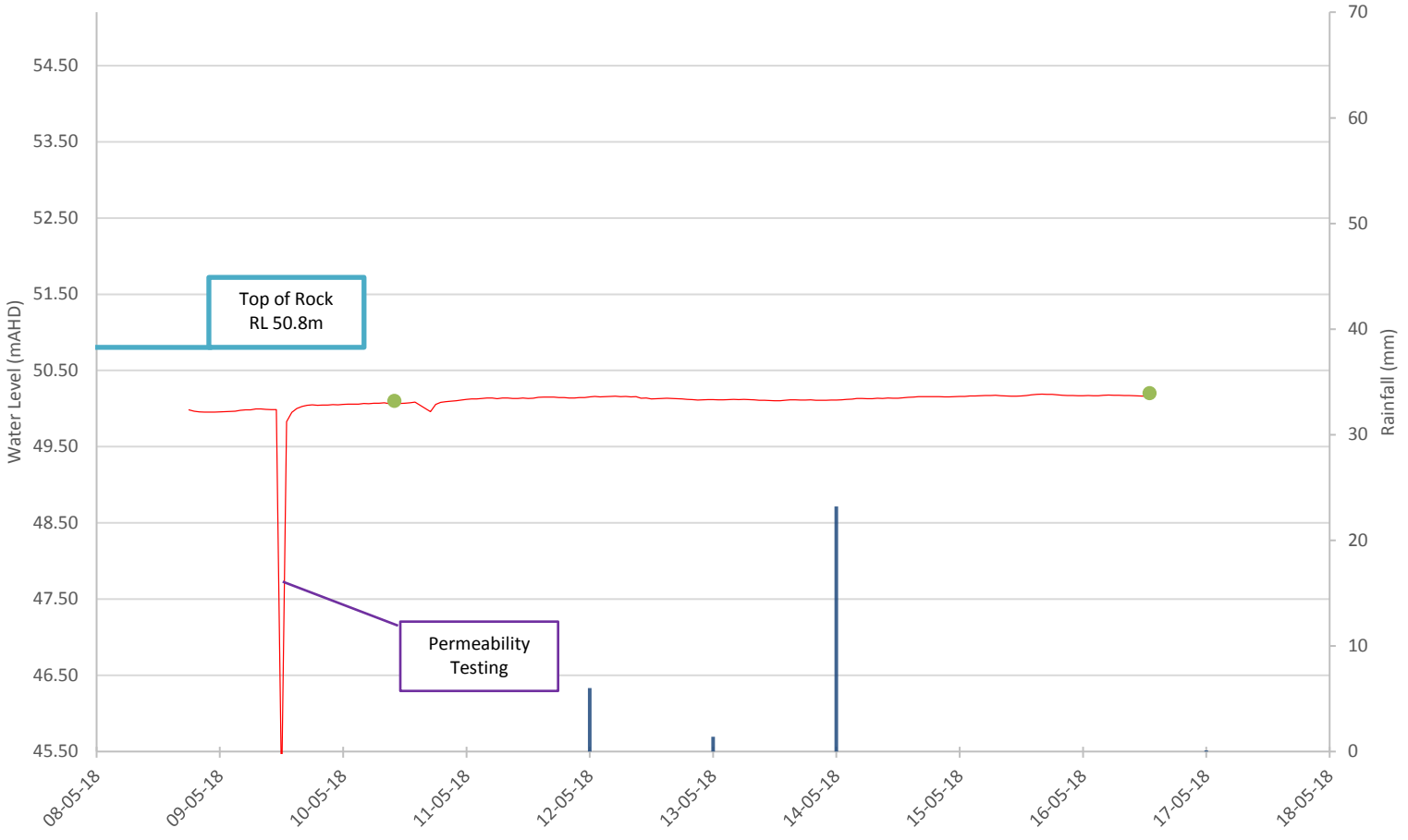
Note: Reading Interval = 1 hour

Douglas Partners
Geotechnics / Environment / Groundwater

Water Level
Manual Levels
Rainfall data

Date:	From:	Drawn:
23-05-18	08-05-18	JAP
Project:	**To:**	**Checked:**
72505.13	16-05-18	LJH

BH17



Note: Reading Interval = 1 hour

Douglas Partners
Geotechnics / Environment / Groundwater

Water Level
Manual Levels
Rainfall data

Date:	From:	Drawn:
23-05-18	08-05-18	JAP
Project:	**To:**	**Checked:**
72505.13	16-05-18	LJH

Monthly Rainfall (millimetres)

RANDWICK RACECOURSE

Station Number: 066073 · State: NSW · Opened: 1937 · Status: Open · Latitude: 33.91°S · Longitude: 151.23°E · Elevation: 25 m

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1937	40.4	37.4	261.1	178.8	16.8	425.4	95.7	137.2	5.6	88.1	125.9	38.1	1450.5
1938	299.2	111.5	18.5	85.8	74.8	0.0	82.4	242.7	52.6	67.9	24.9	2.3	1062.6
1939	79.7	2.0	219.0	97.8	155.3	6.1	20.9	57.4	78.1	52.1	43.6	8.4	820.4
1940	14.2	22.1	16.0	172.5	206.3	98.5	107.7	49.5	68.5	53.1	78.0	233.5	1119.9
1941	128.5	55.6	45.4	95.1	44.2	52.9	44.7	93.5	47.9	47.8	36.3	17.8	709.7
1942	14.5	57.8	475.5	12.5	33.2	149.0	53.5	30.2	21.1	152.4	133.1	102.2	1235.0
1943	52.1	7.6	28.7	30.4	404.0	27.2	11.0	188.0	132.4	42.3	186.0	79.9	1189.6
1944	69.9	104.1	61.2	54.1	90.1	43.7	75.8	109.2	29.8	16.5	26.4	33.5	714.3
1945	74.2	52.7	21.8	297.2	159.8	192.6	82.6	46.6	7.4	35.3	55.4	48.5	1074.1
1946	13.0	82.8	106.7	232.4	69.4	175.6	4.3	3.8	19.9	69.0	70.7	33.0	880.6
1947	60.0	113.2	68.8	192.7	93.2	75.5	15.7	34.9	13.0	49.8	92.9	176.4	986.1
1948	202.1	51.6	103.0	40.4	173.3	151.6	30.5	15.5	50.0	29.2	15.0	81.3	943.5
1949	242.5	121.4	133.4	33.8	117.2	350.8	55.1	138.7	249.9	29.1	85.3	53.9	1611.1
1950	154.5	156.2	142.6	158.9	171.2	541.2	340.3	82.8	112.0	111.9	117.9	30.1	2119.6
1951	291.3	68.9	144.6	36.1	154.3	398.7	23.9	102.2	43.4	50.9	17.3	21.9	1353.5
1952	40.2	52.9	118.4	317.6	22.3	161.0	196.6	287.4	20.5	194.7	75.8	36.1	1523.5
1953	73.1	162.9	154.6	19.9	341.6	49.7	74.7	50.6	28.2	64.9	34.8	10.2	1065.2
1954	98.3	206.7	54.9	13.1	29.9	8.9	68.4	23.8	56.7	167.2	104.5	77.0	909.4
1955	177.3	279.5	188.1	127.0	269.5	145.3	67.6	9.2	20.6	44.3	219.0	248.6	1796.0
1956	87.8	609.2	296.6	84.8	143.4	229.3	58.3	81.9	28.9	61.7	8.9	30.1	1720.9
1957	64.7	73.8	147.9	48.0	4.6	32.8	213.6	160.1	30.2	10.2	40.3	52.4	878.6
1958	106.0	350.9	272.2	56.6	13.5	226.1	26.5	81.1	41.2	47.8	6.8	127.5	1356.2
1959	150.8	218.7	154.8	48.5	56.6	150.5	195.3	93.7	64.3	422.1	79.4	41.0	1675.7
1960	60.1	83.7	38.4	29.2	116.5	86.8	118.4	59.8	50.8	259.1	64.6	242.2	1209.6
1961	56.4	77.7	46.2	95.3	23.7	41.9	47.1	225.8	61.5	60.5	570.7	146.9	1453.7
1962	147.1	130.5	45.3	107.8	309.6	2.5	71.8	139.7	93.4	26.9	20.0	170.1	1264.7
1963	145.1	62.6	420.6	281.8	278.4	319.2	85.2	342.2	23.5	72.9	41.6	287.6	2360.7
1964	12.0	27.5	163.1	172.9	47.8	390.2	9.7	32.0	19.8	58.7	138.7	24.7	1097.1
1965	12.4	5.3	9.2	110.1	63.0	242.2	87.8	20.6	118.2	180.2	33.7	62.6	945.3
1966	26.4	168.9	206.5	250.4	75.7	140.2	19.4	113.5	77.3	60.8	189.6	86.4	1415.1
1967	185.5	181.2	128.0	34.9	59.2	325.9	28.3	210.1	100.9	77.2	99.6	51.2	1482.0
1968	137.7	9.7	112.0	14.4	122.0	29.8	68.3	29.8	0.8	5.1	22.1	75.2	626.9
1969	41.2	224.4	101.7	193.0	53.8	255.4	44.0	175.0	88.9	61.4	261.0	56.3	1556.1
1970	142.0	22.1	222.5	58.6	12.9	32.6	2.5	33.7	180.1	19.0	141.9	297.1	1165.0
1971	166.1	224.0	78.6	66.2	127.4	79.3	25.8	111.3	67.6	6.6	84.4	146.6	1183.9
1972	448.0	97.5	186.8	96.0	100.6	141.1		40.4	13.5	167.9	67.1	30.9	
1973	247.1	336.4	140.3	91.2	36.3	80.3	133.4	110.2	92.0	169.2	110.0	24.5	1570.9
1974	240.0	125.6	347.0	214.0	262.8	231.2	12.8	224.8	67.8	43.8	113.7	21.8	1905.3
1975	25.4	162.0	413.8	87.8	42.6	414.1	56.8	35.4	65.0	105.2	50.0	27.8	1485.9
1976	344.4	236.0	414.0	40.0	36.6	178.8	174.6	50.0	198.0	307.0	144.9	29.2	2153.5
1977	161.6	226.8	276.8	32.8	134.2	131.8	10.0	17.6	83.4	8.0	28.0	33.8	1144.8
1978	312.0	9.2	395.4	162.4	174.2	410.8	16.8	84.0	142.2	145.4	121.2	92.2	2065.8
1979	165.0	46.6	280.8	20.8	148.8	203.4	40.0	11.8	4.6	37.8	85.8	7.8	1053.2
1980	146.5	115.3	89.7	31.5	216.4	58.6	55.8	23.2	0.8	6.6	54.6	10.2	809.2
1981	79.8	256.0	48.5	144.9	134.6	144.1	68.0	13.4	4.3	292.7	141.3	78.2	1405.8
1982	50.0	25.4	194.8	5.8	40.0	163.8	195.4	25.0	237.5	55.2	17.7	21.4	1032.0
1983	43.0	45.4	282.4	284.3	203.0	79.0	53.0	94.3	47.6	167.2	51.0	123.7	1473.9
1984	192.0	105.4	213.2	86.0	174.9	77.5	168.5	9.0	53.3	61.6	593.9	100.6	1835.9

Quality control: 12.3 Done & acceptable, *12.3* Not completed or unknown

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Monthly Rainfall (millimetres)

RANDWICK RACECOURSE

Station Number: 066073 · State: NSW · Opened: 1937 · Status: Open · Latitude: 33.91°S · Longitude: 151.23°E · Elevation: 25 m

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	10.0	68.1	81.0	306.0	165.5	136.5	101.0	37.0	88.0	167.5	92.0	119.0	1371.6
1986	210.2	101.0	25.0	134.0	65.5	6.0	28.5	436.0	29.0	83.5	139.0	17.0	1274.7
1987	90.0	45.5	134.5	88.0	61.5	126.5	172.5	209.0	12.0	245.0	189.0	66.5	1440.0
1988	121.0	134.0	97.0	597.0	101.5	117.5	105.5	66.5	89.0	2.0	152.5	148.0	1731.5
1989	190.5	97.0	187.5	393.0	204.0	307.0	18.0	50.0	2.0	22.5	66.5	132.0	1670.0
1990	79.5	734.0	178.0	289.0	188.0	54.5	89.0	214.5	202.0	32.0	31.0	73.0	2164.5
1991	101.0	70.0	19.0	71.0	191.5	257.0	156.0	2.5	28.5	14.0	35.0	167.5	1113.0
1992	77.0	388.5	66.0	83.5	71.0	126.5	14.0	67.5	39.0	121.0	173.0	145.5	1372.5
1993	101.5	82.0	100.0	74.0	27.0	84.0	109.5	68.0	126.0	91.5	92.0	43.0	998.5
1994	38.0	97.0	133.0	104.0	38.0	80.0	86.0	50.0	44.0	56.5	58.0	79.0	863.5
1995	76.0	63.0	193.0	40.0	218.0	167.0	9.0	0.0	248.0	61.0	148.5	82.0	1305.5
1996	171.5	52.5	58.0	63.0	278.5	244.5	71.0	112.0	146.0	29.5	110.5	40.0	1377.0
1997	217.0	143.0	46.0	16.5	247.0	121.0	250.0	33.5	163.0	53.0	34.5	33.0	1357.5
1998	107.0	61.5	43.0	331.0	262.5	176.5	110.5	498.2	55.1	47.6	79.3	76.0	1848.2
1999	219.3	164.9	40.6	245.0	89.7	95.4	170.2	105.4	39.0	141.7	51.5	85.0	1447.7
2000	31.5	32.0	243.0	57.0	46.5	41.7	36.0	27.2	39.0	81.0	148.0	46.4	829.3
2001	148.0	98.6	68.6	123.0	398.0	24.2	158.9	73.7	36.2		100.0	50.0	
2002		406.4		89.0	141.2	37.6	28.6	21.8	28.8	6.6		70.4	
2003		57.6	136.4	223.4	387.2	61.0	81.0	54.0	9.8	91.0	95.8	54.4	
2004					11.0	55.4		152.6		204.2	82.8	77.8	
2005	64.4	130.8	127.8	22.8	85.2		80.8	1.6	44.4	52.4	118.3		
2006	129.6	38.4	39.4	10.8	46.0	267.2	165.0	86.2	155.0	14.2	45.4	99.6	1096.8
2007	63.2	106.2	62.0			383.2	60.8	101.6	48.6	19.4	145.2	84.8	
2008	58.4	282.0	62.5	128.3	12.0	140.7	139.5			75.5	79.0	98.5	
2009	38.5	143.0	72.8	162.8	218.6	119.6	83.5	9.8	24.7	162.7	28.0	75.0	1139.0
2010	40.5			37.0	266.5	168.5	142.5	32.0	38.8	66.1		110.2	
2011	70.0	19.0	209.4	203.2	143.0	86.6	294.8			41.8	166.2	88.2	
2012	130.0		247.6	170.6	35.6	271.2	78.6	22.0	23.6	31.8		41.6	
2013	184.4		57.6	201.4	88.6	361.2	56.4	16.8	88.6	24.0			
2014	17.5		146.4	112.0	35.3		13.4	210.0	72.2	79.8	21.8	98.4	
2015	183.8	45.8	66.0	333.2	109.8		60.4	75.9		28.8		103.0	
2016		34.4	201.4		12.4	279.5	92.6	145.0	83.5	38.6	26.4	56.2	
2017	51.6	203.2	248.8	81.3	47.5	*174.5*	26.6	29.4	0.8	*61.4*	*88.2*	*45.6*	1058.9
2018	*37.8*	*101.4*	*103.2*	*45.0*									

Quality control: 12.3 Done & acceptable, *12.3* Not completed or unknown

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Monthly Rainfall (millimetres)

RANDWICK RACECOURSE

Station Number: 066073 · State: NSW · Opened: 1937 · Status: Open · Latitude: 33.91°S · Longitude: 151.23°E · Elevation: 25 m

Statistics for this station calculated over all years of data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	117.7	129.9	146.6	126.4	126.7	160.6	83.9	93.2	66.5	82.6	99.0	80.2	1323.5
Lowest	10.0	2.0	9.2	5.8	4.6	0.0	2.5	0.0	0.8	2.0	6.8	2.3	626.9
5th percentile	14.0	9.6	21.5	14.3	12.9	8.5	10.0	8.5	3.8	6.6	17.6	10.2	812.0
10th percentile	26.1	24.1	39.2	22.4	23.6	31.8	13.9	13.1	8.8	14.2	23.5	21.7	871.1
Median	94.2	97.5	128.0	91.2	101.1	140.4	68.4	66.5	48.6	59.6	81.1	70.4	1290.1
90th percentile	225.5	265.4	281.1	285.2	266.8	353.9	172.9	211.0	149.6	170.3	169.6	151.9	1842.1
95th percentile	292.5	358.4	397.2	318.9	311.2	400.5	198.3	247.2	198.8	245.7	196.9	234.4	2106.2
Highest	448.0	734.0	475.5	597.0	404.0	541.2	340.3	498.2	249.9	422.1	593.9	297.1	2360.7

Statistics calculated over the period 1961-1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	140.9	136.7	184.0	149.7	122.2	164.1	68.6	106.2	75.5	91.6	128.4	85.4	1453.1
Lowest	10.0	5.3	9.2	5.8	12.9	2.5	2.5	9.0	0.8	2.0	17.7	7.8	626.9
5th Percentile	12.2	9.4	34.1	17.3	29.4	16.7	9.8	12.5	1.3	5.8	20.9	13.3	863.6
10th percentile	24.1	20.9	46.1	30.4	36.6	32.3	12.2	17.2	4.1	6.6	27.4	21.0	1014.7
Median	143.6	103.2	170.6	101.9	111.8	138.4	55.8	58.2	67.7	61.1	95.8	69.8	1440.0
90th percentile	253.6	238.0	397.2	290.7	221.0	332.3	169.3	224.9	181.9	186.7	196.7	150.2	2083.3
95th percentile	329.8	300.2	413.9	353.9	271.4	401.5	173.8	289.8	200.2	271.2	431.3	234.7	2160.1
Highest	448.0	734.0	420.6	597.0	309.6	414.1	195.4	436.0	237.5	307.0	593.9	297.1	2360.7

1) Calculation of statistics

Summary statistics, other than the Highest and Lowest values, are only calculated if there are at least 20 years of data available.

2) Gaps and missing data

Gaps may be caused by a damaged instrument, a temporary change to the site operation, or due to the absence or illness of an observer.

3) Further information

http://www.bom.gov.au/climate/cdo/about/about-rain-data.shtml.

Product code: IDCJAC0001 reference: 37763448 Created on Wed 23 May 2018 13:13:03 PM EST

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Daily Rainfall (millimetres)

RANDWICK (RANDWICK ST)

Station Number: 066052 · State: NSW · Opened: 1917 · Status: Open · Latitude: 33.91°S · Longitude: 151.24°E · Elevation: 74 m

2018	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1st	7.6	0.8	0	0	0.2							
2nd	0	7.0	0	0	0							
3rd	4.0	12.6	0	1.2	0							
4th	4.4	1.8	0	0	0							
5th	1.2	0	0	0.1	0							
6th	0	0	5.8	0	0							
7th	0	0	3.6	0	0							
8th	1.4	0	0	0	0							
9th	15.6	0	0	0	0							
10th	7.4	1.8	0	0.8	0							
11th	0	2.6	0	0	0							
12th	0	0	0.2	0	6.0							
13th	0	0	79.0	0	1.4							
14th	3.2	0	10.0	0	23.2							
15th	1.6	0	0	0	0							
16th	0.1	0	0	0	0							
17th	0.2	0	0	0	0.1							
18th	0	0	0	2.0								
19th	0	0	0	0								
20th	0	2.4	0	0								
21st	0	0.2	4.6	0								
22nd	0	0	2.0	0								
23rd	0	0	4.8	0								
24th	0.6	0	0	0								
25th	0	0	0.4	0.4								
26th	0	60.4	7.0	0.2								
27th	0	2.6	0	0								
28th	0	0	0	10.2								
29th	0		0	15.2								
30th	0		0	24.6								
31st	2.6		0									
Highest daily	15.6	60.4	79.0	24.6	23.2							
Monthly Total	49.9	92.2	117.4	54.7								

↓ This day is part of an accumulated total
Quality control: 12.3 Done & acceptable, *12.3* Not completed or unknown

Product code: IDCJAC0009 reference: 37763125

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Daily Rainfall (millimetres)

RANDWICK (RANDWICK ST)

Station Number: 066052 · State: NSW · Opened: 1917 · Status: Open · Latitude: 33.91°S · Longitude: 151.24°E · Elevation: 74 m

Statistics for this station calculated over all years of data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	101.0	112.1	132.3	117.6	117.2	136.4	95.8	87.7	65.9	75.1	82.8	76.2
Median	76.6	83.6	107.3	85.2	88.1	112.2	71.6	61.3	51.9	54.8	73.8	61.5
Highest daily	178.0	225.0	242.8	177.3	155.2	104.1	161.3	296.6	88.2	265.4	164.3	143.0
Date of highest daily	17th 1988	3rd 1990	28th 1942	28th 1966	29th 1906	10th 1969	28th 1908	6th 1986	17th 2013	29th 1959	19th 1900	13th 1910

1) Calculation of statistics

Summary statistics, other than the Highest and Lowest values, are only calculated if there are at least 20 years of data available.

2) Gaps and missing data

Gaps may be caused by a damaged instrument, a temporary change to the site operation, or due to the absence or illness of an observer.

3) Further information

http://www.bom.gov.au/climate/cdo/about/about-rain-data.shtml.

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Appendix J

Results of Falling-Head Permeability Tests

Douglas Partners Pty Ltd
ABN 75 053 980 117
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96 Hermitage Road
West Ryde NSW 2114
PO Box 472
West Ryde NSW 1685
Phone (02) 9809 0666
Fax (02) 9809 4095

Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test date:	10-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

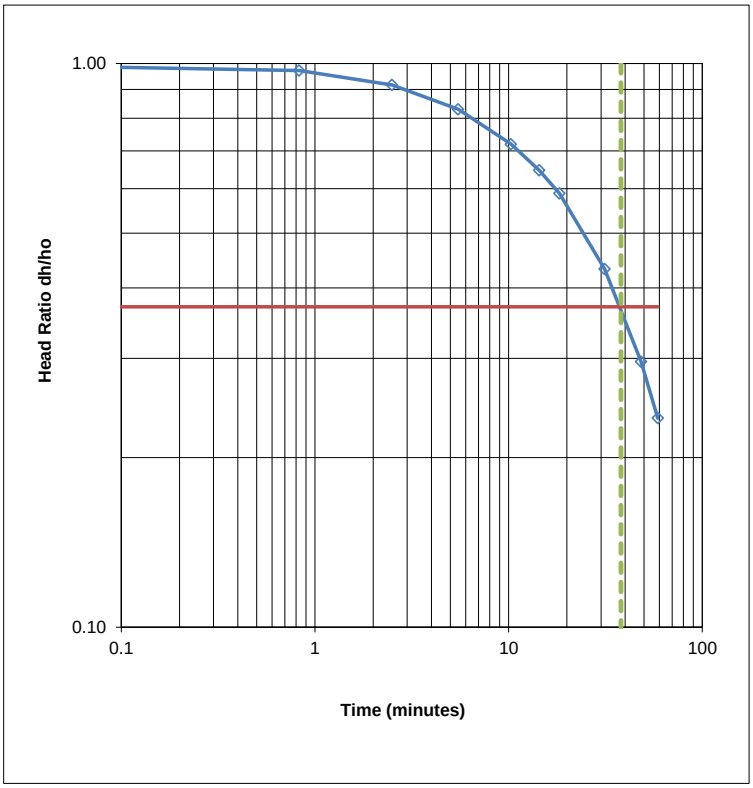
Test Location		**Test No.**	BH4	
Description:	BH4 Falling Head 1	Easting:	337045	m
Material type:	Sandstone	Northing	6245563	m
		Surface Level:	51.9	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	3.6	m
Well screen diameter (2R)	110	mm	Depth to water at start of test	0.15	m
Length of well screen (Le)	3.2	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.01	0.15	3.45	1.000
0.83	0.25	3.35	0.972
2.50	0.44	3.16	0.916
5.50	0.74	2.86	0.829
10.30	1.12	2.48	0.719
14.40	1.37	2.23	0.646
18.30	1.57	2.03	0.588
31.34	2.11	1.49	0.432
48.30	2.58	1.02	0.296
59.00	2.79	0.81	0.235



To = 38 Min
2280 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**1.7E-07**	m/sec
	=	**0.063**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test date:	17-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

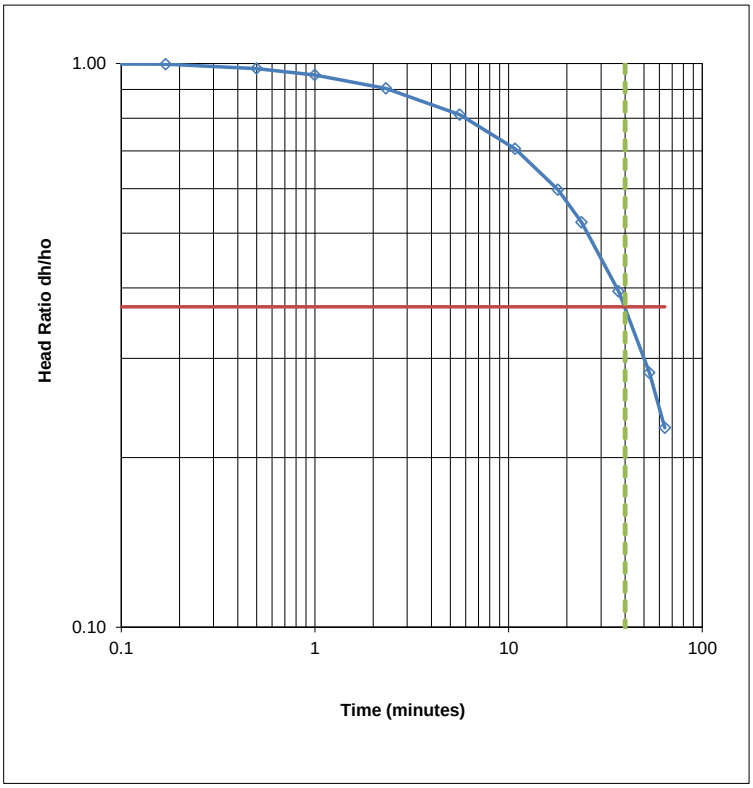
Test Location		**Test No.**	BH4	
Description:	BH4 Falling Head 2	Easting:	337045	m
Material type:	Sandstone	Northing	6245563	m
		Surface Level:	51.9	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	3.7	m
Well screen diameter (2R)	110	mm	Depth to water at start of test	0.2	m
Length of well screen (Le)	3.2	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.01	0.20	3.50	1.000
0.17	0.21	3.49	0.997
0.50	0.27	3.43	0.980
1.00	0.36	3.34	0.954
2.33	0.54	3.16	0.903
5.60	0.86	2.84	0.811
10.83	1.23	2.47	0.706
18.00	1.61	2.09	0.597
23.80	1.87	1.83	0.523
37.00	2.32	1.38	0.394
53.30	2.71	0.99	0.283
64.17	2.91	0.79	0.226



To = 40 Min
2400 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**1.7E-07**	m/sec
	=	**0.060**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test Date:	10-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

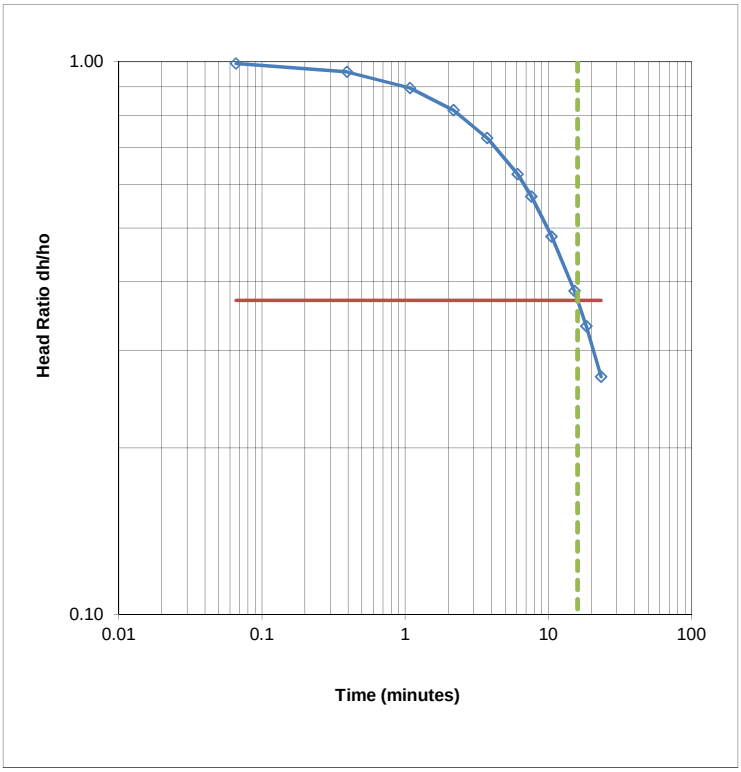
Test Location		**Test No.**	BH8	
Description:	BH8 Falling Head 1	Easting:	337038	m
Material type:	Sand	Northing	6245507	m
		Surface Level:	50.5	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	3	m
Well screen diameter (2R)	110	mm	Depth to water at start of test	0.14	m
Length of well screen (Le)	1.1	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.07	0.16	2.84	0.993
0.39	0.26	2.74	0.958
1.08	0.436	2.56	0.897
2.18	0.663	2.34	0.817
3.75	0.92	2.08	0.727
6.10	1.21	1.79	0.626
7.62	1.37	1.63	0.570
10.53	1.62	1.38	0.483
15.22	1.9	1.10	0.385
18.40	2.05	0.95	0.332
23.3	2.23	0.77	0.269



To = 16 Min
960 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**8.9E-07**	m/sec
	=	**0.319**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test date:	10-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

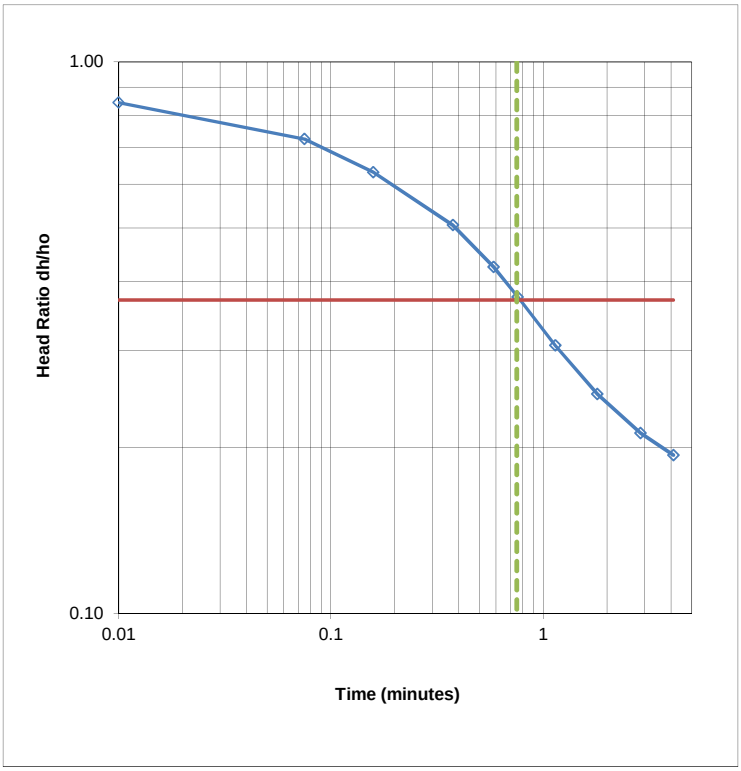
Test Location		**Test No.**	BH9	
Description:	BH9 Falling Head 1	Easting:	337026	m
Material type:	Sand	Northing	6245465	m
		Surface Level:	49.2	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	5.1	m
Well screen diameter (2R)	110	mm	Depth to water at start of test	3.5	m
Length of well screen (Le)	4.73	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.01	3.75	1.35	0.844
0.08	3.94	1.16	0.725
0.16	4.09	1.01	0.631
0.38	4.29	0.81	0.506
0.58	4.42	0.68	0.425
0.76	4.5	0.60	0.375
1.14	4.61	0.49	0.306
1.80	4.7	0.40	0.250
2.87	4.76	0.34	0.213
4.10	4.79	0.31	0.194



To = 0.75 Min
45 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**6.5E-06**	m/sec
	=	**2.354**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test date:	17-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

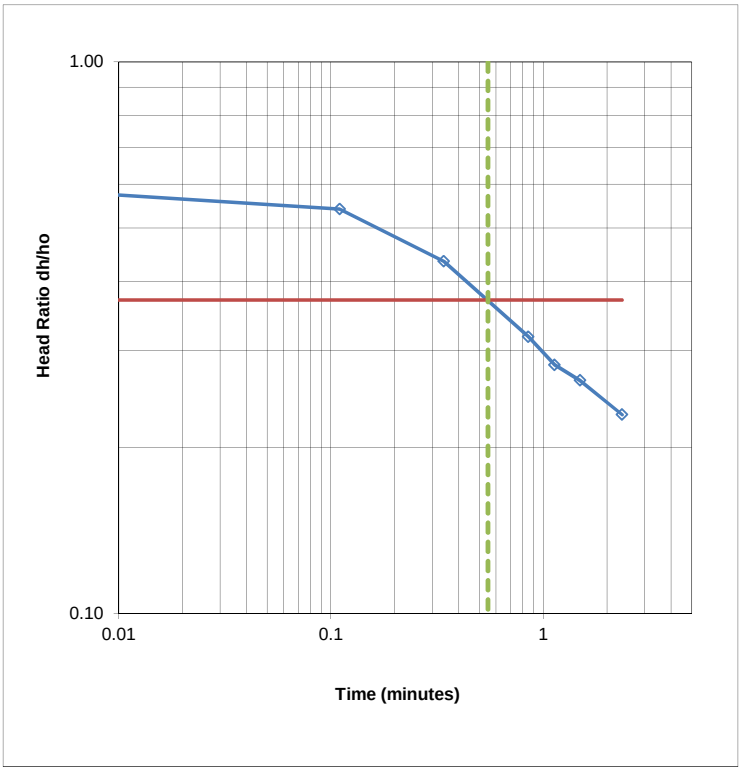
Test Location		**Test No.**	BH9	
Description:	BH9 Falling Head 2	Easting:	337026	m
Material type:	Sand	Northing	6245465	m
		Surface Level:	49.2	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	5.2	m
Well screen diameter (2R)	110	mm	Depth to water at start of test	3.5	m
Length of well screen (Le)	4.73	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.01	4.22	0.98	0.576
0.11	4.28	0.92	0.541
0.34	4.46	0.74	0.435
0.85	4.66	0.54	0.318
1.13	4.72	0.48	0.282
1.49	4.75	0.45	0.265
2.35	4.81	0.39	0.229



To = 0.55 Min
33 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**8.9E-06**	m/sec
	=	**3.210**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test date:	10-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

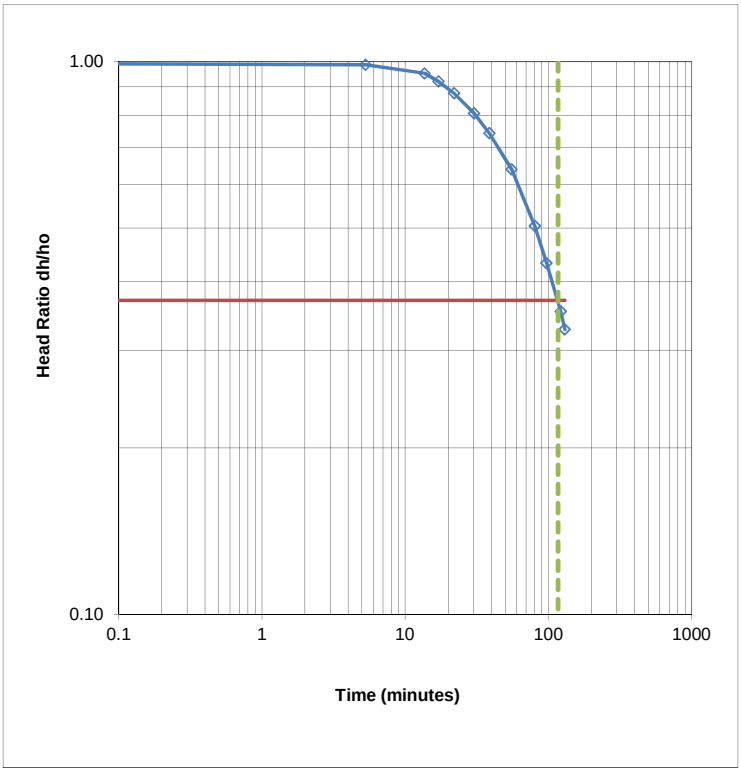
Test Location		**Test No.**	BH10	
Description:	BH10 Falling Head 1	Easting:	337082	m
Material type:	Sandstone	Northing	6245474	m
		Surface Level:	52.2	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	4.7	m
Well screen diameter (2R)	100	mm	Depth to water at start of test	0	m
Length of well screen (Le)	3.3	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.00	0.01	4.69	0.998
5.30	0.06	4.64	0.987
13.67	0.22	4.48	0.953
17.10	0.37	4.33	0.921
22.00	0.58	4.12	0.877
30.30	0.91	3.79	0.806
38.70	1.21	3.49	0.743
55.30	1.7	3.00	0.638
80.30	2.33	2.37	0.504
97.00	2.67	2.03	0.432
122	3.04	1.66	0.353
130	3.16	1.54	0.328



To = 117 Min
7020 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**5.7E-08**	m/sec
	=	**0.020**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test date:	17-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

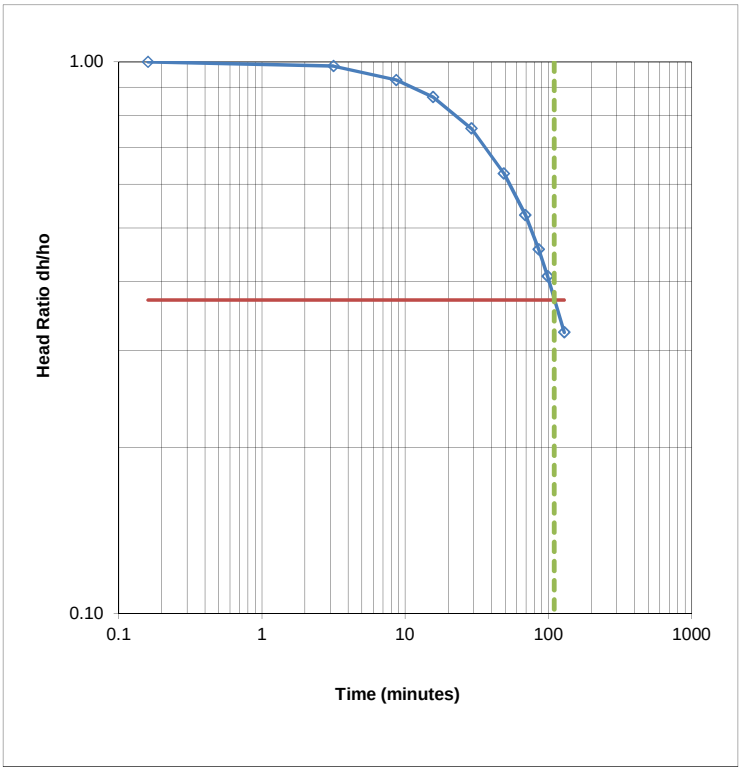
Test Location		**Test No.**	BH10	
Description:	BH10 Falling Head 2	Easting:	337082	m
Material type:	Sandstone	Northing	6245474	m
		Surface Level:	52.2	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	4.9	m
Well screen diameter (2R)	100	mm	Depth to water at start of test	0	m
Length of well screen (Le)	3.3	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.16	0.20	4.70	1.000
3.16	0.28	4.62	0.983
8.67	0.54	4.36	0.928
15.70	0.84	4.06	0.864
29.00	1.34	3.56	0.757
49.00	1.95	2.95	0.628
69.00	2.42	2.48	0.528
85.50	2.75	2.15	0.457
98.67	2.98	1.92	0.409
129.17	3.38	1.52	0.323



To = 110 Min
6600 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**6.0E-08**	m/sec
	=	**0.022**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test date:	10-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

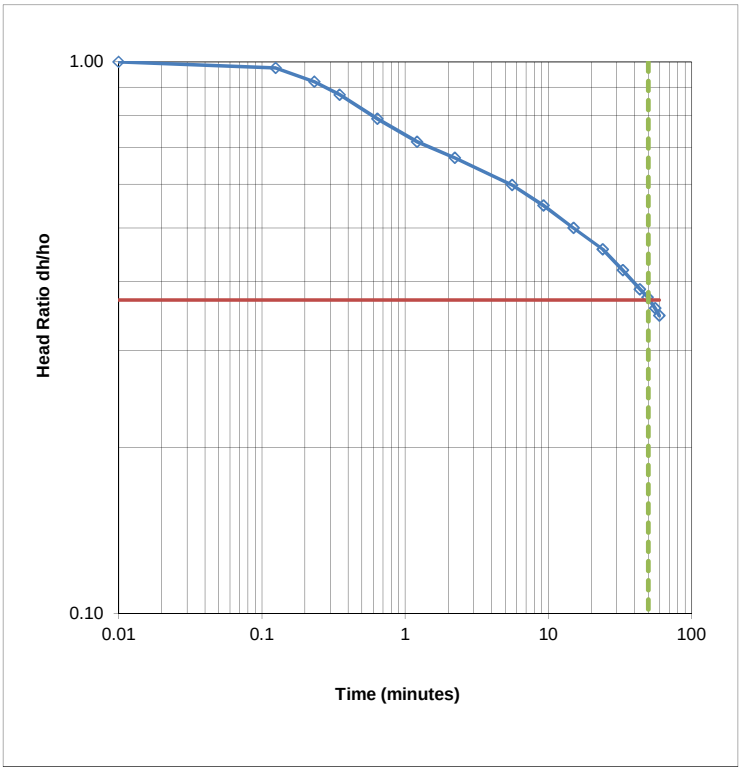
Test Location		**Test No.**	BH11	
Description:	BH11 Falling Head 1	Easting:	337083	m
Material type:	Sand	Northing	6245477	m
		Surface Level:	52.5	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	4.7	m
Well screen diameter (2R)	110	mm	Depth to water at start of test	0	m
Length of well screen (Le)	2.2	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.01	0.00	4.70	1.000
0.13	0.12	4.58	0.975
0.23	0.37	4.33	0.921
0.35	0.60	4.10	0.872
0.64	1.00	3.71	0.788
1.21	1.33	3.37	0.717
2.23	1.55	3.15	0.670
5.60	1.89	2.81	0.598
9.27	2.12	2.58	0.549
15.00	2.35	2.35	0.500
23.90	2.55	2.15	0.457
33.13	2.73	1.97	0.419
43.58	2.88	1.82	0.387
49.35	2.94	1.76	0.374
55.60	3.02	1.68	0.357
59.45	3.07	1.63	0.347



To = 50 Min
3000 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**1.7E-07**	m/sec
	=	**0.063**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test date:	17-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

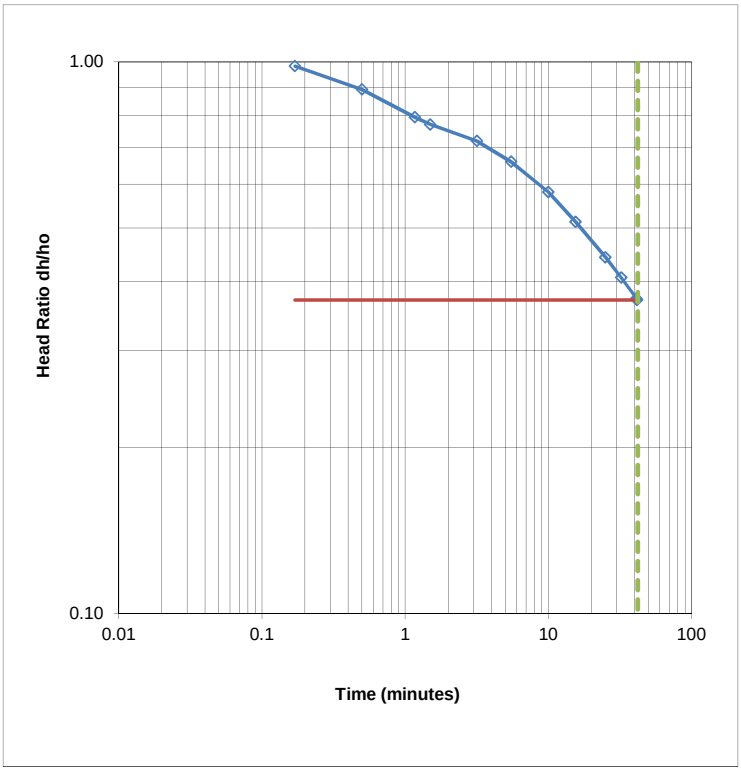
Test Location		**Test No.**	BH11	
Description:	BH11 Falling Head 2	Easting:	337083	m
Material type:	Sand	Northing	6245477	m
		Surface Level:	52.5	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	4.7	m
Well screen diameter (2R)	110	mm	Depth to water at start of test	0.83	m
Length of well screen (Le)	2.2	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.17	0.08	4.62	0.983
0.50	0.51	4.19	0.891
1.17	0.97	3.73	0.794
1.50	1.08	3.62	0.770
3.17	1.32	3.38	0.719
5.50	1.60	3.10	0.660
10.00	1.97	2.73	0.581
15.50	2.29	2.41	0.513
25.00	2.62	2.08	0.443
32.30	2.79	1.91	0.406
41.17	2.95	1.75	0.372
41.50	2.96	1.74	0.370



To = 42 Min
2520 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**2.1E-07**	m/sec
	=	**0.075**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test date:	10-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

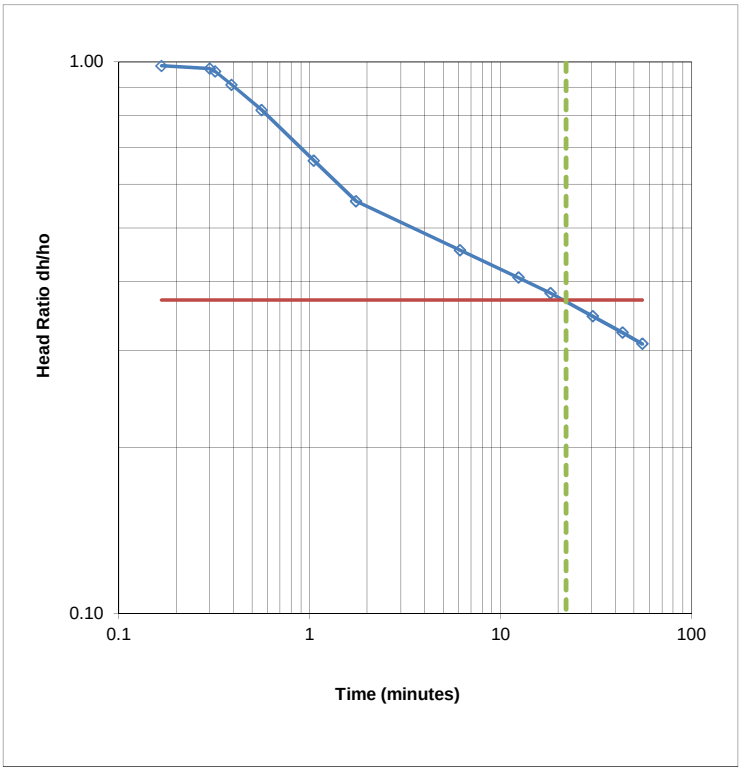
Test Location		**Test No.**	BH12	
Description:	BH12 Falling Head 1	Easting:	337090	m
Material type:	Sand	Northing	6245535	m
		Surface Level:	55.7	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	6.1	m
Well screen diameter (2R)	118	mm	Depth to water at start of test	0	m
Length of well screen (Le)	3.1	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.17	0.10	6.00	0.984
0.30	0.17	5.93	0.972
0.32	0.24	5.86	0.961
0.39	0.55	5.55	0.909
0.56	1.11	4.99	0.818
1.05	2.06	4.04	0.662
1.75	2.69	3.41	0.559
6.13	3.32	2.78	0.456
12.40	3.62	2.48	0.407
18.25	3.776	2.32	0.381
30.40	3.99	2.11	0.346
43.55	4.13	1.97	0.323
55.2	4.22	1.88	0.308



To = 22 Min
1320 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**3.0E-07**	m/sec
	=	**0.109**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test date:	17-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

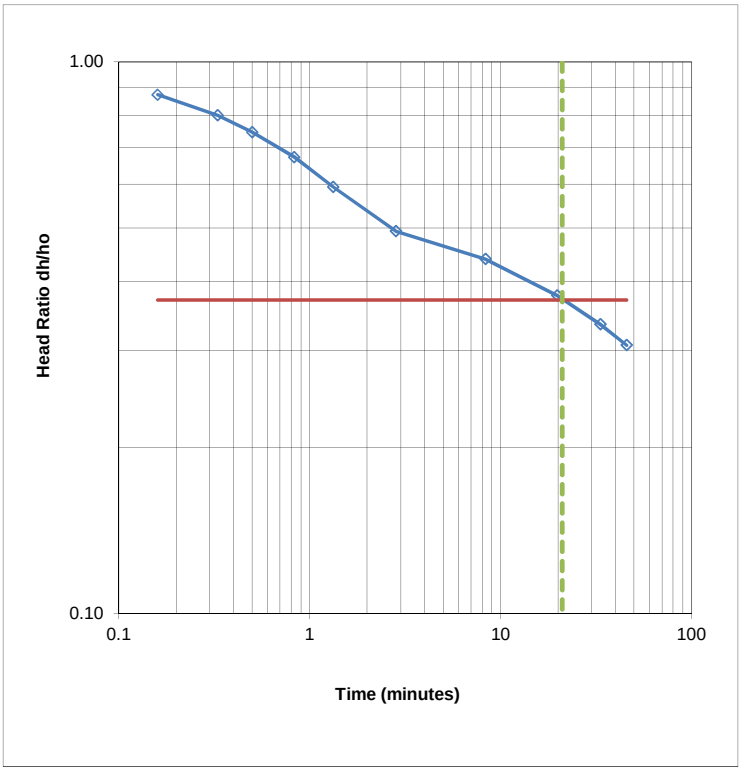
Test Location		**Test No.**	BH12	
Description:	BH12 Falling Head 2	Easting:	337090	m
Material type:	Sand	Northing	6245535	m
		Surface Level:	55.7	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	6.1	m
Well screen diameter (2R)	118	mm	Depth to water at start of test	0	m
Length of well screen (Le)	3.1	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.16	0.78	5.32	0.872
0.33	1.22	4.88	0.800
0.50	1.55	4.55	0.746
0.83	2	4.10	0.672
1.33	2.48	3.62	0.593
2.83	3.09	3.01	0.493
8.33	3.42	2.68	0.439
19.83	3.8	2.30	0.377
33.30	4.06	2.04	0.334
45.67	4.23	1.87	0.307



To = 21 Min
1260 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**3.2E-07**	m/sec
	=	**0.114**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test date:	10-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

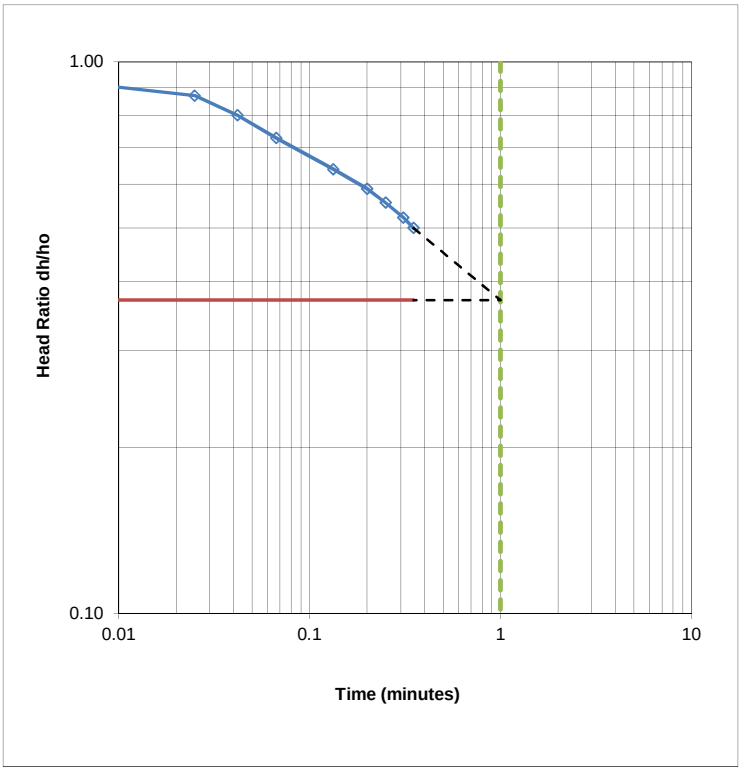
Test Location		**Test No.**	BH13	
Description:	BH13 Falling Head 1	Easting:	337045	m
Material type:	Sand	Northing	6245565	m
		Surface Level:	52.0	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	3.8	m
Well screen diameter (2R)	110	mm	Depth to water at start of test	2	m
Length of well screen (Le)	2.2	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.00	2.03	1.77	0.983
0.03	2.24	1.56	0.869
0.04	2.36	1.44	0.800
0.07	2.49	1.31	0.728
0.13	2.65	1.15	0.639
0.20	2.74	1.06	0.589
0.25	2.8	1.00	0.556
0.31	2.86	0.94	0.522
0.35	2.9	0.90	0.500



To = 1 Min
60 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**8.7E-06**	m/sec
	=	**3.144**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test date:	17-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

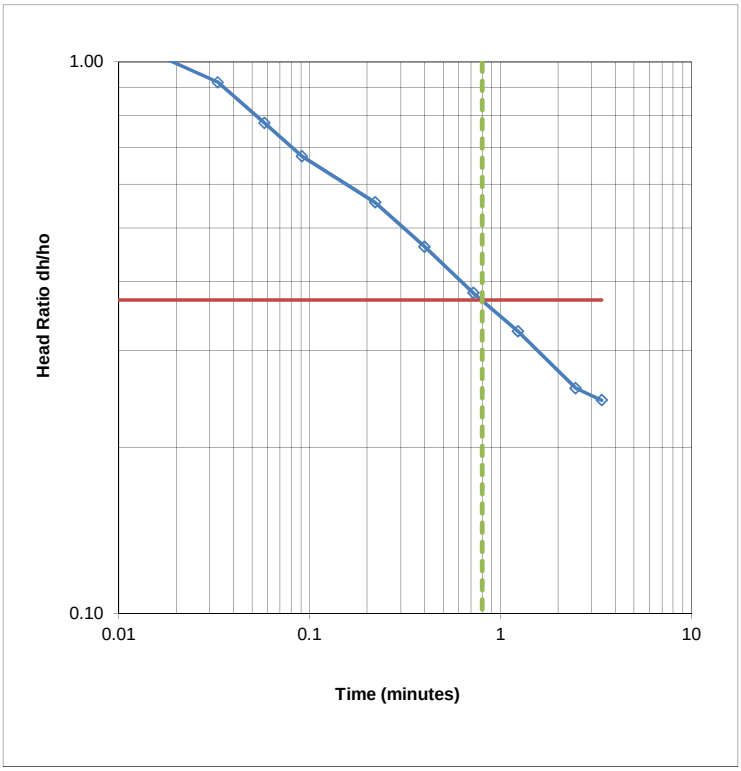
Test Location		**Test No.**	BH13	
Description:	BH13 Falling Head 2	Easting:	337045	m
Material type:	Sand	Northing	6245565	m
		Surface Level:	52.0	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	3.5	m
Well screen diameter (2R)	110	mm	Depth to water at start of test	1.9	m
Length of well screen (Le)	2.2	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.01	1.57	1.93	1.206
0.02	1.87	1.63	1.019
0.03	2.03	1.47	0.919
0.06	2.26	1.24	0.775
0.09	2.42	1.08	0.675
0.22	2.61	0.89	0.556
0.40	2.76	0.74	0.463
0.72	2.89	0.61	0.381
1.23	2.98	0.52	0.325
2.47	3.09	0.41	0.256
3.38	3.11	0.39	0.244



To = 0.8 Min
48 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**1.1E-05**	m/sec
	=	**3.930**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test date:	10-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

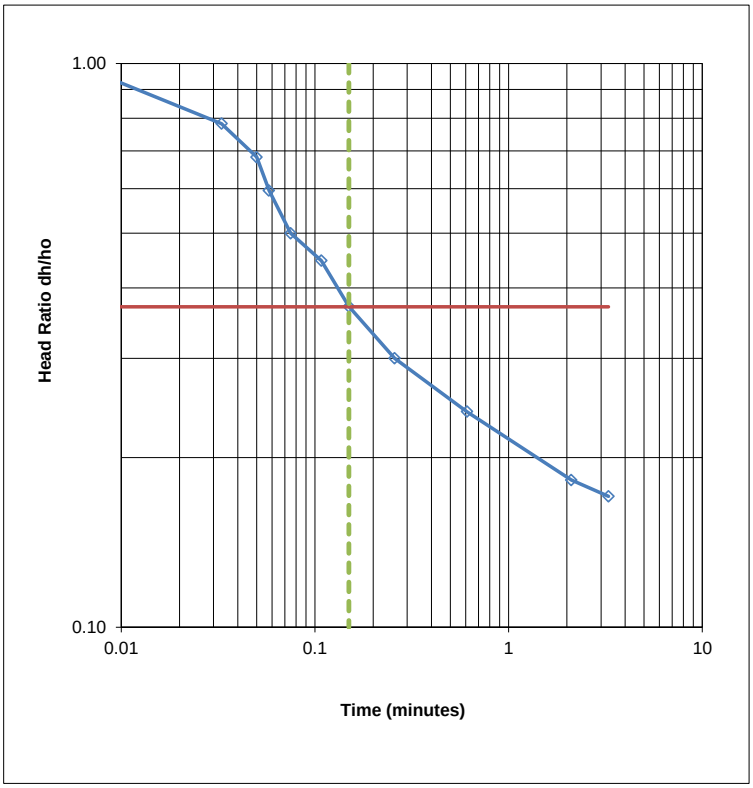
Test Location		**Test No.**	BH14	
Description:	BH14 Falling Head 1	Easting:	336983	m
Material type:	Sand	Northing	6245427	m
		Surface Level:	47.5	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	4.5	m
Well screen diameter (2R)	110	mm	Depth to water at start of test	2.8	m
Length of well screen (Le)	5.1	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.01	2.88	1.62	0.953
0.03	3.17	1.33	0.782
0.05	3.34	1.16	0.682
0.06	3.49	1.01	0.595
0.08	3.65	0.85	0.500
0.11	3.74	0.76	0.447
0.15	3.87	0.63	0.371
0.26	3.99	0.51	0.300
0.61	4.09	0.41	0.241
2.11	4.19	0.31	0.182
3.28	4.21	0.29	0.171



To = 0.15 Min
9 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**3.1E-05**	m/sec
	=	**11.102**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test date:	17-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

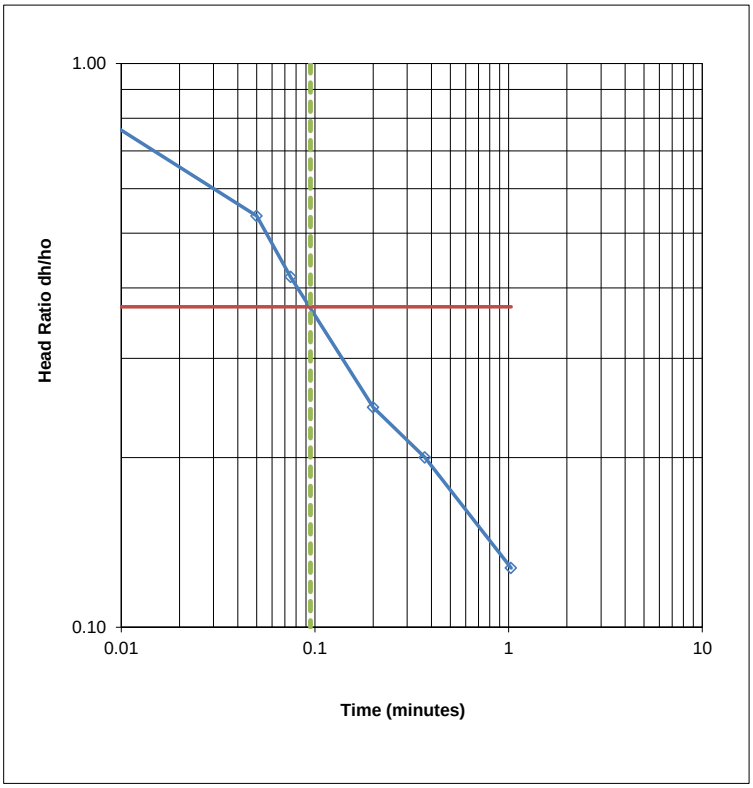
Test Location		**Test No.**	BH14	
Description:	BH14 Falling Head 2	Easting:	336983	m
Material type:	Sand	Northing	6245427	m
		Surface Level:	47.5	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	4.2	m
Well screen diameter (2R)	110	mm	Depth to water at start of test	3.1	m
Length of well screen (Le)	5.1	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.00	3.09	1.11	1.009
0.01	3.32	0.88	0.800
0.05	3.61	0.59	0.536
0.08	3.74	0.46	0.418
0.20	3.93	0.27	0.245
0.37	3.98	0.22	0.200
1.03	4.06	0.14	0.127



To = 0.095 Min
5.7 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**4.9E-05**	m/sec
	=	**17.530**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test date:	10-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

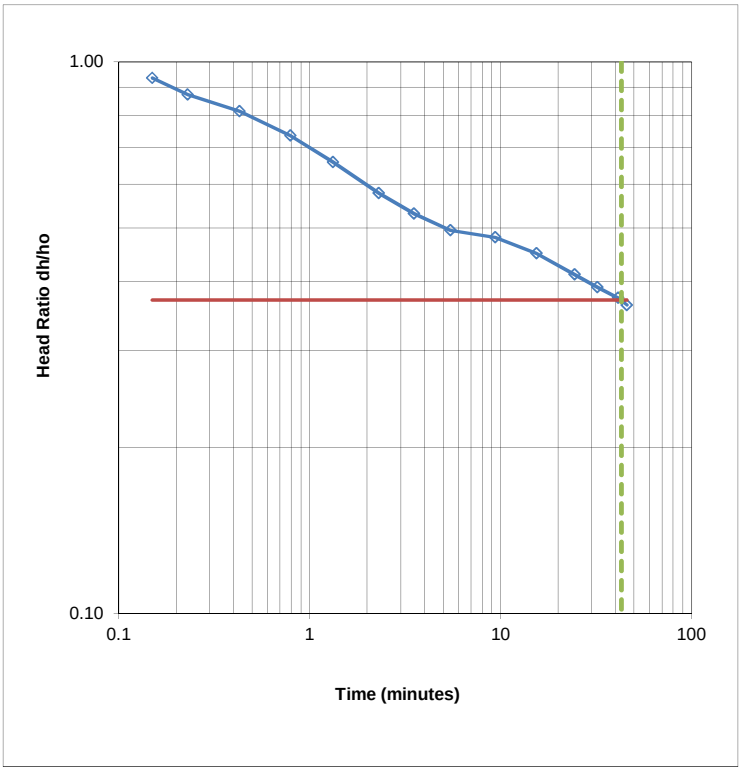
Test Location		**Test No.**	BH16	
Description:	BH16 Falling Head 1	Easting:	336986	m
Material type:	Sand	Northing	6245643	m
		Surface Level:	55.2	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	4.2	m
Well screen diameter (2R)	110	mm	Depth to water at start of test	0	m
Length of well screen (Le)	2.1	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.15	0.27	3.93	0.936
0.23	0.53	3.67	0.873
0.43	0.78	3.42	0.814
0.79	1.11	3.09	0.736
1.33	1.43	2.77	0.659
2.30	1.77	2.43	0.579
3.52	1.97	2.23	0.531
5.45	2.12	2.08	0.495
9.35	2.18	2.02	0.481
15.40	2.31	1.89	0.450
24.38	2.47	1.73	0.412
32.12	2.56	1.64	0.390
41.2	2.63	1.57	0.374
45.77	2.677	1.523	0.363



To = 43 Min
2580 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**2.1E-07**	m/sec
	=	**0.076**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test date:	17-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

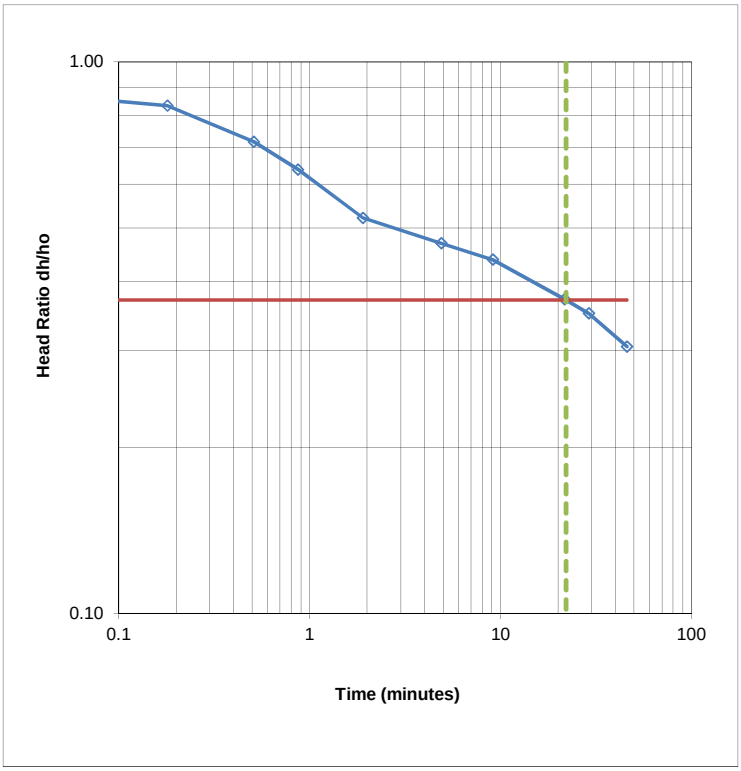
Test Location		**Test No.**	BH16	
Description:	BH16 Falling Head 2	Easting:	336986	m
Material type:	Sand	Northing	6245643	m
		Surface Level:	55.2	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	4.2	m
Well screen diameter (2R)	110	mm	Depth to water at start of test	0	m
Length of well screen (Le)	2.1	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.01	0.35	3.85	0.917
0.18	0.70	3.50	0.833
0.51	1.19	3.01	0.717
0.87	1.52	2.68	0.638
1.90	2.01	2.19	0.521
4.90	2.23	1.97	0.469
9.10	2.36	1.84	0.438
21.60	2.64	1.56	0.371
29.00	2.73	1.47	0.350
45.85	2.92	1.28	0.305



To = 22 Min
1320 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**4.1E-07**	m/sec
	=	**0.148**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test Date:	10-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

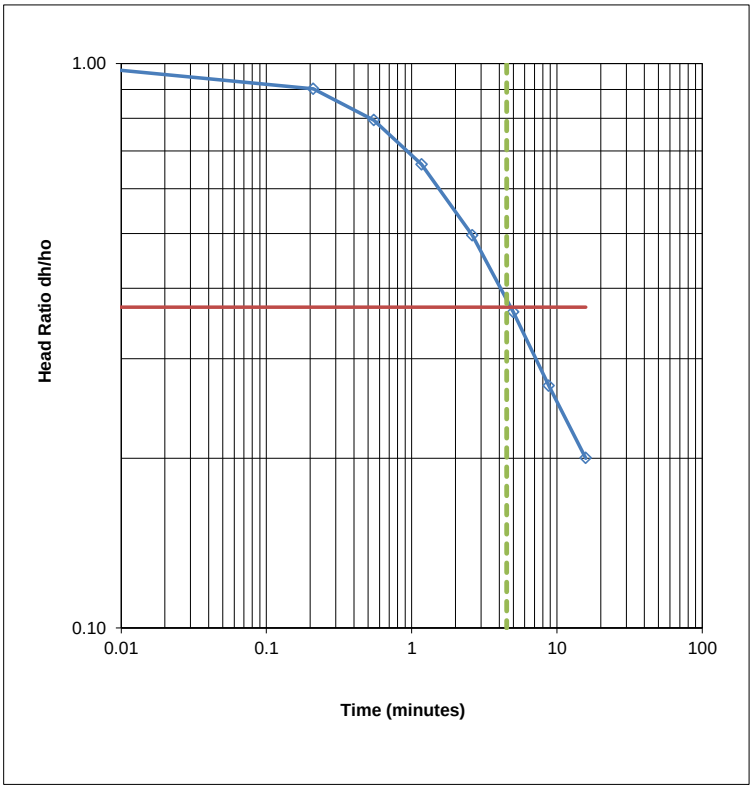
Test Location		**Test No.**	BH17	
Description:	BH17 Falling Head 1	Easting:	336983	m
Material type:	Sandstone	Northing	6245644	m
		Surface Level:	55.2	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	5.1	m
Well screen diameter (2R)	100	mm	Depth to water at start of test	0	m
Length of well screen (Le)	5	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.01	0.11	4.99	0.978
0.21	0.50	4.60	0.902
0.55	1.05	4.05	0.794
1.17	1.72	3.38	0.663
2.62	2.57	2.53	0.496
5.01	3.25	1.85	0.363
8.78	3.73	1.37	0.269
15.77	4.08	1.02	0.200



To = 4.5 Min
270 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**1.1E-06**	m/sec
	=	**0.384**	cm/hour

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Permeability Testing - Falling Head Test Report

Client:	LendLease Building Pty Ltd	Project No:	72505.13
Project:	Randwick Campus Redevelopment	Test Date:	17-May-18
Location:	Hospital Rd and High, Magill and Botany Sts, Randwick	Tested by:	JAP

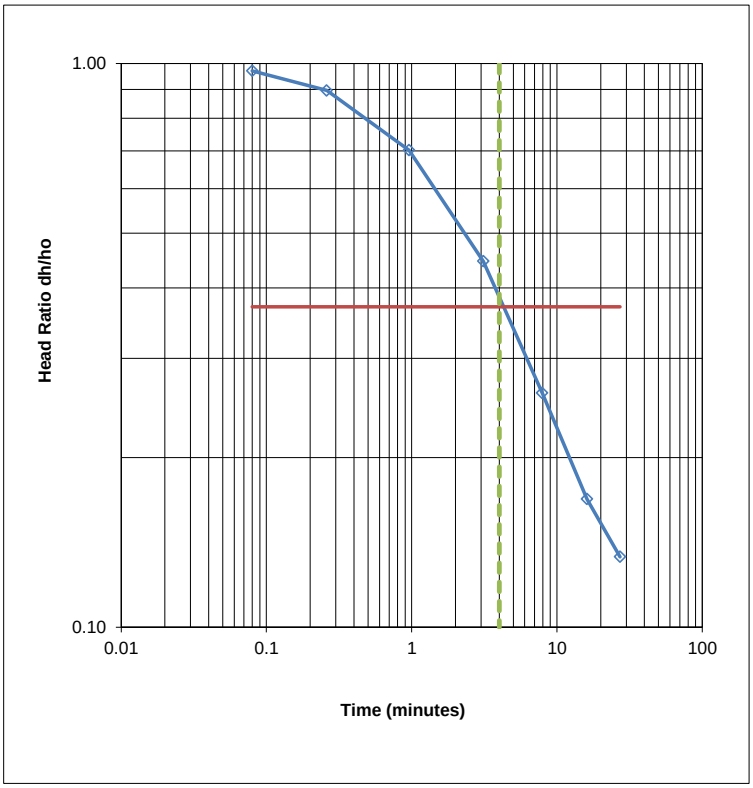
Test Location		**Test No.**	BH17	
Description:	BH17 Falling Head 2	Easting:	336983	m
Material type:	Sandstone	Northing	6245644	m
		Surface Level:	55.2	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	4.8	m
Well screen diameter (2R)	100	mm	Depth to water at start of test	0	m
Length of well screen (Le)	5	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.08	0.14	4.66	0.971
0.26	0.50	4.30	0.896
0.96	1.43	3.37	0.702
3.11	2.66	2.14	0.446
7.90	3.55	1.25	0.260
16.10	3.99	0.81	0.169
27.20	4.16	0.64	0.133



To = 4 Min
240 Sec

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**1.2E-06**	m/sec
	=	**0.432**	cm/hour