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Report on
Preliminary Geotechnical Investigation

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

Prepared for
Health Infrastructure

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

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Executive Summary

This report presents the results of a preliminary 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 assess the subsurface conditions across the site and to provide comments for preliminary design and planning purposes.

It is understood that the redevelopment includes:

- A new multi-storey Acute Services Building (ASB), about 150 m by 130 m in area, with basement Level -02 extending to RL 47 m. This will require excavation to depths of up to 8 m;
- Potential future regrading of Hospital Road, which will require excavation to depths of up to about 6 m below current surface levels; and
- A potential future tunnel below Hospital Road to link the existing Sydney Children's Hospital to the new ASB; and
- A future expansion area, located immediately north of the ASB and extending up to High Street (Stage 2).

The investigation included a desktop study of previous rock-cored boreholes in proximity to the site and regional mapping, together with the drilling of nine rock-cored boreholes (BH1 to BH9) across the site (where access was readily available to drilling rigs), installation of one groundwater monitoring well in BH7 to measure the groundwater level and laboratory testing for geotechnical purposes.

The subsurface conditions generally include sandy filling and ripped sandstone filling of variable thickness, overlying predominantly 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 sandstone.

Based on measurements of groundwater within previous and current boreholes and monitoring wells, groundwater is expected at levels of between RL 49 m and RL 52 m. For most of the site, groundwater seepage is expected at the soil and rock interface, and within bedrock along rock joints and extremely/highly weathered bedrock bands. At the southern (i.e. lower-lying) end of the site, a water table is expected within the sand profile below the proposed basement excavation depths.

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 deep excavations, a secant pile shoring wall embedded into bedrock is recommended to cut-off water flow. 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 Group Pty Ltd. Along sections of the proposed basement and possible future regrading of Hospital Road, where the top of bedrock is relatively shallow, a contiguous pile wall may be suitable instead of a secant pile wall.

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 may be suitable, however further assessment of the groundwater conditions and further estimation of groundwater inflow to the basement excavation is required for design. Based on the current preliminary information on groundwater at this site, groundwater inflow to the northern end of the basement excavation is estimated to be approximately 3 m^3/day. The volume of groundwater ingress will ultimately depend on the soil permeability, rock fracturing and prevailing weather conditions. Greater volumes of groundwater ingress may also be experienced if leaking stormwater systems are present in the surrounding sandy soils or heavy continuous rainfall is experienced.

It is expected that 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. 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.

For detailed design, further geotechnical investigation including rock-cored boreholes and groundwater monitoring wells is recommended to further characterise the subsurface conditions when site access is more readily available to drilling rigs (i.e. post-demolition of existing buildings).

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1. Introduction

This report presents the results of a preliminary 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 (SYD170971.P.001.Rev0, dated 18 August 2017) and a sub-consultant agreement with Health Infrastructure (HI). The investigation was carried out in consultation with HI, the project managers (Aurecon), and the structural engineers Enstruct Group Pty Ltd (Enstruct).

It is understood that the redevelopment includes:

- A new multi-storey Acute Services Building (ASB), about 150 m by 130 m in area, with basement Level -02 extending to RL 47 m. This will require excavation to depths of up to 8 m;
- Potential future regrading of Hospital Road, which will require excavation to depths of up to about 6 m below current surface levels; and
- A potential future tunnel below Hospital Road to link the existing Sydney Children's Hospital to the new ASB.

It is understood that a future expansion area, located immediately north of the ASB and extending up to High Street, is also being considered as part of this preliminary investigation. No details of this future development are known at this stage.

The investigation included the drilling of nine boreholes, installation of one groundwater monitoring well and laboratory testing 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 preliminary design of the ASB site, and the regrading of Hospital Road.

The geotechnical investigation was conducted in conjunction with a preliminary site (contamination) investigation, for which the results have been reported separately in DP's Report on Preliminary Site (Contamination) Investigation (DP Project 72505.12, dated 8 February 2018).

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 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 are 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.

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 about 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 extend below ground, with a main stormwater pipeline extending through 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.

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 current field investigation 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 high-pressure water) to confirm that the proposed borehole locations were unaffected by buried services.

- Drilling of Boreholes:
  - Nine boreholes (No.'s 1 to 9) were drilled to depths of between 16.0 m and 20.5 m, and were located within the existing road pavements, except for BH7, which was drilled within a residential property (refer to Drawing 1 in Appendix B for borehole locations);
  - The boreholes were drilled through the filling and soil to the top of weathered rock using a bobcat-mounted or truck-mounted drilling rig 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 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;
  - All 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 Well:
  - One groundwater monitoring well was installed within borehole BH7 to a depth of about 20.5 m to allow a subsequent measurement of the groundwater level and collection of groundwater samples for environmental laboratory testing. The well was constructed to target groundwater within the rock. Further details of the well construction are provided n the remarks on the corresponding borehole log; and
  - The groundwater level was measured within the well on one occasion following purging of drilling fluid and any influent groundwater.
- Reinstatement:
  - All boreholes located within the existing road pavements were reinstated with stabilised sand, roadbase gravel and cold-mix asphalt at the ground surface; 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 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 omitted from the scope of works due to the presence of closely-spaced in-ground and overhead services along road pavements, as well as the current light-rail construction works along High Street. Randwick City Council requested via email dated 11 September 2017 that no groundwater monitoring wells be installed within road pavements.

Information from previous investigations in proximity to the site was used to supplement the current boreholes at this early stage of the development.

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

6. Field Work Results

6.1 Site Walkover

A number of rock outcrops were exposed within existing cuttings in and around the hospital campus. Photographs of the rock outcrops 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.

The 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. Along the east side of Hospital Road, medium strength sandstone was exposed in significant calcite staining, which is a sign of groundwater seepage, was also evident along part of a rock face at Level B4 (refer to photographs 1 and 2). It is likely that groundwater seepage along adverse rock defects has contributed to the rock fall.

Within the driveway access to a delivery dock, there is 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 tunnel and lift shaft, linking the proposed ASB to the Sydney Children's Hospital.

The existing asphaltic concrete (AC) pavement surfaces around the site perimeter appear to be in relatively good condition, except near the current borehole BH2 on Hospital Road, where crocodile cracking of the AC wearing surface was observed along the wheel paths (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 the current boreholes BH1 to BH9 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 the current boreholes (BH1 to BH9) is summarised as follows:

- PAVEMENT: A 30 – 70 mm thick asphaltic concrete surfacing overlying roadbase gravel to depths of between 0.2 m and 0.4 m in BH1 to BH6 as well as BH8 and BH9;
- FILLING: Sandy filling and/or ripped sandstone in all boreholes to depths of between 0.2 m and 2.3 m;
- SAND: Predominantly 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. 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 and BH9; 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°.

Groundwater was measured at a depth of 5.0 m (RL 42.6 m) in BH6 whilst drilling. No groundwater was observed during auger drilling in the other eight current boreholes. The use of water for rotary/washbore drilling and rock coring purposes precluded any further observation of groundwater.

The results of the groundwater measurements during drilling and following purging within the groundwater monitoring well at BH7 are provided in Table 1. It is noted that the groundwater level recharged to a similar level within five minutes of collecting groundwater samples at BH7

Table 1: Summary of Groundwater Level Measurements

Borehole	During Drilling		Standpipe Well (Measured on 13 October 2017)		
	Depth (m)	Reduced Level (m AHD)	Date Groundwater Purged	Depth (m)	Reduced Level (m AHD)
BH6	5.0	42.6	-	-	-
BH7	-	-	6 October 2017	5.1	49.5

7. Laboratory Testing

7.1 Physical Soil Properties

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 detailed laboratory test results of the physical properties are included in Appendix F and are summarised in Table 2 below.

Table 2: 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	-	-	-

Borehole	Depth (m)	Material	W_F (%)	W_P (%)	W_L (%)	PI (%)	CBR (%)	MDD (t/m^3)	OMC (%)
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

7.2 Chemical Soil Properties

Six 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 3 below.

Table 3: 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

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 approximately 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 2 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:

- A new multi-storey Acute Services Building (ASB), about 150 m by 130 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. Working column loads are understood to be up to 15,000 kN;
- Separate patient and public bridges over Hospital Road;
- Potential future regrading of Hospital Road to surface levels of RL 50.5 m to RL 54.4 m. This will require excavation to depths of up to about 6 m within the middle area and reducing to the existing ground surface levels at each end near High and Magill Streets; and
- A potential future tunnel below the new Hospital Road to link the existing Sydney Children's Hospital to the new building. The proposed invert level of the tunnel is at about RL 47 m (i.e. similar to the proposed basement Level -02). It is anticipated that this tunnel will require excavation of about 3 m further below the proposed Hospital Road level, and will be constructed as a cut-and-cover tunnel.

It is understood that a future expansion area, located immediately north of the proposed ASB site and extending up to High Street, is also being considered as part of this preliminary investigation. 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.

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. 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 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 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 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 sandstone.

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. This has not been confirmed by current boreholes.

A summary of the geotechnical model for current boreholes BH1 to BH9 are provided in Table 4.

Table 4: 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)

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

Based on measurements of groundwater within previous and current boreholes and monitoring wells, groundwater is expected at levels of between RL 49 m and RL 52 m. For most of the site, groundwater seepage is expected at the soil and rock interface, and within bedrock along rock joints and extremely/highly weathered bedrock bands. At the southern (i.e. lower-lying) end of the site, a water table is expected within the sand profile below the proposed basement excavation depths.

The groundwater level should be expected to fluctuate with variations in climate. For preliminary design, groundwater may rise by about 1 m following extended periods of rainfall. The groundwater 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, flowing downslope towards the south. Further investigation is required to assess the groundwater conditions.

9.2 Dilapidation Surveys

It is recommended that dilapidation (building condition) reports be undertaken on 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 are likely to intersect pavements, fillings, natural and bedrock of variable strength.

Excavation of soil and extremely low to very low strength bedrock should be readily achieved using conventional earthmoving equipment, such as tracked hydraulic 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

Preliminary information on groundwater is only available at this stage of the development due to restricted access and groundwater well approvals. Further investigation of the groundwater conditions is recommended at a later stage to confirm the groundwater conditions across the site.

Based on preliminary information, groundwater seepage is expected at the soil and rock interface, and within bedrock along rock joints and extremely/highly weathered bedrock bands for most of the site. At the southern (i.e. lower-lying) end of the site, a water table is expected within the sand profile below the proposed basement excavation depths.

Therefore, a secant pile shoring wall embedded into bedrock is recommended to cut-off water flow into the basement. For deep excavations, a secant pile shoring wall embedded into bedrock is recommended to cut-off water flow. 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. Along sections of the proposed basement and Hospital Road where the top of bedrock is relatively shallow, a contiguous pile wall may be suitable instead of a secant pile wall. Further discussion of secant and contiguous pile shoring walls is provided in Section 9.5.2.

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 may be suitable, however further assessment of the groundwater conditions to supplement the preliminary estimate of groundwater inflow to the basement excavation is required for design. The data available at this stage indicates that water levels are above the northern end of the proposed basement level. Based on the current preliminary information on groundwater at this site, groundwater

inflow to the northern end of the basement excavation is estimated to be approximately 3 m^3/day. The volume of groundwater ingress will ultimately depend on the soil permeability, rock fracturing and prevailing weather conditions. Greater volumes of groundwater ingress may also be experienced if leaking stormwater systems are present in the surrounding sandy soils or heavy continuous rainfall cause the groundwater levels to rise. Further assessment of the potential 'damming' effect of the ASB basement walls on the surrounding area should also be considered for a tanked basement. For a drained basement, the impact of a lower groundwater level should be investigated.

Dewatering during excavations for ASB basement, Hospital Road and tunnel should be managed through sump and pump techniques.

The potential to dewater and dispose groundwater off-site into Randwick City Council's (Council) stormwater system will depend on the contamination status of the groundwater as well as other groundwater properties including pH and total suspended solids. Council guidelines may set criteria to be satisfied for disposal of groundwater to the local stormwater system.

Based on the result of one previous particle size distribution test on natural sand collected within the Hospital Precinct and using Hazen's equation to predict the soil permeability or hydraulic conductivity (k), the fine to medium grained sand had a 'k' value in the order of 4×10^{-4} m/s. This 'k' value represents a soil of high permeability, typical of sand at this site. It is noted that the hydraulic conductivity of sandy soil is highly dependent upon the grain size, the soil density and the degree of saturation.

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 DP's experience, a 'k' value in the order of 10^{-8} to 10^{-9} m/sec may be adopted as a preliminary estimate of the permeability of the bedrock. 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. The permeability of the bedrock can also be estimated by undertaking water packer tests within boreholes for detailed design prior to construction.

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, 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 to for the operation.

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 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

and 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, 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.

9.5.2 Retaining Wall Types

Due to the presence of sand, groundwater seepage at the soil and rock interface and possibly rising groundwater 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 at this stage 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 be installed through the contiguous pile wall to prevent the build-up of hydrostatic pressure behind the wall.

Along sections of the proposed basement and Hospital Road where the top of bedrock is relatively shallow, a contiguous pile wall, which comprises closely spaced/touching CFA piles may be suitable alternative to a secant pile wall. It will be necessary to ensure that gaps between 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.

9.5.3 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 5. 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 5: 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 6. 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 6: 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.

9.5.4 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. For the eastern retaining wall along the regraded Hospital Road, permanent ground anchors may be required to support the eastern wall.

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 7.

Table 7: 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 7 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.

9.5.5 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 excavations for the basement levels may intersect up to 6 m of medium strength (or stronger) bedrock. For deep 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 Cross Section E-E', for a 6 m deep vertical and unsupported excavation in medium strength (or stronger) bedrock, about 130 m long, lateral movement in the order of 5 - 10 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 20 mm gap between the proposed excavation face and the new structure should be allowed to account for such rock stress relief movement. Further assessment of the expected lateral movement due to rock stress relief should be carried out at a later stage once more borehole information is available. 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 road 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.

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 Level -02 and any future regrading of Hospital Road will expose bedrock and sand at the northern and southern ends, respectively. The potential future tunnel is likely to intersect mostly bedrock.

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.

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 8 for appropriate design parameters. Parameters for both the working stress and limit-state design approaches have been provided.

Table 8: Design Parameters for Footings

Material Description	Allowable End Bearing Pressure (kPa)		Ultimate End Bearing Pressure [3] (kPa)		Young's Modulus E (MPa)
	End Bearing	Shaft Adhesion[1,2]	End Bearing	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 footings are required to confirm medium to high strength sandstone.

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 8 for the various rock strengths.

The foundation design parameters presented in Table 8 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 footings designed on the basis of an allowable bearing pressure of 6,000 kPa is recommended to confirm the absence of 'weak' clay bands directly beneath the footings. Further borehole investigation is also required to confirm the presence of high strength sandstone.

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.

9.7.3 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).

9.7.4 Underpinning of Existing Footings

Given the site conditions, it may be inevitable to locate future excavations at a sufficient distance away from existing buildings or structures. If future bulk excavation levels (e.g. for the proposed Hospital Road and pedestrian tunnel) extend below existing footings, it would be important to expose the existing footings of the adjacent buildings or structures to confirm their foundation conditions and to assess whether any requirement to underpin existing footings is necessary. While it is likely that the existing multi-storey buildings adjacent to the potential future Hospital Road and tunnel are supported by footings bearing on bedrock, smaller lightly-loaded structures may be founded on soil above bedrock.

Common techniques used to underpin footings founded in sandy soils include jet (high pressure) grouting and grout injection. Mini or micro-piles can also be used to underpin the existing footings down to an underlying stronger layer such as bedrock.

For existing footings founded in low strength rock above future bulk excavation levels, underpinning using a series of hit-and-miss grout or concrete panels may be necessary to provide appropriate support.

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 seven soil samples tested from BH1 to BH7 have a 'non-aggressive' exposure classification with respect to buried concrete and steel elements, assuming 'Soil Conditions B' (i.e. all soils above groundwater).

The two soil samples tested from BH8 and BH9 have a 'mild' exposure classification with respect to buried concrete and steel elements, assuming 'Soil Conditions B' (i.e. all soils above 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 current 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) for footing design. However the seismic impact of the soils above the rock on the retaining walls and footing 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 5 m below the finished floor level of RL 47.0m. As a guide, pile foundations will need to be socketed into the rock strata of at least low strength by a minimum of 2 m in the pile footings designed to resist the horizontal loads applied by the vibrating soil mass between the bulk excavation level and the top of the pile socket.

Based on the subsurface profile encountered in the previous and current investigations, the northern (High Street) end of the proposed future expansion area may have a Site Sub-soil Class B_e (rock) in accordance with AS 1170.4, if less than 3 m deep of soil or rock with a compressive strength of less than 1 MPa exists.

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.

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.

Along the potential future regrading of Hospital Road, it is anticipated that the bulk levels will expose extremely low to low strength sandstone and medium dense sand at the northern and southern ends, respectively (refer to Drawing 2 in Appendix B). Similar ground conditions are expected within the ASB basement footprint, with medium and high strength sandstone also expected.

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) 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 9.

Table 9: 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 9, 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 10.

Table 10: 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.

Further assessment of the hydraulic conductivity of the soil, and the depths to bedrock and groundwater is recommended at proposed tank locations.

9.13 Further Investigation

It will be necessary to undertake additional rock-cored boreholes and install groundwater monitoring wells for more detailed planning and design once site access is more readily available to drilling rigs. The investigation should target areas between current boreholes and assess the subsurface conditions to appropriate depths (i.e. below proposed bulk excavation level and foundation level) for the intended development. We propose a further 12 rock-cored boreholes and four groundwater monitoring wells. The findings of a detailed geotechnical investigation may indicate that additional in situ testing, targeting geological features or areas specific to the proposed development, may be required.

Further assessment of the groundwater levels and potential fluctuation levels with the sand profile is required for detailed design of the basement shoring wall.

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 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. 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;
12. 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
13. 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 (SYD170971, dated 18 August 2017). The work was carried out under a sub-consultant agreement with Health Infrastructure (Contract HI17299). This report is provided for the exclusive use of Health Infrastructure 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

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

POTENTIAL FUTURE (STAGE 2) REGRADE OF HOSPITAL ROAD LEVELS RL 50.5 TO RL 54.4m OVER ~150m LENGTH

POTENTIAL FUTURE (STAGE 2) TUNNEL (RL 47.0m) TO LINK TO SYDNEY CHILDREN'S HOSPITAL

LEGEND

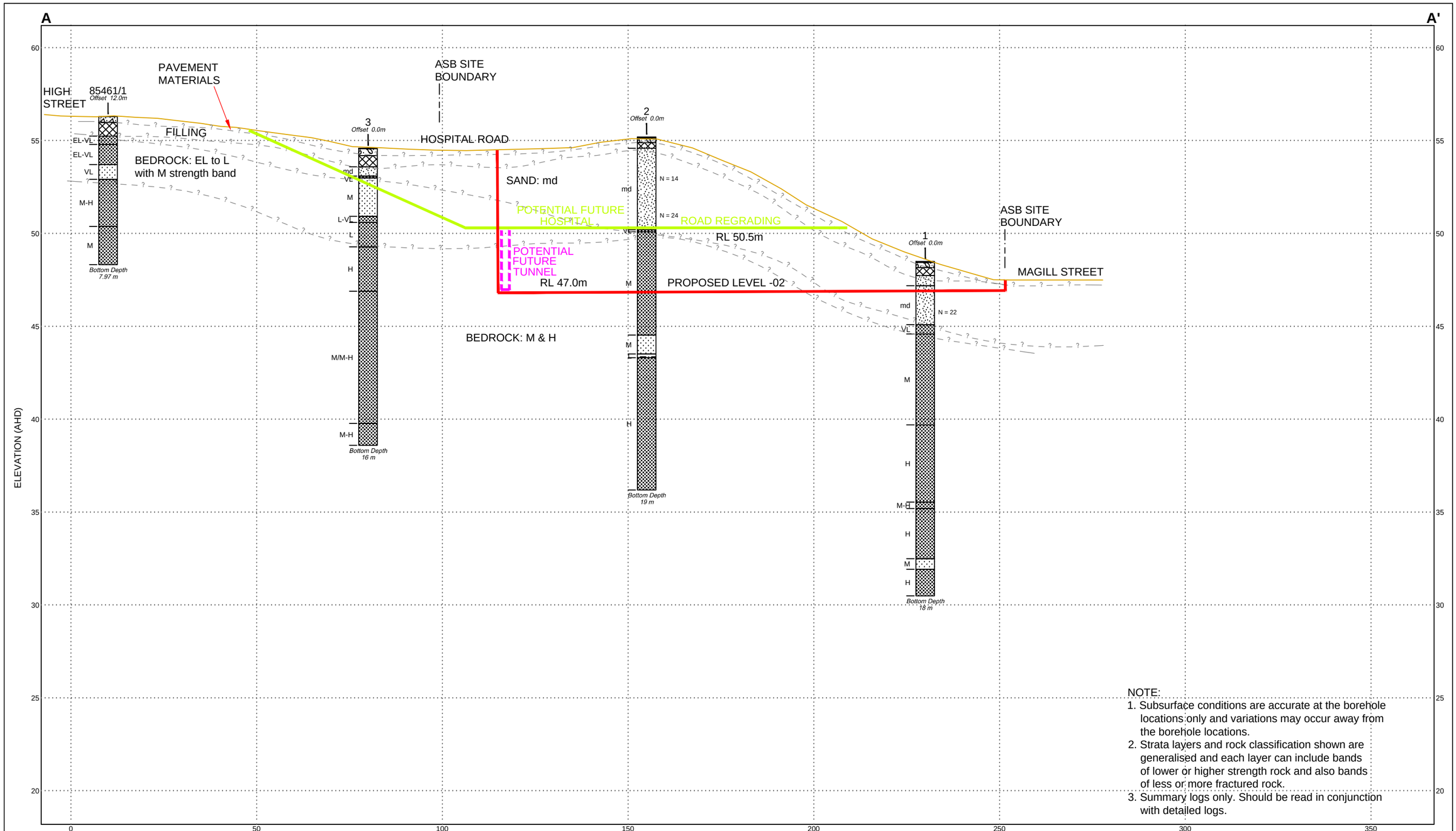
- Previous borehole (UNSW Wallace Wurth Building, Proj. 71543, 2010)
- Previous borehole (UNSW Bioscience Building Proj. 73492, 2013)
- Previous borehole (Prince of Wales Hospital Proj. 85461.00, 2016)
- Current borehole
- W Groundwater monitoring well
- A A' Interpreted geotechnical Cross Section
-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

NOTE:
1: Base image from Nearmap.com (Dated 6.8.2017)
2: Test locations were located using high resolution hand held GPS.

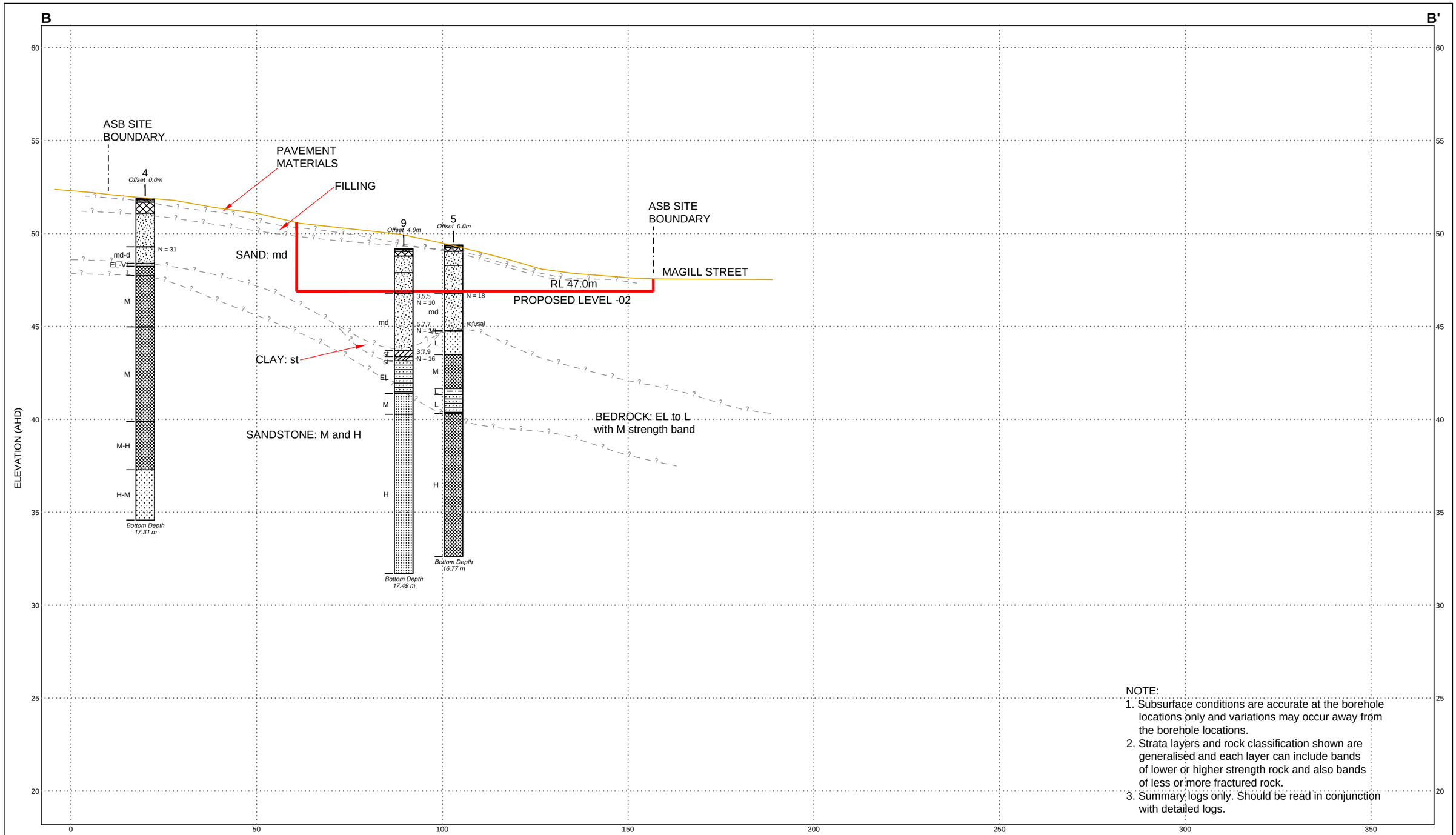
0 5 10 20 30 40 50 75 100 125m
1:1250 @ A3

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Health Infrastructure		TITLE: **Locations of Previous and Current Boreholes**	PROJECT No: 72505.11
OFFICE: Sydney	DRAWN BY: PSCH	**Randwick Campus Redevelopment**	DRAWING No: 1
SCALE: 1:1250 @ A3	DATE: 6.2.2018	**Hospital Road and High, Magill and Botany Streets, RANDWICK**	REVISION: 2



Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Health Infrastructure	TITLE: **Interpreted Geotechnical Cross Section A-A'** **Randwick Campus Redevelopment** **Hospital Road and High, Magill and Botany Streets, RANDWICK**	PROJECT No: 72505.11
	OFFICE: Sydney / DRAWN BY: PAV/LD		DRAWING No: 2
	SCALE: 1:1000 (H) 1:200 (V) @ A3 / DATE: 7.2.2018		REVISION: 2



NOTE:
1. Subsurface conditions are accurate at the borehole locations only and variations may occur away from the borehole locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.

DISTANCE ALONG PROFILE (m)

LEGEND

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

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

0 20
Horizontal Scale (metres)

Vertical Exaggeration = 5.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Health Infrastructure		TITLE: **Interpreted Geotechnical Cross Section B-B'**	PROJECT No: 72505.11
OFFICE: Sydney	DRAWN BY: PAV/LD	**Randwick Campus Redevelopment**	DRAWING No: 3
SCALE: 1:1000 (H) 1:200 (V) @ A3	DATE: 7.2.2018	**Hospital Road and High, Magill and Botany Streets, RANDWICK**	REVISION: 2

C

C'

ELEVATION (AHD)

HIGH STREET

71543-3
Offset - 25.0m
N = 15
N = 17
md
EL-VL
EL-VL&M
VL&M-H
H-M
EL-VL
H-VH
Bottom Depth 18.3 m

71543-2
Offset - 25.0m
EL&VL
EL&VL
EL&VL
M,H-VH
EL&VL
Bottom Depth 14.4 m

71543-7
Offset - 25.0m
N = 10
md
refusal
M
M-H
Bottom Depth 8.35 m

7
Offset 15.0m
N = 10
N = 20
refusal
M
L-M
M
H
Bottom Depth 20.47 m

71543-5
Offset 25.0m
N = 16
N = 22
md
N = 23
VL refusal
M-H
Bottom Depth 8.8 m

ASB SITE BOUNDARY

73492-5
Offset - 25.0m
N = 5
N = 6
I-md
N = 25
refusal
EL-VL
H
Bottom Depth 9.58 m

73492-6
Offset - 35.0m
I
N = 10
I-md
N = 22
N = 26
EL
H
Bottom Depth 8 m

SAND: l to md

BEDROCK: M & H

SANDSTONE AND IGNEOUS DYKE: HIGHLY VARIABLE STRENGTH

ASB SITE BOUNDARY

6
Offset - 25.0m
MAGILL STREET
FILLING
N = 4
I
md
N = 20
md
N = 37
d
CLAYEY SAND: d
L
BEDROCK: EL to L
M
H
Bottom Depth 16.5 m

13/10/2017
3/2013
22/9/2017

NOTE:
1. Subsurface conditions are accurate at the borehole locations only and variations may occur away from the borehole locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.

DISTANCE ALONG PROFILE (m)

LEGEND

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

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

Horizontal Scale (metres)

Vertical Exaggeration = 5.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Health Infrastructure		
OFFICE: Sydney	DRAWN BY: PAV/LD	
SCALE: 1:1000 (H) 1:200 (V) @ A3	DATE: 7.2.2018	

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

PROJECT No:	72505.11
DRAWING No:	4
REVISION:	2

D

D'

BOTANY STREET

HOSPITAL ROAD

PAVEMENT MATERIALS

POTENTIAL FUTURE DEVELOPMENT AREA

71543-3
Offset 0.0m

85461/1
Offset 0.0m

FILLING

SAND: md

BEDROCK: EL to VL

BEDROCK: M to H

SANDSTONE AND IGNEOUS DYKE HIGHLY VARIABLE STRENGTH

N = 15

N = 17

md

EL-VL

EL-VL&M

H-M

EL-VL

H-VH

Bottom Depth 18.3 m

EL-VL

EL-VL

VL

M-H

M

Bottom Depth 7.97 m

ELEVATION (AHD)

60 55 50 45 40 35 30 25 20

0 50 100 150 200 250 300 350

DISTANCE ALONG PROFILE (m)

NOTE:
1. Subsurface conditions are accurate at the borehole locations only and variations may occur away from the borehole locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.

LEGEND

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

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

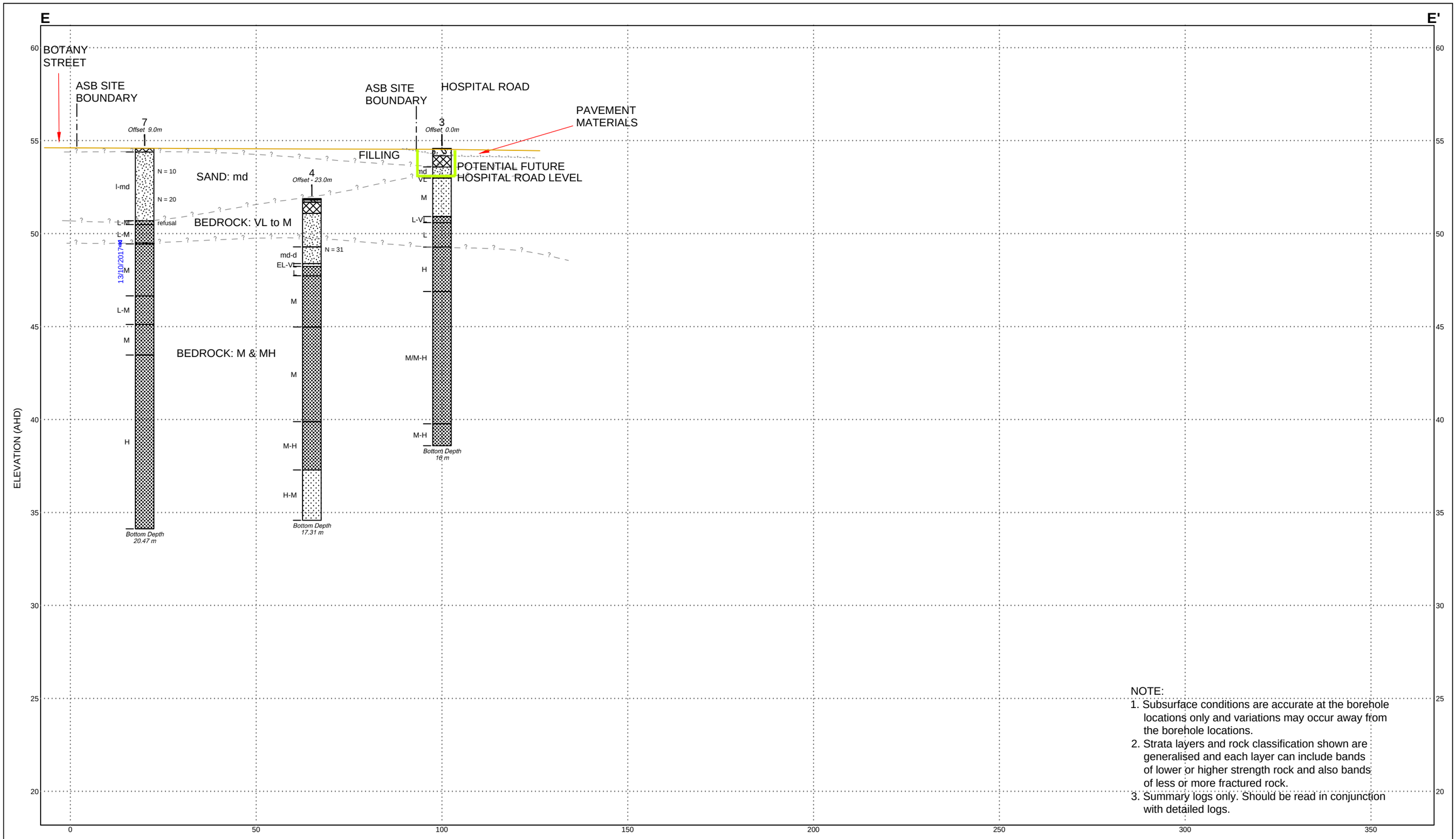
0 20
Horizontal Scale (metres)

Vertical Exaggeration = 5.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Health Infrastructure		TITLE: sInterpreted Geotechnical Cross Section D-D'
OFFICE: Sydney	DRAWN BY: PAV/LD	Randwick Campus Redevelopment
SCALE: 1:1000 (H) 1:200 (V) @ A3	DATE: 7.2.2018	Hospital Road and High, Magill and Botany Streets, RANDWICK

PROJECT No: 72505.11
DRAWING No: 5
REVISION: 2



NOTE:
1. Subsurface conditions are accurate at the borehole locations only and variations may occur away from the borehole locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.

LEGEND

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

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

0 20
Horizontal Scale (metres)

Vertical Exaggeration = 5.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Health Infrastructure		TITLE: **Interpreted Geotechnical Cross Section E-E'**	PROJECT No: 72505.11
OFFICE: Sydney	DRAWN BY: PAV/LD	**Randwick Campus Redevelopment**	DRAWING No: 6
SCALE: 1:1000 (H) 1:200 (V) @ A3	DATE: 7.2.2018	**Hospital Road and High, Magill and Botany Streets, RANDWICK**	REVISION: 2

F

F'

BOTANY STREET

ASB SITE BOUNDARY

UNSW 73492-6
Offset 0.0m

ASB SITE BOUNDARY

2
Offset 0.0m

HOSPITAL ROAD

PAVEMENT MATERIALS

FILLING

SAND: l and md

8
Offset 8.0m

POTENTIAL FUTURE HOSPITAL ROAD LEVEL RL 50.5m

BEDROCK: EL & VL

RL 47.0m PROPOSED LEVEL - 02

7.10/10mm refusal

BEDROCK: L

BEDROCK: M & H

LAMINITE: L

N = 10
N = 22
N = 26
N = 14
N = 24

l
md
EL
VL
L
M
H

3/2013

Bottom Depth 8 m

Bottom Depth 17.39 m

Bottom Depth 19 m

ELEVATION (AHD)

60 55 50 45 40 35 30 25 20

0 50 100 150 200 250 300 350

DISTANCE ALONG PROFILE (m)

NOTE:
1. Subsurface conditions are accurate at the borehole locations only and variations may occur away from the borehole locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.

LEGEND

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

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

0 20
Horizontal Scale (metres)

Vertical Exaggeration = 5.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Health Infrastructure

OFFICE: Sydney

DRAWN BY: PAV/LD

SCALE: 1:1000 (H) 1:200 (V) @ A3

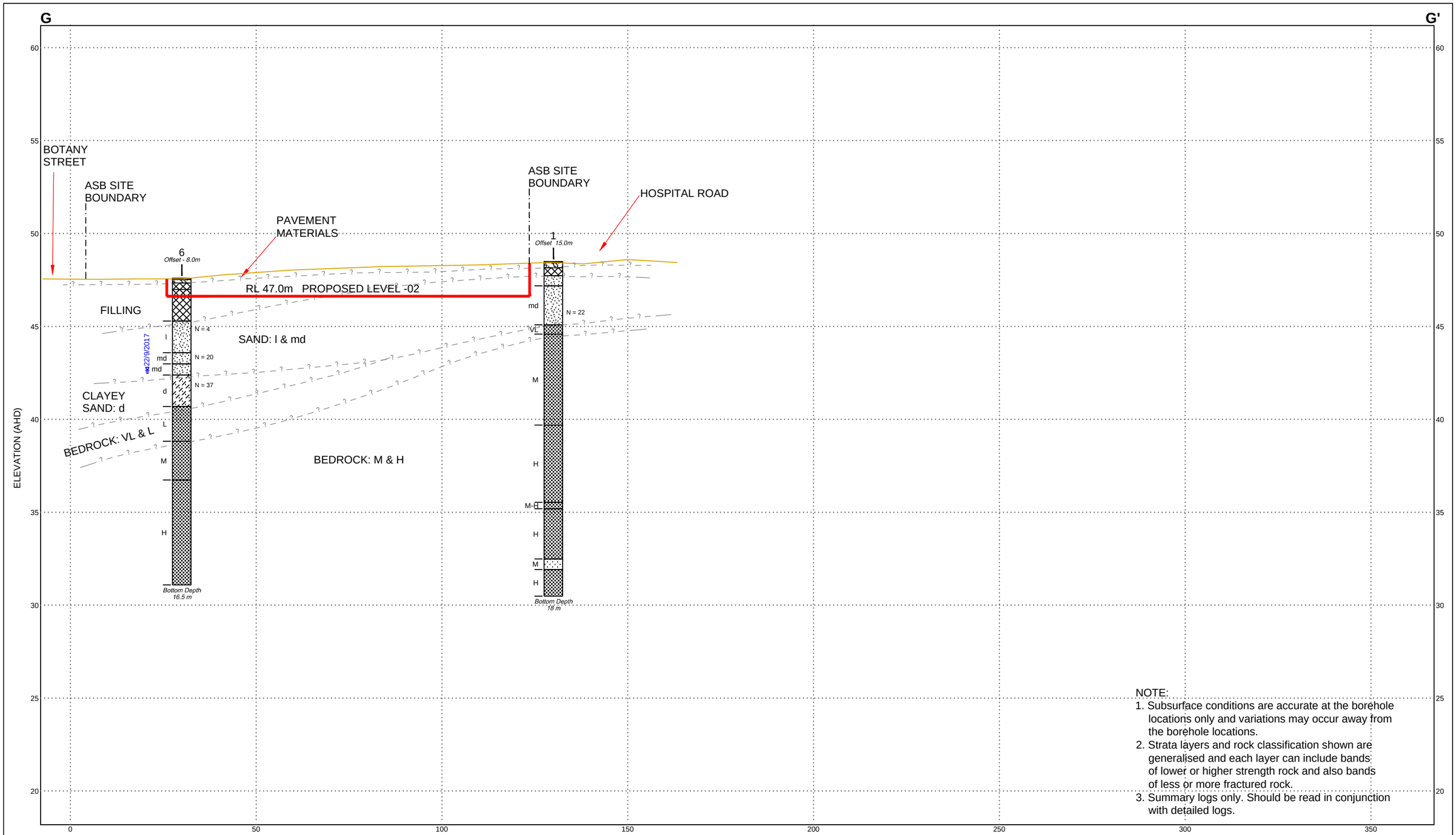
DATE: 7.2.2018

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

PROJECT No: 72505.11

DRAWING No: 7

REVISION: 2



NOTE:
1. Subsurface conditions are accurate at the borehole locations only and variations may occur away from the borehole locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.

LEGEND

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

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

Horizontal Scale (metres) 0 20

Vertical Exaggeration = 5.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Health Infrastructure		
OFFICE: Sydney	DRAWN BY: PAV/LD	
SCALE: 1:1000 (H) 1:200 (V) @ A3	DATE: 7.2.2018	

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

PROJECT No:	72505.11
DRAWING No:	8
REVISION:	2

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
								7.89 & 7.91m: B5°, cly vn				
48	7.97	Bore discontinued at 7.97m - target depth reached										
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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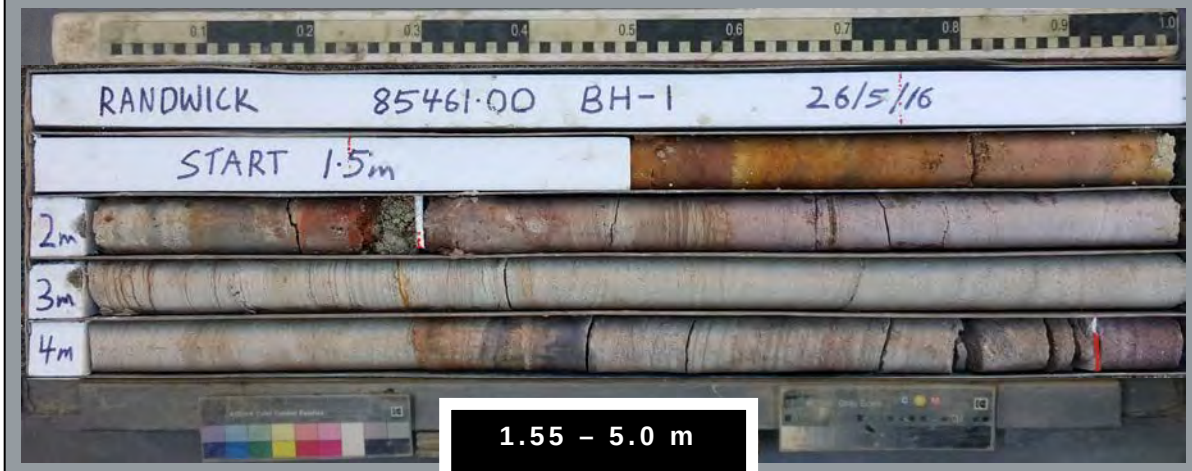
SITE INFRASTRUCTURE INVESTIGATION - RANDWICK

BORE 1 PROJECT 85461.00 MAY 2016

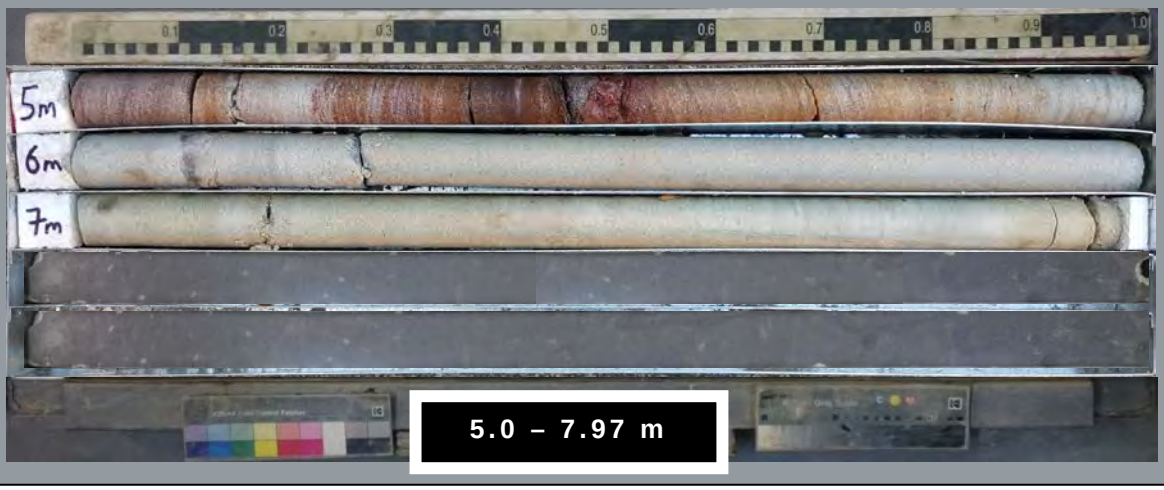


1.55 – 5.0 m

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/E			
57	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									A/E			
	3.5	SAND - orange brown, medium grained sand, moist							A			
59								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										
60	4.65							4.65m: CORE LOSS: 100mm 4.75-4.85m: dyke	C	92	0	PL(A) = 0.7MPa
61	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)						6.33-7.25m: dyke 6.53-7.25m: highly fractured to fractured sandstone (dyke) in subvertical joints	C	100	0	
	7.2							7.2m: CORE LOSS: 480mm				
62								7.68-7.78m: fragmented in 0.02m intervals 7.88-8.13m: J, subvertical, rough 8.05-8.08m: clay band	C	62	0	PL(A) = 1.9MPa PL(A) = 4.9MPa
63	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	
								9.45-9.65m: 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											
69	14.4	Bore discontinued at 14.4m						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				
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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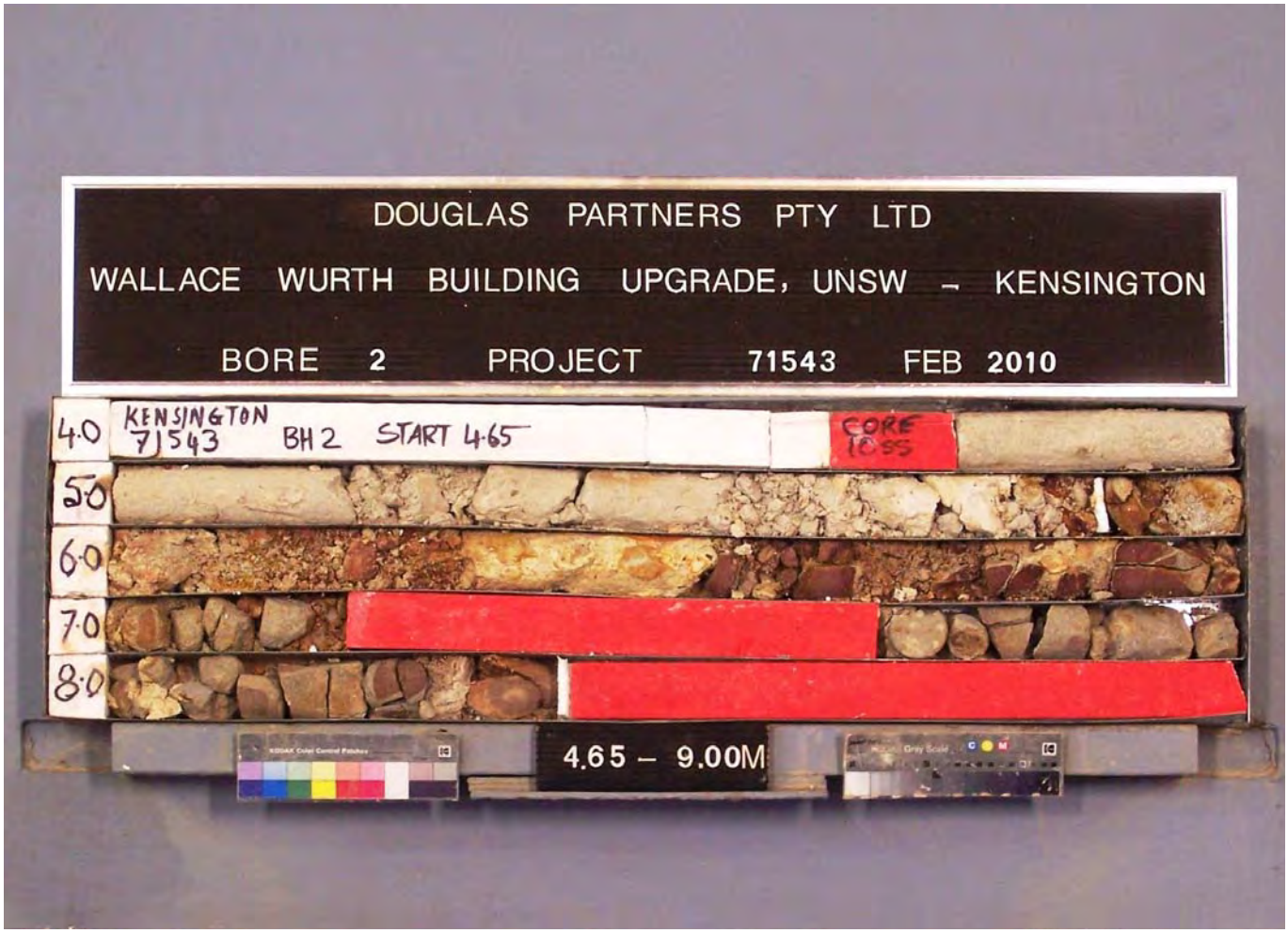
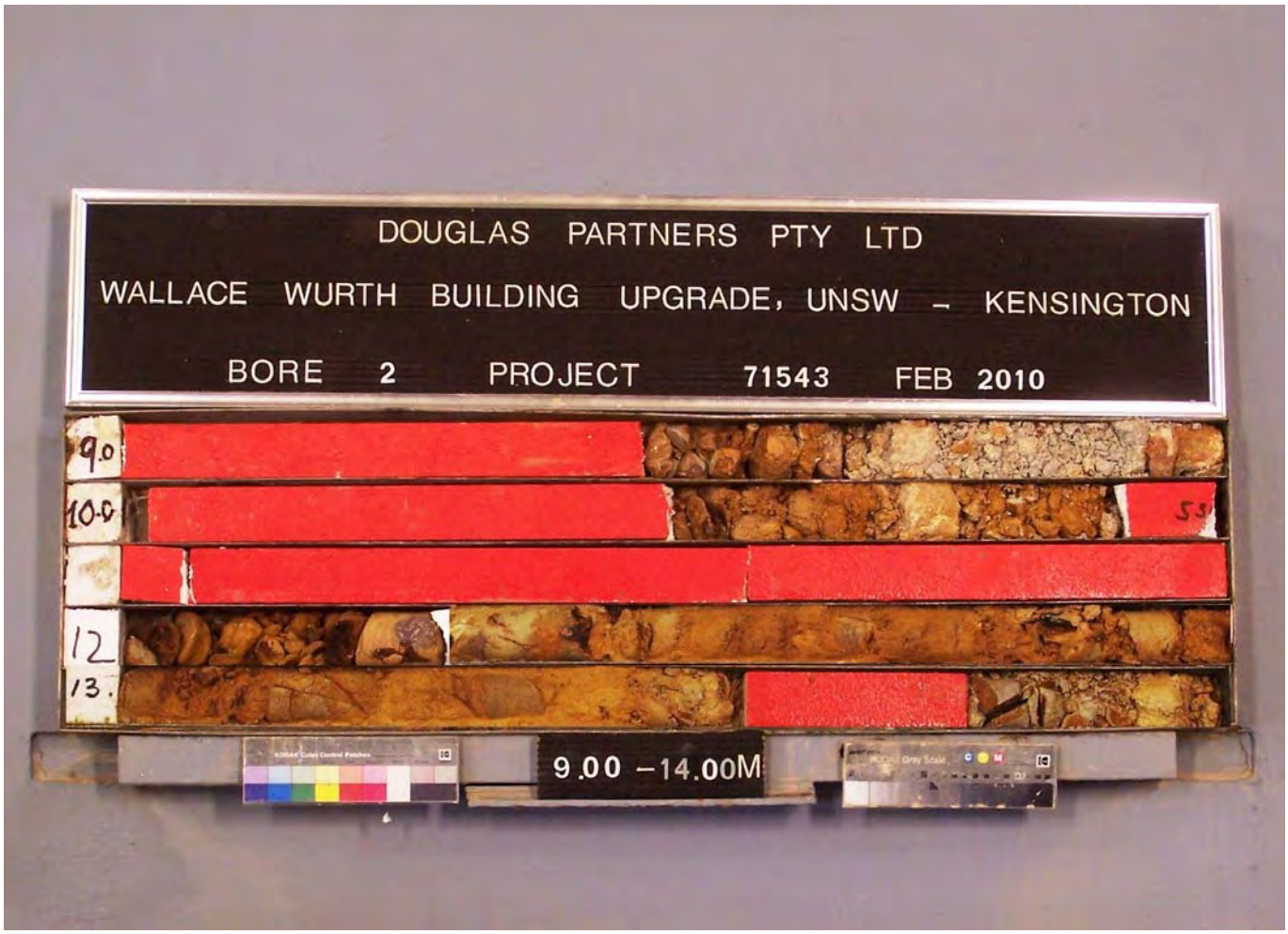
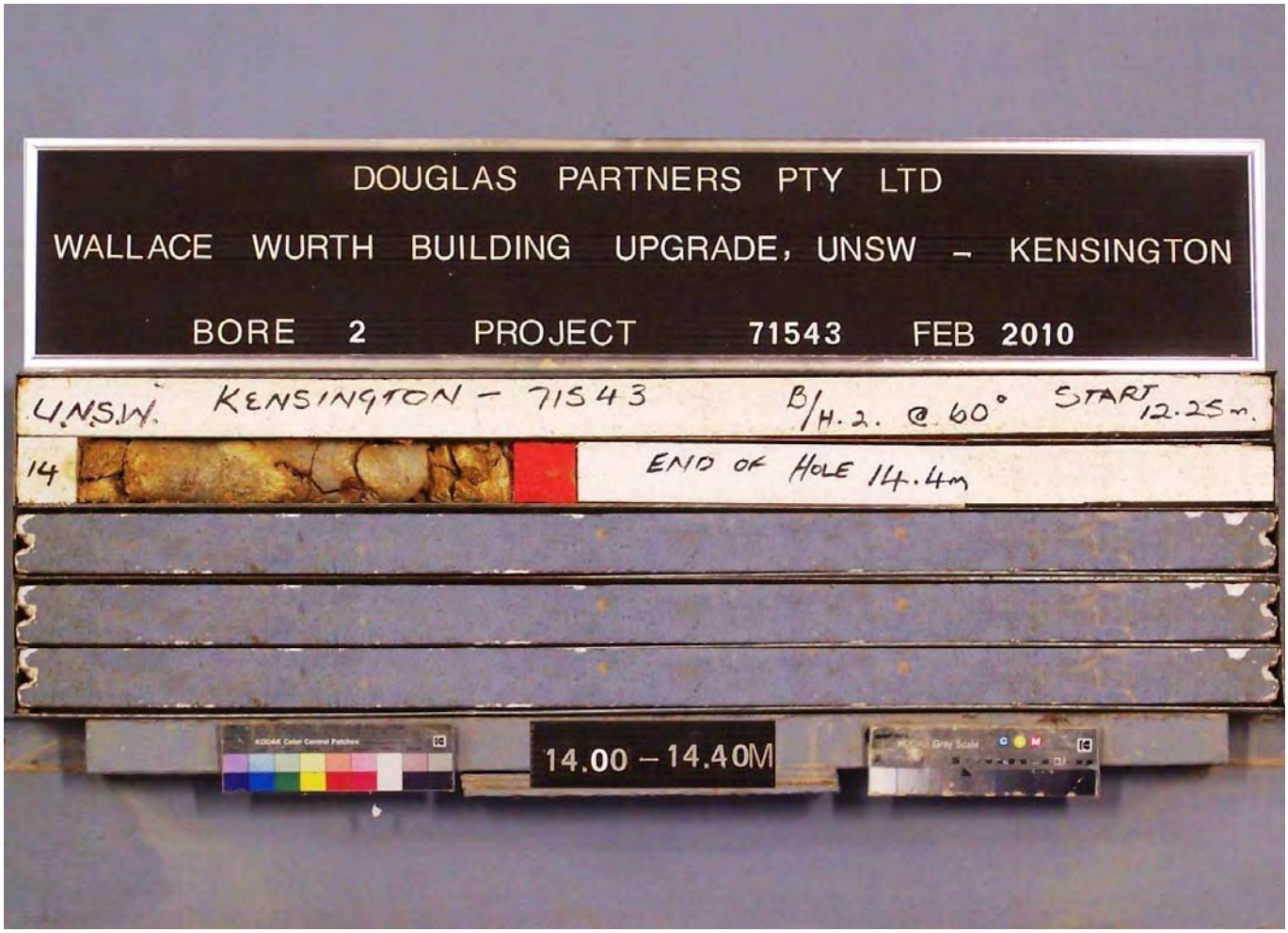

DOUGLAS PARTNERS PTY LTD
WALLACE WURTH BUILDING UPGRADE, UNSW – KENSINGTON
BORE 2 PROJECT 71543 FEB 2010
4.0
KENSINGTON 71543 BH2 START 4.65
CORE LOSS
5.0
6.0
7.0
8.0
4.65 – 9.00M


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				
49	7											
48	8								R			
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

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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	13.0	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	IGNEOUS ROCK (DYKE) - extremely low to very low strength, extremely weathered, light grey brown, igneous rock (dyke)						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	ROTARY DRILLING										
	16								R			
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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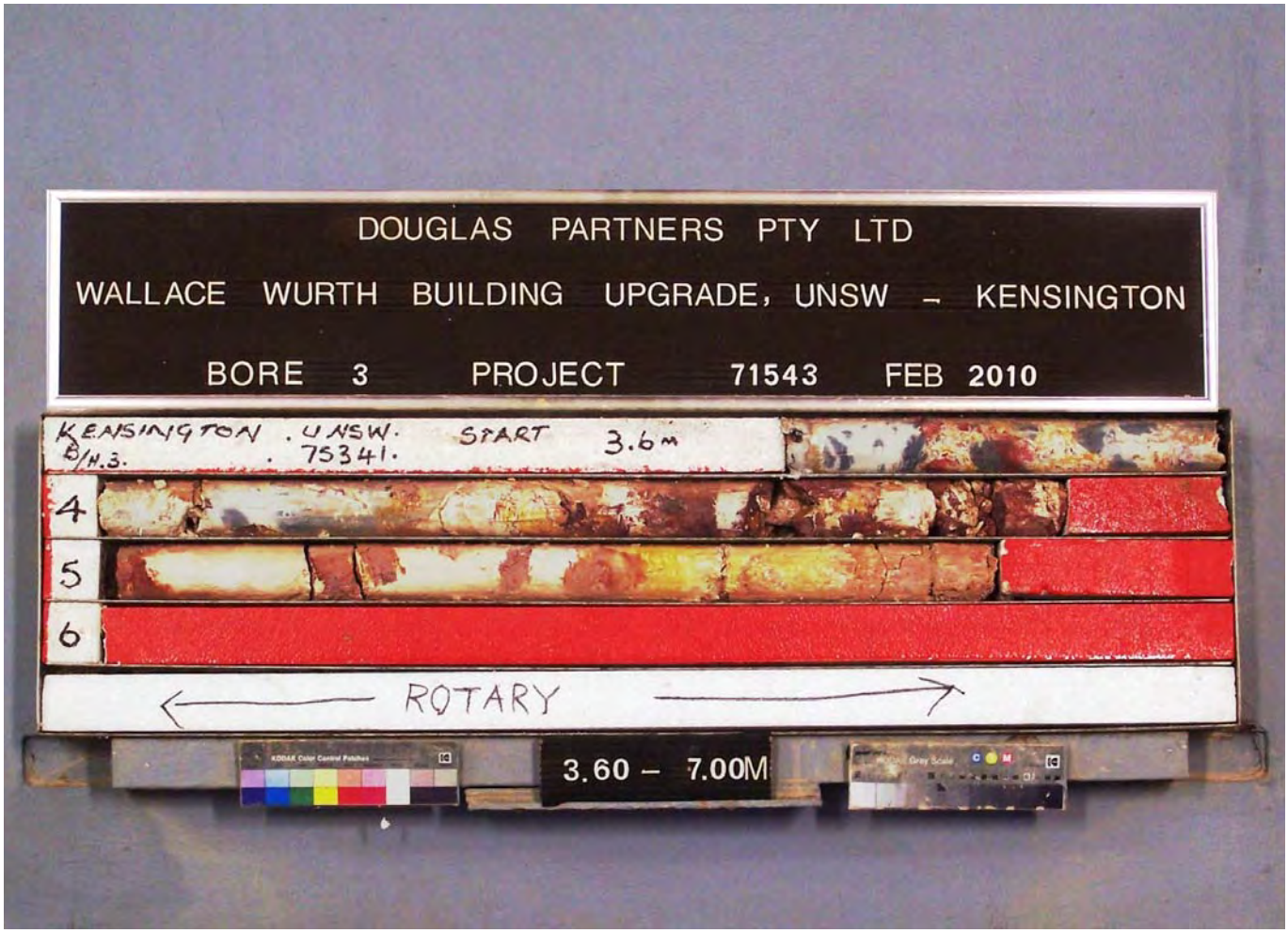
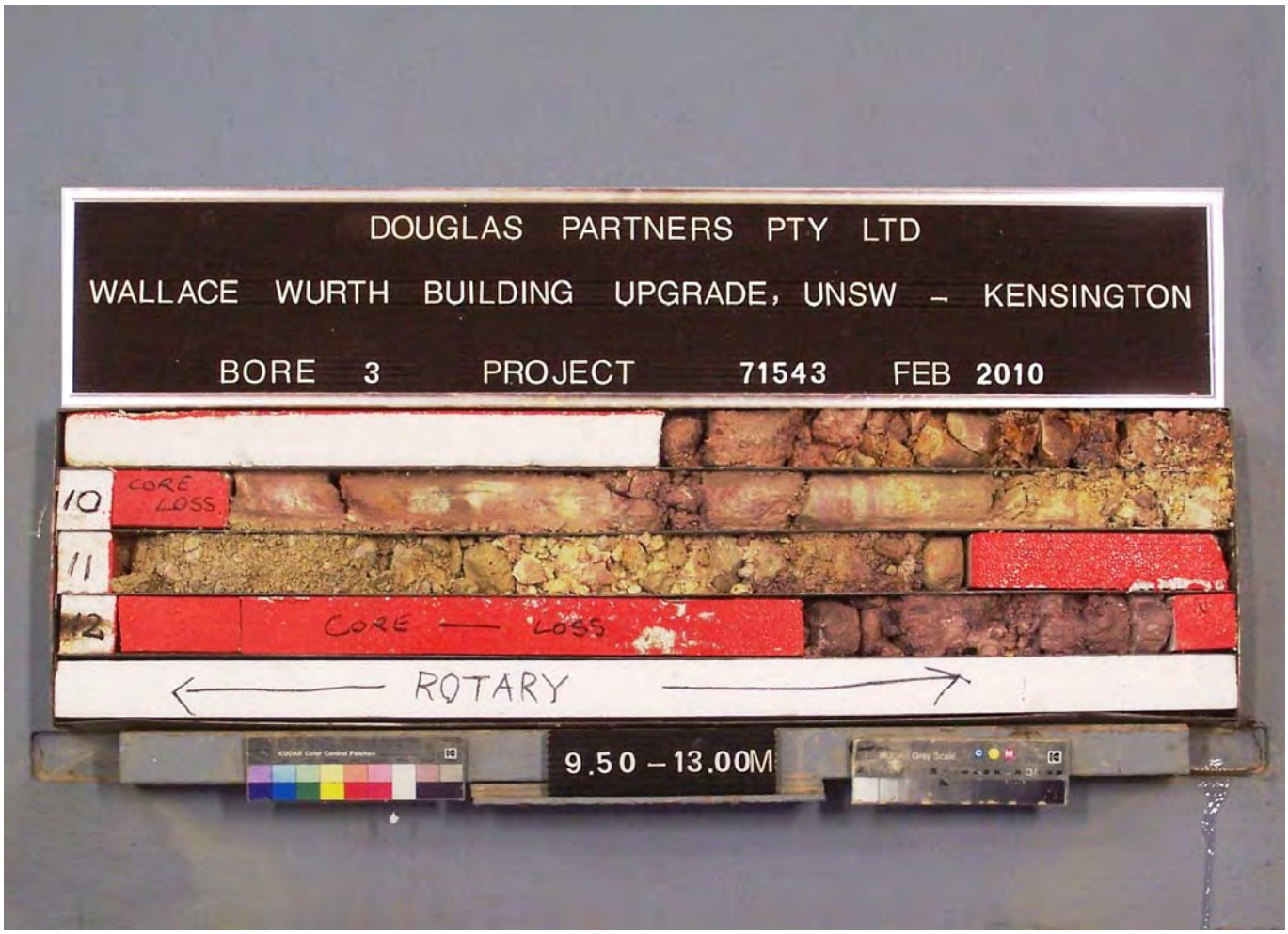

DOUGLAS PARTNERS PTY LTD
WALLACE WURTH BUILDING UPGRADE, UNSW – KENSINGTON
BORE 3 PROJECT 71543 FEB 2010
KENSINGTON . UNSW. START 3.6m
B/H.3. . 75341.
4
5
6
ROTARY
3.60 – 7.00M


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				PL(A) = 0.5MPa
49								6.62m: B0°, 5mm sandy clay 6.65m: B0°, 10mm sandy clay				PL(A) = 0.4MPa
48								7.44 & 8.28m: (x2) B0°-5°, clay veneer	C	100	99	PL(A) = 1.1MPa
47	8.8	Bore discontinued at 8.8m										PL(A) = 1.1MPa

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
Initiels: STE
Date: 17/3/10

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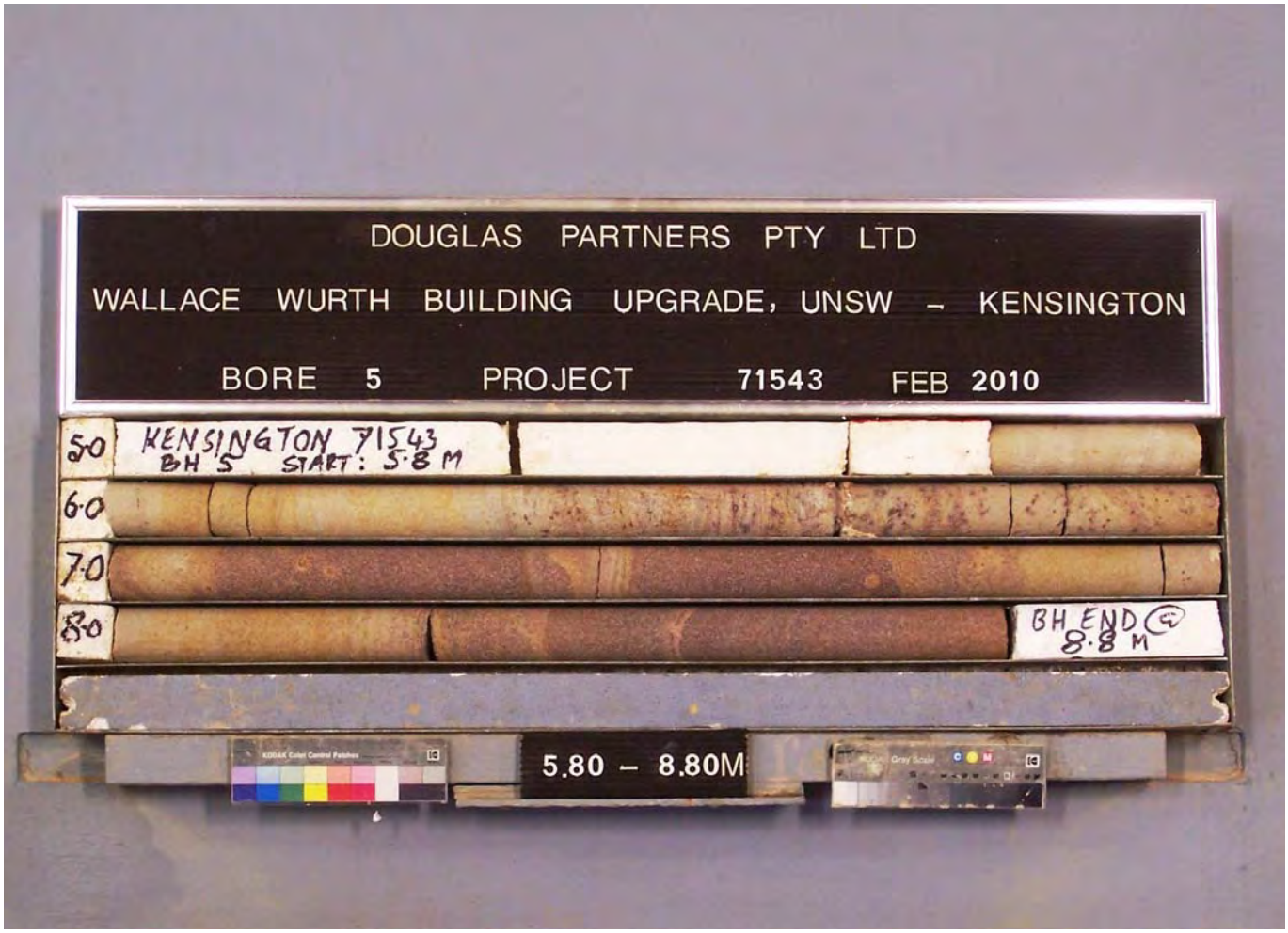
DOUGLAS PARTNERS PTY LTD
WALLACE WURTH BUILDING UPGRADE, UNSW - KENSINGTON
BORE 5 PROJECT 71543 FEB 2010
5.0
KENSINGTON 71543
BH 5 START: 5.8 M
6.0
7.0
8.0
BH END @ 8.8 M
5.80 - 8.80M

BOREHOLE LOG

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

SURFACE LEVEL: 55.8 AHD **BORE No:** 7
EASTING: **PROJECT No:** 71543
NORTHING: **DATE:** 29 Jan 10
DIP/AZIMUTH: 90°/-- **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			
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			
54 2									A			
									A			
									S			4,5,5 N = 10
53 3	3.0	SAND - medium dense, orange brown, medium grained sand, moist							A			
									A			
									A			
52 4									S			11,15,20/10mm refusal
	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				
51 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
	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
50 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 (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	0.1	CONCRETE							A/E			
	0.4	FILLING - yellow brown, sand and crushed sandstone filling, humid							E			
54	1	FILLING - poorly compacted, brown, fine to medium grained sand filling with some sandstone gravel and a trace of organic matter, humid							E			
		- with some brick fragments at 1.5m							E S			5,3,2 N = 5
53	2								E			
									E			
52	3								E 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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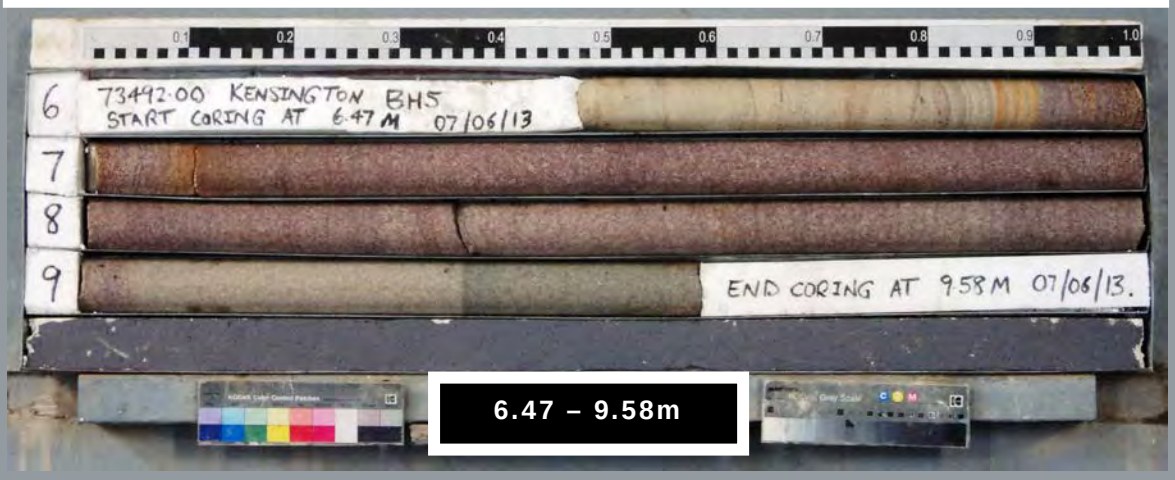
PROPOSED BUILDING UPGRADE, UNSW - KENSINGTON

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 (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	0.08	BRICK PAVING										
		FILLING - brown and yellow brown, fine to medium grained sand filling with a trace of gravel and rootlets, humid							D/E*			
	0.5								B			
									D/E			
1	1.0	SAND - apparently loose, yellow brown, fine to medium grained sand, humid										
									D/E			
		SAND - loose to medium dense becoming medium dense, yellow brown, fine to medium grained sand, humid							E			
51									S			3,3,7 N = 10
2									A			
50												
3									S			4,8,14 N = 22
49												
4		- wet below 4.0m				06-06-13						
48	4.8								S			4,6,20 N = 26
	4.9	SANDSTONE - extremely low strength, light grey and orange brown, fine to medium grained sandstone										PL(A) = 1.1
5												
47		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
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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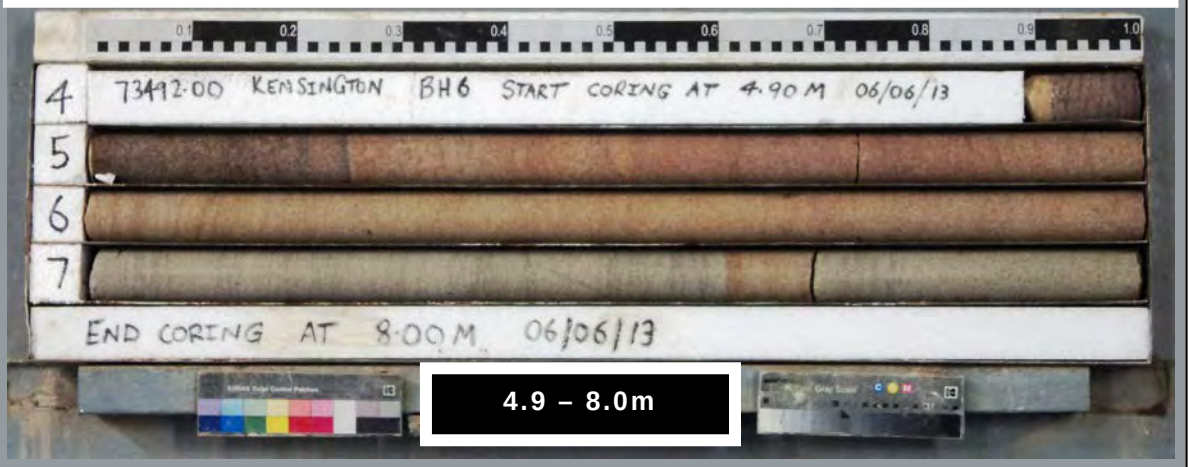
PROPOSED BUILDING UPGRADE, UNSW - KENSINGTON

BORE 6 PROJECT 73492 JUNE 2013



4.9 – 8.0m

Appendix D

Site Photographs

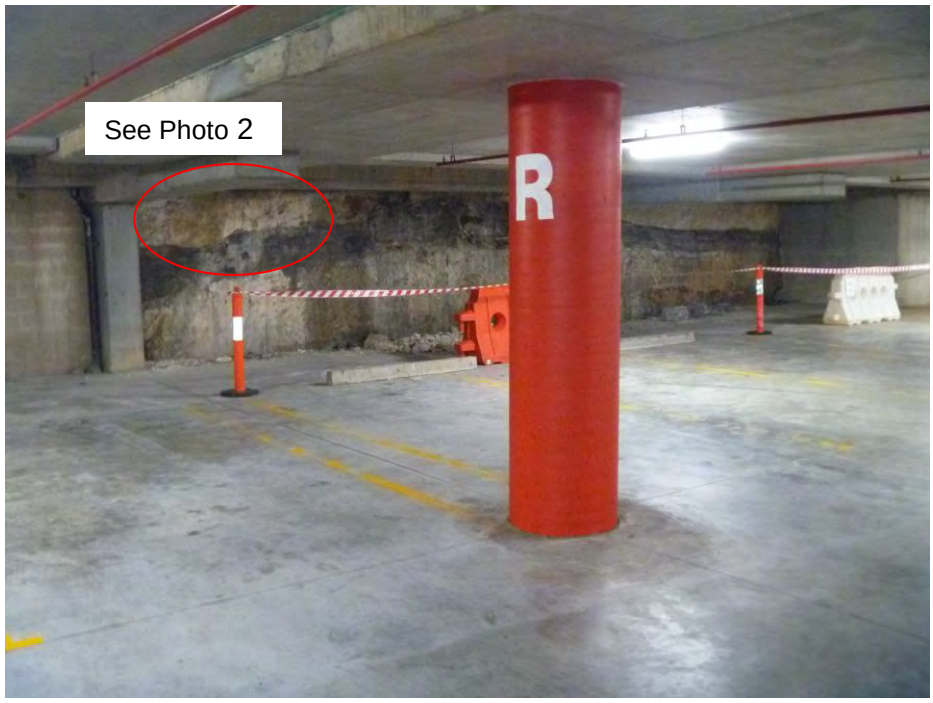


Photo 1 – Medium to high strength sandstone outcrop with 0.3 – 0.9 m thick siltstone band in Car Park Level B4. A rock fall has occurred.

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).

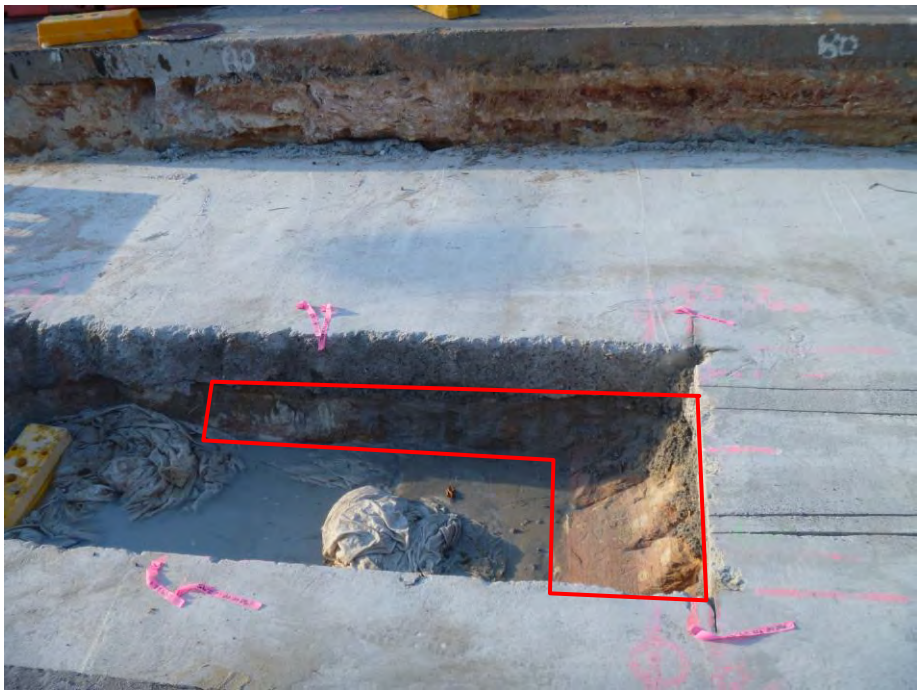


Photo 6 – Ripped sandstone filling over medium strength sandstone at about 1 m below High Street pavement.

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 Methods

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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

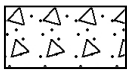
Symbols & Abbreviations

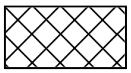
Graphic Symbols for Soil and Rock

General

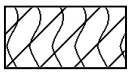

Asphalt

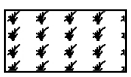

Road base

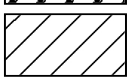

Concrete


Filling

Soils


Topsoil

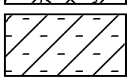

Peat


Clay


Silty clay

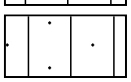

Sandy clay

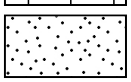

Gravelly clay

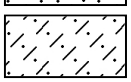

Shaly clay

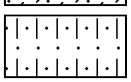

Silt


Clayey silt


Sandy silt

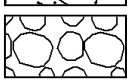

Sand


Clayey sand


Silty sand


Gravel

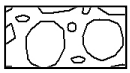

Sandy gravel


Cobbles, boulders

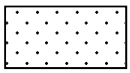

Talus

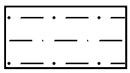
Sedimentary Rocks

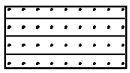

Boulder conglomerate

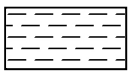

Conglomerate


Conglomeratic sandstone

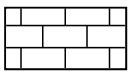

Sandstone


Siltstone

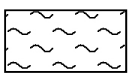

Laminite

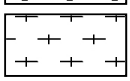

Mudstone, claystone, shale

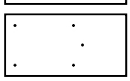

Coal


Limestone

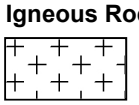
Metamorphic Rocks

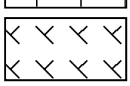

Slate, phyllite, schist

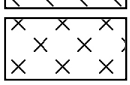

Gneiss

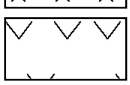

Quartzite

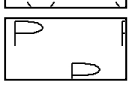
Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Health Infrastructure
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											
43		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
	6											
42								6.65m: Ds, 10mm 6.77m: Ds, 20mm				PL(A) = 0.42
	7											PL(A) = 0.71
41												
	8							7.92m: B0°- 5°, ro, un, cly vn				
40									C	100	99	PL(A) = 0.83
	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
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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
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											
33								15.16-15.31m: B (x3) 5°-10°, ro, un, cly vn				PL(A) = 2.33
	16 16.0							15.53m: J30°, ro, un, cln				
		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: Health Infrastructure
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										
		- with some dark brown silty sand bands to 2.0m							A			
53	2								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 PL(A) = 0.62
49	6	SANDSTONE - medium strength, slightly weathered, slightly fractured then unbroken, light yellow-brown medium grained sandstone. Typically indistinctly bedded with some distinct ironstained beds							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: Health Infrastructure
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
45		SANDSTONE *(continued)*										
	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											
	13											
42								13.48m: Ds, 30mm				PL(A) = 0.9
	14							13.68m: Ds, 20mm				PL(A) = 1.22
41									C	100	94	
	15							15.09-15.28m: B (x4) 10°, pl, cly, 5mm				
40		15.34-15.8m: some distinct siltstone beds										PL(A) = 1.29
	16							15.72m: B10°, pl, he				
								15.76m: Ds, 20mm				PL(A) = 1.31
39	17											
												PL(A) = 1.52
38								17.63m: Ds, 10mm	C	100	99	
	18											
37												PL(A) = 1.25
	19 19.0	Bore discontinued at 19.0m - target depth reached										
36												

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: Health Infrastructure
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						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 20°	A/E			
	0.4	ROADBASE - dark grey, sandy gravel, igneous, angular, up to 30mm diameter, damp							A/E			
1	1.0	FILLING - light brown to brown, fine to medium grained sand filling with traces of fine gravel, damp - grey-brown with trace of earthenware fragments from 0.7m							A/E			
	1.5								A/E			
53	1.6	SAND - apparently medium dense, yellow-brown medium grained sand, damp						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 - very low strength, light yellow-brown, medium grained sandstone										
		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										
50	4											
	4.0	SANDSTONE - low strength, slightly weathered, slightly fractured, light grey, medium grained sandstone. Typically indistinctly bedded										
	5											
49	5.31	SANDSTONE - high strength, slightly weathered then fresh, slightly fractured, light grey medium and coarse grained sandstone. Typically indistinctly bedded										
	6											
48		6.42m:-6.52m: very low strength band - 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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BOREHOLE LOG

CLIENT: Health Infrastructure
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: Health Infrastructure
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
	0.04	ASPHALTIC CONCRETE (typically <10mm diameter)							A			
	0.07											
	0.2	ASPHALTIC CONCRETE (typically <20mm diameter)							A			
51	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 5.92m: B20°, pl, ro, stn, cly 5.96m: B20°, pl, ro, vn, cly 6.14m: B20°, pl, ro, vn, cly				PL(A) = 0.71
46	6	6.4m: indistinct irregular bedding dipping 0°- 20°										
	6.91	SANDSTONE - medium strength, fresh, slightly fractured and unbroken, pale grey, medium to coarse grained sandstone, massive, trace carbonaceous flecks							C	100	99	PL(A) = 0.71
45	7											
								7.63m: Ds, 15mm sandy clay				PL(A) = 0.66
44	8											
												PL(A) = 0.95
43	9							>>	C	100	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: 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: Health Infrastructure
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)	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: 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: Health Infrastructure
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)	Sampling & In Situ Testing: 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											
	4.65	SANDSTONE - very low strength, orange-brown sandstone										
44	5	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
	5.9	SANDSTONE - medium strength, fresh, 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, dark grey siltstone with 20% fine sand						7.72m: B0°, pl, sm, cly vn				PL(A) = 0.15
	8.05	LAMINITE - low strength, fresh, slightly fractured to unbroken, dark grey siltstone interlaminated and interbedded with 30% pale grey, fine grained sandstone, horizontally bedded						8.05m: B5°, pl, sm, stn, sandy cly	C	100	100	
41	9											PL(A) = 0.19
	9.09	8.27-8.38m: disturbed bedding, possible healed shear zone										
40		SANDSTONE - high strength, fresh, unbroken then slightly fractured, medium to coarse grained sandstone						9.42m: Ds, 10mm, sandy cly				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)

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BOREHOLE LOG

CLIENT: Health Infrastructure
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 - see next page 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: Health Infrastructure
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	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
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								A			
		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											
	4.0	SAND - medium dense, fine to medium grained sand, damp							S			8,11,9 N = 20
44	4											
	4.6	SAND - medium dense, orange-brown, fine to medium grained sand with some clay, moist				▼			A			
43	5											
	5.2	CLAYEY SAND - dense, grey-brown, clayey fine to medium grained sand, wet (possibly extremely low strength sandstone) 5.5m: grey							A			
									S			5,17,20 N = 37
42	6							Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 20°				
	6.9	SANDSTONE - low strength, slightly weathered, fractured to slightly fractured, pale grey and orange, medium to coarse grained sandstone										PL(A) = 0.15
41	7											
								7.6-7.67m: Ds, 70mm, cly				PL(A) = 0.12
	8							7.82-7.86m: Ds, 40mm, cly	C	100	81	
								7.95-7.98m: Ds, 30mm, cly				
40								8.36m: B20°, pl, ro, un, cly				
		8.61-8.66m: disturbed siltstone laminations						8.43m: B20°, pl, ro, cly co, 7mm				
	8.77	SANDSTONE - medium strength, fresh, slightly fractured, pale grey, medium to coarse grained sandstone, indistinct bedding typically dipping 10°- 20°						8.56-8.63m: Ds, 70mm cly				PL(A) = 0.77
39	9							8.75m: Ds, 15mm, sandy cly				
								9m: B20°, pl, ro, cly vn	C	100	99	
								9.06m: B10°, pl, ro, stn, cly				
38												PL(A) = 0.94

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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BOREHOLE LOG

CLIENT: Health Infrastructure
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				
	10.85								C	100	99	PL(A) = 1.6
11		SANDSTONE - high strength, fresh, unbroken, pale grey, medium to coarse grained sandstone, irregular bedding dipping 0°- 20°										
36												
12												PL(A) = 1.41
35								>>				
13									C	100	100	PL(A) = 1.95
34												
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				
15												PL(A) = 1.37
32		15.55m: with some fine quartz gravel bands							C	100	93	
16												PL(A) = 2.78
		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				
31	16.5	Bore discontinued at 16.5m - target depth reached										
17												
30												
18												
29												
19												
28												

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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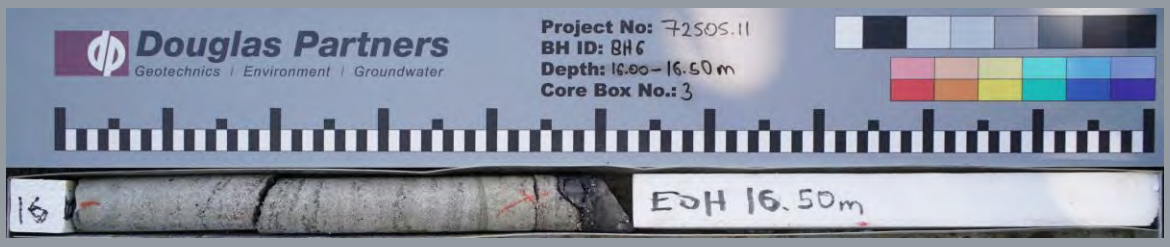
BORE: 6 PROJECT: RANDWICK SEPTEMBER 2017

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: Health Infrastructure
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	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				
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	C	98	97	PL(A) = 0.31 PL(A) = 0.35 PL(A) = 0.19 PL(A) = 0.72
49	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										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, typically indistinct bedding dipping 10-20°						8.26m: B0°- 10°, un, cly, 5mm 8.62m: B0°- 10°, ro, un, cly vn	C	100	92	PL(A) = 0.26
46	9											PL(A) = 0.17
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: Health Infrastructure
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 (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
44	11	SANDSTONE - medium strength, slightly weathered to fresh, slightly fractured to unbroken, light grey medium to coarse grained sandstone. Massive with some siltstone flecks 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 flecks, 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							14.58m: B20°, pl, he	C	100	98	PL(A) = 1.86
39	15											PL(A) = 1.13
38	16							16.32m: J45°, ro, un, cln 16.32-16.34m: B (x2) 5°-10°, ro, un, cbs vn				PL(A) = 0.74 PL(A) = 1.26
37	17	16.95-18.05m: fine grained band with some carbonaceous laminations						17m: Ds, 10mm 17.39m: B0°- 5°, ro, un, cbs vn 17.59m: B0°- 5°, ro, pl, cbs vn	C	100	97	PL(A) = 0.16 PL(A) = 1.22
36	18							17.9m: B0°- 5°, ro, pl, cbs vn 18.05m: Ds, 20mm 18.39-18.45m: J30°-60°,un, he, cbs, 1mm				PL(A) = 1.46
35	19							18.77m: Ds, 20mm 19.19m: B5°, ro, pl, cln 19.77m: B0°- 5°, ro, un, cbs vn	C	100	100	PL(A) = 1.39

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: Health Infrastructure
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)	Type	Core Rec. %	RQD %	Test Results & Comments
		SANDSTONE *(continued)*						20.24m: B5°, ro, pl, cln 20.42m: J20°, ro, un, cln	C	100	100	PL(A) = 0.88
34	20.47	Bore discontinued at 20.47m - target depth reached										
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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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: Health Infrastructure
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
47	2.77	SANDSTONE - low then medium strength, slightly weathered, fractured to slightly fractured, orange and grey, medium to coarse grained sandstone							C	100	100	PL(A) = 0.26
	3							3.71m: B15°, vn, cly				
	4							4.15m: B10°, vn, cly 4.38m: B20°, co, cly, 2mm 4.61m: B20°, co, sandy cly, 1mm 4.64m: B15°, co, cly, 2mm 4.72m: B0°, sm, co, cly, 3mm				PL(A) = 0.43
46	5											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							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 6.69-6.76m: J50°, un, ro, vn, fe				
	7											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: *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: Health Infrastructure
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	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
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	
38	12											PL(A) = 2.23
												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
												PL(A) = 1.36
34	16											
		16.44m: irregular bedding dipping 10-20°						16.44m: B0-10°, cu, co, sandy cly, 10mm	C	100	99	
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: *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: Health Infrastructure
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)	Sampling & In Situ Testing: 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						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						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: 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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
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 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
39		SANDSTONE - high strength, fresh, slightly fractured to unbroken, pale grey, medium to coarse grained sandstone, irregular bedding dipping 10-20° *(continued)*						10.12m: B20°, co, cly, 1mm 10.3m: Ds, 20mm, cly				
38	11							10.74m: B20°, vn, cly 10.77m: B5-10°, cu, co, cly, 3mm 10.94m: B10°, co, cly, 2mm	C	100	98	PL(A) = 1.12
37	12							11.97m: B20°, vn, sandy cly				PL(A) = 0.9
		12.48-12.58m: grey, fine to medium grained 12.58-13.48m: massive						12.58m: B10°, vn, cly				
36	13								C	100	100	PL(A) = 1.72
								13.48m: B15-20°, co, sandy cly, 1mm				
35	14							14.04m: B20°, stn, cly				PL(A) = 1.38
34	15											PL(A) = 1.85
								15.29m: B15°, vn, cly				
33	16	16.23-17.27m: with some quartz gravel bands and carbonaceous laminations						16m: B0-5°, cu, co, cly, 2mm	C	100	98	PL(A) = 1.4
32	17											PL(A) = 1.01
		17.27m: massive										PL(A) = 1.13
	17.49	Bore discontinued at 17.49m - target depth reached						17.44m: B0°, co, cly, 2mm				
31	18											
30	19											

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: 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)

Douglas Partners
Geotechnics / Environment / Groundwater

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

Appendix F

Results of Laboratory Testing – Physical Properties

Material Test Report

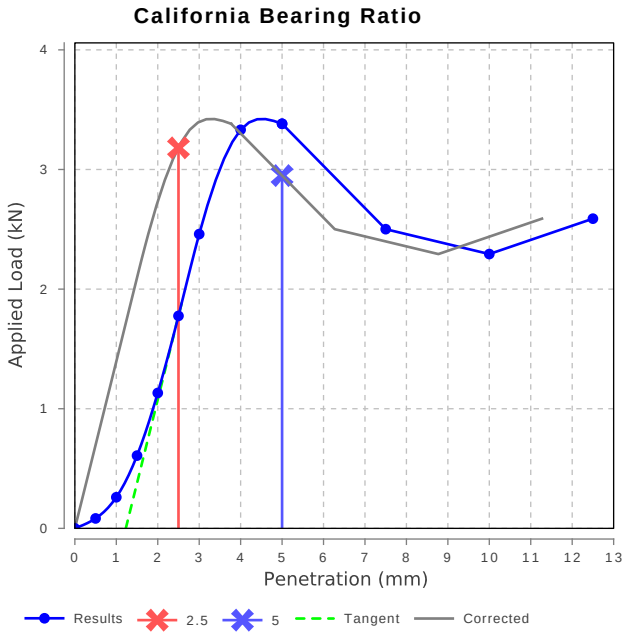
Douglas Partners
Geotechnics | Environment | Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
Fax: (02) 9809 0666
Email: mark.matthews@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

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

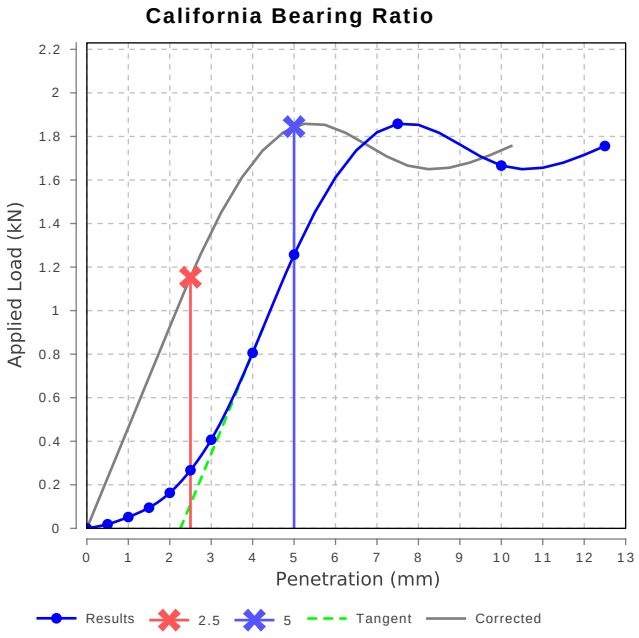
Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
Fax: (02) 9809 0666
Email: mark.matthews@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

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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Sydney Laboratory
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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

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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
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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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Sydney Laboratory
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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: **72505.11-1**
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
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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

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

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.

Douglas Partners
Geotechnics · Environment · Groundwater

CHAIN OF CUSTODY

Project Name: RCR Project .....
Project No: 72505.11..... Sampler: ...ARM..... .....
Project Mgr: PAV.....Mob. Phone: 0422 000 438 .....
Email: peter.valenti@douglaspartners.com.au .....
Date Required: ...standard ..... Lab Quote No. .....

To: Envirolab Services
12 Ashley Street, Chatswood NSW 2068
Attn: Tania Notaras
Phone: 02 9910 6200 Fax: 02 9910 6201
Email: tnotaras@envirolabservices.com.au

Sample ID	Sample Depth (m)	Lab ID	Sampling Date	Sample Type S - soil W – water	Container type	pH	Sulphate	Chloride	Electrical Conductivity				Notes
✓ BH1	0.5-0.6	1	18/9	S	Plastic	x	x	x	x				
✓ BH2	4.0-4.45	2	18/9	S	Plastic	x	x	x	x				
✓ BH3	1.3-1.4	3	21/9	S	Plastic	x	x	x	x				
✓ BH4	2.5-2.95	4	21/9	S	Plastic	x	x	x	x				

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200
Job No: 176263
Date Received: 22/9/17
Time Received: 15:00
Received by: MT
Temp: Cool/Ambient 24.5
Cooling: Ice/Icepack
Security: Intact/Broken/None

Lab Report No. .....
Send Results to: Douglas Partners Address: 96 Hermitage Road, West Ryde 2114
Phone: (02) 9809 0666
Fax: (02) 9809 4095

Relinquished by: PAV Signed: RJ Date & Time: 22/9/17 Received By: MT EES Date & Time: 22/9/17 15:00.

Relinquished by: Signed: Date & Time: Received By: Date & Time:

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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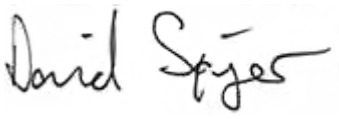
Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

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.

Douglas Partners
Geotechnics · Environment · Groundwater

CHAIN OF CUSTODY

Project Name: RCR Project .....
Project No: 72505.11..... Sampler: ...ARM..... .....
Project Mgr: PAV.....Mob. Phone: 0422 000 438 .....
Email: peter.valenti@douglaspartners.com.au.....
Date Required: Tues 6/2/18 (3 day turnaround) .. Lab Quote No. .....

To: Envirolab Services
12 Ashley Street, Chatswood NSW 2068
Attn: Tania Notaras
Phone: 02 9910 6200 Fax: 02 9910 6201
Email: tnotaras@envirolabservices.com.au

				Sample Type									
Sample ID	Sample Depth (m)	Lab ID	Sampling Date	S - soil W – water	Container type	pH	Sulphate	Chloride	Electrical Conductivity				Notes
BH8	2.5-2.66	1	24/1	S	Plastic	x	x	x	x				
BH9	5.5-5.95	2	25/1	S	Plastic	x	x	x	x				

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200
Lab No: 184350
Date Received: 1/2/18
Time Received: 15:45
Received by: MT
Temp: Cool/Ambient 23.0
Cooling: Ice/Icepack
Security: Intact/Broken/None

Lab Report No. .....
Send Results to: Douglas Partners Address: 96 Hermitage Road, West Ryde 2114
Phone: (02) 9809 0666
Fax: (02) 9809 4095

Relinquished by: A.McIntyre	Signed:	Date & Time: 1/2/18 14:30	Received By: MT	ECS	Date & Time: 1/2/18 15:45
Relinquished by:	Signed:	Date & Time:	Received By:		Date & Time: