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Integrated Practical Solutions

Report on
Contamination Assessment for SSD

Proposed UNSW D14 Building
High Street, Kensington

Prepared for
The University of New South Wales
(Developer and Applicant)

Lendlease
(Design and Construct Partner)

Douglas Partners
Geotechnics / Environment / Groundwater

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Table of Contents

Page

Report on Contamination Assessment for SSD
UNSW Hall (D14)
High Street, Kensington

1. Introduction

This report presents the results of a contamination assessment, undertaken at the UNSW Hall (D14) at the University of New South Wales at High Street, Kensington (UNSW). The investigation was commissioned by Ms Tania Costa of The University of New South Wales (the development and applicant) and Lendlease (Design and Construct Partner) and was undertaken in accordance with Douglas Partners' proposal SYD180599.P.001.Rev1 dated 18 June 2018.

The aim of the investigation was to assess the risk and nature of potential contamination at the site, comment on the suitability of the site for the proposed land use, and provide recommendations for further investigations (if necessary) and/ or remediation and management requirements.

The investigation included three rock cored bores, drilling of three shallow augered bores, and cone penetration tests (CPTs) at four of the borehole locations. Two groundwater monitoring wells were installed for geotechnical investigation purposes (measurement of groundwater levels). The details of the current field work and laboratory analysis of selected samples are presented in this report, together with comments and recommendations on the issues listed above.

The investigation was undertaken in conjunction with a geotechnical investigation (Project 86457.00) which is reported separately.

This report was prepared to support the State Significant Development (SSD) works which are described in Section 4 of this report. A separate contamination report has been prepared in support of the Review of Environmental Factors (REF) works (DP Report 86457.01.R.001.Rev2, referred to herein as the DP (2018) REF report).

2. Scope of Works

The scope of this investigation comprised:

- Review of previous investigations undertaken on the site and made available to DP by the client;
- Review of historical aerial photographs, public databases and published mapping via a LotSearch Report;
- Review of historical titles;
- A site walkover to identify current site features and visually apparent areas of environmental concern. This was conducted prior to drilling to identify areas of environmental concern (AECs) to be targeted during sampling;
- Collection of soil samples from the geotechnical test bores for environmental testing;

- Screening by an environmental scientist for volatile organic compounds (VOC) using a photo-ionisation detection (PID) instrument;
- Dispatch of selected soil samples (plus 10% QA/QC samples) for analysis by a NATA accredited laboratory for a range of common contaminants and parameters as listed below:
    - Heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn) (HM);
    - Total recoverable hydrocarbons (TRH) a screening test for total petroleum hydrocarbons);
    - BTEX (benzene, toluene, ethyl benzene, xylenes);
    - Polycyclic aromatic hydrocarbons (PAH);
    - Organochlorine pesticides (OCP);
    - Organophosphate pesticides (OPP);
    - Polychlorinated biphenyls (PCB);
    - Volatile organic compounds (VOC);
    - Cation exchange capacity (CEC);
    - TCLP (for waste classification purposes);
    - pH;
    - Asbestos ID in 40 g samples;
    - Asbestos in soil from 500 ml samples; and
    - QA/ QC analysis including replicate samples, trip spikes and trip blanks.
- Provision of a contamination assessment report, including preliminary waste classification, describing the methodology and results of the assessment.

3. Site Identification

The site comprises a broadly rectangular shaped area the general layout of which is shown on Drawing 1, Appendix B. The site is part of Lot 3 in Deposited Plan 1104617 with an area of approximately 5,200 m^2. Currently the site is occupied by the UNSW Hall (formerly Phillip Baxter College).

UNSW Hall is a four storey brick building which is currently occupied by student accommodation. The building features include:

- 208 fully furnished dorm rooms (with an average size of 10 x 12 m);
- Shared bathrooms;
- Social and group study rooms on each floor;
- Breakfast and dinner service;
- A large common room;
- Outdoor BBQ area and courtyard;

- A central lawn; and
- Coin operated laundry facilities.

The site slopes to the west from an RL of approximately 34.5 m AHD in the east to an RL of 30.5 m AHD in the west. The site is bounded by The UNSW Village and then High Street to the north, The White House and Goldstein Dining Hall to the east, The Business School (formerly chemistry) to the south and Alumni Park to the west.

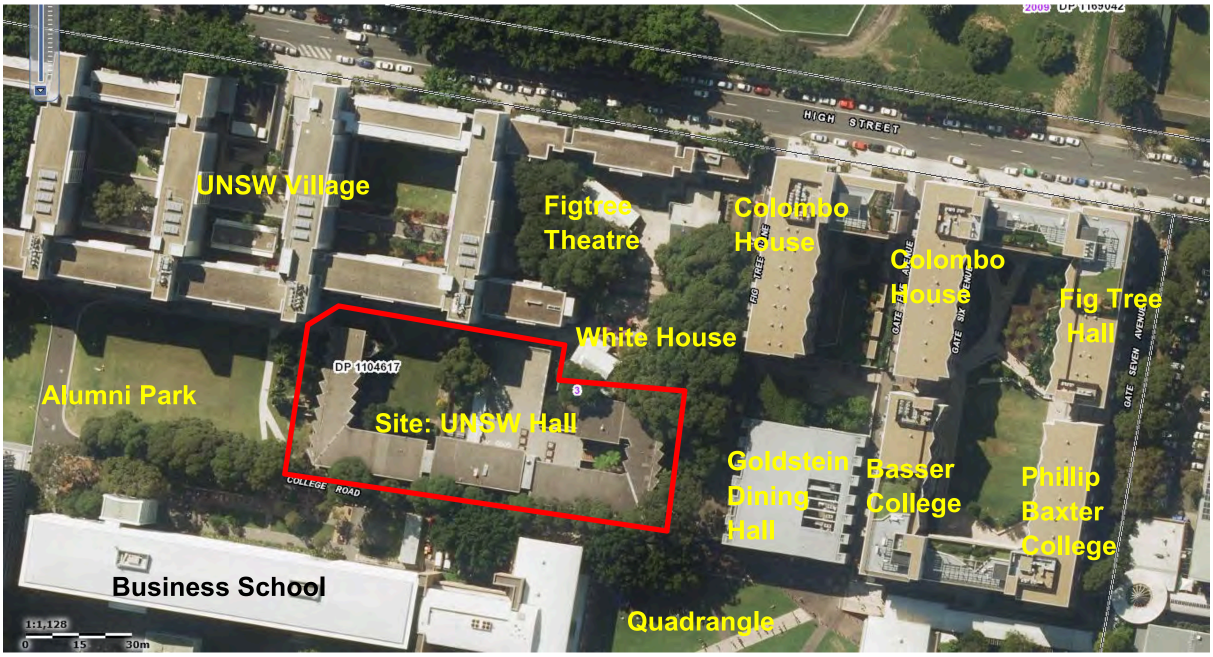


Figure 1: Site Boundary

4. Proposed Development

Preliminary concept plans of the proposed development are provided in Appendix A. In general, the SSD works includes the following:

- The construction of a 7 storey building with an approximate ground floor area of 15,000 m^2 comprising of flexible student study space, faculty office space, function space and ground level retail; and
- Associated public domain, ramps and landscaping works

5. Geology, Topography and Hydrogeology

Reference to the *Sydney* 1:100 000 Geology of Sydney Geological Series Sheet indicates that the site is located on Quaternary transgressive dunes. The transgressive dunes typically comprise medium to fine grained, marine sand with podsols. The dunes overly Hawkesbury Sandstone which typically comprises medium to coarse grained quartz sandstone with some shale bands or lenses.

The *Sydney* 1:100,000 Soils Landscape Sheet indicates that the site is underlain by the Tuggerah soil landscape group. The soil landscape group typically occurs on gently undulating rises. Local relief to 20 m and slopes are usually <1-10%. The soils typically comprise Deep (>200 cm) Podzols on dunes and Podzol/Humus Podzol intergrades on swales. The typical limitations of the group include extreme wind erosion hazard, non-cohesive, highly permeable soil, very low soil fertility, localised flooding and permanently high water tables.

The NSW National Resource Atlas *Acid Sulfate Soil Risk* Map indicates that the site is located in an area of no known occurrence of acid sulfate soil.

Based on local topography it is anticipated that the general regional groundwater flow direction would be west and north west. The nearest sensitive water receiving bodies are in Centennial Park and the East Lakes system. However, it is not considered likely that groundwater from the site would have any impact on these water bodies, given the distance (at least 1.5 km to Centennial Park) from the subject site and the receiving bodies.

A review of registered groundwater bores indicates that there are no registered bores within the site. There are a number of registered bores within UNSW and in the Randwick / Kensington area. The registered use of the bores within UNSW is for monitoring, recreational and industrial uses. The bores were drilled to depths of between 28.5 and 41 m bgl. Groundwater was recorded at depths of between 7.2 and 7.5 m bgl. It is understood that groundwater is extracted at UNSW for irrigation of the gardens and playing fields.

6. Site History

6.1 Previous Reports

DP has undertaken a number of previous investigations within the UNSW grounds as indicated on Drawing 2, Appendix B. The most relevant projects to the current investigation include:

- Project Series 44301 (2006) and Project 45674 (2008) located at the UNSW Village (5 m north of the current project site);
- Project 85547 (2017) located at Building D7 (180 m west of the current project site);
- Project 73565 (2013) located at the Material Science Building (170 m south west of the current project site);
- Project 37220 (2004) located between the Dalton Building and Materials Science Building which was undertaken for a proposed analytical centre (70 m south west of the current project site); and
- Project 85893 (2017) located at the Electrical Engineering Building (100 m south east of the current project site).

If required a complete reference list of the reports undertaken for the above project series can be provided. The relevant details from these project series is summarised in the following subsections. The location of the previous investigations relative to current investigation site is presented on Drawing 2, Appendix

6.1.1 Project Series 44301 & 45674

Project 45301 was a geotechnical and contamination investigation for the UNSW village. The project included a series of investigations incorporating test bores and cone penetration tests (CPTs). The soil profile encountered (prior to development of the UNSW village in 2008) was as follows:

Filling	Encountered in each of the CPTs and bores to depths of between 0.3 m and 1.6 m, except for Bore 114 which was discontinued in filling at 4 m depth. Trace gravel, slag, charcoal and rootlets were noted in some locations;
Sand	Majority of the subsurface conditions encountered comprised sands and silty sand which increased in density from loose and medium dense to very dense;
Clayey and Peaty Sands	Occasional thin clayey and peaty layers were encountered in the CPTs and boreholes, generally below 4 m depth;
Residual Clayey Sand	Clayey sand encountered in Borehole 113A overlying weathered rock; and
Sandstone	Rock was only encountered in Borehole 113A with extremely and very low strength from 16.2 m and then medium and high strength from 18.5 m depth to 22.05 m.

Groundwater monitoring wells were installed at three locations. Groundwater ranged in depth in the groundwater wells from 6.3 to 9.1 m bgl (22.8 m AHD to 24.5 m AHD). The observed direction of groundwater flow was to the west.

The investigation identified that the primary potential sources of contamination at the site were the following:

- Filling of unknown origin;
- Potentially contaminating land use and ingress of contaminants from adjacent sites;
- Stores of small quantities of hydrocarbon based products;
- Demolition of previous structures (asbestos risk); and
- A Cobalt 60 radiation source. Based on reports provided by ANSTO and UNSW[1] it was determined that the removal of Cobalt 60 had been undertaken in an appropriate manner. The reports indicated that radiation contamination was no longer an issue of concern for the site.

Laboratory results indicated that potential chemical contaminants at the site were generally present at low levels (or below laboratory practical quantitation limits) and well within the assessment criteria. However, a few surficial soil samples recorded concentrations of heavy metals above the phytotoxicity based assessment criteria. Asbestos contamination was identified in filling at the site.

[1] Health Physics Report: The Retrieval and transport of an AAEC supplied Cobalt 60 source from the UNSW to ANSTO's Lucas Heights facility (ANSTO, 21 November 2007);
Radioactive Contamination Inspection Report (UNSW, reference: OHS & WC 011107, 11 October 2007).

Laboratory results for groundwater were generally within the GILs with the exception of low levels of heavy metals and TRH C6-C10 in one sample (and its replicate). The source of the TRH was not known and the elevated levels detected in groundwater were not repeatable and therefore the original result was determined to not be representative of the groundwater quality.

A remediation action plan was prepared for the site. The RAP recommended the removal or capping of asbestos contaminated soils at the site. Following the completion of remediation works a validation report was prepared. The validation report concluded that:

- Asbestos containing materials had been effectively removed from the site, such that the site has been remediated to the extent practical;
- The risk associated with asbestos contamination at the site was reduced to a negligible level;
- A construction phase Asbestos Management Plan was recommended to manage potential asbestos risk;
- Under the proposed development all areas of the site it was assumed that any residual fill would contained by concrete or covered with 500 mm of topsoil in garden areas, further reducing the potential for exposure to residual asbestos, if present at the site; and
- It was considered that the site was appropriately validated in accordance with the RAP (with respect to asbestos), and that the site was suitable for the proposed residential land-use.

Project 45674 was a virgin excavated natural material (VENM) assessment undertaken for the same development project on the natural sands, post demolition and remediation works. The natural sand was classified as VENM.

6.1.2 Project 85547

Project series 85547 was undertaken as a review of project information for the Science and Engineering building works, with specific regard to hazardous materials within buildings. Asbestos and lead was noted in a number of locations within buildings D8 and E8. It was found that due to the age of the building, asbestos and lead was present in the building fabric and in the fill layers of the soil in the vicinity of the buildings.

6.1.3 Project Series 73565

Project series 73565 was undertaken for the UNSW Material Science Building which is located to the east of the current project area. The investigation included 11 CPTs and three boreholes. Ten of the CPTs were undertaken to practical refusal at depths of between 15.3 m and 29.0 m, whereas the 11th CPT was terminated where the limit of acceptable rod inclination was reached. The boreholes were drilled to depths of between 22.6 m and 32.3 m.

The CPTs and boreholes encountered fill to depths of 0.3 – 1.2 m, over loose and medium dense sand, that graded to dense or very dense sand at depths of approximately 5 – 7 m. Some thin clay bands were encountered below a depth of 17 m. The boreholes encountered extremely low to very low strength sandstone below the bedrock surface. No contamination testing was included in this project.

6.1.4 Project 37220

Project 37220 included a preliminary (desktop) contamination and geotechnical investigation. The geotechnical investigation included three bores and five cone penetration tests. Relatively uniform subsurface conditions were encountered over the site, with predominantly medium dense and dense sands overlain by a thin surface layer of filling comprising sand, asphalt and gravel (road base). Medium to high strength sandstone was intersected at depths ranging from 7.9 m (RL 21) to 16 m (RL 12.1). Loose and very loose sand zones were indicated in several locations within 3 m of ground surface level. The sands were then generally medium dense and dense becoming consistently dense and very dense below RL 22 to RL 23.5. A cemented zone was encountered from 6.1 m to 6.5 m depth in Bore 8.

Groundwater was only observed in CPT 7 at 7.2 m depth (RL 21.1), however collapse of the hole after removal of the CPT probe was noted in CPTs 1, 3, 4 and 5 between RL 21.5 and RL 22. Collapse of the hole can indicate close proximity to groundwater. No free groundwater was observed in the bores while auger drilling. The use of fluids during rotary drilling precluded groundwater observations. It should be noted that groundwater levels are transient and affected by climatic conditions. No contamination testing was included in this project.

6.1.5 Project 85893

Project 85893 included a number of limited geotechnical investigations for the upgrades to the Electrical Engineering building. Two boreholes were drilled to depths of 5.7 m and 7.0 m. The subsurface conditions encountered in boreholes BH1 and BH2 can be summarised as pavement materials including asphaltic concrete and roadbase (possibly cement-stabilised) to depths of 0.25 m and 0.5 m, underlain by extremely low and very low strength sandstone to depths of 0.4 m and 1.1 m. Low strength, or low to medium and medium strength sandstone with some extremely low strength bands extended to the base of the boreholes (5.7 m and 7.0 m deep).

No free groundwater was observed during augering of the boreholes (i.e. within depths of 0.4 m and 1.1 m). The use of drilling fluid to core the rock precluded any further observation of groundwater.

6.2 Other Consultant Reports

In addition to the DP reports the following reports were provided for review:

- Coffey (2010) Ge*otechnical and Environmental Report, Basser and Goldstein Colleges, UNSW,* prepared for UNSW C/- Taylor Thomson Whitting, ref. GEOTLCOV24080AA-AE27 September 2010;
- Coffey (2011) *Geotechnical and Environmental Report , UNSW Gate 2 Student Residences*, prepared for Brookfield Multiplex ref GEOTLCOV24080AD-AB, 5 May 2011; and
- Noel Arnold and Associates (2014) *Asbestos Risk Assessment, University of New South Wales, Kensington Campus (D14), UNSW Hall, Kensington NSW 2033*, Site Reference: KCS-D14, NA ref: C108081: J123597 dated February 2014.

6.2.1 Coffey (2010)

Coffey (2010) was a preliminary geotechnical and contamination investigation for the colleges to the east of the site. The investigation included a site history assessment, drilling of test bores and limited contamination testing of soils.

The profile encountered typically comprised a variable fill layer (to a maximum depth of 3.3 m bgl) underlain by sand and then sandstone. The contamination assessment carried out at the Site was limited. It was not intended to meet the NSW EPA (1995) Sampling Design Guidelines. Based on the limited results, the chemicals of concern were detected below the adopted site criteria with the exception of TPH C10-C36, PAH and nickel exceeding the adopted site criteria in a number of fill samples.

6.2.2 Coffey (2011)

Coffey (2011) was a preliminary geotechnical and contamination investigation site to the west of the site. The investigation included a site history assessment, drilling of test bores and limited contamination testing of soils. The profile encountered typically comprised a variable fill layer (to a maximum depth of 1.7 m bgl) underlain by sand.

The results of the laboratory analysis indicated that concentrations of chemical contaminants were within the adopted health-based and ecological assessment criteria. Asbestos fibres were detected in soils in one location.

6.2.3 Noel Arnold (2014)

This report presents the findings of an asbestos risk assessment undertaken at the UNSW Hall. A number of asbestos containing materials or suspected asbestos containing materials were identified within the building. The report provides recommendations and control measures to manage asbestos risk within the building.

6.3 Title Deeds

A historical title deeds search was used to obtain ownership and occupancy information including company names and the occupations of individuals. The title information can assist in the identification of previous land uses by the company names or the site owners and can, therefore, assist in establishing whether there were potentially contaminating activities occurring at the site. A summary of the title deeds and possible land uses (with reference to the aerial photographs and the Historical Business Directory) is presented in Table 1. A copy of the search is provided in Appendix D.

Table 1: Historical Title Deeds

Date of Acquisition and term held	Registered Proprietor(s) & Occupations where available	Possible Land-use
Not provided	Kensington Race Course	Race track
28.11.1952	Part tinted yellow on the attached cadastre Reserved from Sale or Lease other than Annual Lease – subsequently measured for NSW University of Technology.	University
	Part tinted yellow on the attached cadastre appropriated for the purposes of The NSW University of Technology.	
12.12.1952	Part tinted yellow on the attached cadastre vested in The NSW University of Technology.	
26.08.1964	Minister for Education.	
26.08.1964 (1964 to date)	# The University of New South Wales (Formerly The NSW University of Technology).	

# Denotes Current Registered Proprietor

Leases:

- Numerous leases were found from 15.08.1994 onwards that have since expired due to effluxion of time or have been surrendered – These have not been investigated
  Please refer to the current title 3/1104617 for current leases

Easements: NIL

6.4 Aerial Photographs

Historical aerial photographs were obtained by Lotsearch from databases held by the NSW Land & Property Information Division for the years, 1943, 1955, 1961, 1965, 1975, 1982, 1991, 2000, 2009 and 2016. DP obtained one additional aerial photograph for 1930 from NSW Land & Property Information Division which is presented in Figure 2 below. Extracts of the remaining aerial photographs are provided in the Lotsearch Report, and a summary of features observed for the site and surrounding properties is presented in Table 2. It is noted that the Lotsearch indicates the site boundary as including the Alumni Lawn. The correct site boundary is provided in Figure 1, and Drawing 1, Appendix B.

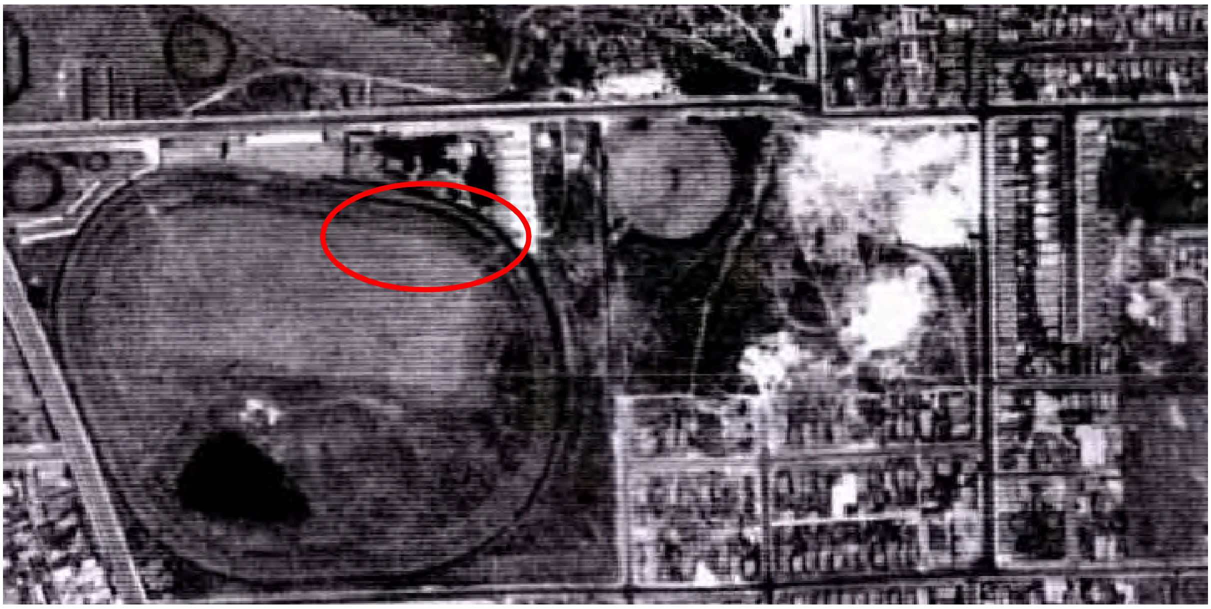


Figure 2: 1930 Aerial Photograph

Table 2: Aerial Photograph Review

Year	Site Features	Surrounding Features
1930	The site appears to be part of the Kensington Race Track. In the 1930 aerial photograph the site appears to be occupied by the north east turn of the race track, part of the track infield and part and one or two out buildings (or part thereof).	The area to the south and west of the site appears to be occupied by the Kensington Racecourse, to the east is the racecourse outfield including a number of small out building then a playing field. To the north is the Kensington Racecourse outfield with a number out buildings, High Street the Randwick Racecourse.
1943	There does not appear to have been any significant change to the site. The only difference from the 1930 aerial photograph of note is that a number of vehicles appear to be parked within the track infield.	There does not appear to have been any significant change to the surrounding area.
1955	In the 1955 aerial photograph the Kensington Racecourse appears to have been closed and the track cleared / demolished. There appears to be at least two new small structures in the north eastern portion of the site A trench appears to dissect the site from the south east to the north west.	There appear to be a number of new buildings north west of the site (The Temporary Buildings that housed a number of schools including drama) and as noted in the site features, the Kensington Racecourse appears to have been closed and demolished.

Year	Site Features	Surrounding Features
1961	It appears that the site may be occupied by new tennis courts in the 1961 aerial photograph and other construction activities related to adjacent building works.	Several new structures appear to have been constructed within the university, outside the current study area including the chemical engineering process building to the west, UNSW Building School (E12 – formerly chemistry building), The Dalton Building The Fig Tree Theatre, the Round House, Basser College and Science Hall.
1965	In the 1965 aerial photograph it appears that Phillip Baxter College which occupies the eastern half of the investigation area and was opened in 1965 (now University Hall) was under construction	There appears to be a number of new building constructed within university grounds outside the current study area including Goldstein College
1970	In the 1970 aerial photograph it appears that construction on Phillip Baxter College has been completed. The south western corner of the site appears to have been paved and converted to an on grade carpark.	There appears to be a number of new buildings constructed within university grounds outside the current study area including Goldstein College, International House and Applied Science Building (now chemistry).
1982	There does not appear to be any significant change to the site in the 1982 aerial photograph	There does not appear to be any significant change to the site in the 1982 aerial photograph
1991	There does not appear to be any significant change to the site in the 1991 aerial photograph	There does not appear to be any significant change to the site in the 1991 aerial photograph
2000	There does not appear to be any significant change to the site in the 2000 aerial photograph.	The Quadrangle Building and lawn appears to have been constructed to the south east of the site. A number of other new buildings appear to have been constructed within the university grounds.
2009	There does not appear to be any significant change to the site in the 2009 aerial photograph.	The Temporary Buildings to the north of the site appear to have been demolished and construction on the University Village appears to have commenced. A number of new buildings appear to have been constructed to the west of the study area including the law building
2016	There does not appear to be any significant change to the site in the 2016aerial photograph.	A number of new buildings appear to have been constructed to the west of the study area including the Hilmer Building. The building to the north west of the site (the Chemical

Year	Site Features	Surrounding Features
		Engineering Process Building) appears to have been demolished and converted to a lawn (Alumni Park)

6.5 EPA Records

The EPA publishes records of contaminated sites under section 58 of the *Contaminated Land Management Act* 1997 (CLM Act) on a public database accessed via the internet. The notices relate to investigation and/or remediation of sites considered to be significantly contaminated under the definition in the CLM Act. More specifically the notices cover the following:

- Actions taken by the EPA under sections 15, 17, 19, 21, 23, 26 or 28 of the CLM Act;
- Actions taken by the EPA under sections 35 or 36 of the Environmentally Hazardous Chemicals Act 1985; and
- Site audit statements provided to the EPA under section 52 of the CLM Act on sites subject to an in-force remediation order.

A search of the public database undertaken in the Lotsearch report indicated that the site was not listed.

It should be noted that the EPA record of Notices for contaminated land does not provide a record of all contaminated land in NSW.

The NSW EPA also issues environmental protection licenses under section 308 of the *Protection of the Environment Operations Act* 1997 (POEO Act). The register contains:

- Environmental protection licenses;
- Applications for new licenses and to transfer or vary existing licenses;
- Environment protection and noise control licenses;
- Convictions in prosecutions under the POEO Act;
- The result of civil proceedings;
- License review information;
- Exemptions from provisions of the POEO Act or Regulations;
- Approvals granted under Clause 9 of the POEO (Control of Burning) Regulation; and
- Approvals granted under Clause 7a of the POEO (Clean Air) Regulation.

A search of the public register undertaken in the Lotsearch report indicated that there are no current Environment Protection Licences issued to the site. Other EPA activities include the PFAS investigation programme. There were no sites within 1000 m of the site where the EPA has commenced a PFAS investigation.

6.6 Historic Business Directory

A record of the historic businesses from 1986, 1982, 1978, 1975, 1970, 1965, 1961 and 1950 was included in the Lotsearch Report. No businesses, other than those related to the University were identified within the site in the records. No motor garages of dry cleaners were identified at the site. A number of service stations and motor garages are noted on Anzac Parade, and therefore are very unlikely to impact the site.

6.7 Historic Maps

The 1919 and 1949 historic maps indicate that the Kensington Race Course was present at the site at these times.

6.8 Ecological Constraints

No items of significant ecological value were identified within the site or immediately adjacent to it such as high value native vegetation, groundwater dependant ecosystems or RAMSAR wetlands.

7. Site Walkover

An environmental scientist from DP undertook a site walkover on 26 July 2018. Site photographs referred to herein are provided in Appendix C. The following features were noted during the site inspection:

- The majority of site is occupied by a four storey brick dormitory (Photographs 1 and 2);
- A central lawn with a number of small trees and shrubs surrounding a central grass lawn (Photograph 3);
- A number of underground services are present within the site area;
- The site slopes down to the west. It is possible that the slope is function of site cut and fill works particularity behind retaining walls;
- The site is bounded by The UNSW Village and then High Street to the north (Photograph 4), The White House (Photograph 5) and Goldstein Dining Hall (Photograph 6) to the east, The Business School (formerly chemistry, Photograph 7) to the south and Alumni Park (Photograph 8) to the west; and
- No significant chemical stores were noted during the site inspection (except minor, household cleaning products).

8. Conceptual Site Model

A conceptual site model (CSM) is a representation of site-related information regarding contamination sources, receptors and exposure pathways between those sources and receptors. The CSM provides the framework for identifying how the site became contaminated and how potential receptors may be exposed to contamination either in the present or the future i.e. it enables an assessment of the potential source – pathway – receptor linkages (complete pathways).

8.1 Potential Sources

Based on the current investigation, the following potential sources of contamination and associated contaminants of potential concern (COPC) have been identified.

S1 – Filling and demolition rubble: Associated with site redevelopment:

COPC include metals, total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene, xylene (BTEX), polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), organochlorine pesticides (OCP), phenols, and asbestos.

S2 – Previous activities related to Kensington Racecourse. Activities related to housing of animals:

COPC include metals, TPH, PAH. It is possible that animals may have also been dosed for pests such as ticks.

S3 – Chemical Stores (particularly with former chemistry building to the south):

COPC include metals, VOC, TPH, BTEX, PAH and phenols.

S4 – Substations within the site:

COPC include metals, asbestos, OCP and PCB.

8.2 Potential Receptors

Specific details of the proposed development are unknown at this stage, however, it is understood that concept plans are for a multi-storey faculty building, possibly with basement floors and for future redevelopments in areas of the existing Fitness and Aquatic Centre, Square House and Block House Buildings

Human Health Receptors:

R1 – Maintenance and construction workers;

R2 – Current and future users (UNSW staff and students); and

R3 – Adjacent users (residential and commercial).

Environmental Receptors

R4 – Groundwater.

8.3 Potential Pathways

The potential pathways for the identified receptors are as follows:

P1 – Ingestion and dermal contact;

P2 – Inhalation of dust and/or vapours;

P3 – Leaching of contaminants and vertical mitigation into groundwater;

P4 – Surface water run-off leading to groundwater;

P5 – Lateral migration of groundwater; and

P6 – Contact with extracted groundwater used for irrigation

8.4 Summary of Potential Complete Pathways

A 'source–pathway–receptor' approach has been used to assess the potential risks of harm being caused to human, water or environmental receptors from contamination sources on or in the vicinity of the site, via exposure pathways (complete pathways). The possible pathways between the above sources (S1 to S5) and receptors (R1 to R4) are provided in Table 3 below.

Table 3: Summary of Potential Complete Pathways

Source	Transport Pathway	Receptor	Risk Management Action Recommended
S1 – Filling and building rubble: Associated with site redevelopment; COPC TPH, BTEX, PAH, PCB,OCP, phenols, and asbestos	P1 – Ingestion and dermal contact P2 – Inhalation of dust and/or vapours	R1: Maintenance and construction workers R2: Current and future users	The potential for contamination from the identified sources is generally considered to be low to moderate. An unexpected finds protocol is recommended for site redevelopment works. Further testing within building footprints is recommended (when structures are demolished).
S2 – Previous activities related to Kensington Racecourse. COPC include metals, TPH, PAH. It is possible that animals may have also been dosed for pests such as ticks.	P2 – Inhalation of dust and/or vapours	R3 – Adjacent users (residential and commercial)	
	P3 – Leaching of contaminants and vertical mitigation into groundwater	R4 – Groundwater	
S3 – Chemical Stores COPC include metals, VOC, TPH, BTEX, PAH and phenols. S4 – Substations within the site COPC include metals, asbestos, OCP and PCB	P4 – Surface water run-off P5 – Lateral migration of groundwater. P6 – Contact with extracted groundwater used for irrigation		

9. Fieldwork

The minimum number of sampling points for a site of this size (5,200 m^2) in accordance with the NSW EPA *Sampling Design Guidelines* (1995) for contaminated site investigations would be 13 sampling points. NEPC (2013) recommends the use of professional judgement in determining appropriate sample numbers. However, given existing use of the building by the University, a reduced number of sampling points was used based on a targeted regime to accommodate existing site restraints.

The investigation has been devised broadly in accordance with the seven step data quality objective (DQO) process as specified in Schedule B2 of the *National Environment Protection (Assessment of*

Site Contamination) Measure 1999 as amended 2013 (NEPC 2013This DSI has been prepared to address the requirements of *State Environmental Planning Policy No. 55 (SEPP 55) – Remediation of Land*.

9.1 Test Locations and Rationale

The boreholes were located in accessible areas following service location undertaken by an environmental engineer between 25 and 26 July 2018. The locations were chosen to gain coverage of the accessible parts of the site.

9.2 Drilling Methods

The field work comprised:

- Electronic scanning for buried services at proposed CPT and borehole locations;
- Four CPTs (CPT1 CPT4, CPT5 and CPT6) taken to depths of between 5.44 and 13.62 m using a ballasted truck-mounted test rig;
- Five boreholes (BH1, BH2, BH4, BH5 and BH6) drilled to a depth 3.0 to 12.05 m using a excavator or truck mounted drilling rig using spiral flight auger attachment and nlmc rock coring techniques;
- Two groundwater monitoring wells were installed for geotechnical purposes; and
- One borehole (BH3 / 3A) drilled to a depth of 0.5 m using a hand auger.

Ground elevations at the CPT and borehole locations were obtained by interpolation from the survey drawing provided by the client (Drawing No. K-SS-2018.010 Revision A dated 27 March 2018).

The CPTs and excavator-drilled boreholes were supervised by a geotechnical engineer, and a geotechnical engineer carried out the hand-augered boreholes.

9.3 Soil Sampling Procedures

Environmental sampling was performed according to standard operating procedures outlined in the DP *Field Procedures Manual*. All sampling data was recorded on borehole logs included in Appendix E and samples selected for laboratory analysis were recorded on DP chain-of-custody (COC) sheets (Appendix F). The general soil sampling procedure comprised:

- Use of disposable sampling equipment including disposal nitrile gloves;
- Transfer of samples into laboratory-prepared glass jars and capping immediately with Teflon lined lids;
- All re-used equipment where applicable was decontaminated between samples using a 3% solution of Decon 90 and rinsing with deionised water;
- Labelling of sampling containers with individual and unique identification, including project number sample location and sample depth; and

- Placement of sample containers and bags into a cooled, insulated and sealed container for transport to the laboratory.

Envirolab Services Pty Ltd (Envirolab), accredited by NATA, was employed to conduct the primary sample analysis and ALS Environmental, accredited by NATA, was employed to conduct analysis of the inter-laboratory duplicate. The laboratories are required to carry out in-house QC procedures.

Groundwater levels were measured in the groundwater wells, however there was no contamination testing conducted from the wells.

9.4 Analytical Rationale

The analytical scheme was designed to obtain an indication of the potential presence and possible distribution of identified contaminants of concern based on information obtained for past and present activities and features within the site. The primary contaminants of concern as identified in Section 8 were metals, VOC, TPH, BTEX, PAH, OCP, OPP, PCB, phenols and asbestos.

10. Site Assessment Criteria

Analytical results from laboratory testing of soils are assessed against Site Assessment Criteria (SAC) primarily comprising (Tier 1) investigation levels, screening levels and management limits sourced from Schedule B1 of NEPC, 2013. This guideline has been endorsed by the NSW EPA under the Contaminated Land Management (CLM) Act 1997. Schedule B of NEPC (2013) provides investigation and screening levels for commonly encountered contaminants which are applicable to generic land uses and include consideration of, where relevant, the soil type and the depth of contamination. The investigation and screening levels are not intended to be used as clean up levels. They establish concentrations above which further appropriate investigation (e.g. Tier 2 or Tier 3) should be undertaken.

In addition to SAC sourced from NEPC (2013), screening levels (for direct contact) have been adopted from the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) *Technical Report no.10 Health screening levels for petroleum hydrocarbons in soil and groundwater* (2011). The following sub-sections outline the adopted SAC for soil as documented in NEPC (2013) and CRC CARE, 2011.

In general, based on the non-residential, university use proposed at the site, and the use of hardstand covering the majority of the site, it is considered that the land use scenario assumptions most consistent with the development are those of the commercial land use scenario.

10.1 Health Investigation Levels

Table 4 shows the health investigation levels (HIL) that have been adopted as SAC for assessing the human health risk from a contaminant via all relevant pathways of exposure. HIL D, for commercial/ industrial land use, has been adopted as discussed above.

The relevant HIL D Are provided in Table 4, below (note: the table does not contain the complete list of HIL provided in NEPC (2013)).

Table 4: Health Investigation Levels

Contaminant	HIL – D (mg/kg)
Metals	
Arsenic	3,000
Cadmium	900
Chromium (VI)	3,600
Copper	240,000
Lead	1,500
Mercury (inorganic)	730
Nickel	6,000
Zinc	400,000
PAH	
Carcinogenic PAH (as Benzo(a)pyrene TEQ)	40
Total PAH	4,000
OCP	
DDT+DDE+DDD	3,600
Aldrin + Dieldrin	45
Chlordane	530
Endosulfan	2,000
Endrin	100
Heptachlor	50
HCB	80
Methoxychlor	2,500
OPP	
Chlorpyrifos	2,000
PCB	7
Phenols	
Phenol	240,000
Pentachlorophenol	660
Cresols	25,000

10.2 Health Screening Levels for Vapour Intrusion

Table 5 shows the health screening levels (HSL) for petroleum hydrocarbon compounds adopted for the assessment and are based on the exposure to petroleum hydrocarbons through the dominant vapour inhalation exposure pathway only (i.e. not direct contact to soils). The HSL have been adopted from Column HSL D (for commercial/industrial sites). As sand has been identified at the site, the most conservative HSL for the three soil types have been listed in Table 5.

Table 5: Soil Health Screening Levels for Vapour Intrusion

Contaminant	HSL – D (mg/kg)
	Depth 0 m to <1 m
Naphthalene	NL
TPH C_6-C_{10} less BTEX	250
TPH >C_{10}-C_{16} less	NL
Benzene	3
Toluene	NL
Ethylbenzene	NL
Xylenes	230

Notes: NL is 'not limiting' (where the derived soil HSL exceeds the soil saturation concentration)

10.3 Health Screening Level for Direct Contact

Table 6 shows the HSL for direct contact for commercial and industrial sites (HSL D), sourced from CRC CARE (2011), which are mentioned but not presented in NEPC (2013).

Table 6: Soil Health Screening Levels for Direct Contact

Contaminant	HSL – D (mg/kg)
Naphthalene	11,000
TPH C_6-C_{10}	26,000
TPH >C_{10}-C_{16}	20,000
TPH >C_{16}-C_{34}	27,000
TPH >C_{34}-C_{40}	38,000
Benzene	430
Toluene	99,000
Ethylbenzene	27,000
Xylenes	81,000

10.4 Ecological Investigation Levels and Ecological Screening Levels

Ecological Investigation Levels (EIL) have been derived for selected metals and organic compounds and are applicable for assessing risk to terrestrial ecosystems (NEPC, 2013). EIL depend on specific soil physiochemical properties and land use scenarios and generally apply to the top 2 m of soil, which corresponds to the root zone and habitation zone of many species. The EIL is determined for a contaminant based on the sum of the ambient background concentration (ABC) and an added contaminant limit (ACL). The ABC of a contaminant is the soil concentration in a specific locality that is the sum of naturally occurring background levels and the contaminants levels that have been introduced from diffuse or non-point sources (e.g. motor vehicle emissions). The ACL is the added concentration (above the ABC) of a contaminant above which further appropriate investigation and evaluation of the impact on ecological values is required.

The EIL is calculated using the following formula:

EIL = ABC + ACL,

The ABC is determined through direct measurement at an appropriate reference site (preferred) or through the use of methods defined by Olszowy et al *Trace element concentrations in soils from rural and urban areas of Australia*, Contaminated Sites monograph no. 4, South Australian Health Commission, Adelaide, Australia 1995 (Olszowy, 1995) or Hamon et al, *Geochemical indices allow estimation of heavy metal background concentrations in soils*, Global Biogeochemical Cycles, vol. 18, GB1014, (Hamon, 2004). ACL is based on the soil characteristics of pH, CEC and clay content.

EIL (and ACLs where appropriate) have been derived in NEPC (2013) for only a short list of contaminants comprising arsenic, copper, chromium (III), DDT, naphthalene, nickel, lead and zinc. An *Interactive (Excel) Calculation Spreadsheet* may be used for calculating site-specific EIL for these contaminants, and has been provided in the ASC NEPM Toolbox available on the SCEW (Standing Council on Environment and Water) website (http://www.scew.gov.au/node/941).

The adopted EIL, derived from Tables 1B(1) to 1B(5), Schedule B1 of NEPC (2013) the *Interactive (Excel) Calculation Spreadsheet* are shown in Table 7. The following site specific data and assumptions have been used to determine the EILs:

- A protection level of 60% typical for commercial / industrial land use;
- The EILs apply to the top 2 m of the soil profile;
- Given the likely source of soil contaminants (i.e. historical site use/fill) the contamination is considered as "aged" (>2 years);
- ABCs have been derived using the *Interactive (Excel) Calculation Spreadsheet* using input parameters of NSW for the State in which the site is located, and high for traffic volumes.
- A pH of 8.5 has been used as an input value based on site specific data. This input value is the (rounded) average of the results (see laboratory certificate, Appendix F);
- A CEC of 15.47 cmol/kg has been used as an input value based on site specific data. This input value is the (rounded) average of the results; and
- In the absence of site specific data, a conservative clay content value of 10% and a conservative organic carbon content value of 1% have been used.

Table 7: Ecological Investigation Levels (EIL)

Analyte		EIL – D (mg/kg)
Metals	Arsenic	160
	Copper	320
	Nickel	320
	Chromium III	680
	Lead	1,800
	Zinc	1,000
PAH	Naphthalene	370
OCP	DDT	640

Ecological Screening Levels (ESL) are used to assess the risk of selected petroleum hydrocarbon compounds, BTEX and benzo(a)pyrene to terrestrial ecosystems. ESL apply to the top 2 m of the soil profile as for EIL.

ESL have been derived in NEPC (2013) for petroleum fractions F1 to F4 as well as BTEX and benzo(a)pyrene. The adopted ESL, from Table 1B(6), Schedule B1 of NEPC (2013) are shown in Table 8. ESL are for commercial and industrial land use with coarse grained soils as the soil types encountered were primarily fine grained (silts and clays).

Table 8: Ecological Screening Levels (ESL) in mg/kg

Analyte		ESL Commercial / Industrial	Comments
TRH	C6 – C10 (less BTEX) [F1]	215*	All ESLs are low reliability apart from those marked with * which are moderate reliability
	>C10-C16 [F2]	170*	
	>C16-C34 [F3]	1,700	
	>C34-C40 [F4]	3,300	
BTEX	Benzene	75	
	Toluene	135	
	Ethylbenzene	165	
	Xylenes	180	
PAH	Benzo(a)pyrene	1.4	

With respect to the ESL for benzo(a)pyrene [B(a)P], It is also noted that NEPC (2013) states:

- *A further review of Canadian soil quality guidelines was undertaken for BTEX and benzo(a)pyrene (Warne 2010b) and the Australian methodology applied to the ecotoxicological data as far as possible to derive equivalent ESLs. However, data limitations did not allow the full* *use of the EIL derivation methodology and the resulting values are adopted as low reliability ESLs* [Schedule B1]; and

- *In the Australian and NZ WQGs (ANZECC & ARMCANZ 2000), low reliability TVs were only used for interim guidance. A similar approach should be adopted regarding low reliability EILs—that such values should be considered to be a knowledge or data gap that requires further work to resolve* [Schedule B5b].

It is noted that work towards the development of a higher reliability threshold has been undertaken since the publication of the low reliability ESL for benzo(a)pyrene in NEPC (2013). CRC CARE Technical Report No. 39, *Risk-based management and remediation guidance for benzo(a)pyrene* (2017) [CRC CARE (2017)] includes a literature review of the source of the NEPC (2013) ESL and subsequent developments, as well as development of high reliability ESL for BaP. Specifically, CRC CARE (2017) notes:

- *The NEPM*[2] *provides ecological screening levels (ESLs) for B(a)P based on the* [then applicable] *Canadian soil quality guidelines (SQG);*
- *The* [then applicable] *Canadian guidelines for B(a)P stated that a limited toxicity data set was available including one invertebrate bioassay and two plant bioassays;*
- *The* [then applicable] *Canadian guideline was based on toxicity data generated from one data point that accounts for biomagnification;*
- *Because the ESLs in the NEPM are classified as low reliability, it is useful to consider whether there is additional and more recent information that allows higher reliability values to be estimated. Note that values derived in this way are intended to assist in informing an assessment of B(a)P following NEPM ecological risk assessment guidelines, but as they have not been developed through the NEPM review process, they should not be cited as NEPM ESLs;*
- For the ESL derived in CRC CARE (2017):
  - *The number of species … allows a more reliable ESL to be derived using the* [species sensitivity distribution] *SSD method – with chronic data of 13 species from five taxa reported;*
  - [the derived ESL are] *conservative higher reliability ecological guideline derived from the SSD for each land use for fresh B(a)P when compared to the NEPM low reliability guidelines. Given that the curve fit is good and that the database included only chronic data, the derived values can be considered to have high reliability;*
  - *The standard species protection for each use has been adjusted to take into account biomagnification following Heemsbergen et al. (2009);*
  - *The values ….. have been calculated from results of bioassays using fresh B(a)P and do not take into account the changing bioavailability that occurs with ageing or* [Total organic carbon] *TOC concentration in soils;*
  - *The guidelines derived above are of a similar order of magnitude to the revised Canadian guidelines (CCME 2010).*

[2] NEPC (2013)

Based on the above, the CRC CARE (2017) derived ecological guidelines have also been referenced herein to assist in assessing the significance of B(a)P exceedances. These derived ecological guidelines are as follows:

- Commercial and industrial (65% protection): 172 mg/kg.

10.5 Management Limits

In addition to appropriate consideration and application of the HSL there are additional considerations which reflect the nature and properties of petroleum hydrocarbons, including:

- Formation of observable light non-aqueous phase liquids (LNAPL);
- Fire and explosion hazards; and
- Effects on buried infrastructure e.g. penetration of, or damage to, in-ground services.

Management limits to avoid or minimise these potential effects have been adopted in NEPC (2013) as interim Tier 1 guidance. The adopted management limits, from Table 1B(7), Schedule B1 of NEPC (2013) are shown in Table 9. Management Limits are available for 'fine' and 'coarse' soil textures, with the 'coarse' texture Management Limits being the same or lower than the 'fine' texture limits. Given that various soil types were encountered, the more conservative management limits (for 'coarse' soil textures) have been adopted as a preliminary screen.

Table 9: Management Limits

Contaminant	Management Limit - Commercial and Industrial (mg/kg) (coarse soil texture)
TPH $C_6 – C_{10}$	700
TPH $>C_{10}$-C_{16}	1,000
TPH $>C_{16}$-C_{34}	3,500
TPH $>C_{34}$-C_{40}	10,000

10.6 Asbestos is Soil

Bonded asbestos-containing material (ACM) is the most common form of asbestos contamination across Australia, generally arising from:

- Inadequate removal and disposal practices during demolition of buildings containing asbestos products;
- Widespread dumping of asbestos products and asbestos containing fill on vacant land and development sites; and
- Commonly occurring in historical fill containing unsorted demolition materials.

Mining, manufacturing or distribution of asbestos products may result in sites being contaminated by friable asbestos including free fibres. Severe weathering or damage to bonded ACM may also result in the formation of friable asbestos comprising fibrous asbestos (FA) and/or asbestos fines (AF).

Asbestos only poses a risk to human health when asbestos fibres are made airborne and inhaled. If asbestos is bound in a matrix such as cement or resin, it is not readily made airborne except through substantial physical damage. Bonded ACM in sound condition represents a low human health risk, whilst both FA and AF materials have the potential to generate, or be associated with, free asbestos fibres. Consequently, FA and AF must be carefully managed to prevent the release of asbestos fibres into the air.

For 40 gram asbestos samples the presence or absence of asbestos at a limit of reporting of 0.1 g/kg as well as a visual assessment for the presence or absence of ACM has been adopted as the SAC.

NEPC (2013) defines the various asbestos types referred to above as follows:

Bonded ACM: Asbestos containing material which is in sound condition, bound in a matrix of cement or resin, and cannot pass a 7 mm x 7 mm sieve;

FA: Fibrous asbestos material including severely weathered cement sheet, insulation products and woven asbestos material. This material is typically unbonded or was previously bonded and is now significantly degraded and crumbling; and

AF: Asbestos fines including free fibres, small fibre bundles and also small fragments of bonded ACM that pass through a 7 mm x 7 mm sieve.

For 500 gram bag samples the adopted SAC for AF / FA will be 0.001% w/w and for ACM 0.05 % w/w (applicable to any fill soils retained on site) will be adopted consistent with the commercial/ industrial D threshold.

10.7 Waste Classification

The preliminary waste classification of the fill material was undertaken in accordance the NSW EPA Waste Classification Guidelines (2014).

The assessment of the natural soils was undertaken with reference to the Protection of the Environment Operations (POEO) Act which defines virgin excavated natural material (VENM) as:

'natural material (such as clay, gravel, sand, soil or rock fines):

(a) that has been excavated or quarried from areas that are not contaminated with manufactured chemicals, or with process residues, as a result of industrial, commercial, mining or agricultural activities and

(b) that does not contain any sulfidic ores or soils or any other waste

As a means of assessing the presence of manufactured chemicals or process residues, the analytical data for samples of natural soils were compared against published background concentrations, as shown in Table F3.

11. Field Work Observations

Details of the subsurface conditions encountered in each borehole are provided in the bore logs in Appendix E, together with notes defining classification methods and descriptive terms.

The borehole logs and interpretation of corresponding geotechnical testing results indicates that the site is underlain by filling over natural deposits of sediment. The sub-surface conditions encountered generally were:

Pavement	A asphaltic concrete pavement was present at the surface in BH5 to 0.05 m bgl
Filling	Fill was encountered in all test bores. The fill was typically present to a depth of between 0.5 to 0.7 m bgl. BH3 & BH3A (drilled with hand tools) encountered refusal at 0.2 m bgl and 0.5 m bgl respectively on sandstone boulders. The depth of fill in BH 2 was greater than 3 m (the maximum depth reached in the test bore). Fill was typically described as brown and grey fine to medium grained sand and sandy gravel. The following anthropogenic inclusions were noted in the fill – Terracotta and tile fragments in BH1 at 0.5 m bgl; – A buried asphaltic concrete layer in BH2 at 0.3 m bgl and concrete and steel wire in BH2 at 0.3-0.6 m bgl – Slag in BH4 at 0.3 m bgl
Sand	Sand was encountered in BH1, BH4, BH5 and BH6. The sand was typically described as loose, (becoming dense at depth) yellow mottled grey and brown fine to medium grained sand with a trace of sandstone gravel. The depth of the base of the sand unit generally increases to the west from 5.4 m bgl in BH5 to 10.7 m bgl in BH4. A thin layer of sandy clay was observed in BH4 at a depth of 8.0 m bgl.
Sandstone	Test bores BH4, BH5 and BH5 were extended to and into bedrock using NMLC rock coring techniques. Sandstone was encountered at a depth of 10.7 m bgl, 5.4 m bgl and 5.83 m bgl in BH4, BH5 and BH6 respectively. Sandstone was described as yellow brown, light grey orange and red very low strength, fractured, medium to coarse sandstone, becoming medium strength and then high strength at increasing depth.

No signs of significant contamination such as significant building rubble or chemical odours were noted. Photo-ionisation detector (PID) screening results were all below 1 ppm indicating a low potential for volatile contaminants.

Groundwater monitoring wells were installed in two locations. Groundwater ranged in depth 5.9 m to 7.4 m bgl two weeks after the installation of the wells. The observed direction of groundwater flow was to the west. Groundwater levels may be transient and can be affected by climate and other factors.

12. Results Summary

The results of the laboratory analysis undertaken are presented in the following tables attached in Appendix F:

Table F1: Summary of Laboratory Results for Soil Analysis;

Table F2: Summary of Laboratory Results for Analysis of Asbestos in Soil; and

Table F3: Summary of Laboratory Results for Waste Classification

The NATA laboratory certificates of analysis together with the chain of custody and sample receipt information are included in Appendix F.

13. Analysis and Discussion of Results

13.1 Suitability for Proposed Development

The site history indicates that the site formed part of the site the Kensington Racecourse until circa 1952 before being redeveloped for the University of New South Wales.

Several structures were demolished following the transfer to the site to the university. Over the course of the past 70 years the University has undergone a number of expansions and redevelopments. Within the subject area the Phillip Baxter College (now University Hall) was opened in 1966 and is still onsite in largely its original form.

The risk of contamination at the site was generally considered to be low to moderate with the primary potential source of contamination that was identified being imported fill and demolition waste from previous site buildings / structures.

Soil samples were analysed for the identified contaminants of concern identified in the conceptual site model, being heavy metals, asbestos, TRH, BTEX, VOC, OCP, OPP, PCBs and phenols.

The results of soil analysis were all were within human health and ecological based investigation levels adopted for the investigation with the following exception:

- Benzo(a)pyrene [B(a)P] recorded above the ESL of 1.4 mg/kg in sample 6/0.5 (at 2.5 mg/kg).

Statistical analysis of the B(a)P results in filling was undertaken in accordance with NEPC (2013). Calculation of the 95% Upper Confidence Limit (UCL) average for B(a)P for filling samples was conducted using the US EPA ProUCL programme, with results included in Appendix F. The highest result of the primary or replicate (where available) sample was used for each location. The calculated UCL using the recommended 95% KM (t) UCL method was 1.1 mg/kg. The standard deviation of the values recorded at or above the PQL was 0.915 mg/kg. As such, whilst the 95% UCL is below the ESL and the maximum value is less than 250% of the ESL, the standard deviation is greater than 50% of the ESL indicating that the statistical results cannot be used to characterise the dataset in accordance with NEPC (2013). Additional sampling and analysis may allow better characterisation of the B(a)P concentrations at the site in accordance with NEPC (2013) requirements.

Review of the results in accordance with the reference levels in CRC CARE (2017) (refer to Section 10.4) indicates that the concentrations of B(a)P recorded at the site are significantly less than ecological threshold of 172 mg/kg derived from a larger, more robust, dataset than the NEPC (2013) low reliability ESL.

It is also noted that the ESL and CRC CARE (2017) thresholds are both based on “fresh” contamination assuming a 100% bioavailability and does not take into account lower bioavailability which may be associated with contaminant ‘aging’, soil properties or form/ source (e.g. presence in slag). Given that the filling in which the B(a)P was recorded is expected to have been present at the site for approximately 50 years, it reasonable to assume that some reduction in the bioavailability of the B(a)P has occurred due to the aging of the contaminant, with the more bioavailable B(a)P having been subject to biological transformation.

It is also noted that trees observed at and adjacent to the site during the field work appeared to be generally healthy.

Overall, the recorded B(a)P concentrations are not considered to significantly impact the suitability of the site for the proposed development due to:

- The concentrations being well within the CRC CARE (2017) high reliability reference levels;
- The expected bioavailability being less than 100%;
- No signs of distress being observed in current trees at or near the site;
- The minimal proposed landscaping at the site;
- The proposed landscaping comprising trees, whose root systems are expected to extend below the filling, reducing the percentage intake of water and nutrients from the filling; and
- Terrestrial organisms currently present in the soil at the site are expected to be adapted to the current soil conditions, and the disturbance or removal and replacement of the current soils would likely have a greater negative impact on the terrestrial ecology than the retention of the current soils.

As with all new plantings it is recommended that the species to be planted are chosen with reference to the suitability of the site conditions, including soil chemistry.

No asbestos was observed during drilling or detected in laboratory analysis. No building rubble was noted in the test bore logs. It is noted however that no test bores were drilled within the building footprints and no test pits were included in the current investigation. Therefore asbestos risk cannot be ruled out. It is noted that asbestos containing materials were identified in the building materials (Noel Arnold 2014). Appropriate management strategies should be adopted during demolition to limit or prevent the spread of hazardous materials.

13.2 Preliminary Waste Classification

EPA (2014) contains a six step procedure for determining the type of waste and the waste classification. Part of the procedure, for materials not classified as special waste or pre-classified waste, is a comparison of analytical data initially against contaminant threshold (CT) values specific to a waste category. Alternatively, the data can be assessed against specific contaminant concentration

(SCC) thresholds when used in conjunction with toxicity characteristic leaching procedure (TCLP) thresholds.

The guidelines relevant to this waste classification are shown in the attached Table F3.

Table 10: Six Step Classification Procedure

Step	Comments	Rationale
1. Is the waste special waste?	No	No asbestos-containing materials (ACM), clinical or related waste, or waste tyres were observed in the test bores. Asbestos was not detected by the analytical laboratory.
2. Is the waste liquid waste?	No	The fill comprised a soil matrix.
3. Is the waste “pre-classified”?	No	The fill material not pre-classified with reference to EPA (2014).
4. Does the waste possess hazardous waste characteristics?	No	The waste was not observed to contain or considered at risk to contain explosives, gases, flammable solids, oxidising agents, organic peroxides, toxic substances, corrosive substances, coal tar, batteries, lead paint or dangerous goods containers.
5. Determining a wastes classification using chemical assessment	Conducted	Refer to Table F3.
6. Is the waste putrescible?	No	The fill does not contain materials considered to be putrescible [a].

Note: a wastes that are generally not classified as putrescible include soils, timber, garden trimmings, agricultural, forest and crop materials, and natural fibrous organic and vegetative materials (EPA, 2014).

As shown on the Table F3, the majority of contaminant concentrations for the analysed fill samples were within the contaminant thresholds (CT1s) for General Solid Waste (GSW). TCLP tests were conducted for the analytes exceeding the CT1 thresholds on representative “worst case” samples. The SCC and TCLP concentrations for those samples were within the contaminant thresholds SCC1 and TCLP1, for GSW. No asbestos was detected in the fill.

Based on the observations at the time of sampling and the reported analytical results, the fill (including surface soils) described in Section 11 within the current investigation area, is preliminarily classified as General Solid Waste (non-putrescible), as defined in EPA (2014).

It is recommended that that the further waste classification assessment be undertaken following excavation of fill (where required) and prior to loading out to confirm the provisional classifications above.

The following Table 11 presents the results of the assessment of natural soils and bedrock at the site with reference to the VENM definition and EPA.

Table 11: VENM Classification Procedure

Item	Comments	Rationale
1. Is the material natural?	Yes	Natural materials logged as grey and yellow sand These materials underlie the fill at the site.
2. Is the material impacted by manufactured chemicals or process residues?	No	There were no visual indicators of chemical contamination of the materials in the test pits. Contaminant concentrations were within typical background levels (Table 4).
3. Are the materials acid sulphate soils?	No	A review of the Acid Sulfate Soil Risk Map shows the site in an area of no ASS occurrence.
4. Are there current or previous land uses that have (or may have) contaminated the materials?	No	Previous land uses may have impacted on surface soils overlying the materials. Low chemical concentrations indicate no likely impact on the natural materials.

As shown in the attached Table F3, all contaminant concentrations for the analysed natural soil samples were within the typical background concentrations. Based on the outcomes presented in Table 11, the natural sands and sandstone bedrock (refer to Section 11 and the test bore logs (Appendix E) within the area subject to classification as shown on Drawing 1, are preliminarily classified as **VENM**. If during excavation the natural *in situ* soil is found to contain possible signs of contamination or is cross-contaminated with any non-VENM materials the excavated natural soil cannot be classified as VENM. In this regard, it is also recommended that care should be taken during the bulk excavation of the VENM to prevent cross contamination between the VENM and non-VENM materials.

The materials classified as VENM are pre-classified as General Solid Waste (non-putrescible) under EPA (2014). Furthermore, VENM may be applied to land in an off-site location without the requirement of a licence under the POEO Act.

14. Conclusion and Recommendations

Based on the results of the investigation it is considered that the risk of contamination at the site is low and that the site is suitable for the proposed development from a contamination standpoint.

As per the recommendations of the DP (2018) REF report, it is recommended that an unexpected finds protocol be prepared prior to the commencement of REF works, and should be updated (if required) based on any findings during REF works. The updated unexpected finds protocol would be applicable for the SSD works.

The DP (2018) REF report also recommends that following demolition of the existing structures, further (data gap) investigation be undertaken within the footprint of those structures to fully characterise the site. Furthermore, validation of the removal of any hazardous building materials encountered during demolition is recommended in the DP (2018) REF report. These works are to be completed prior to the commencement of SSD works.

Additionally, any recommendations that arise from the data gap assessment / validation works (such as the removal of contaminated soils / asbestos if encountered by the data gap investigation) must also be undertaken prior to and/or during the SSD works as documented in the data gap assessment / validation report. Therefore it is recommended that a contingency remediation action plan (RAP) be prepared to facilitate these potential remedial works. The contingency RAP should outline the proposed scope of the data gap assessment, the remedial and validation process for the most likely remediation works (if required) and the unexpected finds protocol recommended previously.

15. Limitations

Douglas Partners (DP) has prepared this report for University of New South Wales, High Street, Kensington in accordance with DP's proposal dated 18 June 2018, and acceptance from the University of New South Wales. This report is provided for the exclusive use of The University of New South Wales (the development and applicant) and Lendlease (Design and Construct Partner) for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so 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. 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.

Although the sampling plan adopted for this investigation is considered appropriate to achieve the stated project objectives, there are necessarily parts of the site that have not been sampled and analysed. This is either due to undetected variations in ground conditions or to access constraints (as discussed above), or to parts of the site being inaccessible and not available for sampling, or to vegetation preventing visual inspection and reasonable access. It is therefore considered possible that HBM, including asbestos, may be present in unobserved or untested parts of the site, between and beyond sampling locations, and hence no warranty can be given that asbestos is not present.

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 environmental 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

Introduction

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

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

Copyright

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

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

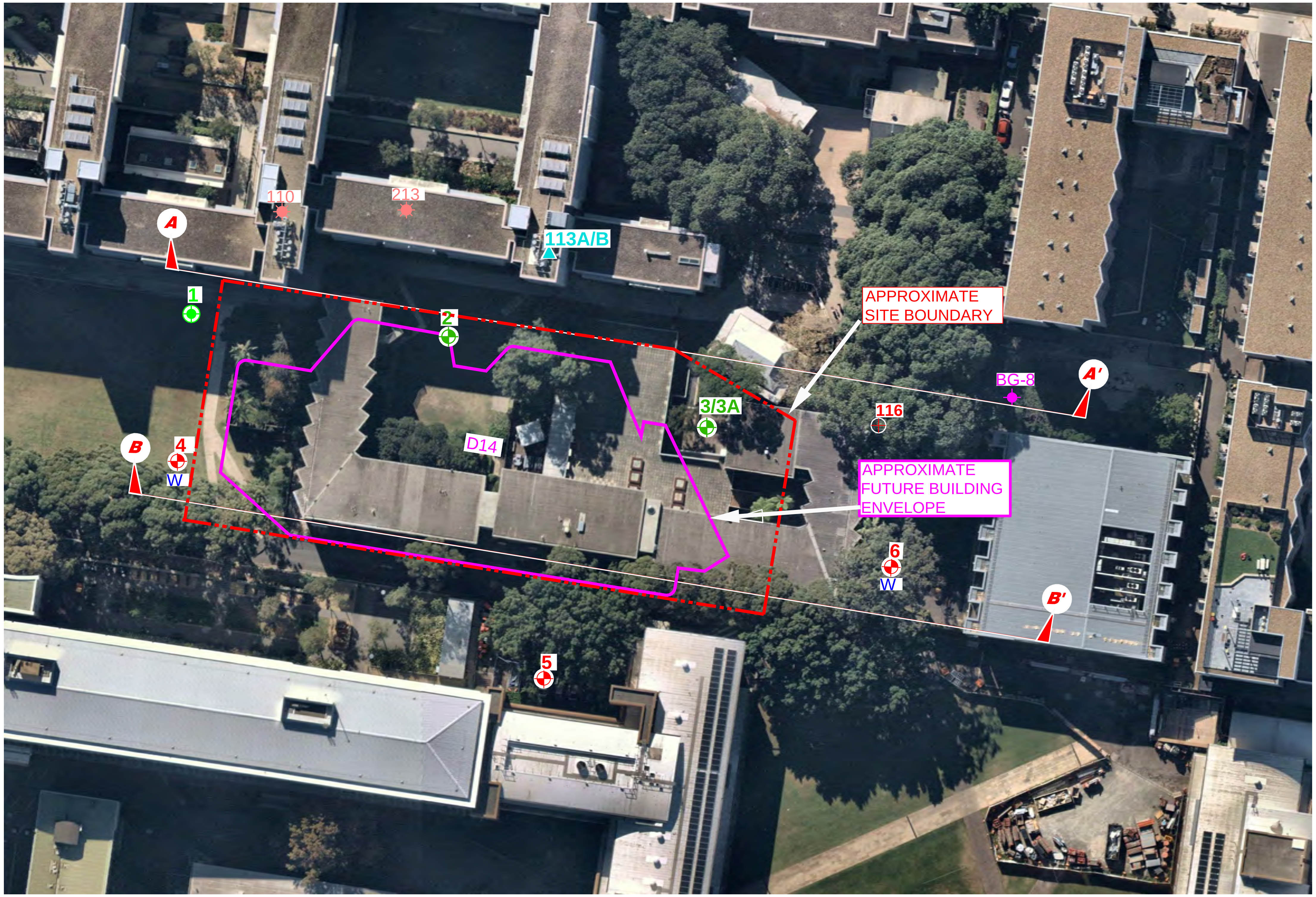
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate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

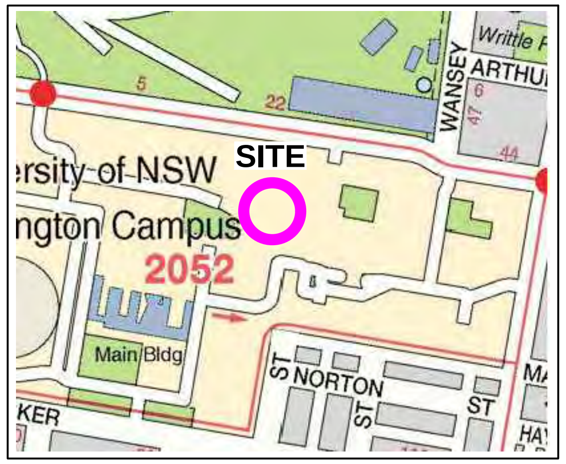
Site Inspection

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

Appendix B

Drawings





Locality Plan

LEGEND

PREVIOUS INVESTIGATION

- Borehole (Coffey)
- Borehole (DP Proj. 44301)
- CPT (DP Proj. 44301)
- Borehole and CPT (DP Proj. 44301)

CURRENT INVESTIGATION

- CPTu & contamination borehole
- Contamination borehole
- W CPTu, cored borehole and well
- CPTu and cored borehole
- A — A' Geotechnical Cross Section A-A'

NOTE:

1: Base image from Nearmap.com (Dated 5.5.2018)

2: Test locations are approximate only and are shown with reference to existing features.

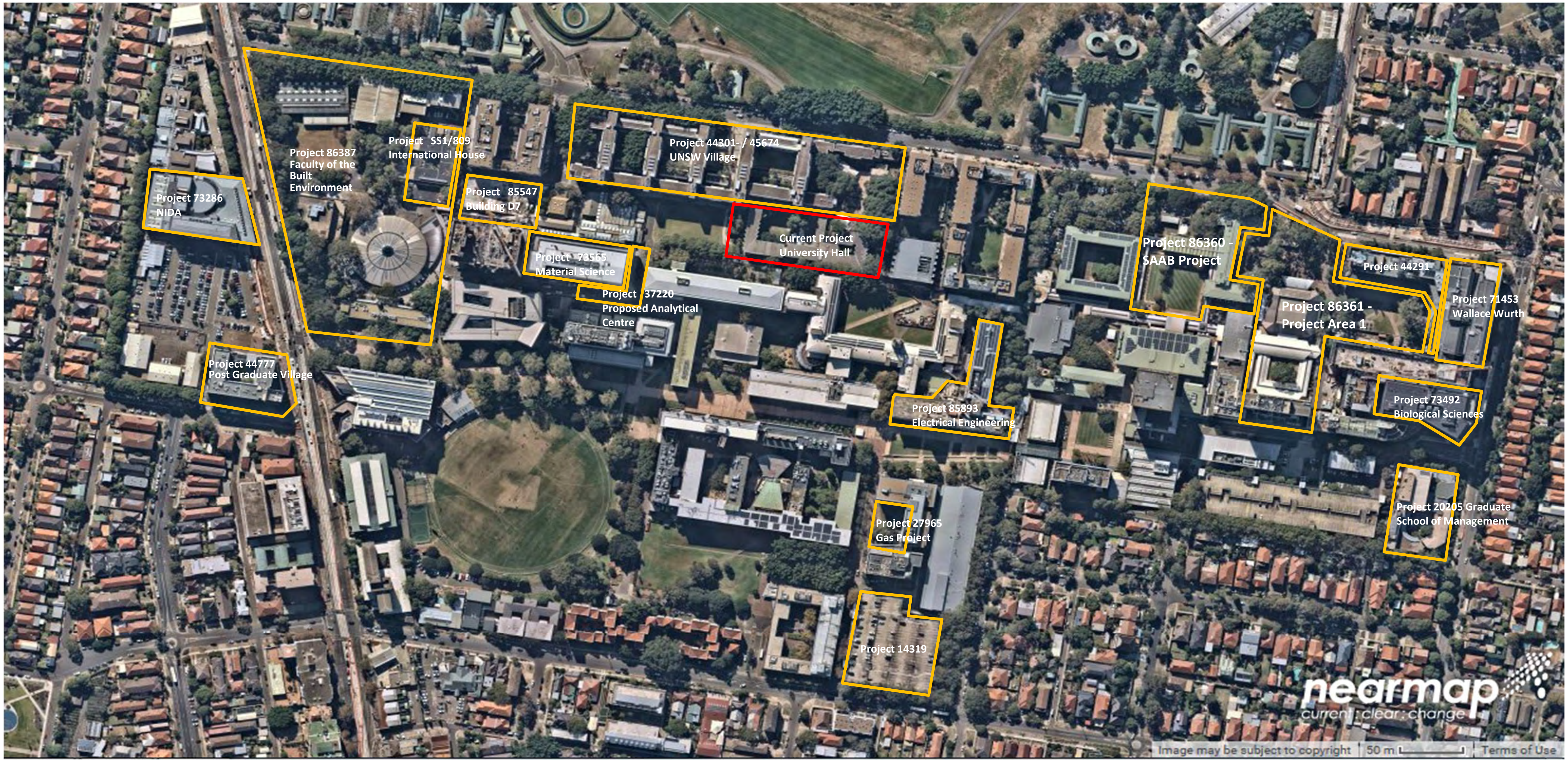
0 5 10 15 20 30 40 60 80m

1:800 @ A3

Douglas Partners

Geotechnics / Environment / Groundwater

CLIENT: University of New South Wales		TITLE: **Test Location Plan**	PROJECT No: 86457.00
OFFICE: Sydney	DRAWN BY: PSCH	**Proposed UNSW D14 Building**	DRAWING No: 1
SCALE: 1:800 @ A3	DATE: 2.11.2018	**High Street, KENSINGTON**	REVISION: 1



Douglas Partners Geotechnics / Environment / Groundwater	CLIENT:	Univerisity of New South Wales		TITLE:	**Major DP Projects at UNSW**	PROJECT No: 86457.01
	OFFICE:	Sydney	DRAWN BY: KDP		**University Hall Site**	DRAWING No: 2
	SCALE:	As shown	DATE: 17.07.2018		**Preliminary Contamination Investigation**	REVISION: A

UNSW D14
PLANNING APPLICATION

DRAWING LIST

Drawing Number	Drawing Title
ADDA00000	Cover Sheet
ADDA00001	Site Plan
ADDA00002	Precinct Plan
ADDA20M00	Upper Ground Plant
ADDA20000	Ground Plan
ADDA20100	Level 1 Plan
ADDA20200	Level 2 Plan
ADDA20300	Level 3-6 Plan
ADDA20700	Level 7 Plan
ADDA20800	Plant Plan
ADDA29000	Roof Plan
ADDA30000	GFA Randwick Schedule
ADDA30010	NLA Schedule
ADDA41000	Elevation South
ADDA42000	Elevation West
ADDA43000	Elevation North
ADDA44000	Elevation East
ADDA51000	Section E-W
ADDA52000	Section N-S
ADDA90000	Materials & Finishes Schedule
ADDA99000	Shadow Diagram Winter
ADDA99010	Shadow Diagram Winter
ADDA99020	Shadow Diagram Winter
ADDA99030	Shadow Diagram Winter

DRAFT 24-10-2018

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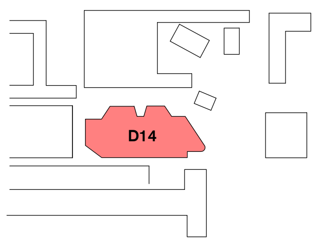
Jonathan Evans 6613
Mladen Prnjatovic 7468
Ben Green 7066
Chi Melhem 7754

Rev	Date	For
01	24.10.18	Draft SSDA

Legend

Key Plan



Owner and Applicant UNSW SYDNEY

D&C Partner lendlease

Architect Tzannes

Scale @ A3

North

Project UNSW D14

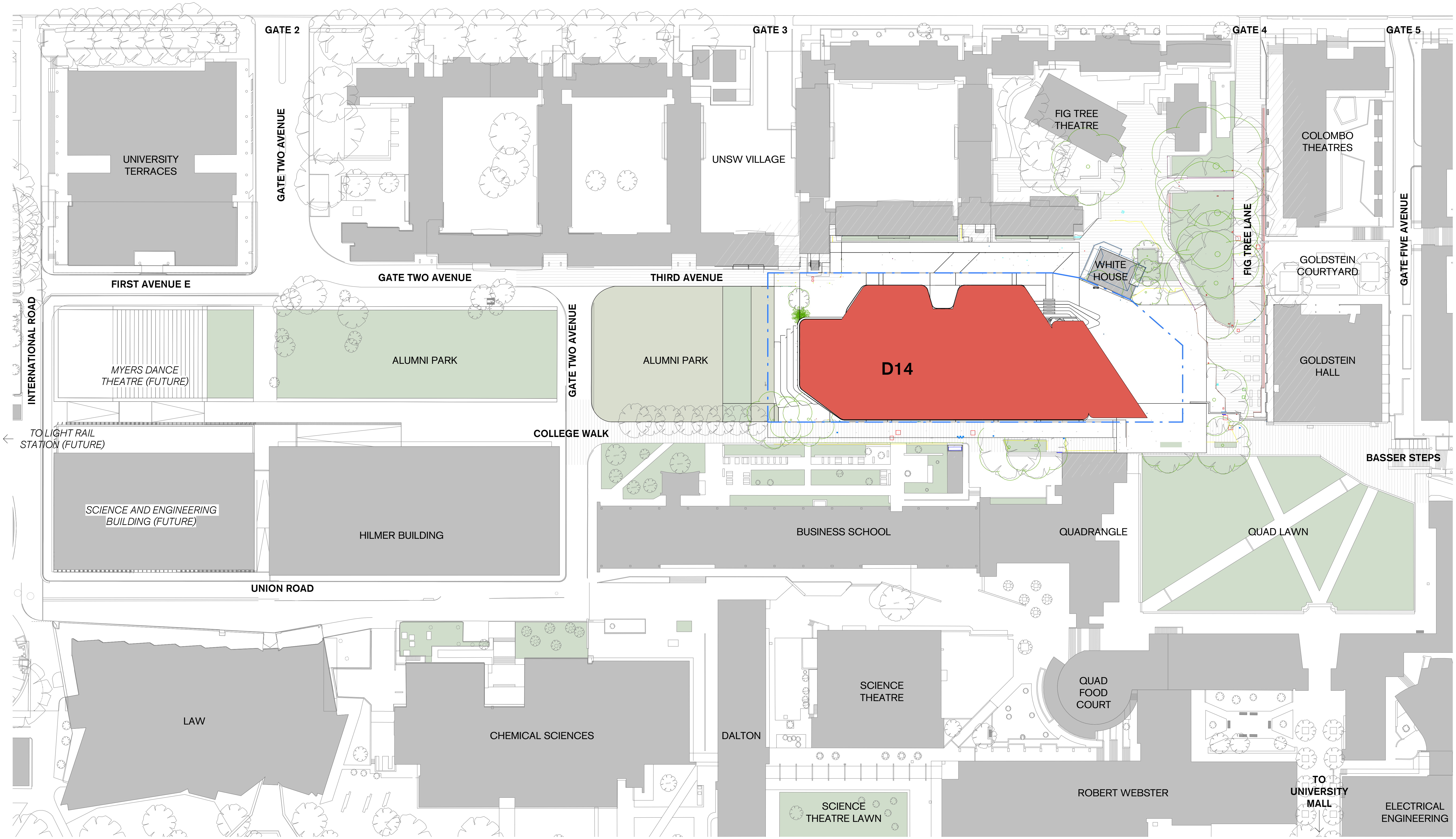
Address UNSW Kensington Campus

Status PLANNING APPLICATION

Drawing Cover Sheet

Date 24.10.18

Project No. 18026 **Drawing No.** ADDA00000 **Revision** 01



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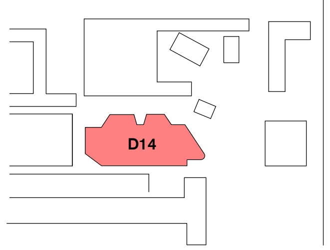
Chi Melhem 7754

Rev	Date	For
01	24.10.18	Draft SSDA

Legend
Scope Boundary

Key Plan



Owner and Applicant
UNSW SYDNEY

D&C Partner
Lendlease

Architect
Tzannes

Scale
As indicated @ A3
0 10 20 30 m

North

Project
UNSW D14

Address
UNSW Kensington Campus

Status
PLANNING APPLICATION

Drawing
Site Plan

Date
24.10.18

Project No.	Drawing No.	Revision
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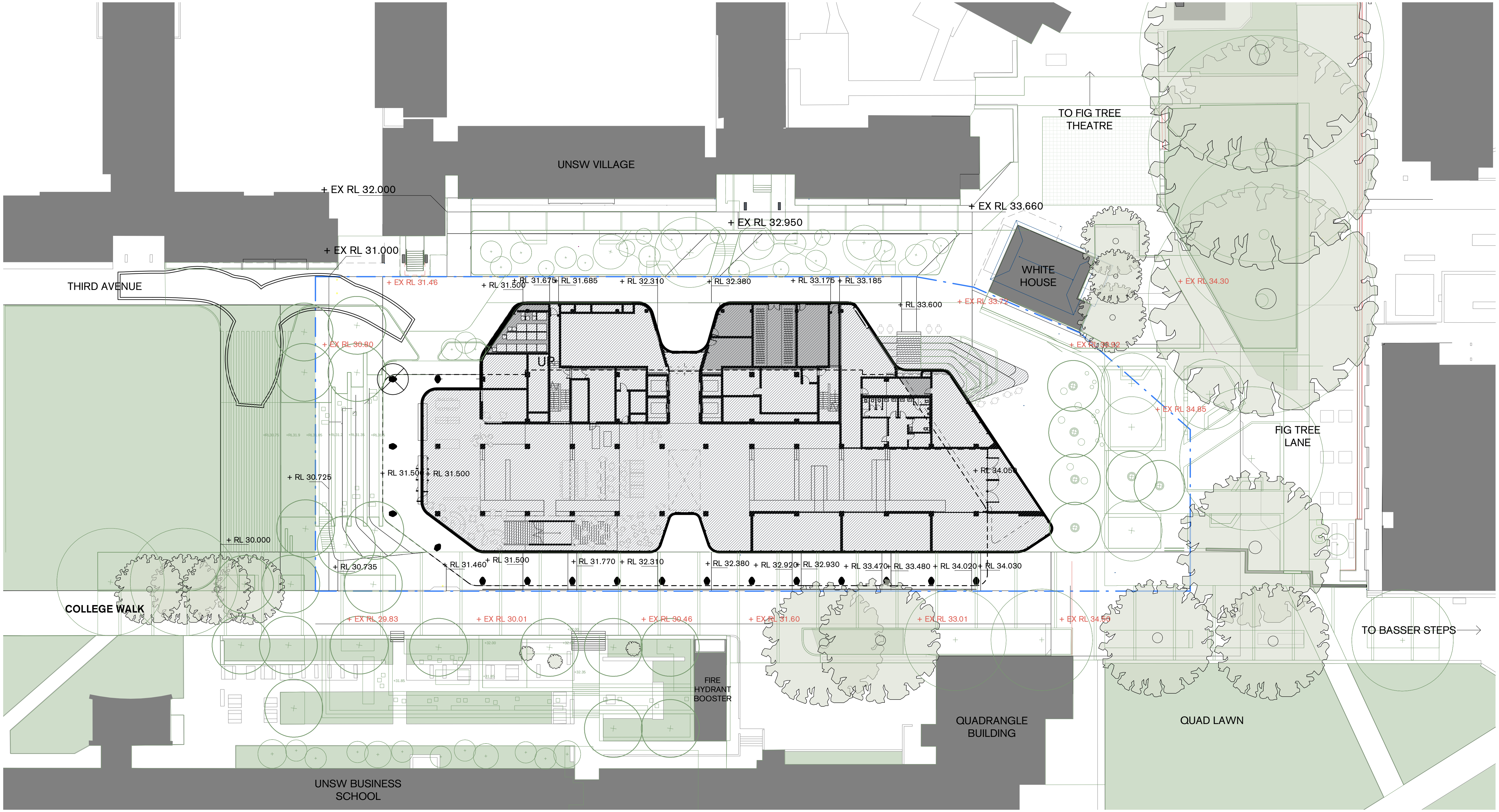

DRAFT 24-10-2018

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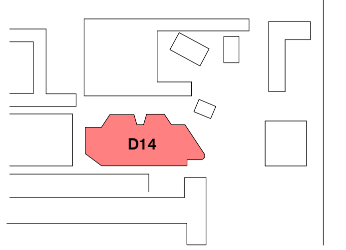
Rev	Date	For
01	24.10.18	Draft SSDA

Legend

Key Plan



Owner and Applicant

UNSW SYDNEY

D&C Partner

lendlease

Architect

Tzannes

Scale

1 : 500 @ A3

0 5 10 15 m

North

Project
UNSW D14

Address
UNSW Kensington Campus

Status
PLANNING APPLICATION

Drawing
Precinct Plan

Date
24.10.18

Project No.	Drawing No.	Revision
18026	ADDA00002	01

DRAFT 24-10-2018

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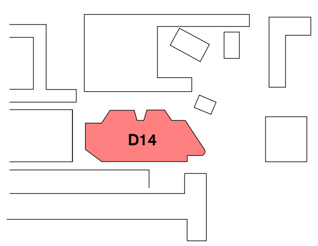
Rev	Date	For
01	24.10.18	Draft SSDA

Legend

Scope Boundary

Key Plan



Owner and Applicant

UNSW SYDNEY

D&C Partner

lendlease

Architect

Tzannes

Scale

1 : 250 @ A3

0 2.5 5 7.5 m

North

Project

UNSW D14

Address

UNSW Kensington Campus

Status

PLANNING APPLICATION

Drawing

Upper Ground Plant

Date

24.10.18

Project No.	Drawing No.	Revision
18026	ADDA20M00	01

DRAFT 24-10-2018

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Rev	Date	For
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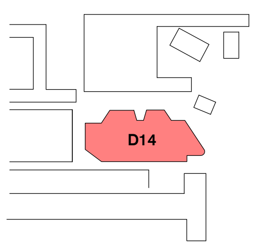
Key Plan



Owner and Applicant

UNSW SYDNEY

D&C Partner

lendlease

Architect

Tzannes

Scale

1 : 250 @ A3

0 2.5 5 7.5 m

North

Project

UNSW D14

Address

UNSW Kensington Campus

Status

PLANNING APPLICATION

Drawing

Ground Plan

Date

24.10.18

Project No.	Drawing No.	Revision
18026	ADDA20000	01