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REPORT
on
REMEDIAL ACTION PLAN

UTS BLACKFRIARS CAMPUS
CHIPPENDALE

Prepared for
University of Technology, Sydney

Project 45996.04 Rev 2
September 2014

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Project 45996.02 Rev 2
January 2015

Douglas Partners Pty Ltd
ABN 75 053 980 117

96 Hermitage Road
West Ryde NSW 2114
Australia

PO Box 472
West Ryde NSW 1685

Phone (02) 9809 0666
Fax (02) 9809 4095
sydney@douglaspartners.com.au

Glossary of Terms

AC	Asbestos cement
ANZECC	Australian and New Zealand Environmental & Conservation Council
AST	Above ground storage tank
B(a)P	Benzo(a)Pyrene (a Polycyclic Aromatic Hydrocarbon compound)
bgl	below ground level
BTEX	Benzene, Toluene, Ethyl Benzene, Xylene
C_6–C_9	Light hydrocarbon chain groups
C_{10}–C_{14}	Medium hydrocarbon chain groups
C_{15}–C_{28}	Heavy hydrocarbon chain groups
C_{29}–C_{36}	Heavy hydrocarbon chain
DEC	Department of Environment and Conservation (NSW)
DP	Douglas Partners Pty Ltd
EPA	Environmental Protection Authority
ha	Hectares
mg/kg	Milligrams per kilogram
mg/L	Milligrams per litre
NATA	National Association of Testing Authorities
NSW	New South Wales
ND(nd)	Not detected above the PQL
OCP	Organochlorine Pesticides
OPP	Organophosphate Pesticides
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PID	Photoionisation detector
ppm	Parts per million
PQL	Practical Quantitation Limit
%RPD	Relative percentage difference
TRH	Total Recoverable Hydrocarbons
TOPIC	Total Photoionisable Compounds
µg/L	Microgram per litre (or parts per billion)
UCL	Upper confidence limit of data set
UST	Underground storage tank
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

This Remediation Action Plan (RAP) outlines the methods and procedures that will be used to remediate the UTS Blackfriars Campus, located at Chippendale, to a condition suitable for the proposed land use, being childcare (part) and education facilities. The existing heritage buildings will be retained and refurbished, whilst several new buildings will also be constructed.

The subject site covers an irregularly shaped area of approximately 1,600 square metres, and is occupied by several heritage buildings (offices and residential), a childcare centre, timber hall, car parking and landscaping. Environmental assessment reports prepared by Coffey for the subject site in 1993/1994 identified past site uses including distillery, industrial (nature unknown) and school.

A review of the analytical results of the previous investigations conducted at the site by both Douglas Partners Pty Ltd (DP) in 2009 and Coffey International (Coffey) between 1993 and 1998 indicated that the majority of contaminants were at concentrations within the adopted site assessment criteria but that certain heavy metals, TPH and PAH contaminants were, present at a number of locations at concentrations which would be deemed as hotspots. The detected contaminants are generally considered to be associated with the presence of ash and slag, which is sporadically distributed in the filling material located on the site.

No groundwater contamination issues have been identified.

The objective of the remedial works to be undertaken is to provide a practical strategy which mitigates the potential for environmental and human health impacts posed by the presence of contaminated soil. The objective has been deemed to be achieved when a Validation Report has been completed which shows that the site has been capped in accordance with the requirements of the RAP.

The preferred remedial option is the isolation of the contaminated soil by covering with a properly designed physical barrier system**.** This involves the installation of an engineered physical barrier system to limit the exposure of site users and/or off-site receptors to

contaminants which attains an optimal balance of risk reduction, environmental integrity, cost and long term manageability.

Physical barrier designs have been developed for the various areas of the proposed development including building slabs, paving, landscaping, retained trees and new tree plantings. No specific barrier system is intended for the existing heritage buildings which are being retained.

All physical barrier types will be underlain with a marker layer (geogrid, geotextile or similar) laid on the final surface of the contaminated fill material. Given the nature of the proposed development (a child care centre) the general minimum constructional requirements for a suitable physical barrier system is considered to be a permanent, engineered total thickness of 500 mm overlying the marker layer. The concrete slab (of lesser thickness) is considered an adequate barrier at proposed building locations.

The remediation of the site will be monitored by an experienced, qualified environmental consultant to ensure that the site has been remediated to the standard set out in, and in compliance with, the RAP. At the completion of the project the consultant will prepare a Validation Report. The report shall state that the works were carried out in accordance with the RAP and has been made suitable for its industrial use. It will contain a documentary record of the works.

The final validation report will also include an Environmental Management Plan (EMP) which will be used as an instrument to manage the integrity of the physical barrier system and protect workers who may become exposed to the contaminated materials in the future.

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UTS BLACKFRIARS CAMPUS, CHIPPENDALE

1. INTRODUCTION

1.1 General

Douglas Partners Pty Ltd (DP) has been commissioned by Mr Mario Hadjia of Hutchinson Builders Pty Ltd to prepare a Remedial Action Plan (RAP) for the above site in 2009. The University of Technology Sydney (UTS) subsequently commissioned a revision of the RAP in September 2014 to incorporate any changes to the contaminated land assessment guidelines and development proposals. This report presents the revision of the RAP.

The subject site forms part of the UTS and is known as the "UTS Blackfriars Campus". The proposed development of the site includes a relocated childcare centre and paved and grassed landscaping features. The existing heritage buildings will be retained and refurbished, whilst several new buildings will also be constructed. Further details are provided in Section 3.2 of this RAP.

The objective of the RAP is to outline the methods and procedures necessary to remediate the subject site to a level suitable for the proposed land use. This RAP details the methods and procedures by which the remediation and site validation will be achieved. It is intended that, following implementation of the RAP, the site can be considered:-

- appropriately remediated to a condition which would prevent unacceptable risks to human health and/or the environment; and
- suitable for the intended land-use.

It should be noted that this RAP does not form a detailed specification for the proposed site remediation works, but rather represents a planning document which outlines the means by which site remediation can render the site suitable for the intended land-use.

1.2 Previous Reports

The RAP has been developed based on the results of the following investigations conducted by DP and Coffey Partners International (Coffey):-

- Coffey *"UTS Blackfriars Site – Investigations"*, 2nd September, 1993;
- Coffey "*Environmental Site Assessment UTS Blackfriars Development Chippendale"*, September 1994;
- Coffey *"Health and Safety Plan* (draft)", August 1998;
- Coffey *"Environmental Management Plan* (draft)", August 1998;
- Coffey *"Site Management Plan"*, August 1998; and
- DP "*Phase 2 Contamination Assessment, UTS Blackfriars Campus, Chippendale*" March 2009 (ref: 45996.01).

The analytical results of the contamination assessments conducted at the site by Coffey and DP indicated that the concentrations of contaminants were generally below the adopted site assessment criteria (SAC) although in various locations, sporadically distributed, concentrations of certain heavy metals (primarily lead), PAH and TPH were at levels which are either designated as hotspots or indicate a potentially random spread of similar contaminants.

The detected contaminants are considered to be associated with the fill materials placed over the site, and the presence of ash and slag materials within. As stated above, the spread of contaminants was considered sporadic.

2. METHODS AND OBJECTIVES OF THE RAP

The objective of the RAP is to provide a mechanism by which the site can be remediated in an acceptable manner, with minimal environmental impact, and to a condition suitable for the proposed land-use. The main objective of this RAP is therefore to provide a strategy for site remediation which:-

- Minimises impacts from the site on the environment and on public health and safety during site demolition, remediation and construction;
- Maximises the protection of workers involved with site demolition, remediation and construction; and
- Renders the site safe for the proposed (childcare) land-use and minimises potential exposure pathways to contaminants present in filling materials (soil) and minimises the potential for any related impacts on groundwater quality.

Additional objectives of the RAP are as follows:

- Set remediation goals to verify that the site has been rendered suitable for the proposed use and will pose no unacceptable risk to human health or the environment;
- Document the remedial options that may be implemented to reduce risks to acceptable levels for the proposed site use, with recommendations on the adopted option;
- Provide an Environmental Management Plan (EMP) which details the environmental safeguards required to complete the remediation and construction in an environmentally acceptable manner;
- Identify the legislative requirements of the relevant regulatory authorities for the remedial works; and
- Comply with the relevant planning instruments and local government policies.

The general scope of work designed to achieve the RAP objectives stated above is described below:

- Provide an adequate description of the site, its history and available background information;
- Provide a summary of the results of the previous site investigations and assess the contamination status of the site;
- Develop site assessment / acceptance criteria for the relevant environmental media, on the basis of the identified chemicals of concern and the proposed land uses;
- Identify potential remedial options available for the site and nominate the preferred remedial strategy;
- Develop contingency plans for the various situations that may arise during the remediation programme;
- Highlight the requirement for the works to be undertaken in accordance with the Environmental Management Plan and Health and Safety Plan prepared for the remedial works.

It is proposed that the remediation method will involve the placement of a suitable physical barrier layer over the site, comprising pavement materials and also clean fill and/or geo-membranes in areas where non-paved landscaping is proposed.

3. SITE INFORMATION

3.1 Site Description

The subject site forms an irregular, almost rectangular-shaped land parcel located at the north-eastern corner of Blackfriars and Buckland Streets, Chippendale, as shown on UTS Drawing 28651, Appendix A. The site is approximately 1,600 square metres in area and is comprised of the following land parcels:

Lot 1 in DP122324
Lot 1 in DP724081
Lot 1 in DP832799
Lots 10 -16 Sec 3 in DP466
Lots 18 - 20 Sec 3 in DP466
Lots 22 – 25 Sec 3 in DP466
Lots 1 – 14 Sec 4 in DP466
Lot 221 in DP133367
Lots 9 – 12 Sec 5 in DP466

The local government authority is the City of Sydney Council.

The site is the Blackfriars Campus of the UTS. Specific features of the site include:

- A two storey heritage listed building (Building B2), located on the western boundary, and occupied by the Australian Learning and Teaching Council;
- A two storey heritage listed building (Building B5), located on the eastern boundary, and used by the Faculty of Arts & Social Studies, International studies and China Research Centre. The campus security office is also located in this building;
- A timber clad demountable building (Building B1) located in the south-western corner and occupied by the offices of the CAMRA Project and Cultural Asset Mapping in Regional Australia;
- A two storey brick residence, labelled as “The Residence”, located in the south-eastern corner;
- A single storey timber hall, located in the north-eastern corner of the site;
- A single storey clad building, located in the north-western corner, used as the Blackfriars Children’s Centre. The building and surrounding children’s play areas are fenced off from the remainder of the site;
- Open, bitumen covered car parking facilities and landscaping (paved areas, lawns and gardens) between the buildings;
- Numerous small to large canopy trees are present within the site, particularly in the north-western corner and close to the western and southern site boundaries.

No hazardous materials survey was conducted, and therefore the nature and extent of asbestos containing materials in the existing buildings is not known.

The site is bordered by a high brick wall (in some locations forming the wall of adjoining buildings) along the northern and eastern boundaries. Part of the wall close to the north-eastern corner is propped with steel members fixed into a concrete footing. The fencing along the southern and eastern boundaries comprises steel encased in sandstone columns and footings.

Reference may be made to Plan No 72875.DGN, prepared by Rygate & Company Pty Limited, in Appendix A for the existing site layout.

At the time of conducting the fieldwork for the DP assessment there was no visible evidence of potential underground or above ground petroleum storage systems.

Furthermore, there were no surface indicators of potential soil contamination such as staining, vegetation deterioration or die-back. The lawns were lush and foliage prominent.

The following land uses were noted in the area around the site at the time of the DP investigation:

To the north: Blackfriars Broadway Inn (a 3 storey building), a carwash and University of Notre Dame (Sydney Campus) buildings.

To the east: The University of Notre Dame (including a number of 3 to 4 storey buildings positioned apparently on the site boundary), Blackfriars Place and a 4 storey residential (possibly student accommodation) building

To the south: Blackfriars Street, commercial and residential properties beyond (typically 3 storeys in height)

To the west: Buckland Street and residential properties beyond (typically 3 storeys in height; probable student accommodation).

3.2 Proposed Development

From the information provided, it is understood that the proposed development of the site is to comprise the following:

- Demolition of the existing, non-heritage buildings (including the child care centre);
- Refurbishment of several existing heritage buildings, including the relocation of the child care centre to the south-eastern corner of the site; and
- Formation of car parking, courtyards, and children's play area (part of the proposed child care centre).

No bulk excavations (e.g. for basement construction) are proposed. Minor areas of landscaping and paving, including areas designated for tree planting, have been included in the layout and minor excavations associated with these requirements and with the installation of services will be required during redevelopment.

Reference may be made to the Ground Floor Plan of the proposed development, prepared by Daryl Jackson Robin Dyke Pty Ltd (Drawing No CC01GDAP 28652 Rev 02), and Landscape Plan, prepared by pod Landscape Architecture (Drawing No CC01GDLP 28663 Rev 02), both in Appendix B, for details of the proposed development and landscaping layout. DP has included a further, edited version of Drawing CC01GDAP 28652 Rev 02 in Appendix B. This edited version labels Buildings 2 and 5 which are heritage listed and are to remain. These drawings show the site to be within the larger Black Friars campus area shown in the superseded drawing 3532_DA004-P7 by Nettleton Tribe, 2009 in Appendix B.

3.3 Site History

In developing a picture of the history of the site, DP reviewed information presented in previous Coffey reports, and reviewed information provided by WorkCover NSW and the Department of Water and Energy. This section presents a summary of the findings.

An archaeological assessment was conducted by Casey and Lowe Associates in August 1993 was included as part of the Coffey 1994 report. The assessment revealed the following:

- Blackfriars School was established on the site in 1883;
- Prior to the school, the site was occupied by an industrial estate which was the largest in nineteenth century Sydney;
- In 1825, the Brisbane Distillery was built over a large area, which included the subject site. A brewery was added to the site at a later date;
- Blackwattle creek, which drained to the nearby Blackwattle swamp, was dammed to create a reservoir beside the distillery. The path of Blackwattle creek is now occupied by a sewer line;
- In 1852, the distillery was taken over by Colonial Sugar Refining Company (formerly Australasian Sugar Company). During the refinery's occupation, complaints were made about the pollution of the dam and Blackwattle swamp creek. The waste was later diverted into the Abercrombie Street sewer;
- In 1878, the refinery was moved, the buildings were removed and the land was later subdivided;
- The Department of Education bought the subject site in 1883 for the development of a school, and school buildings were completed in 1884;
- The original swamp creek survived into the 1890s;
- The school was recently closed and the site taken over by the UTS.

A NSW DWE groundwater bore search was conducted on the 10 February 2009. Seven bores were found within a 1 km radius of the site. All the bores were for monitoring purposes. The water bearing zones for two of the bores (109649 and 109648) were indicated as 3.2 - 6.2 m and 5.2 - 6.2 m respectively. Drillers logs were also available for Bores 109649 and 109648. Filling was encountered at depths between the surface and 4.8 m, silty sand between 4.8 m and 5.9 m, silty clay between 2.9 m and 4.9 m, silty sand between 4.9 m and 5.8 m and sandstone between 5.8 m and 7.20 m.

A search for dangerous goods licences registered with NSW WorkCover was conducted in February 2009, and did not locate any records pertaining to the site.

3.4 Topography, Geology and Hydrogeology

The general topography of the site and environs appears to slope gently downwards to the north, towards Sydney Harbour. Based on the local topography, the inferred groundwater and stormwater flow would also be towards Sydney Harbour (north).

The Soil Landscape Map of Sydney (Soil Landscape Series Sheet 9130, Scale 1:100,000, 2002), prepared by the Soil Conservation Service of NSW, indicates that the site is located within a Disturbed Terrain; land that may be extensively disturbed by human activity including complete disturbance, removal or burial of soil, or landfill including soil, rock, building, and waste materials. The investigations by Coffey and DP indicated fill depths of between 1.6 m and 4.1 m below ground level.

Reference to the Sydney 1:100 000 Geological Series Sheet indicates that the site is underlain by stream alluvium and estuarine deposits (silty to peaty quartz sand, silt and clay) as well as man made filling. The natural deposits are considered to be mainly alluvium beneath the site.

Sandstone bedrock was encountered during the Coffey and DP investigations at depths ranging from 3.8 m and 8.3 m below ground level.

Free groundwater was not encountered during drilling for the DP investigation (2009). Groundwater was observed in four wells installed at the site at depths of between 2.08 m and 3.0 m below ground level. These finding confirm the Coffey findings of groundwater at about 3.0 m below ground level, reported in 1993. The results show little or no changes in groundwater levels beneath the site over a period of 15 years (note that some fluctuations may have occurred over that time).

Based on the measured groundwater levels and regional topography, the inferred direction of groundwater flow is towards the north. The groundwater is likely to feed into Blackwattle Bay, which is located approximately 1.3 km north of the subject site.

A review of digital data supplied by NSW Department of Environment and Climate Change (DECC) based on 1:25,000 ASS Risk Mapping, 1994-1998 indicated that the site is located within an area of no known occurrences of acid sulphate soils.

4. RESULTS OF PREVIOUS INVESTIGATIONS

4.1 Coffey Reports

The client provided the following reports prepared by Coffey to DP for review.

- *UTS Blackfriars Site – Investigations*, 2nd September, 1993;
- *Environmental Site Assessment UTS Blackfriars Development Chippendale*, September 1994;
- *Health and Safety Plan* (draft), August 1998;
- *Environmental Management Plan* (draft), August 1998; and
- *Site Management Plan*, August 1998.

4.1.1 UTS Blackfriars Site – Investigations, 2nd September, 1993

This report details the findings of a geotechnical and environmental investigation of a portion of the Blackfriars Infant School. The investigation was undertaken on the north-western corner of the current subject site (the location of the current childcare centre) in order to plan for the, then proposed childcare centre. The scope of work included the drilling of 4 boreholes to bedrock and the collection of environmental and geotechnical soil samples.

The logs indicated fill materials to depths of between 2.3 m and 3.9 m, and sandstone bedrock at depths of between 5.4 m and 8.3 m below ground level (bgl). The fill was

described as a mixture of sand, sandstone rubble, sandy clay, coal waste, bricks and glass fragments. Groundwater was encountered at about 3 m below ground level (bgl).

Two soil samples form each borehole (eight in total between depths of 0.6 m and 2.2 m bgl) were analysed for Total Petroleum Hydrocarbons (TPH), Polycyclic Aromatic Hydrocarbons (PAH), and a suite of heavy metals (copper, lead, zinc, cadmium, chromium, arsenic, selenium and mercury). The regulatory guidelines and thresholds which were adopted were those recommended in the 1992 Australian and New Zealand Conservation Council (ANZECC) *Guidelines for the Assessment and Management of Contaminated Sites*. [Note: Other relevant, "landuse specific" guidelines, including the NEPM Guidelines on the Investigation Levels of Soil and Groundwater, have been issued since then.]

The laboratory results indicated that the level of copper exceeded the guideline in two locations, zinc in three locations, mercury in two locations and PAH in three locations. The exceedances were detected in the fill material between 1.1 m and 2.0 m bgl, although, the report stated that the contamination appeared to be restricted to the top 3.9 m fill material. *The report exceedances remain exceedances when compared to current guidelines (refer to Section 5.2).*

No evidence of hydrocarbons or solvents was observed during the drilling or in the retrieved groundwater samples.

4.1.2 Environmental Site Assessment UTS Blackfriars Development Chippendale, September 1994

This assessment was required for redevelopment of the site into university buildings, a university residence and a childcare centre. The site condition at the time of the assessment was described as under redevelopment including the construction of underground services, pavements, buildings and landscaping. The report stated that the recommendations set out in the earlier report (Section 4.2.1 of this report) were superseded by the recommendations in this report.

The fieldwork involved the excavation of 11 test pits to a maximum depth of 3.1 m bgl. Eight soil samples were analysed for heavy metals, PAH, TPH, phenols, conductivity and pH.

The contaminant concentrations were compared to the ANZECC (1992) guidelines, Canadian Council of Ministers of the Environment (1991) *Interim Canadian Environmental Quality Criteria for Contaminated Sites* and the Dutch Ministry of Housing, Spatial Planning and Environment (1994) *Environmental Quality Objectives in the Netherlands*.

The laboratory results indicated that the level of copper and mercury exceeded the guidelines in five locations, lead and zinc in four locations, TPH (C_{15} - C_{28}) in one location and PAH in two locations. It was noted that higher heavy metal levels were detected in this investigation than in the earlier Coffey report. Toxicity characteristic leaching procedure (TCLP) tests were also conducted on selected samples and found the contaminants in the soil are not mobile. *The majority of the report exceedances remain exceedances when compared to current guidelines (refer to Section 5.2).*

The report concluded that given the current state of the site and that contaminated fill probably exists beneath historical buildings, it seems there would be little benefit in remediating the on site contaminated soils. The following was recommended for the long term:

- Operations and maintenance manual contain warnings of underlying contaminated soils;
- Warning layer in turfed and garden beds;
- Trap doors and other entrances into building under spaces should be locked and clearly signposted;
- Where garden beds may be disturbed in the future, fences should be constructed to prevent access by site users;
- In the area of the childcare centre, a cover comprising 150 mm turfed topsoil overlying 150 mm compacted roadbase overlying a plastic warning layer and the 20 mm bitumen already covering the site. It is also recommended an additional plastic warning layer be placed between the topsoil and the child care centre building footprint ;[*Note: meaning not clear, do they mean a second plastic warning layer be placed between the topsoil and compacted roadbase (or underlying material) over the footprint of the child care centre building?]*
- Soils beneath the university residence should be treated in the same way as the childcare centre, or by applying a sand or concrete or brick paving;

- Soil imported to the site should be assessed for contamination prior to placement; and
- Long term maintenance plan should be implemented to maintain the barrier system.

Note that the abovementioned capping method is generally considered inadequate by today's standards.

Overall, the report concluded that the risk of leachate migration into groundwater originating from the site is relatively low, however, groundwater assessment was recommended to determine if further management is required. Coffey recommended sampling from three locations (up-gradient, down-gradient and to provide flow direction information).

4.1.3 Health and Safety Plan (draft), August 1998

This document provided a general framework for protection against the capped soil contamination. It outlined the responsibilities of the on-site workers, the controls (work and decontamination zones), the site hazards to be aware of, the safe work practices and the reporting of any breaches of the plan.

4.1.4 Environmental Management Plan (draft), August 1998

The purpose of this plan was to ensure that all contaminated material left on site is covered and that any disposed off-site is carried out appropriately. It outlined a number of rules that need to be followed.

4.1.5 Site Management Plan, August 1998

This plan was produced to manage the soil contamination through:

- Placement of protective barriers;
- Maintenance of protective barriers;
- Application of controls on site excavation works; and
- Application of controls on works underneath buildings where there are no soil covers.

At the time this report was prepared, the status of the site was as follows.

- Protective covers had been placed over the site except areas covered by buildings or pavement. In the area of the childcare centre, the cover comprised 150 mm turf topsoil

overlying 50 mm concrete overlying an orange plastic warning layer. In other unpaved areas, the cover comprised 150 mm topsoil overlying an orange plastic warning layer.

- Timber barriers had been placed around the large trees.

Note that investigation by DP in 2009 did not uncover evidence of the plastic warning layer in any of the bores. However, the hand augered bores in the child care centre did encounter refusal on hard layers, probably roadbase. Furthermore, the timber barriers around the large trees were not evident.

Subsequent recommendations were as follows:

- For excavation and work underneath buildings, a workplace health and safety plan must be developed;
- Trapdoors and other entrances need to be locked and signposted;
- The Operation and maintenance manual must state that works on site need to be carried out in accordance with this plan;
- EPA approval must be granted for off site removal of any soil underneath the warning layer;
- Site works must be conducted in a way that protects the environment.

The plan also stated that a biannual inspection should be undertaken to check the status of the soil and a report (including a review of excavation, disposal and safety records) should be provided to UTS.

4.1.6 DP Report

DP was commissioned by Hutchinson Builders in 2009 to complete a Phase 2 Contamination Assessment on the UTS Blackfriars Campus. At the time, the site was the subject of the current proposed development including relocation of the childcare centre, student common facilities, and paved and grassed landscaping features. The existing heritage buildings were to be retained and refurbished, whilst several new buildings would also be constructed. *The assessment was a precursor to the development of this RAP.*

At the time of the investigation (February / March 2009), the subject features and uses were the same as those outlined in Section 3.1 of this report.

The objectives of the phase 2 contamination assessment were to:-

- assess soil and groundwater conditions for contamination resulting from historical use of and activities undertaken at the property with regard to the proposed development;
- provide an opinion on the site's suitability for the proposed redevelopment; and
- provide a Preliminary *in situ* Waste Classification and Acid Sulphate Soil (ASS) assessment.

The Phase 2 Contamination Assessment involved the following general scope of works:

- Review of the Coffey reports (referenced earlier in this section);
- Review of additional site history information, WorkCover NSW records, and regional groundwater information;
- Soil sampling at a total of sixteen (16) locations spaced across the accessible areas of the site. This number complies with the NSW DECC sampling design guidelines. Note that the termination of hand augered bores was governed by augering difficulties;
- Screening of recovered soil samples for volatile vapours using a calibrated, field portable photo-ionisation detector (PID);
- Installation of four (4) groundwater monitoring wells;
- Conducting laboratory analysis on selected soil samples at a NATA accredited analytical laboratory for a combination of the following potential contaminants:
  - Heavy Metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn);
  - Total Petroleum Hydrocarbons (TPH);
  - Monocyclic Aromatic Hydrocarbons (Benzene, Toluene, Ethylbenzene and Xylene – BTEX);
  - Polycyclic Aromatic Hydrocarbons (PAH);
  - Organochlorine Pesticides (OCP) / Polychlorinated Biphenyls (PCB);
  - Phenols;
  - Cyanide;
  - Asbestos;

  - Volatile Organic Compounds (VOC);
  - SPOCAS test (for acid sulphate soil assessment);
  - TCLP (leaching) for waste classification purposes.

- Conducting laboratory analysis on four groundwater samples for Heavy Metals, TPH, BTEX, PAH, Phenols, PCB, OCP, VOC and hardness.

Given the proposed land uses (i.e. childcare, and student facilities) the laboratory test results were assessed against the health based criteria for residential development with accessible soils (childcare centre), and the health based criteria for residential development with minimal soil access (remainder of site). In additional, provisional phytotoxicity-based investigation levels for sandy loams were applicable in the area of the proposed landscape. With regard to petroleum hydrocarbons, the NSW EPA *Contaminated Sites: Guidelines for Assessing Service Station Sites* (1994) threshold concentrations for sensitive land were adopted as the site assessment criteria (SAC).

The fieldwork for the assessment revealed the presence of fill materials to depths ranging from about 2.0 m in the western portion to about 4.1 m in the eastern portion, overlying soft to firm clay (alluvium) then sandstone bedrock. The bedrock was encountered at depths ranging from 3.8 m to 5.2 m depth. Groundwater was encountered in a number of bores ranging in depths between 2.3 m and 3.8 m below existing ground level.

The results of the soil analysis indicate that the majority of organic and inorganic contaminant concentrations in all sampled and tested soils were within the adopted SAC. The exceptions were as follows:

- Concentrations of benzo(a)pyrene (ranging from 2.2 mg/kg to 36 mg/kg), exceeding the SAC, were detected in 13 out of 48 soil samples analysed;
- Concentrations of Total PAH (ranging from 31 mg/kg to 430 mg/kg), exceeding the SAC, were detected in 10 of the 48 soil samples analysed;
- Concentrations of TPH (C10-C36) of 1,360 mg/kg and 2,120 mg/kg, exceeding the SAC of 1,000 mg/kg, at Bore 1 and Bore 11;
- Sample 9/0.2-0.5 collected from the surficial filling had lead concentrations of 1,500 mg/kg, which exceeded the SAC (1,200 mg/kg); and

- Exceedances of PPILs for copper, lead, mercury, nickel and zinc were detected in several samples collected from the surficial filling.

No groundwater contamination issues were identified.

The results were found to be similar to those reported by Coffey.

Based on the results of the assessment, it was considered that the site can be rendered suitable for the proposed redevelopment, subject to the preparation and implementation of a remedial action plan (RAP). An Environmental Management Plan (EMP) would also be required for the long term management of on-site contaminated soils.

The filling encountered in the test bores was given a preliminary General Solid Waste (non-putrescible) classification in accordance with the DECCW *Waste Classification Guidelines*, 2009, provided that the material is not cross-contaminated with other material. However, further *ex situ* waste classification of the filling was recommended upon excavation and stockpiling. It was also noted that building rubble was encountered in the test bores, thus, there was considered to be a potential for asbestos to be present in the filling materials.

Preliminary test results also indicated a low potential for the presence of Acid Sulphate Soils (ASS) which is in agreement with the risk map classification indicating that no known ASS occurrences were previously recorded in the area. However, due to a slightly elevated S_{POS} value and hence the potential for the presence of ASS recorded in a sample of grey clay filling, it was recommended that further ASS analysis should be conducted during the additional *ex situ* waste classification assessment of excavated material.

5. SITE ASSESSMENT CRITERIA

5.1 Soil

On the basis that the proposed land-use includes a child care centre and educational facilities, the soil analytical results adopted for site characterisation and the proposed remediation strategy are as follows:

- Health-based (soil) Investigation Levels (HILs) for residential development with gardens and accessible soil, including children's day care centres (Column 1 HILs) for Urban Development Sites in NSW as specified in NSW DEC [now EPA] *Guidelines for the NSW Site Auditors Scheme, 2006 [applicable to the proposed childcare centre];*
- Health-based (soil) Investigation Levels (HILs) for residential development with minimal access to soil including high-rise apartments and flats (Column 3 HILs) [*applicable to the remainder of the site*];
- The provisional phytotoxicity investigation levels (PPILs) published in the NSW DEC *Guidelines for the NSW Site Auditors Scheme, 2006,* which have been used as a screening guide for potential adverse impacts on future plant growth [*applicable to the top soil (top 500 mm) in unsealed/unpaved landscape areas*]. Note that the published PPBIL typically apply to sandy loam soils or soils of a closely similar texture for pH 6–8;
- Threshold concentrations for sensitive sites, NSW EPA *Guidelines for Assessing Service Station Sites,* 1994, for assessing petroleum hydrocarbons *[applicable to the whole of the site]*.

Based on the above guidelines, the SAC are summarised in Table 1 below.

Table 1 – Site Assessment Criteria for Soils

Analyte	Health Based Site Assessment Criteria[1] (childcare centre) (mg/kg)	Health Based Site Assessment Criteria[2] (remainder of site) (mg/kg)	Phytotoxicity Based Site Assessment Criteria[3] (Imported Fill, and whole of the site[unsealed areas]) (mg/kg)
As	100	400	20
Cd	20	80	3
^{6}Cr	12%	48%	400
Cu	1000	4000	100
Hg	15	60	1
Ni	600	2400	60
Pb	300	1200	300 / 600[7]
Zn	7000	28000	200
C_6-C_9	65[4]	65[4]	65[4]
C_{10}-C_{14}	1000 [4]	1000 [4]	1000 [4]
C_{15}-C_{28}			
C_{29}-C_{36}			
Benzene	1[4]	1[4]	1[4]
Ethyl Benzene	50[4]	50[4]	50[4]
Toluene	130[4]	130[4]	130[4]
Xylene	25[4]	25[4]	25[4]
PAH (Total)	20	8	8 / 20 [8]
Benzo(a)pyrene	1	4	1 / 4 [8]
Phenols	8500	34000	8500 / 34000 [8]
PCBs	10	40	10 / 40 [8]
Asbestos	None Detected in surface soils[5]	None Detected in surface soils[5]	None Detected
Aldrin + Dieldrin	10	40	10 / 40 [8]
Chlordane	50	200	50 / 200 [8]
DDD+DDE+DDT	200	800	200 / 800 [8]
Heptachlor	10	40	10 / 40 [8]

Notes:

1. NSW EPA *Contaminated Sites Guidelines for the NSW Site Auditor Scheme* (2006) Health Investigation Levels Column 1 for residential development with gardens and accessible soil, including children's day care centres (NEHF A)
2. NSW EPA *Contaminated Sites Guidelines for the NSW Site Auditor Scheme* (2006) Health Investigation Levels Column 2 for residential development with minimal access to soils (NEHF D)
3. NSW EPA *Contaminated Sites Guidelines for the NSW Site Auditor Scheme* (2006) Provisional Phytotoxicity based investigation levels (PPBIL) to be used in conjunction with NEHFA or NEHF D for

assessing imported fill materials proposed for placement in capping layer, and soils within the plant root zones [top 500 mm of soil in unpaved/unsealed areas]

4. NSW EPA *Guidelines for Assessing Service Station Sites*, 1994. Threshold concentrations for sensitive sites, (for TPH and BTEX), for all land uses.
5. NSW EPA Advice to Site Auditors, dated 31 March 2000, reference CH8028/HOF3511.
6. all Chromium are assumed to exist in the stable Cr(III) oxidation state, as Cr(VI) will be too reactive and unstable under the normal environment.
7. NEHF A for lead is less than the PPBIL, hence within the childcare centre, 300mg/kg is the SAC
8. SAC dependant upon area of fill placement (ie. childcare centre or remainder of the site)

Soil / fill material is considered to meet the health based SAC if:

i) The 95% UCL of the average concentrations for a data set of samples of like material complies with the adopted SAC (Table 2, Columns 1 or 2) [Note that statistical analysis does not apply to the assessment of PPILs];

ii) Any individual analyte concentration in the soil is not considered to present a potential health risk. For some analytes (non-volatile), 250% of the HIL value is adopted for the absolute maximum upper limit concentration for individual samples, however, the 95% UCL of the average concentrations must comply.

iii) The standard deviation of the results must be less than 50% of the values given in Table 2, Columns 1 or 2.

5.2 Groundwater

Sydney Harbour is considered to be the ultimate receiving body for groundwater sourced from or passing beneath the site, whereas the groundwater in the immediate environ may be classified as a "fresh water" ecosystem. On this basis, the groundwater investigation levels (GILs) were selected for the protection of 95% of species for a freshwater ecosystem (a conservative approach, as opposed to marine ecosystems) in line with DECC guidance. The applicable guideline is the *Guidelines for Fresh and Marine Water Quality*' Australia and New Zealand Environment and Conservation Council (ANZECC, 2000). The trigger values for the protection of 95% species for a fresh water ecosystem were used where available. In the absence of the 95% level of protection trigger values the moderate and low reliability trigger values and/or other recognized standing screening criteria were also referenced.

In cases where Australian criteria are not available, then the internationally recognized Dutch Intervention Values are adopted as screening reference. It is noted that these international standards are not endorsed by EPA, but are considered relevant as useful assessment screening values.

Based on the above guidelines, the adopted GIL are summarised in Table 2 below. [Note: Based on the analytical findings of the groundwater samples, no signs of unacceptable groundwater impacts or elevated concentrations of contaminants were noted. As such, groundwater contamination beneath the site is not considered to be an issue of concern and remediation of groundwater is not considered required. The GILs have, nevertheless, been established for reference purposes.

The adopted assessment criteria for the groundwater samples are presented in the following table.

Table 2 – Groundwater Investigation Levels

Analyte	Groundwater Investigation Level (mg/L)		Source
	Fresh Water Trigger Value (slightly to moderately disturbed ecosystems – 95% protection)	Other	
Metals			
Arsenic	0.013-0.024	-	ANZECC, 2000
Cadmium	0.0002	-	ANZECC, 2000
Chromium (III)	0.0033-0.001*	-	ANZECC, 2000
Copper	0.0014	-	ANZECC, 2000
Lead	0.0034	-	ANZECC, 2000
Zinc	0.008	-	ANZECC, 2000
Nickel	0.011	-	ANZECC, 2000
Mercury	0.00006	-	ANZECC, 2000
TPH/BTEX	-	-	
C_6 to C_9 Fraction	-	-	-
C_{10} to C_{36} Fraction	-	0.6[1]	DUTCH, 2000
Benzene	0.95	-	ANZECC, 2000
Toluene	0.18*	-	ANZECC, 2000
Ethylbenzene	0.08*	-	ANZECC, 2000
Total Xylenes	0.075-0.35*	-	ANZECC, 2000
PAH			
Benzo(a)pyrene	0.0001*	-	ANZECC, 2000
Naphthalene	0.016	-	ANZECC, 2000
Anthrancene	0.00001*	-	ANZECC, 2000
Phenanthrene	0.0006*	-	ANZECC, 2000
Fluoranthene	0.001*	-	ANZECC, 2000
OCP			
HCB	0.05*	-	ANZECC, 2000
BHC	-	-	ANZECC, 2000
Lindane	0.0002	-	ANZECC, 2000
Heptachlor	0.00009	-	ANZECC, 2000
Methoxychlor	0.000005*	-	ANZECC, 2000
Aldrin	0.000001*	-	ANZECC, 2000
Dieldrin	0.00001*	-	ANZECC, 2000
Enrin	0.00002	-	ANZECC, 2000
Endosulfan – alpha	0.0000002*	-	ANZECC, 2000
Endosulfan - beta	0.000007*	-	ANZECC, 2000
Endosulfan	0.0000002	-	ANZECC, 2000
DDE	0.00003*	-	ANZECC, 2000
DDT	0.00001	-	ANZECC, 2000
Mirex	0.00004*	-	ANZECC, 2000
Toxaphene	0.0002	-	ANZECC, 2000

Analyte	Groundwater Investigation Level (mg/L)		Source
Chlordane	0.00008	-	ANZECC, 2000
PCB			
Arochlor 1016	0.000001*	-	ANZECC, 2000
Arochlor 1221	0.001*	-	ANZECC, 2000
Arochlor 1232	0.0003*	-	ANZECC, 2000
Arochlor 1242	0.0006	-	ANZECC, 2000
Arochlor 1248	0.00003*	-	ANZECC, 2000
Arochlor 1254	0.00003	-	ANZECC, 2000
Arochlor 1260	0.025*	-	ANZECC, 2000
Arochlor 1262	0.050*	-	ANZECC, 2000
Arochlor 1268	0.050*	-	ANZECC, 2000
Phenols			
Phenol	0.32	-	ANZECC, 2000
Cyanide			
Cyanide	0.007	-	ANZECC, 2000

Notes:

*: insufficient data for reliable trigger value (interim working value or low reliability value used)

1: In assessing TPH (C_{10}-C_{36}) concentrations in groundwater, the Dutch Intervention Value (Dutch, 2000) was utilised as the GIL, as there are currently no high reliability Australian based guidelines other than a low reliability threshold of 7 µg/L, which is not routinely achievable by the NATA accredited laboratories.

The GIL applicable to VOC have not been listed as all groundwater tests to date have not detected any VOC.

As of 2013, new investigation and screening levels were introduced by the National Environment Protection Council (NEPC), known as the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (amended 2013) {NEPC, 2013], Schedule B1. Schedule B1, NEPC (2013) provides investigation and screening levels for commonly encountered contaminants which are applicable to generic land uses and includes consideration of, where relevant, the soil type and depth of contamination.

The data obtained during previous investigations conducted by DP and others has been compared against the NEPC (2013) guideline values with the exception of Ecological Investigation Levels (EILs) and Ecological Screening Levels (ESLs). Based on the previous and current guidelines, DP still considers the adopted recommended remediation strategy to

be the best option for remediation purposes. In the case of EILs and ESLs the formerly adopted PPILs are considered to be appropriated and have been retained.

6. SITE CHARACTERISATION

Based on the investigations undertaken by both DP (2009) and Coffey (1993 to 1998) the pertinent characteristics of the subject site are as follows:

- The site is irregular in shape, occupying an area of approximately 1,600 square metres.
- The site is currently occupied by a number of UTS buildings, some of which are heritage listed and will be retained (and refurbished) under the proposed development.
- The existing ground surface comprises predominantly building ground floors, bitumen, concrete and grass. Based on available earlier investigation reports, there is likely to be a below-surface warning layer (plastic) beneath the topsoil and compacted roadbase in the existing child care centre, as part of the capping profile recommended by Coffey. Although a warning layer was also recommended for the remainder of the site (beneath a topsoil layer) there was no evidence encountered during the fieldwork for the DP investigation.
- The site is underlain by fill materials. The encountered depths of filling ranging from about 1.6 m to 4.1 m below existing ground level. The fill generally comprises clayey sand/sand/clay/silty sand/sandy clay material with various amounts of gravel, brick, concrete, plastic and sandstone fragments. Ash and slag inclusions were encountered in the filling at a number of sampled locations. Given the uncontrolled nature of the filling, it is likely that ash and/or slag are sporadically present in the general filling.
- The filling material is sporadically contaminated with primarily PAH, and to a lesser extent TPH and some metals. PAH concentrations at some sampled locations significantly exceed the adopted SAC. Toxicity Characteristic Leaching Procedure (TCLP) testing indicates that the PAH is not leachable. The PAH contaminant is considered to be due primarily to the presence of ash and slag in the imported fill materials. Other potential contaminants including metals, BTEX, OCP, PCB, Phenols, Cyanide, Volatile Organic Compounds (VOC) and Asbestos were not encountered in the soils at concentrations greater than laboratory detection limits or background levels.

- Based on test results, the filling has been given a preliminary classification of General Solid Waste (non-putrescible) in accordance with the DECCW *Waste Classification Guidelines*, 2009, provided that the material is not cross-contaminated with other material (further *ex-situ* testing is recommended). As construction debris (brick, tile, gravel, glass and concrete fragments) were noted in all of the bores, there is a potential for asbestos to be present in the filling. In this regard, it is prudent that special care should be adopted during excavation to check for the presence of asbestos in the filling. If potential asbestos containing materials are noted, then the affected filling materials should be demarcated and segregated from the general bulk of the filling for further verification testing by a qualified environmental consultant. The waste classification of the affected materials must be verified and the waste class reconfirmed before they can be disposed off-site.

- In general, the test results indicted a low potential for the presence of acid sulphate soils (ASS) in the soils analysed, which is in agreement with the risk map classification indicating that no known ASS occurrences were previously recorded in the area. However, due to the slightly elevated S_{POS} value and hence the potential presence of ASS in sample 13/1.7-2.0, it is recommended that further ASS analysis should be conducted during the additional *ex situ* waste classification assessment of the stockpiled material, in order to verify the validity of the SPOCAS results. Further ex-situ testing was thus recommended.

- Testing of groundwater samples, from close to both the upgradient (southern) and down-gradient (northern) site boundaries did not uncover the presence of elevated concentrations of contaminants. As such, groundwater contamination beneath the site is not considered to be an issue of concern.

The following Table 3 presents a summary of the laboratory test data for the adopted soil analytes, reported by both DP and Coffey. The 95% upper confidence limit (UCL) of the average concentrations was calculated using *PRO UCL Version 4* (downloaded from the US EPA website).

Table 3 – Summary of Soils Test Results

Analyte	Number of Samples Tested	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Mean Concentration (mg/kg)	95%UCL of Mean Concentration (mg/kg)
As	40	1.2	9.0	4.9	5.3 (N)
Cd	40	<0.1	2.1	0.7	0.8 (N)
Cr	40	3.0	32	12	14 (N)
Cu	40	2.0	350	60	82 (N)
Hg	39	0.004	47	2.04	3.8 (LN)
Ni	24	1.0	137	12	21 (LN)
Pb	40	10	3900	289	525 (LN)
Zn	39	2.0	960	169	230 (N)
C_6-C_9	32	<10	<25	NA	NA
C_{10}-C_{36}	32	<30	2120	271	445 (AN)
Benzene	16	<0.5	<0.5	NA	NA
Ethyl Benzene	16	<0.5	<0.5	NA	NA
Toluene	16	<1.0	<1.0	NA	NA
Xylene	16	<3.0	<3.0	NA	NA
PAH (Total)	59	<0.2	556	56	85 (AN)
Benzo(a)pyrene	56	<0.05	36	4.1	5.8 (AN)
Phenols	18	<1	<5	NA	NA
PCBs	10	<0.1	<1	NA	NA
Cyanide	10	<0.5	<0.5	NA	NA
Cresol	8	<2	<2	NA	NA
VOC	3	<2.0	<2.0	NA	NA
OCP	10	NA	NA	NA	NA

Notes:
N: Normal distribution
LN: Lognormal distribution
AN: Normal distribution, adjusted for skewness
NA: Not Applicable

7. REMEDIATION OBJECTIVES AND PREFERENCE

7.1 Remediation Rationale

Generally, the main objectives of site remediation works are to ensure that the remediated site is rendered suitable for the proposed child care centre and educational facilities development, and that the works will pose no unacceptable risk to human health or to the environment.

7.1.1 Data Quality Objectives

The scope of remediation works has been devised broadly with reference to the seven step data quality objective process, as defined in Australian Standard *Guide to the Investigation and Sampling of Sites with Potentially Contaminated Soil: non-volatile and semi-volatile compounds* (AS 4482.1 – 2005). The DQO process is outlined as follows:

(a) State the Problem

The site will require to be rendered suitable for the proposed child care centre and educational facilities development.

(b) Identify the Decision

Elevated levels of contaminants (viz. lead, PAH, TPH) have been recorded in filling material across the site to be remediated. Given the low leachability of the contaminants of concern and, hence, their relative immobility, the potential for contaminant migration is not considered an issue of concern. Implementation of a permanent capping over this material will further reduce the potential environmental impacts due to these materials.

The isolation or capping of the soil contamination to create a physical barrier system is considered to be the preferred, practical remedial strategy for the project. Given the heterogeneous and uncontrolled nature of the fill, there is a strong likelihood that further residual, unidentified 'hot-spots' are present in the soil material. In this regard, a capping strategy is considered to be a more robust and encompassing strategy than a strategy that is based on the removal of 'identified hot-spots' [and hence has an elevated level of

uncertainties with respect to the impacts due to residual contamination]. The isolation and encapsulation strategy is also considered to be a more conservative approach and, under the proposed development scenario, this remedial strategy is considered to pose a lesser environmental risk than other remedial options. The strategy will also result in the minimisation of waste and in the disposal of soil to landfill. In addition to reducing the quantities of waste to be disposed to landfill, this will also reduce the associated traffic movements generated from associated waste disposal activities.

(c) Identify Inputs to the Decision

Findings of the previous DP and Coffey investigations have been used to characterise the site with regard to the likely nature and extent of the contamination over the site. The ANZECC publication, *Guidelines for the Assessment of On-site Containment of Contaminated Soil*, 1999, has been considered in the development of the capping strategy. The risks associated with the site are deemed to be satisfactorily managed by the adoption of the strategies outlined in these documents.

The key inputs to the Validation Report for the success of the strategy will include;

- capping construction details,
- survey data relating to pre-bulk earthwork levels and final levels,
- photographic record of the works,
- plans,
- Environmental Management Plan (EMP)

(d) Define the Boundary of the Assessment

The boundary of the assessment is summarised in Section 3 “Site Information” and UTS Drawing 28651 in Appendix A.

(e) Develop a Decision Rule

The progress and completeness of the site remediation works will be verified in a Validation Report. Remediation is deemed to be complete when an appropriate permanent physical

barrier system has been constructed which satisfies the requirements of the RAP, and an EMP has been prepared and implemented.

(f) Specify Acceptable Limits on Decision Errors

Specific limits for the acceptability of data obtained in the remediation validation would generally be in accordance with NEPC (2013) for the collection of environmental samples.

(g) Optimise the Design for Obtaining Data

The sampling programme for the remediation validation is outlined in Section 9 of the RAP. The assessment will be conducted by experienced environmental professionals to ensure that the sampling and analytical regime adopted will result in the collection of accurate, representative data.

Based on a fulfilment of the data quality objectives an assessment of the overall data quality will be presented in the final validation report.

7.2 Remediation Options

The preferred remediation hierarchy for this RAP is in accordance with Section 3.1.8 of the *Australia and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*, ANZECC 1992 and to the principles of the Waste Hierarchy established by the EPA under the *Waste Avoidance and Resource Recovery Act 2001*.

The ANZECC 1992 guidelines state that the preferred order of options for site clean-up and management are:

- on-site treatment of the soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level; and
- off-site treatment of excavated soil which, depending on the residual levels of contamination in the treated material is then returned to the site, removed to an approved waste disposal site or facility or used as fill or landfill.

Should it not be possible for either of these options to be implemented, then other options to be considered include:

- removal of the contaminated soil to an appropriate site or facility, followed where necessary by replacement with clean fill;
- Isolation of the soil by covering with a properly designed barrier;
- Choosing a less sensitive land-use to minimise the need for remedial works which may include partial remediation; or
- Leaving contaminated material in-situ providing there is no immediate danger to the environment or community and the site has appropriate controls in place.

The broad categories of commonly employed soil remediation options that have been used to attain remedial objectives are listed below in the order of the preferred remedial hierarchy:

- treatment;
- removal to landfill;
- physical barrier systems;
- institutional controls; and
- no action.

Information on each of the potential remedial options is provided below.

7.2.1 Treatment Technologies

Treatment technologies are used to permanently and significantly reduce the toxicity, mobility or volume of wastes or contaminants. Examples of possible treatment technologies include; bioremediation, thermal treatment, stabilisation, soil screening/washing, chemical treatment and physical treatment.

On-site treatment of the contaminated material would typically involve the excavation, stockpiling, treatment and replacement of the contaminated material. Effectiveness of the treatment process depends on the nature and extent of the contamination. Typically bioremediation will only be effective if the contaminants are simple, organic compounds that are easily biodegradable. Thermal treatment is expensive and the process will potentially result in various forms of environmental impacts (e.g. air emissions, waste and effluent

disposal problems), and is not effective for inorganic contaminants. Stabilisation aims at reducing the leachability (and hence mobility) of the contaminants, and is not effective if the contaminants are already in an immobile form. Soil screening/washing, chemical and physical treatment typically involves massive earthworks and are limited in application if multiple contaminants are involved.

Considering the variable nature of the generally non-leachable contamination within the filling [heavy metals, PAH, TPH] spread over a large area and to known depths up to approximately 4 m, on-site treatment of the contaminated material would not be a feasible nor a practical option.

7.2.2 Removal to Landfill

Removal to landfill involves physically excavating and moving impacted soil to an off-site location for storage, treatment or disposal. Disposal to landfill may require prior treatment of the impacted soil if the chemical levels exceed landfill criteria as determined in the NSW DECCW *Waste Classification Guidelines*, 2009.

Whilst this type of treatment is feasible for the site it may cause potential impacts on the heritage buildings, trees, boundary structures, local community (from waste transport), as well as imposing an unnecessary burden on the capacity of the receiving landfill. Essentially this option would only be suitable under circumstances where there is an elevated potential for unacceptable offsite impacts, such that source removal is critical, or where construction of basements was proposed and which would in any case require to remove the waste soils as part of the site formation process. To undertake such removal when it is not necessary would contravene the principles of the Waste Avoidance and Resource Recovery Act, 2001.

7.2.3 Physical Barrier Systems

Physical barrier systems limit access to the impacted material, mitigate surface water infiltration through the underlying material and control or reduce migration of the contaminants into the surrounding environment. This option can include creating barriers around and/or on top of the impacted material, or relocating the contaminants on-site to a properly constructed, engineered entombment (or containment cell). In addition, the physical barrier is also used to control the emission of odours, or volatiles (if present) and to reduce erosion, infiltration and improve site aesthetics.

Physical barrier layers can include low permeability soils such as clays, synthetic membranes such as high density polyethylene (HDPE), bituminous materials, paving and concrete. Appropriate site grading and drainage systems may also be required to divert water away from the capped areas (pavements and slabs) and to control surface run-off. Concrete barriers, bituminous pavements and various membranes may be vulnerable to cracking or shearing, depending on their proposed use, loading and exposure but these cracks or ruptures can be repaired providing an appropriate management programme comprising regular inspection and maintenance is developed and implemented as necessary. A combination of barrier types can provide additional security against failures.

Implementation of a barrier system will often require measures to manage the integrity of the barrier system, including works that will require penetration of the barrier system, such as installation / maintenance of underground utilities. These measures are typically outlined in an EMP.

Given the uncontrolled nature of the fill material, the low mobility of the contaminants and the nature of the proposed development (whereby the majority of the site will be paved/sealed), this remedial option is considered to be an appropriate remediation strategy for the site.

7.2.4 Institutional Controls

Institutional controls include measures such as land-use restrictions through zoning controls to preclude certain types of land use, mechanisms of notification such as the Planning Certificate or land title information, site access restrictions, restriction on long term intrusive works or redevelopment and relocation or isolation of potential receptors. Generally, development control is exercised through the development approval process, and any restriction in land-use or the need for ongoing site management can be flagged via the site audit system. Although exposure can be reduced by these means, the impacted media (contaminants) are not subject to appropriate treatment, or management. This option is not considered feasible and is not considered further.

7.2.5 No Action

No action means that no response is considered necessary to remediate the site as there is not considered to be a risk to the environment or the community from the contamination

identified. No action represents the current situation in regard to site remediation and will not result in any improvement of the existing site condition or reduction of risk via appropriate management. This option is not considered feasible and is not considered further.

7.3 The Preferred Remediation Strategy

7.3.1 Determination of the Preferred Remediation Strategy

An assessment of remedial options was undertaken in accordance with the ANZECC hierarchy, to nominate the preferred remedial strategy for the site, as follows:

On-Site Treatment of the Soil: DP considers that the bulk excavation and on-site treatment of contaminated soil is not practical for the following reasons:

- The majority of the soil contamination identified on the site appears to be associated with the historical uncontrolled fill present over the whole site. Although various hotspots have been identified it is likely that the real distribution of soil contamination and hotspots in the heterogeneous fill is sporadic in nature and spread across the entire site and it is considered that additional sampling would be unlikely to provide any further insight into the nature and extent of the contamination. It is therefore considered impractical to segregate and remove all hotspots of soil contamination in isolation for on-site treatment, or for removal off-site;
- The range of chemicals detected in the soil material would require a number of treatments to be applied in an attempt to meet suitable validation criteria. Even after the implementation of a series of soil treatment programmes, it is considered likely that the concentrations of substances such as long chain TRH organic compounds, PAHs, and metals are likely to remain elevated within the filling on-site. DP therefore considers that effectiveness of soil treatment would thus be questionable, with a very high level of uncertainties, and would present an unacceptable time penalty and financial burden to the current project;
- The bulk excavation of materials, noting fills depths of up to about 4 m, would have significant bearing on the structural integrity of heritage buildings (which are to be

contained) and boundary structures, some of which are common with neighbouring properties;

- The excavation and on-site treatment processes of the contaminated soil may cause undue environmental impacts such as odour, dust, surface water contamination and sedimentation which under the proposed remediation strategies is unlikely to eventuate. The most effective management strategy to prevent these environmental impacts is to minimise exposure to the contaminated soil during the redevelopment works.

Off-Site Treatment of Excavated Soil: DP considers the off-site treatment of the contaminated soil would be impractical for similar reasons as the on-site treatment of the soil, as detailed above.

Removal of the Contaminated Soil and Disposal to an Appropriate Site or Facility:
DP considered that the extent of contamination may be wide spread and affecting the bulk of the uncontrolled filling. In this regard, piecemeal “hotspot” removal would not be effective. Alternatively it would not be practical to completely excavate and remove all fill from the site for the following reasons:

- bore logs from the previous investigations indicate that fill material is present at considerable thicknesses in some sections of the site and to access these fills would require wholesale removal of the existing buildings and pavements, which is not possible due to heritage listing of a number of the buildings;
- the costs associated with the excavation, transport, off-site disposal and potential treatment of the large volume of fill material contained on the site would be prohibitive.

Isolation of the Soil by Covering with a Properly Designed Barrier: In view of the immobile nature and widespread extent of the contamination, whilst noting the absence of groundwater impacts, the isolation or capping of the soil contamination to create a physical barrier system is considered to be the preferred remedial strategy for the project. Under the proposed development scenario this remedial strategy is considered to pose a lesser environmental risk than the above mentioned remedial options. Further details of the preferred remedial strategy are provided below.

7.3.2 Assessment of the Suitability of the Physical Barrier System

Based on the contamination issues identified on the site and the impractically of implementing full-scale remediation by bulk removal and/or treatment of the contaminants, DP considers that the management of the contamination by a physical barrier system and via a constructional EMP is the most appropriate remedial strategy. Longer term management relies on the barrier being permanently maintained and by resurfacing where necessary, or being interrupted/removed only during short term events such as the installation of additional services i.e. during the main redevelopment, including the related remedial works, or during future maintenance. Major disruptions to the barrier are anticipated to fall into the category of developments requiring consent.

This option will result in a substantial reduction in health and environmental risk to an acceptable level, whilst also achieving the sustainable development goal of minimisation of waste. The option calls for the construction of an appropriately engineered barrier system over the filling, which is both technically feasible and easy to install, manage and maintain in the long run. The preferred option, therefore, attains an optimal balance amongst the various remediation objectives including risk reduction, environmental integrity, cost and long term manageability.

Barrier system designs have been developed for areas of:

- Heritage buildings;
- New building slabs;
- Paved areas (including service trenches);
- Landscaped areas (including service trenches);
- Trees to be retained; and
- New trees and shrubs.

The various physical barrier system designs are shown in Drawing 2, Appendix A.

8. DESIGN AND CONSTRUCTION OF THE PHYSICAL BARRIER SYSTEM

The investigations undertaken on the site by both DP and Coffey have determined that there is little potential for the identified soil (fill) contaminants to leach and mobilise to the groundwater regime. The testing of groundwater samples recovered from beneath the site has confirmed this statement. As such the physical barrier is designed primarily as a separation between humans and the contaminated soils. However, the grading of the physical barrier, and the provision of adequate surface water drainage, will minimise the infiltration of surface water into the contaminated soils.

As mentioned above, the identified soil contaminants have been determined to be essentially non-leachable. As such, no leachate collection and treatment system is considered necessary as part of the physical barrier design.

The identified contaminants in the fill, at the concentrations encountered, are not volatile in nature and thus not expected to generate vapors or gases considered potentially harmful to human health. As such, no gas collection and treatment system is considered necessary as part of the physical barrier system.

The designs of the physical barrier systems for the various components of surface cover proposed for the site have been developed with consideration of the following factors:

- Final design ground levels required by Council, which are understood to be similar to those existing;
- Ease of construction;
- Ease of management;
- Likelihood of future penetration of the barrier system and the straightforward nature of the repair of the barrier system;
- The retention of heritage structures;
- The presence of significant boundary walls being retained;
- The retention of a number of large trees, and their primary root zones;
- Aesthetic considerations.

The following subsections outline the specific design details for the physical barrier in each of the areas.

As a general guide, a batter slope of between 30 and 45 degrees will be retained for any excavation adjacent to existing heritage buildings or boundary structures, as shown on Drawing 2, Appendix A. This includes existing footpaths, stairs, verandahs etc which will be retained as part of the heritage listing.

In general, it is considered that suitable clays compacted to 95% of their standard compaction in 250 mm layers to the required thickness would act as a practical barrier. Should the barrier be required to support structural loadings, consideration should be given to increasing this compaction and the potential for shrink / swell to occur. In this regard guidance of a suitably qualified geotechnical engineer would be required.

8.1 Heritage Buildings

The existing heritage listed buildings (Buildings 2and 5) shown on the Ground Floor Site Plan (Drawing No CC01GDAP 28652 Rev 02as edited by DP to show building numbers), Appendix B, will be permanently retained (and refurbished) as part of the redevelopment and therefore a purpose built physical barrier system between the building ground floor and the underlying soils is not feasible, nor deemed necessary (as the soil beneath the building will be effectively covered by the building structure and hence not routinely accessible, whereas access to the subfloor area will be restricted. No sampling has been carried out within these building footprints, however, it is anticipated that the nature of filling beneath these buildings is similar to that encountered over the remainder of the site.

The management of human health and environmental exposure to the soils beneath the heritage buildings will comprise the following:

- Preparation of an Environmental Management Plan (EMP);
- Nomination of a person / authority responsible to ensure the implementation of the EMP;

- Upgrading (if required) and maintaining adequate roof and surface water drainage and collection measures (ie. preventing ponding of water around the building peripherals and preventing direction of water beneath the building).

8.2 Building Slabs

The proposed development includes the construction of a new child care centre. The new buildings will be slab on ground construction, with pier supports.

All surplus materials excavated during the pier boring, footing construction, building platform leveling and service trench excavation will be stockpiled and classified for off-site disposal, in accordance with the NSW DECCW *Waste Classification Guidelines*, 2009. An assessment for acid sulphate potential will also be undertaken on the excavated materials, as recommended in the DP Phase 2 Contamination Assessment report (Ref: 45996.01). The classified soils will be disposed off site at a landfill facility licensed to accept the waste under the classification determined (*Note that a preliminary General Solid Waste (non putrescible) classification has been assigned to the fill materials, but the potential for presence of asbestos contamination in demolition rubble inclusions should be noted*).

The handling of soils during the pier boring, excavation and leveling works will be undertaken in accordance with the management plan presented later in this RAP. Adequate personal protective equipment (PPE), as stipulated in this RAP, will be worn at all times.

Upon installation of the piers and services, excavation of the footings, and preparation of the ground surface (which is likely to include a degree of compaction), a marker layer (geogrid, geotextile or similar) will be laid. Given the anticipated low leachability of the contaminants, the marker layer does not need to be impermeable.

The slab blinding layer (typically comprising sand or a sub-base mix) will be laid directly on the marker layer. The building slab will then be formed directly on the blinding layer.

In summary, the physical barrier at the locations of proposed new buildings (or extensions) will comprise the marker layer, overlain by the blinding layer (building design thickness) and

the ground floor slab (building design thickness). The physical barrier thickness design is considered adequate as no future penetration of the concrete slab is anticipated unless the buildings are to be demolished. Under that circumstance the marker layer (together with the EMP) will provide a warning as to the presence of contaminated soils beneath.

The schematic of the building slab physical barrier is shown on Drawing 2, Appendix A (detail titled - 'Building Slab').

The laying of underground services beneath the building slabs will be carried out in accordance with the schematic shown on Drawing 2, Appendix A. As all service lines are likely to be installed at depths of less than 0.5 m, it may be more practical (where a significant number of services are proposed) to construct a 0.5 m layer of clean soil beneath the underside of the building slab. The details are not presented on Drawing 2, but would entail the following:

- Excavation of the existing fill to a nominal depth of 500 mm below the design underside of the slab (a lesser depth, to the maximum proposed service invert depth, would be acceptable);
- The excavated materials will be stockpiled and assessed for waste classification and acid sulphate soil potential. The classified soils will be disposed off site at a landfill facility licensed to accept the waste under the classification determined (*Note that a preliminary General Solid Waste (non putrescible) classification has been assigned to the fill materials, but the potential for presence of asbestos contamination in demolition rubble inclusions should be noted*);
- The exposed fill materials will be compacted as required;
- The marker layer will be placed over the entire area(s) proposed for the building slab;
- Imported VENM or validated ENM materials will be placed and compacted to an appropriate specification, to the underside of the building slab;
- Underground service trenches will be excavated and service lines laid within the VENM or ENM materials;
- The building blinding layer and slab will then be formed.

It is understood that this physical barrier system is proposed for the footprints of proposed Buildings 1 and 3.

8.3 Paved Areas

The proposed development includes a variety of paved configurations, as shown on the Landscape Plan in Appendix B. Some of the paved areas will be utilised by both vehicles and pedestrians, some by pedestrians alone, and some will be constructed solely for the child care centre.

Despite the variation in pavement types and uses, a generic physical barrier system has been designed to enable ease of construction and to also marry with the physical barrier system designed for the general landscaped areas. In designing the physical barrier system, consideration has been given to the potential for laying and/or servicing underground utilities in the future, and the likely repair / upgrade of the paving layer itself.

In general, the physical barrier system in areas of proposed paving will comprise the marker layer (as previously discussed), a layer of imported validated materials, the paving sub-base / base-course layer, then the pavers at the surface. The total construction thickness will be at least 500 mm.

The imported validated materials must comprise either Virgin Excavated Natural Materials (VENM) or Excavated Natural Materials (ENM), as defined in Section 9.1 of this RAP.

Construction of the barrier system will comprise the following stages:

- Removal and disposal of existing surface layers (bitumen, grass, concrete);
- Excavation of the existing fill to a depth of at least 500 mm below the design final ground level;
- Excavation of service trenches (where required) to the design invert levels;
- The excavated materials will be stockpiled and assessed for waste classification and acid sulphate soil potential. The classified soils will be disposed off site at a landfill facility licensed to accept the waste under the classification determined (*Note that a*

preliminary General Solid Waste (non putrescible) classification has been assigned to the fill materials, but the potential for presence of asbestos contamination in demolition rubble inclusions should be noted);

- The exposed fill materials will be compacted as required;
- The marker layer will be placed over the entire area(s) proposed for paving, including the side walls and base of any service trenches;
- Utilities lines will be placed as required in the lined service trenches;
- Imported VENM or validated ENM materials will be placed and compacted to an appropriate specification, at a thickness equivalent to 500 mm less the paver and sub-base / base-course thickness. A specific grading may be required for backfilling in service trenches. Typically a sand or gravel backfill materials is placed around utilities lines. This form of backfill is considered appropriate in the service trenches;
- The sub-base / base-course will be laid and compacted;
- The pavers will be laid as per design. The final paver surface will be designed with a minimum 2% grade towards purpose built sub-surface drainage systems.

Note that it is important to accurately locate the final positions and alignments of the service trenches, such that minimal disturbance will arise through future maintenance or repair works.

The handling of soils during the removal of the contaminated fill will be undertaken in accordance with the management plan presented later in this RAP. Adequate PPE, as stipulated in this RAP, will be worn at all times.

The schematic of the paving physical barrier, including service trenches, is shown on Drawing 2, Appendix A (detail titled - ‘Paving’).

8.4 General Landscaping

The proposed development includes landscaped areas that marry into proposed paved areas, as shown on the Landscape Plan in Appendix B. For the purpose of this report,

landscaping refers to proposed lawns, gardens and shrub planting. The planting of trees is discussed in Section 7.6.

A generic physical barrier system has again been designed to enable ease of construction and to also marry with the physical barrier system designed for the paved areas. In designing the physical barrier system, consideration has been given to the potential for laying and/or servicing underground utilities in the future, and the likely repair / upgrade of lawns, gardens and shrub plantings.

In general, the physical barrier system in areas of proposed landscaping will comprise the marker layer (as previously discussed), a layer of imported validated materials, a topsoil layer and turf. There may be minor variations in the thickness or type of topsoil and/or the use of other suitable planting materials. The total construction thickness will be at least 500 mm.

The imported validated materials must comprise either VENM or ENM, as defined in Section 9.1 of this RAP, and may be selected or enhanced to provide adequate nutrient levels and/or drainage characteristics for improved plant growth.

Construction of the physical barrier system will comprise the following stages:

- Removal and disposal of existing surface layers (bitumen, grass, concrete);
- Excavation of the existing fill to a depth of at least 500 mm below the design final ground level;
- Excavation of service trenches (where required) to the design invert levels;
- The excavated materials will be stockpiled and assessed for waste classification and acid sulphate soil potential. The classified soils will be disposed off site at a landfill facility licensed to accept the waste under the classification determined (*Note that a preliminary General Solid Waste (non putrescible) classification has been assigned to the fill materials, but the potential for presence of asbestos contamination in demolition rubble inclusions should be noted*);
- The exposed fill materials will be compacted as required;

- The marker layer will be placed over the entire area(s) proposed for paving, including the side walls and base of any service trenches;
- Utilities lines will be placed as required in the lined service trenches;
- Imported VENM or ENM materials will be placed and compacted to an appropriate specification, at a thickness equivalent to 500 mm less the paver and sub-base / base-course thickness. A specific grading may be required for backfilling in service trenches. Typically a sand or gravel backfill materials is placed around utilities lines. This form of backfill is considered appropriate in the service trenches;
- Appropriate planting will be carried out on the finished surfaces once complete.

Note that it is important to accurately locate the final positions and alignments of the service trenches, such that minimal disturbance will arise through future maintenance or repair works. These positions will be included in the EMP.

The handling of soils during the removal of the contaminated fill will be undertaken in accordance with the management plan presented later in this RAP. Adequate PPE, as stipulated in this RAP, will be worn at all times.

The schematic of the paving physical barrier, including service trenches, is shown on Drawing 2, Appendix A (detail titled - 'General Landscaping').

8.5 Trees to be Retained

Due to heritage and/or "ecological significance" reasons, a number of large existing trees will be retained as part of the proposed development. The trees to be retained are shown in *Arboricultural Development Impact Assessment*, Urban Forestry Australia, 2012 in Appendix B of this report. The relevant table and drawing within the attached report are found in Appendix E and Appendix F respectively..

Excavation of soils around the root zones of significant trees always presents a challenge, as the loss of soils (even if temporary) may have a long term impact on the viability on the future of the tree. In order to minimise the potential impact on the survival of each of the

retained trees, whilst also abiding by the objective of the remedial works (ie. appropriately remediated to a condition which would prevent unacceptable risks to human health and/or the environment; and ensure the suitability of the site for it's intended land use) the following procedures will be implemented:

- An arborist will identify the primary root zones (PRZ) of each of the trees to be retained. This will become the zone within which bulk fill excavation will not be permitted. Temporary fencing will be erected around each PRZ during site works;
- Additional soil samples will be recovered by hand within the PRZ (sample numbers to be determined based on the identified PRZ area, but minimum of 4 per tree location). The bores will continue to a maximum depth of 0.5m below existing ground level. Recovered samples (2 from each bore) will be analysed for the identified contaminants of concern, viz. PAH, TPH and Heavy Metals;
- Based on the test results, the following remedial strategies will be implemented within the PRZ:
  - If low to moderate contaminant concentrations are detected (i.e. exceeding EIL/ESL, but below HIL/HSL), a permeable surface cover (necessary to permit continued water infiltration around the tree roots), such as timber decking, will be erected at or above existing ground level. The decking will be designed to prevent direct human contact with the soils beneath.
  - If high contaminant concentrations (exceeding HIL/HSL) are detected, some hand excavation of detected "hot spots" or surface soils will take place, under the direction of the arborist. A marker layer and clean soil (probably topsoil) replacement may be required. Once these works are complete to the satisfaction of the Environmental Consultant, the decking construction as detailed above will be undertaken.
- The EMP will detail management requirements, including the maintenance of the decking materials, in the primary root zones.

Any imported validated materials used for soil replacement will comprise either VENM or ENM, as defined in Section 9.1 of this RAP, and may be selected or enhanced to provide adequate nutrient levels and/or drainage characteristics for improved plant growth.

The handling of soils during the removal of any contaminated fill will be undertaken in accordance with the management plan presented later in this RAP, and instructions issued by the arborist. Adequate PPE, as stipulated in this RAP, will be worn at all times.

8.6 New Tree and Shrub Planting

As indicated on the Landscape Concept Plan, prepared by Context pod Landscape Architecture (Drawing No CC01GDLP 28663 Rev 02) in Appendix B of this report, a number of new trees / shrubs will be planted as part of the proposed redevelopment.

A generic physical barrier system has again been designed to enable ease of the planting works and to also marry with the physical barrier system designed for the paved and landscaped areas. In designing the physical barrier system, consideration has been given to the exposure of the new plantings to the contaminated soils, and the potential for maintenance and/or replacement of the plantings in the future.

In general, the physical barrier system in areas of proposed tree and shrub planting will comprise the marker layer (as previously discussed), a layer of imported validated materials, a topsoil layer and turf, or paving layer. There may be minor variations in the thickness or type of topsoil and/or the use of other suitable planting materials. The total construction thickness will be at least 500 mm, with a minimum distance between the contaminated material and tree root bulb of 200 mm.

The imported validated materials will comprise either VENM or ENM, as defined in Section 9.1 of this RAP, and may be selected or enhanced to provide adequate nutrient levels and/or drainage characteristics for improved plant growth.

Construction of the physical barrier system at proposed tree or shrub planting sites will comprise the following stages:

- Removal and disposal of existing surface layers (bitumen, grass, concrete);
- Excavation of the existing fill to the required depth of at least 500 mm below the design final ground level, or to a depth of 200 mm below the proposed base planting level,

whichever is greater. The excavation width will be the width of the plant root bulb plus a minimum 200 mm all around;

- The excavated materials will be stockpiled and assessed for waste classification and acid sulphate soil potential. The classified soils will be disposed off site at a landfill facility licensed to accept the waste under the classification determined (*Note that a preliminary General Solid Waste (non putrescible) classification has been assigned to the fill materials, but the potential for presence of asbestos contamination in demolition rubble inclusions should be noted*);
- The marker layer will be placed over the entire excavation surface, including side walls;
- Imported VENM or ENM materials will be placed in the base of the excavation (minimum 200 mm thickness);
- The plant will be positioned in the centre of the excavation, and then the imported VENM or ENM will be placed and compacted around the annulus, as required;
- Topsoil and/or paving materials will be placed at the surface as required.

Note that the minimum thickness of the physical barrier system adjacent to and beyond the tree or shrub planting excavation will be 500 mm.

The handling of soils during the removal of the contaminated fill will be undertaken in accordance with the management plan presented later in this RAP. Adequate PPE, as stipulated in this RAP, will be worn at all times.

The schematic of the tree and shrub planting physical barrier, is shown on Drawing 2, Appendix A (detail titled - 'New Tree Planting').

9. WASTE DISPOSAL

9.1 Waste Classification

DP conducted a preliminary waste classification as part of the Phase 2 Contamination Assessment. Reference should be made to that document for full details. In summary, in-situ

samples were selected for analysis of potential contaminants and TCLP testing. Based on the overall results, the fill was assigned a preliminary classification of General Solid Waste (non-putrescible) as defined under the DECCW *Waste Classification Guidelines*, 2009, provided that the material is not cross-contaminated with other material. However, further *ex situ* waste classification of the filling was recommended upon excavation and stockpiling. It was also noted that building rubble was encountered in the test bores, thus, there was considered to be a potential for asbestos to be present in the filling materials.

Preliminary test results also indicted a low potential for the presence of Acid Sulphate Soils (ASS) which is in agreement with the risk map classification indicating that no known ASS occurrences were previously recorded in the area. However, due to the slight potential for the presence of ASS recorded in one of the tested samples collected from the grey clay filling, it was recommended that further ASS analysis should be conducted during the additional *ex situ* waste classification assessment of excavated material.

Upon excavation and stockpiling of the fill materials proposed for off-site disposal, sampling and testing will be undertaken to assign specific waste classifications. In general, depending upon the volume of stockpiled soils being classified at any one occasion; samples will generally be recovered at a rate of 1 in 100 m^3, or a minimum of 3 samples per stockpile. Each recovered sample will be analysed for the following:

- Heavy Metals;
- PAH;
- Asbestos;
- TCLP (PAH and metals);
- SPOCAS.

A waste classification report will be issued, providing a classification for each stockpile in accordance with the DECC *Waste Classification Guidelines, April 2008, Part 1: Classifying Waste and Part 4: Acid Sulphate Soils* (if applicable).

Once classified, the nominated licensed landfill facility will be contacted to arrange receipt of the materials. A check will be conducted to ensure the nominated landfill has the appropriate license in place for receipt of the materials.

Appropriate pre-treatment may be required (on site or off site) if the materials are found to be either ASS or classified as Hazardous Materials (refer to Section 8.2). Under these circumstances, appropriately licensed contractors will be engaged to undertake the necessary works in accordance with appropriate guidelines.

Similarly, if asbestos is encountered within the materials, an appropriately licensed contractor may be required to carry out the soil removal works.

9.2 Spoil Contingency Plan

Materials which fail to meet the NSW EPA disposal criteria (ie. general or restricted solid waste) following waste testing will require to be segregated and separately stockpiled pending further testing and possibly treatment. The contingency plan to cater for the storage, treatment and disposal of excavated spoil which fails to meet landfill criteria is as follows:-

- Materials will be carefully excavated and placed in well delineated and contained locations;
- Stockpiles of excavated materials will be appropriately bunded with hay bales/sandbags and if required, covered and/or lined with impermeable plastic sheeting;
- Sampling and analysis of segregated stockpiles will be conducted in accordance with Section 8.1;
- Disposal arrangements will be determined based on sampling results as follows:-
  - material which falls below the disposal guidelines for General or Restricted Solid Waste shall be collected and disposed direct to landfill;
  - those materials which exceed the criteria for landfill disposal shall remain segregated in stockpiles and await treatment/alternate disposal arrangements;
- Stockpiled materials which cannot be directly disposed at landfill (i.e. those which fail the combined specific concentration and TCLP test, or materials which require to be stored pending treatment) will be covered by anchored geotextile to prevent erosion and wind blow of contaminated materials;

- A suitably qualified and hazardous materials remediation contractor will be engaged to assess the contamination and develop an appropriate treatment method, which may involve chemical or physical stabilisation / immobilisation methods;
- Approval as to the appropriateness of the treatment and disposal method for materials exceeding the guidelines will be obtained from the NSW EPA, and a disposal consent will be sought from the EPA prior to the removal of such wastes from the site;
- Treatment of the materials may be carried out either on-site or off-site at an appropriately licensed facility, subject to EPA approval.

9.3 Stockpiling of Contaminated Material

Excavated contaminated material shall be stockpiled at a suitably segregated location(s) away from the main construction area(s). These areas will be fenced off in order to maintain separation from the remediated (capped) and validated areas to prevent inadvertent access.

All stockpiles of contaminated material shall be surrounded by star pickets and marking tape or other suitable material to clearly delineate their boundaries. Stockpiles shall be lightly conditioned by sprinkler or covered by geotextile or similar cover to prevent dust blow. Should the stockpile remain on-site for over 48 hours, geotextile silt fences or hay bales should be erected around each stockpile to prevent losses by surface erosion. Any stockpile to remain on-site overnight should be adequately secured in order to reduce the risk of sediment runoff.

9.4 Loading and Transport of Contaminated Material

Transport of contaminated material from the site shall be via a clearly delineated haul route and this route shall be used exclusively for entry and egress of vehicles used to transport contaminated materials within and away from the site.

Removal of waste materials from the site shall only be carried out by a licensed contractor holding appropriate license, consent or approvals to dispose the waste materials according

to the classification outlined in the DECCW *Waste Classification Guidelines, 2009* and with the appropriate approvals obtained from the NSW EPA, if required.

Details of all contaminated and spoil materials removed from the site (including VENM) shall be documented by the contractor with copies of weighbridge slips, trip tickets and consignment disposal confirmation (where appropriate) provided to the Environmental Consultant. A site log shall be maintained by the Principal's Representative (PR) based on discrete excavation (numbered) locations to track disposed loads against on-site origin, location of the materials and sample numbers.

The proposed waste transport route will be notified to the local Council and truck dispatch shall be logged and recorded by the contractor for each load leaving the site. A record of the truck dispatch will be provided to the Environmental Consultant via the PR.

9.5 Disposal of Contaminated Material

All contaminated materials excavated and removed from the site shall be disposed of to an appropriately licensed landfill. Copies of all necessary approvals shall be given to the Environmental Consultant via the PR prior to any contaminated material being removed from the site. Copies of all consignment notes for the transport, receipt and disposal of the materials will be maintained as part of the site log and made available to the Environmental Consultant for inspection and reporting purposes upon request.

All relevant analysis results shall be made available to the contractor to enable selection of a suitable disposal location. Holding arrangements, treatment and disposal requirements for excavated materials which fail to meet the landfill disposal guideline levels for moderately contaminated fill are discussed elsewhere.

10. SITE VALIDATION PLAN

Validation requirements for the physical barriers including pavements and capping soils include:

- Surveyed site levels following excavation (prior to construction of the physical barrier system);
- Surveyed site levels upon completion of physical barrier system construction;
- as-built engineering plans indicating the details of any new barrier system for each type (ie. building slab, paving, service lines, general landscaping, retained trees, and new tree plantings);
- Photographic record of the excavations, construction and completion of each physical barrier type;
- Validation reports confirming the VENM or ENM classification of imported materials;
- Inspection records for the works, prepared by a suitably qualified Environmental Consultant;
- Compaction certification (where required, such as pavement areas); and
- stormwater control plans and details and evidence relating to the installation of the stormwater controls (i.e. surface drainage).

Information from the above will require to be compiled in a suitable format and presented in the validation report(s) to be prepared by the Environmental Consultant.

On the basis of the construction schedule proposed (refer to Section 11) several stage validation reports will be prepared (i.e. for each stage of work) with one overarching validation report prepared at the completion of all works. Any additional sampling, including that of root zones as outlined in Section 10.2 will be included in the validation report.

10.1 Imported Materials

Any imported materials proposed for use as filling within the site must be appropriately validated prior to being used within the site. Only the following materials will be permitted for use within the site (upon meeting appropriate checking and validation, see below):

- Virgin Excavated Natural Materials (VENM) as defined under the Protection of the Environment Operations Amendment (Scheduled Activities and Waste) Regulation 2008;

- Excavated Natural Material (ENM) as defined under the Protection of the Environment Operations (Waste) Regulation 2005 – General Exemption Under Part 6, Clause 51 and 51A – The excavated natural material exemption 2008;
- Quarried natural aggregates / gravels such as blue metal;
- Recycled aggregates meeting the criteria outlined in the Protection of the Environment Operations (Waste) Regulation 2005 – General Exemption Under Part 6, Clause 51 and 51A – The recovered aggregate exemption 2008.

All materials used as filling, including topsoil and pavement basecourse, must be certified within one of the abovementioned categories. The Environmental Consultant for the UTS Blackfriars site must review and be satisfied with the certification provided prior to allowing the materials to be imported to the site.

Additional confirmatory sampling and testing of the materials may be required by the Environmental Consultant prior to allowing the materials to be imported to the site.

10.2 Validation Sample Collection and Analysis

It is proposed that any validation, waste classification or additional site characterisation samples be collected and analysed at the following frequency:-

- STOCKPILED MATERIAL - 1 sample per 100 m^3 will be taken (or minimum of 3 samples per stockpile) for waste classification. Sample materials to be logged and described in each case. Recovered samples will be analysed for Heavy Metals, PAH, asbestos and TCLP (if required).
- SAMPLES FROM EXCAVATIONS (IF REQUIRED) – 1 sample per 25 m^2 on the excavation base and 1 sample per 15 liner metres along the excavation side walls. Sample depths and materials to be logged in each case. Samples to be analysed for Heavy Metals, PAH, TPH, BTEX and asbestos. *Note that, in general, validation sampling of excavations is not required. May be required in circumstances where the physical barrier system cannot be constructed to specification*.

- IMPORTED VENM or ENM (IF REQUIRED) – 1 sample per 100 - 250 m^3 of imported fill plus certification that the material comprises VENM or ENM including details of the source site. Samples to be analysed for Heavy Metals, PAH, TPH, BTEX, OCP, PCB, Phenols and asbestos.
- TREES TO BE RETAINED – Minimum of 4 samples in the primary root zone, maximum depth 500 mm. Sample depths and materials to be logged in each case. Samples to be analysed for Heavy Metals, PAH, TPH, BTEX and asbestos.
- Asbestos sampling will be conducted in accordance with the NEPM (2013) guidelines. Laboratory analysis of soil will be reported as % weight for weight for fines, and visually for bonded asbestos.

10.3 Sample Collection and Handling

Sampling data shall be recorded to comply with routine Chain of Custody requirements.

The general sampling, handling, transport and tracking procedures comprises:-

- the use of stainless steel sampling equipment;
- washing of all sampling equipment, including drills or excavator parts in contact with the sample, in a 3% solution of phosphate free detergent (Decon 90) then rinsing with distilled water prior to each sample being collected; transfer of the sample into new glass jars, sealed with a teflon lined lid to eliminate cross contamination during transportation to the laboratory;
- labelling of the sample containers with individual and unique identification including Project No. and Sample No.;
- placement of the containers into a chilled, enclosed and secure container for transport to the laboratory; and
- use of chain of custody documentation to ensure that sample tracking and custody can be cross-checked at any point in the transfer of samples from the field to hand-over to the laboratory.

10.4 Quality Assurance Plan

10.4.1 Field QA

Quality assurance (QA) and quality control (QC) procedures will be adopted throughout the field sampling programme to ensure sampling precision and accuracy and prevent cross contamination.

DP will ensure sampling accuracy and precision through the analysis of 10% field duplicate/replicate samples (with 5% inter-laboratory duplicate/replicate and 5% intra-laboratory duplicate/replicates) as well as the collection of field rinsate samples of sampling equipment at a rate of one per 20 samples, or one per day of sampling operations.

Appropriate sampling procedures will be undertaken to ensure that cross contamination does not occur and will follow DP's Standard Operating Procedures Manual. This specifies that:-

- Standard operating procedures are followed;
- Site safety plans are developed prior to commencement of works;
- Duplicate or replicate field samples are collected and analysed;
- Equipment rinsate samples are analysed as part of the QA/QC programme;
- Samples are stored under secure, temperature controlled conditions;
- Chain of custody documentation is employed for the handling, transport and delivery of samples to the selected laboratory; and that
- Proper disposal of contaminated soil, fill or groundwater originating from the site area is completed.

10.4.2 Laboratory Quality Assurance and Quality Control

DP's preferred laboratory will undertake in-house QA/QC procedures involving the routine testing of:-

- Reagent blanks;
- Spike recovery analysis;
- Laboratory duplicate analysis;

- Analysis of control standards;
- Calibration standards and blanks; and
- Statistical analysis of QC data including control standards and recovery plots.

10.5 Achievement of Data Quality Objectives

The DQO process for the remediation and validation works is outlined in Section 6.1.1 of this report.

10.6 Validation Reporting

A validation assessment report will be prepared by a qualified environmental consultant in accordance with NSW DEC Contaminated Sites *Guidelines for Consultants Reporting on Contaminated Sites* (2011) and other appropriate guidance documentation. The report will be submitted to the appropriate certifying authority at the completion of the remediation works program.

The validation report will confirm that the site has been remediated to a suitable standard for the proposed land-use and that no related adverse human health and environmental effects have occurred as a result of the temporary works. The validation report will also include a summary of the information from previous investigations, particularly the materials that remain on-site.

The validation report will record the nature of the physical barrier system at all locations on the site with suitable supporting documentation being provided in regard to barrier thickness, integrity, capping materials, and other treatments applied.

The validation report will include details of the total volume of contaminated materials removed from site, present detailed analytical results where applicable, confirm that placed fill is clean and indicate the final disposal destination of the materials removed from site.

The final validation report will also include, or accompanied by an Environmental Management Plan (EMP) which will include details on the management procedures to be adopted in ensuring the integrity of the physical barrier system, and health and safety precautions to be implemented when accessing (or potentially accessing) the capped contaminated materials.

11. ENVIRONMENTAL MANAGEMENT DURING REMEDIATION AND CONSTRUCTION

It is understood that the remediation and construction works will be carried out in the following general sequence:

- Demolition and removal of existing buildings (non heritage listed) in the southern portion of the site. (The existing site access driveway will be retained for access to the northern portion of the site);
- Construction of new child care centre in the southern portion of the site;
- Excavation of fill materials and construction of physical barrier system in the southern portion of the site, around the newly constructed buildings. Areas provided with the physical barrier system will be fenced off from the remainder of the site to prevent cross contamination during further stages.

This generic EMP applies generally to each of the abovementioned works phases, and should be followed in conjunction with any other environmental management protocols stipulated in relevant WorkCover NSW, Australian Standard, and/or Council requirements.

A site specific Construction Environmental Management Plan (CEMP) shall be provided by the remediation and construction contractor(s). The site specific CEMP shall be reviewed by the environmental consultant. As a minimum, the site specific CEMP shall detail the following:

- Works sequence and timeline;
- Health and Safety Protocols;
- Dust minimisation measures;

- Noise minimisation measures;
- Environment protection measures;
- Equipment to be used;
- Stockpiling locations, including nominated areas for materials not meeting landfill disposal requirements / classifications;
- Nominated landfill(s);
- Truck movements / site access / site egress;
- Proposed source(s) of materials for import, and methods of certification;
- Method(s) for surveying before and after physical barrier construction;
- Measures to prevent cross contamination between areas being remediated (capped) and those already capped;
- Method(s) for inspecting and certifying construction of the physical barrier systems, including any hold points (*may be organised and commissioned by the Principal*).

The remediation and construction works shall be undertaken with all due regard to the minimisation of environmental effects and to meet all statutory requirements. The successful contractor shall have in place the site specific CEMP such that work on the site complies with the requirements as laid down in relevant legislation, guidelines and codes, including, *inter alia*, provisions from the following Acts:-

- Hazardous Chemicals Act;
- Environmentally Hazardous Chemicals Act;
- Dangerous Goods Act;
- Protection of the Environment Operations Act;
- Construction Safety Act;
- Work Health and Safety Act;
- All relevant EPA guidelines; and
- Council DCPs.

The contractor shall also be responsible to ensure that the site works comply with the following conditions:-

- fugitive dust leaving the confines of the site is minimised;
- no water containing any suspended matter or contaminants leaves the site in a manner which could pollute the environment;
- vehicles shall be cleaned and secured so that no mud, soil or water are deposited on any public roadways or adjacent areas; and
- noise and vibration levels at the site boundaries comply with the legislative requirements.

The appointed remediation and construction contractors will be provided with a copy of this RAP so that they are aware of the contamination status of the soils and the remediation methodology to be adopted.

The environmental consultant will also review the CEMP and conduct an induction to ensure adequate understanding of the RAP.

The following sub-sections provide details of the environmental management practices to be employed as a minimum at the site in order to minimise and/or prevent environmental impact as a result of the remediation and/or construction works. Again, it is noted that other statutory requirements must also be followed.

11.1 Site Delineation

As stated above, construction within the site will be staged to permit ease of relocation of the childcare centre and minimal disturbance to the ongoing use of the site. Each stage of remediation and construction will be appropriately fenced off from the remainder of the site. The fencing will include appropriate hoarding and will be designed to:

- Prevent unauthorised entry to the work site;
- Minimise the potential for cross contamination between remediated and yet to be remediate portions of the site;
- Capture and contain minor dust generations;
- Manage some of the noise generation.

The fencing alignment applicable to each stage of works will be included in the CEMP.

11.2 Dust Control

Although no asbestos has been identified in the fill materials at the site, the presence of various amounts of building rubble in the fill suggests there is a potential for asbestos of some form to be present in the fill.

Generation of dust, therefore, will be kept to a minimum at all times.

During working hours, water sprays will be used to keep the surface of any works areas and stockpiled soils (which will be kept to a minimum) reasonably damp, in order to suppress any dust. Water used for dust suppression will be only the minimum required to reduce dust generation and will not be allowed to escape the confines of the works areas. If excessive dust is being generated, works will cease until the dust is sufficiently suppressed.

During non-working hours, all soil stockpiles will be covered with industrial strength plastic and/or tarpaulins, securely weighted to ensure they are not blown away by strong winds.

Note that should asbestos be encountered in the fill during any stage of remediation and/or construction works, air monitoring will be required. Air monitoring devices would be kept at locations nominated by an appointed Occupational Hygienist, but will generally be at the works area boundaries. The Hygienist would check the filters regularly for asbestos fibres. If asbestos fibres are detected during the course of the works, the remediation works will cease and dust prevention measures improved. The Occupational Hygienist will provide instruction.

11.3 Soil / Sediment Containment

Industry standard sediment control measures, such as sediment fencing and/or hay bales, shall be installed where there is a potential for sediment to spill onto neighbouring properties, public roads or the stormwater drainage lines.

The sediment control measures shall be regularly inspected and maintained by the site foreman. The environmental consultant will also carry out regular inspections.

11.4 Noise Management

Noise impacts will generally result from the excavators, truck movements and construction equipment within the site and surrounding streets, all of which have noise levels within levels normally expected at a construction site.

In order to minimise noise impacts during the remediation works, the following measures shall be implemented:

- Construction noise will be confined to the hours stipulated by Council. No machinery / trucks will be permitted to access the site outside these hours of operation;
- Signage at the site entrance providing contact details for the site superintendent, so that noise complaints can be readily addressed;
- Establishment and monitoring of a complaints log;
- All equipment and machinery will comply with regulatory standards for noise generation;
- Fitting mobile equipment with exhaust mufflers, when and if required; and
- Adopting traffic management measures to reduce noise.

11.5 Odour Control

In order to control odours at the site boundaries, the following processes shall be adopted:

- All plant and equipment exhaust levels will be monitored by the site foreman / superintendent to ensure acceptable levels. If unacceptable levels are determined, the equipment will be replaced or repaired;
- If strong hydrocarbon odours are detected from any of the machinery a hydrocarbon mitigating agent will be used;

- A complaints register will be set up on-site for recording complaints from residents or tenants, with respect to odours or dust. The complaints register will be completed by the Site Superintendent, as well as the corrective actions implemented; and
- Once a complaint is received, the site superintendent will implement a corrective action to rectify any problems associated with the odour or dust source.

Investigations performed to date have not identified any volatile contaminants in the soil that could generate odours and, therefore, odours are not anticipated or expected to be significant. If, however, odours are detected during the works the following protocol will be applied:

- Odour source and type of odour to be investigated by the environmental consultant. This could include air monitoring or sampling of any suspect media in addition to observations of physical conditions;
- Temporary covering of the source to mitigate odours whilst waiting for monitoring/analytical results. This could include the temporary reinstatement of ground conditions;
- Assessing more permanent ways of dealing with the issue. This could include disposal of odorous material off site, the use of masking agents or the controlled progressive excavation etc; and
- The re-use of odorous soils for construction purposes will not be undertaken unless the material has been aerated or suitably treated and the odorous material assessed to be suitable and the odour to have adequately attenuated.

12. OCCUPATIONAL HEALTH & SAFETY

A site specific Occupational Health & Safety (OHS) Plan is to be prepared and submitted for approval by the appointed remediation and construction contractor(s). The following protocols are to be observed during the works and are to be incorporated into the appropriate contractors' plan.

- Site Induction. As part of the site induction, site workers are to be advised on:
  - the contamination status of the site including the location, nature, type and concentration of contaminants present;
  - the risks associated with the contaminants;
  - the location and the methods of field identification of contamination hot-spots;
  - the occupational health and safety monitoring to be undertaken (as required by site conditions); and
  - the occupational health and safety controls to mitigate the risks (including personal protective equipment [PPE] and, as required, air monitoring).

- Small scale earthmoving activities (for example, trenching) will not create a significant dust problem, however, dust levels must be kept to a minimum at all times and water suppression techniques are to be available and used as appropriate (Refer to Section 10.1).

- All earthworks plant to incorporate air-conditioned cabs and:
  - Cabs to be enclosed at all times during operation;
  - Cabs to be cleaned daily to remove accumulated dust and dirt;
  - Cabs to be monitored for dust and, in the case of asbestos works, asbestos; and
  - Appropriate personal PPE to be available within the cab.

- Work to cease immediately when odours, unusual discolouration or fibro (or other asbestos-based materials) found within the fill (in the case of asbestos, refer to Section 12, Asbestos Finds Protocol). When asbestos, odours or other indicators of environmental concern are noted, the project Environmental Manager must be informed immediately. He will assess the situation and make a determination on the steps to be taken to make the situation safe and to resolve the issue. This would include seeking advice from the environmental consultant and/or an occupational hygienist (for asbestos); and

- NO material containing asbestos-based materials is to be left exposed for an extended period or compacted when exposed.

12.1 Personal Protective Equipment (PPE)

All personnel working where contact can be made with contaminated soil (dust or direct contact), will comply with a minimum level of PPE. The minimum level is in addition or complementary to PPE required for the project generally and will include the following:

- Hard hat complying with AS 1801 (type 1);
- Coloured reflective vest or high visibility work clothing complying with AS 462 and 1906.4;
- Steel-capped safety boots;
- Leather or nitrile gloves or similar when working directly in contaminated soil such as trench excavations and laying services; and
- Long sleeved shirt and long trousers (may be combined with safety vest as per above).

All staff shall be provided with safety goggles and a P2 disposable dust mask with a valve complying with AS 1716, for use as conditions dictate (e.g. dusty conditions).

In addition to PPE there are also management measures which should be observed. These will include observing a no smoking, eating or drinking rule when outside of site sheds, washing hands and face before eating etc. Toolbox sessions and inductions will also emphasise the need to limit hand-to-mouth gestures.

12.2 PPE in Asbestos Affected Areas (if encountered)

As discussed earlier in this report, asbestos has not been identified as a specific contaminant associated with the site. However, as building rubble has been found at some sampled locations there is considered to be a possibility of asbestos being present within the fill.

WorkCover classifies the presence of fragments of asbestos-cement sheet (fibro) in soil as friable asbestos and soil containing fibro needs to be removed by a contractor with a Class AS1 licence. Should asbestos be encountered during the works (refer to Section 12), the PPE for works associated with areas containing asbestos also needs to conform to the requirements of the Code of Practice for the Safe Removal of Asbestos, NOHSC, 2005 but generally as follows:

- Masks suitable for asbestos removal work will be worn at all times during removal work by those involved and should be a P2 disposable dust mask or a particulate half-face mask with a P3 filter as determined for the asbestos removal task to be undertaken;
- Disposable coveralls, preferably orange in colour. Coveralls shall not be used more than once. A reflective orange vest needs to be worn if coveralls not coloured orange;
- Suitable gloves; and
- Steel capped boots.

12.3 Air Monitoring (if Asbestos Encountered)

Air monitoring for asbestos fibres will be carried out within the site and on its borders during asbestos-contaminated soil removal (if asbestos is found) and will include monitors placed at the perimeter of the asbestos work zone and/or the site.

The sampling locations will be determined by the extent of the potential source of airborne fibres (area of disturbed fill), the nature of down-gradient receptors (sensitive receptors such as residences) and potential fibre generating activities taking place (plant movement).

Air monitoring (if required) will be carried out by a qualified Occupational Hygienist. Filter analysis (fibre counting) will be carried out by a NATA accredited laboratory. Monitoring results must be available the day after sampling. The action level of asbestos air monitoring will be as shown below:

- < 0.01 fibres per millilitre – Continue with control measures;
- > or = 0.01 fibres per millilitre – Review control measures; and
- > or = 0.02 fibres per millilitre – Stop removal work and find the cause.

Concentrations exceeding the action level will require that operations are temporarily ceased and an Occupational Hygienist is consulted to investigate the exceedance and to provide a specific protocol or management plan for continued safe work.

13. UNEXPECTED ASBESTOS FINDS PROTOCOL

Whilst investigations to date have not determined the presence of asbestos in the fill / soils, it is possible (due to the presence of building rubble in the fill) that asbestos-based materials may be uncovered during the remediation and/or construction works. This is likely to be in the form of asbestos-cement sheet fragments (fibro) and is only likely to occur.

The physical barrier system proposed for the site is also considered suitable for soils containing asbestos. As such, the remediation approach will not change upon the identification of asbestos in the soil. The only changes will be in the execution of the works (i.e. worker and public protection, monitoring, and licensing) and the classification of any soils requiring off-site disposal.

In the event that asbestos-containing material is encountered, the following 'Asbestos Finds Protocol' has been established:

1. Upon discovery of suspected asbestos containing material, the site foreman is to be notified and the affected area closed off by the use of barrier tape and warning signs. Warning signs shall be specific to Asbestos Hazards and shall comply with the Australian Standard 1319-1994 – Safety Signs for the Occupational Environment;
2. The Environmental Consultant or an Occupational Hygienist is to be notified to inspect the area and confirm the presence of asbestos and determine extent of remediation works and confirm the protocols to be adopted. A report detailing this information will be compiled and provided to the construction manager;
3. The impacted soil (where it forms part of the required construction or remediation excavation process) will be stockpiled for waste classification purposes (including sampling and chemical analysis) and will be disposed of, as a minimum, as asbestos

contaminated waste at an appropriately licensed solid waste landfill site. The stockpile will be lightly wetted and covered with a plastic sheet whilst awaiting disposal;

4. All work associated with asbestos in soil will be undertaken by a contractor holding a class AS1 Licence. The AS1 licensed contractor will liaise with WorkCover as required and obtain all necessary permits to undertake the work. Works will be carried out in accordance with the *Code of Practice for the Safe Removal of Asbestos*, 2nd Edition, 2005;
5. Monitoring for airborne asbestos fibres is to be carried out during the soil excavation;
6. Documentary evidence (weighbridge dockets) of correct disposal is to be provided to the construction manager;
7. At the completion of the excavation, a clearance inspection is to be carried out and written certification is to be provided by an Occupational Hygienist that the area is safe to be accessed and worked; and
8. The area may be reopened for further general excavation or construction work.

Although the presence of fibro in soil is potentially classifiable as friable asbestos by WorkCover (the actual classification status is to be verified by the occupational hygienist), the removal and disposal of soil containing fibro will not include a formal, wet decontamination procedure, encapsulation of the affected area or the use of negative air unit. The licensed contactor must establish, however, a separate area where employees can safely and securely leave clothing and change into disposable suits as necessary.

14. CONTINGENCY PLAN

In some circumstances, remediation works can be unpredictable. The following Table 4 presents anticipated potential problems or events and the corresponding corrective actions to be implemented.

Table 4 - Contingency Plan

Incident / Event	Corrective Action
Design physical barrier thickness cannot be achieved	Environmental consultant to ascertain the risk associated with a reduced barrier thickness and/or determine an alternative, including possibly a more permanent hardstand cover.
Underground storage tank uncovered during excavation works (not anticipated)	Area to be fenced off from remainder of works UST to be decommissioned and removed by a licensed contractor in accordance with WorkCover guidelines. Environmental consultant to investigate the likely nature and extent of soil and groundwater contamination at the location of the UST and advise appropriate remediation, if considered necessary. Remediation to be undertaken and validated by environmental consultant.
Area of potentially significant contamination encountered during excavations (ie. visible or odorous indicators)	Area to be fenced off from remainder of works Environmental consultant to investigate soil and groundwater contamination at the location of the potentially significant contamination and advise appropriate remediation, if considered necessary. Remediation to be undertaken and validated by environmental consultant.
Asbestos-containing materials encountered during excavation works	Action outlined in Section 12
Spillage/leakage of oil, hydraulic fluid, or other fuels from the excavator/backhoe and trucks	For major spill; place sandbags down slope, cover area in sand, excavate impacted sand and soils and dispose of at an appropriate EPA approved facility. For minor spill; cover area in sand, excavate impacted sand and soils and dispose at an EPA approved facility. Stop spillage/leakage where apparent.
Failure of sediment control measures	Replace or repair failed control measure Determine reason for failure and ensure no repeat Clean up any materials penetrating the safeguard and return to either the stockpile or excavation (origin).

Other contingency plans are outlined in various sections of this RAP.

15. SITE PERSONNEL AND RESPONSIBILITIES

The project CEMP will outline the environmental responsibilities and authorities for the Project Manager, Project Environmental Manager, Site Manager and Foremen. The environmental responsibilities and authorities for the implementation of this RAP must comply with the approved CEMP requirements.

The objective of this section is to define a clear line of responsibility and to ensure that the function of the role of each of the personnel is identified in order to maximise the safety of all site users and occupants with respect to environmental and OH&S issues.

Figure 1, below, shows the overall organisational structure and responsibility for the remedial works.

All designated personnel and contractors working on the site must be made aware of the line of responsibility for implementing the RAP and must follow environmental management and health and safety procedures. Each of the designated individuals must be aware of their own responsibilities on the site and who to contact in the event of an incident, or for advice on procedures and protocols to maximise:

- OH&S to all site users, occupants and surrounding community; and
- environmental protection for the site and surrounding areas.

All designated personnel must have read and/or understood the provisions of the RAP prior to entry to the site, commencement of site works or monitoring works which may have health and safety or environmental implications. All personnel will have to undergo a site induction, and will have to sign a statement to that effect.

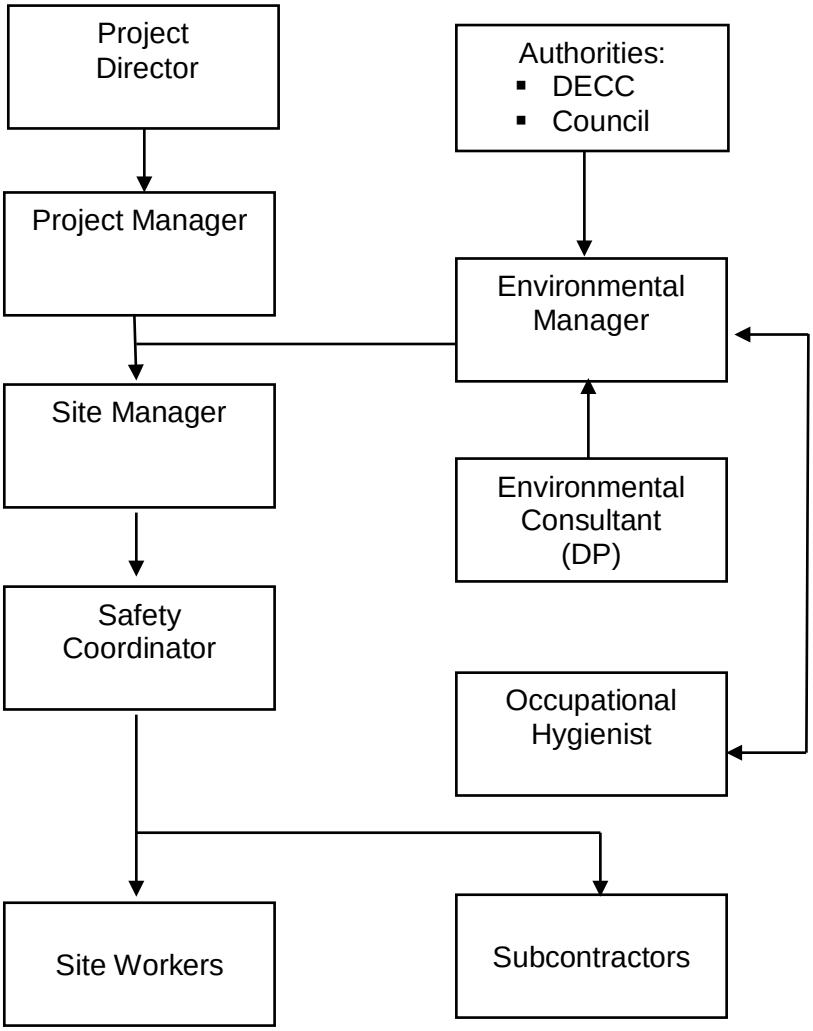
Similarly, all contractors employed to carry out the works on or near contaminated spoil at the site will be responsible for ensuring that their employees are aware of, and comply with, the requirements of the approved CEMP.

The above provisos clearly do not pertain to casual users and visitors of the facility once it is operational.

The personnel involved in implementing the CEMP during remedial works are:

- Hutchinson Builders Construction Manager;
- Hutchinson Builders Project Manager;
- Hutchinson Builders Site Manager;
- Hutchinson Builders Environment Manager
- Hutchinson Builders Site Safety Coordinator; and
- Individual sub-contractors.

FIGURE 1: Line of Responsibility



16. CONCLUSION

Subject to proper implementation of the RAP and validation reporting, DP consider that the site can be made suitable for the proposed redevelopment.

The site remediation is to involve the construction of a suitable physical barrier system. The system will effectively cap the underlying fill materials which have been found to be sporadically contaminated, primarily with some metals, PAH and TPH.

Based on the contamination assessment findings, short term exposure during remediation and construction works is not expected to pose an unacceptable risk to workers. An EMP will be developed as part of the final validation process, which will be used as an instrument to manage the integrity of the physical barrier system and protect workers who may become exposed to the contaminated materials in the future.

It should also be noted that the City of Sydney DCP on Contaminated Land will require placement of a covenant on the title for the land. Any maintenance works that are required or any works that are carried out need to be advised to an Environmental Health Officer from Council and records collected for any works conducted at the site. These records should be kept for future reference.

DOUGLAS PARTNERS PTY LTD

Reviewed by:

pp. **Kate Sargent**
Environmental Scientist

Paul Gorman
Senior Associate

APPENDIX A
Site Drawings
Notes About this Report

PRELIMINARY

LEGEND

- ELECTRICITY PIT
- ELECTRICITY POLE WITH LIGHT
- ELECTRICITY POLE
- GAS VALVE
- HYDRANT
- LIGHT POLE
- MANHOLE (UNSPECIFIED)
- POLE (UNSPECIFIED)
- PIT (UNSPECIFIED)
- SEWER PIT
- SEWER MANHOLE
- STOP VALVE
- STORMWATER GRATE
- STORMWATER MANHOLE
- STORMWATER PIT
- TELECOM PIT
- TELECOM PILLAR
- TRAFFIC SIGNAL
- WATER VALVE
- E — UNDERGROUND ELECTRICITY
- G — UNDERGROUND GAS
- E — OVERHEAD POWER LINES
- S — UNDERGROUND SEWER
- UNDERGROUND STORMWATER
- W — UNDERGROUND WATER
- T — UNDERGROUND TELECOMMUNICATIONS

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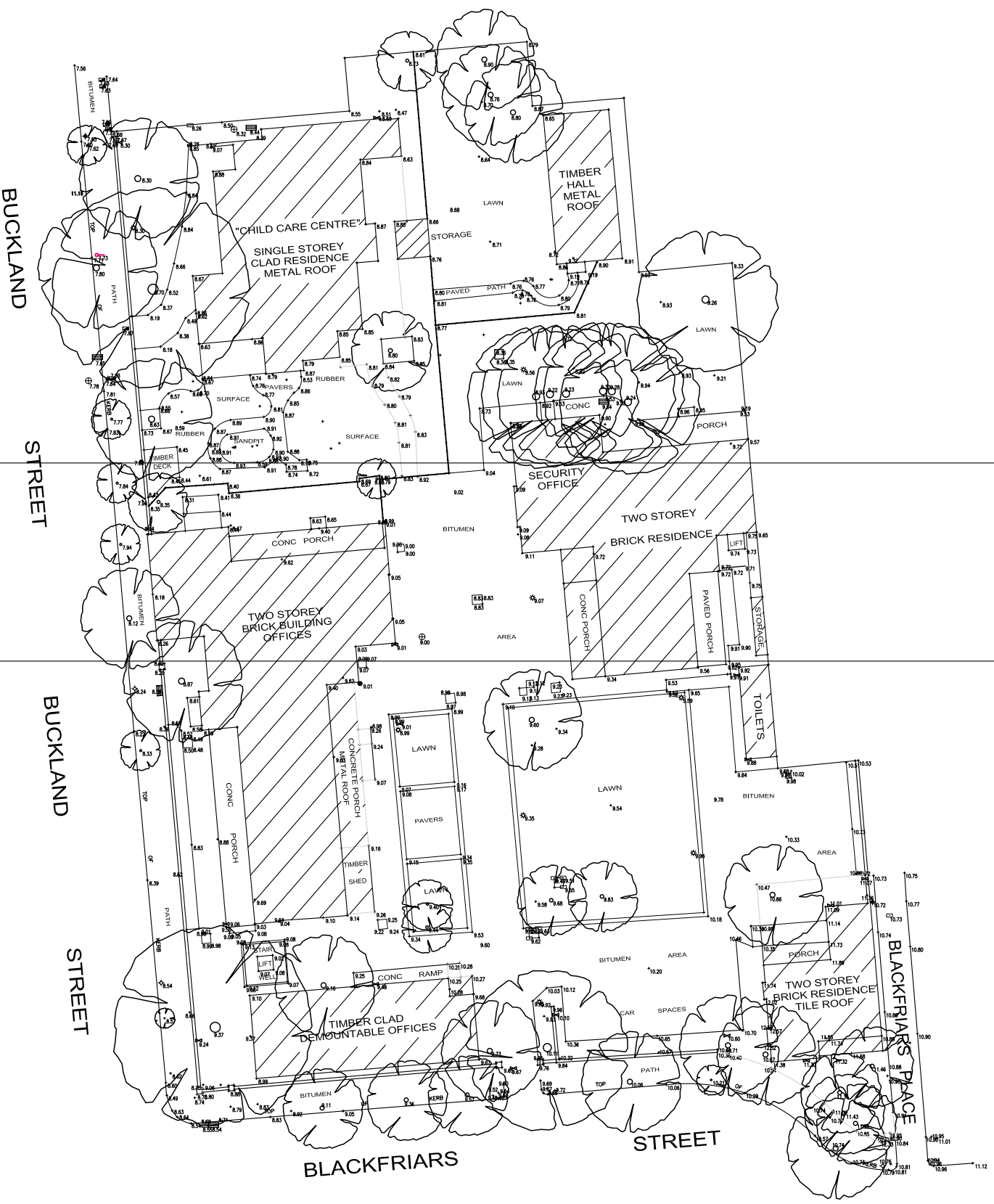

NOTES:

CONSTRUCTION WORKS MUST BE RELATED TO THE SITE BENCH MARK AND NOT LEVELS OF STRUCTURES SHOWN ON THE PLAN.

LIMITED BOUNDARY SURVEY MADE. IF ANY CONSTRUCTION IS INTENDED IN THE PROXIMITY OF THE BOUNDARIES IT IS RECOMMENDED THAT A FURTHER SURVEY BE REQUESTED FOR THE MARKING OF THE RELEVANT BOUNDARIES.

TREE SPREADS & TRUNK DIAMETERS SHOWN ARE DIAGRAMMATIC ONLY AND TREE HEIGHTS ARE ESTIMATED. IF ANY OF THESE ELEMENTS ARE CRITICAL TO DESIGN (IN PARTICULAR DRIPLINES) MORE SPECIFIC DETAILS SHOULD BE REQUESTED FOR ACCURATE LOCATION.

VISIBLE SURFACE PITS ONLY SHOWN.
THE EXISTENCE AND POSITION OF UNDERGROUND SERVICES HAS NOT BEEN INVESTIGATED. IT IS THE RESPONSIBILITY OF EACH CONTRACTOR AND/OR CONSULTANT TO CONTACT THE RELEVANT AUTHORITY AND/OR "Dial Before You Dig" (Phone 1100 Fax 1300 652 077) BEFORE COMMENCING ANY EXCAVATION.

THIS PLAN HAS BEEN CREATED AT A SCALE OF 1:200 AND MAY NOT BE SATISFACTORY FOR OTHER PURPOSES. THE ACCURACY OF ANY ENLARGEMENT OR OTHER REPRODUCTION MAY BE LESS THAN THAT OF THE ORIGINAL.

9.86

REV.	DATE	AMENDMENTS

RYGATE & COMPANY PTY. LIMITED

SURVEYORS, TOWN PLANNERS
ROAD & DRAINAGE ENGINEERS
81 YORK STREET, SYDNEY 2000

PHONE 9262 6800
FAX 9262 6843
ABN 61 001 204897
www.rygate.com.au
Email: surveyors@rygate.com.au

SURVEYOR	DRAWN	CHECKED	APPROVED
SF	SC		

0 — 20
REDUCTION RATIO 1:200 @ A1

DATUM : AUSTRALIAN HEIGHT DATUM

CONTOUR INTERVAL :

ORIGIN OF LEVELS : P.M.109010 R.L.9.615 A.H.D

THIS TITLE BLOCK AND NOTES FORM AN INTEGRAL PART OF THE PLAN AND MUST BE REPRODUCED IN ANY USE, DUPLICATION OR AMENDMENT.

CLIENT

UNIVERSITY OF TECHNOLOGY SYDNEY

NOTES:

LOCALITY — CONSTRUCTION WORKS MUST BE RELATED TO THE SITE BENCH MARK AND NOT LEVELS OF STRUCTURES SHOWN ON THE PLAN

L.G.A. — LIMITED BOUNDARY SURVEY MADE. IF ANY CONSTRUCTION IS INTENDED IN THE PROXIMITY OF THE BOUNDARIES IT IS RECOMMENDED THAT A FURTHER SURVEY BE REQUESTED FOR THE MARKING OF THE RELEVANT BOUNDARIES.

PLAN
SHOWING DETAIL & LEVELS
BLACKFRIARS CAMPUS

TREE SPREADS & TRUNK DIAMETERS SHOWN ARE DIAGRAMMATIC ONLY AND TREE HEIGHTS ARE ESTIMATED. IF ANY OF THESE ELEMENTS ARE CRITICAL TO DESIGN (IN PARTICULAR DRIPLINES) MORE SPECIFIC DETAILS SHOULD BE REQUESTED FOR ACCURATE LOCATION.

VISIBLE SURFACE PITS ONLY SHOWN.
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CAD REFERENCE —

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REFERENCE No.	PLAN No.	DATE	SHEET No.
72875	72875.DGN	26/09/2007	— OF — SHEETS

PRELIMINARY

LEGEND

- ELECTRICITY PIT
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- UNDERGROUND STORMWATER
- W — UNDERGROUND WATER
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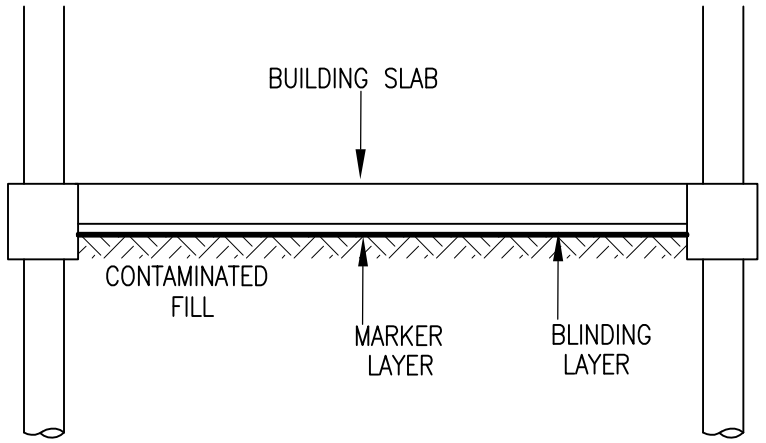
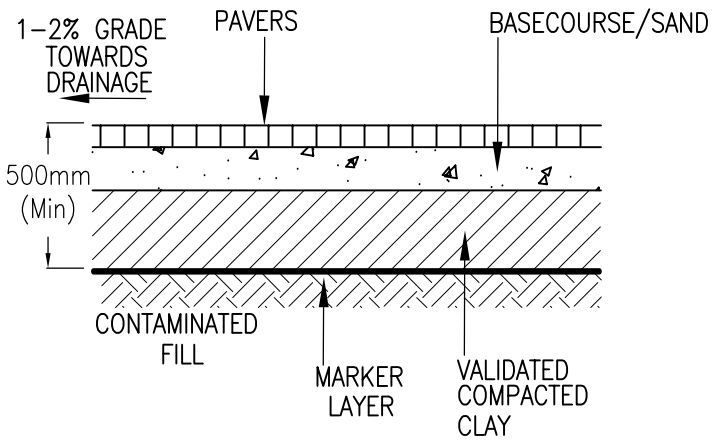
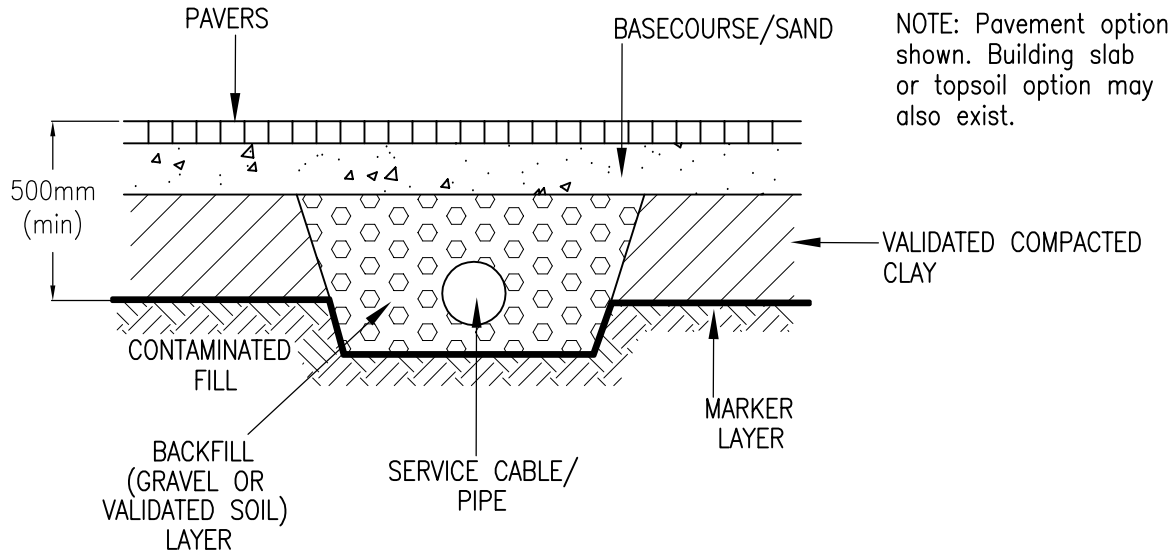


BUILDING SLAB

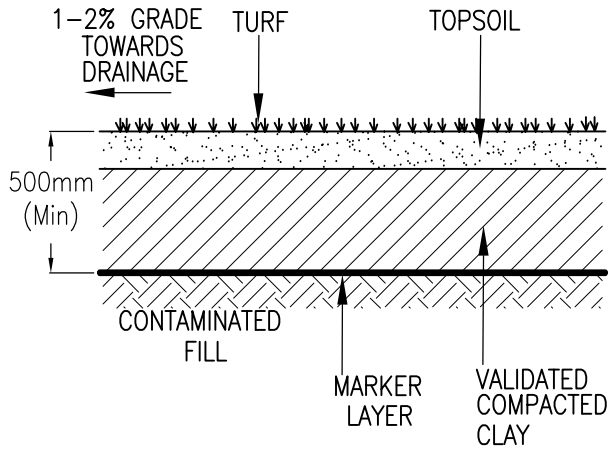


PAVING

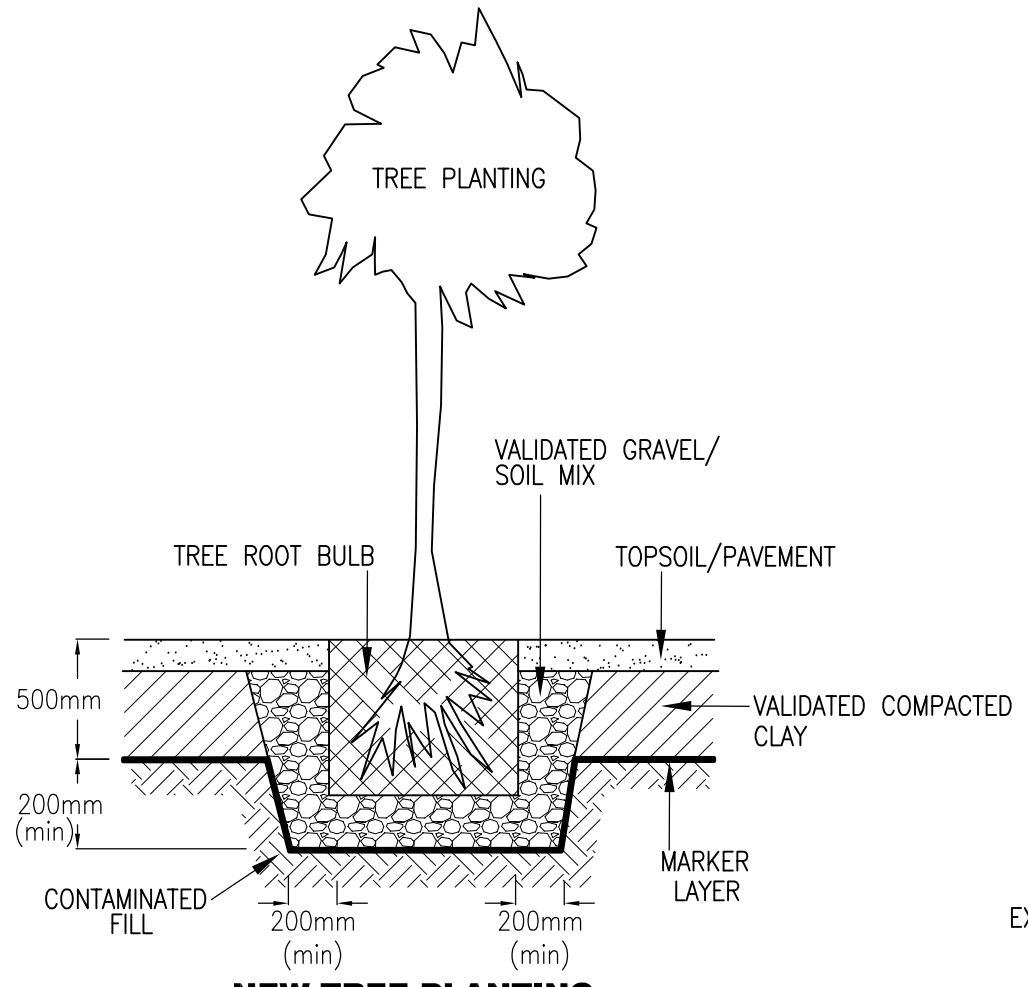


NOTE: Pavement option shown. Building slab or topsoil option may also exist.

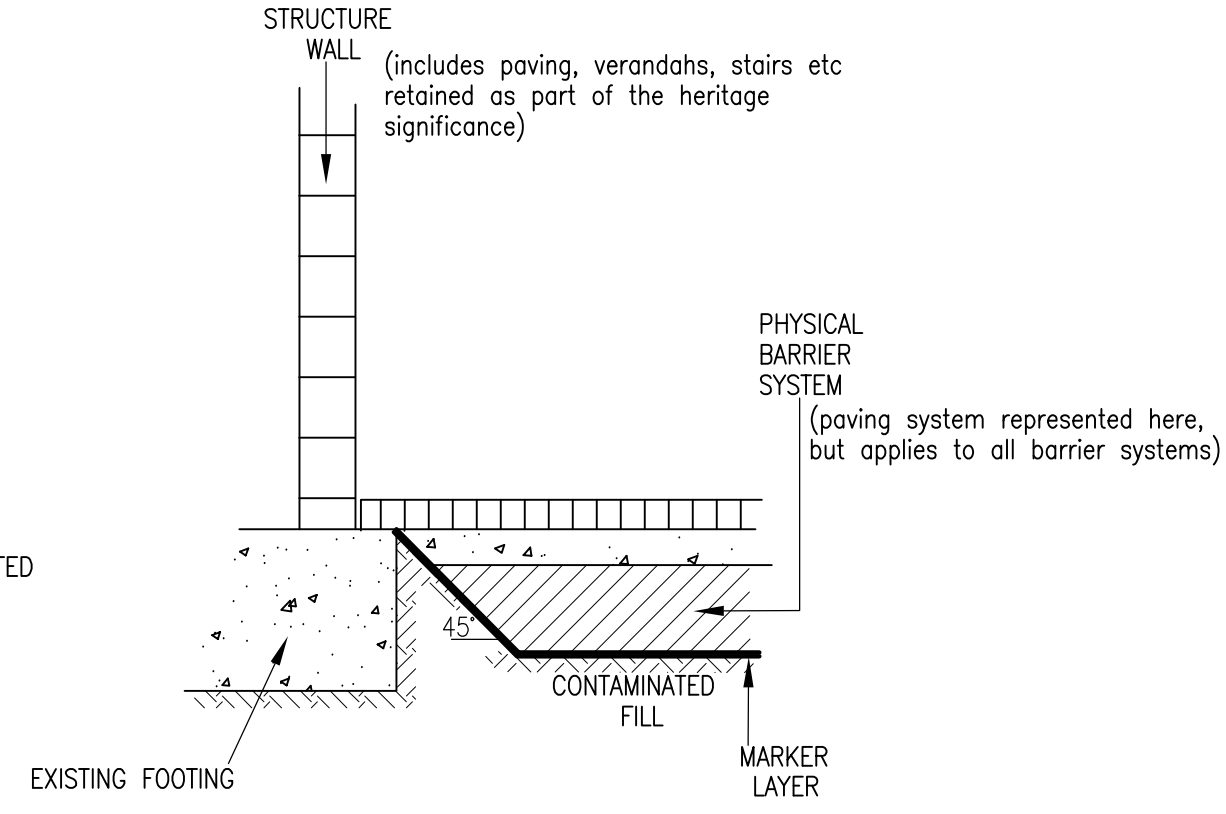
SERVICE LINE



GENERAL LANDSCAPING



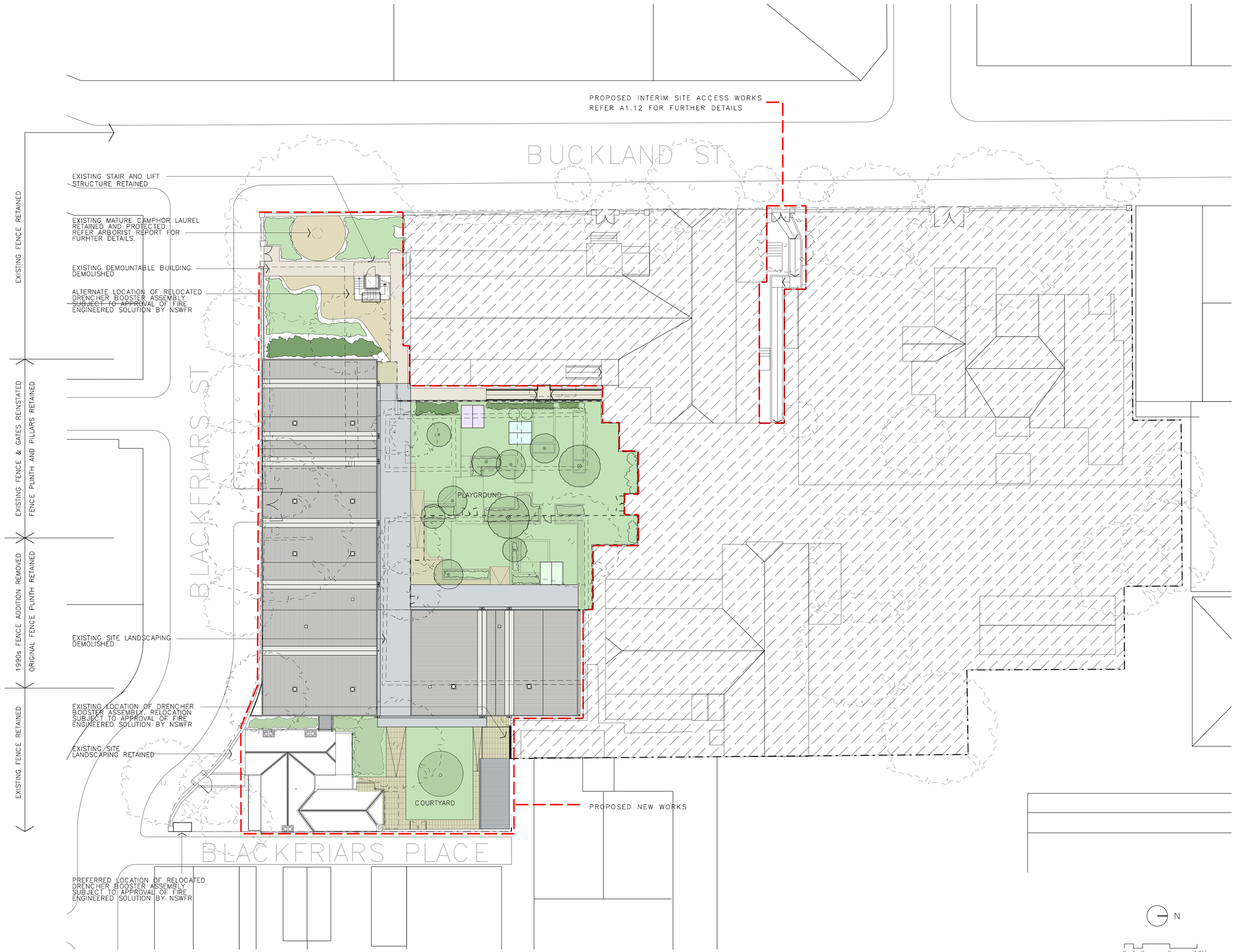
NEW TREE PLANTING
(Refer to Context plans for more detail)



EXCAVATIONS ADJACENT TO EXISTING STRUCTURES

Douglas Partners
Geotechnics • Environment • Groundwater

CLIENT: Hutchinson Builders			TITLE: **Barrier System Details**	PROJECT No: 45996.02
DRAWN BY: PSCH	SCALE: N.T.S.	OFFICE: Sydney	**UTS Blackfriars Campus**	DRAWING No: 2
APPROVED BY:		DATE: 6.3.2009	**CHIPPENDALE**	REVISION: A



Rev.	Description	Approved Date
P1	Preliminary Issue	22.08.12
P2	Review issue	03.09.12
01	DA issue	06.09.12
02	Final DA issue	22.03.13

Consultants

Architects

Daryl Jackson Robin Dyke Pty Ltd

LACOSTE + STEVENSON Architects

64 Rose Street Chippendale NSW 2008
T +612 9319 2955 F +612 9698 1116
www.djrd.com.au

JACKSON ARCHITECTURE

Project Name
UTS
BLACKFRIARS CHILDRENS CENTRE

University of Technology, Sydney
FACILITIES MANAGEMENT UNIT
Tower, Building 1, Level 19, 15 Broadway
Broadway NSW 2007
Ph: 9514-2830 Fax: 9514-4690

Consultant Drawing Title
SITE PLAN

Consultant Drawing No
A1.01

FMU Project Number
02447-N-12

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TD	GH	GH	22.03.13

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CC01AP	28651	02

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
Proposed Development Drawings

MATERIALS KEY

WP	WET POUR RUBBER
D	DECK - HARDWOOD TIMBER
SP	SAND PIT
AT	ARTIFICIAL TURF
M	PLAY MULCH
MP	MULCHED PLANTING BED
IC	INSITU CONCRETE, EXPOSED AGG FINISH
BE	BRICK EDGE
SB	TIMBER STORAGE BOX
	750mm HIGH INTERNAL FENCE
	1.5m HIGH BOUNDARY FENCE

PLANTING SCHEDULE

	LATIN/COMMON NAME	MATURE HT	SIZE	SPACING	QTY
	Trees				
BC	Backhousia citriodora - Lemon Myrtle	6-7m	100L	-	3
BM	Bambusa multiplex - Stripestem Fernleaf	3-4m	35L	-	5
CR	Citrus reticulata 'Emperor' - Emperor Mandarin	5m	25L	-	2
FR	Fraxinus ang. 'Raywood' - Claret Ash	10m	400L	-	1
LI	Lagerstroemia ind. x. L.Fauriei 'Biloxi' - Crepe Myrtle	6-7m	75L	-	3
TS	Triadica sebifera - Chinese Tallow Wood	7m	100L	-	1
UP	Ulmus parvifolia - Chinese Elm	8-9m	100L	-	1
	Shrubs, Grasses and Groundcover				
C	Coleonema p. 'Compactum' - Dwarf Diosma	1m	200	700	28
d	Dianella tas. 'Wyeena' TAS 300 PBR - Wyenna	800mm	150L	500	23
DB	Dietes bicolour - Fortnight Lily	1m	200	700	23
L	Liriope muscari 'Evergreen Giant' - Liriope	600mm	200	500	55
	Ophiopogon japonicus - Mondo Grass	300mm	150	300	75
P	Pennisetum adv. 'Rubrum' - Purple Fountain Grass	1.2m	200	700	22
s	Scaevola aem. 'Purple Fanfair' - Scaevola	300mm	150	500	24
W	Westringia f. 'Jervis Gem' - Dwarf Westringia	1m	200	700	16

*All plants specified are water wise, drought tolerant and low maintenance
All planting beds will be mulched to help retain soil moisture

Rev.	Description	Approved Date
1	Preliminary DA Review	120828
2	for DA Submission	120904

Consultant

ric mcconaghy pty ltd
po box 6
woodford nsw 2778
mobile: 0419 229 920
office: 02 4758 6556
email: ric@rmpl.com.au
www.rmpl.com.au

pod landscape architecture
Level 7, 80 William St
East Sydney NSW
Australia 2011

Project Name
BLACKFRIARS CHILDCARE

FMU Project Number
02447-N-12

University of Technology, Sydney
FACILITIES MANAGEMENT UNIT
Tower, Building 1, Level 19, 15 Broadway
B r o a d w a y N S W 2 0 0 7
Ph: 9514-2830 Fax: 9514-4690

Drawing Title
LANDSCAPE PLAN

Drawn By	Checked	Approved By	Date App.
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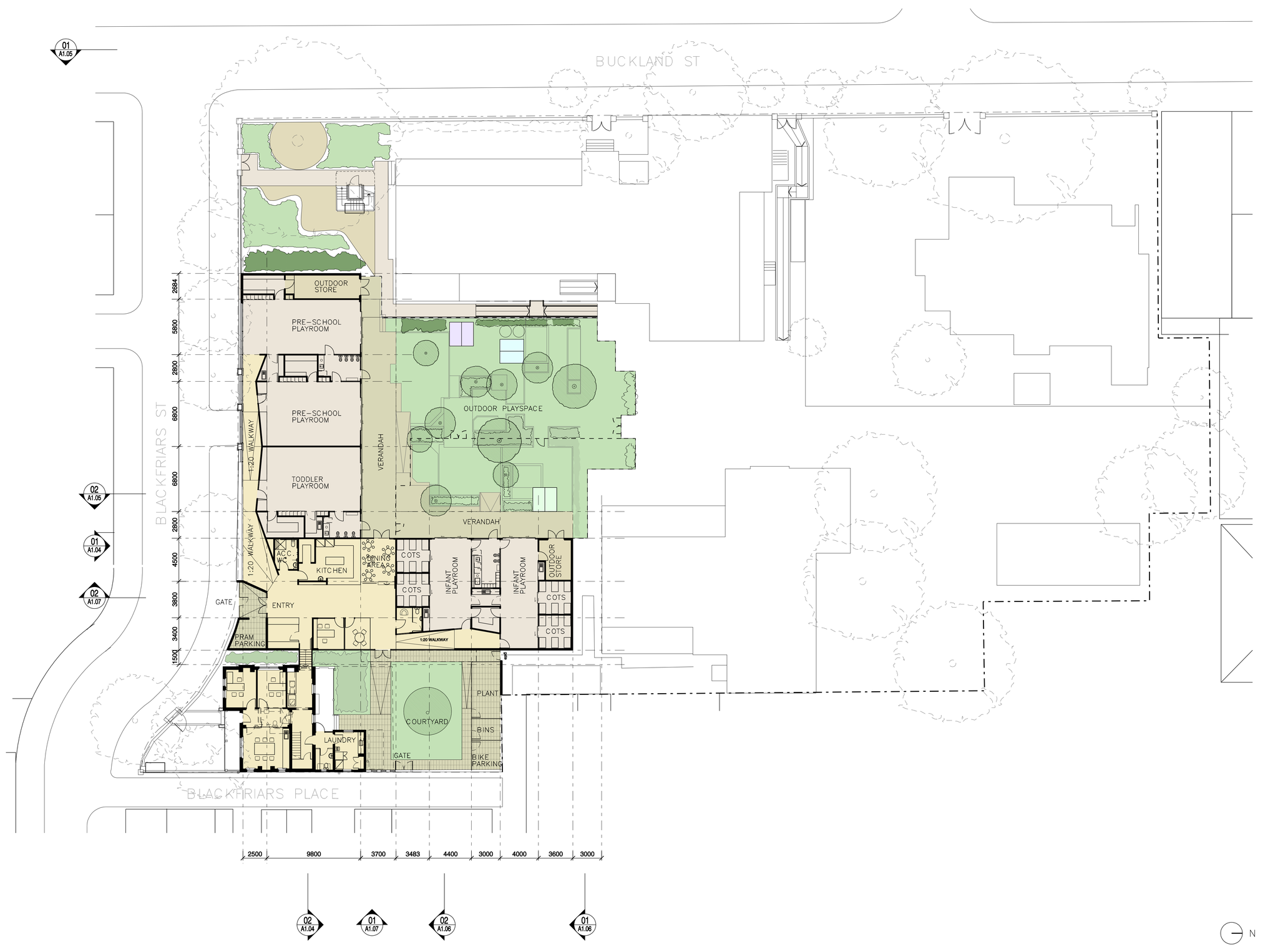

Rev.	Description	Approved Date
P1	Preliminary issue	22.08.12
P2	Review issue	03.09.12
01	DA issue	06.09.12
02	Final DA issue	22.03.13

Consultants

Architects

Daryl Jackson Robin Dyke Pty Ltd

LACOSTE + STEVENSON Architects

64 Rose Street Chippendale NSW 2008
T +612 9319 2955 F +612 9698 1116
www.djrd.com.au

Project Name
UTS
BLACKFRIARS CHILDRENS CENTRE

University of Technology, Sydney
FACILITIES MANAGEMENT UNIT
Tower, Building 1, Level 19, 15 Broadway
Broadway NSW 2007
Ph: 9514-2830 Fax: 9514-4690

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GROUND FLOOR PLAN

Consultant Drawing No
A1.02

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URBAN FORESTRY AUSTRALIA

TREE MANAGEMENT CONSULTING ARBORICULTURISTS

ARBORICULTURAL

DEVELOPMENT IMPACT ASSESSMENT

for

University of Technology, Sydney
C/- Daryl Jackson Robin Dyke Pty Ltd
64 Rose Street
CHIPPENDALE NSW 2008

SITE ADDRESS
UTS CAMPUS
BLACKFRIARS STREET
CHIPPENDALE NSW

SEPTEMBER 2012

MEMBER OF
INSTITUTE OF AUSTRALIAN
CONSULTING ARBORICULTURISTS

URBAN FORESTRY AUSTRALIA
Consulting Arboriculturists
www.urbanforestryaustralia.com.au
PO Box 151
Newport Beach NSW 2106
Email:cat@urbanforestryaustralia.com.au
Telephone: (02) 9918 9833
Facsimile: (02) 9918 9844
Mobile: 0414 997 417

CONTENTS

1 INTRODUCTION

1.1 This Arboricultural report was commissioned by Daryl Jackson Robin Dyke Architects, on behalf of the owners of the subject site.
"The site" is identified as the University of Technology Sydney Blackfriars Campus, 4 – 12 Buckland Street, Chippendale, New South Wales.

1.2 This report is to accompany a development application to the City of Sydney for a proposed childcare centre.

1.3 The purpose of this report is to assess the *vigour* and *condition* of the surveyed trees and identify the potential impacts the proposed development may have on those trees in proximity to the works.

1.4 This report gives recommendations for tree retention or removal, and provides guidelines for tree protection and maintenance.

1.5 Care has been taken to obtain all information from reliable sources.
All data has been verified as far as possible; however, I can neither guarantee nor be responsible for the accuracy of information provided by others.

1.6 This Arboricultural report is not intended as an assessment of any impacts on trees by any proposed future development of the site, other than the current development application.

1.7 This report is not intended to be a comprehensive tree *hazard* or *risk* assessment; however the report may make recommendations, where appropriate, for further assessment, treatment or testing of trees where potential structural problems have been identified, or where below ground investigation may be required.

2 METHODOLOGY

2.1 In preparation for this report, Catriona Mackenzie, Australian Qualification Framework Level 5 arboriculturist and principal of Urban Forestry Australia ("UFA") carried out ground level *visual tree assessments* of twenty-three (23) trees in, or in close proximity to the site. Inspection details of these trees are provided in Appendix E – *Schedule of Assessed Trees.*

2.2 Tree heights and canopy spreads were visually estimated. Unless otherwise noted in the Schedule of Assessed Trees (Appendix E), trunk diameters were measured at 1.4 metres above ground level using a diameter tape.

2.3 Trees surrounded by construction/exclusion fencing were subject to limited inspections as UFA did not have permission to enter those areas. Where relevant, this is noted in Appendix E.

2.4 Field observations were written down and photographs of the site and trees taken using a Canon EOS1000D digital SLR camera.

2.5 No *aerial inspections*, *root mapping* or woody tissue testing were undertaken as part of the tree assessments. Information contained in this tree report covers only the trees that were examined and reflects the condition of those trees at the time of inspection.

2.6 Plans and documents referenced for the preparation of this report include:

- Details and Levels Plan, Sheet 1, Ref. No. 72875, dated 26/09/2007, prepared by Rygate & Company Pty Limited.
- Plans, DA100C, 101C, 102C, 103C, 104C, 201C, 202C, 301C, CMP01C, L01C & L02B, all dated 25/06/12, prepared by Daryl Jackson Robin Dyke Architects.
- Landscape Plan, Dwg. 28663, Rev. 2, dated 04/09/2102, prepared by Ric McConaghy Pty Ltd and POD Landscape Architecture.
- Conservation Management Plan ("CMP"), dated March 2012, prepared by Wayne McPhee & Associates Pty Ltd.

2.7 No hydraulic plans for the proposed development have been reviewed in the preparation of this report.

2.8 The trees are shown on a marked up copy of the site survey. This plan is attached as Appendix F – Tree Location Plan.

3 OBSERVATIONS AND DISCUSSION

3.1 Assessed Trees

3.1.1 Twenty-three (23) trees or tree groups were assessed and included in this report. Details of these are included in the Schedule of Assessed Trees – Appendix E.

3.1.2 Seventeen (17) trees are in the site (T1 – T17). Six (6) trees are located in the road reserve of Blackfriars Street (T18 – T23).

3.1.3 Of the 17 assessed site trees:

- Eight (8) trees are of species or physical dimensions identifying them as exempt from protection under the TPO, i.e. Trees 2, 3, 4, 10, 11, 12, 14 and 15.
- Nine (9) are introduced exotic species (Trees 1, 5, 6, 7, 8, 9, 13, 16 and 17).

3.1.4 The site trees are not identified as having heritage or cultural significance.

- No trees are identified in any of the City of Sydney Registers of Significant Trees 2005.
- According to the CMP (p.53, 2nd last paragraph)

  'Extant soft landscaping, including shrubbery and plane trees of relatively recent planting are assessed as not having heritage value'.

3.2 Proposed Tree Removal

3.2.1 Of the eight (8) trees exempt from protection in the site, five (5) are proposed for removal - Trees T2, T3 and T4 – *Olea europaea* var. *africana* (African Olives) and Trees T14 and T15 – *Sapium sebiferum* (Chinese Tallow Tree).

3.2.2 Seven (7) protected site trees will be removed to accommodate the proposed childcare centre.

- Trees T5, T6 and T8 (Chinese Tallow Tree),
- T7 – *Cinnamomum camphora* (Camphor Laurel)
- T13 – *Robinia pseudoacacia* (Black Locust),
- T16 and T17 – *Acer negundo* (Box Elder).

3.2.3 Of these 7 trees to be removed, six (6) have low retention values due to problems associated with health and structural condition. Trees 16 and 17 have high landscape significance, but both have short *Useful Life Expectancy* ("ULE") due to various factors influencing reasonable mid to long-term retention.

3.2.4 Tree 7 – Camphor Laurel was proposed for short term retention.

The tree appears to have been *topped* in the past which may account for the stem *cluster* at approximately 4m above ground. The tree has a medium retention value and could be removed when the crown starts to grow well above the adjoining building and is more exposed to winds. However, the tree is reasonably well protected at this time from strong winds by the existing two storey building a few metres northeast of the tree.

In addition to this, if the tree was to be retained, the cluster of branches should be subject to closer inspection to determine the need for a cabling system to reduce the risk of damage or personal injury should a stem fail. It is my understanding this tree was proposed to be retained for a few years until the proposed Chinese Elm to the west has grown and developed a crown offering some useable shade to the play area.

3.2.5 The potential for whole or part tree failure will increase over time and, despite using cabling to prevent a stem or branch from falling to the ground, the costs of managing the cabling over years and the increase in wind loads on the crown may outweigh the landscape benefit the tree provides for a short term.

3.2.6 In regard to the potential impact of the proposed development, the tree would benefit from the removal of the surrounding pavements, yet will be susceptible to ground compaction over time as children use the area in the root zone for play. The uplifted root plate of the tree cannot be disturbed. Mulch will tend to slide away from the mound, exposing the ground and roots to potential damage.

3.2.7 As the tree is proposed for a short to medium term retention, it may be prudent to remove it prior to development due to its identified problems. A temporary shade structure could be erected until such time replacement trees provide adequate shade.

3.3 Potential Impacts on Trees Proposed for Retention

3.3.1 Under the Australian Standard 4970-2009 *Protection of trees on development sites* (AS4970), encroachments less than 10% of the *Tree Protection Zone* (TPZ) are considered to be minor. There are no specifications provided in AS4970 for potential impacts of 10% or greater. The 10% figure is taken to be a threshold and trigger where arboricultural investigations into TPZ encroachments beyond this figure need to be considered.

3.3.2 The potential extent of impacts on protected trees to be retained can be generally rated using the *Impact Level Rating* ("ILR") table 1, below.

IMPACT LEVEL RATING	
0	0 – 0.9% of root zone impacted – ***no*** impact of significance
L	1 to 10% of root zone impacted – ***low*** level of impact
L - M	>10 to 15% of root zone impacted – ***low to moderate*** level of impact
M	>15 to 20% of root zone impacted – ***moderate*** level of impact
M – H	>20 to 25% of root zone impacted – ***moderate to high*** level of impact
H	>25 to 35% of root zone impacted – ***high*** level of impact
S	>35% of root zone impacted – ***significant*** level of impact

Table 1: Guideline to the rating of impacts on trees to be retained.
Based on discussions with executive members of the Institute of Australian Consulting Arboriculturists.

3.3.3 Tree 1 – *Cinnamomum camphora* (Camphor Laurel)

This large, mature tree is growing in a bitumen paved area, restricted by the boundary wall along Buckland and Blackfriars Streets. The notional 3.4m radial SRZ extends well into the public footpath areas, however, in reality, the anchoring roots are most likely to extend several metres north and south, parallel to the west boundary wall. This is more or less confirmed by the obvious cracking and upheaval of the bitumen pavement that covers the tree's entire root zone. Some woody root growth is evident towards the area beneath the existing demountable office.

3.3.4 The proposed building (and on-site detention tank) will be approximately 14.5m east of the tree and, in theory, outside the tree's 11.2m notional TPZ. Due to the obvious built constraints to root growth to the south and west, the tree may have developed root mass well into the footprint of the proposed on ground floor slab, despite the dryness of the ground beneath the existing building. The floor slab will diminish the level of soil oxygen available for root initiation and could possibly have an effect on tree vigour.

3.3.5 However, the estimated TPZ encroachment (providing for a 20.5m distance from the tree as a more realistic TPZ offset to the east), is in the vicinity of 74m^2 or 19% of the TPZ. This is a potentially moderate level of impact which, given the existing site, design and planning constraints, is not an unreasonable encroachment. Provided the tree is managed appropriately during demolition of the existing demountable office and the site development the tree should tolerate the changes in its growing environment.

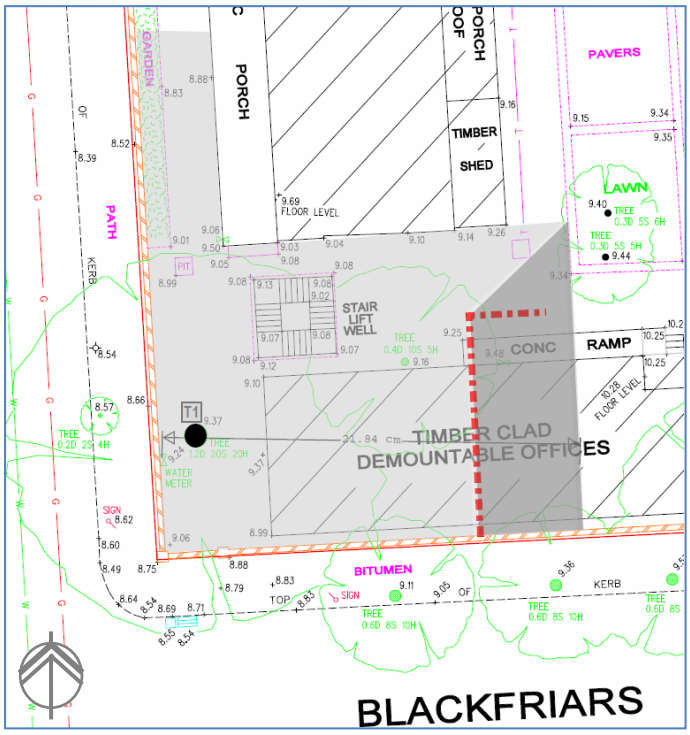

Figure 1
The stem of T1 is identified with a black circle.
The light grey area identifies the 391m^2 irregular area of the more realistic TPZ. The dark grey area identifies the estimated 19% TPZ encroachment resulting from the proposal.
Not to scale.

3.3.6 It is not known at this stage what the ground treatment will be in the area currently occupied by the demountable office, which will be exposed after removal of the building.

The best treatment, assuming the bitumen pavement extends under the existing building, will be in line with the recommended treatment of the paved areas immediately surrounding the tree. That is, the bitumen will be broken up to provide many cracks where water and air are available to tree roots. The bitumen will not be removed a there is a high risk of loss of fine, non-woody roots that may have adhered to the underside of the bitumen. Rather than take this risk of further impact on the vigour and viability of the tree, a coarse, sandy growing media can be placed over the bitumen pavement, and hardy groundcovers, perennials or grasses may be grown on top of the pavement to improve the visual amenity of this dull corner.

3.3.7 Trees 9, 10, 11, 12, 18 and 19 – various species.

No works are proposed in the vicinity of these trees. The trees are all to be retained.

3.3.8 Trees 20 and 21 – *Platanus* x *hybrida* (London Plane)

The crown of T20 appears to extend over the development footprint, although it would be much higher than the roof line, having developed ascending branches due to crown competition with Tree 16 in the site. If pruning is required, it would be confined to small branches at the crown perimeter.

Tree 21 is unlikely to require any pruning as the crown is well clear of the proposed roofline and is biased to the south, away from the development.

3.3.9 The anchor roots of T20 and T21 are unlikely to have extended below the existing wall footing and grown into the site. There is no visible evidence the wall footing has been breached by tree roots and cracking of the bitumen footpath suggests a lineal root growth parallel to the kerb. The proposed on ground floor slab is unlikely to have an impact on any existing soil water movement into the trees' root zones.

3.3.10 Tree 22 – *Lophostemon confertus* (Brush Box)

The crown of this tree is held quite high over the existing building and will be clear of the proposed. However, the method of roof construction may require light trimming of the smaller branches extending into the work area. The tree is vigorous enough to tolerate this light trimming if it is required. Similarly to Trees 20 and 21, the tree is unlikely to be affected by the on-ground floor slab proposed in the site.

3.3.11 Tree 23 – (Brush Box)

Demolition of the existing building is unlikely to affect this tree, provide care is taken to avoid contact with branches extending over the roofline. The proposed building will be offset from the tree and will not require any pruning for roof clearance.

4 CONCLUSIONS

- Seventeen (17) trees in the site were assessed for potential impacts resulting from the proposed development.
- No trees have identified conservation status.
- Twelve (12) trees are proposed to be removed, however five (5) of these trees are not protected under the Tree Preservation Order.
- Of the seven (7) trees to be removed, only Tree 7 has a potential medium range retention value.
- The tree does has identifiable structural problems that are likely to warrant removal in the near future, given the proposed use of the site for a childcare centre where the occupancy rate under the tree will be very high. Hence, it is more appropriate to remove the risks of damage or injury by removing the tree and providing new plantings that can be retained for a longer term.
- The largest and most visually dominant of the site trees is Tree 1 - Camphor Laurel in the southeast corner of the site. This tree can be retained with potentially minor to moderate impact on its vigour and long-term retention. It will require a high level of care during demolition, construction and landscaping to ensure it is provided with appropriate protection and management.
- The other five (5) site trees to be retained (Trees 9, 10, 11 and 12) are not affected by works and would be expected to be retained for the remainder of their ULE's.
- The street trees T18 to T23 are not expected to suffer any adverse of long-term impacts on their vigour, condition or estimated ULE's. Some minor pruning of the trees will not adversely affect their vigour or natural from and growth habit.

5 RECOMMENDATIONS

5.1 Tree Removal

5.1.1 Remove nominated trees to facilitate site development. Refer to Appendix E for trees to be removed.

.

5.2 Minimising Impacts on Trees to be Retained

5.2.1 The following advice is provided to protect trees if they are to be retained.

Tree 1 – Camphor Laurel

- Fencing consisting of f1.8m high link fencing supported on plastic of concrete feet is to be placed no less than 1.5m east of the tree trunk (to protect trunk from debris/damage)
- The paved areas within an 8m radius of the tree are to be covered with geo-textile fabric and mulch to a minimum 50mm depth to capture dust and other potential soil contaminants during the demolition of the demountable office.
- Any possible future planting in the root zone of the tree should aim only to crack the existing bitumen to allow some water infiltration and air exchange. Do not completely remove the bitumen as non-woody roots are likely to be adhering to the underside of the pavement.
- 100mm depth coarse draining landscape soil for planting of grasses or groundcovers can be placed over the cracked bitumen in the tree root zone.
- An Australian Qualification Framework ("AQF") Level 5 arboriculturist is to supervise any works within 8m of the tree.

5.2.2 Trees 20 – 23 –London Plane and Brush Box street trees

- Any pruning is to be undertakn by tree workers with a minimum AQF level 3 in arboriculture.
- Works are to carried out in accordance with Australian Standard 4373-2007 Pruning of Amenity Trees and the NSW WorkCover Code of Practice for the Amenity Tree Industry.
- Pruning is to be limited to small branches less than 80mm diameters and is not to remove more than 10% of the overall crown foliage density.
- Any conflicts with construction access and trees are to be addressed by the project AQF5 arboriculturist.

5.3 Tree Protection – general recommendations

5.3.1 The Tree Protection is to be in accordance with the following:

- Tree Protection Devices (TPD) may include mulching, tree guards and other devices other than fencing.
- The TPD must be in place prior to any site works commencing, including clearing, demolition or grading.

- The most appropriate fencing for tree protection is 1.8m chainlink with 50mm metal pole supports. During installation care must be taken to avoid damage to significant roots. The practicality of providing this fencing on this site must be addressed by the arboriculturist.
- Locate large primary roots by careful removal of soil within the fencing area. ***Do not drive any posts or pickets into tree roots.*** Replace soil back over tree roots.
- It is recommended that the arboriculturist provide written certification that the TPD is/are installed and will satisfy tree protection requirements.
- Nothing should occur inside the tree protection fenced areas, so therefore all access to personnel and machinery, storage of fuel, chemicals, cement or site sheds is prohibited.
- Signage should explain exclusion from the area defined by TPD and carry a contact name for access or advice (see Figure 2 below for example).
- The TPD cannot be removed, altered, or relocated without the project arborists' prior assessment and approval.

5.4 Arboricultural advice

5.4.1 Stockpiling and location of site sheds

- It is advised that any areas of proposed stockpiling within the TPZ of trees to be retained must be covered with thick, coarse mulch, placement of wooden pallets over the mulch, covering of the pallets with a tarpaulin (or similar), and the placement of materials on top of this device.

5.4.2 Underground Services

- All proposed stormwater lines and other underground services should be located as far away as practicable, or suspended beneath the floor of the building where possible, to avoid excavation within the TPZ of trees to be retained.
- For underground services, where the incursion to the TPZ is less than 10% of the total TPZ, a chain trenching device may be used. A backhoe or skid steer loader is unacceptable due to the potential for excessive compaction and root damage.
- Where large woody roots (greater than 50mm in diameter) are encountered during excavation or trenching, these shall be retained intact wherever possible (e.g. by sub-surface boring beneath roots or
  re-routing the service etc).
- Excavations required for underground services within the TPZ of any tree to be retained should only be undertaken by sub-surface boring. The Invert Level of the conduit, plus the conduit diameter, must be lower than the estimated root zone depth as specified. This will depend on the soil conditions at the site. Where this is not practical and root pruning is the only alternative, proposed root pruning should be assessed by the arborist to determine continued health and stability
  of the subject tree.
- If trees show signs of stress or deterioration, remedial action shall be taken to improve the health and vigour of the subject tree(s) in accordance with best practice arboricultural principles.

5.4.3 Fill Material

- Placement of fill material within the TPZ of trees to be retained should be avoided where possible. Where placement of fill cannot be avoided, the material should be a coarse, gap graded material such as 20 — 50mm crushed basalt or equivalent to provide some aeration to the root zone. Note that roadbase or crushed sandstone or other material containing a high percentage of fines is unacceptable for this purpose.
- The fill material should be consolidated with a non-vibrating roller to minimise compaction of the underlying soil.
- A permeable geotextile may be used beneath the sub-base to prevent migration of the stone into the sub-grade. No fill material should be placed in direct contact with the trunk.

5.4.4 Fencing and walls within the SRZ and TPZ of retained trees.

- Where fencing and/or masonry walls are to be constructed along site boundaries, they must provide for the presence of any living woody tree roots greater than 50mm diameter.
- Hand digging must occur within the SRZ of trees to be retained.
- For masonry walls or fences it may be acceptable to delete continuous concrete strip footings and replace with suspended in-fill panels (e.g. steel or timber pickets, lattice etc) fixed to pillars.

5.4.5 Pavements

- Pavements should be avoided within the TPZ of trees to be retained where possible.
- Proposed paved areas within the TPZ of trees to be retained should be placed above grade to minimise excavations within the root zone and avoid root severance and damage.

5.4.6 Landscaping within tree root zones.

- The level of introduced planting media into any proposed landscaped areas within the Tree Protection Zone (TPZ), is not to be greater than 100mm depth, and be of a coarse, sandy material to avoid development of soil layers that may impede water infiltration.
- Container size of proposed plants within the TPZ of trees should be determined prior to purchase of plants. This is to identify planting locations, and container size of plants at the time of planting. Otherwise, any proposed landscaping within the TPZ must consist of tubestock only. This is required to ensure that damage to tree roots and excessive root loss or disturbance is avoided.
- Mattocks and similar digging instruments must not be used within the TPZ of the trees. Planting holes should be dug carefully by hand with a garden trowel, or similar small tool.
- Where possible, do not plant canopy trees beneath, or within 6 - 8m of overhead power lines.

5.4.7 Other

- No washing or rinsing of tools or other equipment, preparation of any mortars, cement mixing, or brick cutting is to occur within 8m upslope of any palms or trees to be retained.
- Regular monitoring of the trees during development works for unforeseen changes or decline will help maintain the trees in a healthy state.

5.5 Post Construction Tree Care

5.5.1 Tree preservation requires a long-term commitment to monitoring and rectifying problems associated with trees.

- Mulching – removal of mulch after construction to remove any contaminants. Replacement with a good quality mulch and addition of 10% organic matter will improve beneficial soil micro-organisms, retain moisture and improve aeration and water infiltration.
- Irrigation – An arboriculturist should determine whether irrigation should be carried out during extended periods of drought.
- Pest management – Monitoring is required as trees under stress are more prone to insect attack.
- Hazard Management – monitoring and management of the trees and routine re-assessment by a qualified arboriculturist is required for adequate long-term safety of residents.

Report prepared by Catriona Mackenzie
September, 2012.

MEMBER ISA — *Accredited member of* INSTITUTE OF AUSTRALIAN CONSULTING ARBORICULTURISTS ® — Australian Institute of Horticulture

Catriona Mackenzie
Consulting arboriculturist, horticulturist and landscape designer.
Certificate of Horticulture *Honours*
Diploma of Horticulture (Arboriculture) *Distinction*
Associate Diploma of Applied Science (Landscape) *Distinction*
Member of the Australian Institute of Horticulture
Member of the International Society of Arboriculture Australian Chapter
Founding Member of the Institute of Australian Consulting Arboriculturists

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APPENDIX A

TERMS AND DEFINITIONS

TERMS AND DEFINITIONS

The following relates to terms or abbreviations that may have been used in this report and provides the reader with a detailed explanation of those terms.

Aerial inspection Where the subject tree is climbed by a professional tree worker or arborist specifically to inspect and assess the upper stem and crown of the tree for signs or symptoms of defects, disease, etc.

Age classes

Y *Young* refers to a well-established but juvenile tree
SM *Semi-mature* refers to a tree at growth stages between immaturity and full size
EM *Early-mature* refers to a tree that is more or less full sized and vigourously growing.
M *Mature* refers to a full sized tree with some capacity for further growth
LM *Late Mature* refers to a full sized tree with little capacity for growth that is not yet about to enter decline
OM *Over-mature* refers to a tree about to enter decline or already declining
LS *Live Stag* refers to a tree in a significant state of decline. This is the last life stage of a tree prior to death.

Cluster describes a group of branches or stems arising from the same point on a larger branch or stem.

Co-dominant refers to stems or branches equal in size and relative importance.

Condition refers to the tree's form and growth habit, as modified by its environment (aspect, suppression by other trees, soils) and the state of the scaffold (i.e. trunk and major branches), including structural defects such as cavities, crooked trunks or weak trunk/branch junctions. These are not directly connected with health and it is possible for a tree to be healthy but in poor condition.

Crown All the parts of a tree arising above the trunk where it terminates by its division forming branches, e.g. the branches, leaves, flowers and fruit: or the total amount of foliage supported by branches.

Deadwood refers to any whole limb that no longer contains living tissues (e.g. live leaves and/or bark). Some dead wood is common in a number of tree species.

Decay Process of degradation of woody tissues by fungi or bacteria through decomposition of cellulose and lignin. There are numerous types of decay that affect different types of tissues, spread at different rates and have different effect on both the tree's health and structural integrity.

Defect Any structural weakness or deformity.

Diameter at Breast Height (DBH) refers to the tree trunk diameter at breast height, i.e. measured at 1.4 m above ground level.

Dieback Death of growth tips/shoots and partial limbs, generally from tip to base. Dieback is often an indicator of stress and tree health.

Epicormic Shoots which arise from adventitious or latent buds. These shoots often have a weak point of attachment. They are often a response to stress in the tree.
Epicormic growth/shoots are generally a survival mechanism, often indicating the presence of a current, or past stress event such as fire, pruning, drought, etc.

Hanger Unattached, cut or broken branches that are caught in the canopy.

Health (syn. vigour) refers to the tree's vigour as exhibited by the crown density, leaf colour, presence of epicormic shoots, ability to withstand disease invasion, and the degree of dieback.

Lopping Cutting between branch unions (not to branch collars), or at internodes on a tree, with the final cut leaving a stub. Lopping may result in dieback of the stub and can create infection courts for disease or pest attack.

Reaction wood Specialised secondary xylem which develops in response to a lean or similar mechanical stress, attempting to restore the stem to vertical. In broad-leaved trees, reaction wood is termed *tension wood* and forms on the upper surfaces of branches and leaning trunks. It exerts an internal contraction that tends to pull the trunk to the vertical or a branch to its original angle of growth. In conifers, *compression wood* develops on the underside of branches and leaning trunks. The compressive force tends to push the trunk upright, or the branch to its original angle of growth.

Root Mapping The exploratory process of recording the location of roots usually in reference to a datum point where depth, root diameter, root orientation and distance from trunk to existing or proposed structures are measured. It may be slightly invasive (disturbs or displaces soil to locate but not damage roots, e.g. hand excavation, or use of air or water knife), or non-invasive (does not disturb soil, e.g. ground penetrating radar).

Scales Scale insects are sap-sucking insects that conceal themselves underneath waxy, leathery or cottony shells or secretions. They are small, flat or rounded, black, brown or white scales that stick on branches, stems & leaves. Scales are soft-body insects that hide under a covering, shell. Scale generally live in colonies and cause growth reduction as well as weakening and distorting the new leaves and shoots.
They feed by their piercing and sucking mouthparts that are attached to the plant, withdrawing the sap and excreting a liquid sweet sugary substance called honeydew.

Sooty Mould An unsightly black fungus covering the branches and/or leaves, preventing sunlight from reaching the leaf surface. A sticky substance, known as 'Honey dew', is a waste product of scale insects and provides an excellent substrate for the growth & development of sooty mould.

Structural Root Zone (SRZ) Refers to the radial distance in metres, measured from the centre of the tree stem, which defines the critical area required to maintain stability of the tree. Only thorough investigation into the location of structural roots within this area can identify whether any minor incursions into this protection zone are feasible. Note: The SRZ is calculated on the diameter measured immediately above the root/stem buttress (DAB). Where this measurement is not taken in the field, it is calculated by adding 12.5% to the stem diameter at breast height (DBH).(Based on averages calculated from DBH and DAB measurements taken from 20 mature Brush Box and Camphor Laurel).
Note: The SRZ may not be symmetrical in shape/area where there is existing obstruction or confinement to lateral root growth, e.g. structures such as walls, rocky outcrops, etc).

Suppressed In crown class, trees which have been overtopped and whose crown development is restricted from above.

Sweep A curve in the trunk, generally near the ground. This usually occurs when a tree is partially wind thrown when young, but then stabilises itself and straightens due to reaction wood. Stem sweep can also be a naturally developed feature of some tree species. E.g. *Araucaria columnaris* (Cook Pine), that has no relationship to a defect or partial windthrow.

Topping or heading is a pruning practice that results in removal of terminal growth leaving a cut stub end. Topping causes serious damage to the tree.

Tree Protection Zone (TPZ). Refers to the radial distance in metres, measured from the centre of the tree stem which defines the *tree protection zone* for a tree to be retained. This is generally the minimum distance from the center of the tree trunk where protective fencing or barriers are to be installed to create an exclusion zone. The **TPZ** surrounding a tree aids the tree's ability to cope with disturbances associated with construction works. Tree protection involves minimising root damage that is caused by activities such as construction. Tree protection also reduces the chance of a tree's decline in health or death and the possibly damage to structural stability of the tree from root damage.
To limit damage to the tree, protection within a specified distance of the tree's trunk must be maintained throughout the proposed development works. No excavation, stockpiling of building materials or the use of machinery is permitted within the TPZ.
Note: In many circumstances the tree root zone does not occupy a symmetrically radial area from the trunk, but may be an irregular area due to the presence of obstructions to root spread or inhospitable growing conditions.

USEFUL LIFE EXPECTANCY (ULE)
In a planning context, the time a tree can expect to be usefully retained is the most important long-term consideration. ULE i.e. a system designed to classify trees into a number of categories so that information regarding tree retention can be concisely communicated in a non-technical manner. ULE categories are easily verifiable by experienced personnel without great disparity. A tree's ULE category is the life expectancy of the tree modified first by its age, health, condition, safety and location (to give the life expectancy); then by economics (i.e. cost of maintenance - retaining trees at an excessive management cost is not normally acceptable); and finally, effects on better trees, and sustained amenity (i.e. establishing a range of age classes in a local population). ULE assessments are not static but may be modified as dictated by changes in tree health and environment. Trees with a short ULE may at present be making a contribution to the landscape, but their value to the local amenity will decrease rapidly towards the end of this period, prior to them being removed for safety or aesthetic reasons. For details of ULE categories see Appendix B, modified from Barrell 2001.

Vigour (syn. health) refers to the tree's health as exhibited by the crown density, leaf colour, presence of epicormic shoots, ability to withstand disease invasion, and the degree of dieback.

Woody roots usually used in reference to the first order roots i.e. structural (anchor) roots and woody lateral roots within the Structural Root Zone. Damage, disturbance to, or severing of these roots can compromise the stability of the tree.

APPENDIX B

ULE CATEGORIES

Useful Life Expectancy (ULE) CATEGORIES (after Barrell 1996, updated 01/04/01)

The five categories and their sub-groups are as follows:

1. Long ULE - tree appeared retainable at the time of assessment for over 40 years with an acceptable degree of risk, assuming reasonable maintenance:

A. structurally sound trees located in positions that can accommodate future growth
B. trees which could be made suitable for long term retention by remedial care
C. trees of special significance which would warrant extraordinary efforts to secure their long term retention

2. Medium ULE - tree appeared to be retainable at the time of assessment for 15 to 40 years with an acceptable degree of risk, assuming reasonable maintenance:

A. trees which may only live from 15 to 40 years
B. trees which may live for more than 40 years but would be removed for safety or nuisance reasons
C. trees which may live for more than 40 years but would be removed to prevent interference with more suitable individuals or to provide space for new planting
D. trees which could be made suitable for retention in the medium term by remedial care

3. Short ULE - tree appeared to be retainable at the time of assessment for 5 to 15 years with an acceptable degree of risk, assuming reasonable maintenance:

A. trees which may only live from 5 to 15 years
B. trees which may live for more than 15 years but would be removed for safety or nuisance reasons
C. trees which may live for more than 15 years but would be removed to prevent interference with more suitable individuals or to provide space for new planting
D. trees which require substantial remediation and are only suitable for retention in the short term

4. Removal - trees which should be removed within the next 5 years

A. dead, dying, suppressed or declining trees
B. dangerous trees through instability or recent loss of adjacent trees
C. dangerous trees because of structural defects including cavities, decay, included bark, wounds or poor form.
D. damaged trees that are clearly not safe to retain.
E. trees which may live for more than 5 years but would be removed to prevent interference with more suitable individuals or to provide space for new planting.
F. trees which are damaging or may cause damage to existing structures within the next 5 years.
G. trees that will become dangerous after removal of other trees for the reasons given in (a) to (f).
H. trees in categories (a) to (g) that have a high wildlife habitat value and, with appropriate treatment, could be retained subject to regular review.

5. Small, young or regularly pruned - Trees that can be reliably moved or replaced.

A. small trees less than 5m in height.
B. young trees less than 15 years old but over 5m in height.
C. formal hedges and trees intended for regular pruning to artificially control growth.

APPENDIX C

SIGNIFICANCE OF A TREE ASSESSMENT RATING

IACA Significance of a Tree, Assessment Rating System (STARS)© (IACA 2010)©

In the development of this document IACA acknowledges the contribution and original concept of the Footprint Green Tree Significance & Retention Value Matrix, developed by Footprint Green Pty Ltd in June 2001.

The landscape significance of a tree is an essential criterion to establish the importance that a particular tree may have on a site. However, rating the significance of a tree becomes subjective and difficult to ascertain in a consistent and repetitive fashion due to assessor bias. It is therefore necessary to have a rating system utilising structured qualitative criteria to assist in determining the retention value for a tree. To assist this process all definitions for terms used in the *Tree Significance - Assessment Criteria* and *Tree Retention Value - Priority Matrix*, are taken from the IACA Dictionary for Managing Trees in Urban Environments 2009.

This rating system will assist in the planning processes for proposed works, above and below ground where trees are to be retained on or adjacent a development site. The system uses a scale of *High*, *Medium* and *Low* significance in the landscape. Once the landscape significance of an individual tree has been defined, the retention value can be determined. An example of its use in an Arboricultural report is shown as Appendix A.

Tree Significance - Assessment Criteria

1. High Significance in landscape

- The tree is in good condition and good vigour;
- The tree has a form typical for the species;
- The tree is a remnant or is a planted locally indigenous specimen and/or is rare or uncommon in the local area or of botanical interest or of substantial age;
- The tree is listed as a Heritage Item, Threatened Species or part of an Endangered ecological community or listed on Councils significant Tree Register;
- The tree is visually prominent and visible from a considerable distance when viewed from most directions within the landscape due to its size and scale and makes a positive contribution to the local amenity;
- The tree supports social and cultural sentiments or spiritual associations, reflected by the broader population or community group or has commemorative values;
- The tree's growth is unrestricted by above and below ground influences, supporting its ability to reach dimensions typical for the taxa *in situ* - tree is appropriate to the site conditions.

2. Medium Significance in landscape

- The tree is in fair-good condition and good or low vigour;
- The tree has form typical or atypical of the species;
- The tree is a planted locally indigenous or a common species with its taxa commonly planted in the local area
- The tree is visible from surrounding properties, although not visually prominent as partially obstructed by other vegetation or buildings when viewed from the street,
- The tree provides a fair contribution to the visual character and amenity of the local area,
- The tree's growth is moderately restricted by above or below ground influences, reducing its ability to reach dimensions typical for the taxa *in situ*.

3. Low Significance in landscape

- The tree is in fair-poor condition and good or low vigour;
- The tree has form atypical of the species;
- The tree is not visible or is partly visible from surrounding properties as obstructed by other vegetation or buildings,
- The tree provides a minor contribution or has a negative impact on the visual character and amenity of the local area,
- The tree is a young specimen which may or may not have reached dimension to be protected by local Tree Preservation orders or similar protection mechanisms and can easily be replaced with a suitable specimen,
- The tree's growth is severely restricted by above or below ground influences, unlikely to reach dimensions typical for the taxa *in situ* - tree is inappropriate to the site conditions,
- The tree is listed as exempt under the provisions of the local Council Tree Preservation Order or similar protection mechanisms,
- The tree has a wound or defect that has potential to become structurally unsound.

Environmental Pest / Noxious Weed Species

- The tree is an Environmental Pest Species due to its invasiveness or poisonous/ allergenic properties,
- The tree is a declared noxious weed by legislation.

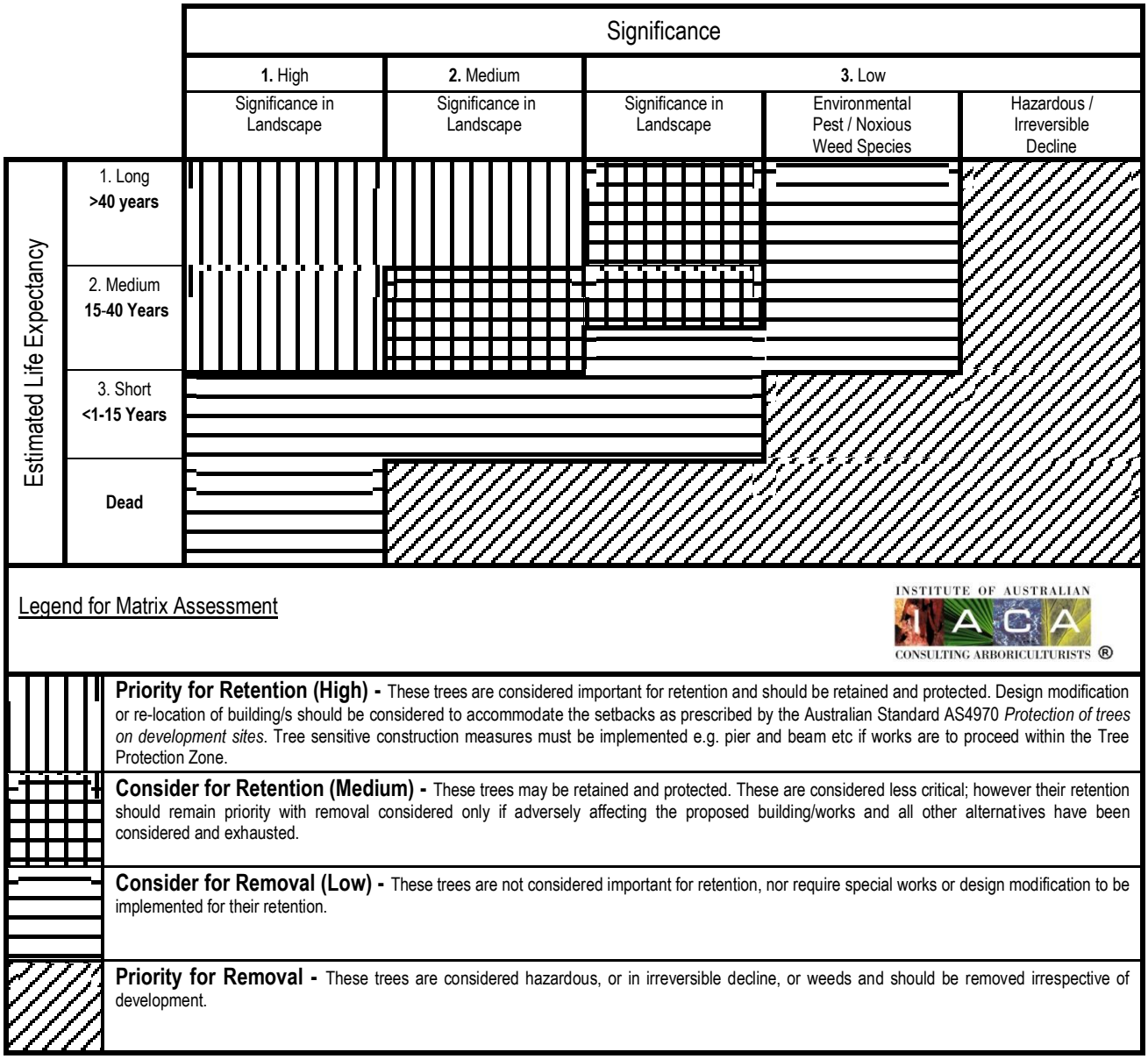
Hazardous/Irreversible Decline

- The tree is structurally unsound and/or unstable and is considered potentially dangerous,
- The tree is dead, or is in irreversible decline, or has the potential to fail or collapse in full or part in the immediate to short term.

The tree is to have a minimum of three (3) criteria in a category to be classified in that group.

Note: The assessment criteria are for individual trees only, however, can be applied to a monocultural stand in its entirety e.g. hedge.

Table 1 - Tree Retention Value - Priority Matrix.



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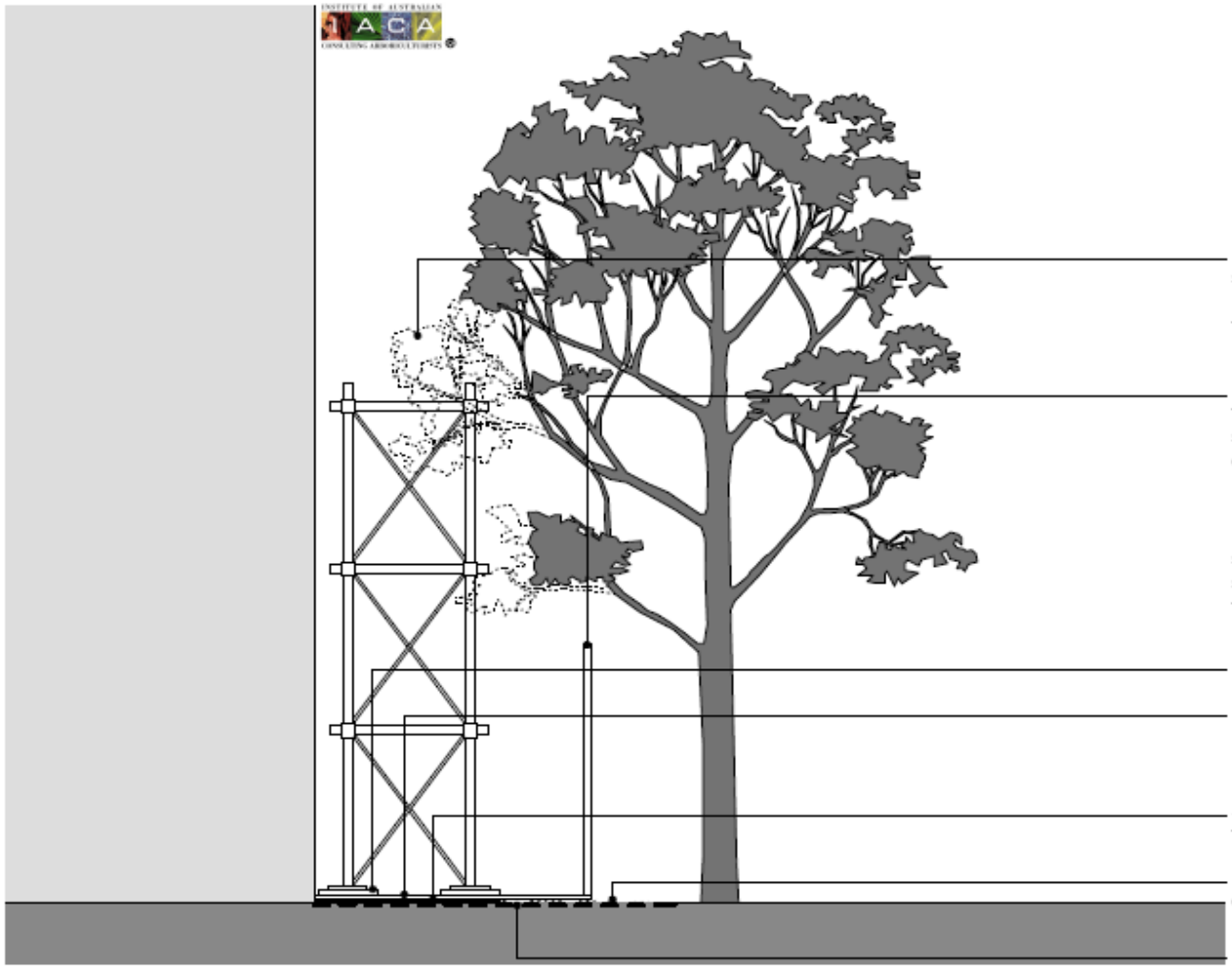
Footprint Green Pty Ltd 2001, *Footprint Green Tree Significance & Retention Value Matrix*, Avalon, NSW Australia, www.footprintgreen.com.au

APPENDIX D

TREE PROTECTION DEVICES

Figure 1



Indicative Scaffolding within a Tree Protection Zone (TPZ) — Not to Scale

Figure 2

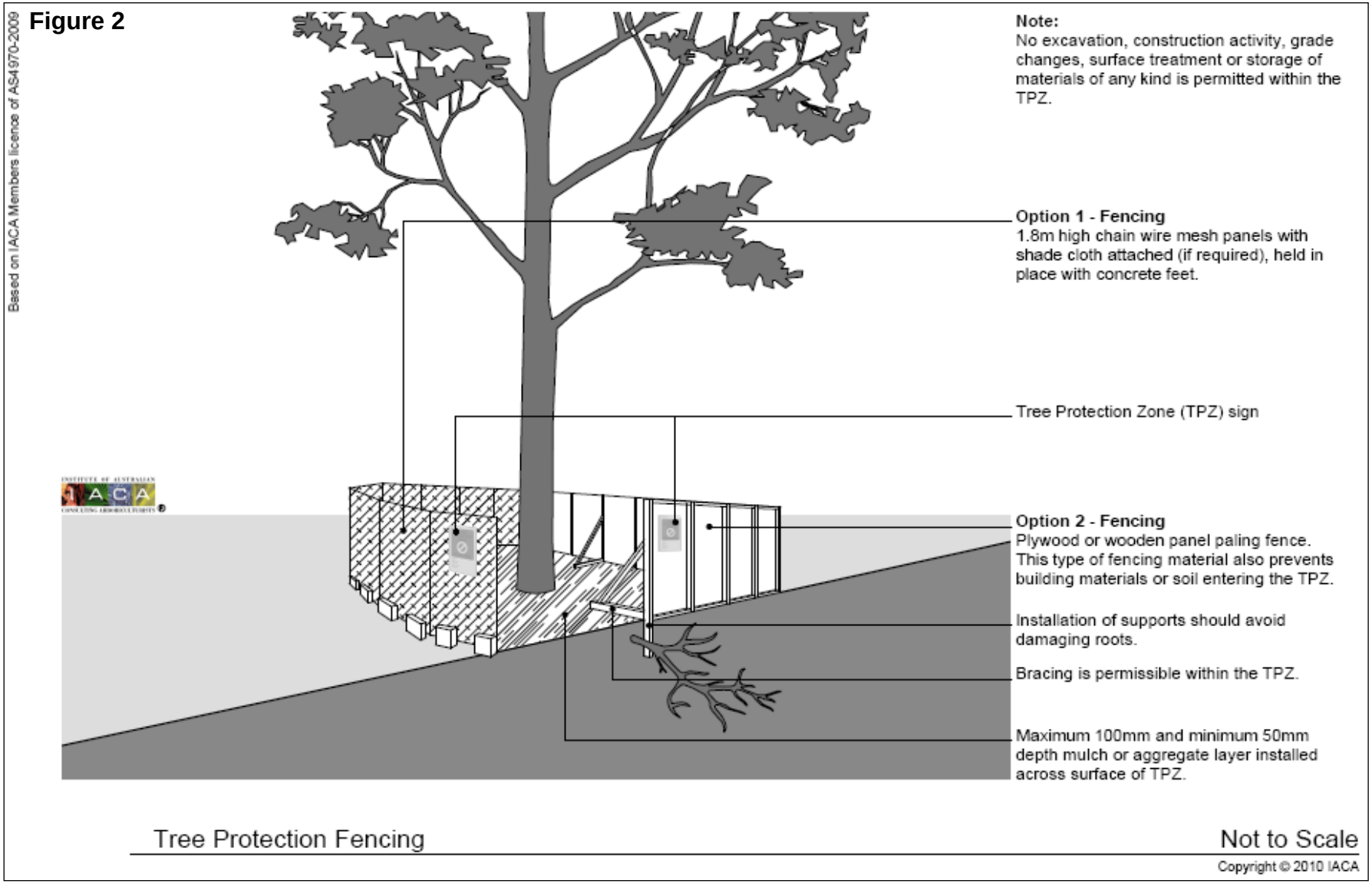
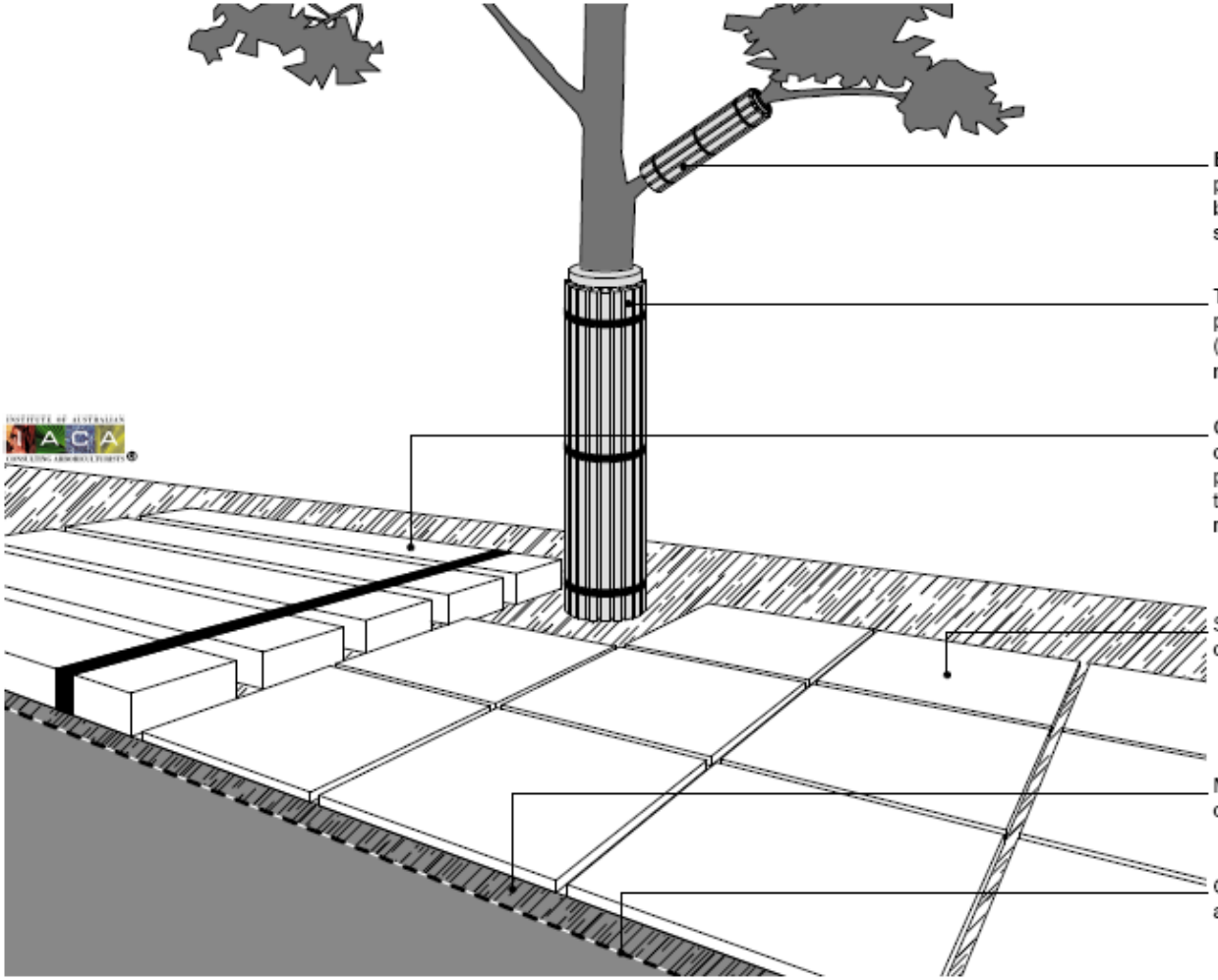

Based on IACA Members licence of AS4970-2009
Note:
No excavation, construction activity, grade changes, surface treatment or storage of materials of any kind is permitted within the TPZ.
Option 1 - Fencing
1.8m high chain wire mesh panels with shade cloth attached (if required), held in place with concrete feet.
Tree Protection Zone (TPZ) sign
Option 2 - Fencing
Plywood or wooden panel paling fence. This type of fencing material also prevents building materials or soil entering the TPZ.
Installation of supports should avoid damaging roots.
Bracing is permissible within the TPZ.
Maximum 100mm and minimum 50mm depth mulch or aggregate layer installed across surface of TPZ.
Tree Protection Fencing
Not to Scale
Copyright © 2010 IACA

Figure 3



Examples of Branch, Trunk and Ground Protection

Not to Scale

Based on IACA Members license of AS4970-2009

Figure 4

Example of Tree Protection Zone (TPZ) Signage

Scale 1:5 @ A4

APPENDIX E

SCHEDULE OF ASSESSED TREES

SCHEDULE OF ASSESSED TREES

UTS Blackfriars Street, Chippendale. July, 2012.

Tree No.	*Genus* and *species* Common Name	Ht (m)	Sp (m)	DBH (mm)	Age	V	C	Comments and Recommendations	ULE	TSR	RV	SRZ† (m)	TPZ† (m)	TPZ (area)	ILR
1	*Cinnamomum camphora* **Camphor Laurel**	12 – 13	18 av.	925	M	N	F	Introduced exotic, evergreen species. Environmental weed/pest species. Growing in paved area raised above street level. Pavement heaving from roots evident. Badly pruned – *lopped* branches up to 250mmØ with poor wound sealing, branch tears and *dieback*. Scattered *deadwood* to 100mmØ. Several small *hangers*. Some dieback but not significant. Water meter close by. Elkhorn growing on stem @ 3m. Branches low to NNW and SSW, about 3m AGL.	3A	H	M	3.4	11.2	391	M
2	*Olea europaea* var. *africana* **African Olive**	6 – 7	8 av.	300 (2 x 200)	EM	N	F	Introduced exotic species. Environmental weed/pest species. Species exempt from protection under TPO. Very close to building and footing. Roots cracking/lifting pavement. Poorly pruned.	2B	L	L	2.2	3.6	41	NA
3	*Olea europaea* var. *africana* **African Olive**	6 – 7	4 av.	*400 GL	EM	N	F – P	Introduced exotic species. Environmental weed/pest species. Species exempt from protection under TPO. Limited inspection – tree surrounded by fencing. *Suppressed* and highly asymmetrical stem and crown bias to S. Poorly pruned – long stub remains.	2B	L	L	2.2	4.2	55	NA
4	*Olea europaea* var. *africana* **African Olive**	6 – 7	8 av.	*425 GL	EM	N	F – G	Introduced exotic species. Environmental weed/pest species. Species exempt from protection under TPO. Limited inspection – tree surrounded by fencing. Slight stem kink. Wide branching habit – symmetrical crown.	2B	M	L	2.2	4.6	65	NA
5	*Sapium sebiferum* **Chinese Tallow Tree**	6 – 7	7 av.	375 (2 x 250)	SM	P	F	Introduced exotic, deciduous species. Leafless state. Sap and leaves reputed to be toxic. Large, blackened girdling root around most of stem base. Heavy Pink Wax *scale* infestation causing substantial dieback of tips/small branches. Heavy *sooty mould* coverage of branches surface roots, nearby signage, etc. Tree directly over stormwater pipes and closes to pit. *Co-dominant* stems near base.	2D	L	L	2.4	4.6	65	NA
6	*Sapium sebiferum* **Chinese Tallow Tree**	6	5 av.	*425 GL	SM	P	F – G	Introduced exotic, deciduous species. Leafless state. Sap and leaves reputed to be toxic. Heavy Pink Wax scale infestation causing dieback of tips/small branches. Heavy sooty mould coverage of branches and stem. Large surface roots at road edge to S.	2B	L	L	2.2	4.6	65	NA

Tree No.	*Genus* and *species* Common Name	Ht (m)	Sp (m)	DBH (mm)	Age	V	C	Comments and Recommendations	ULE	TSR	RV	SRZ† (m)	TPZ† (m)	TPZ (area)	ILR
7	*Cinnamomum camphora* **Camphor Laurel**	15	14 av.	575	EM	N	F	Introduced exotic, evergreen, environmental pest species. Slight thinning of crown to N. Previously *topped* @ 4m and left to regrow – stem *cluster* effect. Anchoring root system heaved above surrounding ground. Some minor lifting of pavers, and pavement to W.	2D	H	M	2.9	7	152	NA
8	*Sapium sebiferum* **Chinese Tallow Tree**	7 – 8	7 av.	450 (400 + 200)	M	L	F	Introduced exotic, deciduous species. Leafless state. Sap and leaves reputed to be toxic. Some damage occurring to wall retaining raised garden area – highly likely to be roots from this tree. Lots of Pink Wax scale noted, though sooty mould not yet severe.	2B	M	L	2.5	5.4	92	NA
9	Unidentified deciduous species	13 – 14	6 av.	*500 GL	M	?	?	Introduced exotic, deciduous species. Leafless state. Limited inspection – fenced off. Species possibly *Robinia pseudoacacia*. Suppressed to S. Lower stem blackened. Very close to building. Badly pruned.	2B?	M	M?	2.4	5.4	92	0
10	*Olea europaea* var. *africana* **African Olive**	8 – 12	6 av.	*500 AG	M	N	?	Introduced exotic species. Environmental weed/pest species. Limited inspection – tree fenced off. Species exempt from protection under TPO.	2B?	M	L	2.4	5.4	92	0
11	*Olea europaea* var. *africana* **African Olive**	8 – 12	6 av.	*500 AG	M	N	?	Introduced exotic species. Environmental weed/pest species. Species exempt from protection under TPO. Limited inspection – tree fenced off.	2B?	M	L	2.4	5.4	92	0
12	*Olea europaea* var. *africana* **African Olive**	8 – 12	6 av.	*500 AG	M	N	?	Introduced exotic species. Environmental weed/pest species. Species exempt from protection under TPO. Limited inspection – tree fenced off.	2B?	M	L	2.4	5.4	92	0
13	*Robinia pseudoacacia* **Black Locust**	9	10 av.	375	M	N	P	Introduced exotic, deciduous species. Leafless state. Unsubstantiated species identification but most likely to be *R. pseudoacacia*. Also possible this is a variety/cultivar of Black Locust as no thorns were noted. Bark and leaves reported to be toxic. Very poor form due to recent topping-possibly related to dieback. Was heavily suppressed by recently removed tree to E.	3B	L	L	2.4	4.6	65	NA
14	*Sapium sebiferum* **Chinese Tallow Tree**	4	4	200	SM	L	P	Introduced exotic, deciduous species. Leafless state. Sap and leaves reputed to be toxic. Less than 5m height and 300mm stem diameter – exempt from protection under TPO. Lean to E likely caused by vehicle colliding with tree. Partially lifted root plate. Damage to asphalt. Pink Wax scale noted, though sooty mould not severe.	4A	L	L	1.8	2.4	18	NA

Tree No.	*Genus* and *species* Common Name	Ht (m)	Sp (m)	DBH (mm)	Age	V	C	Comments and Recommendations	ULE	TSR	RV	SRZ† (m)	TPZ† (m)	TPZ (area)	ILR
15	*Sapium sebiferum* **Chinese Tallow Tree**	4	4	200	SM	L	P	Introduced exotic, deciduous species. Leafless state. Sap and leaves reputed to be toxic. Less than 5m height and 300mm stem diameter – exempt from protection under TPO. Suppressed, highly asymmetrical crown to S. Pink Wax scale noted, though sooty mould not severe.	4A	L	L	1.8	2.4	18	NA
16	*Acer negundo* **Box Elder**	13 – 14	13 av.	525	M	N	F	Introduced exotic, deciduous species. Leafless state. Has been lopped in the past with an area of deadwood suggesting possible *decay* pocket or decay column in crown interior. Long, loaded branches with substantial *reaction wood*. Some deadwood over 4m long. Confined growing space – restricted by close walls E and S. Hangers in crown. Slight stem *sweep* to N due to nearby trees. Needs *aerial inspection* if retained.	3 – 4?	H	L – M?	2.7	6.4	127	NA
17	*Acer negundo* **Box Elder**	12	8 av.	400	EM	N	F	Introduced exotic, deciduous species. Leafless state. Co-dominant stems @ 2.1m. Paved to stem base. Wall within 1.5m S. Badly pruned. Suppressed to E by larger Box Elder.	3B	H	L	2.5	4.8	72	NA
18	*Lophostemon confertus* **Brush Box**	13 – 15	9 av.	475	EM	N	F – G	Introduced native species. Street tree. Suppressed to N by nearby Olives – has developed a lean to S over road. Several vehicle impact damage sites on stem to S. High, lofty crown. Restricted root zone.	2B	H	M	2.6	5.8	104	0
19	*Fraxinus griffithii* **Evergreen Ash**	2	1.5	50	Y	N	F	Introduced exotic, evergreen species. Street tree.	2A	L	L	1.5	2	7	0
20	*Platanus x hybrida* **London Plane**	17 – 18	13 av.	600	EM	N	F	Introduced exotic, deciduous species. Leafless state. Street tree. Roots haunching at kerb side. Lineal root system parallel to kerb. No obvious roots at wall to N. Slight stem kink upper crown.	2D	H	M – H	2.9	7.2	163	0 – L
21	*Platanus x hybrida* **London Plane**	13 – 14	11 av.	450	EM	N	F	Introduced exotic, deciduous species. Leafless state. Street tree. Stem leans to SSW, although crown generally balanced. Restricted root zone. Stem damaged from vehicle collisions. Path repairs undertaken on tension side of root system.	2D	H	M – H	2.5	5.4	92	0 – L
22	*Lophostemon confertus* **Brush Box**	10 – 12	9 av.	500	EM	N	F	Introduced native species. Street tree. Co-dominant stems @ 1.6m. Restricted root zone.	2D	H	M – H	2.7	6	113	0 – L
23	*Lophostemon confertus* **Brush Box**	10 – 11	8 av.	400	EM	N		Introduced native species. Street tree. Kerb displacement. Restricted root zone.	2D	H	M – H	2.5	4.8	72	0 – L

KEY

Trees to be retained.

Trees exempt from protection under TPO but proposed to be retained

Trees proposed to be removed.

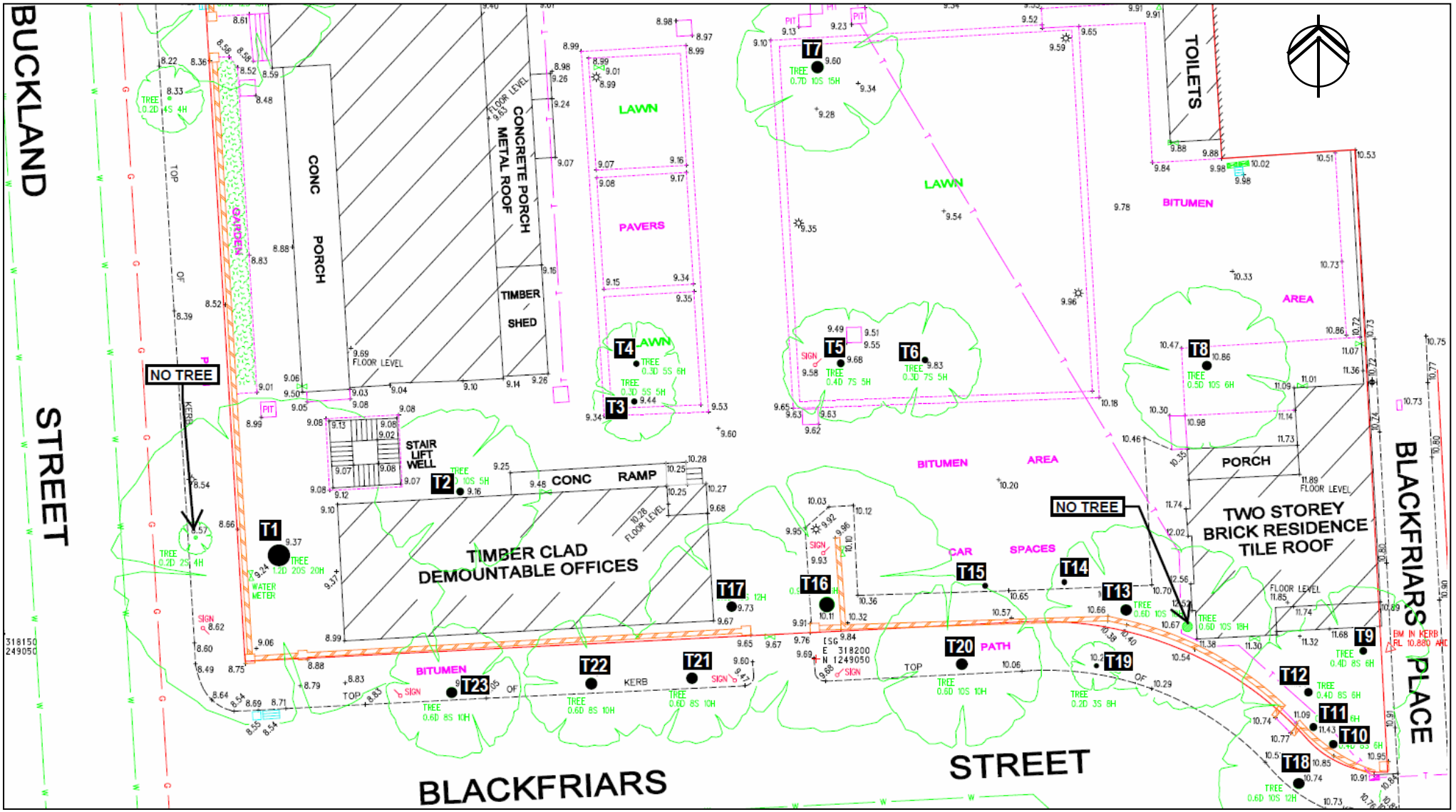
† Notional radial offset of a symmetrical, unrestricted root system – subject to change depending on site conditions affecting tree root growth.
* Visually estimated.
GL at ground level.
AGL above ground level.

LEGEND

H refers to the approximate height of a tree in metres, from base of stem to top of tree crown.
Sp refers to the approximate and average spread in metres of branches/canopy (the 'crown') of a tree.
DBH refers to the approximate diameter of tree stem at breast height i.e. 1.4 metres above ground (unless otherwise noted), and expressed in millimetres.
Age refer to Appendix A -Terms and Definitions for more detail.
V refers to the tree's vigour (health). L – Low vigour, N – normal vigour, P = poor vigour. Refer to Appendix A -Terms and Definitions for more detail.
C refers to the tree's structural condition. F = fair condition, G = good condition, P = poor condition. Refer to Appendix A -Terms and Definitions for more detail.
ULE refers to the estimated *Useful Life Expectancy* of a tree. Refer to Appendices A and B for details. Note: Where further investigation or testing of trees is required, a ULE cannot be accorded to those trees until these investigations have taken place.
TSR The *Tree Significance Rating* considers the importance of the tree as a result of its prominence in the landscape and its amenity value, from the point of public benefit. Refer to Appendix C – Significance of a Tree Assessment Rating for more detail.
RV Refers to the retention value of a tree, based on the tree's ULE *and* Tree Significance. Refer to Appendix C – Significance of a Tree Assessment Rating for more detail. Note: a RV cannot be accorded to a tree where the ULE is not provided.
SRZ Structural Root Zone (SRZ) refers to the critical radial offset in metres from the centre of the tree's stem required to maintain stability of the tree. The SRZ is calculated on the diameter measured immediately above the root buttress or flare (DAB). Where this measurement is not taken in the field, it is calculated by adding 12.5% to the stem diameter at breast height (DBH). Refer to Appendix A -Terms and Definitions for more detail.
TPZ Tree Protection Zone (TPZ) refers to the *tree protection zones* for trees to be retained. The measurement given is a radial offset in metres from the centre of the tree's stem. Refer to Appendix A -Terms and Definitions for more detail.
ILR Impact Level rating 0 = None (0%); L = Low (0.25 – 10%); L – M = Low to Moderate (11 – 15%); M = Moderate (16 – 20%); M – H = Moderate to High (21 – 25%); H = High (26 – 35%); S = Significant (>35%). Refer to Appendix A for more details.

APPENDIX F

TREE LOCATION PLAN



Note: Plan is not to scale.

MIXED USE

GRAFTON LANE

BUCKLAND HOUSE

GRAFTON STREET

CARWASH

BACKPACKER ACCOMMODATION

ST.BENEDICTS CHURCH

PROPOSED BUILDING 3

SECURED ENTRY GATE

BIKE RACKS

PLANT

BIN ENCLOSURE

NOTRE DAME UNIVERSITY

EXISTING BUIDING 5

SECURED GATE

EXISTING BUILDING 2

RESIDENTIAL APARTMENTS

BUCKLAND STREET

CHILD CARE OUTDOOR PLAY AREA

PROPOSED BUILDING 1

PROPOSED NEW ADDITION

EXISTING BUIDING 7 CHILDCARE

RESIDENTIAL APARTMENTS

ABERCROMBIE STREET

FUTURE CUB DEVELOPMENT

BLACKFRIARS STREET

BOUNDARY

Client

University of Technology, Sydney

Project

student accommodation blackfriars

proposed alterations and additions

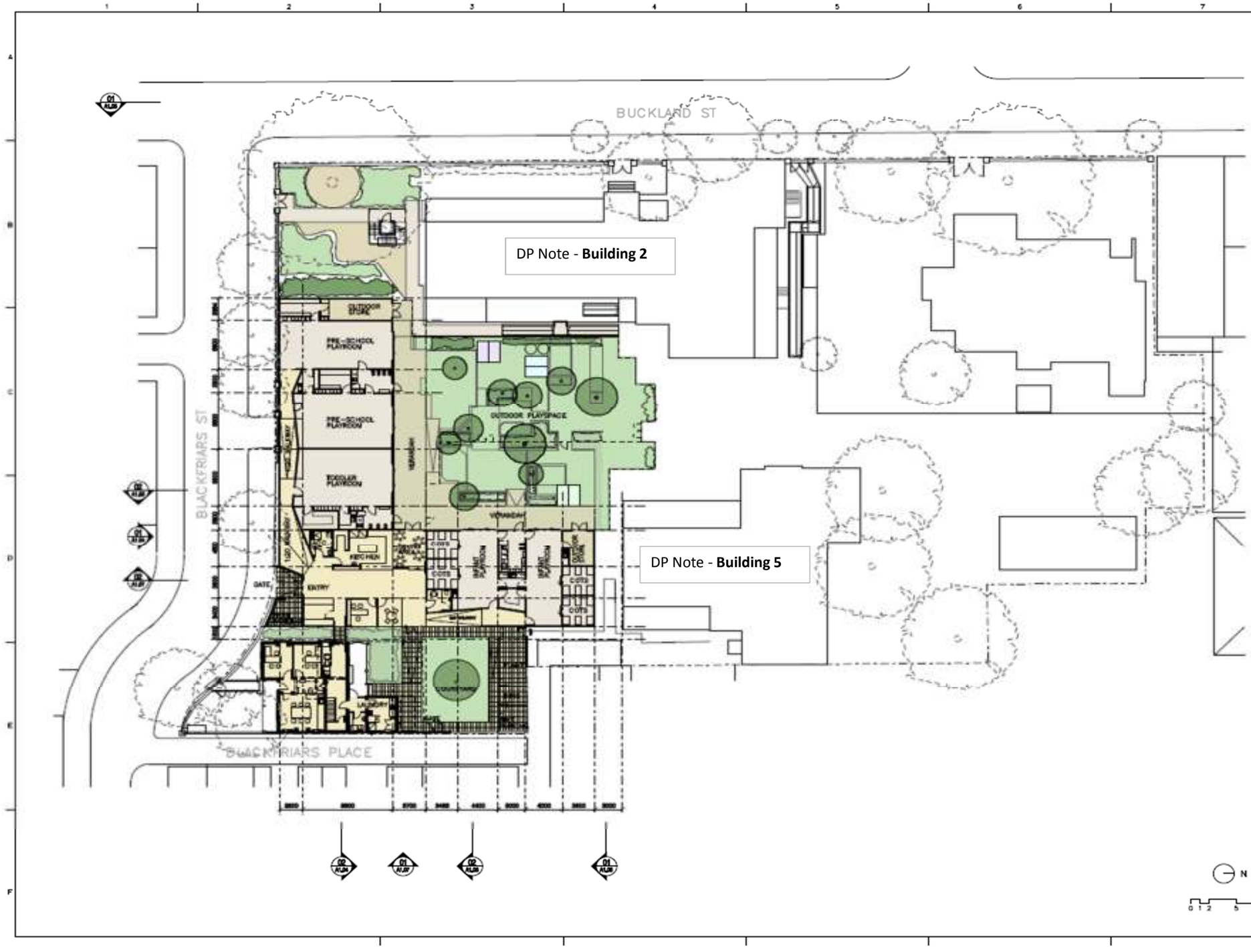
Title: Ground Floor Site Plan

Scale: 1:250 @ A1

Date: March 2009

Number: 3532_DA004 – P7

nettleton tribe



Rev.	Description	Approved Date
P2	Preliminary Issue	22.08.12
01	Review Issue	05.03.13
01	DA Issue	07.03.13
02	Final DA Issue	22.03.13

Consultants
Architects
Daryl Jackson Robin Dyke Pty Ltd
LACOSTE + STEVENSON Architects

DP note:

Numbers added to identify buildings 2 and 5 which are heritage listed and are to remain.

Project Name
UTS
BLACKFRIARS CHILDRENS CENTRE

UTS
University of Technology, Sydney
FACILITIES MANAGEMENT UNIT
Tower, Building 1, Level 19, 15 Broadway
Broadway NSW 2007
Ph: 9514-2850 Fax: 9514-4690

Consultant Drawing Title
GROUND FLOOR PLAN

Consultant Drawing No
A1.02

FMU Project Number
02447-N-12

Drawn By	Checked	Approved By	Date App.
TD	GH	GH	22.03.13

Drawing Scale	Drawing Status	
1:200	DA ISSUE	A1

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