Aurora Projects Pty Ltd
Upgrading of J17 & J18 Building, UNSW
Geotechnical Investigation

CORE PHOTOGRAPHS

Pells Sullivan Meynink

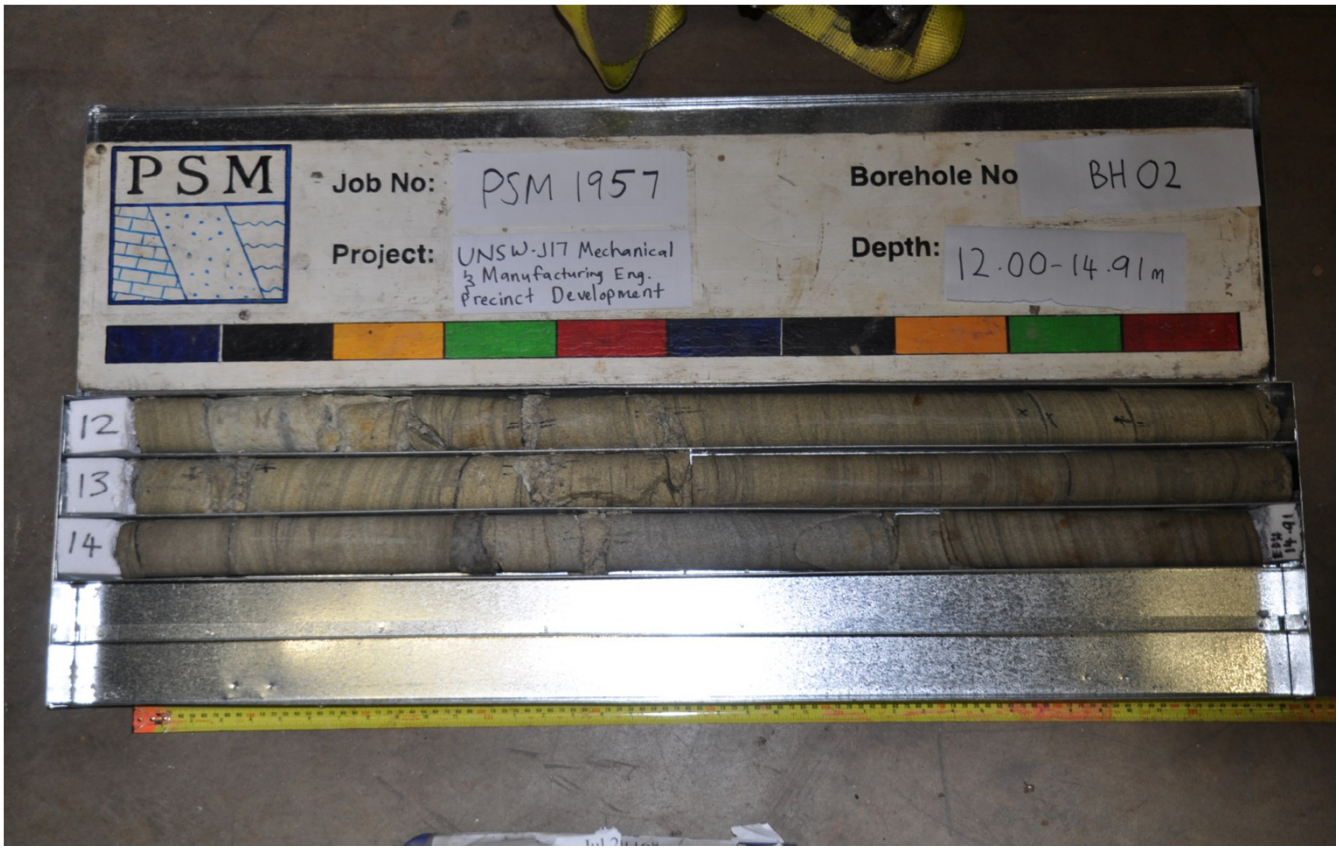
PSM1957-002R.Rev2	Appendix B1

Aurora Projects Pty Ltd
Upgrading of J17 & J18 Building, UNSW
Geotechnical Investigation

CORE PHOTOGRAPHS

Pells Sullivan Meynink

PSM1957-002R.Rev2	Appendix B2



Pells Sullivan Meynink

Aurora Projects Pty Ltd
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Geotechnical Investigation

CORE PHOTOGRAPHS

PSM1957-002R.Rev2	Appendix B3

APPENDIX C

CONTAMINATION REPORT

Contamination Assessment

Pells Sullivan Meynink

School of Mechanical and Manufacturing Engineering,
University of NSW,
NSW

October 2012
JBS 42248–51111 Rev 1
JBS Environmental Pty Ltd

Contamination Assessment

Pells Sullivan Meynink

School of Mechanical and Manufacturing Engineering,
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List of Abbreviations

A list of the common abbreviations used throughout this report is provided below.

ACM	Asbestos Containing Material
AHD	Australian Height Datum
Bgs	below ground surface
BTEX	Benzene, toluene, ethylbenzene and xylenes
B(a)P	Benzo(a)pyrene
DECCW	NSW Department of Environment, Climate Change and Water
DQOs	Data Quality Objectives
DWE	NSW Department of Water and Energy
EMP	Environmental Management Plan
EPA	NSW Environment Protection Authority
Ha	Hectare
HIL	Health based investigation level
JBS	JBS Environmental Pty Ltd
LOR	Limit of Reporting
OEH	Office of Environment and Heritage
PAHs	Polycyclic aromatic hydrocarbons
PQL	Practical Quantitation Limit
QA/QC	Quality Assurance/Quality Control
RPD	Relative Percentage Difference
SAQP	Sampling, Analysis and Quality Plan
TPH	Total Petroleum Hydrocarbons
UNSW	University of New South Wales

Executive Summary

Introduction and Objectives

JBS Environmental Pty Ltd was engaged by Pells Sullivan Meynink (PSM) to provide environmental services in relation to the proposed additions to the Mechanical Engineering buildings within the University of NSW (UNSW) grounds (the site). A review of cadastral information provided on the NSW Government Land and Property SIX Viewer website[1] (SIX Viewer) indicated that the site comprises part of Lot 3 DP1104617. The site has an approximate area of 4856m^2.

The site is currently used by the Mechanical and Manufacturing Engineering School. It is understood that two areas of the two Mechanical and Manufacturing Engineering buildings are to undergo internal refurbishment, one area is to be demolished and rebuilt and another small additional structure built as shown on **Figure 2**. The Contamination Assessment (CA) report is required to draw conclusions regarding the potential for contamination as support for a DA submission.

The objectives of this investigation are to draw conclusions regarding the potential for contamination prior to building works to enable appropriate management of any potential risks as part of the works. This includes assessment of any requirements with respect to State Environmental Planning Policy (SEPP) 55: Remediation of Land, and if appropriate, draw conclusions regarding the suitability of the site for the intended land use, or make recommendations to enable such conclusions to be drawn.

The investigation was conducted in general accordance with relevant guidelines made or endorsed by NSW Environment Protection Authority (EPA).

Scope of Work

The scope of work comprised: identification of the location and extent of the site; review of historical documentation to identify potential areas of environmental concern and contaminants of potential concern (COPC); review of reports of previous site investigations; development of a sampling and analysis program; soil sampling and analysis; a comparison of concentrations of COPC identified in soils to guidelines made or endorsed by EPA; and preparation of a CA report.

Site Description

One of JBS Environmental's trained and experienced field scientists undertook a site inspection on 3 July 2012. At the time of the inspection, the site comprised two university buildings belonging to the School of Mechanical and Manufacturing Engineering separated by a section of Willis Lane.

The majority of the site comprised the two multi storey university buildings, with some small areas paved with bitumen or concrete both in relatively good condition. The building to the west was at a lower level than the eastern building, separated by a 3m to 4m retaining wall, constructed of open concrete block.

Summary of Investigation Results

Soil samples were collected from four drilled borehole locations. At the time of sampling, the majority of the site was covered by the two university buildings which were still in

[1] http://imagery.maps.nsw.gov.au/, accessed 13 July 2012 (SIX Viewer 2010).

use. It was therefore considered that soil bore locations between the two buildings would likely be representative of the soils beneath the two buildings where no ground disturbance will occur, and behind the retaining wall where new construction may disturb ground. Boreholes were conducted within and adjacent to the site, with two boreholes completed within the retaining wall and two boreholes completed in Willis Lane.

The material encountered at the site was a layer of fill material, up to 3.4 m thick of silty sand and silty clay, overlying sandstone bedrock. This is consistent with the height of the retaining wall. The fill may be reworked natural materials obtained during cut and fill to form current site levels.

Assessment of the soil analytical results indicated that no odours or staining were noted in the materials sampled. Also, no visible asbestos containing material (ACM) was observed on the ground surface or within any of the material sampled.

Soil Analytical Results

No odours or staining were noted in the materials sampled. Also, no visible ACM was observed on the ground surface or within any of the material sampled.

The concentrations of TPH, BTEX OCPs and PCBs in the soil samples selected for analysis were all below the laboratory limit of reporting (LOR) and less than the adopted EPA-endorsed health based investigation levels for landuses including open space and secondary schools (HIL-E). These criteria were considered the most appropriate and conservative for the intended use of the site.

The concentrations of metals in the soil samples selected for analysis were all less than the adopted health based criteria (HIL-E) and the phytotoxicity investigation levels (PILs).

The concentrations of both benzo(a)pyrene and total PAHs in soil samples analysed were all less than the adopted health based criteria (HIL-E).

Asbestos was not detected in the three soil samples submitted for analysis.

The results of the soil aggressivity analysis included chloride, sulphate, conductivity and pH results for 2 sample locations. The results were provided to PSM for separate assessment and reporting.

The result of the sPOCAS analysis reported that the sample did not contain potential or actual acid sulphate soils.

In the event that off-site disposal of soil is required, sample results for the fill material were also compared against the Waste Classification Guidelines (DECCW 2009)[2]. TPH/BTEX, heavy metals, PAHs, OCPs and PCB concentrations were all within the general solid waste criteria.

Conclusions and Recommendations

Based on the findings of the CA and subject to the limitations in **Section 11** the following conclusions are made:

- Concentrations of COPC reported were below appropriate conservative EPA-endorsed health-based criteria, and do not represent an unacceptable risk to workers during works or to future users if left on site;

[2] Waste Classification Guidelines, Part 1: Classifying Waste, Department of Environment, Climate Change and Water NSW, December 2009 (DECCW 2009).

- The site in its current condition is considered suitable for the continued university/open space land use without further investigation or need for long term site management;
- Appropriate site management controls successfully implemented during development of the site for the intended landuse will adequately manage waste soils and any unexpected finds through appropriate unexpected finds protocols; and
- Fill material across the site is provisionally classified as General Solid Waste in accordance with DECCW 2009, should material require removal from site. Further testing would be required to confirm waste classification should any unexpected finds be encountered during development, or to assess whether the material may be able to be reused at other locations under an appropriate general exemption from waste regulations.

1 Introduction

1.1 Background

JBS Environmental Pty Ltd was engaged by Pells Sullivan Maynink (PSM) to conduct a contamination assessment (CA) on the proposed demolition and additions to the School of Mechanical and Manufacturing Engineering buildings within the University of NSW (UNSW grounds (the site). The site location is shown on **Figure 1**. The site has an approximate area of 4856 m^2.

The site is currently used by the Mechanical and Manufacturing Engineering School. It is understood that two areas of the two Mechanical and Manufacturing Engineering buildings are to undergo internal refurbishment, one area is to be demolished and rebuilt and another small additional structure built as indicated on **Figure 2**. The Contamination Assessment (CA) report is required to draw conclusions regarding the potential for contamination as support for a Development Application (DA) submission.

The investigation has been conducted in general accordance with relevant NSW Environment Protection Authority (EPA) guidelines (**Section 6**).

1.2 Objective

The objectives of this investigation are to draw conclusions regarding the potential for contamination prior to building works to enable appropriate management of any potential risks as part of the works. This includes assessment of any requirements with respect to State Environmental Planning Policy (SEPP) 55: Remediation of Land, and if appropriate, draw conclusions regarding the suitability of the site for the intended land use, or make recommendations to enable such conclusions to be drawn.

It is a further objective that JBS Environmental that we conduct the works to a high standard and in a timely fashion to enable resulting development works to progress. Our experienced senior level staff will have direct input into the design of the sampling program and final report.

1.3 Scope of Work

The scope of work for the CA of the site comprised:

- Identification of the location and extent of the site by reference to street address, geographical coordinates, areas as per Lot boundaries as shown on an aerial photograph, zoning and formal title descriptions;
- Review of site history and site conditions to identify potential areas of environmental concern (AECs) and associated contaminants of potential concern (COPCs);
- Preparation of all required safety documentation;
- A detailed site inspection;
- Collection of soil samples from four boreholes drilled at pre-determined locations within the boundaries of the site, targeting identified AECs and associated COPCs;
- Analysis of selected soil samples at a laboratory NATA accredited for total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene and xylene (BTEX compounds), polycyclic aromatic hydrocarbons (PAHs), heavy metals (arsenic,

cadmium, chromium, copper, nickel, lead, zinc and mercury), organochlorine pesticides (OCPs), polychlorinated biphenyls (PCBs) and asbestos;

- Assess whether the contamination identified at the site, if any, poses an unacceptable risk to potential receptors, and if so provide recommendations for management actions required; and
- Prepare this CA report in general accordance with relevant EPA guidelines

2 Site Condition & Surrounding Environment

2.1 Site Identification

The location of the site is shown on **Figure 1**, and current site layout is shown on **Figure 2**. The site details are summarised in **Table 2.1** and described in detail in the following sections.

Table 2.1 Summary Site Details

Lot/DP	Part of Lot 3 DP1104617
Address	School of Mechanical and Manufacturing Engineering, University of NSW, NSW
Local Government Authority	Randwick
MGA Coordinates (MGA 56) of approximate centre of the site	E: 336512.43 N: 6245442.28
Site Zoning	Currently occupied by the University of New South Wales (UNSW)
Current Use	used by the UNSW Mechanical and Manufacturing Engineering School
Proposed Use	Ongoing use as Mechanical and Manufacturing Engineering School
Site Area	4856 m^2

2.2 Site Description

A site inspection was undertaken by one of JBS Environmental's trained and experienced field scientists on 3 July 2012. At the time of the inspection the site comprised two buildings utilised by the School of Mechanical and Manufacturing Engineering (**Photos 1 and 2, Appendix A**).

The majority of the site comprised the two multi storey university buildings east and west of Willis Lane, with some small areas paved with bitumen or concrete both in relatively good condition. The building to the west was at a lower level than the eastern building, separated by a 3m to 4m retaining wall, constructed of open concrete block. (**Photos 5 and 6, Appendix A**). The remainder of the site was relatively level with a slight slope towards Willis Lane into the storm water infrastructure on either side of the lane (**Photo 3, Appendix A**).

2.3 Surrounding Landuse

Current landuse of adjacent properties or properties across adjacent roads is summarised as follows:

- North – directly to the north of the site Willis Lane continued in to an open space grassed area;
- South – directly south of the site Willis Lane continued into a multi-story parking facility;
- East – directly to the east of the site was a line of trees along Willis Street, with residential building further to the east. West – directly to the east of the site was a green area with several trees lining Engineering Road, with more university buildings to the west.

2.4 Topography

A review of the topography of the general area (SIX Viewer 2012) indicated that the site is at approximately 30-40 m AHD, and the surrounding land falls gently to the south west towards the Mill Stream system approximately 2 km from the site.

The site is relatively flat with a 3 m to 4 m drop and retaining wall running north to south between the two areas of the site.

2.5 Hydrology

A review of topographical contours on topographic maps (SIX Viewer 2010) indicated that surface runoff would flow south west. The Mill Stream System is located approximately 2 km south west of the site.

The entire site is either covered by university buildings or is sealed with concrete and bitumen. The majority of precipitation falling onto the site is expected to run directly into drainage on the buildings or into the storm water system along Willis Lane and Engineering Road.

2.6 Geology

Review of the regional geological map (DMR 1983[3]) indicated the site is in an area which is underlain by both fine to medium grained 'marine sands' and Hawkesbury Sandstone both in close proximity.

Based on the site inspection and sampling and review of the regional soil and landscape map (DCLM 1983[4]) it was found that the site is located on undulating to rolling rises and low hills of Hawkesbury Sandstone. The local relief is 20-80 m with slopes <10 m and rock outcrops of <10%. The description of the soils provided on the soil map includes shallow well sorted siliceous sands overlying moderately deep yellow podzolic soils with sandy topsoils on crests and gentle slopes; podzols on steep slopes, lower slopes and in depressions. Limitations include very high rates of soil erosion, localised steep slopes, very low soil fertility and non-cohesive topsoil.

2.7 Hydrogeology

A search of the NSW Natural Resource Atlas (NRAtlas)[5] completed on the 27 June 2012 found a number of groundwater bores registered within a 1.5 km radius of the site. The closest reported being bores: GW111568 <0.5km to the northwest; GW110856 <0.5km to the west; GW106098 <0.5km to the southwest; GW109680 <0.5km to the southeast; and GW108971 <1.0km to the northeast.

GW106098 was installed for domestic purposes and was drilled to 9.5 m bgs through sand with no standing water details.

GW108971 was also installed for recreational use and had a standing water level of 60 m bgs and 186 m bgs in white sandstone.

GW109680 was installed for groundwater remediation purposes and had a standing water level of 3.9 m bgs in sandstone.

GW110856 was installed as a groundwater monitoring bore and had a standing water level of 10 m bgs with no geological information.

GW111568 was installed as a ground water monitoring bore and had a standing water level of 5.1 m bgs in sand.

[3] *Sydney Geological Series Sheet 9130 (Edition 1) 1983.* Geological Survey of NSW Department of Mineral Resources, (DMR 1983).
[4] Sydney *Soil Landscape Series Sheet 9130.* Department of Conservation and Land Management of NSW, 1993 (DCLM 1993).
[5] http://www.nratlas.nsw.gov.au/wmc/custom/homepage/home.html

2.7 Acid Sulfate Soil

Review of the acid sulphate soil map for the Botany Bay area (DLWC 1997)[6] indicates that this site is located in an area of no known occurrence of acid sulphate soil. This is consistent with observations made during the site inspection by JBS.

[6] Acid Sulphate Soil Risk Map, Edition 2, Botany Bay, Department of Land and Water Conservation 1997 (DLWA, 1997)

3 Site History

3.1 Aerial Photographs

Aerial photographs from 1930, 1951, 1961, 1970, 1978, 1986, 199 and 2004 were obtained from the Department of Land and Property. Copies of the Aerial Photographs are included in **Appendix B**.

Relevant information from the aerial photograph review is summarised below:

- **1930 -** The site appeared to be secondary race course to Randwick Racecourse with residential housing to the south and east of the site.
- **1951** – The site appeared to be a large grassed area with buildings being erected to the northwest. The southern and western sides of the site remained similar to the previous photograph.
- **1961** - The site appeared to have been cleared and construction to the northwest had been completed. Further development to the current university campus was visible to the northwest of the site.
- **1970** - The current engineering buildings making up the site were constructed with more development across the university campus.
- **1978 -** The site remained similar to the previous photograph with development visible directly to the south of the site. The rest of the campus and surrounding area remained similar to the previous photograph.
- **1986** – The site and surrounding area appears similar to the previous photograph.
- **1994 -** The site appeared similar to the previous photograph other than the addition of a multi-story parking area to the south.
- **2004 -** The site and the immediate surrounding area appeared similar to the previous photograph other than the development of another university building to the south west of the site.

3.2 NSW EPA Records

A search of the NSW EPA's public register under the *Protection of the Environment Operations Act 1997* was undertaken, and results are included in **Appendix C**. The search identified that, for the site, there were:

- No prevention, clean-up or prohibition notices; and
- No transfer, variation, suspension, surrender or revocation of an environment protection licence.

A search was also undertaken through the NSW EPA's public contaminated land register (**Appendix C**) with no results for the site or nearby properties.

There are no records of notices under the CLM Act for the sites being regulated by the EPA in proximity to the site.

3.3 Australian and NSW Heritage Register

A search of the Australian Heritage Trust database and the NSW Heritage Inventory indicated that the site is not listed on the heritage register (**Appendix C**).

3.4 Site History Summary

The site history review indicates that the site was originally a secondary racecourse for Randwick Racecourse, with the surrounding building being developed in the 1970's. Current site levels suggest there may have been filling, possibly as part of cut and fill activities using site-won rather than imported materials, during development of the site.

3.5 Integrity Assessment

The information obtained from sources noted above has been found to be in general agreement regarding the history of the site.

Based on a range of sources and the general consistency of the historical information, it is considered that the historical assessment has an acceptable level of accuracy.

4 Potential Contamination Issues

4.1 Potential Areas and Substances of Environmental Concern

Based on the site history review, and JBS' site inspection, areas of environmental concern have been identified and are presented in **Table 4.1**.

Table 4.1 Areas of Environmental Concern and associated Contaminants of Potential Concern

Area of Environmental Concern (AEC)	Contaminants of Potential Concern (COPCs)
Fill material	Heavy metals, TPH, BTEX, PAHs, OCP, PCB, asbestos

The presence of fill was identified during the JBS site inspection.

4.2 Potentially Contaminated Media

Potentially contaminated media present at the site may include:

- Fill material;
- Natural soils;
- Groundwater; and
- Surface water

Fill to a depth of at least 1.7 m and possibly as reworked natural soils to a depth of 3.4 m behind the western retaining wall.

Undisturbed natural soils at the site consist of weathered sandstone bedrock. Due to the relatively non porous nature of the rock, natural soils across the site are not considered as potentially contaminated medium.

Groundwater at the site is anticipated to be at depths > 3.9 m below the ground surface within the natural material. Due to the relatively non porous nature of the natural material and the depth to groundwater, groundwater is not considered a potentially contaminated medium.

Surface water was not identified as a potentially contaminated medium based on the absence of any permanent water body present on the site, and the distance to the nearest permanent water body.

4.3 Potential for Migration

Contaminants generally migrate from site via a combination of windblown dusts, rainwater infiltration, groundwater migration and surface water runoff. The potential for contaminants to migrate is a combination of:

- The nature of the contaminants (solid/liquid and mobility characteristics);
- The extent of the contaminants (isolated or widespread);
- The location of the contaminants (surface soils or at depth); and
- The site topography, geology, hydrology and hydrogeology.

The potential contaminants identified as part of the site history review and site inspection are present in solid (impacted soil or fill) form.

Site inspection has indicated that the ground surface is either covered with university buildings or well maintained and sealed with bitumen. As a result, the potential for migration of contaminants via wind-blown dust is low with the absence of any loose soils within the site.

The potential for migration of contamination via surface water generation is expected to be low given the sealed nature of the site. No further assessment of the potential for contaminants to migrate from the site will be undertaken as there are no surface water bodies close to the site.

Rainfall is not anticipated to infiltrate the site due to the sealed nature of the ground surface. Rainwater would be directed into the stormwater infrastructure running along Willis Lane or Engineering Road.

5 Sampling and Analysis Plan

5.1 Data Quality Objectives

Data quality objectives (DQOs) were developed for the investigation, as discussed in the following sections.

5.1.1 State the Problem

It is understood that a CA is required to support DA submission for proposed refurbishment and additions to the existing Mechanical Engineering building. The majority of works proposed will be refurbishment and façade related. Contamination and geotechnical services are required in relation to a new building extension being added to the eastern side of the building in the western portion of the site

5.1.2 Identify the Decision

Based on the decision making process for assessing urban redevelopment sites detailed in DEC (2006)[7], the following decisions must be made:

- Are there any unacceptable risks to likely future onsite receptors from soil?
- Are there any issues relating to the local area background soil concentrations that exceed appropriate soil criteria?
- Are there any impacts of chemical mixtures?
- Are there any aesthetic issues?
- Is there any evidence of, or potential for, migration of contaminants from the site?
- Is a site management strategy required?

5.1.3 Identify Inputs to the Decision

Inputs to the decisions are:

- The site description from observations made during the site inspection, as described in **Section 1**;
- Historical reviews of current and former sources of contamination and results from analytical testing of soil samples;
- Soil environmental data as collected by soil sampling and analysis consisting of total concentrations;
- Soil criteria to be achieved on the site as based on the current and future landuse as defined by assessment criteria nominated in **Section 6.2**;
- Confirmation that data generated by sample analyses are of an acceptable quality to allow reliable comparison to assessment criteria as undertaken by assessment of quality assurance / quality control as per the data quality indicators established in **Section 5.1.6**.

[7] *Contaminated Sites: Guidelines for the NSW Site Auditor Scheme, 2nd Edition,* NSW EPA, 2006 (DEC 2006).

5.1.4 Define the Study Boundaries

The site is legally identified as part of Lot 3 DP1104617. The site boundaries are shown on **Figure 2**. The CA targeted the potential contamination issues detailed in **Section 4**.

The maximum vertical extent of the environmental soil investigation was approximately 4.4 m below ground level, 1.0 m into natural material.

Due to the nature of potential contaminants identified, seasonality was not assessed as part of this investigation.

5.1.5 Develop a Decision Rule

Soil analytical data was assessed against NSW EPA endorsed criteria including:

- *National Environment Protection (Assessment of Site Contamination) Measure,* National Environment Protection Council, 1999 (NEPC 1999);
- *Contaminated Sites: Guidelines for the NSW Site Auditor Scheme (2nd Edition)*, Department of Environment and Conservation NSW (DEC 2006); and
- *Contaminated Sites: Guidelines for Assessing Service Station Sites,* NSW EPA, 1994 (EPA 1994).

The decision rules adopted to answer the decisions identified in **Section 5.1.2** are summarised in **Table 5.1**.

Table 5.1 Summary of Decision Rules

Decision Required to be Made	Decision Rule
1. Are there any unacceptable risks to onsite future receptors from soils?	Soil analytical data was compared against NSW EPA endorsed criteria. Statistical analyses of the data in accordance with relevant guidance documents was undertaken, where appropriate, to facilitate the decisions. The following statistical criteria will be adopted with respect to soils: Either: the reported concentrations are all below the site criteria; Or: the average site concentration for each analyte must be below the adopted site criterion; no single analyte concentration exceeds 250% of the adopted site criterion; and the standard deviation of the results must be less than 50% of the site criteria. And: the 95% upper confidence limit (UCL) [8] of the average concentration for each analyte must be below the adopted site criterion. If the statistical criteria stated above are satisfied, the decision is No. If the statistical criteria are not satisfied, the decision is Yes.
2. Are there any issues relating to the local area background soil concentrations that exceed appropriate soil criteria?	If the 95% UCL of surface soils exceeds published background concentrations (NEPC 1999), the decision is Yes. Otherwise, the decision is No.
3. Are there any aesthetic issues?	If there were any unacceptable odours or soil discolouration, the decision was Yes. Otherwise, the decision was No.
4. Are there any chemical mixtures?	Are there more than one group of contaminants present which increase the risk of harm? If there is, the decision is Yes. Otherwise, the decision is No.
5. Is there any evidence of, or potential for, migration of contaminants from the site?	Are contaminants present at concentrations exceeding the adopted criteria? If yes, the decision is Yes. Otherwise, the decision is No.
6. Is a site management strategy required?	Was the answer to any of the above decisions Yes? If yes, a site management strategy is required. If no, a site management strategy is not required.

[8] *Sampling Design Guidelines.* (NSW EPA,1995)

5.1.6 Specify Limits of Decision Error

This step is to establish the decision maker's tolerable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data. Data generated during this project must be appropriate to allow decisions to be made with confidence.

Specific limits for this project have been adopted in accordance with the appropriate guidance from the NSW EPA, NEPC (1999), appropriate indicators of data quality (DQIs used to assess quality assurance / quality control) and standard JBS Environmental procedures for field sampling and handling.

To assess the usability of the data prior to making decisions, the data was assessed against pre-determined Data Quality Indicators (DQIs) for completeness, comparability, representativeness, precision and accuracy. The acceptable limit on decision error is 100% compliance with DQIs.

The pre-determined Data Quality Indicators (DQIs) established for the project are discussed below in relation to precision, accuracy, representativeness, comparability and completeness (PARCC parameters), and are shown in **Table 5.2**.

- **Precision** - measures the reproducibility of measurements under a given set of conditions. The precision of the laboratory data and sampling techniques is assessed by calculating the Relative Percent Difference (RPD) of duplicate samples.
- **Accuracy** - measures the bias in a measurement system. The accuracy of the laboratory data that are generated during this study is a measure of the closeness of the analytical results obtained by a method to the 'true' value. Accuracy is assessed by reference to the analytical results of laboratory control samples, laboratory spikes and analyses against reference standards.
- **Representativeness** –expresses the degree which sample data accurately and precisely represent a characteristic of a population or an environmental condition. Representativeness is achieved by collecting samples on a representative basis across the site, and by using an adequate number of sample locations to characterise the site to the required accuracy.
- **Comparability** - expresses the confidence with which one data set can be compared with another. This is achieved through maintaining a level of consistency in techniques used to collect samples; ensuring analysing laboratories use consistent analysis techniques and reporting methods.
- **Completeness** – is defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal is set at there being sufficient valid data generated during the study.

Table 5.2 Summary of Quality Assurance / Quality Control Program

Data Quality Objective	Frequency	Data Quality Indicator
Precision		
Blind duplicates (intra laboratory)	1 / 20 samples	<50% RPD[1]
Blind duplicates (inter laboratory)	NA	NA
Accuracy		
Surrogate spikes	All organic samples	70-130%
Laboratory control samples	1 per lab batch	<LOR
Matrix spikes	1 per lab batch	70-130%
Representativeness		
Sampling appropriate for media and analytes		-
Samples extracted and analysed within holding times.	-	organics (14 days), inorganics (6 months)
Comparability		
Standard operating procedures for sample collection & handling	All Samples	All samples
Standard analytical methods used for all analyses	All Samples	All samples
Consistent field conditions, sampling staff and laboratory analysis	All Samples	All samples
Limits of reporting appropriate and consistent	All Samples	All samples
Completeness		
Sample description and COCs completed and appropriate	All Samples	All samples
Appropriate documentation	All Samples	All samples
Satisfactory frequency and result for QC samples	All QA/QC samples	-
Data from critical samples is considered valid	-	Critical samples valid

[1] Relative per cent difference

If any of the DQIs are not met, further assessment will be necessary to determine whether the non-conformance will significantly affect the usefulness of the data. Corrective actions may include requesting further information from samplers and/or analytical laboratories, downgrading of the quality of the data or alternatively, re-collection of the data.

5.1.7 Optimise the Design for Obtaining Data

Various strategies for developing a statistically based sampling plan are identified in EPA (1995)[9], including judgemental, random, systematic and stratified sampling patterns.

Random sampling is not appropriate based on the areas of environmental concern and the site layout.

Based on the site layout and known history of the site, a judgemental sampling program was implemented for the current investigation (as shown in **Figure 2**), given areas to be investigated were restricted due to the limited accessible areas for sampling. EPA (1995) indicates a minimum recommended sampling density of five locations for a 500 m^2 area, the smallest area included in the guidance. Four sampling locations for the site, with an accessible area of less than 300 m^2, is considered appropriately conservative to meet project objectives, particularly as the bulk of the site will be undergoing only internal refurbishment. Sampling focussed on accessible areas within or in proximity to the site areas where construction potentially requiring ground disturbance will occur.

5.2 Soil Sampling Methodology

Due to access limitations soil samples were collected from two boreholes on Willis Lane and from two locations in the retaining wall along the west of Willis Lane, where additional building will occur (**Figure 2**).

[9] *Sampling Design Guidelines.* NSW EPA. September 1995. (EPA 1995)

Soil samples were collected from solid flight augers below the hardstand at 0.1-0.2 m, 0.5 m, and then at 0.5 m intervals until at least 0.5 m into natural soils. During the collection of soil samples, features such as seepage, discolouration, staining, odours and other indications of contamination were noted.

Collected samples were immediately transferred to laboratory supplied sample jars. The sample jars was then transferred to a chilled ice box for sample preservation prior to and during shipment to the testing laboratory. A chain-of-custody form was completed and forwarded with the samples to the testing laboratory. Based upon field observations, samples were analysed in accordance with the laboratory schedule (**Table 6.3**).

Note that not all samples collected were analysed. All samples will remain at the primary laboratory for a period of two months for possible future analysis if required following the receipt of sample results and provided analytes are within technical holding times.

Copies of borehole logs are provided in **Appendix D**.

5.3 Laboratory Analyses

JBS contracted Envirolab Service Pty Ltd (Envirolab), SGS Environmental (SGS) and Pickford and Rhyder Consulting Pty Ltd for laboratory analysis. The laboratories are NATA accredited for the respective analyses undertaken. In addition, the laboratories were required to meet JBS' internal QA/QC requirements. Laboratory analysis of samples was conducted with reference to COPCs listed in **Table 6.3**. Copies of the laboratories Certificates of Analysis are provided in **Appendix F**.

Table 5.3 Analytical Schedule

Area of Environmental Concern (AEC)	Sampling Locations (soil)	No. of Analyses (including QA/QC)
Potential fill material	4	Heavy metals– 6 samples TPH/BTEX – 6 samples OCPs/PCBs – 6 samples PAHs – 6 samples Asbestos – 6 samples Soil Aggressivity – 2 sample sPOCAS -1 sample

Only one sample was analysed for sPOCAS due to observations made during soil sampling, which did not identify any signs of actual or potential acid sulphate soils. Soil samples were collected for soil aggressivity assessment to be completed by PSM as part of geotechnical investigations. The results are included in this CA report but no interpretation of soil aggressivity is made.

6 Assessment Criteria

6.1 Regulatory Guidelines

The investigation was undertaken with consideration to aspects of the following guidelines and technical references, as relevant:

- *Contaminated Sites: Guidelines for Assessing Service Station Sites,* NSW EPA, 1994 (EPA 1994)
- *Contaminated Sites: Sampling Design Guidelines,* NSW EPA, 1995 (EPA 1995)
- *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*, NSW EPA, 1997 (EPA 1997)
- *Contaminated Sites: Guidelines for the NSW Site Auditor Scheme, 2nd Edition,* NSW EPA, 2006 (DEC 2006)
- *National Environment Protection (Assessment of Site Contamination) Measure,* National Environment Protection Council, 1999 (NEPC 1999)
- *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites,* Australian and New Zealand Environment and Conservation Council and the National Health and Medical Research Council, 1992 (ANZECC/NHMRC 1992)
- *Contaminated Sites: Guidelines on Duty to Report Contamination under the Contaminated Land Management Act 1997,* NSW DECC, June 2009 (DECC 2009)
- *Health screening levels for petroleum hydrocarbons in soil and groundwater. Summary.* September 2011, Friebel, E. & Nadebaum, P. CRC CARE Technical report no. 10, CRC for Conntamination Asessment and remediation of the Environment (CRC 2011)

6.2 Soil Criteria

Based on the current university use of the site and the future university use and in accordance with the decision process for assessment of urban redevelopment sites (DEC 2006), concentrations of contaminants in the soil were compared against health-based investigation levels for Parks, recreational open space, playing fields including secondary schools (HIL-E) and Provisional phytotoxicity-based investigation levels (**Table 5.1**). The open space and secondary schools landuse scenarios were considered to be closest to the current and intended university and roadway uses. Where required results were statistically assessed in accordance with the method summarised in **Table 6.1.**

Table 6.1 Soil Criteria (all units in mg/kg)

	Limit of Reporting	Laboratory Method	Parks, recreational, open space, playing fields including secondary schools (HIL-E)	Provisional phytotoxicity – based investigation levels (mg/kg)
METALS				
Arsenic	4.0	ICP-AES (USEPA 200.7)	200	20
Cadmium	1.0	ICP-AES (USEPA 200.7)	40	3
Chromium (VI)	1.0	ICP-AES (USEPA 200.7)	200	1
Copper	1.0	ICP-AES (USEPA 200.7)	2000	100
Nickel	1.0	ICP-AES (USEPA 200.7)	600	60
Lead	1.0	ICP-AES (USEPA 200.7)	600	600
Zinc	1.0	ICP-AES (USEPA 200.7)	30	100000
Mercury (inorganic)	0.1	ICP-AES (USEPA 200.7)	14000	60
PETROLEUM HYDROCARBONS				
C6 – C9 Fraction	25	Purge Trap-GCMS (USEPA8260)	65[2]	
C10 – C36 Fraction	250	Purge Trap-GCFID (USEPA8000)	1000[2]	
BTEX				
Benzene	1.0	Purge Trap-GCMS (USEPA8260)	1[2]	
Toluene	1.0	Purge Trap-GCMS (USEPA8260)	130[2]	
Ethylbenzene	1.0	Purge Trap-GCMS (USEPA8260)	50[2]	
Total Xylenes	3.0	Purge Trap-GCMS (USEPA8260)	25[2]	
POLYCYCLIC AROMATIC HYDROCARBONS				
Benzo(a)pyrene	0.05	GCMS (USEPA8270)	2	
Total PAHs	1.55	GCMS (USEPA8270)	40	
ORGANOCHLORINE PESTICIDES				
Aldrin + Dieldrin	0.2	GCECD (USEPA8140,8080)	20	
Chlordane	0.1	GCECD (USEPA8140,8080)	100	
DDT + DDD + DDE	0.3	GCECD (USEPA8140,8080)	400	
Heptachlor	0.1	GCECD (USEPA8140,8080)	20	
PCBs				
PCBs (total)	0.9	GCECD (USEPA8140,8080)	20	
OTHER				
Asbestos	0.1g/kg	PLM / Dispersion Staining	No asbestos capable of being detected via the analytical program, which comprises both visual identification and sample analysis by a NATA accredited laboratory	

[1] Column 3 (NEHF - E), Health-based Investigation Levels (DEC 2006)
[2] Table 3 (EPA 1994)
3 Column 5, Health-based Investigation Levels (DEC 2006)

The results of asbestos analysis were assessed against NSW OEH guidance of no visible asbestos at the surface.

7 Quality Assurance / Quality Control

7.1 QA/QC Results

The QA/QC results for soil are summarised in **Table 7.1** and discussed in **Section 7.2**. Detailed laboratory QA/QC results are included with the laboratory reports in **Appendix F** and the summarised field and laboratory QA/QC results are provided in **Appendix G**.

Table 7.1 - QA/QC Results Summary

Data Quality Objective	Results	DQI met?
Precision		
Soil		
Blind Duplicates (intra-laboratory)	Frequency 14%, 0-100 % RPD	Partial[1]
Split Duplicates (inter-laboratory)	NA	NA
Accuracy		
Surrogate spikes	90 - 139% Recovery	Partial[1]
Laboratory control samples	81 – 139%	Partial[1]
Matrix spikes	100%	Yes
Representativeness		
Sampling appropriate for media and analytes	All sampling conducted in accordance with JBS standard operating procedures	Yes
Method blanks	<LOR	Yes
Samples extracted and analysed within holding times.	All samples were extracted and analysed within holding times	Yes
Comparability		
Standard operating procedures used for sample collection & handling	Consistent team of field staff used throughout works following JBS standard operating procedures.	Yes
Standard analytical methods used	Standard analytical methods used. Primary and secondary laboratories were NATA accredited for all analyses.	Yes
Consistent field conditions, sampling staff and laboratory analysis	Sampling was conducted by a consistent team of field staff in the same conditions throughout the investigation. Analytical laboratory remained consistent throughout the investigation.	Yes
Limits of reporting appropriate and consistent	Laboratory limits of reporting were consistent and appropriate.	Yes
Completeness		
Soil description & COCs completed	All borehole logs and COCs were completed appropriately.	Yes
Appropriate documentation	All appropriate field documentation is included in the Appendices of this report.	Yes
Satisfactory frequency/result for QC samples	The QC results are considered adequate for the purposes of the investigation.	Yes
Data from critical samples is considered valid	Data from critical samples is considered valid.	Yes

[1] See below for discussion where DQI exceeded.

7.2 Discussion of QA/QC Results

Precision

A field intra-laboratory duplicate soil sample was analysed at a rate of one per seven samples (14%). The results of analysis for the intra-laboratory duplicate soil sample were within the acceptance criteria with the exception of the following:

- Copper with an RPD of 67% between primary sample BH01-0.9-1.0 and duplicate sample QC01; and
- Zinc with an RPD of 100% between primary sample BH01-0.9-1.0 and duplicate sample QC01.

It is considered that the elevated RPD for the intra-laboratory duplicate sample is due to the heterogeneous nature of the fill material. As the levels of both copper and zinc were relatively low, and below adopted investigation criteria, it is not considered to affect the reliability of the data with respect to the site assessment.

No field inter-laboratory duplicate sample was collected due to the small number of samples collected for this investigation.

Accuracy

Surrogate spikes were included with all organic analyses. The surrogate spike recoveries were all within the data acceptance criteria with the exception of TPH C_{10}-C_{36} with a recovery of 94-139%. Although this is outside of the JBS prescribed DQO, it is within the NATA accredited laboratories acceptable range. It is therefore not considered to affect the reliability of the data set.

The laboratory control sample recoveries were all within the data acceptance criteria with the exception of TPH C_{10}-C_{36} with a recovery of 139%. Although the high recovery is outside of the JBS prescribed DQOs it is still within the NATA accredited laboratories acceptable range.

The matrix spike recovery was within the data acceptance criteria.

Representativeness

All soil sampling works completed during the investigation was conducted in accordance with JBS standard operating procedures. Soil sampling was conducted by solid augered drilling techniques, where necessary, which are considered appropriate for the potential site contaminants.

Analysis of method blanks was conducted for the single laboratory batch. The method blank recoveries were all within the data acceptance.

The extraction and analysis of selected soil samples was completed within the recommended holding times for all analytes and therefore considered to be appropriate.

Comparability

Experienced JBS personnel undertook all sampling in accordance with standard JBS sampling methods.

All field works and sampling were undertaken by one experienced JBS field scientist.

The laboratory LORs are consistent and are considered appropriate.

Completeness

Samples were transported under full chain of custody (COC) documentation. The COC documentation was completed correctly and the selected analyses were correctly conducted.

All field documentation is complete and is correct. Calibration records are included in **Appendix E**.

The frequency of analysis and result for all QC samples are appropriate.

7.3 QA/QC Assessment

The results of the field and laboratory QA/QC program indicate that the analytical data obtained from this investigation generally met the predetermined DQIs or, where the DQIs were exceeded, did not indicate systematic sampling or analytical errors. As such the soil water analytical data are considered to be of adequate quality to be relied on for the purposes of assessing the environmental condition at the site.

8 Results of Analysis and Field Observations

8.1 Field Observations

The material types identified during field activities conducted on 3 July, 2012, are summarised below with detailed logs provided in **Appendix D**.

The materials sampled at the site typically comprised:

- from beneath the Bitumen slab to depths of at least 1.7 m and up to 3.4 m behind the western retaining wall – Fill, comprising silty clayey sand, silty sand, red, yellow and brown, medium density, damp with some weathered sandstone, sandstone gravels and brick gravels; overlying
- Natural yellow and white sands and weathered sandstone bedrock.

No odours or staining were noted in the materials sampled. Also, no visible asbestos containing material (ACM) was observed on the ground surface or within any of the material sampled.

8.2 Soil Analytical Results

The soil sampling locations are shown on **Figure 2**, with the soil analytical results summarised in **Table 1 to 4**. Laboratory analytical reports and chain of custody documentation is provided in **Appendix F**.

8.2.1 TPH and BTEX

The concentrations of TPH and BTEX in the soil samples selected for analysis were all below laboratory LORs and less than the adopted health based criteria.

8.2.2 Metals

The concentrations of metals in the soil samples selected for analysis were all less than the adopted health based criteria (HIL-E) and the phytotoxicity investigation levels (PILs).

8.2.3 PAHs

The concentrations of both benzo(a)pyrene and total PAHs in soil samples analysed were all less than the adopted health based criteria (HIL-E).

8.2.4 OCPs and PCBs

The concentrations of OCPs and PCBs were below laboratory LORs and less than the adopted health-based criteria (HIL E).

8.2.5 Asbestos

Asbestos was not detected in the three soil samples submitted for analysis.

8.2.6 Soil Aggressivity

The results of the soil agressivity analysis included chloride, sulphate, conductivity and pH results for 2 soil sample. The results are included in **Appendix F**, however no interpretation is made in this CA report. The results are to be separately assessed by PSM.

8.2.7 sPOCAS

The result of the sPOCAS analysis reported that the sample did not contain potential or actual acid sulphate soils.

8.2.8 Waste Classification

In the event that off-site disposal of soil is required, sample results for the fill material were compared against the Waste Classification Guidelines (DECCW 2009)[10]. TPH/BTEX, heavy metals, PAHs, OCPs and PCB concentrations were all within the general solid waste criteria.

[10] Waste Classification Guidelines, Part 1: Classifying Waste, Department of Environment, Climate Change and Water NSW, December 2009 (DECCW 2009).

9 Assessment of Risk

Based on the decision making process for assessing urban redevelopment sites detailed in DEC (2006) and outlined in **Section 5.1.2**, a qualitative assessment of risk has been undertaken on the basis of the decision rules outlined in **Table 5.1**.

9.1 Potential Risks to Future On-Site Receptors

The concentrations of contaminants of concern at the locations sampled were all less than the health based criteria. It is therefore considered that there is no unacceptable risk to on-site receptors from soils at the site.

9.2 Background soil concentrations

Background soil concentrations are those represented by samples collected in the natural material. All results were within the health based criteria and heavy metals concentrations were all below background ranges as included in NEPC (1999). It is therefore considered that there are no issues relating to natural background soil concentrations at the site.

9.3 Chemical Mixtures

No issues relating to chemical mixtures in relation to the identified contaminants of concern were identified. Therefore chemical mixtures are considered not to be an issue at the site.

9.4 Aesthetics

No staining, odours or visible ACM fragments were identified during the site investigation works. Therefore it is considered that there were no such aesthetic issues identified at the site.

9.5 Potential for Contaminant Migration

It is considered that neither vertical nor lateral migration of contaminants at the site is likely due to low or no reported COPC concentrations and the presence of hardstand above the majority of the site.

9.6 Site Management Strategy

Based on the results reported herein, and the above characterisation and responses to decisions developed as part of project DQOs, a long-term site management strategy is not required. Appropriate site management controls successfully implemented during development of the site for the intended landuses will adequately manage waste soils and any unexpected finds through appropriate unexpected finds protocols.

10 Conclusions and Recommendations

Based on the findings of the CA and subject to the limitations in **Section 11**, the following conclusions are made:

- Concentrations of COPC reported were below appropriate conservative EPA-endorsed health-based criteria, and do not represent an unacceptable risk to workers during works or to future users if left on site;
- The site in its current condition is considered suitable for the continued university/open space land use without further investigation or need for long term site management;
- Appropriate site management controls successfully implemented during development of the site for the intended landuse will adequately manage waste soils and any unexpected finds through appropriate unexpected finds protocols; and
- Fill material across the site is provisionally classified as General Solid Waste in accordance with DECCW 2009, should material require removal from site. Further testing would be required to confirm waste classification should any unexpected finds be encountered during development, or to assess whether the material may be able to be reused at other locations under an appropriate general exemption from waste regulations.

11 Limitations

This report has been prepared for use by the client who commissioned the works in accordance with the project brief only and has been based in part on information obtained from other parties. The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

JBS Environmental Pty Ltd accepts no liability for use or interpretation by any person or body other than the client. This report should not be reproduced without prior approval by the client, or amended in any way without prior approval by JBS Environmental Pty Ltd, and should not be relied upon by other parties, who should make their own enquires.

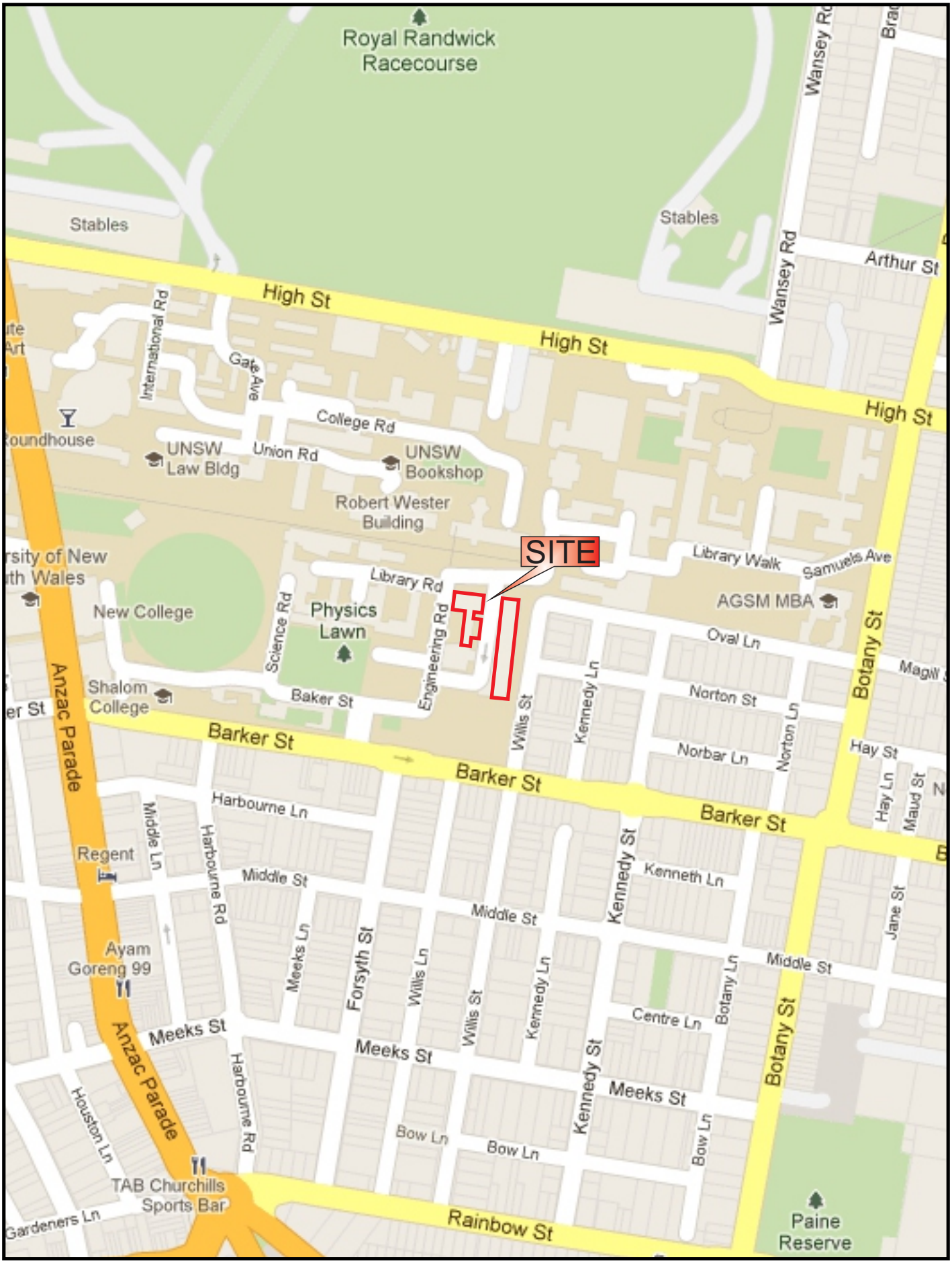
Sampling and chemical analysis of environmental media is based on appropriate guidance documents made and approved by the relevant regulatory authorities. Conclusions arising from the review and assessment of environmental data are based on the sampling and analysis considered appropriate based on the regulatory requirements and site history, not on sampling and analysis of all media at all locations for all potential contaminants.

Limited sampling and laboratory analyses were undertaken as part of the investigations, as described herein. Ground conditions between sampling locations may vary, and this should be considered when extrapolating between sampling points. Chemical analytes are based on the information detailed in the site history. Further chemicals or categories of chemicals may exist at the sites, which were not identified in the site history and which may not be expected at the site.

Changes to the subsurface conditions may occur subsequent to the investigations described herein, through natural processes or through the intentional or accidental addition of contaminants. The conclusions and recommendations reached in this report are based on the information obtained at the time of the investigations.

This report does not provide a complete assessment of the environmental status of the site, and it is limited to the scope defined herein. Should information become available regarding conditions at the site including previously unknown sources of contamination, JBS Environmental Pty Ltd reserves the right to review the report in the context of the additional information.

Figures



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0 50 100 200 m
Scale: Approximate

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date
A4			
1	Original Issue - R01	SE	09-10-2012

Legend:
Approximate Site Boundary

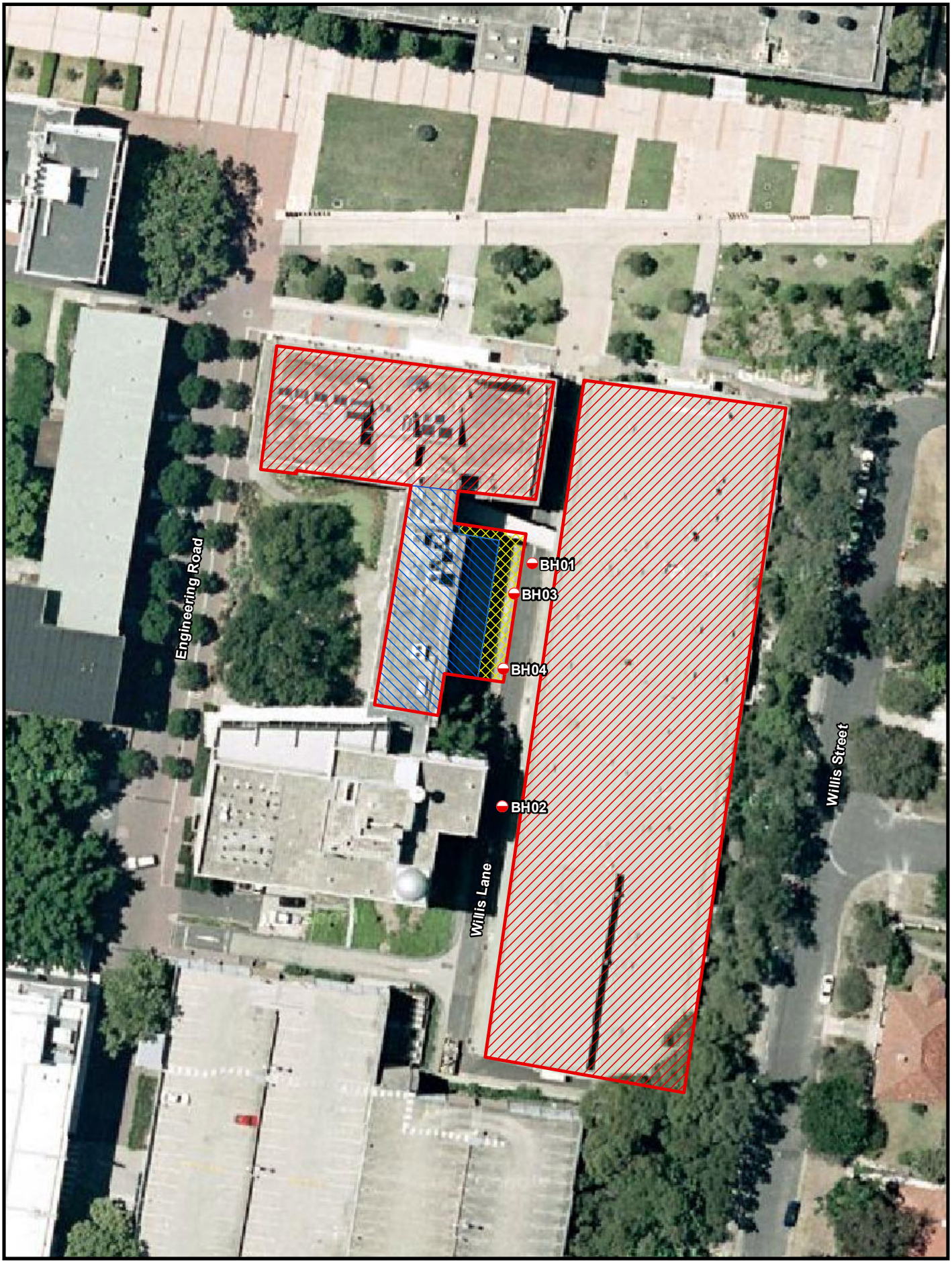
JBS ENVIRONMENTAL

Figure 1: Site Location

Client: Pells Sullivan Maynink

Project: Willis Lane, University of NSW, Kingsford, NSW

Job No: 42248 File Name: 42248_01



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Scale: 1:800

Datum: GDA 1994 MGA Zone 56 - AHD

A4			
1	Original Issue - R01	SE	09-10-2012
Rev	Description	Drn.	Date:

Legend:

- Approximate Site Boundary
- Internal Refurbish
- Demolish and Rebuild
- Build
- Borehole Location

JBS ENVIRONMENTAL

Figure 2: Site Layout and Sample Locations

Client: Pells Sullivan Maynink

Project: Willis Lane, University of NSW, Kingsford, NSW

Job No: 42248 File Name: 42248_02

Tables

Client: Pells Sullivan Meynink
Project name: Contamination Assessment
Site address: Willis Lane, UNSW, NSW
Table 1. Soil Analytical Results - Heavy Metals, Asbestos, TPH and BTEX

			8 metals in soil								Asbestos fibres	TPH in Soil					BTEX in Soil				
			Arsenic	Cadmium	Chromium (III+VI)	Copper	Lead	Mercury	Nickel	Zinc		C6 - C9	C10 - C14	C15 - C28	C29-C36	C10-C36	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	-	mg/kg	mg/kg	mg/kg	mg/kg		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL			4	0.5	1	1	1	0.1	1	1		25	50	100	100	250	0.2	1	0.5	2	1
DEC 2006 HIL E			200	40	240000	2000	600	30	600	14000	-	-	-	-	-	-	-	-	-	-	-
DEC 2006 PIL			20	3	1/400	100	600	1	60	200	-	-	-	-	-	-	-	-	-	-	-
EPA 1994 Health and Ecological			-	-	-	-	300	-	-	-	-	65	-	-	-	1000	1	50	130	-	-
Field ID	**Depth**	**Date**																			
BH01	0.9-1	3/07/2012	<4	<0.5	5	<1	3	<0.1	2	2	No asbestos detected at reporting limit of 0.1 g/kg No respirable fibres	<25	<50	<100	<100	<250	<0.2	<1	<0.5	<2	<1
BH02	0.4-0.5	3/07/2012	<4	<0.5	30	9	9	<0.1	17	13	No asbestos detected at reporting limit of 0.1 g/kg No respirable fibres	<25	<50	<100	<100	<250	<0.2	<1	<0.5	<2	<1
BH02	1.4-1.5	3/07/2012	<4	<0.5	1	10	54	<0.1	<1	15	No asbestos detected at reporting limit of 0.1 g/kg No respirable fibres	<25	<50	<100	<100	<250	<0.2	<1	<0.5	<2	<1
BH03	0.4-0.5	3/07/2012	<4	<0.5	3	2	10	<0.1	<1	9	No asbestos detected at reporting limit of 0.1 g/kg No respirable fibres	<25	<50	<100	<100	<250	<0.2	<1	<0.5	<2	<1
BH04	0-0.1	3/07/2012	<4	<0.5	4	4	43	<0.1	2	21	No asbestos detected at reporting limit of 0.1 g/kg No respirable fibres	<25	<50	<100	<100	<250	<0.2	<1	<0.5	<2	<1

Client: Pells Sullivan Meynink
Project name: Contamination Assessment
Site address: Willis Lane, UNSW, NSW
Table 2. Soil Analytical Results - PAHs and PCBs

			PAHs in Soil															PCBs in Soil							
			Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)&(k)fluoranthene	Benzo(g,h,i)perylene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAHs	Arochlor 1016	Arochlor 1221	Arochlor 1232	Arochlor 1242	Arochlor 1248	Arochlor 1254	Arochlor 1260	Total PCBs
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL			0.1	0.1	0.1	0.1	0.05	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.55	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7
DEC 2006 HIL E			-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	40	-	-	-	-	-	-	-	20
DEC 2006 PIL			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPA 1994 Health and Ecological			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Field ID	**Depth**	**Date**																								
BH01	0.9-1	3/07/2012	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1.55	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
BH02	0.4-0.5	3/07/2012	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1.55	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH02	1.4-1.5	3/07/2012	<0.1	<0.1	<0.1	<0.1	0.07	<0.2	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.27	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH03	0.4-0.5	3/07/2012	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1.55	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH04	0-0.1	3/07/2012	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1.55	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Client: Pells Sullivan Meynink
Project name: Contamination Assessment
Site address: Willis Lane, UNSW, NSW
Table 3. Soil Analytical Results - Miscellaneous inorganics and PCBs

			Miscellaneous Inorg - soil				Organochlorine Pesticides																			
			Chloride	Conductivity (1:5 aqueous extract)	pH (aqueous extract)	Sulphate	4,4-DDE	a-BHC	Aldrin	b-BHC	Chlordane (cis)	Chlordane (trans)	d-BHC	DDD	DDT	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan sulphate	Endrin	Endrin aldehyde	g-BHC (Lindane)	Heptachlor	Heptachlor epoxide	Hexachlorobenzene	Methoxychlor
			mg/kg	mg/kg	pH_Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL			2	1		2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
DEC 2006 HIL E			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-
DEC 2006 PIL			-	-	-	2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPA 1994 Health and Ecological			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Field ID	**Depth**	**Date**																								
BH01	0.9-1	3/07/2012	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH01	2.4-2.5	3/07/2012	10	45	5.3	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH02	0.4-0.5	3/07/2012	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH02	1.4-1.5	3/07/2012	5	57	5.1	54	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH03	0.4-0.5	3/07/2012	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH04	0-0.1	3/07/2012	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Client: Pells Sullivan Meynink
Project name: Contamination Assessment
Site address: Willis Lane, UNSW, NSW
Table 4. Soil Analytical Results - sPOCAS

			sPOCAS																						
			Acid Reacted Calcium	Acid Reacted Magnesium	acidity - Excess Acid Neutralising Capacity	acidity - Peroxide Oxidisable Sulfur	Calcium in Peroxide	Excess Acid Neutralising Capacity	FID	KCl Extractable Calcium	KCl Extractable Magnesium	KCl Extractable Sulfur	Liming Rate	Magnesium in Peroxide	Net Acidity (acidity units)	Peroxide Oxidisable Sulfur	pH (KCl)	pH (Ox)	sulfidic - Excess Acid Neutralising Capacity	sulfidic - Titratable Actual Acidity	sulfidic - Titratable Peroxide Acidity	Sulfur in Peroxide	Titratable Actual Acidity	Titratable Peroxide Acidity	Titratable Sulfidic Acidity	TSA (mol H+/tonne)
			%	pH Unit	mole H+/t	mole H+/t	%	%S	mg/kg	%	%	%	kg CaCO3/t	%	mole H+/t	%	pH Unit	pH Unit	%S	%S	%S	%	mole H+/t	pH Unit	pH Unit	mg/kg
EQL			0.005	0.005	5	5	0.005	0.05	1.5	0.005	0.005	0.005	0.75	0.005	10	0.005			0.05	0.01	0.01	0.005	5	5	5	0.01
Field ID	**Depth**	**Date**																								
BH01	2-2.4	3/07/2012	0.009	<0.005	<5	<5	0.07	<0.05	<1.5	0.06	0.006	0.01	1.2	0.009	17	0.007	5.1	5	<0.05	0.02	<0.01	0.02	12	<5	<5	<0.01

Appendix A

Site Photogrpahs

Photo 1: Willis Lane (the site) looking south from the northern end of the site

Photo 2: Willis lane (the site) looking south from the center of the site

Photo 3: Storm water infrastructure along Willis Lane

Photo 4: The mechanical and manufacturing engineering store located on the eastern side of Willis Lane.

Photo 5: The retaining wall along the western side of the site, looking south

Photo 6: The retaining wall along the western side of the site.

Appendix B

Historical Aerial Photographs

Source: Base Image - Department of Lands, Sydney, 20-02-1930, Run 17

0 40 80 160 m

Scale: 1:4,000

Datum: GDA 1994 MGA Zone 56 - AHD

A4			
0	Original Issue - Aerials	SE	02-07-2012
Rev	Description	Drn.	Date:

Legend:

Approximate Site Boundary

JBS ENVIRONMENTAL

Figure: University of NSW, February 1930, Run 17

Client: Pells Sullivan Maynink

Project: Willis Lane, University of NSW, Kingsford, NSW

Job No: 42248 File Name: 42248_1930

Source: Base Image - Department of Lands, Sydney, 05-1951, Run 15

0 40 80 160 m

Scale: 1:4,000

Datum: GDA 1994 MGA Zone 56 - AHD

A4			
0	Original Issue - Aerials	SE	02-07-2012
Rev	Description	Drn.	Date:

Legend:

- Approximate Site Boundary

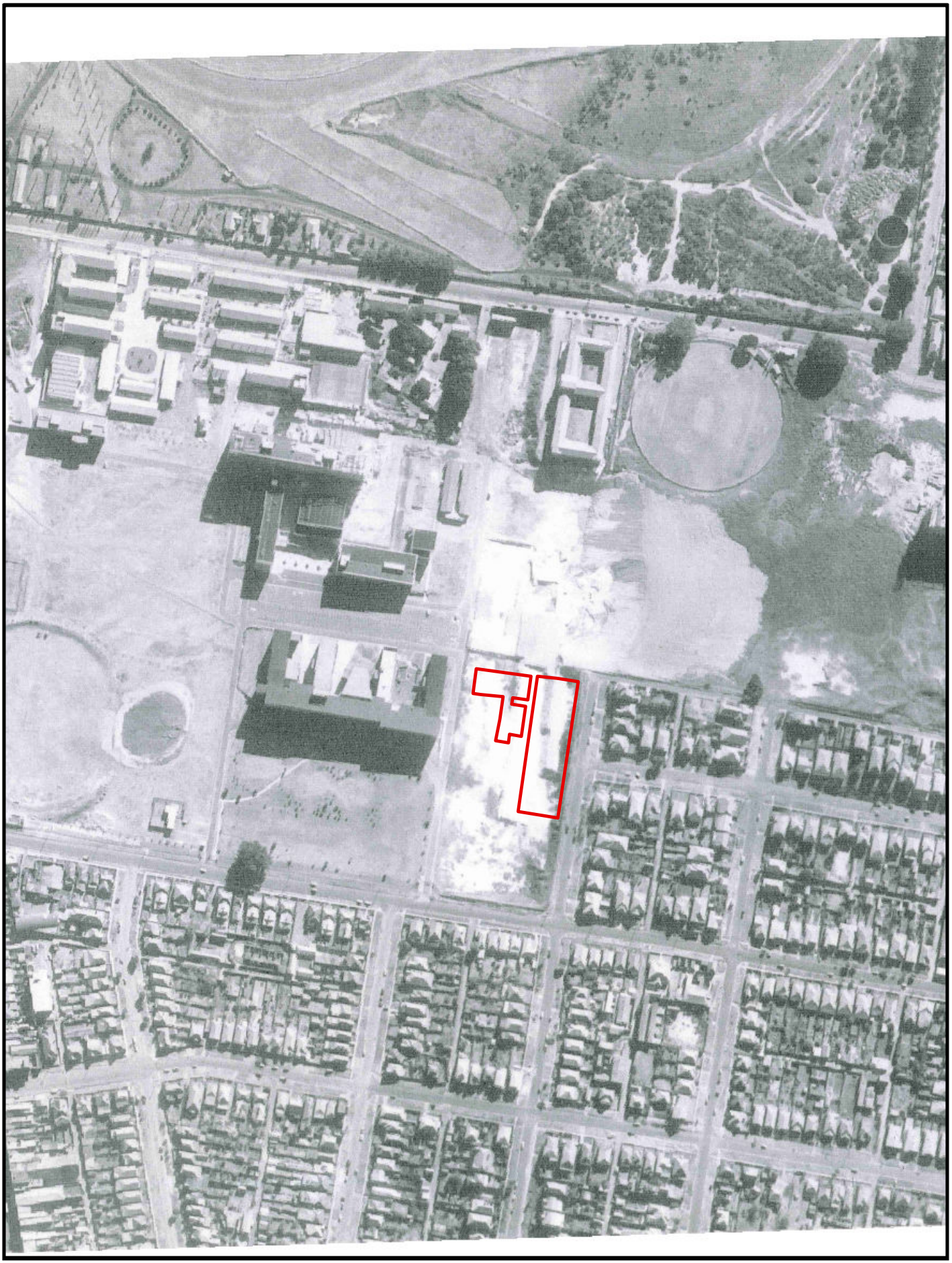
JBS ENVIRONMENTAL

Figure: University of NSW, May 1951, Run 15

Client: Pells Sullivan Maynink

Project: Willis Lane, University of NSW, Kingsford, NSW

Job No: 42248 File Name: 42248_1951



Source: Base Image - Department of Lands, Sydney, 1961, Run 38E

0 40 80 160 m

Scale: 1:4,000

Datum: GDA 1994 MGA Zone 56 - AHD

A4			
0	Original Issue - Aerials	SE	02-07-2012
Rev	Description	Drn.	Date:

Legend:

- Approximate Site Boundary

JBS ENVIRONMENTAL

Figure: University of NSW, 1961, Run 38E

Client: Pells Sullivan Maynink

Project: Willis Lane, University of NSW, Kingsford, NSW

Job No: 42248 File Name: 42248_1961