Douglas Partners
Geotechnics | Environment | Groundwater

Report on
Detailed Site Investigation

Proposed Car Park
Westmead Health Campus
Cnr Darcy and Institute Roads
Westmead

Prepared for
Health Infrastructure

Project 73603.01
November 2013

Integrated Practical Solutions

Douglas Partners
Geotechnics | Environment | Groundwater

Document History

Document details

Project No.	73603.01	Document No.	1
Document title	Report on Detailed Site Investigation, Proposed Car Park, Westmead Health Campus		
Site address	Cnr Darcy Road & Institute Road, Westmead		
Report prepared for	Health Infrastructure		
File name	P:\73603.01 WESTMEAD, Proposed Car Park, Contamination Assessment DW\Docs\REPORT\73603.01 draft DSI.docx		

Document status and review

Revision	Prepared by	Reviewed by	Date issued
Draft	D Walker	L Rockett	3 October 2013
Final	D Walker	L Rockett	27 November 2013

Distribution of copies

Revision	Electronic	Paper	Issued to
Draft	1		Health Infrastructure
Final	1		Health Infrastructure

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

	Signature	Date
Author		27 November 2013
Reviewer		27 November 2013

NCS INTERNATIONAL
CERTIFIED QUALITY MANAGEMENT SYSTEM

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
96 Hermitage Road
West Ryde NSW 2114
PO Box 472
West Ryde NSW 1685
Phone (02) 9809 0666
Fax (02) 9809 4095

Douglas Partners
Geotechnics / Environment / Groundwater

Executive Summary

This report presents the results of a Detailed Site Investigation (DSI) of contamination for a proposed new multi-level car park development at Westmead Health Campus (WHC) at the corner of Darcy Road and Institute Road, Westmead. The DSI was requested by Health Infrastructure for planning purposes. In addition, this report provides a provisional waste classification of soil for off-site disposal during construction.

The site is located at the western part of Lot 100 in Deposited Plan 1119583, Westmead, and has a triangular shape which covers approximately 1.3 ha. At the time of fieldwork (August 2013), the site was primarily used as a ground level car park for WHC. Parking areas at the site have an asphalt surface, although approximately one third of the site comprises grassed and garden areas including some large trees. An office building for the 'Western Sydney Local Health District Office' was present at the eastern part of the site

According to aerial photographs and historical title deeds, the site appears to have been used as agricultural land up until the 1930s when it was developed into part of an athletics track and sports ground. The athletics track appears to have been converted into a race track in the 1950s (according to aerial photographs), and used as a half-mile speedway track during the 1960s (according to internet searches). The race track and associated facilities appear to have been upgraded at certain stages, up until the time at which the WHC was developed during the 1970s. Demolition of buildings at the site would have occurred to accommodate the hospital campus development. The construction of the current car park and on-site office building appears to have occurred between 1978 and 1986 (according to aerial photographs).

Several licences for the Children's Hospital at Westmead and Westmead Hospital premises relating to the generation and storage of hazardous, industrial or 'Group A' waste include an extensive list. It is considered unlikely that these substances would have been introduced to the subject site, assuming that waste disposal practices were appropriately managed at both premises.

Fieldwork comprised soil sampling from 16 test bores and eight test pits. Three groundwater monitoring wells were installed at three selected test bore locations and were subsequently developed and sampled.

Filling depths were variable across the site, and ranged from depths of 0.3 m to 1.9 m below ground level (bgl). Deepest filling was observed at the eastern most corner, the southern corner and in mounded garden areas. Anthropogenic materials including fibre-cement (or fibro) were observed in the filling at a number of sampling locations. Fibre-cement fragments were also observed on the ground surface in a garden area.

No free groundwater was observed whilst drilling or test pitting. Measured groundwater levels in the wells indicate that the groundwater flow is generally toward the north-west or north.

Selected soil samples were analysed for eight priority heavy metals; polycyclic aromatic hydrocarbons, (PAH); total recoverable hydrocarbons (TRH); benzene, toluene, ethylbenzene, xylene, and naphthalene (BTEXN); organochlorine pesticides (OCP); polychlorinated biphenyls (PCBs) and phenols. Concentrations of chemical contaminants in soil were within the respective health investigation levels (HILs), health screening levels (HSLs), ecological investigation levels (EILs), and ecological screening levels (EILs) and management limits.

Selected soil samples and fibre-cement materials samples were analysed for asbestos. The presence of asbestos in the observed fibre-cement was confirmed by the analysis of two material samples. Asbestos was detected in seven of twenty-two analysed filling samples. Eleven of 24 test locations were identified to contain fibre-cement or detected asbestos in filling

Results of provisional waste classification testing indicate that concentrations of chemical contaminants (i.e. excluding asbestos) are within guideline values for General Solid Waste. Asbestos, however, is classified as Special Waste (Asbestos). It is considered that filling at the site containing fibre-cement fragments or detectable asbestos has a provisional waste classification as Special Waste (Asbestos). Filling that does not contain asbestos (or fibre-cement fragments) has a provisional waste classification of General Solid Waste (non-putrescible). From a practical point of view, however, it may be difficult to separate the two waste streams and a Special Waste (Asbestos) classification is likely to apply to most of the soil.

As natural soils do not show signs of contamination, either from observations or analytical testing, natural soils/rock at the site (except the old topsoil horizon identified at Bore 101) have a classification of Virgin Excavated Natural Material (VENM) provided that the material is not cross-contaminated, contains filling or mixed with other non-VENM material, or contain any signs of environmental or aesthetic concern.

Groundwater samples were analysed for the eight priority heavy metals, TRH, BTEXN, PAH, OCP, and phenols. Concentrations of arsenic, cadmium, copper, lead, mercury, nickel were all within the groundwater investigation levels (GILs). Concentrations of chromium were above the GIL for chromium (VI), but within the GIL for chromium (III) for all analysed samples. The detected concentrations of chromium are likely to be chromium (III), given that chromium (VI) is not considered to be a potential contaminant of concern for the site and chromium (III) is the common valence state in the environment. It is considered, therefore, that no further assessment is warranted for the detected chromium in groundwater. Concentrations of zinc were above the GIL in only the samples obtained from Bore 10. These concentrations are commonly found by DP in the Sydney Region and considered to be within the normal range of background concentrations particularly when considering the hardness of the groundwater. No significant source of zinc on site was detected. It is, however, noted that groundwater at this location does appear to have been impacted from an anthropogenic source (discussed below). Notwithstanding, no further assessment of zinc groundwater is considered warranted. PCB, OCP and total phenols were not detected in any groundwater sample and, therefore, concentrations are within the respective GILs. PAH was only detected in the groundwater samples collected from Bore 10. Detectable PAH comprised naphthalene and phenanthrene which were at concentrations within the GIL. Benzene and toluene were not detected in any groundwater sample. Ethylbenzene, xylenes and TRH were only detected in the groundwater samples from Bore 10. All concentrations of TRH and BTEX were within the respective HSLs. Review of the TRH chromatogram revealed that the detectable TRH response is not dissimilar to a response for 2-stroke fuel or petrol, although the review was not conclusive. The source of the detected TRH, ethylbenzene, xylenes, phenanthrene and naphthalene has not been determined but is probably from off-site. Given that concentrations are within the respective GILs, and HSLs, further assessment of TRH, BTEX and PAH in groundwater is not considered necessary.

Given the considerable asbestos contamination identified, it is considered that a Remediation Action Plan (RAP) will need to be prepared for the remediation of asbestos in order to render the site suitable for the proposed development. Typical approaches for remediating asbestos contamination include:

- complete removal of the asbestos contamination to a licensed landfill;
- burial of the asbestos at the site beneath a capping layer that is managed by procedures provided in an environmental management plan; or
- a combination of the above two options (i.e. disposal of some asbestos contaminated soil to a licensed landfill and capping the remainder of asbestos contaminated filling on site).

The remediation should be validated by a qualified environmental consultant. Excavation and removal of asbestos contaminated soil would need to be undertaken by an appropriately licensed (AS A) contractor. A qualified occupational hygienist would need to periodically inspect and validate the works and prepare certificate(s) stating the work was undertaken in a satisfactory manner and that the resultant health risk associated with the asbestos contamination has been reduced to an insignificant level. The occupational hygienist would also carry out air monitoring during the remediation.

It is considered that the site can be made suitable for the proposed car park development.

Douglas Partners
Geotechnics | Environment | Groundwater

Table of Contents

Page

Glossary of Terms

ANZECC	Australian and New Zealand Conservation Council and Agriculture
ARMCANZ	Agriculture, and Resource Management Council of Australia and New Zealand
Amended ASC NEPM	National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013
ASS	Acid sulphate soils
bgl	below ground level
BTEX	Benzene, Toluene, Ethyl Benzene, and Xylenes
BTEXN	Benzene, Toluene, Ethyl Benzene, Xylenes, and Naphthalene
CEC	Cation Exchange Capacity
CSM	Conceptual Site Model
CLM	Contaminated Land Management
DECC	Department of Environment and Climate Change
DP	Douglas Partners Pty Ltd
DQI	Data Quality Indicators
DQO	Data Quality Objective
DSI	Detailed Site Investigation
EC	Electrical Conductivity
EIL	Ecological Investigation Level
EPA	Environment Protection Authority
EMP	Environmental Management Plan
ESL	Environmental Screening Level
GIL	Groundwater Investigation Level
GPS	Global Positioning System
HIL	Heath Investigation Level
LCS	Laboratory Control Sample
LNAPL	Light non-Aqueous phase liquids
m	metres
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
NATA	National Association of Testing Authorities, Australia
NHMRC	National Health and Medical Research Council
NRMMC	National Resource Management Ministerial Council, Australia
NSW	New South Wales
µg/L	micrograms per litre
OCP	Organochlorine pesticides
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated biphenyls
PQL	Practical Quantitation Limit

PID	Photo-ionisation detector
POEO	Protection of the Environment Operations
ppm	parts per million
QA	Quality Assurance
QC	Quality Control
RAP	Remediation Action Plan
RPD	Relative Percentage Difference
TCLP	Toxicity characteristic leaching procedure
TEQ	Toxicity equivalent quotient
TOPIC	Total photoionisable compounds
TPH	Total petroleum hydrocarbons
TRH	Total recoverable hydrocarbons
WHC	Westmead Health Campus
VENM	Virgin Excavated Natural Material
VOC	Volatile organic compounds

Report on Detailed Site Investigation
Proposed Car Park, Westmead Health Campus
Cnr Darcy Road & Institute Road, Westmead

1. Introduction

This report presents the results of a Detailed Site Investigation (DSI) of contamination for a proposed new car park development at Westmead Health Campus (WHC) in the location of the existing car park known as 'Çar Park 7' at the corner of Darcy Road and Institute Road, Westmead. The DSI was requested by Health Infrastructure for planning purposes and was undertaken in accordance with Douglas Partners' (DP) proposal dated 5 August 2013 and Westfield Car Park Planning Consultancy Agreement (Contract No. H134823), dated 13 August 2013.

WHC includes Westmead Hospital and Children's Hospital Westmead. It is understood that the proposed car park is to accommodate over 800 car parking spaces for the current shortfall of on-campus parking. The proposed development will comprise a multi-level car park, although only feasibility study plans had been made available at the time conducting the DSI.

The aim of the DSI is to:

- Identify potential sources of contamination resulting from past and present site uses;
- Identify the contaminants of concern, if any;
- Identify areas of potential contamination;
- Identify potential human and ecological receptors;
- Identify potentially affected media (soil, groundwater, surface water etc);
- Provide data on the contamination status of the subsoils and groundwater present at the site;
- Develop a Conceptual Site Model; and
- Make recommendations for further investigations and/or remediation required to render the site suitable for the proposed development works.

In addition, this report provides a provisional waste classification of soil for off-site disposal during construction.

This DSI is not subject to an audit by an accredited contaminated land auditor.

Environmental investigations at the site were undertaken concurrently with geotechnical investigations. The results of the geotechnical investigations are reported separately.

2. Scope of Works

The scope of works was broadly based on NSW Environmental Protection Authority (EPA) endorsed guidelines. The scope of works for the investigation was as follows:

- Review of available site history information including:
  - Current and historical land titles;
  - Historical aerial photographs;
  - Any relevant Notices or notifications under the *Contaminated Land Management Act* 1997 and the *Protection of the Environment Operations Act 1997*;
  - The WorkCover records for Dangerous Goods Licences;
  - Section 149 (2) and (5) certificate;
- Review of available site information in regards to topography, geology and hydrogeology including registered groundwater bores;
- Conduct a walkover to identify areas of environmental concern;
- Collect soil samples from 10 test bores drilled for geotechnical purposes;
- Collect soil samples from eight test pits excavated for geotechnical purposes;
- Collect soil samples from six additional test bores;
- Install and develop groundwater monitoring wells at three test bore locations;
- Sample each of the groundwater wells using low flow techniques;
- Screen all soil samples for volatile organic compounds using a calibrated photo-ionisation detector (PID); and
- Analyse selected soil (or material) samples at a NATA accredited laboratory for combinations of common analytes:
  - The priority heavy metals arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc (36 primary samples, 4 replicate samples);
  - Polycyclic aromatic hydrocarbons (PAH) (36 primary samples);
  - Total recoverable hydrocarbons (TRH) (36 primary samples, four replicate samples);
  - Benzene, toluene, ethyl benzene, xylene and naphthalene (BTEXN) (36 primary samples, 4 replicate samples);
  - Organochlorine pesticides (OCP) (24 primary samples);
  - Total phenols (24 primary samples);
  - Polychlorinated biphenyls (PCB) (24 primary samples);
  - Asbestos (22 soil samples, two material samples);
  - Cation exchange capacity (CEC) (three samples);
  - Clay content (three samples);
  - Organic carbon content (three samples);

- pH (three samples); and
- Nickel in Toxicity Characteristic Leaching Procedure (TCLP) (three samples);

- Analyse a groundwater sample from each monitoring well (plus one QA/QC replicate sample) at a NATA accredited laboratory for combinations of common analytes:
  - The priority heavy metals: arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc (three samples plus one replicate sample);
  - Polycyclic aromatic hydrocarbons (PAH) (three samples);
  - Total recoverable hydrocarbons (TRH) (three samples plus 1 replicate sample);
  - Benzene, toluene, ethyl benzene, xylene and naphthalene (BTEXN) (three samples);
  - Organochlorine pesticides (OCP) (three samples);
  - Total phenols (three samples);
  - Polychlorinated biphenyls (PCB) (three samples);
  - pH (three samples); and
  - hardness (3 samples);
- Analyse one trip spike and one trip blank for BTEX for every day of sampling for QA/QC purposes;
- Provision of this DSI report with reference to EPA endorsed guidelines and detailing the methodology, analytical results and a discussion of results. Results of the waste classification assessment are also discussed

3. Site Identification and Description

The site is located at the western part of Lot 100 in Deposited Plan 1119583, Westmead, and has a triangular shape which covers approximately 1.3 ha as shown in Drawing 1, Appendix A. The north of the site is bounded by Institute Road and the south-west of the site is bounded by Darcy Road. Hospital buildings and an associated car park are adjacent to the south-east of the site.

At the time of fieldwork (August 2013), the site was primarily used as a ground level car park for WHC (Photo 1, Appendix B). Parking areas are accessed via Darcy Road and Institute Road. An office building for the 'Western Sydney Local Health District Office' was present at the eastern part of the site (Photo 2, Appendix B). The office building is of brick construction and comprises a ground level and basement level. Retaining walls are present at the south-eastern part of the building (Photo 3, Appendix B). A narrow road from Institute Road crosses the site for access to the office building and other parks of WHC. Parking areas at the site have an asphalt surface, although approximately one third of the site comprises grassed and garden areas including some large trees. The site slopes gently down to the north-west. Much of the grassed and garden areas have been formed with mounded soil (Photos 4 and 5, Appendix B).

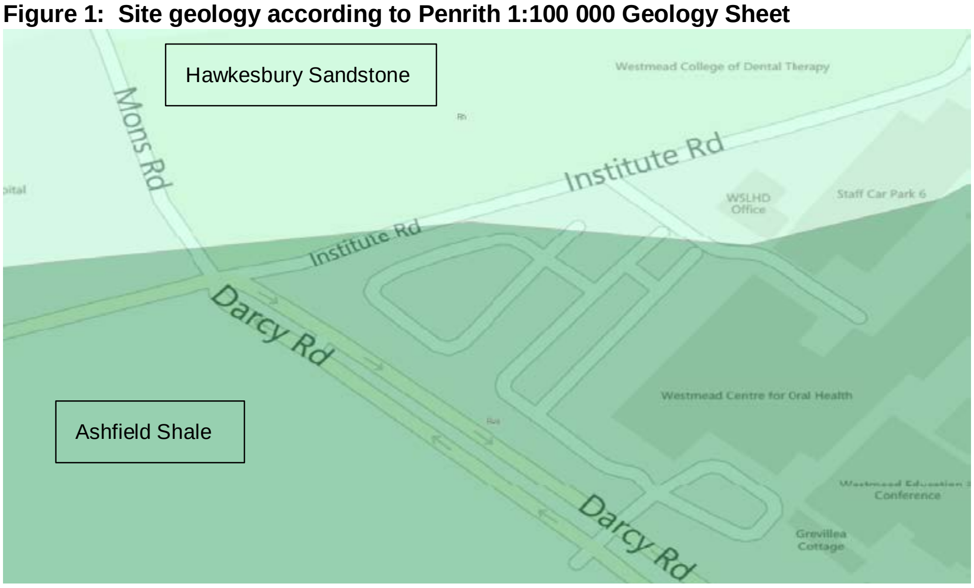
Land adjacent to the north of the site is primarily occupied by commercial buildings. A school occupies the land adjacent to the west of the site.

4. Regional Topography, Geology and Hydrogeology

The land at and surrounding the site gently falls to the north and north-west. Stormwater is expected to either enter the local drainage system or infiltrate soil in the grassed and garden areas. The closest receiving water body is Toongabbie Creek which is approximately 400 m to the north of the site. Groundwater is anticipated to migrate towards the north or north-west.

According to the Penrith 1:100 000 Geology Sheet, the site is located at the boundary of Ashfield Shale and Hawkesbury Sandstone, as shown in Figure 1. Ashfield Shale comprises dark-grey to black claystone-siltstone and fine sandstone-siltstone laminate. Hawkesbury Sandstone comprises medium to very coarse-grained quartz sandstone, minor laminated mudstone and siltstone lenses.

Figure 1: Site geology according to Penrith 1:100 000 Geology Sheet



Base map from Microsoft Virtual Earth

According to the Penrith 1: 100 000 Soils Landscape Sheet the site is located within the Blacktown Soil Landscape which comprises gently undulating rises on shales with broad rounded crests and ridges with gently inclined slopes. Soils typically have poor soil drainage.

According to NSW Acid Sulfate Soil Risk mapping (1994-1998) the site is not located within or close to an area with a risk for acid sulphate soils.

A search of the registered groundwater bore database was conducted on 26 August 2013 using the New South Wales Natural Resource Atlas website (NR Atlas). One registered groundwater bore, GW108378, is located approximately 50 m to the north of the site, as shown in Appendix B, and is authorised for industrial purposes. The bore was drilled to a depth of 282 m, through a layer of topsoil, followed by clay and numerous layers of shale and sandstone. No water quality data was provided with the groundwater works summary.

5. Site History

5.1 Aerial Photographs

Historical aerial photographs from the years 1930, 1943, 1956, 1961, 1965, 1970, 1978, 1986, 1991, and 2002 and 2011 were obtained and reviewed in order to identify the likely past features and changes to the site, particularly those of a potentially contaminating nature. The findings are summarised below and copies of the aerial photographs are provided in Appendix D.

<u>1930</u>

The site appears to have been used as part of agricultural land. Darcy Road was present, although Institute Road comprises only a gravel track. Trees were present at the site and the land does not appear to have been used for market gardens.

Land surrounding the site appears to have been used for primarily agricultural purposes, with some residential dwellings located to the west.

<u>1943</u>

The site appears to have undergone significant change since 1930. Trees had been cleared to make way for a sports ground with athletics track that extended well beyond the site boundary. Small, elongated structures were present alongside the athletics track

Land surrounding the site continued to be primarily used for agricultural purposes with some residential dwellings present to the west.

<u>1956</u>

The site appears to have been further developed since 1943. The small, elongated structures present in 1943 had been removed. Four rectangular buildings had been constructed at the centre of the site and could be accessed via a gravel track. Some tree growth had occurred since 1956. The athletics track appears to have been upgraded and may have been used as a speedway (for car racing).

Land surrounding the site continued to be primarily used for agricultural purposes with some residential dwellings present to the west. Some small buildings had been constructed close to the athletics track, to the south-east of the site.

<u>1961</u>

The site appears to have undergone minor changes since 1961 with numerous small structures and/or stored materials being present around the four rectangular buildings.

Land surrounding the site continued to be primarily used for agricultural purposes with some residential dwellings present to the west. Some buildings had been constructed close to the athletics track, to the south-east of the site. The roadway to the north (now Institute Road) had been somewhat developed.

1965

The site does not appear to have undergone significant change since 1961. The image shows that the racing track was in use, with many vehicles parked around the track as well as on Darcy Road and nearby streets.

Land surrounding the site continued to be primarily used for agricultural purposes with some residential dwellings present to the west.

1970

The site does not appear to have undergone significant change since 1965, except the race track appears to have been upgraded.

Land surrounding the site had undergone significant development, with commercial buildings constructed on the adjacent land to the north and probably a school building constructed to the south.

1978

The site had undergone significant change since 1978. The four rectangular buildings present in 1970 had been removed. The sports ground and race track were not present as the land adjacent to the south-east of the site had been developed with hospital buildings and associated car parking. The site appears to have been used for car parking and storage for the adjacent hospital construction.

School buildings at the adjacent land to the south had been constructed since 1970. Further commercial development to the adjacent land to the north had also occurred. Institute Road had been developed.

1986

The site had undergone significant change since 1978. The site had primarily been constructed into an asphalt car park with surrounding grassed areas and gardens. An office building had been constructed at the eastern part of the site. The car parks could be accessed from Darcy Road or Institute Road.

The hospital construction to the south of the site appears to have been completed by 1986. Some further school buildings had been constructed at the land to the south of the site.

1991

The site appears to be relatively unchanged since 1991.

Several school buildings had been constructed at the adjacent land to the south of the site.

2002

The site appears to be relatively unchanged since 1991.

Some school buildings had been constructed at the adjacent land to the south of the site. Some commercial development had occurred at the land adjacent to the west of the site.

2011

The site appears to be relatively unchanged since 2002.

Some school buildings had been constructed at the adjacent land to the south of the site. Some commercial development appears to have occurred to the adjacent land to the north-west of the site. Darcy Road had been expanded since 1991.

5.2 Title Deeds

A search of historical land titles for the site was conducted by Service First Registration Pty Ltd. Table 1 summarises the reported title deed information for the site as well as provide an inferred land use based on the titled data and aerial photographs. A copy of the results of the search is provided in Appendix E.

Table 1: Results of Historical Title Deeds Search for Part of Lot 100 in Deposited plan 1119583 (originally part of Lot 5 in Deposited Plan 1077852) indicated in yellow only on the cadastre, Appendix E

Date of Acquisition and term held	Registered Proprietor(s) & Occupations where available	Possible Land Use
	The early title to the subject land was found to be Crown Land	Vacant
22.08.1906	Hospital Paddock forming part of the Hospital for the Insane	Paddock
16.01.1931	Athletic and Sports Ground	Vacant then athletics and sports ground
26.02.1932 (1932 to 1933)	Henry Ohlsen Timothy Lockitt James Moys McKay Samuel Alfred Hanscombe George Henry Mobbs William Robert Hulks Michael Benedict Donnellan (Trustees)	Athletics and sports ground
18.07.1933 (1933 to 1947)	Henry Ohlsen James Moys McKay Samuel Alfred Hanscombe George Henry Mobbs William Robert Hulks Henry Edward Haddrill James Cumming Browning (Trustees)	Athletics and sports ground
18.12.1947 (1947 to 1948)	Henry Edward Haddrill James Cumming Browning Philip Henry Jeffery (Company Director) Hedley Victor Horwood (Garage Proprietor) Harold Steel Hewitt (Boot Retailer)	Athletics and sports ground

Date of Acquisition and term held	Registered Proprietor(s) & Occupations where available	Possible Land Use
	Harry Raymond Thurston (Bank Officer) Edwin Doige Baskerville (Railway Employee) (Trustees)	
11.10.1948 (1948 to 1959)	James Cumming Browning Philip Henry Jeffery (Company Director) Hedley Victor Horwood (Garage Proprietor) Harold Steel Hewitt (Boot Retailer) Harry Raymond Thurston (Bank Officer) Edwin Doige Baskerville (Railway Employee) Charles McArthur Miller (Works Manager) (Trustees)	Athletics and sports ground or speedway
25.07.1959 (1959 to 1973)	James Cumming Browning Hedley Victor Horwood (Garage Proprietor) Harold Steel Hewitt (Boot Retailer) Edwin Doige Baskerville (Railway Employee) Douglas William Lindsay Stanley Angelo Ricard Mannelli Dawson Frederick Charles Berry (Trustees)	Speedway and sports ground
30.11.1973	Surrendered to the Crown	In transition from speedway and sports ground to hospital
06.01.1978 (1978 to Date)	Health Commission of New South Wales (Acquired for Westmead Hospital) Now # Health Administration Corporation	Hospital campus

Notes: # Denotes current registered proprietor
Easements: Nil
Leases to 25.07.1995: Nil
Leases from 25.07.1995: Not investigated

5.3 Search of Database for Dangerous Goods

A search of records held by WorkCover NSW has not located any information on licences for keeping dangerous goods at the site. A copy of the search result is provided in Appendix F.

5.4 Council Section 149 (2 & 5) Certificate

The Council Section 149 (2 & 5) planning certificate for the site was obtained and reviewed. According to the certificate for Lot 100 in Deposited Plan 1119583, the land is zoned for the provision of infrastructure and, as of 28 August 2013, the land is not affected by any matters contained in Clause 59(2), as amended, in the *Contaminated Land Management Act* 1997. The land is not subject to a site audit statement. A copy of the certificate is provided in Appendix G.

5.5 Regulatory Search for Notices, Licenses and Applications

A search was undertaken on 4 September 2013 of sites that are listed under s. 58 of the Contaminated Lands Management Act (CLM) 1997 (sites that are regulated), and the list of NSW contaminated sites notified to the EPA under s. 60 of the CLM Act (reported to the EPA that may become regulated). The search did not reveal any listings for the site or neighbouring properties. It should be noted that the NSW EPA's database for contaminated land does not provide a record of all contaminated land in NSW.

On 4 September 2013, a search of the public register for licences, applications and notices under s. 308 of the *Protection of the Environment Operations Act* 1997, revealed several listings of licences for the Children's Hospital at Westmead and Westmead Hospital premises. The licences relate to the generation and storage of hazardous, industrial or 'Group A' waste. Waste items that were permitted to be generated or stored one or both of the listed premises include:

- Arsenic and arsenic compounds;
- Clinical and related wastes;
- Grease trap waste;
- Mercury and mercury compounds;
- Organic solvents excluding halogenated solvents;
- Phenol, phenol compounds including chlorophenols;
- Organohalogen compounds (with some exclusions);
- Waste chemicals arising from research and development or teaching activities including those which are not identified and/or are new and whose effects on human health and/or environment are not known;
- Waste from the production, formulation and use of photographic chemicals and processing materials;
- Waste from the production and preparation of pharmaceutical products; and
- Waste pharmaceuticals, drugs and medicines.

5.6 Internet Search

According to the web page http://www.vintagespeedway.com/Westmead.html, the site was used as a part of a half-mile speedway track during the 1960s, primarily for stock car racing.

6. Conceptual Site Model

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

6.1 Potential Contamination Sources

Potential sources of contamination are listed in Table 2 have been identified from site historical information and site walkover inspection

Table 2: Potential Contamination Sources and Contaminants of Concern

Potential Source	Description of Potential Contaminating Activity	Contaminants of Concern	Risk Rating
Importation and placement of contaminated filling	Mounding of soil in grassed and garden areas suggests filling is present. The filling may have been imported from a contaminated site.	Various - Common contaminants associated with filling are heavy metals, total petroleum hydrocarbons (TPH), BTEXN, PAH, PCB, OCP, phenols and asbestos.	Moderate
Demolition of buildings	Buildings were demolished at the site in the 1970s. These buildings may have contained hazardous building materials which could have contaminated the soil during demolition.	Asbestos, lead, and PCB	Low to Moderate
Previous use as speedway and storage of fuels	Spills and leaks of oils and fuels	TPH, BTEXN, PAH, and lead	Low
Current site use as a car park	Leaks of fuels or oils from vehicles	TPH, BTEXN, PAH, and lead	Low
Hospital waste materials	Improper disposal practices of generated waste materials from hospital premises	Various including arsenic, mercury, TPH, phenol, volatile organic compounds (VOC) –see Section 5.5.	Very low

Note that the potential for contamination associated with the previous site use as a speedway has been assessed as low as the site was last used as a speedway at least 35 years ago and the site has been subject to significant disturbance and redevelopment since that time.

In summary the sources are defined as:

- S1 - Contaminated imported fill soils, demolition of previous buildings and residual contamination from previous site use;
- S2 - Fuel and oil impacted soils from current site use as a car park; and
- S3 - Hospital Waste materials from current neighbouring operations.

6.2 Potential Contamination Migration Pathways

The pathways by which the potential sources of contamination could reach potential receptors are described below:

- Human Contact (P1) – including dermal contact, inhalation and ingestion from surface or exposed contamination sourced from site;
- Migration via surface runoff (P2) – Surface contamination could migrate via surface run-off;
- Migration via subsoils (P3) – Infiltration of water into subsoils could result in the migration of contaminants towards the groundwater table; and
- Migration via groundwater (P4) – groundwater migration to the site from an off-site contamination source.

6.3 Potential Receptors of Concern

The potential receptors of potential contamination sourced from on-site or migrating onto the site were considered to be:

- Construction workers for the car park construction (R1);
- Maintenance workers, following car park construction (R2);
- Hospital Staff (R3);
- Public, hospital visitors and patients (R4);
- Groundwater (R5); and
- Toongabbie Creek (R6).

6.4 Conceptual Site Model

A conceptual site model (CSM) is presented in Table 3. It is a representation of site information regarding the potential contamination sources and associated exposure pathways and potential receptors identified from site historical information and previous investigations. The CSM provides the framework for identifying how the site became contaminated and how potential receptors may be exposed to contamination either in the present or the future i.e. it enables an assessment of the potential source – pathway – receptor linkages.

Table 3: Conceptual Site Model

Potential Source	Pathway	Receptor
Existing contaminated filling; residual contamination from previous site use (speedway); and previous demolition of buildings.(S1)	Dermal contact / ingestion (P1)	Construction workers; maintenance workers, hospital staff, public, visitors, patients and visitors (R1, R2, R3, R4)
	Dust inhalation (P1)	Construction workers; maintenance workers, hospital staff, public, visitors, patients and visitors (R1, R2, R3, R4)
	Groundwater & surface water flow (migration) (P2, P3 & P4)	Groundwater and Toongabbie Creek (ecological receptor) (R5 & R6)
Current site use as a car park (spills of fuels, oils etc) (S2)	Dermal contact / ingestion (P1)	Construction workers; maintenance workers, hospital staff, public, visitors, patients and visitors (R1, R2, R3, R4)
	Dust inhalation / vapours (P1)	Construction workers; maintenance workers, hospital staff, public, visitors, patients and visitors (R1, R2, R3, R4)
	Groundwater & surface water flow (migration) (P2, P3 & P4)	Groundwater & Toongabbie Creek (ecological receptor) (R5 & R6)
Hospital waste materials (migration onto site) (S3)	Dermal contact / ingestion (P1)	Construction workers; maintenance workers, hospital staff, public, visitors, patients and visitors (R1, R2, R3, R4)
	Dust inhalation / vapours (P1)	Construction workers; maintenance workers, hospital staff, public, visitors, patients and visitors (R1, R2, R3, R4)

7. Fieldwork and Analysis

Prior to the commencement of drilling, all test locations were checked for underground services using an electronic scanner and a review of available plans. Drilling of 16 test bores (for environmental and geotechnical investigations) was undertaken between 26 August 2013 and 30 August 2013. Excavation of eight test pits (for environmental and geotechnical investigations) was undertaken on 31 August 2013 and 7 September 2013. Groundwater sampling was undertaken on 6 September 2013. A high precision digital GPS was used to determine the coordinates and height datum of each test location. Coordinates are provided in the test bore and test pit logs in Appendix H.

7.1 Sampling Locations

The site area covers approximately 1.3 ha. The NSW EPA *Sampling Design Guidelines 1995* recommends 24 sampling locations for a site of this size. Soil sampling from 24 test locations was undertaken to achieve this sample density. The soil sample locations were designed to provide for site coverage within accessible areas of the site. Restrictions on the final design of test bore locations included:

- The location of known underground services;
- The on-site office building;
- Vegetation; and
- Traffic movements of the operational car park (test locations were designed to not interrupt traffic movements within the site).

Test bores 2, 4 and 10 were designated for the installation of groundwater monitoring wells in order to provide site coverage; indicate groundwater flow direction; and determine groundwater quality at hydrogeological up- and down-gradient locations.

Drawing 1, Appendix A shows the test locations.

7.2 Soil Sampling Procedures

Soil sampling was undertaken from test bores using a truck-mounted drilling rig and a Bobcat-mounted drilling rig with solid flight auger attachment. Soil sampling from test pits was undertaken using a four tonne excavator with 300 mm wide bucket. Soil samples were collected at intervals based on field observations, including changes in strata and signs of contamination.

All soil sampling was performed according to standard operating procedures outlined in the DP *Field Procedures Manual* (internal manual). All sampling data was recorded on DP chain-of-custody sheets. The general soil sampling procedure comprised:

- Collect soil samples directly from the auger attachment or excavated material (for test pits) using disposable sampling equipment;
- Transfer of samples into laboratory-prepared glass jars, and capping immediately with Teflon lined lids;
- Label sample containers with individual and unique identification, including project number, sample location and sample depth;
- Replicate samples of every sample were placed in sealed plastic bags for volatiles screening using a photo-ionisation detector (PID);
- Collection of 10% replicate samples (5% inter-laboratory replicates and 5% intra-laboratory replicates) for QA/QC purposes; and
- Placement of the sample jars into a cooled (with ice; topped up as required), insulated and sealed container for transport to the laboratory (Envirolab Services).

7.3 Soil Samples Analytical Scope and Rationale

The soil analytical scope is summarised in Table 4.

Table 4: Analytical Scheme for Soil Samples

Sample Location	Depth (m)	Sample Type	Heavy Metals	BTEXN	TRH	PAH	OCP	PCB	Phenols	Asbestos	pH, total organic carbon, CEC & clay content
1	0.6-0.7	Filling	✓	✓	✓	✓	✓	✓	✓		
A1	0.6-0.7	Material								✓	
1	1.4-1.5	Filling	✓	✓	✓	✓					
BD1/260813	1.4-1.5	Filling	✓	✓	✓						
2	0.8-1.0	Natural Soil	✓	✓	✓	✓	✓	✓	✓	✓	
3	0.5	Filling	✓	✓	✓	✓	✓	✓	✓	✓	
3	1	Natural Soil	✓	✓	✓	✓					
4	0.5	Filling	✓	✓	✓	✓	✓	✓	✓	✓	
5	0.5	Filling	✓	✓	✓	✓	✓	✓	✓	✓	
6	0.5	Natural Soil	✓	✓	✓	✓	✓	✓	✓	✓	
7	0.5	Natural Soil	✓	✓	✓	✓	✓	✓	✓	✓	
8	0.5	Natural Soil	✓	✓	✓	✓	✓	✓	✓	✓	
9	0.5	Natural Soil	✓	✓	✓	✓	✓	✓	✓	✓	
10	1	Natural Soil	✓	✓	✓	✓	✓	✓	✓	✓	
11	0-0.1	Filling	✓	✓	✓	✓					
A2	0.1	Material								✓	
11	1.4-1.5	Filling	✓	✓	✓	✓	✓	✓	✓		
12	0-0.1	Filling	✓	✓	✓	✓	✓	✓	✓	✓	
12	0.9-1.0	Filling (possibly natural)	✓	✓	✓	✓					
13	0.4-0.5	Filling	✓	✓	✓	✓	✓	✓	✓	✓	
BD4/270813	0.4-0.5	Filling	✓	✓	✓						
14	0.4-0.5	Filling	✓	✓	✓	✓	✓	✓	✓	✓	
BD1/270813	0.4-0.5	Filling	✓	✓	✓						
15	0.4-0.5	Filling	✓	✓	✓	✓	✓	✓	✓	✓	
16	0.4-0.5	Filling (possibly natural)	✓	✓	✓	✓	✓	✓	✓	✓	
101	0.5	Filling	✓	✓	✓	✓					
101	1	Filling	✓	✓	✓	✓	✓	✓	✓	✓	
101	1.5	Filling									✓
102	0.1	Filling	✓	✓	✓	✓	✓	✓	✓	✓	
103	0.5	Filling	✓	✓	✓	✓	✓	✓	✓	✓	
103	1	Natural Soil	✓	✓	✓	✓					
104	0.5	Filling	✓	✓	✓	✓	✓	✓	✓	✓	
104	1	Filling									✓
104	1.5	Natural Soil	✓	✓	✓	✓					
105	0.1	Filling	✓	✓	✓	✓	✓	✓	✓	✓	

Sample Location	Depth (m)	Sample Type	Heavy Metals	BTEXN	TRH	PAH	OCP	PCB	Phenols	Asbestos	pH, total organic carbon, CEC & clay content
105	0.5	Natural Soil	✓	✓	✓	✓					
106	0.1	Filling	✓	✓	✓	✓				✓	
BD1/100913	0.1	Filling	✓	✓	✓						
106	0.8	Filling	✓	✓	✓	✓	✓	✓	✓		
107	0.1	Filling	✓	✓	✓	✓	✓	✓	✓		
107	0.45-0.5	Filling	✓	✓	✓	✓				✓	
107	1	Natural Soil	✓	✓	✓	✓					
108	0.1	Filling	✓	✓	✓	✓	✓	✓	✓	✓	
108	0.5	Filling	✓	✓	✓	✓					
108	1	Natural									✓

Notes:

A1	Fibre-cement sample from Test Bore 1
A2	Fibre-cement sample from Test Bore 11
BD1/260813	Blind replicate of sample from Test Bore 1, depth 1.4-1.5m
BD4/270813	Blind replicate of sample from Test Bore 13, depth 0.4-0.5m
BD1/270813	Blind replicate of sample from Test Bore 14, depth 0.4-0.5m
BD1-100913	Blind replicate of sample from Test Pit 106, depth 0.1m

The general rationale behind the selection of soil samples and analytes was as follows:

- One sample from each test bore was selected for analysis for a large suite of potential chemical contaminants (heavy metals, TRH, BTEX, PAH, OCP, PCB, and phenols). These were primarily filling samples as filling was considered the most likely source of potential contamination at the site. A smaller set of soil samples (a combination of natural or fill samples) were selected for analysis of a smaller suite of more commonly encountered chemical contaminants (TRH, BTEX, PAH and heavy metals);
- Asbestos analysis was undertaken on a sample from every test location, primarily on filling samples. Material samples A1 and A2 were analysed for asbestos as representative samples of fibre-cement observed at numerous test locations and at the ground surface; and
- The sample from Test Pit 107, depth 0.45 - 0.5 m, was analysed for PAH and heavy metals as ash was identified in this filling and ash can be associated with elevated PAH and heavy metal concentrations.

In addition to the sample analytical scheme shown in Table 4, two filling samples were selected for TCLP analysis for waste classification purposes. TCLP analysis for nickel was conducted on three samples with elevated total concentrations of nickel.

7.4 Well installation and Groundwater Sampling Technique

Test Bores 2, 4 and 10 were converted into groundwater monitoring wells (piezometers). Well construction details are provided on the borehole logs in Appendix H. The piezometers were constructed of 50 mm diameter acid washed, class 18, PVC casing and machine slotted well screen intervals. Joints were screw threaded, thereby avoiding the use of glues and solvents which may contaminate the groundwater. The wells were completed with a gravel pack extending above the well screen and then a bentonite plug. The wells were finished flush with the ground surface by means of a Gatic cover and concrete.

The water levels in the three piezometers were recorded prior to development using an electronic interface probe which can detect the presence of separate phase liquid in the water column [such as light non-aqueous phase liquids (LNAPL) including petroleum hydrocarbons]. The water levels in the piezometers were also measured prior to sampling. Groundwater sampling was undertaken using a low-flow geo-pump (peristaltic pump) and disposable tubing, following stabilisation of field parameters. Field parameters were obtained using a calibrated YSI Quatro Pro Plus multiparameter instrument, with probes placed inside a flow-through cell. The field parameters included temperature, dissolved oxygen (DO), electrical conductivity (EC), pH and oxidation reduction potential (redox).

The pumps and all non-disposable sampling equipment was decontaminated between samples via a “triple rinse” procedure i.e. a rinse of all particulates in tap water followed a decontamination using a 3% Decon 90 solution and a final rinse in deionised water.

Samples were collected in laboratory prepared bottles and vials. The groundwater samples collected for heavy metal testing were filtered in the field through a 45 µm membrane filter into nitric acid preserved bottles.

Collection of groundwater samples was carried out in accordance with the methodology prescribed in the DP *Field Procedures Manual*. Sample handling and transport was as set out below:

- sample containers (supplied by the laboratory) were labelled with individual and unique identification, including project number and sample number;
- collection of an intra-laboratory replicate sample for QA/QC purposes;
- samples were placed in insulated coolers and maintained at a cool temperature (approximately 4°C) until transported to the analytical laboratory, and
- chain-of-custody documentation was maintained at all times and countersigned by the receiving laboratory on transfer of samples.

Samples designated for analysis were dispatched to Envirolab Services, a NATA accredited laboratory.

7.5 Field Quality Assurance and Quality Control (QA/QC)

The field QC procedures for sampling as prescribed in Douglas Partners’ *Field Procedures Manual* were followed during the assessment. Field sampling comprised intra- and inter-laboratory replicate sampling at a rate of approximately one replicate sample for every 10-20 samples. QA/QC also consisted of the use of trip spikes and trip blanks. The comparative QA/QC results are summarised in Appendix H.

7.6 Laboratory QA/QC

The analytical laboratories that were used are NATA accredited and are required to conduct in-house QA/QC procedures. These are normally incorporated into every analytical run and include reagent blanks, spike recovery, surrogate recovery and duplicate samples. These results are included in the laboratory reports in Appendix H and are evaluated in the QA/QC report in Appendix I.

8. Data Quality Objectives

The DSI has been devised broadly in accordance with the seven step data quality objective (DQO) process which is provided in Appendix B, Schedule 2 of the amended ASC NEPM. The seven step DQO process is as follows:

1. State the Problem;
2. Identify the Decision;
3. Identify Inputs to the Decision;
4. Define the Boundary of the Assessment;
5. Develop a Decision Rule;
6. Specify Acceptable Limits on Decision Errors; and
7. Optimise the Design for Obtaining Data.

The DQO process includes a number of data quality indicators (DQI) to confirm the quality of the data. The DQI include precision, accuracy, comparability, representativeness and completeness. The DQO and DQI are discussed in more detail in the QA/QC report in Appendix J. The DQI are undertaken to ensure that the data is reliable and that adequate sampling and analytical precision had been achieved. The DQI indicate (as discussed in Appendix J) that a satisfactory level of sampling and analytical precision was achieved to meet the objectives of the assessment.

9. Assessment Criteria

The analytical results from the laboratory testing have been assessed against the investigation and screening levels in Schedule B1 of the National Environment Protection Council (NEPC) National Environment Protection (Assessment of Site Contamination) Measure 1999, amended 2013 (NEPC 2013). This guideline has been endorsed by the NSW EPA under the *Contaminated Land Management (CLM) Act* 1997. Schedule B of the NEPC (2013) provides investigation and screening levels for commonly encountered contaminants which are applicable to generic land uses and include consideration of, where relevant, the soil type and the depth of contamination. The investigation and screening levels are not intended to be used as clean up levels. They establish concentrations above which further appropriate investigation (e.g. Tier 2 or Tier 3) should be undertaken.

The following sub-sections outline the relevant investigation and screening levels adopted for soils, groundwater and soil vapour as documented in the NEPC (2013). Site specific and/or theoretical assumptions relevant to the selection of the investigation and screening levels have been outlined in each sub-section as required

9.1 Soils

9.1.1 Health-based Investigation Levels (Non-Petroleum Chemical Contaminants)

Table 5 shows the health investigation levels (HIL) that have been adopted as site assessment criteria for assessing the human health risk from a contaminant via all relevant pathways of exposure. As the site is being constructed into a car park for the WHC, an industrial-type land use, HIL have been attained from Column D (Commercial/Industrial) of Table 1A(1) of Schedule B 1 – Guideline on Investigation Levels for Soil and Groundwater of the amended ASC NEPM.

Table 5 only includes contaminants tested in this DSI and does not include the full list provided in ASC NEPM.

Table 5: Health Investigation Levels for Soil Contaminants

Contaminant	HIL D Commercial/Industrial (mg/kg)
Metals and Inorganics	
Arsenic	3 000
Cadmium	900
Copper	240 000
Chromium (screening value based on Cr (VI))	3 600
Lead	1 500
Mercury (inorganic)	730
Nickel	6 000
Zinc	400 000
PAH	
Carcinogenic PAH (as Benzo(a)pyrene TEQ)	40
Total PAH	4 000
OCP	
DDT+DDE+DDD	3 600
Aldrin + Dieldrin	45
Chlordane	530
Endosulfan (total)	2 000
Endrin	100
Heptachlor	50
HCB	80
Methoxychlor	2 500
Phenols	

Contaminant	HIL D Commercial/Industrial (mg/kg)
Total Phenolics (screening value based on pentachlorophenol)	660
Other Organics PCB	 7

It is noted that NEPC (2013), does not provide a HIL for total chromium, but does provide a HIL for chromium (VI) of 3 600 mg/kg. Similarly, it does not provide a HIL for total phenolics, but does provide a HIL for phenol of 240 000 mg/kg, pentachlorophenol of 660 mg/kg and cresols of 25 000 mg/kg. Therefore analytical testing undertaken for total chromium and total phenolics are considered to be screening tests. The HIL for chromium (VI) and pentachlorophenol (the lowest HIL from the listed phenols) have been adopted as the screening values. Further (speciated) analysis and assessment would need to be considered if concentrations are encountered in excess of the screening values. It is also noted that NEPC (2013) does not provide HIL for the complete list of pesticide contaminants tested in this assessment.

9.1.2 Health Screening Level for Vapour Intrusion – Petroleum Hydrocarbons

Table 6 shows the health screening levels (HSL) for petroleum hydrocarbon compounds adopted for the assessment and are based on the exposure to petroleum hydrocarbons through the dominant vapour inhalation exposure pathway only (i.e. not direct contact to soils). The HSL have been obtained from:

- Column HSL D (Commercials / Industrial) of Table 1A(3) of Schedule B 1, Guideline on Investigation Levels for Soil and Groundwater, of the amended ASC NEPM. The HSL derivation has assumed a slab-on-ground construction for building structures, and, therefore are only considered relevant to parts of the site with building structures (current or yet to be constructed); and
- Table B3 of *CRC CARE Technical Report no. 10, Health screening levels for petroleum hydrocarbons in soil and groundwater. Part 2: Application document,* 2011 (CRC CARE, 2011). The HSL derivation is for maintenance workers undertaking intrusive works (in shallow trenches).

Table 6: Soil Health Screening Levels for Vapour Intrusion

Contaminant	Soil Type	HSL D Commercial/ Industrial (mg/kg)				Intrusive Maintenance Worker (Shallow trench) (mg/kg)		
		depth 0 m to <1 m	depth 1 m to <2 m	depth 2 m to 4 m	depth 4 m+	depth 0 m to <2 m	depth 2 m to 4 m	depth 4 m+
Toluene	Sand	NL	NL	NL	NL	NL	NL	NL
Ethylbenzene		NL	NL	NL	NL	NL	NL	NL
Xylenes		230	NL	NL	NL	NL	NL	NL
Naphthalene		NL	NL	NL	NL	NL	NL	NL
Benzene		3	3	3	3	77	160	NL
TPH C_6-C_{10} less BTEX		260	370	630	NL	NL	NL	NL
TPH >C_{10}-C_{16} less Napthalene		NL	NL	NL	NL	NL	NL	NL
TPH C_6-C_{10}		-	-	-	-	NL	NL	NL
TPH >C_{10}-C_{16}		-	-	-	-	NL	NL	NL
Toluene	Silt	NL	NL	NL	NL	NL	NL	NL
Ethylbenzene		NL	NL	NL	NL	NL	NL	NL
Xylenes		NL	NL	NL	NL	NL	NL	NL
Naphthalene		NL	NL	NL	NL	NL	NL	NL
Benzene		4	4	6	10	250	440	NL
TPH C_6-C_{10} less BTEX		250	360	590	NL	NL	NL	NL
TPH >C_{10}-C_{16} less Napthalene		NL	NL	NL	NL	NL	NL	NL
TPH C_6-C_{10}		NL	NL	NL	NL	NL	NL	NL
TPH >C_{10}-C_{16}		NL	NL	NL	NL	NL	NL	NL
Toluene	Clay	NL	NL	NL	NL	NL	NL	NL
Ethylbenzene		NL	NL	NL	NL	NL	NL	NL
Xylenes		NL	NL	NL	NL	NL	NL	NL
Naphthalene		NL	NL	NL	NL	NL	NL	NL
Benzene		4	6	9	20	350	NL	NL
TPH C_6-C_{10} less BTEX		310	480	NL	NL	NL	NL	NL
TPH >C_{10}-C_{16} less Napthalene		NL	NL	NL	NL	NL	NL	NL
TPH C_6-C_{10}		NL	NL	NL	NL	NL	NL	NL
TPH >C_{10}-C_{16}		NL	NL	NL	NL	NL	NL	NL

Note: NL Not limiting

9.1.3 Health Screening Levels for Direct Contact – Petroleum Hydrocarbons

It is assumed that the car park development will result in sealed surfaces (concrete slabs) over the majority of the site and thus direct contact to soils from site users (post-development) is unlikely. However, as only feasibility study plans for the proposed car park have been sighted, HSLs for direct contact have been used as site assessment criteria and have been sourced from Table B4 of CRC CARE (2012). The HSLs for direct contact are summarised in Table 7 and include HSLs for both commercial/industrial sites and for intrusive maintenance workers.

Table 7: Soil Health Screening Levels (HSLs) for Direct Contact (mg/kg)

Contaminant	HSL-D (Commercial / Industrial) (mg/kg)	Intrusive Maintenance Worker (mg/kg)
Toluene	99 000	120 000
Ethylbenzene	27 000	85 000
Xylenes	81 000	130 000
Naphthalene	11 000	29 000
Benzene	430	1 100
TPH C_6-C_{10}	26 000	82 000
TPH >C_{10}-C_{16}	20 000	62 000
TPH >C_{16}-C_{34}	27 000	85 000
TPH >C_{34}-C_{40}	38 000	120 000

9.1.4 Ecological Investigation levels

Ecological Investigation Levels (EILs) have been developed and discussed in NEPC (2013) for selected metals and organic compounds and are applicable for assessing risk to terrestrial ecosystems. Given that the proposed car park development is likely to result in much of the site covered by sealed surfaces (concrete slabs) the assessment of soil conditions for the protection of ecological values at the site may not be warranted. However, as only feasibility study plans for the proposed development have been sighted, EILs have been included as site assessment criteria.

EILs depend on specific soil physiochemical properties and land use scenarios and generally apply to the top 2 m of soil, which essentially corresponds to the root zone and habitation zone of many species. The EIL is determined for a contaminant using the following formula:

EIL = ABC + ACL, where

ABC = Ambient Background Concentration
ACL = Added Contaminant Limit

The ABC of a contaminant is the soil concentration in a specific locality that is the sum of naturally occurring background levels and the contaminants levels that have been introduced from diffuse or non-point sources (e.g. motor vehicle emissions). ACLs are based on the soil characteristics of pH, CEC and clay content.

EILs have been obtained from using the Ecological Investigation Level Calculation Spreadsheet, which was developed by the CSIRO for the National Environment Protection Council.

The following site specific data and assumptions have been used to determine the EILs:

- a protection level for commercial/industrial sites has been adopted;
- the EILs will apply to the top 2 m of the soil profile;
- given the likely source of soil contaminants (i.e. from previous land uses and previous filling) the contamination is considered as "aged" (>2 years);
- A clay content value of 30 % has been used as the site comprises mainly silty clays and the average clay content was 30 % from laboratory analysis (see Section 11, Table 15 for results);
- A pH value of 7 has been adopted as pH results ranged from 5.4 to 8.4 from laboratory analysis (see Section 11, Table 15 for results);
- An organic carbon content of 0.5 % has been adopted as results for total organic carbon ranged from 1900 mg/kg (0.2 %) to 11 000 (1.1 %) from laboratory analysis (see Section 11, Table 15 for results);
- No measured background concentrations were obtained or used for calculations;
- A high traffic volume has been used; and
- A CEC of 20 $cmol_C$/kg has been used as the average CEC obtained was 20 $cmol_C$/kg from laboratory analysis (see Section 11, Table 15 for results).

Table 8: Ecological Investigation Levels (EILs) in mg/kg

Contaminant	EIL
Arsenic	160
Chromium (III)	970
Copper	310
Lead	1800
Nickel	460
Zinc	1200
Naphthalene	370
DDT	640

9.1.5 Ecological Screening levels

Ecological Screening Levels (ESLs) are used to assess the risk of selected petroleum hydrocarbon compounds, BTEX and benzo(a)pyrene to terrestrial ecosystems. ESLs apply to the top 2 m of the soil profile, which essentially corresponds to the root zone and habitation zone of many species. The adopted ESLs, from the Commercial/Industrial ESLs in Table 1B(6), Schedule B1 of NEPC (2013), are shown in Table 9. ESLs are shown for 'fine' soils given that the majority of the soils at the site are silty clays.

Table 9: Ecological Screening Levels (EILs) in mg/kg

Analyte	ESL	Comments
TRH C_6-C_{10} less BTEX	215*	All ESLs are low reliability apart from those marked with * which are moderate reliability
TRH >C_{10}-C_{16} less Naphthalene	170*	
TRH >C_{16}-C_{34}	2500	
TRH >C_{34}-C_{40}	6600	
Benzene	95	
Toluene	135	
Ethylbenzene	185	
Xylenes	180	
Benzo(a)pyrene	0.7	

9.1.6 Management Limits – Petroleum Hydrocarbons

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

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

Management Limits to avoid or minimise these potential effects have been. The adopted Management Limits, from Commercial/Industrial Management Limits in Table 1B(7), Schedule B1 of NEPC (2013) are shown on Table 10. Management Limits are shown for 'fine' soils given that the majority of the soils at the site are silty clays.

Table 10: Management Limits (mg/kg)

Contaminant	Management Limit
TRH C_6 – C_{10}	800
TRH >C_{10}-C_{16}	1,000
TRH >C_{16}-C_{34}	5,000
TRH >C_{34}-C_{40}	10,000

9.1.7 Asbestos in Soil

According to NEPC (2013), the health screening levels for asbestos contamination in soil are:

- 0.05 % (w/w) bonded asbestos;
- 0.001 % (w/w) friable asbestos; and
- No visible asbestos on surface soil.

At this stage, the assessment of asbestos at the site has been limited to screening tests of soil and material samples. If asbestos or indicators of asbestos (e.g. inclusions of building debris or fragments of fibro) are identified, further assessment and/ or management for asbestos in accordance with NEPC (2013) may be recommended.

9.2 Groundwater

9.2.1 Groundwater Investigation Levels

The adopted Groundwater Investigation Levels (GILs) are based on:

- ANZECC & ARMCANZ (2000), *National water quality management strategy. Australian and New Zealand guidelines for fresh and marine water quality*, Australian and New Zealand Conservation Council & Agriculture, and Resource Management Council of Australia and New Zealand; and
- NHMRC (2011), *National water quality management strategy, Australian drinking water guidelines*, National Health and Medical Research Council and National Resource Management Ministerial Council, Australia.

It considered extremely unlikely that groundwater extraction for drinking purposes will be undertaken in the region, and, therefore GILs are primarily based on the protection of ecological values. Toongabbie Creek is a ‘freshwater’ creek and, therefore, the groundwater test results are assessed against the available trigger values for the protection of, as a minimum, 95% of freshwater aquatic species sourced from ANZECC & ARMCANZ (2000). Selected moderate to high reliability trigger values from the guidelines are also listed in Table 1C, Schedule B1 of NEPC (2013). Exceedance of the criteria does not necessarily mean that a substance will cause ecological harm, but prompts further investigations involving an evaluation of risk to assess whether harmful effects may occur as a result of the exceedance.

The adopted GILs for analytes and the corresponding source documents are shown in Table 11. Note that the table does not list GILs for every chemical tested in this assessment but does provide applicable GILs for all chemicals detected in laboratory analysis, excluding TRH.

ANZECC & ARMCANZ, 2000 provides trigger values for individual (speciated) phenols, but not for total phenols. The detection limit for total phenols has been used as a screening criterion and is listed in Table 11 as a GIL.

Table 11: Groundwater Investigation Levels (mg/kg)

Contaminant	GIL [µg/L]	Source of GIL
Volatile Organic Compounds Benzene Toluene Ethylbenzene *o*-xylene *p*-xylene *m*-xylene	 950 180 80 350 200 75	ANZECC & ARMCANZ (2000) low to moderate reliability trigger values, Australian Water Quality Guidelines for the protection of 95% of fresh water species
Polycyclic Aromatic Hydrocarbons Naphthalene	16	ANZECC & ARMCANZ (2000) low to moderate reliability trigger values, Australian Water Quality Guidelines for the protection of 95% of fresh water species.
Benzo(a)pyrene Phenanthrene	0.1 0.6	ANZECC & ARMCANZ (2000) low reliability trigger value, Australian Water Quality Guidelines for the protection of 99% of fresh water species.
Phenols Total Phenolics	50	Detection limit used as screening criterion in absence of guideline value.
Metals Arsenic (III) Arsenic (V) Cadmium Chromium (III) Chromium (VI) Copper Lead Nickel Zinc	 24 13 2 (EH) 28 (EH) 1.0 12.6 (EH) 91 (EH) 99 (EH) 72 (EH)	ANZECC & ARMCANZ (2000) low to high reliabilty trigger values, Australian Water Quality Guidelines for the protection of 95% of fresh water species. Trigger values have been adjusted for hardness where applicable, based on results for hardness: EH – Extremely hard.
Mercury (inorganic)	0.06	ANZECC & ARMCANZ (2000) Australian Water Quality Guidelines for the protection of 99% of fresh water species.
Organochlorine Pesticides Chlordane DDT Hetptachlor	 0.03 0.006 0.01	ANZECC & ARMCANZ (2000) Australian Water Quality Guidelines for the protection of 99% of fresh water species.
Polychlorinated Biphenyls Aroclor 1242 Aroclor 1254	 0.3 0.01	ANZECC & ARMCANZ (2000) Australian Water Quality Guidelines for the protection of 99% of fresh water species

9.2.2 Health Screening Levels – Petroleum Hydrocarbons

Table 12 shows the HSL for petroleum hydrocarbon compounds adopted for the assessment and are based on the exposure to petroleum hydrocarbons through the dominant vapour inhalation exposure pathway. The HSL have been obtained from Column HSL D (Commercials / Industrial) of Table 1A(4) of Schedule B 1, *Guideline on Investigation Levels for Soil and Groundwater* (NEPC, 2013). HSL for intrusive maintenance workers from CRC CARE (2011) have not been listed as the HSL are 'not limiting' for groundwater at depths below 2 m.

Table 12: Groundwater Health Screening Levels for Vapour Intrusion

Contaminant	Soil Type	HSL D Commercial/ Industrial (µg/L)		
		depth 2 m to <4 m	depth 4 m to <8 m	depth 8 m+
Toluene	Sand	NL	NL	NL
Ethylbenzene		NL	NL	NL
Xylenes		NL	NL	NL
Naphthalene		NL	NL	NL
Benzene		5000	5000	5000
TPH C_6-C_{10} less BTEX		6000	6000	7000
TPH >C_{10}-C_{16} less Napthalene		NL	NL	NL
Toluene	Silt	NL	NL	NL
Ethylbenzene		NL	NL	NL
Xylenes		NL	NL	NL
Naphthalene		NL	NL	NL
Benzene		30000	30000	30000
TPH C_6-C_{10} less BTEX		NL	NL	NL
TPH >C_{10}-C_{16} less Napthalene		NL	NL	NL
Toluene	Clay	NL	NL	NL
Ethylbenzene		NL	NL	NL
Xylenes		NL	NL	NL
Naphthalene		NL	NL	NL
Benzene		30000	30000	35000
TPH C_6-C_{10} less BTEX		NL	NL	NL
TPH >C_{10}-C_{16} less Napthalene		NL	NL	NL

Note: NL Not limiting

10. Fieldwork Results

10.1 Soil Observations and Field Screening

All test bores, except Bores 11 and 12, were drilled through a surface layer of asphalt which was underlain by a layer of roadbase (gravelly sand or sandy gravel) filling. Bores 11 and 12 were drilled through a grassed surface. Test pits were excavated at grassed areas.

Filling depths were variable across the site, and ranged from depths of 0.3 m to 1.9 m below ground level (bgl). Deepest filling was observed at the eastern most corner, the southern corner and in mounded garden areas. Various filling materials were observed and included: roadbase, sandy clay, silty clay, clay, sandy clay, silty sandy clay, sand, gravelly clay, gravelly sandy clay, gravelly sand, and silty gravel. Anthropogenic materials including fibre-cement (or fibro) were observed in the filling at a number of sampling locations. Fibre-cement fragments were also observed on the ground surface in a garden area (Photo 6, Appendix B). The presence and locations of fibre-cement is further discussed in Section 12.3. Other anthropogenic materials observed in the filling included:

- Charcoal (possibly of natural origin) at Bore 1;
- Masonry at Test Pits 102, 103 and 104;
- Concrete at Test Pits 101, 104 and 105;
- Clay pipe at Test Pits 101 and107;
- Brick fragments at Test Pit 102;
- Ash at Test Pit 107; and
- Metal pieces at Bore 11.

Natural soil, underlying filling included silty clay, shaly clay, gravelly clay and clay. An old topsoil horizon (sandy silt) was observed at a depth of 1.8 – 2.0 m at Test Pit 101. Test bores 1 – 10 were cored into the underlying rock profile which included shale, laminate and siltstone. Sandstone was only encountered at Test Bore 9 (depth of 7.8 m to 8.0 m), beneath shale.

Natural soil was not encountered at Test Pit 102 which was discontinued at a depth of 0.25 m. It was determined not to go beyond a layer of warning tape at this depth so as to not damage a possible underground service at this location.

No odours were noted in any of the bores. Replicate soil samples collected from the bores in plastic bags were allowed to equilibrate under ambient temperatures before screening for total photoionisable compounds (TOPIC) using a calibrated PID. Readings from the PID are recorded on the test bore logs, Appendix H. All readings were less than 1 ppm indicating a low potential for volatile contaminants to be present in soil.

10.2 Groundwater Field Results

No free groundwater was observed whilst drilling or test pitting. Groundwater levels from monitoring wells were measured immediately prior to undertaking well development and immediately prior to undertaking groundwater sampling. Table 13 shows the measured groundwater levels and the volume of water removed for well development. Each well was developed dry.

Table 13: Groundwater Levels

Well	Ground Surface Level (m AHD)*	Well Development (30 August 2013)			Well Sampling (6 September 2013)	
		Depth to Water (m bgl)	Water Level (m AHD)	Approx. Volume of Water Removed (L)	Depth to Water (m bgl)	Water Level (m AHD)
2	17.75	3.88	13.87	10 (to dry)	4.38	13.37
4	19.71	2.92	16.79	18 (to dry)	3.52	16.19
10	17.00	1.12	15.88	26 (to dry)	3.87	13.13

Notes:

*	Data obtained by high precision digital GPS (typical accuracy of ± 0.2m)
L	litres
m bgl	metres below ground level
m AHD	metres Australian Height Datum

It is considered that the use of water for rock coring has resulted in the elevated groundwater levels obtained prior to development. The water levels obtained on 6 September 2013 are considered to be representative of groundwater levels at the site (at this date).

Groundwater levels indicate that the groundwater flow is generally toward the north-west or north. Drawing 2, Appendix A shows the inferred groundwater flow direction.

Water sampled from each of the wells had the following appearance:

- Test bore 2 - very slight cloudy and brown tinge, changing to brown and cloudy;
- Test bore 4 – cloudy and brown; and
- Test bore 10 – clear and colourless.

No obvious signs of contamination (such as separated phase hydrocarbons or odours) were noted in the samples.

The groundwater sampling depth and stabilised field parameters, collected prior to groundwater sampling, are presented in Table 14.

Table 14: Stabilised Field Parameters

Well	Approx. Sample Depth (m bgl)	pH	Dissolved Oxygen (ppm)	Redox (mV)	Temperature (°C)	Electrical Conductivity (mS/cm)
2	7	6.3	0.5	118	21.3	15.2
4	7	6.3	0.4	113	20.5	14.6
10	7	6.1	4.29	70	20.1	22.9

Notes:

ppm parts per million

mV millivolts

°C degrees centigrade

mS/cm milliSiemens per centimetre

11. Laboratory Testing

The results of laboratory analysis are summarised in the following tables:

- Table 15: Summary of Results of Soil Analysis for DSI;
- Table 16: Summary of Results of Soil Analysis for Waste Classification; and
- Table 17: Summary of Results of Groundwater Analysis.

The full laboratory reports together with the chain of custody and sample receipt information are presented in Appendix I.

Table 15: Summary of Results of Soil Analysis for DSI (All results in mg/kg unless otherwise stated)

			Heavy Metals								Polycyclic Aromatic Hydrocarbons			Petroleum Hydrocarbons											Organochlorine Pesticides (OCP)														
Sample Location (Test Bore or Test Pit) or Sample ID	Sample Depth (m)	Soil Type	Arsenic	Cadmium	Chromium (III + VI)	Copper	Lead	Mercury	Nickel	Zinc	Benzo(a)pyrene	Benzo(a)pyrene TEQ	Total PAHs	TRH C6-C10 less BTEX	TRH >C10-C16 less Naphthalene	TRH C6-C10	TRH >C10-C16	TRH >C16-C34	TRH >C34-C40	Naphthalene	Benzene	Toluene	Ethylbenzene	Total Xylene	DDT	DDT+DDE+DDD	Aldrin + Dieldrin	Chlordane	Endosulfan (total)	Endrin	Heptachlor	HCB	Methoxychlor	PCBs (total)	Phenols (total)	Asbestos (fibres)	pH (pH units)	Total Organic Carbon	Cation Exchange Capacity (meq/100g)	Clay in soils <2um (%w/w)
1	0.6-0.7	Filling	5	1.1	21	42	32	<0.1	58	140	0.14	<0.5	1.5	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	-	-	-	-	-
A1	0.6-0.7	Material	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	AD	-	-	-	-
1	1.4-1.5	Filling	11	0.6	28	21	17	<0.1	7	20	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BD1/260813	1.4-1.5	Filling	10	0.6	27	26	18	<0.1	25	42	-	-	-	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	0.8-1.0	Natural Soil	9	<0.4	17	11	16	<0.1	4	9	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	NAD	-	-	-	-
3	0.5	Filling	5	<0.4	9	37	17	<0.1	23	19	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	NAD	-	-	-	-
3	1	Natural Soil	7	<0.4	13	23	18	<0.1	6	24	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	0.5	Filling	7	0.5	21	21	24	<0.1	18	43	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	NAD	-	-	-	-
5	0.5	Filling	10	<0.4	24	19	23	<0.1	34	24	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	AD	-	-	-	-
6	0.5	Natural Soil	7	<0.4	20	21	19	<0.1	6	24	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	NAD	-	-	-	-
7	0.5	Natural Soil	10	<0.4	24	25	21	<0.1	13	25	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	NAD	-	-	-	-
8	0.5	Natural Soil	7	<0.4	30	18	28	<0.1	12	20	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	NAD	-	-	-	-
9	0.5	Natural Soil	7	<0.4	28	19	21	<0.1	7	21	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	NAD	-	-	-	-
10	1	Natural Soil	9	<0.4	37	18	24	<0.1	16	20	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	NAD	-	-	-	-
11	0-0.1	Filling	6	3.2	20	33	41	<0.1	21	200	0.1	<0.5	0.51	<25	<50	<25	<50	100	<100	<1	<0.2	<0.5	<1	<3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A2	0.1	Material	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	AD	-	-	-	-
11	1.4-1.5	Filling	6	6.7	28	33	33	<0.1	30	500	0.16	<0.5	1.6	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	-	-	-	-	-
12	0-0.1	Filling	8	0.6	16	37	28	<0.1	18	73	0.26	<0.5	2.9	<25	61	<25	61	190	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	NAD	-	-	-	-
12	0.9-1.0	Filling (possibly natural)	7	0.5	21	24	21	<0.1	6	18	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	0.4-0.5	Filling	<4	<0.4	9	35	16	<0.1	22	17	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	NAD	-	-	-	-
BD4/270813	0.4-0.5	Filling	5.9	<0.4	7	36	11	<0.05	26	20	-	-	-	<20	<50	<20	<50	<100	<100	<0.5	<0.1	<0.1	<0.1	<0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	0.4-0.5	Filling	6	0.6	28	20	16	<0.1	30	28	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	NAD	-	-	-	-
BD1/270813	0.4-0.5	Filling	5	0.5	28	27	11	<0.1	64	32	-	-	-	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	0.4-0.5	Filling	<4	0.5	26	33	10	0.1	100	35	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	NAD	-	-	-	-
16	0.4-0.5	Filling (possibly natural)	<4	0.5	26	29	9	<0.1	83	31	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	NAD	-	-	-	-
101	0.5	Filling	7	9.5	21	27	35	0.1	22	520	0.1	<0.5	1.1	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
101	1	Filling	16	0.5	31	16	20	<0.1	5	17	0.07	<0.5	0.07	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	AD	-	-	-	-
101	1.5	Filling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.8	1900	17	33
102	0.1	Filling	9	0.7	19	33	59	<0.1	17	110	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	AD	-	-	-	-
103	0.5	Filling	9	<0.4	20	16	50	<0.1	11	49	<0.05	<0.5	0.14	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	NAD	-	-	-	-
103	1	Natural Soil	10	<0.4	30	14	18	<0.1	6	12	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
104	0.5	Filling	6	<0.4	20	18	57	0.2	9	65	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	AD	-	-	-	-
104	1	Filling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.4	11000	28	18
104	1.5	Natural Soil	6	<0.4	19	20	18	<0.1	6	17	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
105	0.1	Filling	7	<0.4	19	35	39	<0.1	20	97	0.07	<0.5	0.35	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	AD	-	-	-	-
105	0.5	Natural Soil	8	<0.4	31	21	23	<0.1	9	23	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
106	0.1	Filling	7	<0.4	20	20	22	0.1	11	38	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	-	-	-	-	-	-	-	-	-	-	-	AD	-	-	-	-
BD1-100913	0.1	Filling	<2	<0.4	<5	120	<5	<0.05	<5	18	-	-	-	<20	<50	<20	<50	<100	<100	<0.5	<0.1	<0.1	<0.1	<0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
106	0.8	Filling	6	<0.4	26	14	16	<0.1	8	19	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	-	-	-	-	-
107	0.1	Filling	10	<0.4	14	30	20	<0.1	25	36	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	-	-	-	-	-
107	0.45-0.5	Filling	<4	<0.4	12	12	18	<0.1	6	21	<0.05	<0.5	0.16	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	-	-	-	-	-	-	-	-	-	-	-	NAD	-	-	-	-
107	1	Natural Soil	6	<0.4	21	12	16	<0.1	6	17	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
108	0.1	Filling	7	<0.4	26	22	50	<0.1	14	46	0.06	<0.5	0.32	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	<0.1	<0.3	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.7	<5	AD	-	-	-	-
108	0.5	Filling	<4	<0.4	6	3	6	<0.1	3	14	<0.05	<0.5	NIL (+)VE	<25	<50	<25	<50	<100	<100	<1	<0.2	<0.5	<1	<3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
108	1	Natural Soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.4	3700	15	39
Site Assessment Criteria																																								
HIL for Commercial/Industrial Sites			3000	900	3600	240000	1500	730	6000	400000	-	40	4000	-	-	-	-	-	-	-	-	-	-	-	-	3600	45	530	2000	100	50	80	2500	7	660	-	-	-	-	-
HSL for vapour intrusion for Commercial/Industrial Sites			-	-	-	-	-	-	-	-	-	-	-	250*	NL	-	-	-	-	NL	3*	NL	NL	230*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HSL for vapour intrusion, Intrusive Maintenance Worker			-	-	-	-	-	-	-	-	-	-	-	-	-	NL	NL	-	-	NL	77*	NL	NL	NL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HSL for Direct Contact, Commercial/Industrial Sites			-	-	-	-	-	-	-	-	-	-	-	-	-	26000	20000	27000	38000	11000	430	99000	27000	81000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HSL for Direct Contact, Intrusive Maintanence Worker			-	-	-	-	-	-	-	-	-	-	-	-	-	82000	62000	85000	120000	29000	1100	120000	85000	130000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EIL (Commercial/industrial)			160	-	970	310	1800	-	460	1200	-	-	-	-	-	-	-	-	-	370	-	-	-	-	640	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ESL (Commercial/Industrial)			-	-	-	-	-	-	-	-	0.7	-	-	215	170	-	-	2500	6600	-	95	135	185	180	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Management Limit			-	-	-	-	-	-	-	-	-	-	-	-	-	800	1000	5000	10000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Health Screening Level			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NAD	-	-	-	-

Notes

AD	Asbestos detected (exceedence of screening criteria)
NAD	No asbestos detected
*	Only lowest HSL shown as screening value (actual HSL value will depend on soil type and depth)
A1	Fibre-cement sample from Test Bore 1
A2	Fibre-cement sample from Test Bore 11
BD1/260813	Blind replicate of sample from Test Bore 1, depth 1.4-1.5m
BD4/270813	Blind replicate of sample from Test Bore 13, depth 0.4-0.5m
BD1/270813	Blind replicate of sample from Test Bore 14, depth 0.4-0.5m
BD1-100913	Blind replicate of sample from Test Pit 106, depth 0.1m
-	Not tested / Not applicable

Table 16: Summary of Results of Soil Analysis for Waste Classification (All results in mg/kg unless otherwise stated)

Sample Location (Test Bore or Test Pit) or Sample ID	Sample Depth (m)	Soil Type	Heavy Metals							Polycyclic Aromatic Hydrocarbons		Petrolum Hydrocarbons						Organochlorine Pesticides			
			Arsenic	Cadmium	Chromium (III + VI)	Lead	Mercury	Nickel	Nickel inTCLP (mg/L)	Benzo(a)pyrene	Total PAHs	TRH C6-C9	TRH +C10 - C36 (sum of Total)	Benzene	Toluene	Ethylbenzene	Total Xylene	Endosulfan (total)	Total OCP	PCBs (total)	Asbestos (fibres)
1	0.6-0.7	Filling	5	1.1	21	32	<0.1	58	0.09	0.14	1.5	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	-
A1	0.6-0.7	Material	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	**AD**
1	1.4-1.5	Filling	11	0.6	28	17	<0.1	7	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	-	-	-	-
BD1/260813	1.4-1.5	Filling	10	0.6	27	18	<0.1	25	-	-	-	<25	<250	<0.2	<0.5	<1	<3	-	-	-	-
2	0.8-1.0	Natural Soil	9	<0.4	17	16	<0.1	4	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	NAD
3	0.5	Filling	5	<0.4	9	17	<0.1	23	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	NAD
3	1	Natural Soil	7	<0.4	13	18	<0.1	6	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	-	-	-	-
4	0.5	Filling	7	0.5	21	24	<0.1	18	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	NAD
5	0.5	Filling	10	<0.4	24	23	<0.1	34	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	**AD**
6	0.5	Natural Soil	7	<0.4	20	19	<0.1	6	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	NAD
7	0.5	Natural Soil	10	<0.4	24	21	<0.1	13	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	NAD
8	0.5	Natural Soil	7	<0.4	30	28	<0.1	12	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	NAD
9	0.5	Natural Soil	7	<0.4	28	21	<0.1	7	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	NAD
10	1	Natural Soil	9	<0.4	37	24	<0.1	16	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	NAD
11	0-0.1	Filling	6	3.2	20	41	<0.1	21	-	0.1	0.51	<25	<250	<0.2	<0.5	<1	<3	-	-	-	-
A2	0.1	Material	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**AD**
11	1.4-1.5	Filling	6	6.7	28	33	<0.1	30	-	0.16	1.6	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	-
12	0-0.1	Filling	8	0.6	16	28	<0.1	18	-	0.26	2.9	<25	270	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	NAD
12	0.9-1.0	Filling (possibly natural)	7	0.5	21	21	<0.1	6	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	-	-	-	-
13	0.4-0.5	Filling	<4	<0.4	9	16	<0.1	22	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	NAD
BD4/270813	0.4-0.5	Filling	5.9	<0.4	7	11	<0.05	26	0.05	-	-	<20	<250	<0.1	<0.1	<0.1	<0.3	-	-	-	-
14	0.4-0.5	Filling	6	0.6	28	16	<0.1	30	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	NAD
BD1/270813	0.4-0.5	Filling	5	0.5	28	11	<0.1	64	-	-	-	<25	<250	<0.2	<0.5	<1	<3	-	-	-	-
15	0.4-0.5	Filling	<4	0.5	26	10	0.1	100	0.03	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	NAD
16	0.4-0.5	Filling (possibly natural)	<4	0.5	26	9	<0.1	83	0.05	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	NAD
101	0.5	Filling	7	9.5	21	35	0.1	22	-	0.1	1.1	<25	<250	<0.2	<0.5	<1	<3	-	-	-	-
101	1	Filling	16	0.5	31	20	<0.1	5	-	0.07	0.07	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	**AD**
102	0.1	Filling	9	0.7	19	59	<0.1	17	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	**AD**
103	0.5	Filling	9	<0.4	20	50	<0.1	11	-	<0.05	0.14	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	NAD
103	1	Natural Soil	10	<0.4	30	18	<0.1	6	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	-	-	-	-
104	0.5	Filling	6	<0.4	20	57	0.2	9	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	**AD**
104	1.5	Natural Soil	6	<0.4	19	18	<0.1	6	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	-	-	-	-
105	0.1	Filling	7	<0.4	19	39	<0.1	20	-	0.07	0.35	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	**AD**
105	0.5	Natural Soil	8	<0.4	31	23	<0.1	9	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	-	-	-	-
106	0.1	Filling	7	<0.4	20	22	0.1	11	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	-	-	-	**AD**
BD1-100913	0.1	Filling	<2	<0.4	<5	<5	<0.05	<5	-	-	-	<20	<250	<0.1	<0.1	<0.1	<0.3	-	-	-	-
106	0.8	Filling	6	<0.4	26	16	<0.1	8	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	-
107	0.1	Filling	10	<0.4	14	20	<0.1	25	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	-
107	0.45-0.5	Filling	<4	<0.4	12	18	<0.1	6	-	<0.05	0.16	<25	<250	<0.2	<0.5	<1	<3	-	-	-	NAD
107	1	Natural Soil	6	<0.4	21	16	<0.1	6	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	-	-	-	-
108	0.1	Filling	7	<0.4	26	50	<0.1	14	-	0.06	0.32	<25	<250	<0.2	<0.5	<1	<3	<0.2	<2	<0.7	**AD**
108	0.5	Filling	<4	<0.4	6	6	<0.1	3	-	<0.05	NIL (+)VE	<25	<250	<0.2	<0.5	<1	<3	-	-	-	-
Maximum values of Specific Contaminant Concentration for classification without TCLP																					
General Solid Waste (CT1)			100	20	100 for Cr (VI) only	100	4	40	-	0.8	NA	NA	NA	10	288	600	1000	60	NA	NA	NAD
Maximum values for Specific Contaminant Concentration and Leachable Concentration (with TCLP) when used together																					
General Solid Waste (SCC1 & TCLP1)			500	100	1900 for Cr (VI) only	1500	50	1050	2	10	200	650	10000	18	518	1080	1800	108	<50*	<50	NAD

Notes

AD	Asbestos detected (exceedence of general solid waste criteria)
NAD	No asbestos detected
A1	Fibre-cement sample from Test Bore 1
A2	Fibre-cement sample from Test Bore 11
BD1/260813	Blind replicate of sample from Test Bore 1, depth 1.4-1.5m
BD4/270813	Blind replicate of sample from Test Bore 13, depth 0.4-0.5m
BD1/270813	Blind replicate of sample from Test Bore 14, depth 0.4-0.5m
BD1-100913	Blind replicate of sample from Test Pit 106, depth 0.1m
-	Not tested / No value
NA	Not Applicable
*	Value for scheduled chemicals

Table 17: Summary of Results of Groundwater Analysis (All results in μg/L unless otherwise stated)

Sample Location (Test Bore)	Sample date	Heavy Metals (dissolved)								Polycylic Aromatic Hydrocarbons (PAH)				Total Recoverable Hydrocarbons (TRH)						BTEX					PCB			Organochlorine Pesticides						Total Phenolics	pH (pH units)	Hardness (mgCaCO3/L)
		Arsenic	Cadmium	Chromium (III + VI)	Copper	Lead	Mercury	Nickel	Zinc	Naphthalene	Benzo(a)pyrene	Phenanthrene	All other PAH	TRH C6-C10 less BTEX	TRH >C10-C16 less Naphthalene	TRH C6-C10	TRH >C10-C16	TRH >C16-C34	TRH >C34-C40	Benzene	Toulene	Ethylbenzene	o-xylene	m+p-xylene	Arochlor 1242	Arochlor 1254	All other PCB	Heptachlor	Chlordane	DDT	Endrin	Endosulfan	All other OCP			
Current Investigation Results																																				
2	06-Sep-13	<1	1.4	**2**	2	<1	<0.05	26	28	<0.1	<0.1	<0.1	ND	<10	<50	<10	<50	<100	<100	<1	<1	<1	<1	<2	<0.01	<0.01	ND	<0.001	<0.002	<0.001	<0.001	<0.002	ND	<0.05	7.3	1900 (EH)
4	06-Sep-13	<1	0.9	**2**	2	<1	<0.05	24	33	<0.1	<0.1	<0.1	ND	<10	<50	<10	<50	<100	<100	<1	<1	<1	<1	<2	<0.01	<0.01	ND	<0.001	<0.002	<0.001	<0.001	<0.002	ND	<0.05	7.2	1800 (EH)
10	06-Sep-13	2	0.8	**4**	<1	<1	<0.05	89	**100**	3	<0.1	0.1	ND	190	97	250	100	<100	<100	<1	<1	4	19	35	<0.01	<0.01	ND	<0.001	<0.002	<0.001	<0.001	<0.002	ND	<0.05	6.9	3100 (EH)
BD1/060913	06-Sep-13	2	0.8	**4**	<1	<1	<0.05	94	**110**	3	-	-	-	190	97	250	100	<100	<100	<1	<1	4	19	35	-	-	-	-	-	-	-	-	-	-	-	-
Assessment Criteria																																				
GILs		24 as As(III) 13 as As(V)	2 (EH)	28 (EH) as Cr(III) 1 as Cr(VI)	12.6 (EH)	91 (EH)	0.06	99 (EH)	72 (EH)	16	0.1	0.6	-	-	-	-	-	-	-	950	180	80	350	200+75	0.3	0.01	-	0.01	0.03	0.006	0.01	0.03	-	50	-	-
HSLs for vapour intrusion		-	-	-	-	-	-	-	-	-	-		-	6000*	NL	-	-	-	-	5000	NL	NL	NL	NL	-	-	-	-	-	-	-	-	-	-	-	-

Notes:

BD1/060913	Blind replcate of sample collected from Bore 10
ND	Not detected
-	not defined/ not analysed/ not applicable
Bold	Exceeds GIL
*	Most conservative value shown. Actual value will depend on groundwater depth and soil type.
EH	Extremely hard water

12. Discussion

12.1 Site History

According to aerial photographs and historical title deeds, the site appears to have been used as agricultural land up until the 1930s when it was developed into part of an athletics track and sports ground.

The athletics track appears to have been converted into a race track in the 1950s (according to aerial photographs), and used as a half-mile speedway track during the 1960s (according to internet searches). The race track and associated facilities appear to have been upgraded at certain stages, up until the time at which WHC was developed during the 1970s. Demolition of buildings at the site would have occurred to accommodate the hospital campus development.

The construction of the current car park and on-site office building appears to have occurred between 1978 and 1986 (according to aerial photographs).

Several licences for the Children's Hospital at Westmead and Westmead Hospital premises relating to the generation and storage of hazardous, industrial or 'Group A' waste include an extensive list (see Section 5.5). It is considered unlikely that these substances would have been introduced to the subject site, assuming that waste disposal practices were appropriately managed at both premises.

12.2 Chemical Contaminants in Soil

All results for the eight priority heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc) were within the HIL. Furthermore, concentrations of arsenic, chromium, copper, lead, nickel and zinc were all within the ESL.

Concentrations of benzo(a)pyrene were either low or not detected and all concentrations were within the ESL. Concentrations of carcinogenic PAH (as Benzo(a)pyrene toxic equivalency quotient) were all within the HIL. Concentrations of total PAH were all within the HIL.

Concentrations of TRH C_6-C_{10} were below detection limits in all analysed samples and, therefore, concentrations of TRH C_6-C_{10} less BTEX were within the HSLs for all analysed samples. TRH $>C_{10}$-C_{16} was detected in only one analysed sample and all concentrations of TRH $>C_{10}$-C_{16} less naphthalene were within the HSLs. TRH $>C_{16}$-C_{34} was detected in only one analysed sample and all concentrations of TRH $>C_{16}$-C_{34} were within the HSLs. TRH $>C_{34}$-C_{40} was not detected in any analysed sample and, therefore, all concentrations of TRH$>C_{16}$-C_{34} were within the HSLs. Concentrations of TRH were also within management limits. Naphthalene, benzene, toluene, ethylbenzene, and xylenes were not detected in any analysed samples and, therefore, all concentrations of BTEXN are within the respective HSLs and EIL or ESLs.

Concentrations of OCP, PCBs and phenols were not detected in any analysed sample, and, therefore, concentrations of these chemicals are within the respective HILs and EIL.

12.3 Asbestos in Soil

The presence of asbestos in the observed fibre-cement was confirmed by the analysis of two material samples (A1 and A2). Asbestos was detected in seven of twenty-two analysed soil samples. Asbestos was not detected in analysed natural soil samples.

Table 18 provides a summary of the locations and depths of observed fibre-cement and laboratory detected asbestos. Eleven of 24 test locations were identified to contain fibre-cement or detected asbestos in filling and is shown on Drawing 2, Appendix A. Asbestos contamination was identified in all eight test pits, and, therefore, the majority of the asbestos contamination was identified in areas of mounded filling (garden and grassed areas), although asbestos contamination has also been identified beneath asphalt surfaces at Bore 1 and Bore 5. No respirable fibres were detected in any of the analysed soil samples.

Table 18: Location and depth of observed fibre-cement and detected asbestos

Sample Location	Observed fibre-cement or detected asbestos in filling	Depth (m)	Comments
1	**Fibre-cement observed**	0.55-0.9	Asbestos confirmed in fibre-cement sample A1
2	Not observed/detected		
3	Not observed/detected		
4	Not observed/detected		
5	**Asbestos detected**	0.5	Fibre-cement not observed. Asbestos detected as loose fibre bundles.
6	Not observed/detected		
7	Not observed/detected		
8	Not observed/detected		
9	Not observed/detected		
10	Not observed/detected		
11	**Fibre-cement observed**	0-0.2 & 1.1-1.6	Asbestos confirmed in fibre-cement sample A2
12	Not observed/detected		
13	Not observed/detected		
14	Not observed/detected		
15	Not observed/detected		
16	Not observed/detected		
101	**Fibre-cement observed**	0.05-1.3 & 1.7-1.8	Large fibre-cement sheets observed at 1.7-1.8m
	Asbestos detected	1	Detected as loose fibre bundles
102	**Fibre-cement observed**	0-0.25	Test pit terminated at 0.25m
	Asbestos detected	0.1	Detected as loose fibre bundles
103	**Fibre-cement observed**	0-0.9	
104	**Fibre-cement observed**	0-1.4	

Sample Location	Observed fibre-cement or detected asbestos in filling	Depth (m)	Comments
	Asbestos detected	0.5	Asbestos embedded in several fragments of fibre cement
105	**Asbestos detected**	0.1	Fibre-cement not observed, although concrete fragments observed. Asbestos detected as loose fibre bundles.
106	**Asbestos detected**	0.1	Fibre-cement not observed
107	**Fibre-cement observed**	0-0.35	
108	**Asbestos detected**	0.1	Fibre-cement not observed. Asbestos detected as loose fibre bundles.

Despite the distribution of identified asbestos contamination shown in Drawing 2, Appendix A, it is considered that the extent of asbestos contamination has not been clearly delineated for the following reasons:

- Most samples were obtained from boreholes (not test pits). Test trenches/pits are preferred to boreholes in determining the presence or extent of any asbestos contamination, because a larger area of the subsurface is exposed for visual inspections (providing more reliable subsurface information). Test pits in asphalt areas were not considered appropriate for the investigation given the busy use of the car park, timing of the investigation and the relative expense of re-instating the car park;
- The variability of observed filling depths and types observed across the site, particularly within garden/grassed areas compared to asphalt areas;
- Not every garden or grassed areas was investigated (due to the scope of the investigation and obstructions such as large trees or underground services); and
- The typical random nature of asbestos contamination, which can be sporadic, particularly if the contamination is from fibre-cement fragments in heterogeneous filling.

12.4 Provisional Waste Classification Results

Results shown in Table 16 have been compared to criteria sourced from the Department of Environment and Climate Change (DECC) NSW *Waste Classification Guidelines,* revised December 2009. Results of provisional waste classification testing indicate that concentrations of chemical contaminants (i.e. excluding asbestos) are within guideline values for General Solid Waste. Asbestos, however, is classified as Special Waste (Asbestos).

It is considered that filling at the site containing fibre-cement fragments or detectable asbestos has a provisional waste classification as Special Waste (Asbestos). Filling that does not contain asbestos (or fibre-cement fragments) has a provisional waste classification of General Solid Waste (non-putrescible). In this regard, excavated asbestos contaminated filling should be segregated from other filling materials to prevent cross-contamination. From a practical point of view, however, it may be difficult to separate the two waste streams and a Special Waste (Asbestos) classification is likely to apply to most of the soil.

Note that the old topsoil horizon identified at Bore101, depth 1.8-2.0 m, is classified as part of the general solid waste materials (assuming it has not been impacted by overlying asbestos contaminated filling).

The *Protection of the Environment Operations Act 1997*, the *Protection of the Environment Operations Amendment (Scheduled Activities and Waste) Regulation 2008*, and the *Waste Classification Guidelines* 2009, define virgin excavated natural materials (VENM) such as clay, gravel, sand, soil and rock, as materials that:

- Are not mixed with any other waste;
- Have been excavated from areas that are not contaminated as a result of industrial, commercial, mining or agricultural activities;
- Do not contain sulphidic ores or soils; and
- Consist of excavated natural materials that meet such criteria as may be approved by the NSW EPA.

As natural soils do not show signs of contamination, either from observations or analytical testing, natural soils/rock at the site (except the old topsoil horizon identified at Bore 101) have a classification of Virgin Excavated Natural Material (VENM) provided that the material is not cross-contaminated, contains filling or mixed with other non-VENM material, or contain any signs of environmental or aesthetic concern.

12.5 Contaminants in Groundwater

Hardness results indicate that the water is extremely hard and GILs for heavy metals have been adjusted for hardness where appropriate. Concentrations of arsenic, cadmium, copper, lead, mercury, nickel were all within the GILs and are considered to be at typical background concentrations of the Sydney region.

Concentrations of chromium were above the GIL for chromium (VI), but within the GIL for chromium (III) for all analysed samples. The detected concentrations of chromium are likely to be chromium (III), given that chromium (VI) is not considered to be a potential contaminant of concern for the site and chromium (III) is the common valence state in the environment. It is considered, therefore, that no further assessment is warranted for the detected chromium in groundwater.

Concentrations of zinc were above the GIL (72 µg/L) in only the samples obtained from Bore 10. These concentrations (100 µg/L and replicate sample 110 µg/L) are commonly found by DP in the Sydney Region and considered to be within the normal range of background concentrations, particularly when considering the hardness result (3100 mg$CaCO_3$/L) which is well above the extremely hard value (400 mg$CaCO_3$/L) defined in ANZECC & ARMCANZ (2000). No significant source of zinc on site was detected. It is, however, noted that groundwater at this location does appear to have been impacted from an anthropogenic source (discussed below). Notwithstanding, no further assessment of zinc in groundwater is considered warranted.

PCB, OCP and total phenols were not detected in any groundwater sample and, therefore, concentrations are within the respective GILs.

PAH was only detected in the groundwater samples collected from Bore 10. Detectable PAH comprised naphthalene and phenanthrene which were at concentrations within the GIL.

Benzene and toluene were not detected in any groundwater sample. Ethylbenzene, xylenes and TRH were only detected in the groundwater samples from Bore 10. All concentrations of TRH and BTEX were within the respective HSLs.

Review of the TRH chromatogram revealed that the detectable TRH response is not dissimilar to a response for 2-stroke fuel or petrol, although the review was not conclusive.

The source of the detected TRH, ethylbenzene, xylenes, phenanthrene and naphthalene has not been determined, but is probably from off-site for the following reasons:

- The inferred groundwater flow direction (Drawing 2, Appendix A), determined from groundwater levels, suggests that groundwater at Bore 10 has migrated from the Darcy Road direction rather than the subject site;
- BTEX and significant concentrations of PAH and TRH were not detected in any of the analysed soil samples; and
- PAH, TRH and BTEX were not detected in the other two monitoring wells.

Having noted this, a specific off-site source (such as an underground fuel storage tank) of the detected BTEX, PAH and TRH was not observed. Given that concentrations are within the respective GILs, and HSLs, further assessment of TRH, BTEX and PAH in groundwater is not considered necessary.

12.6 Recommendations

Although the asbestos contamination has not been defined, it has been observed that the contamination is widespread across the site. It is considered that delineation of asbestos contamination at the site in its current state would require a significantly high sampling density and, preferably, the use of test pits, rather than test bores, in order to provide a visual assessment of the filling profile. This approach is not considered to be practical, given the operational status of the car park. Also, successful delineation of the contamination is unlikely to significantly alter the need for remediation or the remedial approach undertaken.

Given the considerable asbestos contamination identified, it is considered that a Remediation Action Plan (RAP) will need to be prepared for the remediation of asbestos in order to render the site suitable for the proposed development. Typical approaches for remediating asbestos contamination include:

- complete removal of the asbestos contamination to a licensed landfill;
- burial of the asbestos at the site beneath a capping layer that is managed by procedures provided in an environmental management plan; or
- a combination of the above two options (i.e. disposal of some asbestos contaminated soil to a licensed landfill and capping the remainder of asbestos contaminated filling on site).

The remediation should be validated by a qualified environmental consultant.

It is noted that, although not assessed in detail, there may not be sufficient space (or volume) to dedicate to ''cell(s)'' for containing all the asbestos contaminated soil, and thus burial and capping of all the asbestos contaminated material at the site may not be considered practical.

Capping of the asbestos contaminated soil can include the construction of a physical barrier such as the construction of a concrete slab or placement of 0.5 m of clean soil over the asbestos contaminated soil. The capping approach should include placement of a warning marker layer over the asbestos contaminated soil (prior to construction/placement of the barrier). Consideration would also need to be given to the location of buried asbestos contaminated soil so as to not pose a health risk to workers during intrusive construction activities (such as the placement of underground services). If the proposed development is subject to a statutory site audit, containment of contaminated soil at the site will require appropriate notations on a planning certificate issued under section 149(2) of the *Environmental Planning and Assessment Act* 1979 or a covenant registered on the title to land under section 88B of the *Conveyancing Act* 1919.

Excavation and removal of asbestos contaminated soil would need to be undertaken by an appropriately licensed (AS A) contractor. A qualified occupational hygienist would need to periodically inspect and validate the works and prepare certificate(s) stating the work was undertaken in a satisfactory manner and that the resultant health risk associated with the asbestos contamination has been reduced to an insignificant level. The occupational hygienist would also carry out air monitoring during the remediation.

Inquiries on 20 September 2013 with Sita Australia revealed that tip fees at the Kemps Creek Landfill for asbestos contaminated soil and for soil classified as general solid waste are the same ($150 per tonne plus GST). The rate may vary depending on the volumes of soil involved and whether there is a commercial relationship between the landfill and the contractor. The rate does not account for excavation and transport of soils which is typically higher for asbestos contaminated soils as opposed to soils classified as general solid waste. A licensed transporter is required for asbestos waste.

Although fibre-cement fragments were not frequently observed on the ground surface during fieldwork, rain-events (over time) may expose more fragments which could degrade over time. If development of the proposed car park is postponed or not undertaken, then an asbestos management plan should be put in place to minimise potential exposure of asbestos to site users.

13. Conclusions and Recommendations

It was considered, from a review of site historical information and a site inspection, that filling at the site had the greatest potential to be a source for contamination at the site. This was confirmed as substantial asbestos contamination has been identified in the filling at the site.

TRH, PAH and BTEX has been detected in the groundwater at the western corner of the site and is likely to be as a result of an off-site source, although the source has not been identified. The detected concentrations of these contaminants are not at levels that pose an ecological risk or a human health risk for the proposed development..

Filling materials either have a provisional waste classification as General Solid Waste (non-putrescible) or Special Waste (Asbestos) although separation of the two waste streams may be difficult and the Special Waste (Asbestos) is more likely to apply. Natural soil/rock are provisionally classified as VENM.

It is considered that the site can be made suitable for the proposed car park development. A Remediation Action Plan (RAP) will be required to detail the procedures for remediating the identified asbestos contamination.

14. Limitations

Douglas Partners (DP) has prepared this report for this project at Westmead Health Campus, Westmead in accordance with DP's revised proposal dated 5 August 2013; and Westfield Car Park Planning Consultancy Agreement (Contract No. H134823), 13 August 2013. This report is provided for the exclusive use of Health Infrastructure for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

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

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life.

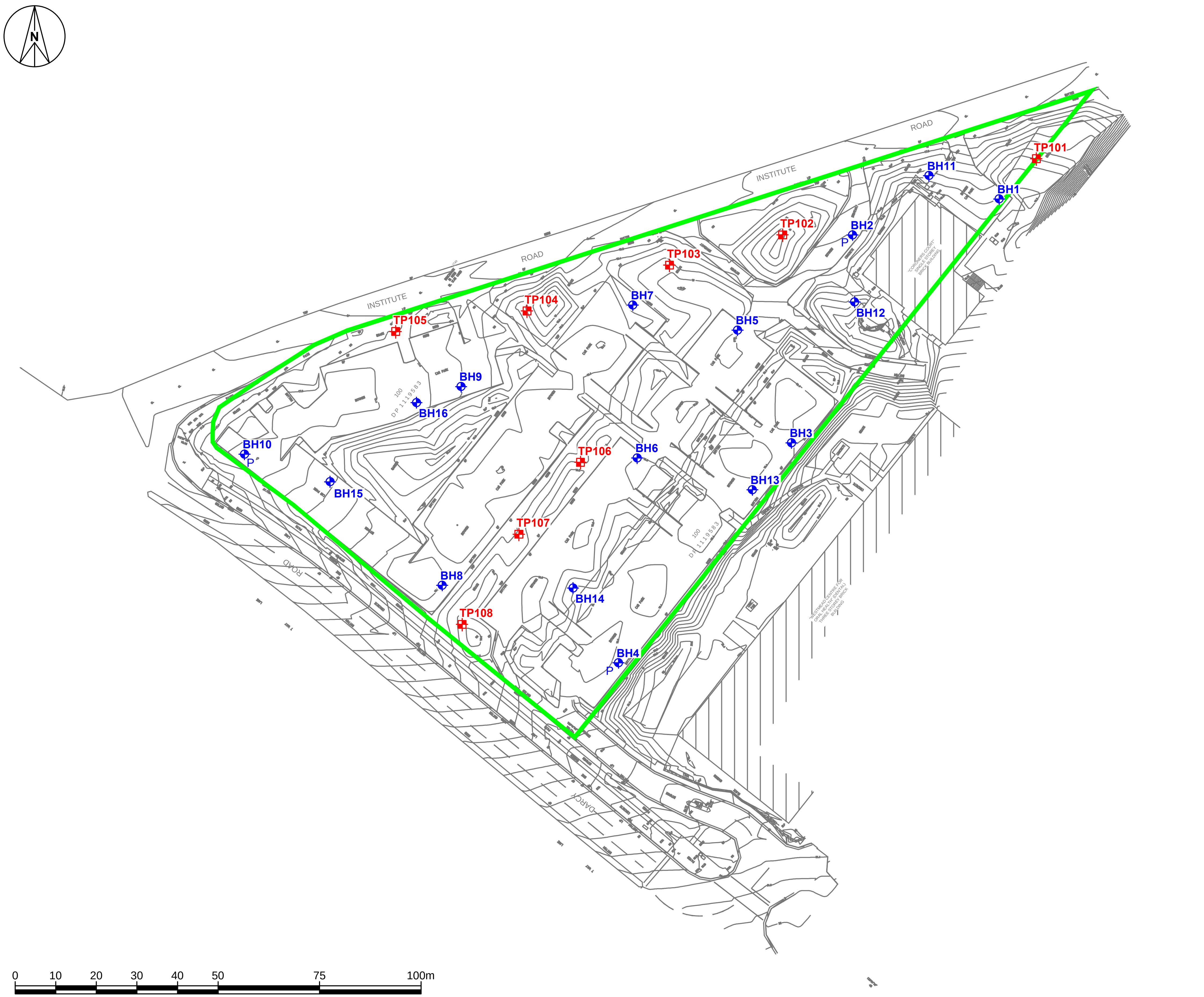
This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the discussions section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the environmental components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

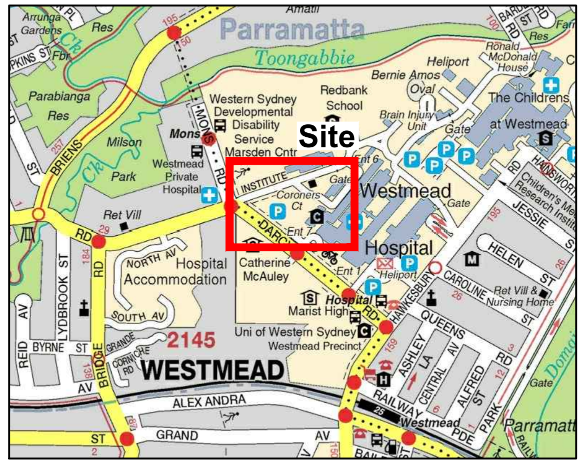
This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

Drawings





Location Plan

Legend

- Borehole Location
- Testpit Location
- P Piezometer
- Site Boundary

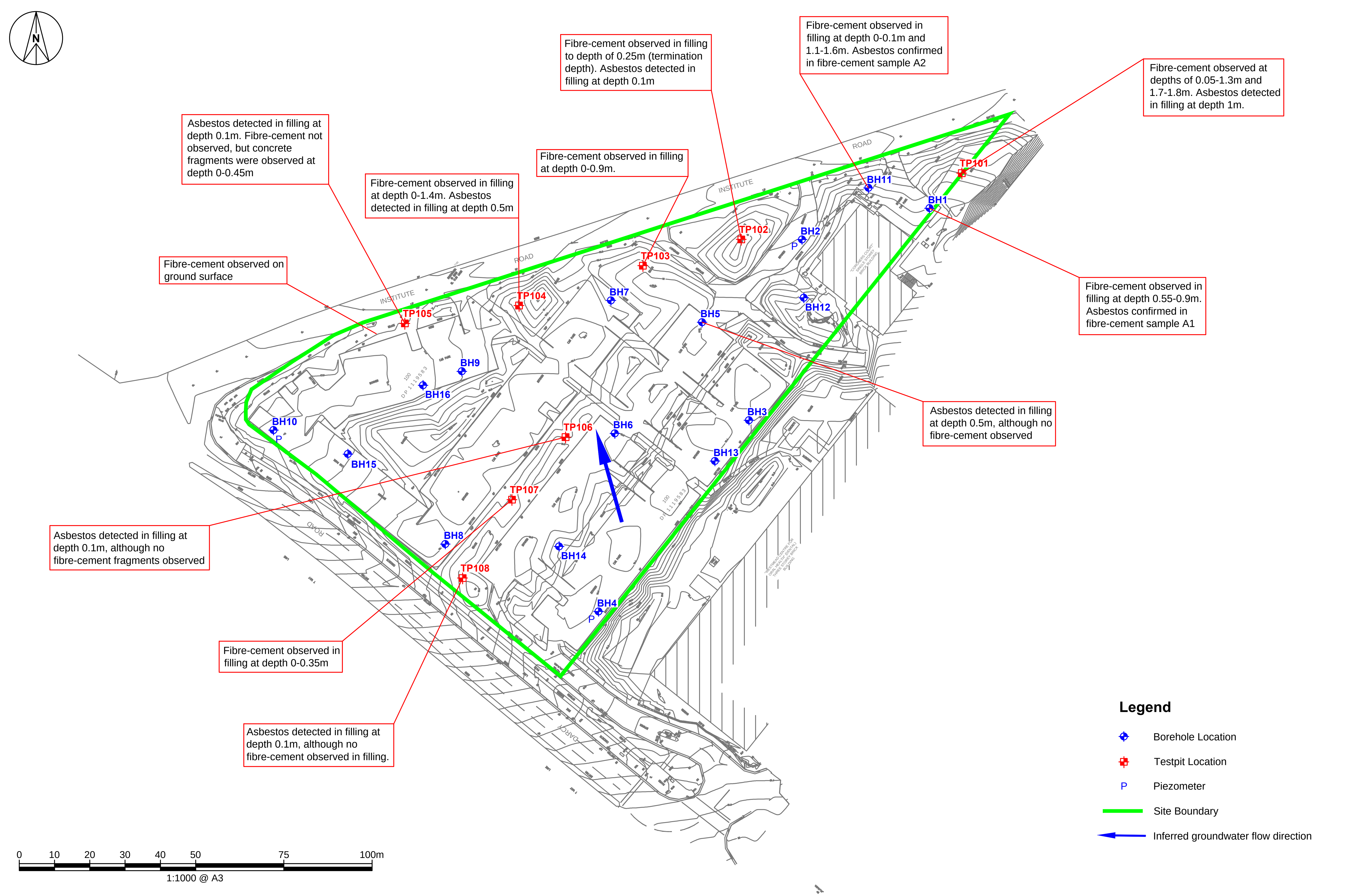
Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Health Infrastructure		TITLE: **Sample Locations**
	OFFICE: Sydney	DRAWN BY: JCP	**Detailed Site Investigation, Proposed Car Park, Westmead Health Campus**
	SCALE: As shown	DATE: 16.9.2013	**Cnr. Darcy Road & Institute Road, Westmead**

PROJECT No:	73603.01
DRAWING No:	1
REVISION:	0

50mm on Original

File Name: P:\73603.01 WESTMEAD, Proposed Car Park, Contamination Assessment DW\Drawings\73603.01_DWG01.dwg

Date printed: 23 Sep 2013 - 12:36PM



Douglas Partners *Geotechnics / Environment / Groundwater*	CLIENT: Health Infrastructure	TITLE: **Observed Fibre-cement & Detected Asbestos**	PROJECT No: 73603.01
	OFFICE: Sydney / DRAWN BY: JCP	**Detailed Site Investigation, Proposed Car Park, Westmead Health Campus**	DRAWING No: 2
	SCALE: As shown / DATE: 16.9.2013	**Cnr. Darcy Road & Institute Road, Westmead**	REVISION: 0

50mm on Original

File Name: P:\73603.01 WESTMEAD, Proposed Car Park, Contamination Assessment DW\Drawings\73603.01_DWG02.dwg

Date printed: 19 Sep 2013 - 09:10AM

Appendix B

Photographs

Photo 1 - Car park (from southern-most corner of site)

Photo 2 - 'Western Sydney Local Health District Office' building

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs**	PROJECT:	73603.01
	Proposed Carpark, DSI, WHC	PLATE No:	1
	Institute Road, Westmead	REV:	A
	CLIENT: Health infrastructure	DATE:	18-Sep-13

Photo 3 - Retaining wall next to office building

Photo 4 - Soil mounded in garden

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs**	PROJECT:	73603.01
	Proposed Carpark, DSI, WHC	PLATE No:	2
	Institute Road, Westmead	REV:	A
	CLIENT: Health infrastructure	DATE:	18-Sep-13

Photo 5 - Mounded soil in grassed area

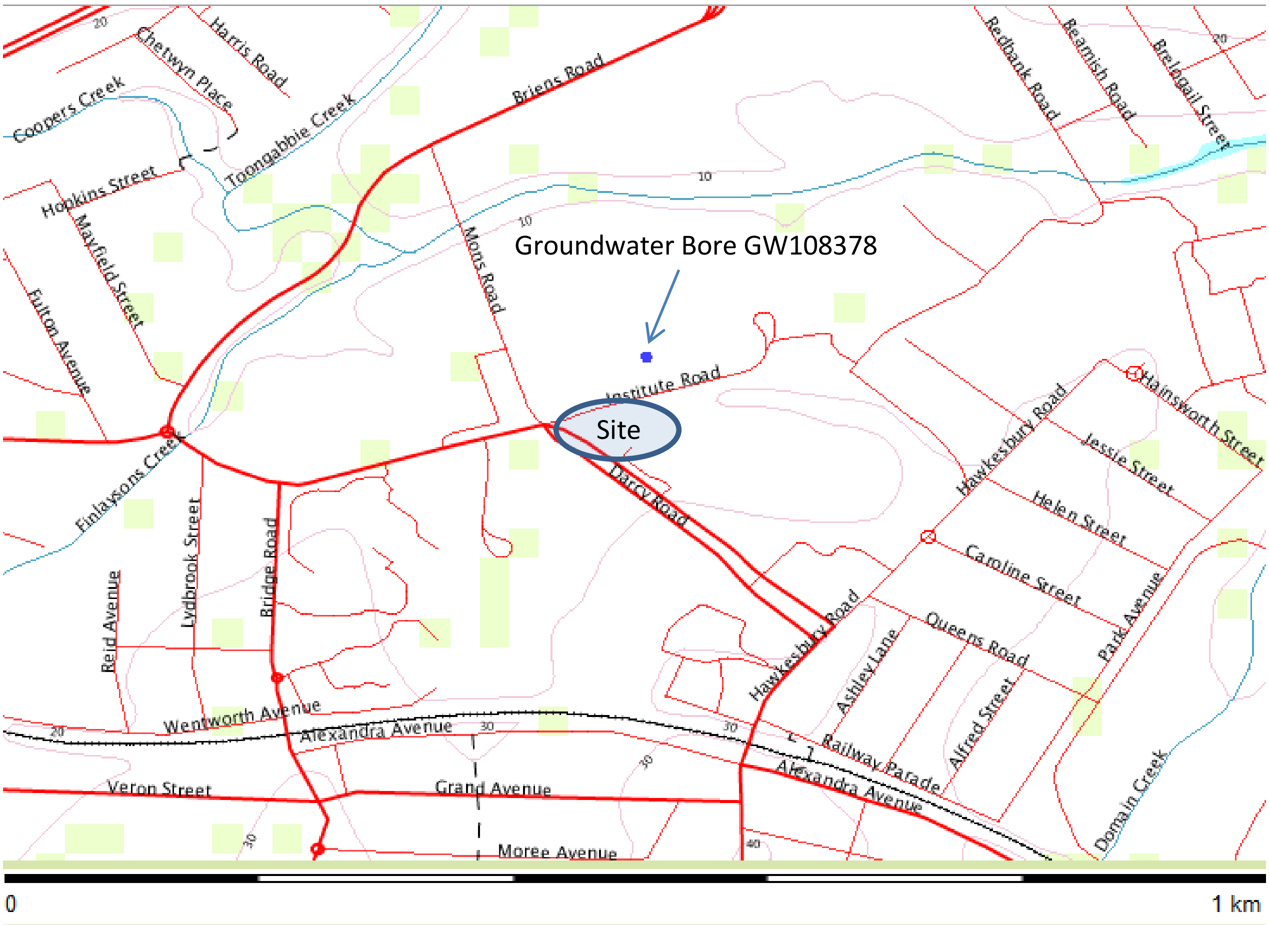
Photo 6 - Fibre-cement fragment observed on ground surface

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs**	PROJECT:	73603.01
	Proposed Carpark, DSI, WHC	PLATE No:	3
	Institute Road, Westmead	REV:	A
	CLIENT: Health infrastructure	DATE:	18-Sep-13

Appendix C

Results of
Registered Groundwater Bore Search

Results of Groundwater Bore Search



Source: http://waterinfo.nsw.gov.au/gw/

Groundwater Works Summary

For information on the meaning of fields please see Glossary
Document Generated on Monday, August 26, 2013

[Print Report]

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW108378

Works Details (top)

GROUNDWATER NUMBER	GW108378
LIC-NUM	10WA109505
AUTHORISED-PURPOSES	INDUSTRIAL
INTENDED-PURPOSES	INDUSTRIAL
WORK-TYPE	Bore
WORK-STATUS	
CONSTRUCTION-METHOD	
OWNER-TYPE	
COMMENCE-DATE	
COMPLETION-DATE	2006-01-31
FINAL-DEPTH (metres)	282.00
DRILLED-DEPTH (metres)	282.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	WESTMEAD HOSPITAL
GWMA	-
GW-ZONE	-
STANDING-WATER-LEVEL	
SALINITY	
YIELD	0.80

Site Details (top)

REGION	10 - SYDNEY SOUTH COAST
RIVER-BASIN	
AREA-DISTRICT	
CMA-MAP	
GRID-ZONE	
SCALE	
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6257945.00
EASTING	313516.00
LATITUDE	33 48' 8"
LONGITUDE	150 59' 8"
GS-MAP	

AMG-ZONE	56
COORD-SOURCE	
REMARK	

Form-A (top)

COUNTY	CUMBERLAND
PARISH	ST JOHN
PORTION-LOT-DP	5 1077852

Licensed (top)

COUNTY	CUMBERLAND
PARISH	ST JOHN
PORTION-LOT-DP	100 1119583

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter; ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	282.00	254			Down Hole Hammer
1	1	Casing	PVC Class 12	0.30	120.00	177	158.6		Other

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
23.00	24.00	1.00				0.10		5.00	

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT
0.00	0.20	0.20	TOPSOIL		
0.20	2.00	1.80	CLAY		
2.00	19.00	17.00	SHALE		
19.00	62.00	43.00	SANDSTONE		
62.00	64.00	2.00	GREY SHALE		
64.00	123.00	59.00	SANDSTONE		
123.00	127.00	4.00	GREY SHALE		
127.00	164.00	37.00	SANDSTONE		
164.00	168.00	4.00	GREY SHALE		
168.00	176.00	8.00	SANDSTONE		
176.00	184.00	8.00	GREY SHALE		

184.00	226.00	42.00	SANDSTONE
226.00	236.00	10.00	GREY SHALE
236.00	260.00	24.00	SANDSTONE
260.00	282.00	22.00	GREY SHALE

Appendix D

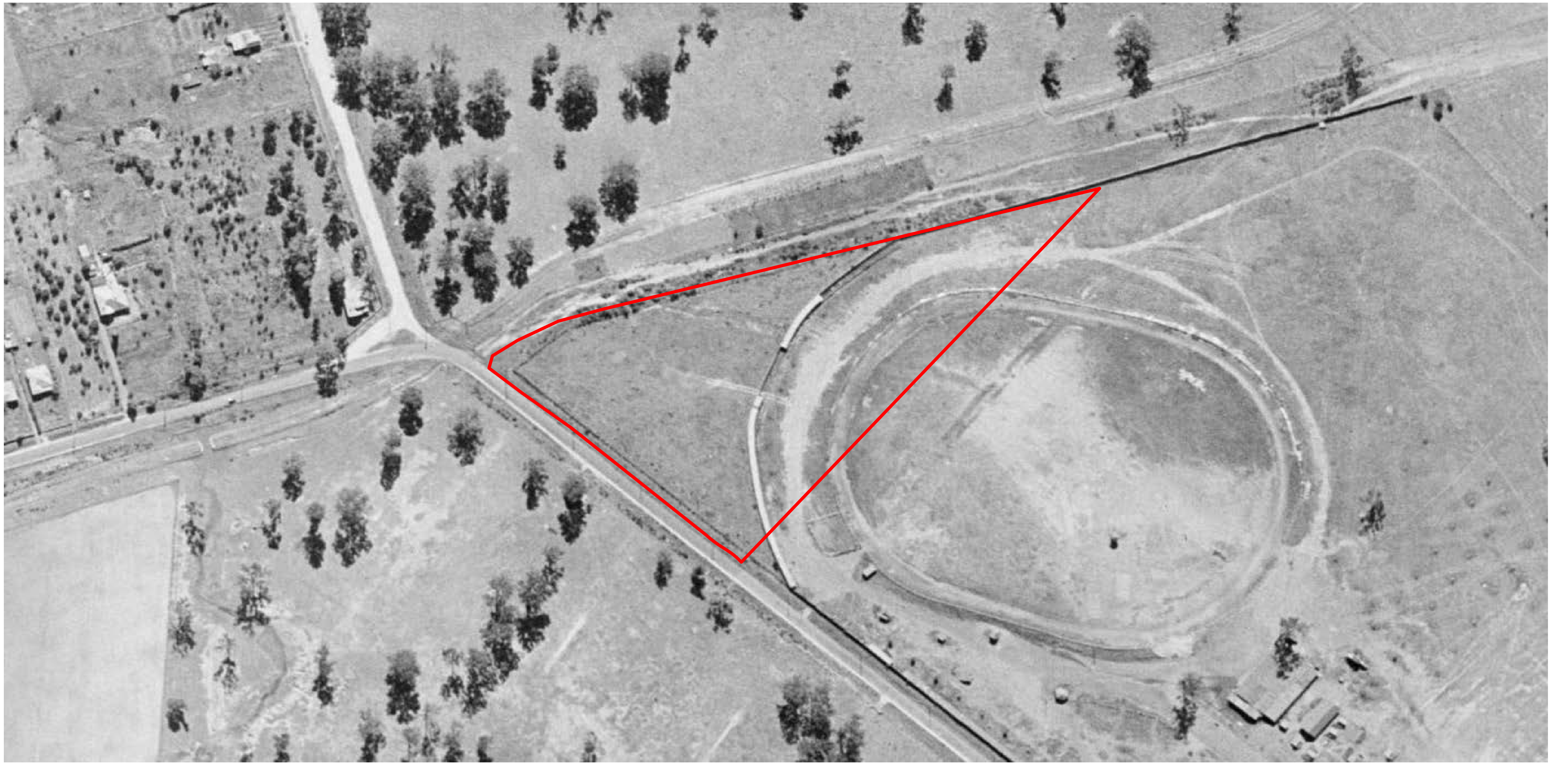
Aerial Photographs

Legend

Site boundary

Source: NSW Government Land & Property Information

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Health Infrastructure		TITLE: **1930 Aerial Photograph**	PROJECT No:	73603.01
	OFFICE: Sydney	DRAWN BY: DW	**Detailed Site Investigation, Proposed Car Park**	PLATE No:	1
	SCALE: As shown	DATE: 03.09.13	**Cnr Darcy Road and Institute Road, Westmead Hospital**	REVISION:	A

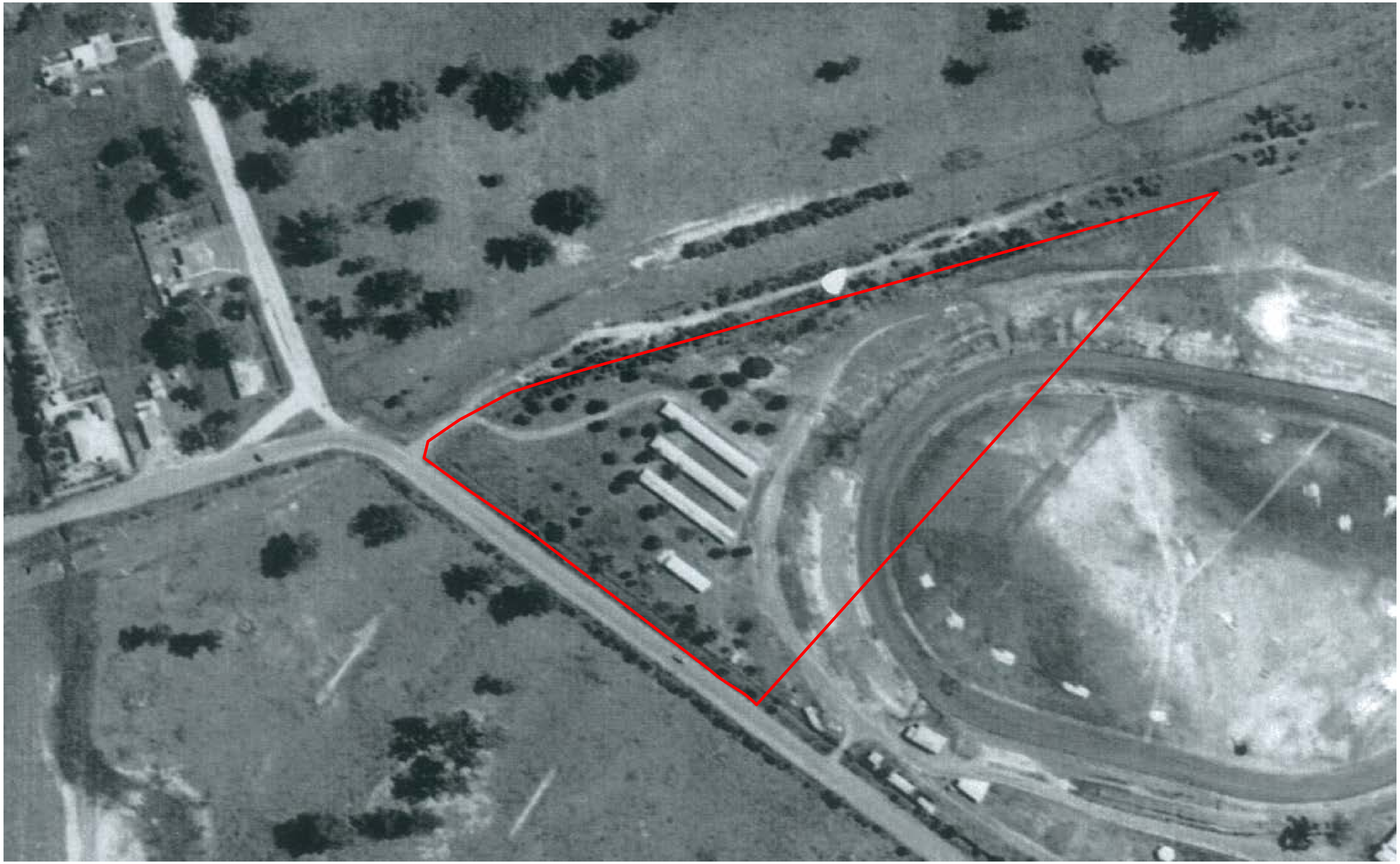


Legend

Site boundary

Source: Six Maps, NSW Government Land & Property Information

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Health Infrastructure		TITLE:	**1943 Aerial Photograph**	PROJECT No:	73603.01
	OFFICE: Sydney	DRAWN BY: DW		**Detailed Site Investigation, Proposed Car Park**	PLATE No:	2
	SCALE: As shown	DATE: 03.09.13		**Cnr Darcy Road and Institute Road, Westmead Hospital**	REVISION:	A

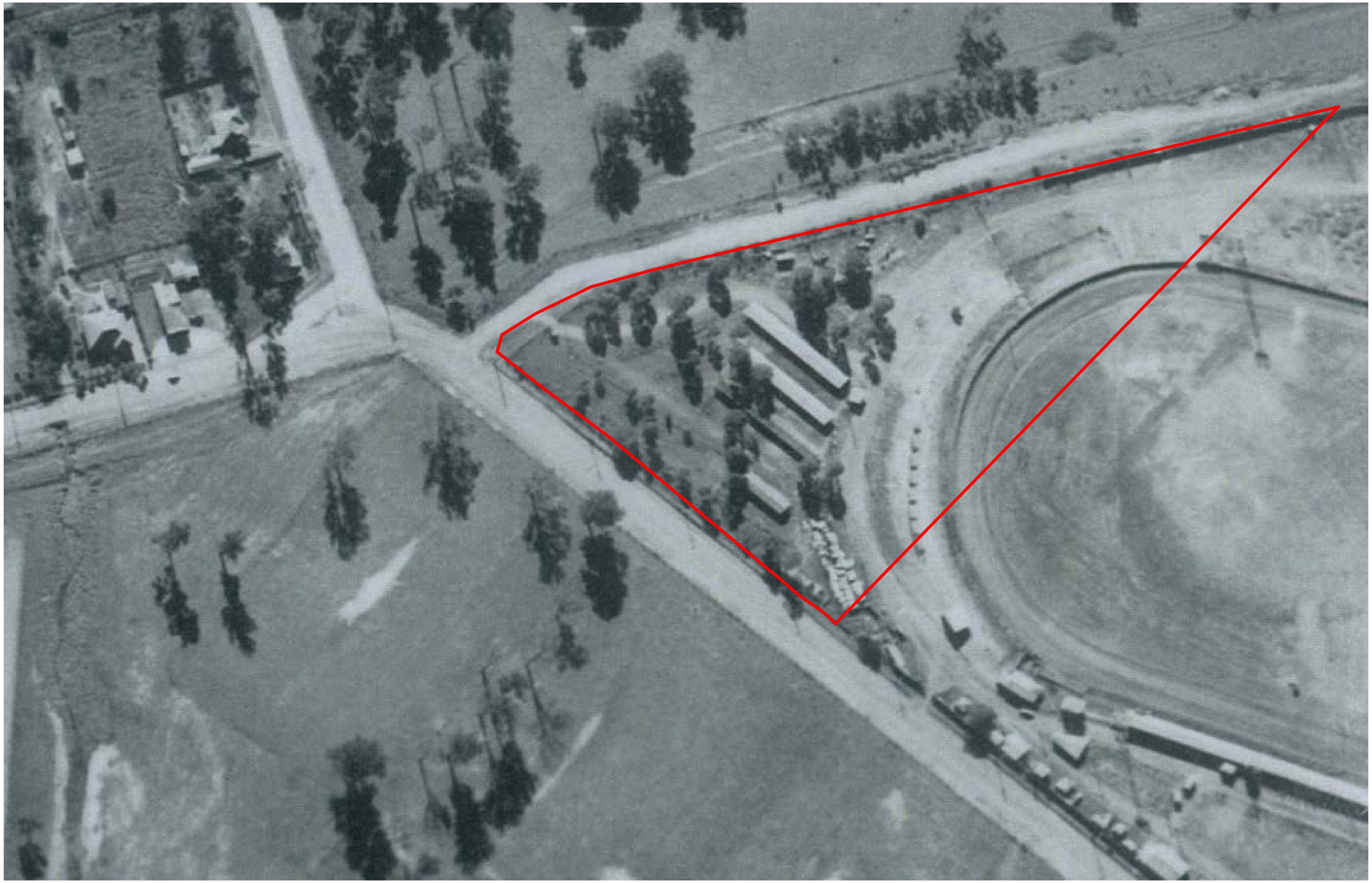


Legend

Site boundary

Source: NSW Government Land & Property Information

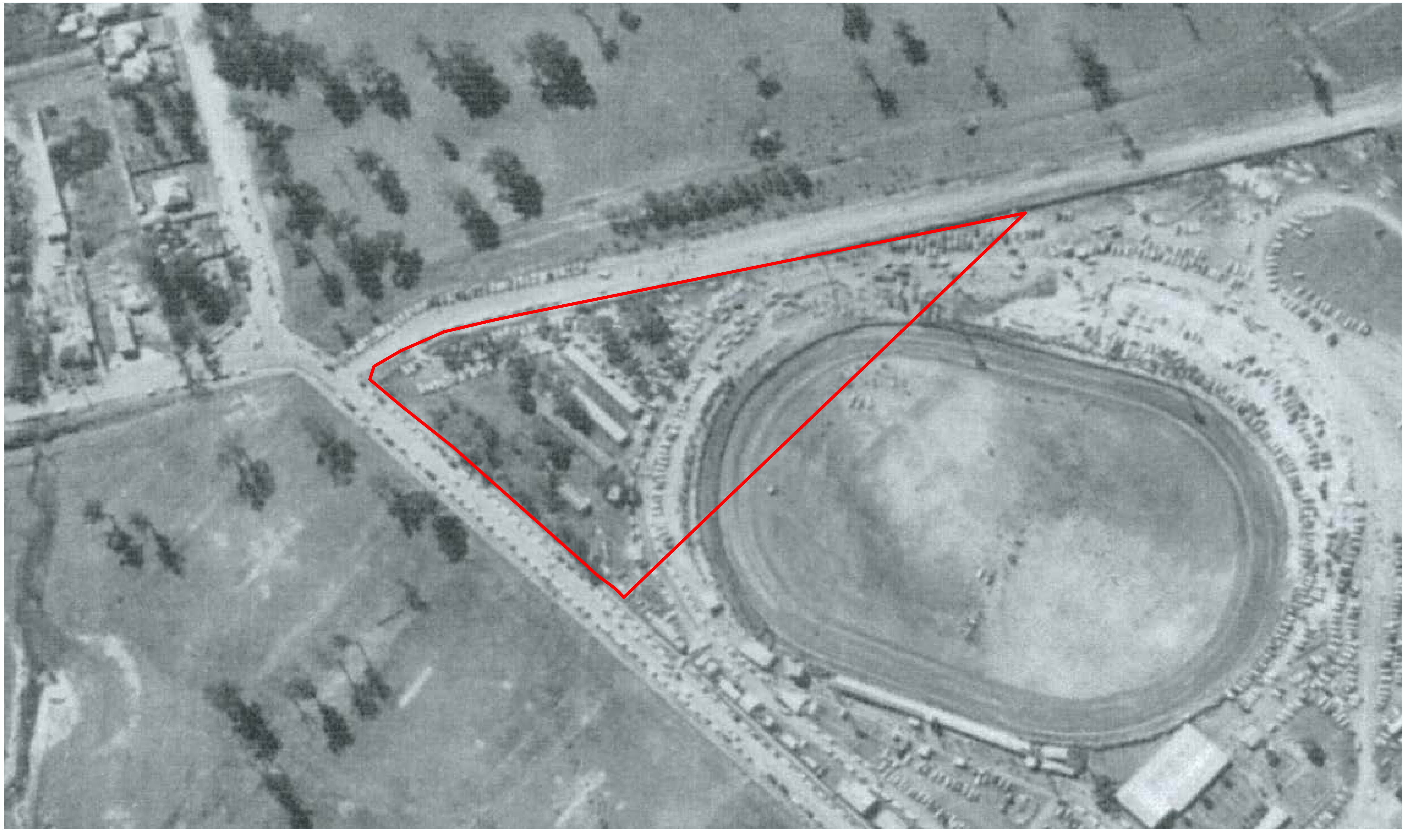
Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Health Infrastructure		TITLE: **1956 Aerial Photograph**	PROJECT No:	73603.01
	OFFICE: Sydney	DRAWN BY: DW	**Detailed Site Investigation, Proposed Car Park**	PLATE No:	3
	SCALE: As shown	DATE: 03.09.13	**Cnr Darcy Road and Institute Road, Westmead Hospital**	REVISION:	A



Legend
Site boundary

Source: NSW Government Land & Property Information

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Health Infrastructure		TITLE: **1961 Aerial Photograph**	PROJECT No:	73603.01
	OFFICE: Sydney	DRAWN BY: DW	**Detailed Site Investigation, Proposed Car Park**	PLATE No:	4
	SCALE: As shown	DATE: 03.09.13	**Cnr Darcy Road and Institute Road, Westmead Hospital**	REVISION:	A

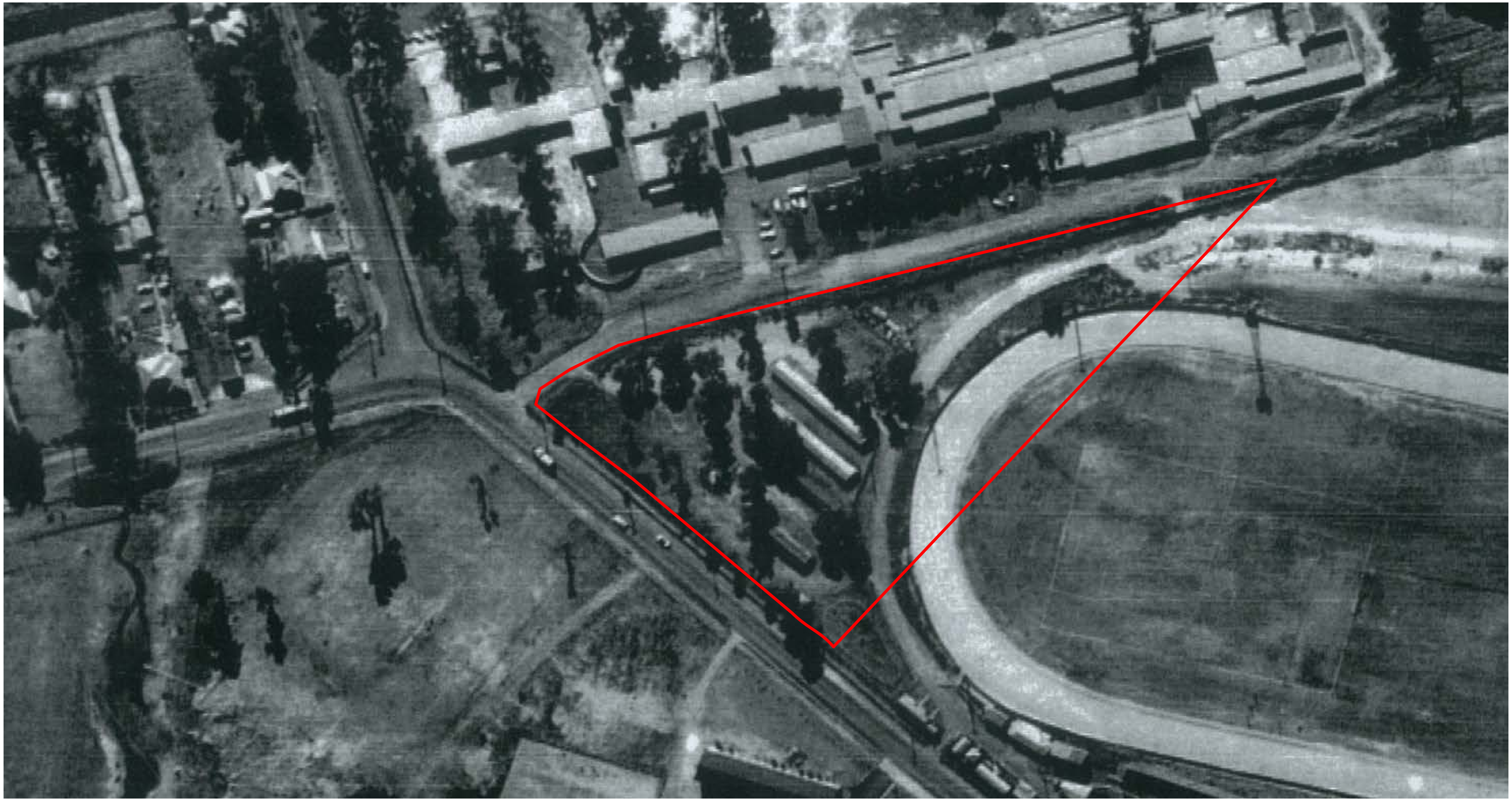


Legend

Site boundary

Source: NSW Government Land & Property Information

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Health Infrastructure		TITLE: **1965 Aerial Photograph**	PROJECT No:	73603.01
	OFFICE: Sydney	DRAWN BY: DW	**Detailed Site Investigation, Proposed Car Park**	PLATE No:	5
	SCALE: As shown	DATE: 03.09.13	**Cnr Darcy Road and Institute Road, Westmead Hospital**	REVISION:	A

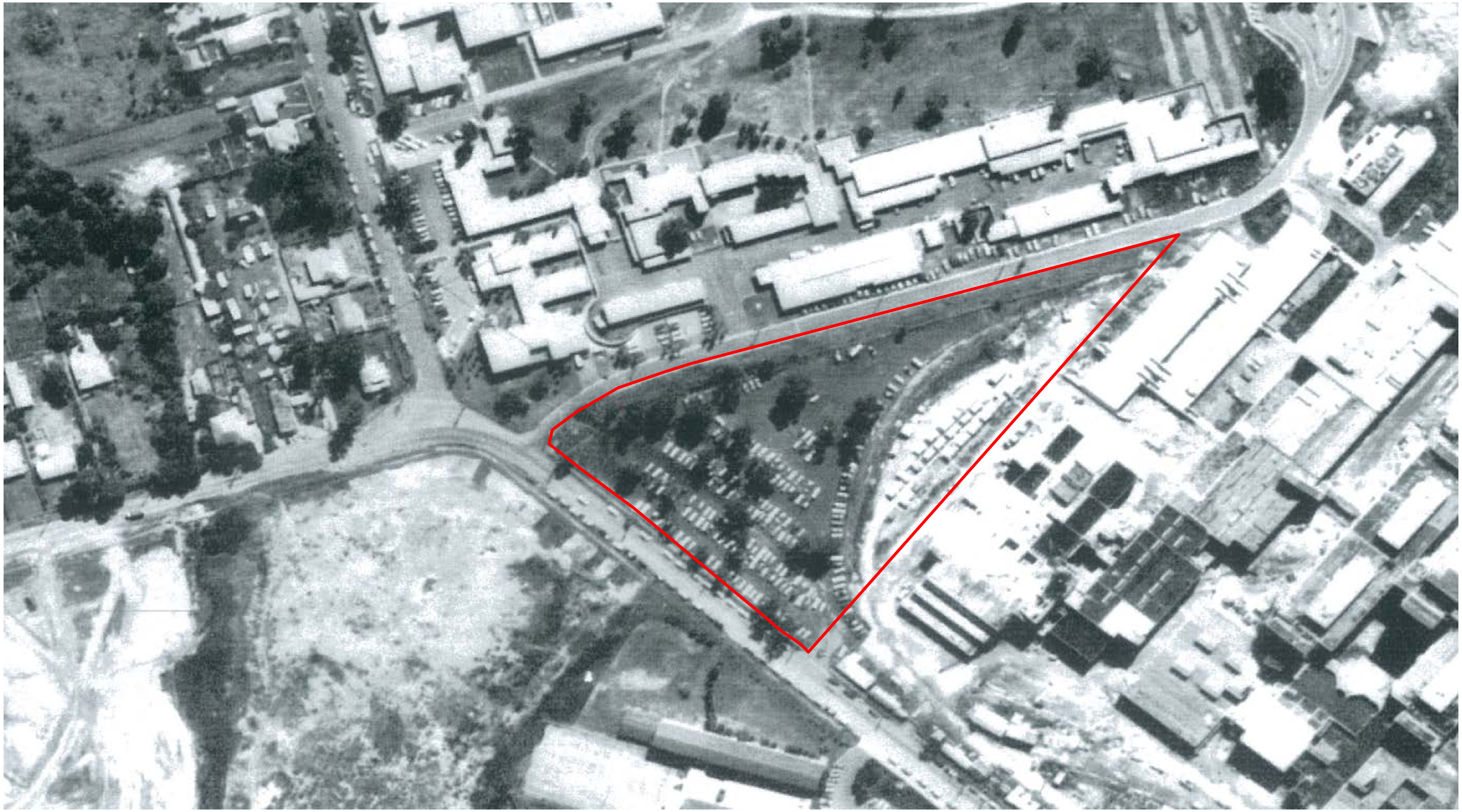


Legend

Site boundary

Source: NSW Government Land & Property Information

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Health Infrastructure		TITLE: **1970 Aerial Photograph**	PROJECT No: 73603.01
	OFFICE: Sydney	DRAWN BY: DW	**Detailed Site Investigation, Proposed Car Park**	PLATE No: 6
	SCALE: As shown	DATE: 03.09.13	**Cnr Darcy Road and Institute Road, Westmead Hospital**	REVISION: A



Legend

Site boundary

Source: NSW Government Land & Property Information

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Health Infrastructure			TITLE:	**1978 Aerial Photograph**	PROJECT No:	73603.01
OFFICE:	Sydney	DRAWN BY:	DW		**Detailed Site Investigation, Proposed Car Park**	PLATE No:	7
SCALE:	As shown	DATE:	03.09.13		**Cnr Darcy Road and Institute Road, Westmead Hospital**	REVISION:	A

Legend

Site boundary

Source: NSW Government Land & Property Information

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Health Infrastructure		TITLE:	1986 Aerial Photograph	PROJECT No:	73603.01
	OFFICE: Sydney	DRAWN BY: DW		Detailed Site Investigation, Proposed Car Park	PLATE No:	8
	SCALE: As shown	DATE: 03.09.13		Cnr Darcy Road and Institute Road, Westmead Hospital	REVISION:	A

Legend

Site boundary

Source: NSW Government Land & Property Information

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Health Infrastructure		TITLE: 1991 Aerial Photograph	PROJECT No:	73603.01
	OFFICE: Sydney	DRAWN BY: DW	Detailed Site Investigation, Proposed Car Park	PLATE No:	9
	SCALE: As shown	DATE: 03.09.13	Cnr Darcy Road and Institute Road, Westmead Hospital	REVISION:	A

Legend

Site boundary

Source: NSW Government Land & Property Information

Douglas Partners — Geotechnics / Environment / Groundwater	CLIENT: Health Infrastructure		TITLE: **2002 Aerial Photograph**	PROJECT No:	73603.01
	OFFICE: Sydney	DRAWN BY: DW	**Detailed Site Investigation, Proposed Car Park**	PLATE No:	10
	SCALE: As shown	DATE: 03.09.13	**Cnr Darcy Road and Institute Road, Westmead Hospital**	REVISION:	A

Legend

Site boundary

Source: Six Maps, NSW Government Land & Property Information

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Health Infrastructure		TITLE:	**2011 Aerial Photograph**	PROJECT No:	73603.01
	OFFICE: Sydney	DRAWN BY: DW		**Detailed Site Investigation, Proposed Car Park**	PLATE No:	11
	SCALE: As shown	DATE: 03.09.13		**Cnr Darcy Road and Institute Road, Westmead Hospital**	REVISION:	A

Appendix E

Historical Title Deed Search Results

Service First Registration Pty Ltd
ACN: 108 037 029
Ph: 02 9233 1314
Fax: 9233 2878
Suite 102, Level 1, 64 Castlereagh Street
Sydney 2000
PO Box 1539 Sydney 2000
DX 189 Sydney

Summary of Owners Report

LPI **Sydney**

Address: - Car Park, Darcy Road, Westmead Hospital

Description: - Part of Lot 5 D.P. 1077852

The early title to the subject land was found to be Crown Land

We are aware of the following events: -

As regards the part shown highlighted yellow on the attached cadastre

Date of Acquisition and term held	Registered Proprietor(s) & Occupations where available	Reference to Title at Acquisition and sale
22.08.1906	Hospital Paddock forming part of the Hospital for the Insane	Revoked 16.01.1931
16.01.1931	Athletic and Sports Ground	Gazette Now Vol 4521 Fol 72 Revoked 30.11.11973
26.02.1932 (1932 to 1933)	Henry Ohlsen Timothy Lockitt James Moys McKay Samuel Alfred Hanscombe George Henry Mobbs William Robert Hulks Michael Benedict Donnellan (Trustees)	Vol 4521 Fol 72
18.07.1933 (1933 to 1947)	Henry Ohlsen James Moys McKay Samuel Alfred Hanscombe George Henry Mobbs William Robert Hulks Henry Edward Haddrill James Cumming Browning (Trustees)	Vol 4521 Fol 72
18.12.1947 (1947 to 1948)	Henry Edward Haddrill James Cumming Browning Philip Henry Jeffery (Company Director) Hedley Victor Horwood (Garage Proprietor) Harold Steel Hewitt (Boot Retailer) Harry Raymond Thurston (Bank Officer) Edwin Doige Baskerville (Railway Employee) (Trustees)	Vol 4521 Fol 72
11.10.1948 (1948 to 1959)	James Cumming Browning Philip Henry Jeffery (Company Director) Hedley Victor Horwood (Garage Proprietor) Harold Steel Hewitt (Boot Retailer) Harry Raymond Thurston (Bank Officer) Edwin Doige Baskerville (Railway Employee) Charles McArthur Miller (Works Manager) (Trustees)	Vol 4521 Fol 72

Service First Registration Pty Ltd

ACN: 108 037 029
Ph: 02 9233 1314
Fax: 9233 2878

Suite 102, Level 1, 64 Castlereagh Street
Sydney 2000
PO Box 1539 Sydney 2000
DX 189 Sydney

Search continued as regards the part shown highlighted yellow on the attached cadastre

Date of Acquisition and term held	**Registered Proprietor(s) & Occupations where available**	**Reference to Title at Acquisition and sale**
25.07.1959 (1959 to 1973)	James Cumming Browning Hedley Victor Horwood (Garage Proprietor) Harold Steel Hewitt (Boot Retailer) Edwin Doige Baskerville (Railway Employee) Douglas William Lindsay Stanley Angelo Ricard Mannelli Dawson Frederick Charles Berry (Trustees)	Vol 4521 Fol 72
30.11.1973	Surrendered to the Crown	

As regards the part highlighted yellow hatched red on the attached cadastre

This part was formerly a road known as Hainsworth Road, subsequently closed

This part of the road was acquired by notification in Government Gazette dated 06.01.1978 Folio 27

Search continued as regards the whole of the subject land

Date of Acquisition and term held	**Registered Proprietor(s) & Occupations where available**	**Reference to Title at Acquisition and sale**
06.01.1978 (1978 to Date)	Health Commission of New South Wales (Acquired for Westmead Hospital) Now # Health Administration Corporation	Gazette Now 100/1119583

# Denotes current registered proprietor

Easements: - NIL

Leases to 25.07.1995: - NIL

Leases from 25.07.1995: - Not investigated

Yours Sincerely
Mark Groll
27 August 2013
(Ph: 0412 199 304)

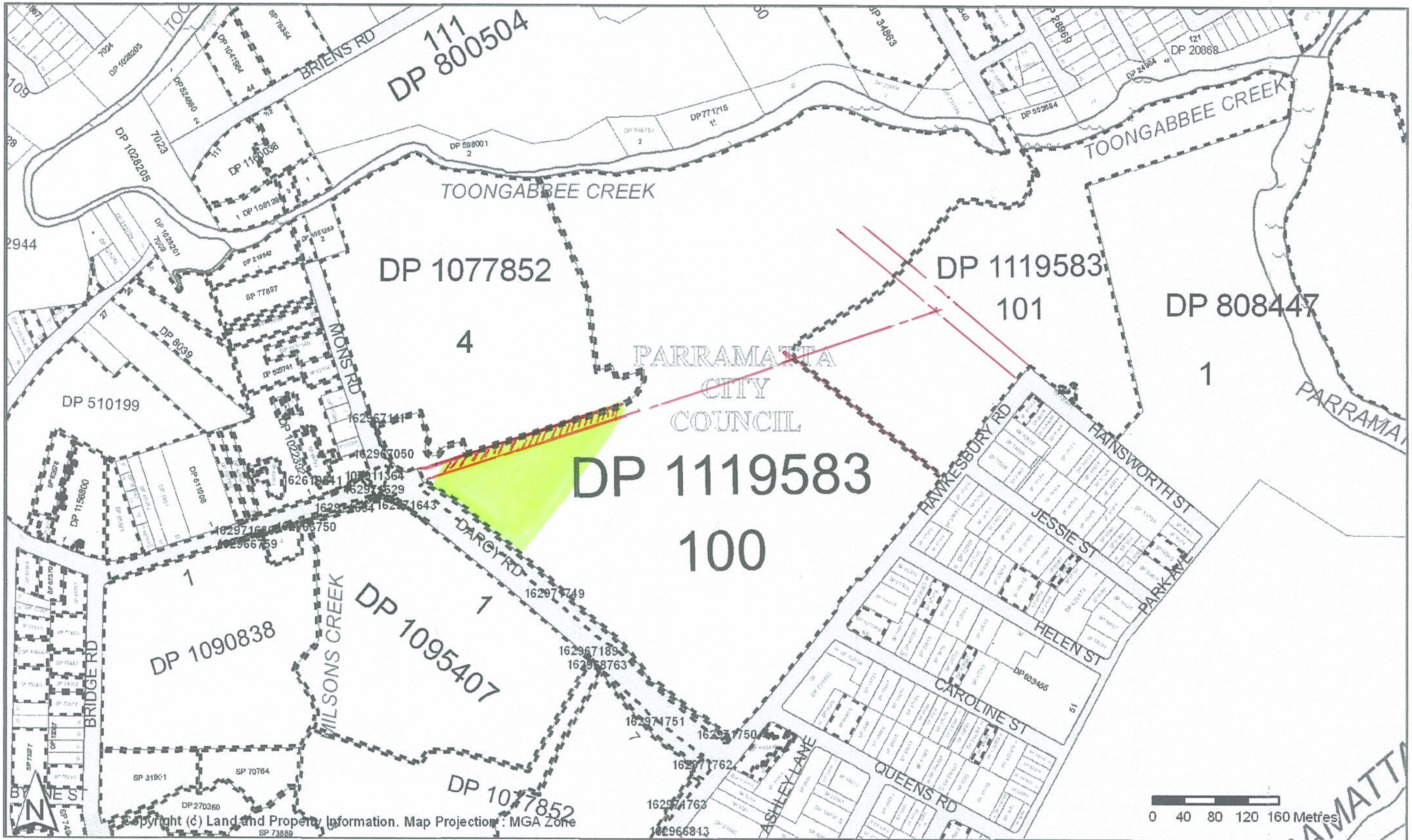
NSW Land & Property Information
A division of the Department of Finance & Services

Cadastral Records Enquiry Report

Ref : surv:scim-grollm

Requested Parcel : Lot 100 DP 1119583 | **Identified Parcel** : Lot 100 DP 1119583

Locality : WESTMEAD | **LGA** : PARRAMATTA | **Parish** : ST JOHN | **County** : CUMBERLAND



Report Generated 4:53:38 PM, 26 August, 2013

This information is provided as a searching aid only. While every endeavour is made to ensure the current cadastral pattern is accurately reflected, the Registrar General cannot guarantee the information provided. For all ACTIVITY PRIOR to SEPT 2002 you must refer to the RGs Charting and Reference Maps.

Site Plan

WESTMEAD HOSPITAL

Legend

- Future Car Park Zone
- 2m Contours (LPI)
- Local Roads (LPI)
- Cadastre (LPI, 2011)

N
W E
S

1:1,500 Scale at A3

Metres

0 50 100

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2013-03-21
Coordinate System: GDA 1994 MGA Zone 56
Project: T:\GIS\Pending Projects\2013-03-20 Westmead Car Park
Map: G1001_SitePlan.mxd 01

Aerial imagery supplied by NearMap and associated third party suppliers (Nov 2012)

PLAN FORM 2 (APPROVED FORM 3)

Plan Drawing only to appear in this space

SIGNATURES, AND SEALS ONLY

SIGNED BY ME John Bedford

AS DELEGATE OF THE HEALTH ADMINISTRATION CORPORATION, PERSUANT TO SECTION 21 (1) HEALTH ADMINISTRATION ACT, 1982 AND I HEREBY CERTIFY THAT I HAVE NO NOTICE OF THE REVOCATION OF SUCH DELEGATION.

....

Department of Lands Approval

I .... in approving this plan certify (Authorised Officer) that all necessary approvals in regard to the allocation of the land shown hereon have been given

Signature ....
Date ....
File Number ....
Office ....

Subdivision Certificate

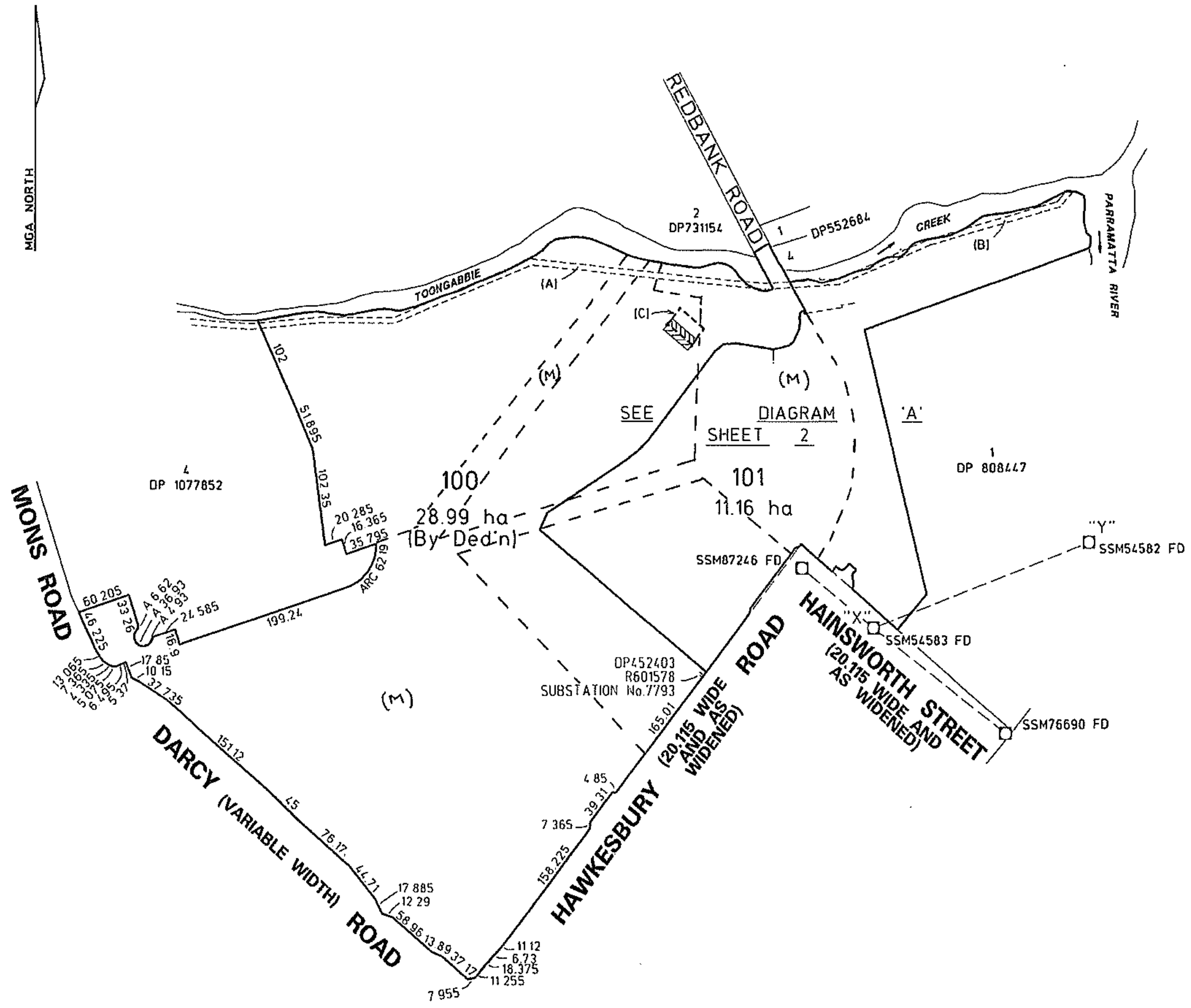
I certify that the provisions of s 109J of the Environmental Planning and Assessment Act 1979 have been satisfied in relation to the proposed SUBDIVISION set out herein
*(insert 'subdivision' or 'new road')

R. Smith
* Authorised Person/~~General Manager~~/~~Accredited Certifier~~

Consent Authority PARRAMATTA CITY COUNCIL
Date of Endorsement 27 SEPTEMBER 2007
Accreditation no ....
Subdivision Certificate no SC/101/2007
File no ....

* Delete whichever is inapplicable

(A) EASEMENT FOR SEWERAGE 6.095 WIDE G.G NO 85 OF 29-8-1958 FOL2597 & 5-9-1958 FOL 2668 (DP447721 & DP447722)
(B) EASEMENT FOR SEWER SUBMAIN 6.095 WIDE VIDE DP447722 G.G.5-9-1958 FOL2668
(C) SUBSTATION PREMISES (HVC 7741) FOR LEASE PURPOSES
(M) LAND EXCLUDES MINERALS



"X" - "Y"
SSM54583 TO SSM54582
69°39'05" 261.342 MGA GROUND DISTANCE
69°39'05" 261.335 OBS
SSM54583 TO SSM76690
126°52'32" 188.22 MGA GROUND DISTANCE
126°52'25" 188.21 OBS

SURVEYING REGULATION 2006 CLAUSES 35(1)(B) AND 61(2)

MARK	MGA CO-ORDINATES EASTING	NORTHING	ZONE	CLASS	ORDER
SSM54582	314 499.349	6 257 971.936	56	B	2
SSM54583	314 254.311	6 257 881.057	56	B	2
SSM76690	314 404.879	6 257 766.108	56	B	2
SSM87246	314 173.684	6 257 944.964	56	B	2

SOURCE MGA CO-ORDINATES ADOPTED FROM SCIMS ON 25 JULY 2006
COMBINED SCALE FACTOR = 1.000022

DP1119583

Registered 15-12-2008

Title System TORRENS

Purpose SUBDIVISION

Ref Map: U9152-33#, 34#

Last Plan DP847561, DP1016677, DP1016834, DP1077852

PLAN OF
SUBDIVISION OF LOT 1 DP847561, LOT 1 DP1016677, LOT 411 DP1016834 AND LOT 5 DP1077852

Lengths are in metres. Reduction Ratio 1: 4000

LGA: PARRAMATTA
Locality: WESTMEAD
Parish: ST JOHN
County: CUMBERLAND

This is sheet 1 of my plan in 5 sheets
(Delete if inapplicable)

Surveying Regulation, 2006

I, STEPHEN F GOLLAN of C/-NSW DEPARTMENT OF COMMERCE a surveyor registered under the Surveying Act, 2002, hereby certify that the survey represented in this plan is accurate, has been made in accordance with the Surveying Regulation, 2006 and was completed on 7 DECEMBER 2006
The survey relates to Lot 101 and 102 and connections. The remainder of Lot 100 has been compiled from DP1077852
(here specify the land actually surveyed or specify any land shown in the plan that is not the subject of the survey)

(Signature) S F Gollan Dated 7/9/2006
Surveyor registered under the Surveying Act, 2002
Datum Line "X" - "Y"
Type: Urban/Rural

Plans used in preparation of Survey/Compilation
DP847561 DP591088 R29619-1603
DP1016677 DP808447 CP2487-3000
DP1016834 DP880498
DP1077852 DP647310
DP452403 DP447721
DP45153 DP447722

PANEL FOR USE ONLY for statements of intention to dedicate public roads, to create public reserves, drainage reserves, easements, restrictions on the use of land or positive covenants

PURSUANT TO SECTION 88B OF THE CONVEYANCING ACT 1919, IT IS INTENDED TO CREATE:

1 EASEMENT FOR SERVICES (ENTIRE LOT)

OFFICE USE ONLY

S.B.55719

SURVEYOR'S REFERENCE S.B.55719 '2006M7100(222) PARTIAL SURVEY REPORT' '2007M7100(492) 5 SHEETS' MPR PERMANENT

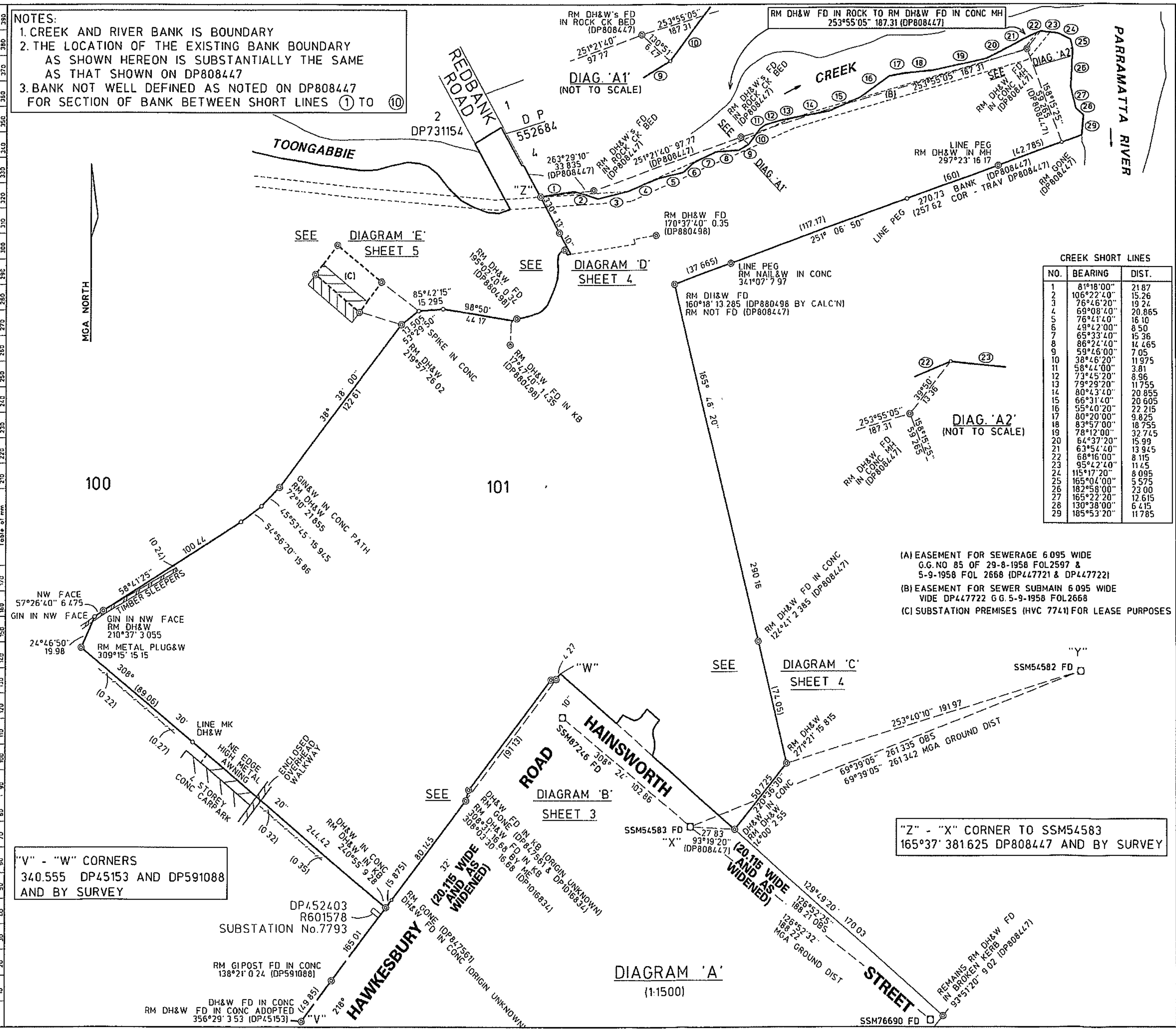
WARNING CREASING OR FOLDING WILL LEAD TO REJECTION

PLAN AMENDED IN LPI AT SURVEYORS REQUEST 14-11-07

PLAN FORM 3 (APPROVED FORM 5) To be used in conjunction with Plan Form 2

WARNING CREASING OR FOLDING WILL LEAD TO REJECTION

NOTES:
1. CREEK AND RIVER BANK IS BOUNDARY
2. THE LOCATION OF THE EXISTING BANK BOUNDARY AS SHOWN HEREON IS SUBSTANTIALLY THE SAME AS THAT SHOWN ON DP808447
3. BANK NOT WELL DEFINED AS NOTED ON DP808447 FOR SECTION OF BANK BETWEEN SHORT LINES (1) TO (10)



CREEK SHORT LINES

NO.	BEARING	DIST.
1	81°18'00"	21.87
2	106°22'40"	15.26
3	76°46'20"	19.24
4	69°08'40"	20.865
5	76°41'40"	16.10
6	49°42'00"	8.50
7	65°33'40"	15.36
8	86°24'40"	14.465
9	59°46'00"	7.05
10	38°46'20"	11.975
11	58°44'00"	3.81
12	73°45'20"	8.96
13	79°29'20"	11.755
14	80°43'40"	20.855
15	66°31'40"	20.605
16	55°40'20"	22.215
17	80°20'00"	9.825
18	83°57'00"	18.755
19	78°12'00"	32.745
20	64°37'20"	15.99
21	63°54'40"	13.945
22	68°16'00"	8.115
23	95°42'40"	11.45
24	115°17'20"	8.095
25	165°04'00"	5.575
26	182°58'00"	23.00
27	165°22'20"	12.615
28	130°38'00"	6.415
29	185°53'20"	11.785

(A) EASEMENT FOR SEWERAGE 6.095 WIDE G.G. NO 85 OF 29-8-1958 FOL2597 & 5-9-1958 FOL 2668 (DP447721 & DP447722)

(B) EASEMENT FOR SEWER SUBMAIN 6.095 WIDE VIDE DP447722 G.G. 5-9-1958 FOL2668

(C) SUBSTATION PREMISES (HVC 7741) FOR LEASE PURPOSES

DP1119583

Registered 15-12-2008

This is sheet 2 of my plan in 5 sheets dated 7 DECEMBER 2006

Surveyor registered under Surveying Act, 2002

This is sheet 2 of my plan of 5 sheets covered by subdivision certificate No SC/101/07 of 27 SEPTEMBER 2007

Authorised Person/~~General Manager/Accredited Certifier~~

For use where space is insufficient in any panel on Plan Form 2

Reduction Ratio 1:1500

Plan Drawing only to appear in this space

SURVEYOR'S REFERENCE S.B 55719

* OFFICE USE ONLY

S.B 55719