10 September 2010

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EDMONDSON PARK SOUTH PART 3A - CONCEPT PLAN

Geotechnical, Contamination and UXO - Site Suitability Assessment

REPORT

Submitted to:
Landcom
Level 2, 330 Church Street
Parramatta NSW 2150

Report Number. 107623113-004-R-Rev1

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Golder Associates

Executive Summary

Golder Associates Pty ltd (Golder) were retained by Landcom to carry out a site suitability review (Geotechnical, Contamination and unexploded ordnance (UXO)) for the proposed redevelopment of the former Ingleburn Military Base located at Campbelltown Road, Edmondson Park NSW (herein referred to as the Site) (refer to Figure 1).

The Site predominantly consists of two distinct parcels of land herein referred to as the Landcom Site (Lands owned by Landcom) and Defence Site (Lands owned by the Department of Defence) (refer to Figure 2) and is further discussed in Section 3.0.

This report has been prepared to address the Edmondson Park South Concept Plan Environmental Assessment Requirements under Part 3A of the Environmental Planning and Assessment Act 1979. Specific key assessment requirements that have been addressed within this report are presented in Section 1.1. Concept plans prepared by Landcom are presented in Appendix B.

The assessment consisted of a review of readily available information including previous investigation reports provided and a Site walkover. The results of the assessment can be summarised as follows:

LANDCOM SITE

Geotechnical

Few potential Geotechnical constraints have been identified which would impede the development of the Site. Based on the investigations carried out to date Golder considers that the Landcom Site is suitable for the proposed land use.

The primary geotechnical constraints identified within the Landcom Site is salinity and soil which will be required to be managed during the development to minimise the potential impacts (environmental and economical).

A preliminary soil and water management plan is provided in Section 9.0 with further assessment to be carried out during detailed design development. Following further assessment a detailed soil and water management plan should be prepared to manage the potential environmental and economical impacts during development.

Detailed investigations will be required for the detailed design stage to assess ground conditions and the need for specific measures to manage these constraints.

Contamination and UXO

Localised contamination, potential UXO and SAA has been identified across the Landcom Site. Areas of potential UXO have been further assessed and remediated, where considered appropriate as part of a detailed investigation (Golder 2005b). UXO Clearance certificates have been issued by a suitably qualified UXO consultant where clearance works have been undertaken.

A draft remediation action plan (RAP) and Environmental Management Plan presented in Appendix D , has been prepared to address the remediation and/or management of identified contamination and SAA. Remediation strategies presented have been reviewed and generally approved by the NSW DECC accredited Site Auditor (SA), (Environ 2005b) engaged by Landcom. A review of the recently amended RAP (Golder 2010a) to reflect the Part 3A application is currently being carried out by the SA.

A Site Audit Statement (SAS) in accordance with the Contaminated Land Management Act (CLM Act 1997) will be prepared by the SA on completion of the remediation and/or management works.

A Site Environmental Management Plan (SEMP), Appendix E has been prepared for the proposed encapsulation area within the Landcom Site and future regional park.

Based on our review of available information and in the context of the proposed development Golder considers that the Site is suitable for proposed residential, open space and commercial land uses subject to:

- The preparation of a soil and water management plan, construction environment management plan and sound engineering practices in accordance with relevant Australian Standards and LGA requirements;
- Remediation and/or management of identified Contamination/UXO in accordance with prepared RAP, EMP and provision of a SAS by a NSW DECCW accredited site auditor on completion of remedial and/or management works. The Site Audit Statement should conclude that the Site is suitable for the proposed land use and identify any conditions; and
- Ongoing management of the proposed encapsulated area and residual SAA in accordance with the SMP (Appendix E) prepared for the conservation area which will form part of the larger Regional Park.

DEFENCE LANDS

Geotechnical

The primary geotechnical constraints have been identified as salinity, soil erodibility and potential slope instability (southern area). These potential constraints do not necessarily impede the development of the Site for the proposed land uses (residential, open space and commercial), however, will be required to be managed during the development to minimise the potential impacts (environmental and economical).

A preliminary soil and water management plan is provided in Section 9.0 with further assessment to be carried out during detailed design development. Following further assessment a detailed soil and water management plan should be prepared to manage the potential environmental and economical impacts during development.

Detailed investigations will be required for the detailed design stage to assess ground conditions and the need for specific measures to manage these constraints.

Contamination and UXO

Localised contamination, potential UXO and small arms ammunition (SAA) has been identified through several environmental investigations carried out across the Defence Site.

New South Wales (NSW) accredited contaminated land Site Auditors have been engaged by Defence to review the adequacy of investigations, remediation works carried out and the provision of a Site Audit Statement (SAS) in accordance with the Contaminated Land Management Act (CLM Act 1997) on completion of remediation works.

Remediation works carried out to date have generally consisted of:

- Remediation (UXO) within former grenade ranges and miniature rifle range;
- Removal of underground storage tanks (USTs) and remediation of localised impacted material;
- Demolition and removal of former structures constructed with asbestos containing fibro cement sheeting; and
- Remediation of former chemical storage areas.

Additional investigations and remediation works are currently being carried out across the larger Defence Site.

An assessment (Noel Arnold, NA 2010) of existing structures were to be retained within the Site boundaries have identified asbestos which will need to be managed including periodic inspections. Based on our review of available information and in the context of the proposed development, Golder considers that the Site is suitable for proposed residential, open space and commercial land uses subject to:

- Implementation of a detailed soil and water management plan, construction environment management plan and sound engineering practices in accordance with relevant Australian Standards and LGA requirements Section 9.0 presents a preliminary soil and water management plan to assist within initial planning and management of salinity; and
- Remediation and/or management of identified Contamination/UXO (where warranted) in accordance with the Contamination Management Plan and provision of a SAS by a NSW DECCW accredited site auditor on completion of remedial and/or management works. The Site Audit Statement should conclude that the Site is suitable for the proposed land use and identify any conditions.

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1.0 INTRODUCTION

Golder Associates Pty ltd (Golder) were retained by Landcom to carry out a site suitability review (Geotechnical, Contamination and unexploded ordnance (UXO)) for the proposed redevelopment of the former Ingleburn Military Base located at Campbelltown Road, Edmondson Park NSW (herein referred to as the Site) (refer to Figure 1).

The Site predominantly consists of two distinct parcels of land herein referred to as the Landcom Site (Lands owned by Landcom) and Defence Site (Lands owned by the Department of Defence) (refer to Figure 2) and is further discussed in Section 3.0.

The Edmondson Park Precinct, including the site, has been the subject of broad strategic planning investigation and environmental assessment over a number of years by Liverpool and Campbelltown City Councils, the Department of Planning, the Department of Defence (the current landowner of the Ingleburn Army Base) and Landcom (owner of certain lands).

The whole of the Edmondson Park Precinct has been released for urban development by the Minister for Planning. Part of the site; the Ingleburn Army Camp, is currently the subject of a 'delayed' rezoning for urban purposes under Liverpool Local Environmental Plan 2008 and Campbelltown (Urban Area) Local Environmental Plan 2002.

In June 2010 the Minister for Planning considered a Preliminary Assessment Report for the Edmondson Park Project that provided justification for the planning, assessment and delivery of the project to occur under Part 3A of the EP&A Act, having regard to the demonstrated contribution that the project will have to achieving State and regional planning objectives.

Subsequently, on the 28 July 2010, pursuant to Clause 6 of SEPP Major Development, the Minister for Planning formed the opinion that the Edmondson Park South Project constitutes a Major Project to be assessed and determined under Part 3A of the EP&A Act, and also authorised the submission of a Concept Plan for the site. In doing so, the Minister also formed the opinion that a State significant site (SSS) study be undertaken to determine whether to list the site as a State Significant site in Schedule 3 of SEPP Major Development.

The Part 3A process under the EP&A Act allows for the Edmondson Park South Project to be planned, assessed and delivered in a holistic manner, with a uniform set of planning provisions and determination by a single consent authority.

1.1 Director General Requirements

This report has been prepared to address the Edmondson Park South Concept Plan Environmental Assessment Requirements under Part 3A of the Environmental Planning and Assessment Act 1979. Specific key assessment requirements that have been addressed within this report are summarised below in Table 1.

Table 1: Director General Requirements

Key Assessment Requirements	Detailed Description
Geotechnical and Contamination	1) *Demonstrate the suitability of the land for the proposed development including with respect to erosion potential, salinity and presence of potential and actual acid sulfate soils if any; outline measures to avoid or reduce adverse impacts. This should be carried out in accordance with relevant guidelines, such as NSW Local Government Initiatives booklets and the Western Sydney Code of Practice 2003.* 2) *Outline actions, management and mitigation measures required including protocols to address unexpected finds, and assess contamination issues associated with the proposal (if any) in accordance with SEPP 55 and other relevant legislation and guidelines.*

1.2 Scope of Services

The scope of services carried out was generally as follows:

- A Site Visit;
- A review of information (contamination and UXO) provided.
- Review of publicly available and provided information including:
  - Historic and current aerial photographs;
  - Geological, topographic, salinity, acid sulfate soils and soil maps;
  - Groundwater bore reports for the Site and general surrounds; and
  - Regulatory databases including databases maintained under the *Contaminated Land Management Act 1997* and *Protection of the Environment Operations Act 1997,* and
  - Director General's Requirements provided.
- Preparation of this Report.

2.0 PROPOSED DEVELOPMENT

Landcom is proposing to deliver a new diverse and sustainable urban community at Edmondson Park South. Once complete, Edmondson Park South will accommodate a mix of land uses, a diversity of housing, a new town centre with employment opportunities for 1,000 people, multi-purpose community and education facilities, a new 150 hectare Regional Park, a number of other local parks and environmental conservation areas. Figure 3 presents the proposed development and land uses. Figures provided by Landcom for the proposed development are provided in Appendix B.

2.1 Concept Plan

The Concept Plan establishes the overall planning framework for the site, including:

- land use type and distribution;
- a mix of housing types and densities (approximately 3,200 dwellings);
- concept location of and approximately 35,000 – 45,000 m^2 of retail / business / commercial floor space within the new Edmondson Park Town Centre;
- identification and location of open space and drainage corridors, environmental conservation lands (to form the new Regional Park), and local active and passive recreation facilities, including levels of embellishment;
- expanded Ingleburn North Primary School and new combined Primary/High School to the north of the site;
- road network layout;
- pedestrian and cycleway network layout;
- pedestrian bridge over the south western railway;
- Campbelltown Road corridor including the establishment of key intersection locations and configuration;
- utilities (including power, telecommunications and gas), infrastructure strategy, potable water strategy, sewer concept plan and water cycle management plan;
- location and dimensions of Bushfire Asset Protection Zones;
- appropriate interpretation of European and Aboriginal heritage located on the site;
- erection of signage and billboards;
- remediation works; and
- demolition.

The Concept Plan also sets out an approval framework that will enable the carrying out of the works necessary to remediate the site in accordance with a Remediation Strategy without the need for undertaking further environmental assessment.

A variety of housing types is proposed to be delivered. This will provide for a range of housing price points and will include moderate income housing and housing for seniors.

It is proposed to develop the Edmondson Park South site progressively in stages over a 15-20 year period. The Concept Plan will address the staging and delivery of the overall development having regard to the progressive delivery of necessary infrastructure, services and facilities; and market demand.

The Concept Plan is accompanied by a proposal with respect to the future developer contributions framework for the provision of local facilities and services within the Liverpool and Campbelltown LGAs as well as State Infrastructure.

2.2 Stage 1 Project Application

The residential subdivision Project Application comprises:

- the creation of 206 residential lots, 8 super lots for future subdivision 15 Environmental Living lots and 3 lots for dedication to Campbelltown City Council as Public Reserve in 5 stages*;
- the dedication of roads to Campbelltown City Council;
- On-site works comprising:
  - tree removal;
  - earthworks including excavation, cut and fill;
  - design and construction of physical infrastructure, including roads, stormwater drainage and utility reticulation, traffic management works, establishment of open space areas;
  - retaining walls as determined during detailed design;
  - design and construction of staged stormwater water quantity and quality infrastructure to achieve objectives required by the Water Cycle Management (WCM) strategy for the greater site;
  - demolition of all existing structures;
  - erosion and sediment control to areas of roadworks and bulk earthworks including provision of temporary sedimentation ponds and diversion drains;
  - Design and construction of an ornamental pond;
  - Landscaping of road reservations;
  - erection of signage and billboards; and;
  - Embellishment of open space.
- Off-site works comprising:
  - construction of the sewer lead in from the Sydney Water carrier main at Ash Road;
  - upgrade of overhead mains and construction of electrical lead-in feeders from the existing zone substation at Prestons;
  - connection to utility services, potable and recycled water, electricity, gas and telecommunications in Campbelltown and MacDonald Roads;
  - Connection to existing stormwater drainage;
  - tree removal;
  - earthworks including excavation, cut and fill;
  - design and construction of physical infrastructure, including roads, stormwater drainage and utility reticulation, traffic management works, including the connection to the existing MacDonald Road;
  - design and construction of staged stormwater water quantity and quality infrastructure to achieve objectives required by the Water Cycle Management (WCM) strategy for the greater site;

- erection of an acoustic wall;
- erection of signage and billboards;
- extension or relocation of existing services including potable and recycled water, gas, telecommunication, power;
- demolition of all existing structures; and;
- Proposed new intersection to existing Macdonald Road.

It is intended to seek staged Construction Certificates as necessary to facilitate the efficient delivery of each phase of, the development works.

The first stage residential Project Application will include the proposed construction of a gravity sewer line through the future Regional Park.

3.0 SITE IDENTIFICATION

The site is approximately 413 ha in area and is situated within Liverpool City Council and Campbelltown Council areas. The site currently comprises land owned by Landcom (88 ha), the Department of Defence (310 ha) and other government landowners (15 ha). Table 2 presents the Legal descriptions, approximate area and current ownership.

Table 2: Legal Description, Area and Ownership

Property Description	Area (ha)	Current Ownership
Landcom Land		
Pt Lot 8 in DP 1127652	23.19	Landcom
Pt Lot 8 in DP 1127652	27.99	Landcom
Pt Lot 7 in DP 1127652	21.84	Landcom
Pt Lot 7 in DP 1127652	13.58	Landcom
Lot 5 in DP1127652	2.853	Landcom
Department of Defence Land		
Lot A in DP 188121	48.25	The Commonwealth of Australia
Lot 1 in DP 1127652	3.49	Minister Administering the EP&A Act
Lot 2 in DP1127652	2.721	Minister Administering the EP&A Act
Lot 3 in DP1127652	0.455	Minister Administering the EP&A Act
Lot 4 in DP1127652	0.307	Minister Administering the EP&A Act
Lot 2 in DP831152	50.5	The Commonwealth of Australia
Lot 1 in DP831152	16.32	The Commonwealth of Australia
Lot 3 in DP831152	37.88	The Commonwealth of Australia
Lot 1 in DP 801456	5.585	The Commonwealth of Australia
Lot 65 in DP654507	5.93	The Commissioner for Main Roads
Lot 2 in DP1144667	43.37	The Commonwealth of Australia
Lot 1 in DP831150	1.84	Minister for Education, Training & Youth Affairs
Lot 1 in DP831149	5.28	The Commonwealth of Australia
Lot 1 in DP831148	20.43	The Commonwealth of Australia
Lot 3 in DP246213	81.99	The Commonwealth of Australia
Other		
Roads (various)		RTA, Campbelltown City Council, Liverpool City Council

Note: Information presented above sourced from Preliminary Environmental Assessment, dated 26 May 2010.

Current Zoning

The Site forms part of the Edmondson Park Precinct within the South West Growth Centre under State Environmental Planning policy (Sydney Region Growth Centres) 2006 (Growth Centres SEPP).

The Edmondson Park Precinct has been released for urban development. The Growth Centres SEPP establishes Liverpool Environmental Plan 2008 (LLEP 2008) and Campbelltown (Urban Area) Local Environmental Plan 2002 (CLEP 2002) as the relevant local environmental planning instruments for the land.

Under LLEP 2008 and CLEP 2002, the Site has been rezoned for a combination of urban and environmental purposes including the creation of a new 150 hectare regional park to be retained in State government ownership.

For that part of land that is currently owned by the Commonwealth, the land use zoning provisions that allow future urban development under LLEP 2008 and CLEP 2002 have been 'delayed' and will only come into effect once:

- Land currently owned by the Department of Defence is vested in the State of NSW; and
- Land that has been identified for the creation of the future regional park has been reserved under the National Parks and Wildlife Act 1974, or is held for the purpose of being so reserved.

Until such time as the 'delayed' rezoning provisions come into effect, the Defence land is zoned for Defence purposes.

Table 3 provides a summary of the relevant 'delayed land use zones. There are a range of exisiting development standards that apply to the land under the existing LEPs, including provisions relating to minimum subdivision lot sizes, maximum FSR, building height and dwelling density.

Table 3: Summary of existing land use zoning (delayed)

Liverpool LEP 2008	Campbelltown LEP 2002
■ E1 National Park and Nature Reserve; ■ RE1 Public Recreation; ■ R1 General Residential; ■ R3 High density Residential; ■ R5 Rural Residential; ■ B2 Local Centre; and ■ SP2 Infrastructure.	■ 2(c) Higher Density Residential; ■ 3(a) General Business; ■ 6(a) Local open Space; ■ 3(c) Neighbourhood Business; ■ 5 Special Uses; ■ 6(c)Private Open Space; ■ 7(d5) Environmental Protection 1ha minimum; and ■ 8(b) National Parks and Nature Reserves

Note: Information presented above sourced from Preliminary Environmental Assessment, dated 26 May 2010.

Surrounding Sites

The Site is bounded by:

- Rural/residential properties to the north;
- Rural/residential and residential properties (Ingleburn Gardens Development) to the east, beyond which is the M5 motorway;
- M5 motorway to the south, beyond which is the Ingleburn Industrial precinct; and
- Zouch Road to the west, beyond which is a mixture of rural/residential properties and church compound.

The general area comprises a mix of rural, residential, open space and commercial industrial properties.

4.0 REPORTS REVIEWED

In preparing this report Golder has reviewed various environmental and geotechnical reports which relate to the Site as a whole or either the Landcom Lands (Landcom Site) and Defence Lands (Defence Site). The reports reviewed were as follows:

Reports Which Relate to the Site as a Whole

- Report "Land Capability Assessment, Proposed Future Development, Edmondson Park Release Area, Edmondson Park " prepared by Geotechnique Pty Ltd dated October 2003 (Geotech 2003) prepared for Liverpool Council;

Reports which relate to the Landcom Site

- Report "*Stage 1 Preliminary Contamination investigation. Zouch Road Ingleburn 92 Ha Site*" prepared by Milsearch Pty Ltd dated September 2000 (Milsearch 2000) for Landcom;
- Report "*Stage 2 Munitions Contamination Investigations Zouch Road Ingleburn 92 Ha Site*" prepared by Milsearch dated 21 January to 6 April 2002 (Milsearch 2002) prepared for Landcom;
- Report "*Stage 2 Munitions Contamination Investigations Additional Investigations Zouch Road Ingleburn 92 Ha Site*" dated 2003 (Milsearch 2003);
- Intern Stage 1 – Initial Advice #1 prepared by Mr Graeme Nyland of Environ (appointed NSW DECCW Accredited Contaminated Land Site Auditor) dated February 2003 (Environ 2003a) prepared for Landcom;
- Interim Advice #2 prepared by Environ dated July 2003 (Environ 2003b);
- Report "*Sampling Analysis Quality Plan (SAQP) Detailed Site Assessment, Zouch Road Ingleburn*" prepared by Parsons Brinkerhoff dated May 2004 (PB 2004) for Landcom;
- Draft Report "Detailed *Contamination Site Investigation, Landcom Project No:12619, Zouch Road, Edmondson Park NSW*" prepared by Golder Associates Pty Ltd (Golder) reference 04623119/12 dated August 2005 (Golder 2005a);
- Report "*Detailed Contamination Site Investigation, Landcom Project No:12619, Zouch Road, Edmondson Park NSW*" prepared by Golder Associates Pty Ltd (Golder) reference 04623119/12 dated August 2005 (Golder 2005b);
- Report " *UXO Investigation Report, Zouch Road, Edmondson Park NSW*" prepared by Bactec South East Asia (Bactec) dated August 2005 (Bactec 2005) for Golder and Landcom;
- Draft Interim Advice #3 prepared by Environ dated September 2005 (Environ 2005);
- Draft Report "*Remediation Action Plan, Landcom Project No: 12619 Zouch Road, Edmondson Park NSW*" prepared by Golder reference 04623119/39 dated October 2005 (Golder 2005c);
- Draft Interim Advice #4 prepared by Environ dated October 2005 (Environ 2005b);
- Report "*Remediation Action Plan, Landcom Project No: 12619 Zouch Road, Edmondson Park NSW*" prepared by Golder reference 107623047-001-R-RevB dated August 2010 (Golder 2010a);
- Report "*Environmental Management Plan, Proposed Remediation Works, Landcom Project No: 12619 Zouch Road, Edmondson Park NSW*" prepared by Golder reference 107623047-002-R-RevB dated August 2010 (Golder 2010b);
- Report "*Site Environmental Management Plan, Conservation Zone Part lot 7 and Part lot 8 in DP1127652, Edmondson Park NSW*" prepared by Golder reference 107623047-003-R-RevB dated August 2010 (Golder 2010c).

Reports which relate to Defence Site

- Report: "*Hazardous Materials Survey Report, No1 Field Hospital Blocks M & N, Ingleburn*" prepared by Hibbs & Associates dated September 1997 (Hibbs1997) prepared for AGC Woodward Clyde Pty Ltd ;
- Report "*Preliminary Geotechnical and Contamination Review, Ingleburn Defence Site*" prepared by Dames and Moore Pty Ltd (D&M Pty Ltd), dated January 1999 (D&M 1999);
- Report "*Stage 2 Contamination Assessment, Small Arms Range, Ingleburn*" prepared by D&M Pty Ltd dated November 1999 (D&M 1999a);
- Report "*Remediation of Poisons Shed Area, Ingleburn Defence Site*" prepared by URS Australia (URS) dated 13 November 2000 (URS 2000);
- Report: "*Geophysical Survey, Maintenance Compounds & POL Stores, Ingleburn Defence Site, NSW*" prepared by Alpha Geoscience dated May 2002 (Alpha 2002);
- Report "*Validation Report for the Freeway Grenade Range, Ingleburn Defence Site*" prepared by URS dated 1 May 2003 (URS 2003a);
- Clearance Certificate: "UXO *Clearance – Throwing Bay Area, 123.1 Grenade Range, Ingleburn Defence Site, NSW*" prepared by Alpha Geoscience dated January 2003 (Alpha 2003a);
- Report "*Validation Report for the Rifle Range Precinct, Ingleburn Defence Site*" prepared by URS dated 1 May 2003 (URS 2003b);
- Report," *Validation of Suspected Grenade Range at the Zouch Road Precinct, Ingleburn Defence Site*" prepared by URS dated 8 October 2003 (URS 2003c);
- Report: "*UXO Site Survey, Ingleburn Defence Site 123.2 (Grenade Range), Zouch Road*" prepared by Alpha Geoscience dated October 2003 (Alpha 2003b);
- Report "*Investigation and Validation of Underground Storage Tanks, Ingleburn Defence Site*" prepared by URS dated 27 November 2003 (URS 2003d);
- Draft Report "*Non Statutory Site Audit, Summary Site Audit Statement, Ingleburn Defence Site, NSW*" prepared by Coffey Pty Ltd dated 18 December 2003 (Coffey 2003);
- Report "*Investigation of Maintenance Compounds and POL Stores, Ingleburn Defence Site*" prepared by URS dated 23 February 2004 (URS 2004);
- Asbestos Materials Survey Reports – *No's 5 & 22 Bass Road, 3 Bartman Road, No's 2, 16, 30 & 35 Blaxland Road, No's 5 &13 Flinders Crescent, 9 Hume Road and 5 Wentworth Road, Ingleburn* prepared by Noel Arnold & Associates March 2010 (NA 2010)

5.0 SITE CHARACTERISATION

5.1.1 Geology

The *1:100,000 Geological Series Sheet 9030, Penrith, Edition 1 (1991)*, maps both the Landcom and Defence Sites as being underlain by Bringelly Shale of the Wianamatta Group (Figure 4). The Bringelly Shale is comprised of shale, carbonaceous claystone, claystone, laminate, fine to medium grained lithic sandstone, rare coal and tuff. The Bringelly Shale is underlain by Ashfield Shale within the Wianamatta Group and subsequently Hawkesbury Sandstone. To the west and east of the site, Quaternary deposits of medium grained sand, clay and silt deposits are present.

The *1:100,000 Soil Landscape Sheet 9030, Penrith, (1991)* maps the soil landscape to be gently undulating, underlain by Wianamatta Group Shales. Soils are shallow to moderately deep (<1.0 m), hardsetting with mottled texture, generally red and brown podzolic soils occur on, crests grading to yellow on lower slopes and drainage lines.

Soil landscapes of the majority of the site belong to the Blacktown Group with the exception of along the drainage channels, which belongs to the South Creek Group. The Blacktown Group lies over gently undulating shale with local relief to 30 m and ground slopes <5°. These soils may be up to 3 m thick, moderately reactive, highly plastic and with localised poor drainage.

Landscape in the South Creek Group comprises flood plains, valley flats and drainage depressions of channels on the Cumberland plains, usually flat with incised channels. Soils in this landscape are often very deep layers of sediments over bedrock or relict soils. This landscape is subject to frequent flooding and erosion hazards.

5.1.2 Topography and Surface Drainage

Topographically, the site consists of undulating landforms comprising rolling hills formed by a series of ridges and drainage channels (creeks). Campbelltown Rd follows the central ridge as it passes through the site, in an east-west trend. To the north of Campbelltown Rd, two major drainage channels flow predominately from the south to north, and west to east, over slopes of <5°. To the south of Campbelltown Rd, one major drainage channel flows from the west to the east. The south-west corner of the site contains a more steeply sloping ground (Figure5), generally draining from north to south. Water flow and/or ponding are likely in most of the significant creeks.

There are several small dams with the majority contain water. Water ponding also occurs at some locations along the drainage depressions.

Surface water generally exits the site from the east and eventually flows into Maxwell's Creek, which flows into Cabramatta Creek and ultimately feeds into Chipping Norton Lake and the Georges River.

5.1.3 Hydrogeology

Two groundwater systems are likely to be present; viz. a deeper regional groundwater within fractured underlying rock and a shallow perched groundwater within the alluvial soils in the low lying areas.

A series of groundwater monitoring wells were installed as part of a detailed contamination investigation undertaken by Golder Associates in 2005. The wells are situated in a portion of land to the north west of the site, within the area currently owned by Landcom. Groundwater conditions encountered during the investigation indicate that groundwater within the Landcom owned site varies considerably between 2.5m to 15.0 m below existing surface level.

Information provided by the environmental consultant currently carrying out investigation works (July 2010) within the Defence lands indicated that depth of groundwater across the defence land varies between 4.0 m to 6.0 m below existing surface levels.

To gain a broader understanding of hydrogeology a search of the NSW Natural Resource Atlas Database was undertaken which identified numerous licensed groundwater monitoring wells within a 1.5km radius of the Site. The available information pertaining to these wells is summarised in Table 4 below.

Table 4: Summary of Groundwater Bores within 1.5km of Site

Well ID	Year Installed	Depth (m)	Driller's Log (m)	SWL (m)	Water Bearing Zones (m)	Salinity	Approx. Distance & Direction from Site
GW105200	2003	303.00	0.0-0.30 Topsoil 0.30-1.50 Red Clay 1.50-4.0 Weathered Shale 4.0-7.0 Brown Shale 7.0-86.0 Blue and Black Shale 86.0-298.0 Sandstone / Bands of Black Shale 298.0-303.0 Slate	13.0	15.0-15.1 140.0-140.1 233.0-233.1	2100 900 8000	600m NW
GW106942	2003	243.00	0.0-1.0 Topsoil 1.0-4.0 Clay, Red 4.0-5.0 Shale, Weathered 5.0-8.0 Shale, Brown 8.0-46.0 Shale, Blue 46.0-50.0 Shale, Grey 50.0-243.0 Sandstone	28.0	168.0-168.1	Fresh	600m SW
GW031197	1976	1.80	-	-	1.20-1.80	-	500m SSW
GW100295	1994	50.00	0.0-1.0 Soil and Clay 1.0-50.0 Sandstone	12.0	50.0-56.0	Good	400m S
GW104018	2000	215.00	0.0-8.0 Clay 8.0-14.5 Shale 14.5-66.0 White Sandstone 66.0-68.0 Shale 68.0-98.0 Grey/White Sandstone 98.0-107.0 Shale with Sandstone bands 107.0-215.0 Grey White Sandstone	6.0	19.0-20.0 29.0-30.0 172.0-173.0	-	500m SE

Limited information is provided by the bore records regarding strata/materials hosting aquifers.

5.1.4 Salinity

Urban Salinity involves the redistribution of salts, and impact these salts have on our urban environment. Salts are a natural part of the Australian landscape. Urban salinity occurs in areas where humans have changed natural ecosystems and effected the movement and storage of salts and water in the environment. Howevere, with increasing knowledge and understanding, urban salinity is being managed with appropriate planning, building techniques and materials aswell as salt tolerant vegetation.

Urban Salinity is caused by a combination of excess water and salt in an urban area, and salt sensitive land uses. The salts can breakdown materials such as concrete and prevent plants from taking up water. The key to salinity processes is that salts are soluble in water. As water gains access to buildings and infrastructure salts can be carried with it. The salts then chemically react with the building materials causing rust for example or when the water evaporates salt crystals form to physical stress on building materials.

Water from sources such as rain, leaking pipes and pools, over watering of gardens, can add to the natural water cycle and conduct salts into building materials.

Salinity has been identified as a geotechnical and environmental issue of concern at the site and may occur in soil and groundwater. The Salinity Potential in Western Sydney Map (DIPNR, 2002) indicates a moderate to high salinity potential typically along low lying areas, creeks and drainage depressions. Figure 5 presents the salinity distribution at the site, which indicates the most vulnerable areas corresponding with low lying

drainage lines identified in Section 4.2. An investigation in 2003 confirmed areas of low to high salinity (Geotechnique 2003). The results of this assessment are further discussed in Sections 6.2.1.

Surface water is non- to marginally saline, with groundwater at depths below 2.5m (especially beneath alluvium) saline to brackish. Groundwater occurs at least 5m below shale.

Salinity management is to be carried out in accordance with local governments' salinity initiative booklets, Western Sydney code of practice for salinity management further discussed in Sections 6.2.2 and 7.2.2 .

5.1.5 Acid Sulfate Soils

Acid Sulfate Soil (ASS) distribution maps presented within the Liverpool City Council Local Environmental Plan 2008 and plans prepared by CSIRO managed Australian Soil Resource Information System. This indicated that the site has a low risk of encountering actual or potential acid sulfate soil.

6.0 LANDCOM LAND

6.1 Historical Landuse and Current Status

Based on historical reviews carried out as part of various investigations the Site operated as a military establishment from 1939 to about 2000. Prior to 1939 the Site was largely occupied by rural properties.

The Landcom Site formed the northern boundary of the larger military base and was used as an infantry training area. The infantry training area included:

- a miniature rifle range within the south western area of the Landcom Site. The rifle range was reorientated in the late 1970's with surplus stop butt material (lead particulate impacted) distributed in the general area and used as fill within an access track within the north western area and south eastern area of the site;
- several grenade ranges which were located within the central and north eastern area of the Site;
- obstacle courses;
- weapons pits and small training structures (anti tank assault area, prisoner of war camp and command posts);
- waste burial pits within the central part of the Landcom Site (east of the rifle range); and
- a sports field.

Live fire exercises were unlikely to have occurred within these areas (other than the rifle range) due to the close proximity of living quarters and camp infrastructure. Blank SAA (Small Arms Ammunition, expended and/or potentially live) is strewn throughout the Site. More detailed information of the historical land uses are presented in contamination investigation reports (Golder 2005b).

A Site visit carried out by Golder in May 2010 and information supplied by Landcom indicates that the Site has largely remained unchanged since the 2005 Golder Investigation. The area is largely heavily vegetated with woodlands and open grass plains. Fire trails continue to be maintained between heavily wooded areas as part of ongoing bushfire management and maintenance of the Site. The Site is surrounded by a wire mesh fence and there were no obvious signs of illegal dumping.

6.2 Geotechnical

6.2.1 Geotechnical Conditions

Golder excavated a total 763 sampling locations (a combination of test pits, boreholes and hand auger holes) as part of its DSI (Golder 2005b). Although the investigation was primarily environmental the subsurface conditions encountered at sampling locations provides significant information pertaining to the geological conditions at the Site.

In addition to the environmental assessment by Golder a land capability study (Geotechnique 2003) in 2003 for the Liverpool City Council included a review of the available geological information and a limited intrusive investigation (of which eleven test pits were excavated within the Landcom Land) to identify potential geotechnical constraints and salinity hazards. The purpose of the Geotechnique study was to assess the site suitability for rezoning being considered by Liverpool Council.

Test pit logs provided as part of Geotechnique Assessment (Geotech 2003) and Borehole logs representing locations drilled as part of Golder 2005 investigation (Golder 2005b) are presented in Appendix C. Test pit and hand auger logs from the Golder 2005 investigation (Golder 2005b) have not been provided due to the extensive number. The logs presented are considered to provide a typical cross section of the subsurface conditions encountered at the Landcom Site.

General Subsurface Conditions

In general the soil profile at the Landcom site consisted of topsoil overlying alluvial and residual soil (composed primarily of silty and gravely clays) above the weathered siltstone / shale bedrock. The residual soils consisted primarily of red / red grey silty clays of medium to high plasticity with varying quantities of ironstone gravels.

The soil profile across the site can be summarised as follows:

- **Topsoil** - Clayey Silt / Silt, low plasticity, brown in a dry to moist condition, loose to firm with traces of fine gravel ranging in thickness between 0.05 to 0.5m;
- **Alluvial** – Silty / Clayey Silt, low plasticity, brown yellow mottled grey traces of fine to medium ironstone gravel.
- **Residual** - The residual soil encountered across the site generally consisted of Silty CLAY, medium to high plasticity in a moist condition, stiff with some fine to medium gravels.
- **FILL** - Fill was encountered at 125 locations across the site with the thickness of fill ranging between 0.1m to 3.4m. The general fill across the site consisted of Silty / Gravely CLAY low to medium plasticity brown red grey with varying quantities of gravel.

  The Fill within the rifle range area generally consisted Silty CLAY, medium to high plasticity, red grey with fine to medium ironstone gravels, with pieces of lead particulate.

  The Fill encountered within the waste disposal trenches consisted of a mixture of silty / gravely clays with areas consisting of building demolition such as concrete blocks, bricks, timber and general building waste including asbestos fibro sheeting.;
- **Bedrock** - Bedrock was encountered at depths between 0.2 to 3.2m and generally consisted of Shale, extremely weathered, extremely low strength, and grey brown.

The Alluvial profiles generally equate to the low lying areas and creek alignments. The Residual profiles are typically encountered in relatively higher ground.

Bedrock was encountered at most of the test pits excavated within the Residual Profile and a limited number of test pits excavated within the Alluvial Profile. Bedrock was typically encountered within the Residual Profile areas less than 2.0 m below existing surface level (BESL).

Groundwater Conditions

Perched groundwater is expected to occur in the various alluvial deposits, more specially near main drainage lines and dams, and is likely to flow in the direction of slope. Regional groundwater, however, is expected to be present in the cracks and fissures within the bedrock and is expected to flow to the east towards the George's River, though Cabramatta Creek may locally influence groundwater beneath the western portion of the site.

The groundwater quality from the Ashfield Shale typically indicates high salinity, where as the groundwater from the underlying Hawkesbury Sandstone typically has low salinity (1,000mg/L), where the Ashfield Shale overlies the Hawkesbury Sandstone, the groundwater in the sandstone is often decreased quality due to infiltration for the overlying shale derived waters (1:100,000 Geology Sheet).

Ten groundwater monitoring well locations were drilled during the detailed site investigation (Golder 2005a). Groundwater was encountered at depths ranging from 2.54m below ground level in BH291 to 14.6m below ground level in BH608. Groundwater within the newly installed wells was sampled from response zones within the weathered siltstone / sandstone. No odour or free product was observed during well development or sampling in any of the groundwater monitoring wells.

Current groundwater information derived from monitoring of the depth to groundwater and a survey of the levels (Table 5) suggest that the general groundwater flow at the Site is in a east to north-easterly direction.

Table 5: Groundwater Levels - Landcom Lands

Monitoring Well Location / ID	Depth of Well (m)	Standing Water Level –BSL (m)	Reduced Level (AHD) – Top of Casing (m)	Water Level – AHD (m)
BH2	8.0	4.45	50.60	46.15
BH249	8.0	Dry on Completion	ND	ND
BH291	8.0	2.54	52.96	50.42
BH521	8.0	3.1	50.83	47.73
BH558	8.0	6.8	59.99	53.19
BH608	15.6	14.6	69.00	54.40
BH614	8.0	Dry on Completion	ND	ND
BH640	15	11.8	61.50	49.70
BH650	8.0	Dry on Completion	62.23	ND
BH675	15	12.0	66.80	54.80

Field indicator parameters consisting of temperature, pH, electrical conductivity (Ec) and Total Dissolve Solids (TDS) were measured in the field using a Hanna HI98130 Instrument. The meter was calibrated at the beginning of each day using the manufactures certified calibration fluids.

The following table provides measurements of indicator parameters for the groundwater monitoring wells and trench water.

Table 6: Water Quality Parameters - Landcom Lands

Sample ID	Date	Temp (^oC)	pH	Ec (μv)	TDS (ms)	Comments
BH2	24.02.05	22.5	6.8	10,850	4.68	Slightly turbid
BH291	24.02.05	22.6	7.1	14,270	7.18	turbid
BH521	24.02.05	22.4	6.84	12,710	6.39	turbid
BH558	24.02.05	23.8	6.91	10,100	5.04	turbid
BH608	24.02.05	22.3	6.9	9,800	4.68	turbid
BH640	24.02.05	21.2	7.17	9,210	4.53	turbid
BH675	24.02.05	21.0	7.2	9,400	4.64	turbid

6.2.2 Geotechnical Constraints

The geotechnical assessment herein is provided to identify potential constraints to be managed during the conceptual design development of the Site. Specific investigations will be required for detailed design.

Preliminary Site Classification

The geological profile suggests that both the residual and alluvial profiles identified will be susceptible to shrink/swell due to moisture fluctuations. Given the thickness and types of clay, encountered and the depth to bedrock, the majority of the site would likely classify as Class “M” (moderately reactive clay and silts) or Class “H” (highly reactive clay) in accordance with Australian Standard (AS) AS2870-1996.

Areas of fill and low lying saturated alluvial areas should be considered as Class “P” (problem sites) and likely to require rehabilitation works to obtain a lower classification, alternatively foundations could be carried to rock. Subject to material type, depth of fill and filling works being carried out in accordance with AS3798 - 2007 filled sites are likely to be classified as Class “M” and Class “H”.

The preliminary classifications presented are applicable to our current assessment of conditions reported. These may change subject to the proposed development levels, excavation and filling works.

Detailed investigations will be required including laboratory analysis and assessment in accordance with AS2870-1996 prior to development.

Salinity (Soil and Water)

A review of Salinity Maps produced by DIPNR and investigations (Geotechnique 2003) carried out to date indicate that parts of the Site is varyingly impacted by saline soils and groundwater. The salinity classification of soils is presented as Figure 5.

Laboratory analysis carried out on selected soil samples indicates the following:

- Samples recovered from near surface (0.0-0.3 m BESL) were generally non saline with the exception of samples collected from the north western corner of the Landcom Site;
- Samples recovered from depths between 0.3 to 1. m were generally slightly saline to moderately saline with some areas of very saline soils in the vicinity of low lying areas/drainage depressions. Samples collected from higher elevations across the Site were generally non saline;
- Samples recovered from depths greater than 1 m were generally moderately to highly saline and corresponded typically with alluvial and low lying profiles.

Soil salinity was observed to increase with depth in both the residual and alluvial profiles. Soils in the upper 1 m soil in the Residual profile are likely to be less saline than in the Alluvial profile.

The results of limited groundwater sampling on the Landcom Site indicate that saline groundwater conditions exist within the fractured shale bedrock.

Laboratory analysis of water samples from dams indicates the water is likely to be non-saline or marginally saline, whereas groundwater at depths exceeding about 2.5m, especially in areas underlain by alluvium, is likely to be saline to brackish.

Construction and design of slabs and other structures will need to consider salinity issues which may occur due to irrigation or introduction of surface water features. These may result in a rise in the groundwater level which could introduce the more saline groundwater to shallower depth. The movement of soils and vegetation removal or disturbance can greatly influence the behaviour of salinity in soil and groundwater. A site specific soil and water management plan will be required to properly manage salinity at the site.

Slope Stability

The natural ground surface within the Landcom Site is assessed to be generally a very low risk of instability with the majority of slopes between 0^{o} to 10^{o} gradient (Figure 6).

A steeper slope (>15^{o}) has been identified within the area of the existing rifle range which is proposed to be re-engineered as part of future proposed remediation works and is not proposed to be developed.

Anticipated Excavation Conditions

It is anticipated that the majority of residential sites, roadways and structures (schools and commercial buildings) are likely to be constructed at or close to existing surface levels with cut to fill to achieve design levels. Therefore, most materials to be excavated are likely to comprise of residual and alluvial soils with some extremely weathered bedrock in places.

The envisaged excavation / earthworks should be able to be achieved using conventional earthworks equipment. Larger equipment may be required if deeper excavations (typically >2.0m depth) where shale and sandstone bedrock may be encountered. Specific investigations will be required to further assess excavation works where required.

There is a skeletal cover of topsoil across the Site. This is not considered suitable for use as structural fill, however, could be suitable for landscaping.

Residual and Alluvial soils excavated as part of development works should be suitable for reuse as engineered fill subject to moisture conditioning and the absence of deleterious material and organic matter. Fill placement should be carried out in a controlled manner in accordance with AS3798-2007 and Council engineering standards. Quality assurance testing should be carried out in accordance with AS1289 test methods and by a suitably qualified geotechnical testing authority (GTA).

Seepage within excavations where encountered, is anticipated to be managed through conventional sump and pump systems. Increase seepage rates may be encountered within low lying areas and should be further assessed through specific investigations.

Deep excavations (>2.0 m) associated with the installation of utilities such as sewerage should be the subject to specific investigations to assess stability of excavations and recommendations for appropriate retention/shoring/benching and backfill requirements.

Soil Erodibility

A review of a previous assessment carried out including laboratory analysis indicated that the majority of samples collected to depths up to 1.0 m BESL are considered to be dispersive or potentially dispersive. Residual soils are generally more dispersive than alluvial soils.

Geotechnique (2003) concluded that "*portions of both residual and alluvial soils within the Site are dispersive or potentially dispersive and therefore susceptible to erosion. However, there may be localised non-*

dispersive soils within the Site and recommended that a detailed investigation be carried out to delineate the boundaries between dispersive and non-dispersive soils". Golder concurs with this conclusion.

Soil Aggressivity

A review of laboratory analysis carried out on selected soil and limited groundwater samples in accordance with AS2159-1995 indicate that the site conditions are generally non-aggressive to mildly aggressive towards concrete structures and mildly to moderately aggressive to iron and steel.

6.2.3 Management of Potential Geotechnical Constraints

The primary potential geotechnical constraints to the development of the Site have been identified as:

- Salinity; and
- Soil erodibility/dispersion.

The above potential constraints do not impede the development of the Site for the proposed land uses (residential, open space and commercial), however, will be required to be managed during the development to minimise the potential impacts (environmental and economical).

A soil and water management plan should be prepared for the proposed development. The soil and water management plan is required to document proposed management strategies to be implemented specific to but not limited to salinity, soil erosion and surface water management during and post construction. The key objects of the soil and water management plan should be to:

- minimise erosion and sediment loss before, during and after construction;
- minimise water pollution due to erosion, siltation and sedimentation;
- maximise re-use of onsite materials; and
- manage salinity within areas to minimise impacts on future building projects and vegetation.

Urban design should utilise existing topography where possible to minimise cut to fill. All earthworks should be carried out in accordance with AS 3798, Landcom and LGA engineering standards, including uncontrolled fill areas which should be assessed and reworked as required.

During the detailed design stage, slope stability should be assessed for individual areas and proposed cut and fill, according to the 'Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning' by the Australian Geomechanics Society (Geomechanics, Vol 42, No.1, 2007).Detailed investigations should be part of this detailed design stage to formulate site specific geotechnical models and obtain specific design inputs and considerations.

6.3 Contamination

As detailed in Section 0 there have been significant investigations carried out at the Landcom Site. The Golder investigation (Golder 2005b) included the excavation of more than 750 test pits/hand auger holes and drilling of 12 boreholes with selected locations converted into groundwater monitoring locations and laboratory analysis program.

The investigation (Golder 2005b) also included remediation of potential UXO and SAA within the former grenade range areas and further assessment of UXO & SAA across the remaining areas of the Landcom Site by a suitably qualified UXO consultant. The results are presented in Golder 2005b report and further discussed in Section 6.4.

Based on the results of the DSI (Golder 2005b) and previous investigations localised areas of environmental concern (Figure 2) were identified which required remediation to render the Site Suitable for the proposed residential, open space and commercial land uses. Typically, contamination is associated with former rifle

range (lead particulate), building construction materials (asbestos) surface distributed and buried within waste burial pits, and hydrocarbon impacted fill material.

A Remediation Action Plan (RAP) was prepared in 2005 (Golder 2005c) and reviewed by the NSW DECCW accredited Contaminated Land Site Auditor engaged by Landcom. Subsequently the RAP has been modified (Golder 2010a, Appendix D) to reflect the current staging of the proposed development, a concept design for the proposed re-engineered lead particulate impacted material and asbestos burial area. In addition to the RAP Golder has prepared a environmental management plan (EMP, Golder 2010b) for the proposed remediation works which is included with the RAP . The amended RAP and EMP are currently being reviewed by the Site Auditor.

The remediation areas are shown on Figure 7. The previously Site Auditor approved remediation strategies (Environ 2005b) to be implemented are generally as follows:

- **Lead Particulate Material (Rifle Range Area and Access Tracks)**: The lead particulate impacted soils (approximately 40,000m^3) will be excavated and relocated to the former rifle range area where it will be re-engineered and capped with suitable material;
- **Surface distributed asbestos containing materials (ACM)**: ACM (fragmented fibro sheeting), impacted surface soils in the vicinity of the former rifle range and other areas of the Landcom Site will be excavated and stockpiled prior to placement within a designated area located within the proposed re-engineered landform (former rifle range area). The remediated surface level validated in accordance with the RAP. Remediation works will be carried out by a suitable qualified NSW WorkCover, AS A licensed contractor and the area validated by a suitably qualified occupational hygienist in accordance with relevant NSW WorkCover and NSW DECCW guidelines;
- **Waste Burial Pits (ACM):** ACM and other waste material (timber, general waste and steel) will excavated from the identified waster burial pits, segregated, recycled where appropriate and ACM impacted material placed within a designated area excavated within the re-engineered landform (former rifle range); and
- **Hydrocarbon Impacted Fill Material**: Approximately 200m^3 of hydrocarbon impacted fill material identified on the central part of the Landcom Site will be excavated, stockpiled, further characterised and disposed off site to an appropriately licensed General Solid Waste Landfill.

A Site Management Plan (Appendix E) to be approved by the NSW DECCW Accredited Site Auditor and relevant stakeholders will be implemented to manage the ongoing residual risks to human health and the environment which is considered to be low after initial remediation works are completed.

Table 7 provides a summary of specific issues on site, the contaminants identified, the remedial status of each issue, and the remedial actions required (if any).

Table 7: Status of Contamination - Landcom Site

Area/Issue Affected	Contaminant of Concern	Current Status	Action Required
Rifle range stop butts access roads where engineered stop butt material has been placed	SAA and lead	Remediation works proposed to be carried out in accordance with RAP (Golder 2010a)	Encapsulation of lead particulate material, provision of a Site Audit Statement (SAS) and implementation of Site Management Plan (SMP)
Waste burial trenches, and localised areas of asbestos containing materials	Asbestos	Remediation works proposed to be carried out in accordance	Encapsulation of asbestos building materials within engineered lead particulate material, provision of SAS and implementation of SMP

Area/Issue Affected	Contaminant of Concern	Current Status	Action Required
		with RAP (Golder 2010a).	
Hydrocarbon Impacted Area – east of burial trenches	Hydrocarbons	Remediation works proposed to be carried out in accordance with RAP (Golder 2010a)	Excavation and disposal offsite at approved landfill facility. Validation after removal and provision of SAS

6.3.1 Site Suitability and Management of Contamination

Landcom have taken a proactive approach to the identification and management of potential contamination. Investigations have been conducted across the Site which has involved the engagement of an independent NSW DECCW accredited Site Auditor to review investigation reports, remedial strategies, remediation action plans (RAPs) and validation reports where remediation works have been completed.

Based on the investigations carried out, proposed remediation works and interim Site Auditor Advice, it is considered that the Site can be made suitable for the proposed land uses subject to the following.

- Implementation of RAP(Golder 2010a) and Environmental Management Plan (Golder 2010b), (Appendix D)
- Provision of Site Audit Statement (SAS) by the appointed NSW DECCW Accredited Contaminated Land Site Auditor and in accordance NSW EPA Site Auditor Guidelines with respect to the Site suitability for the proposed development; and
- Implementation of the Site Management Plan (Golder 2010c) presented in Appendix E required to manage residual risks associated with the encapsulated area.

Unexpected Finds

There is the potential that even after the remediation of identified contamination for unidentified areas to be encountered during development. As such appropriate protocols are included within the RAP (Golder 2005c) and should be further developed and documented within construction environment management plans (CEMPs) to be prepared by the contractor.

Furthermore, contamination identified during development will be managed in accordance with the Contamination Management Plan presented in Appendix F and NSW DECCW Guidelines and a Site Audit Statement obtained from an NSW DECCW accredited Site Auditor.

6.4 Unexploded Ordnance (UXO)

Investigations and assessment of potential UXO carried out within the Landcom Site have included a review historical information (Milsearch 2000), site surveys (Milsearch 2002 and Milsearch 2003) and clearance of potential UXO within former grenade ranges (Golder 2005b and Bactec 2005).

Initial investigations carried out by Milsearch (Milsearch 2000 and Milsearch 2002) confirmed the extent of former grenade ranges, historical and existing rifle ranges and infantry training areas (weapons pits, command posts, prisoner of war camp and anti tank training areas). In addition to confirming the previous military training activities Milsearch identified the presence of waste burial pits within the central part of the Site. Key site features are shown on Figure 2.

Military items of interest identified during initial investigations included fragmented grenade casings and base plates, 3.5inch (81mm) practice mortars, fragments of rocket propelled grenades (predominately within the

former grenade ranges). Small arms ammunition (SAA), predominately spent blank SAA and some live blank SAA was identified across the majority of the Landcom Site; generally concentrated within infantry training areas and weapons pits.

Subsequently remediation of the former grenade ranges (Figure 2) was included during the detailed site investigation works carried out in 2005. Remediation works included a 100% shallow search by the defence approved UXO consultant Bactec South East Asia (Bactec) using metal detectors. Following the search and remediation of these areas a report was prepared and clearance certificate issued (Bactec 2005).

The detailed site investigation (Golder 2005a) also included further assessment of potential UXO/SAA at sampling locations and general sweep between locations. Subsequently eleven 81mm practice mortars were identified north of the existing rifle range and an inert anti tank mine (training mine) was located in an area north of the identified mortars. All items identified were removed from the site by the Australian Army. A 100% search similar to the former grenade ranges was carried out and clearance issued (Bactec 2005).

6.4.1 Management of Potential UXO and SAA

Based on the results of the DSI and UXO remediation works carried out and interim advice from the Site Auditor (Environ 2005a), Golder and the Site Auditor considered that the Site could be made suitable for the proposed development (residential and open space) subject to the implementation of further remediation works (Golder 2010a) and implementation of a site management plan (Conservation Zone, Regional Park, Golder 2010c). Table 8 summarises the status of UXO/SAA at the Site including remedial works carried out to date and proposed to be carried out remedial works to be carried out as part of the redevelopment of the Site.

Table 8: Status of UXO/SAA - Landcom Site

Area/Issue Affected	Current Status	Action Required
Grenade Ranges	Remediation works completed	None, remediation works and clearance certificate issued as part of DSI (Golder 2005b)
Rifle range and Roadway where engineered stop butt material was placed	Remediation works proposed to be carried out.	Remediation to be carried out in accordance with RAP (Golder 2010a) and implementation of Site Management Plan (SMP) followed by the provision of Site Audit Statement (SAS).
Military remnants - Entire Site, especially near slit trenches	Remediation works proposed to be carried out	Removal of all military remnants in accordance with RAP (Golder 2010a) and provision of SAS on completion.
Infantry Training Areas – Entire Site	Remediation and/or management to be carried out prior to development.	In accordance with approved (Environ 2005b) remedial strategies presented within Golder RAPs (Golder 2005c and Golder 2010a), removal of SAA from residential and commercial development areas. Removal of observed SAA and implementation of SMP within Regional Park. A complete search is not proposed within the regional park as this would require reduction of sensitive vegetation (woodlands) Provision of SAS on completion of remedial/management works.

Unexpected Finds

There is the potential that even after the remediation of identified UXO and SAA for unidentified areas to be encountered during development. As such appropriate protocols should be developed and documented within construction environment management plans (CEMPs) prepared by the contractor.

Protocols and procedures, management and reporting requirements where unexpected UXO and SAA are identified are presented in the Contamination Management Plan presented in Appendix F.

Where UXO or live SAA is identified, the NSW DECCW should be notified immediately. The area should be delineated and appropriate signage established. A UXO consultant and accredited by the Department of Defence should assess the find, make safe or organise appropriate personnel to make safe and removal of finds to an appropriate disposal facility.

7.0 DEPARTMENT OF DEFENCE LAND

7.1 Historical land Use and Current Status

Based on historical reviews carried out as part of various investigations the Site operated as a military establishment from 1939 to about 2000. Prior to 1939 the Site was largely occupied by rural properties.

During its operation as a military base the Site was primarily used as an infantry training camp including accommodation areas (barracks and officer living quarters), transport operations (logistics and maintenance), hospital, fitness training (sports fields), rifle ranges, grenade ranges, infantry training areas (weapons pits, obstacles etc) and a sewerage treatment plant.

Infantry training areas were located on the boundaries of the camp within the north and north western parts and south to south eastern part of the Site. Live fire exercises (other than rifle and grenade ranges) were unlikely to have occurred within these areas due to the close proximity of living quarters and camp infrastructure. Blank SAA (expended and live) is strewn throughout the infantry training areas. More detailed information of the historical land uses are presented in contamination investigation reports detailed in Section 0.

A Site visit carried out by Golder and its UXO consultant in July 2010 identified that the majority of former buildings and structures have largely been removed or are in the process of being removed (including asbestos containing building materials). A small number of former living quarters (officer and non commissioned officer) continue to be occupied by tenants.

An environmental consultant and remediation contractor engaged by Defence are currently carrying out further investigations and remediation works within the Defence lands. Remediation and validation works include removal of asbestos containing materials (building material waste) and other contaminated material off site prior to the issuing of a Site Audit Statement (SAS) by an independent NSW DECCW accredited Site Auditor prior to development.

A selection of military structures has been retained within an area (historical precinct) established by the Department of Defence fronting Campbelltown Road. These structures are a representation of the types of structures formerly on the site and will act as a historical representation of the military origins including a selection of equipment, documents and photographs. Building materials used in the construction of these structures and other buildings (cottages) currently across the Site contain asbestos which will require ongoing management.

A sewerage treatment plant (STP) and associated infrastructure was observed within the eastern part of Site and is understood is scheduled to be decommissioned. Assessments currently being carried out will document any contamination and remediation works required prior to the issuing of a SAS by an independent NSW DECCW accredited Site Auditor prior to development. Further discussions with respect to the STP is presented in Section 7.3.1.

7.2 Geotechnical

7.2.1 Geotechnical Conditions

A total of thirty eight (38) test pits and four (4) boreholes (BH) have been excavated as part of geotechnical investigations carried out within the Defence Site boundary. An initial geotechnical review was carried out in 1999 (D&M 1999) for Defence to assess the potential for the site to be redeveloped for residential landuse.

A land capability study (Geotechnique 2003) for Liverpool City Council included a review of the available geological information and a limited intrusive investigation to identify potential geotechnical constraints and salinity hazards to assess the site suitability for rezoning being considered by Liverpool Council.

General Subsurface Conditions

Based on investigations carried out the Defence Site is underlain by two distinct types of sub-surface soil profiles identified as the Residual Profile and the Alluvial Profile. Fill was also encountered at selected

locations. Copies of geotechnical logs prepared by Dames & Moore and Geotechnique are presented in Appendix C.

The Alluvial profiles generally equate to the low lying areas and creek alignments. The Residual profiles are typically encountered in relatively higher ground.

Bedrock was encountered at most of the test pits excavated within the Residual Profile and a limited number of test pits excavated within the Alluvial Profile. Bedrock was typically encountered within the Residual Profile areas less than 2.0 m below existing surface level (BESL).

The soil profile is based on limited test pit information can be generalised as follows:

Alluvial Profile

- Topsoil typically between 0.0 to 0.3m BESL;
- Alluvial soils at depths ranging between 0.3 to 1m BESL;
- Residual Soils between 1 m to greater than 6 m BESL; and
- Bedrock encountered at some locations from 1.5 m to greater than 6 m BESL.

Residual Profile

- Topsoil typically between 0.0 to 0.1 m below existing surface levels (BESL);
- Residual Soils between 0.1 to 2 m BESL; and
- Bedrock encountered at some locations at 1 m to 2 m BESL.

Fill was encountered at a relatively few locations where it ranged in depth from 0.5 to 1.5 m and was generally associated with fill platforms for structures and sports fields. Deeper areas of fill may be encountered across the site typically associated with burial pits and raised building platforms.

Materials as described by Geotechnique (2003) are as follows:

Fill	Gravelly Clay, coal wash, topsoil with some deleterious material (timber, brick and fibro in some places), poorly to moderately compacted.
Topsoil	Clayey Silt, Silty Clay low plasticity, brown dry to moist.
Alluvial Soils	Clay, Silty Clay, Gravelly Clay, Clayey Silt, medium to high plasticity, mottled grey orange brown, red brown, varying moisture content ranging from lower to higher than plastic limit, generally very stiff to hard with ironstone gravels in places.
Residual Soils	Clay, Silty Clay, Sandy Clay, Gravelly Clay, Shaley Clay generally medium to high plasticity, grey dark grey, brown, red, orange with moisture content typically lower than plastic limit with gravels in places
Bedrock	Shale, grey to dark grey, extremely to distinctly weathered, extremely low to low strength, indurated in places; and Sandstone, fine to medium grained, orange pale brown, extremely weathered, extremely low to low strength in places.

Groundwater Conditions

Four groundwater monitoring locations (BH1 to BH4) as shown on Figure 4, were drilled as part of the D&M 1999 Investigation to assess groundwater levels across the Defence Lands. Boreholes were extended to depths ranging between 9 m (BH1) to 21.5m (BH4).

Standing groundwater levels measured within the monitoring locations are presented in Table 9 below:

Table 9: Groundwater Level - Defence Lands

Monitoring Location	Depth to Water (m)
BH1	Dry
BH2	5.13
BH3	8.51
BH4	6.72

Golder understands that additional investigations works across the defence site currently being undertaken indicates groundwater levels at depths ranging between 4 m to 6 m.

Based on limited available information it appears that two groundwater systems are likely to be present; viz. a deeper regional groundwater within fractured underlying rock and a shallow perched groundwater within the alluvial soils in the low lying areas.

7.2.2 Geotechnical Constraints

The geotechnical assessment herein is provided to identify potential constraints to be managed during the conceptual design development of the Site. Specific investigations will be required for detailed design.

Preliminary Site Classification

The geological profile suggests that both the residual and alluvial profiles identified will be susceptible to shrink/swell due to moisture fluctuations. Given the thickness and types of clay, encountered and the depth to bedrock, the majority of the site would likely classify as Class “M” (moderately reactive clay and silts) or Class “H” (highly reactive clay) in accordance with Australian Standard (AS) AS2870-1996.

Areas of fill and low lying saturated alluvial areas should be considered as Class “P” (problem sites) and likely to require rehabilitation works to obtain a lower classification, alternatively foundations could be carried to rock. Subject to material type, depth of fill and filling works being carried out in accordance with AS3798 - 2007 filled sites are likely to be classified as Class “M” and Class “H”.

The preliminary classifications presented are applicable to our current assessment of conditions reported. These may change subject to the proposed development levels, excavation and filling works.

Detailed investigations will be required including laboratory analysis and assessment in accordance with AS2870-1996 prior to development.

Salinity (Soil and Water)

A review of Salinity Maps produced by DIPNR and investigations (Geotechnique 2003) carried out to date indicate that parts of the Site is varyingly impacted by saline soils and groundwater. The salinity classification of soils is presented as Figure 5.

Laboratory analysis carried out on selected soil samples indicates the following:

- Samples recovered from near surface (0.0-0.3 m BESL) were generally non saline with the exception of samples collected from the north western corner of the Landcom Site;
- Samples recovered from depths between 0.3 to 1 m were generally slightly saline to moderately saline with some areas of very saline soils in the vicinity of low lying areas/drainage depressions. Samples collected from higher elevations across the Site were generally non saline;

- Samples recovered from depths greater than 1 m were generally moderately to highly saline and corresponded typically with alluvial and low lying profiles.

Soil salinity was observed to increase with depth in both the residual and alluvial profiles. Soils in the upper 1 m soil in the Residual profile are likely to be less saline than in the Alluvial profile.

The results of limited groundwater sampling on the Landcom Site indicate that saline groundwater conditions exist within the shale bedrock.

Laboratory analysis of water samples from dams indicates the water is likely to be non-saline or marginally saline, whereas groundwater at depths exceeding about 2.5m, especially in areas underlain by alluvium, is likely to be saline to brackish.

Construction and design of slabs and other structures will need to consider salinity issues which may occur due to irrigation or introduction of surface water features. These may result in a rise in the groundwater level which could introduce the more saline groundwater to shallower depth. The movement of soils and vegetation removal or disturbance can greatly influence the behaviour of salinity in soil and groundwater. A site specific soil and water management plan will be required to properly manage salinity at the site.

Slope Stability

The natural ground surface within the Site is assessed to be generally a very low risk of instability with the majority of slopes between 0^{o} to 10^{o} gradient.

Steeper slopes exist within the southern part of Site. Test pits (Geotechnique 2003) indicate shallow rock (0.7 to 1.7 m depth) in this steeper area. Soil slope instability is likely to be a low risk, given the shallow cover of soil over rock and where slope angles are less than 15°.

Anticipated Excavation Conditions

It is anticipated that the majority of residential sites, roadways and structures (schools and commercial buildings) are likely to be constructed at or close to existing surface levels with cut to fill to achieve design levels. Therefore, most materials to be excavated are likely to comprise of residual and alluvial soils with some extremely weathered bedrock in places.

The envisaged excavation / earthworks should be able to be achieved using conventional earthworks equipment. Larger equipment may be required if deeper excavations (typically >2.0m depth) where shale and sandstone bedrock may be encountered. Specific investigations will be required to further assess excavation works where required.

There is a skeletal cover of topsoil across the Site. This is not considered suitable for use as structural fill, however, could be suitable for landscaping.

Residual and Alluvial soils excavated as part of development works should be suitable for reuse as engineered fill subject to moisture conditioning and the absence of deleterious material and organic matter. Fill placement should be carried out in a controlled manner in accordance with AS3798-2007 and Council engineering standards. Quality assurance testing should be carried out in accordance with AS1289 test methods and by a suitably qualified geotechnical testing authority (GTA).

Seepage within excavations where encountered, is anticipated to be managed through conventional sump and pump systems. Increase seepage rates may be encountered within low lying areas and should be further assessed through specific investigations.

Deep excavations (>2.0 m) associated with the installation of utilities such as sewerage should be the subject to specific investigations to assess stability of excavations and recommendations for appropriate retention/shoring/benching and backfill requirements.

Soil Erodibility

A review of a previous assessment carried out including laboratory analysis indicated that the majority of samples collected to depths up to 1.0 m BESL are considered to be dispersive or potentially dispersive. Residual soils are generally more dispersive than alluvial soils.

Geotechnique (2003) concluded that "*portions of both residual and alluvial soils within the Site are dispersive or potentially dispersive and therefore susceptible to erosion. However, there may be localised non-dispersive soils within the Site and recommended that a detailed investigation be carried out to delineate the boundaries between dispersive and non-dispersive soils".* Golder concurs with this conclusion.

Soil Aggressivity

A review of laboratory analysis carried out on selected soil and limited groundwater samples in accordance with AS2159-1995 indicate that the site conditions are generally non-aggressive to mildly aggressive towards concrete structures and mildly to moderately aggressive to iron and steel.

Management of Potential Geotechnical Constraints

The primary potential geotechnical constraints to the development of the Site have been identified as:

- Salinity;
- Soil erodibility/dispersion; and
- Slope Stability (Southern Area of the Site).

The above potential constraints do not impede the development of the Site for the proposed land uses (residential, open space and commercial), however, will be required to be managed during the development to minimise the potential impacts (environmental and economical).

A soil and water management plan should be prepared for the proposed development. The soil and water management plan is required to document proposed management strategies to be implemented specific to but not limited to salinity, soil erosion and surface water management during and post construction. The key objects of the soil and water management plan should be to:

- minimise erosion and sediment loss before, during and after construction;
- minimise water pollution due to erosion, siltation and sedimentation;
- maximise re-use of onsite materials; and
- manage salinity within areas to minimise impacts on future building projects and vegetation.

Where water features are proposed consideration should be given to lining of such features to minimise water infiltration and potential impacts to identified salinity.

Urban design should utilise existing topography where possible to minimise cut to fill. All earthworks should be carried out in accordance with AS 3798, Landcom and LGA engineering standards, including uncontrolled fill areas which should be assessed and reworked as required.

During the detailed design stage, slope stability should be assessed for individual areas and proposed cut and fill, according to the 'Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning' by the Australian Geomechanics Society (Geomechanics, Vol 42, No.1, 2007).Detailed investigations should be part of this detailed design stage to formulate site specific geotechnical models and obtain specific design inputs and considerations.

7.3 Contamination

Numerous investigations have been carried out within the Defence land, which have identified localised areas of contamination (Figure 7). A list of investigation and validation reports reviewed as part of this assessment is presented in Section 4.0.

A preliminary investigation (D&M 1999) identified activities and areas of environmental concern (as shown on Figure 2) which required investigation to confirm the status of contamination. Typically, contamination was identified to be potentially associated with former infantry training areas (grenade ranges, rifle ranges, SAA), underground storage tanks (USTs), petroleum oil and liquid (POL) stores, building construction materials (asbestos), storage of pesticides and waste burial pits.

Subsequently the areas identified were progressively investigated and/or remediated between 2000 and 2003. Table 10 provides a summary of identified areas of concern specific issues on site, the expected contaminants, the remedial status of each issue, and the remedial actions required (if any).

Table 10: Status of Contamination – Defence Site

Areas of Environmental Concern/Issue Affected	Identified/Potential Contaminant of Concern	Current Status	Action Required
Grenade Ranges (Freeway Range and Suspected Zouch Road Range)	UXO, grenade explosive residues, lead and SAA	Investigation works and Remediation works completed (URS 2003a and Alpha 2003a and alpha 2003b)	Finalisation of Draft Site Audit statement (SAS)
Small Arms Range	SAA and metals	Investigation works and Remediation works completed (URS 2003b)	Finalisation of Draft Site Audit statement (SAS)
Underground storage tanks (USTs)	Petroleum hydrocarbons, BTEX and metals	Investigation and remediation works completed (Alpha 2002 and URS 2003c)	Finalisation of Draft Site Audit statement (SAS)
Maintenance Compounds and Petroleum, Oil and Liquid (POL) stores	Hydrocarbons, metals, BTEX	Remediation works largely completed or In progress	Finalisation of Draft Site Audit statement (SAS)
Chemical Storage Area (Poison Shed)	Pesticides and herbicides	Remediation works in progress	Finalisation of Draft Site Audit statement (SAS)
Transformers & Switchgear	Petroleum hydrocarbons and PCBs	Investigation and Remediation works in progress	Will be subject of a Validation report and Def SAS
Suspected and unidentified buried waste, Filled Areas	Metals, pesticides, herbicides, asbestos	Further assessment and remediation works in progress	Will be subject of a Validation report, and Def SAS
Former Buildings and associated infrastructure	Metals, pesticides, herbicides, asbestos, PCBs	Demolition of selected structures and Remediation works in progress	Will be subject of a Validation report, and Def SAS
Sewerage Treatment Plant	Mercury, bio hazards, organic waste	Investigations currently in progress	STP to be decommissioned by Landcom, refer to additional information below.

A NSW DECCW accredited Site Auditor was engaged by Defence in 2003 to carry out a non statutory site audit of the Defence Lands. The draft summary site audit report (Coffey 2003) issued by the site auditor included a review of the investigation and remediation works carried out up to the time of the SAS.

Based on the available information the Auditor generally concluded that the investigated and remediated areas were "*considered suitable for residential land use with gardens and accessible soils (home grown produce contributing to less than 10% fruit and vegetable intake, no poultry*)".

The Site Auditor noted that additional works will be required in other areas of the site as part of ongoing investigation, remediation (where warranted) and validation works at the Ingleburn Defence Site.

We understand that selected reports referenced herein including the Draft Summary SAS were used in the 'delayed' rezoning determination by Liverpool and Campbelltown Council and their assessment that the Site suitability for the proposed land use.

7.3.1 Site Suitability and Management of Contamination

Defence has taken a proactive approach to the identification and management of potential contamination. Investigations have been conducted across the Site and has involved the engagement of independent NSW DECCW accredited Site Auditors to review investigation reports, remedial strategies, remediation action plans (RAPs) and validation reports where remediation works have been completed.

Based on the information provided Golder considers that Defence Site can be made suitable for the proposed development. Further investigation works are ongoing with contamination continuing to be managed through:

- Ongoing investigations (where required) in accordance with relevant NSW EPA/DECCW Guidelines including but not limited to the NSW EPA Site Auditor Guidelines;
- Preparation and implementation of additional RAPs (where required) developed for localised impacted areas identified through current investigations;
- Preparation of validation reports and UXO clearance certificates and/or assessments (where appropriate); and
- Provision of Site Audit Statement (SAS) by a NSW DECCW Accredited Contaminated Land Site Auditor and in accordance NSW EPA Site Auditor Guidelines with respect to the Site suitability for the proposed development.

Sewerage Treatment Plant

A sewerage treatment plant (STP) located within the eastern area of the Defence Site, is currently understood to be the subject of an environmental investigation by Defence. As part of the proposed redevelopment of the Defence Site the STP will be decommissioned (by Landcom) and the area currently occupied by the STP incorporated into the proposed regional park.

The results of the current environmental investigation are not known, however Golders' experience with similar sites is that they have been successfully decommissioned and redeveloped for similar proposed land uses. Our experience is that contamination on this type of infrastructure site is generally associated with heavy metal contamination (mercury) within the areas of settling tanks, potential hydrocarbons associated with plant used on the site and biosolids.

Remediation works are likely to include the excavation and removal off site as appropriate or excavation and encapsulation including ongoing site management (if required) and/or on site remediation (eg. land farming of hydrocarbons if appropriate).

A NSW DECCW accredited Site Auditor will be engaged by Landcom to review investigation reports and the proposed remedial strategies to be implemented. On completion investigation and remediation works (where warranted) a Site Audit Statement (SAS) will be prepared prior to development.

Unexpected Finds

There is the potential that after the remediation of any identified contamination, for unidentified areas to be encountered during development. Appropriate protocols should also be developed and documented within construction environment management plans (CEMPs) prepared by the contractor.

Protocols including procedures, management and reporting requirements where unexpected contamination are identified are presented in the Contamination Management Plan presented in Appendix F.

Furthermore contamination identified during development should also be managed in accordance with NSW DECCW Guidelines and a Site Audit Statement obtained from an NSW DECCW accredited Site Auditor.

7.4 Unexploded Ordnance (UXO)

UXO investigation and clearance works have been carried out at selected locations (Figure 2) identified across the Ingleburn Defence Site. The identified areas (D&M 1999) which could have potential UXO were identified as follows:

- Freeway Grenade Range, located within the southern part of the Defence Land and adjacent to southern boundary shared with the existing M5 Freeway;
- Rifle Range Precinct, located within the southern part of the Defence Site and south of the Freeway rifle Range; and
- Suspected Grenade Range, located within the infantry training area Zouch Road.

The identified areas have been the subject of UXO surveys and clearance as part of investigation and remediation works carried out by Defence.

Clearance works carried out have involved a 100% search within higher risk areas (grenade throwing bay, rifle range stop butt and grenade impact zones) using metal detectors, investigation of targets identified and removal of potential UXO, remnants of exploded ordnance and SAA.

Survey works have been carried out in adjoining areas to assess UXO potential. Surveys included a 10% geophysical search along 1.0m transects.

Items identified during clearance and survey works have included a live grenade, discharged SAA, grenade fragments, inert 81mmm mortar which was removed by Defence personnel. Disused military rifles were also identified buried within the area of the Freeway Grenade Range which were disposed off site after being crushed onsite.

Table 11 provides a, the remedial status of each issue, and the remedial actions required (if any).

Table 11: Status of UXO – Defence Lands

Area (Issue Affected)	Current Status	Action Required
Grenade Ranges (Freeway and Suspected Zouch Road Ranges) – UXO and SAA	100% Search completed within area of former throwing bay and 10% search of adjoining area. Clearance certificate issued (Alpha 2003a and Alpha 2003b)	None, Area considered to be clear of ordnance as defined by Clearance certificate (Alpha 2000 and 2003).
Rifle Range - SAA	Area remediated (URS 2003b) impacted soils immobilised and removed off site.	None, Area considered to be remediated (URS 2003b) and Coffey 2003)
Infantry Training Areas – SAA)	Assessment and removal and/or management of SAA currently being carried out by Defence	Will be subject of a Validation report, clearance certificate and Def SAS
Remaining Areas	Low likelihood, however other areas may contain localised	Review by appropriately qualified UXO consultant, management and/or clearance

Area (Issue Affected)	Current Status	Action Required
	areas of UXO/SAA	as appropriate. Clearance certificates and management plans where appropriate. Unexpected Find Protocols

7.4.1 Management of Contamination and UXO

Landcom and Defence have taken a proactive approach to the identification and management of potential contamination and UXO. Investigations have been conducted across the Site which has involved the engagement of an independent NSW DECCW accredited Site Auditor to review investigation reports, remedial strategies, remediation action plans (RAPs) and validation reports where remediation works have been completed.

Based on the assessments and clearance works carried out it is considered that the Defence Site can be made suitable for the proposed land uses. The areas of highest UXO risk have been cleared of potential UXO and certified by a suitably qualified UXO consultant. Other areas of the Defence Site are considered to have a lower potential of UXO, however potential UXO will continue to be managed through:

- Ongoing investigations (where required) in accordance with relevant NSW EPA/DECCW Guidelines including but not limited to NSW EPA Site Auditor Guidelines;
- Preparation of validation reports and UXO clearance certificates and/or assessments (where appropriate); and
- Clearance by a Suitably qualified UXO consultant and where appropriate provision of Site Audit Statement (SAS) by a NSW DECCW Accredited Contaminated Land Site Auditor and in accordance NSW EPA Site Auditor Guidelines with respect to the Site suitability for the proposed development.

Unexpected Finds

There is the potential that even after the remediation of identified UXO and SAA for unidentified areas to be encountered during development. As such appropriate protocols should be developed and documented within construction environment management plans (CEMPs) prepared by the contractor.

Protocols and procedures, management and reporting requirements where unexpected UXO and SAA are identified are presented in the Contamination Management Plan presented in Appendix F.

Where UXO or live SAA is identified, the NSW DECCW should be notified immediately. The area should be delineated and appropriate signage established. A UXO consultant and accredited by the Department of Defence should assess the find, make safe or organise appropriate personnel to make safe and removal of finds to an appropriate disposal facility.

8.0 SUMMARY AND CONCLUSION

Golder was retained by Landcom to carry out an assessment of suitability (Geotechnical, Contamination and UXO) of the Site for the intended development and land use (residential, open space and commercial).

The assessment consisted of a review of readily available information including previous investigation reports provided and a Site walkover. The results of the assessment can be summarised as follows:

LANDCOM SITE

Geotechnical

Few potential Geotechnical constraints have been identified which would impede the development of the Site. Based on the investigations carried out to date Golder considers that the Landcom Site is suitable for the proposed land use.

The primary geotechnical constraints identified within the Landcom Site is salinity and soil which will be required to be managed during the development to minimise the potential impacts (environmental and economical).

A preliminary soil and water management plan is provided in Section 9.0 with further assessment to be carried out during detailed design development. Following further assessment a detailed soil and water management plan should be prepared to manage the potential environmental and economical impacts during development.

Detailed investigations will be required for the detailed design stage to assess ground conditions and the need for specific measures to manage these constraints.

Contamination and UXO

Localised contamination, potential UXO and SAA has been identified across the Landcom Site. Areas of potential UXO have been further assessed and remediated, where considered appropriate as part of a detailed investigation (Golder 2005b). UXO Clearance certificates have been issued by a suitably qualified UXO consultant where clearance works have been undertaken.

A draft remediation action plan (RAP) and Environmental Management Plan (EMP) presented in Appendix D , have been prepared to address the remediation and/or management of identified contamination and SAA. Remediation strategies presented have been reviewed and generally approved by the NSW DECC accredited SA (Environ 2005b) engaged by Landcom. A review of the recently amended RAP (Golder 2010a) is currently being carried out by the SA.

A Site Audit Statement (SAS) in accordance with the Contaminated Land Management Act (CLM Act 1997) will be prepared by the SA on completion of the remediation and/or management works.

Site Environmental Management Plan (SEMP) prepared for the proposed encapsulation area within the Landcom Site and future regional park.

Based on our review of available information and in the context of the proposed development Golder considers that the Site is suitable for proposed residential, open space and commercial land uses subject to:

- The preparation of a soil and water management plan, construction environment management plan and sound engineering practices in accordance with relevant Australian Standards and LGA requirements;
- Remediation and/or management of identified Contamination/UXO in accordance with prepared RAP, EMP and provision of a SAS by a NSW DECCW accredited site auditor on completion of remedial and/or management works. The Site Audit Statement should conclude that the Site is suitable for the proposed land use and identify any conditions; and
- Ongoing management of the proposed encapsulated area and residual SAA in accordance with the SMP (Appendix E) prepared for the conservation area which will form part of the larger Regional Park.

DEFENCE LANDS

Geotechnical

The primary geotechnical constraints have been identified as salinity, soil erodibility and potential slope instability (southern area). These potential constraints do not impede the development of the Site for the proposed land uses (residential, open space and commercial), however, will be required to be managed during the development to minimise the potential impacts (environmental and economical).

A preliminary soil and water management plan is provided in Section 9.0 with further assessment to be carried out during detailed design development. Following further assessment a detailed soil and water management plan should be prepared to manage the potential environmental and economical impacts during development.

Detailed investigations will be required for the detailed design stage to assess ground conditions and the need for specific measures to manage these constraints.

Contamination and UXO

Localised contamination, potential UXO and small arms ammunition (SAA) has been identified through several environmental investigations carried out across the Defence Site.

New South Wales (NSW) accredited contaminated land Site Auditors have been engaged by Defence to review the adequacy of investigations, remediation works carried out and the provision of a Site Audit Statement (SAS) in accordance with the Contaminated Land Management Act (CLM Act 1997) on completion of remediation works.

Remediation works carried out to date have generally consisted of:

- Remediation (UXO) within former grenade ranges and miniature rifle range;
- Removal of underground storage tanks (USTs) and remediation of localised impacted material;
- Demolition and removal of former structures constructed with asbestos containing fibro cement sheeting; and
- Remediation of former chemical storage areas.

Additional investigations and remediation works are currently being carried out across the larger Defence Site.

An assessment (Noel Arnold, NA 2010) of existing structures were to be retained within the Site boundaries have identified asbestos which will need to be managed including periodic inspections. Based on our review of available information and in the context of the proposed development Golder considers that the Site is suitable for proposed residential, open space and commercial land uses subject to:

- Implementation of a soil and water management plan, construction environment management plan and sound engineering practices in accordance with relevant Australian Standards and LGA requirements Section 9.0 presents a preliminary soil and water management plan to assist within initial planning and management of salinity; and
- Remediation and/or management of identified Contamination/UXO (where warranted) and provision of a SAS by a NSW DECCW accredited site auditor on completion of remedial and/or management works. The Site Audit Statement should conclude that the Site is suitable for the proposed land use and identify any conditions.

9.0 PRELIMINARY SOIL AND WATER MANAGEMENT PLAN

The management of soil and water during development of the Site will be required to manage and minimise potential impacts to the environment. Developments should address any potential soil management issues identified and adopt a preventative approach as opposed to a reactive approach.

Based on the results of investigations carried out salinity has been identified as a potential limitation to the development of the Site, as such soil and water management must incorporate preventative measures when dealing with salinity.

The objectives of the preliminary plan are to:

- Reduce and manage salinity so that impacts on future buildings and vegetation are reduced to an acceptable level;
- Minimise water pollution produced from erosion, saltation and sedimentation;
- Minimises soil erosion and sediment loss during and after the construction and development of the site; and
- Maximise the re-use of site materials.

The management of urban salinity will involve the land use planning, careful urban design and the introduction of construction and maintenance techniques which minimise the impacts on the salinity process and allows us to live with salt.

The NSW Department of Natural Resources has produced a series of informative booklets known as local government salinity initiative (LGSI) series to assist with the management of urban salinity.

The following presents preliminary management strategies to be incorporated into the project soil and water management plan for the future development of the Site:

Design Development

- Additional investigations to be carried out as part of detail design should include further assessment of salinity within both soil and groundwater. Investigations should be in general accordance with LGSI Site Investigations for Urban Salinity and include a water balance study to determine possible source of recharge (rainfall, spring, dams) and paths of discharge;
- The results of additional investigations should be incorporated into the final development design and appropriate modifications were required to minimise potential adverse impacts during and after construction through the preparation of a detailed soil and water management plan;
- Where possible utilise the existing topography in order to minimise cut to fill operations;
- Minimise stormwater infiltration such as lining man made water bodies. Selection of construction materials and techniques for saline environments;
- Reduce groundwater recharge through appropriate land use and management practices to be achieved through minimising deep infiltration and through flow and maximising vegetation coverage;
- Ensure that construction activities do not adversely impede the natural flow of groundwater;
- Improve areas of poor drainage through the design and installation of strip drains to minimise ponding of water in low lying areas and potential water infiltration;
- Selection of salt tolerant vegetation. Where vegetation is required to be removed as part of initial construction works, specifically low lying areas or open space areas susceptible to water level increases, a re-vegetation plan should include planting of deep rooted native plants and local salt tolerant species.

Construction

- Erosion and Sediment Control Plans should be developed and implemented by civil contractors, builders and landscapers in accordance with the NSW Department of Housing guidelines “Managing Urban Stormwater: Soils and Construction, 1998”;
- Sediment control measures are to be installed and inspected prior to the commencement of construction activities and in accordance with Erosion and Sediment Control Plans;
- Revegetation of exposed areas as soon as practical to reduce sediment loading within surface water flows;
- Installation of temporary erosion control measures on exposed cut and fill batters where appropriate. A V-drain could be installed behind the crest of slopes to divert water away from the slope;
- Select construction materials and methods which are suitable for a saline environment. This may include but not be limited to:
  - Construction materials should be suitable for use in moderately reactive sites;
  - Damp-Proof membranes should be provided beneath all floor slabs, footings and internal beams. Properties and installation procedures should be in accordance with AS2870-1996 “Residential Slabs and Footings – Construction”;
  - Floor slabs, piles and footings should have a concrete strength of no less than 32MPa and a cement content not less than 470kg/m^3;
  - A damp-proof course should be provided for masonry structures. The damp-proof course should be in accordance with AS3700-2001 “Masonry Structures”;
  - Ground levels adjacent to masonry structures should be maintained below the level of any damp proof course;
  - Masonry units and Mortar should be of at least salt attack resistance grade “general purpose” as detailed in AS3700-2001 “Masonry Structures”;
  - Ponding of water against any structure should be avoided. Surface drainage should be away from external walls; and
  - Adequate draining of downpipes must be provided to divert water away from structures and managed appropriately through development stormwater management systems;
- Water infiltration (such as detention basins and stormwater) should be minimised.

Additional investigations carried out during design development and post construction should include assessment of salinity, subject to the results downgrading of construction requirements may be possible.

10.0 LIMITATIONS

This Document has been provided by Golder Associates Pty Ltd ("Golder") subject to the following limitations:

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Conditions may exist which were undetectable given the limited nature of the enquiry Golder was retained to undertake with respect to the site. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Document. Accordingly, additional studies and actions may be required.

In addition, it is recognised that the passage of time affects the information and assessment provided in this Document. Golder's opinions are based upon information that existed at the time of the production of the Document. It is understood that the Services provided allowed Golder to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

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Report Signature Page

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Golder 2010C	Draft Site Environmental Management Plan (SEMP), Conservation Zone, Part Lot 7 and 8 in DP1127652, Edmondson Park NSW dated May 2010, Golder Associates Pty Ltd.

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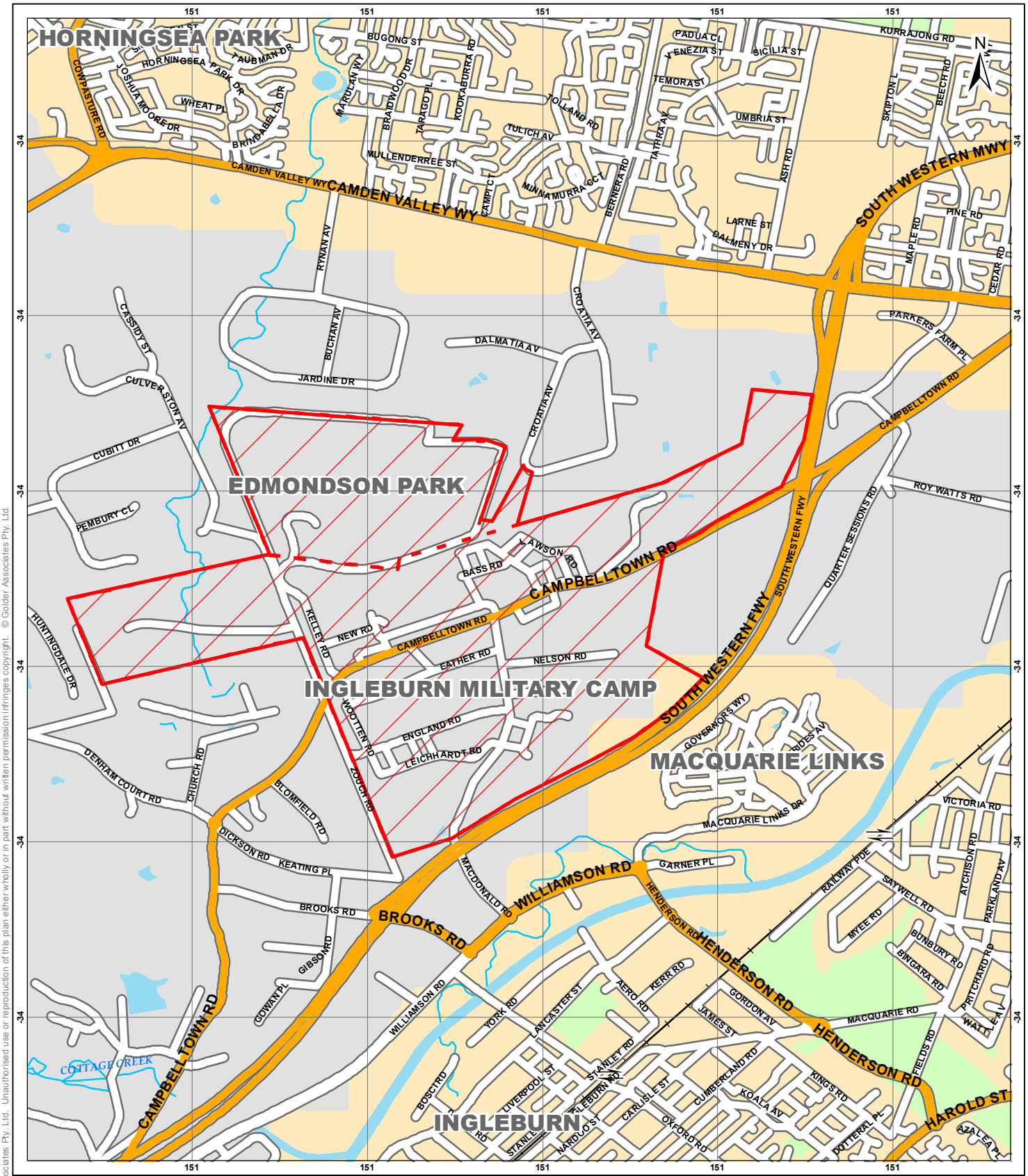
URS 2004	Investigation of Maintenance Compounds and POL Stores, Ingleburn Defence Site, URS, 23 February 2004
Dames & Moore, January 1999	Preliminary Geotechnical and Contamination Review, Ingleburn Defence Site, Dames & Moore Pty Ltd, 7 January 1999
Dames & Moore, November 1999	Stage 2 Contamination Assessment Report – Small Arms Range, Ingleburn, Dames & Moore Pty Ltd, November 1999
URS 2000	Remediation of Poisons Shed Area, Ingleburn Defence Site, URS Australia Pty Ltd, 13 November 2000
URS 2003	Validation Report for the Freeway Grenade Range, Ingleburn Defence Site, URS Australia Pty Ltd, 1 May 2003
URS 2003	Validation Report for the Rifle Range Precinct, Ingleburn Defence Site, URS Australia Pty Ltd, 1 May 2003
URS 2003	Validation for the Suspected Grenade Range at the Zouch Road Precinct, Ingleburn Defence Site, URS Australia Pty Ltd, 8 October 2003
URS 2003	Investigation and Validation Report of Underground Storage Tanks, Ingleburn Defence Site, URS Australia Pty Ltd, 27 November 2003
AGC 1997	Hazardous Materials Survey Report, No.1 Field Hospital, Blocks M&N, Ingleburn Military Facility, Ingleburn NSW 2174, AGC Woodward-Clyde Pty Ltd, September 1997
Campbelltown City Council and Liverpool City Council 2004	Edmondson Park Background Report, Campbelltown City Council and Liverpool City Council, 20 April 2004

APPENDIX A

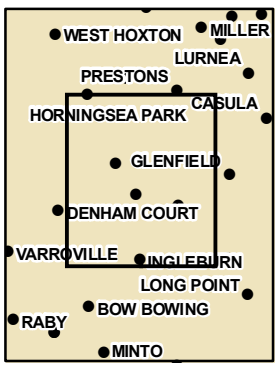
Figures



EDMONDSON PARK SOUTH RELEASE

LANDCOM

SITE LOCATION PLAN



LEGEND

Site Boundary

0 90 180 360 540 720 900 metres

SCALE (at A4) 1:30,000

DATUM GDA 94, PROJECTION MGA Zone 56

PROJECT: 107623113
DATE: 27-08-2010
DRAWN: AJW
CHECKED: GF

FIGURE 1

Golder Associates

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EDMONDSON PARK SOUTH RELEASE

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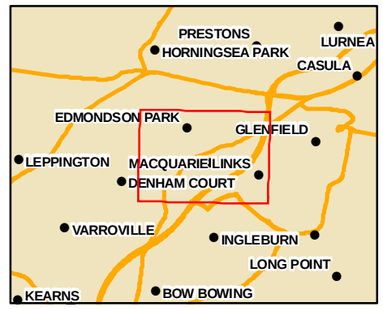
CURRENT SITE FEATURES



LEGEND

- Site Boundary
- ACM Waste
- Sewerage Treatment Plant
- Lead Particulate
- Areas of Environmental Concern
- UXO Remediated Areas
- Roads
- Drainage Lines
- Contours 2m Intervals
- Delineates Boundary Between Landcom Site and Defence Site

NOTES

Aerial Photo, Contours and Topo Supplied by Landcom
Areas of potential USTs investigated, where identified USTs were removed and remediated (URS, 2003)

0 50 100 200 300 400 500 metres

SCALE (at A3) 1:12,000

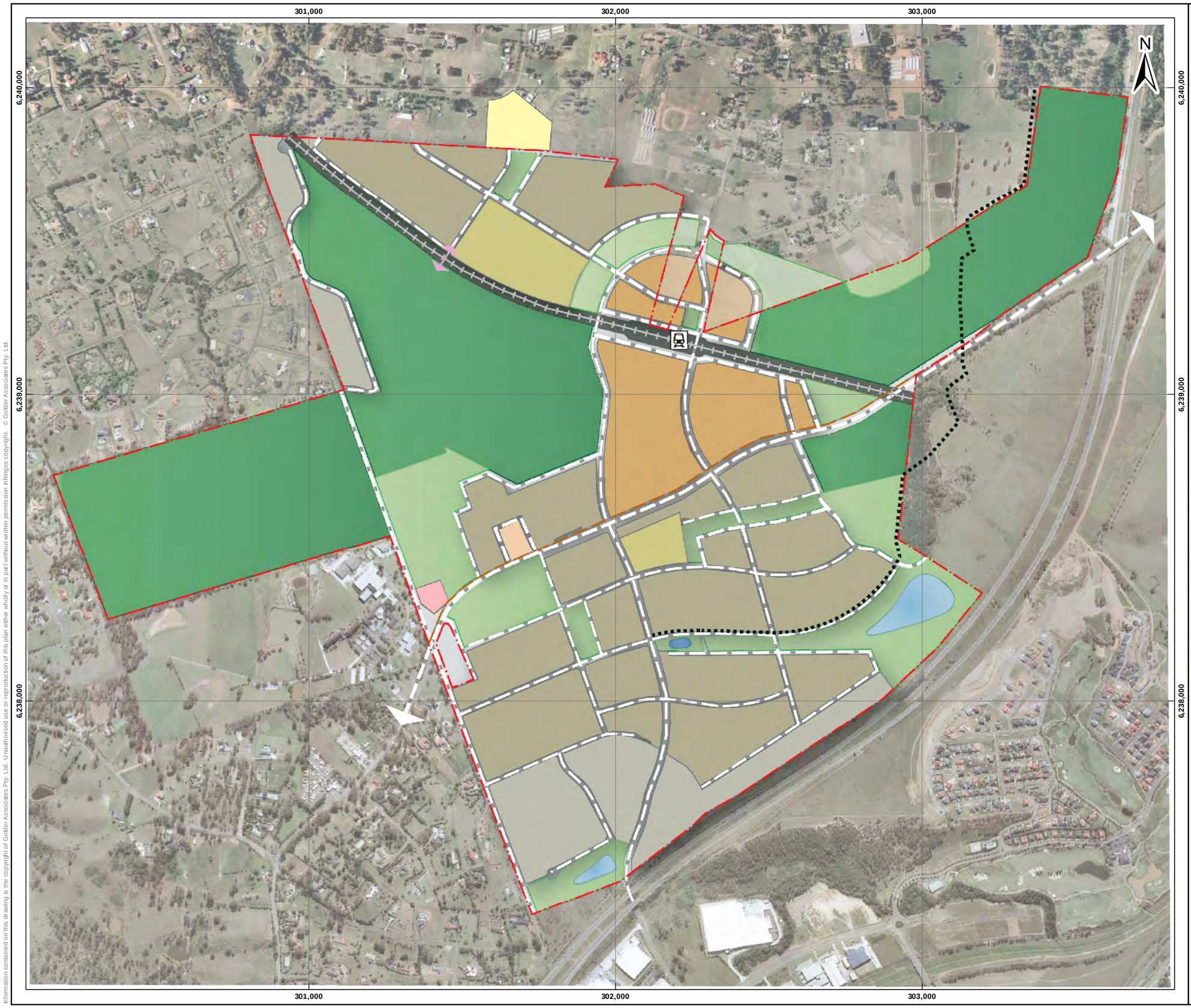
DATUM GDA 94, PROJECTION MGA Zone 56

PROJECT: 107623113
DATE: 27-08-2010
DRAWN: AJW
CHECKED: GF

FIGURE 2

Golder Associates

J:\env\2010\107623113_Landcom_Edmondson Park Release\Technical Doc\GISWorkspaces\Current Site Features.mxd



EDMONDSON PARK SOUTH RELEASE

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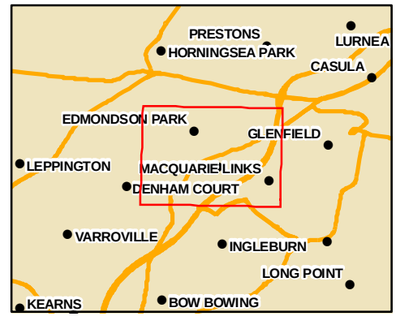
PROPOSED DEVELOPMENT



LEGEND

- Site Boundary
- L.G.A. Boundary
- General Residential
- Environmental Living
- Mixed Use Town Centre
- Public Open Space
- Regional Park
- Heritage Precinct
- Substation
- TCA Rail Corridor
- Train Station
- Schools
- Pedestrian Link over TCA Corridor
- Ornamental Pond
- OSD Basin
- Sewer Line
- Road Links
- Former School Site

NOTES

Master Plan from J.Wyndham Prince 9015/SK13 rev A
Aerial Photography supplied by Landcom

0 50 100 200 300 400 500 metres

SCALE (at A3) **1:12,000**

DATUM GDA 94, PROJECTION MGA Zone 56

PROJECT:	**107623113**
DATE:	**16-09-2010**
DRAWN:	**AJW**
CHECKED:	**GF**

FIGURE 3

Golder Associates

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EDMONDSON PARK SOUTH RELEASE

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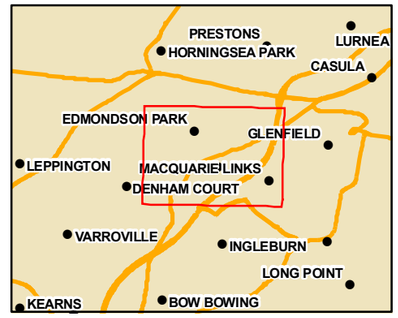
GEOLOGY



LEGEND

- Borehole (Golder 2005)
- Water Sample Location (DP 2003)
- Test Pit Location (DP 2003)
- Borehole (Dames & Moore 1998)
- Sediment Sample (Dames & Moore 1998)
- Surface Water Sample (Dames & Moore 1998)
- Test Pit (Dames & Moore 1998)
- Roads
- Drainage Lines
- Site Boundary
- Contours 2m Intervals
- Sandstone
- Shale
- Quaternary Alluvium
- Delineates Boundary Between Landcom Site and Defence Site

NOTE

Aerial Photo, Contours and Topo supplied by Landcom.
Sandstone outcrop extent from Geotechnique Report Edmondson Park Release Area
Land Capability Assessment 20/10/2003 Drawing 4586/1-5

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0 50 100 200 300 400 500 metres

SCALE (at A3) 1:12,000

DATUM GDA 94, PROJECTION MGA Zone 56

PROJECT: **107623113**
DATE: **27-08-2010**
DRAWN: **AJW**
CHECKED: **GF**

FIGURE 4

Golder Associates

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EDMONDSON PARK SOUTH RELEASE

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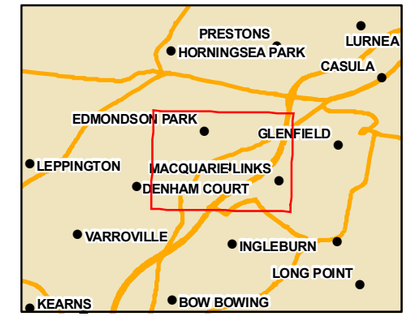
SALINITY



LEGEND

- Site Boundary
- Slightly Saline Near Surface Increasing with Depth
- Slight Saline Soils from 1m Increasing with Depth
- Highly Saline Soils from 1m Increasing with Depth
- Roads
- Drainage Lines
- Contours 2m Intervals
- Delineates Boundary Between Landcom Site and Defence Site

NOTES

Source: Geotechnique Report 4586/1-AE 20 October 2003
Aerial Photography, Contours and Topo supplied by Landcom

0 50 100 200 300 400 500 metres

SCALE (at A3) 1:12,000

DATUM GDA 94, PROJECTION MGA Zone 56

PROJECT: 107623113
DATE: 27-08-2010
DRAWN: AJW
CHECKED: GF

FIGURE 5

Golder Associates

J:\env\2010\107623113_Landcom_Edmondson Park Release\Technical Doc\GIS\Workspaces\Salinity.mxd

EDMONDSON PARK SOUTH RELEASE

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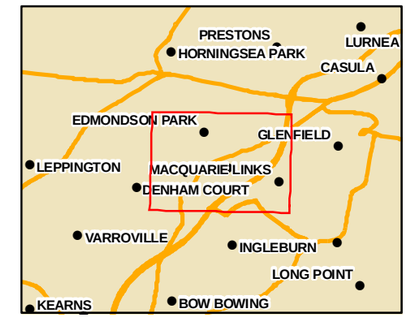
SLOPE



LEGEND

- Site Boundary

Slope

- 0 - 5°
- 5 - 10°
- 10 - 15°
- > 15°
- Roads
- Drainage Lines
- Contours 2m Intervals
- Delineates Boundary Between Landcom Site and Defence Site

NOTES

Aerial, Contours and Topo supplied by Landcom

0 60 120 240 360 480 600 metres

SCALE (at A3) 1:12,000

DATUM GDA 94, PROJECTION MGA Zone 56

PROJECT: 107623113
DATE: 27-08-2010
DRAWN: AJW
CHECKED: GF

FIGURE 6

Golder Associates

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EDMONDSON PARK SOUTH RELEASE

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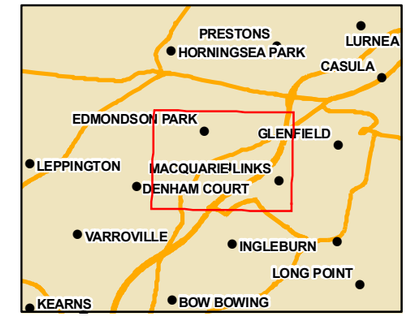
AREAS REQUIRING REMEDIATION



LANDCOM SITE
Remediation in accordance with RAP (Golder 2010)

DEFENCE SITE

ACM Waste

Proposed Encapsulated Area

Waste Burial Trenches

PAH Contaminated Soil

Rifle Range

Sewerage Treatment Plant

Former Infantary Training Area

Former Infantary Training Area

LEGEND

- Roads
- Drainage Lines
- BurialPits
- Contours 2m Intervals
- Lead Particulate
- Site Boundary
- Proposed Encapsulation Area
- ACM Waste
- Sewerage Treatment Plant
- Localised contamination where identified to be remediated in accordance with RAPs and site audit statement issued on completion
- Delineates Boundary Between Landcom Site and Defence Site

0 50 100 200 300 400 500 metres

SCALE (at A3) 1:12,000

DATUM GDA 94, PROJECTION MGA Zone 56

PROJECT: 107623113
DATE: 27-08-2010
DRAWN: AJW
CHECKED: GF

FIGURE 7

Golder Associates

J:\env\2010\107623113_Landcom_Edmondson Park Release\Technical Doc\GIS\Workspaces\Areas Requiring Remediation.mxd