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REPORT
ON
LAND CAPABILITY ASSESSMENT

PROPOSED DEVELOPMENT
WESTERN SYDNEY PARKLANDS

Prepared for
LANDCOM

PROJECT 40465
JANUARY 2006

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EXECUTIVE SUMMARY

This report presents the results of a land capability assessment of the Western Sydney Parklands site, near Doonside, which is proposed for re-zoning for urban (residential and employment) development and public open space. The area of study falls within the Blacktown Local Government Area and is located northwest of Prospect Reservoir. For the purposes of this investigation, the site has been broken up into four distinct areas defined as follows:

- Parcel 2 – Rooty Hill: Residential Release (12 ha);
- Parcel 3 – Doonside: Residential Release (88 ha);
- Parcel 4 – West Huntingwood: Employment Lands (55 ha); and
- Parklands Precinct 2, incorporating the former Telstra site, and undeveloped land adjacent to Eastern Creek (493 ha).

The objective of the study was to determine the suitability of the site for urban development, primarily with regard to site stability, soil erosion potential, soil salinity, soil contamination and minerals potential to assist in the conceptual planning process.

The investigation comprised site history searches, inspection, non-intrusive (electromagnetic) and intrusive (test pitting) investigation followed by laboratory testing of selected samples for physical and chemical characteristics, engineering analysis and reporting.

Most of the site has been cleared and developed for grazing and agriculture but includes remnant concentrations of tree and shrub cover.

The site includes two soil landscapes; South Creek Soil Landscape and the Blacktown Soil Landscape. The soils are underlain at depths generally of about 1 – 3 m by Bringelly Shale comprising shale, carbonaceous claystone, laminite and some minor coal and sandstone bands.

A detailed groundwater study was not undertaken in the site area. However, recent groundwater investigations undertaken in the Blacktown area and previous studies of areas underlain by the Wianamatta Group indicate that the shales have a very low intrinsic permeability and that the groundwater is typically brackish to saline, the water being generally unsuitable for livestock or irrigation.

Laboratory testing has indicated that the clay soils would be susceptible to shrinkage and swelling movements with changes in soil moisture content and that the soils are slightly dispersive to non-dispersive.

No areas of previous instability or potential landslip were identified.

Erosion gullies and localised sheet and rill erosion were also noted in areas of previous surface disturbance for infrastructure and where salinity scalding has occurred. It is considered that the erosion hazard within the site would be within usually accepted bounds that may be managed by good engineering and land management practices.

Testing indicates that moderately saline conditions can be expected throughout the study area, with only minor occurrences of very saline or highly saline conditions generally located within or adjacent to drainage depressions. Given the salinity potential identified the conceptual planning of the development should include minimising water infiltration, planting of deep rooted vegetation, minimising cut and fill operations which inappropriately alter natural drainage patterns, the adoption and implementation of appropriate sediment and erosion controls prior to commencement of construction and the selection of construction materials suitable for use in a saline environment.

A Phase 1 environmental soil assessment was undertaken in Parcel 2 – Rooty Hill, and Parcel 4 – West Huntingwood. The results of this assessment indicate that the sites had been used primarily for agricultural (including market gardening) and residential purposes. Based on the results of an extensive site history review and walkover inspection each lot was given a classification of High, Medium or Low risk of contamination. Each risk category was assigned an investigation methodology to be undertaken as a second phase investigation.

Harvest Scientific Services were commissioned to undertake a preliminary minerals assessment of the site. The site has been identified as being underlain by coal bed measures, which also contain coal bed methane. Both of these resources are outside of the relevant extractive industries planned expansion areas, and as such are not considered likely to be used in the recent future, if ever. Another potential mineral resource within the site is clay and shale for brick making. It is suggested that the use of this resource could be considered before releasing the land for other uses.

The subsurface profiles at most locations are as would be expected for Class M (moderately reactive) and Class H (highly reactive) sites. Lots proposed in areas with shallow groundwater would be classified as Class P sites and as such, design and construction would need to be in accordance with accepted practice.

Soil and water management is an integral part of the development process and should adopt a preventative rather than a reactive approach to the site limitations so that the work can proceed without undue pollution of receiving streams. Following consent, a detailed soil and water management plan will be required and will need to be incorporated into the engineering design of the development. The soil and water management plan shall address: methods for minimising water pollution due to erosion of soils or the development of saline conditions; reducing or managing salinity to provide acceptable conditions for building and revegetation works; minimisation of soil erosion during and after construction; and maximisation of the re-use of materials on site.

Further investigation will be required as conceptual design/planning progresses together with routine inspections and earthworks monitoring during construction and detailed geotechnical investigations on a stage-by-stage basis. Section 12 of this report details the specific further work required.

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CCK
Project 40465
13 January 2006

REPORT ON LAND CAPABILITY ASSESSMENT
WESTERN SYDNEY PARKLANDS
DOONSIDE

1. INTRODUCTION

This report presents the results of a land capability assessment undertaken of the Western Sydney Parklands site (near Doonside) which is proposed for re-zoning for urban (residential and employment) development and public open space. The site boundaries are indicated on Drawing 1 and other relevant drawings which accompany this report (Appendix A). The work was commissioned by Landcom on behalf of the Department of Infrastructure Planning and Natural Resources (DIPNR) owners of the site and was undertaken in liaison with APP Corporation, lead consultant.

The area of study is within the Blacktown Local Government Area and located northwest of Prospect Reservoir. For the purposes of the assessment, the site has been divided into four distinct areas, defined as follows:

- Parcel 2 – Rooty Hill: Residential Release (12 ha);
- Parcel 3 – Doonside: Residential Release (88 ha);
- Parcel 4 – West Huntingwood: Employment Lands (55 ha); and
- Parklands Precinct 2 - incorporating the former Telstra site, and undeveloped land adjacent Eastern Creek (493 ha).

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It is understood that re-zoning of the land in Parcels 2 and 3 to facilitate residential development is proposed and that Parcel 4 will be rezoned to accommodate commercial/industrial premises.

Precinct 2 is part of the 5500 ha corridor of open space known as the Western Sydney Parklands. The objective of the land capability study was to determine the suitability of the site for urban development, primarily with regard to site stability, erosion potential, soil salinity potential, soil contamination and minerals potential.

The investigation comprised site history searches, site inspections, non-intrusive and intrusive site investigation followed by laboratory testing of selected samples, engineering analysis, mapping and reporting.

This report contains details of all work undertaken and results together with comments relating to land capability, engineering design and construction practice. Whilst pertinent results of field work, laboratory testing and associated subconsultant reports are included in the text, further details are provided in the following Appendices:

- A Drawings
- B Photograph Plates
- C Electromagnetic Survey - Field and Processing Methods
- D Test Pit Logs
- E Laboratory Test Results
- F Phase 1 Contamination Assessment Report (Project 40465-1, 40465-2)
- G Harvest Scientific, Minerals Assessment
- H CSIRO Publication *"Guide to Home Owners on Foundation Maintenance and Footing Performance*

2. SITE DESCRIPTION

The site is approximately 650 ha in plan area, and was generally cleared and vegetated with dense long grass at the time of the inspection. Remnant stands of trees surrounded Eastern Creek, portions of the western flood plain and a large part of the northern eastern and south-western sectors of the site. Low lying areas were vegetated with salt resistant vegetation, including Bulrushes and Spiny Rushes.

In addition to salt resistant vegetation, salt scalds and eroded soils were also present across the site. Many salt scalds show salt efflorescence at the surface.

Topographical relief across the site was slight. The western portion of the site from Eastern Creek was flat, except for the northern portion which rose to meet the flanks of The Rooty Hill. The eastern portion was gently undulating, associated with bedrock rise. There were only two significant drainage lines in the eastern portion, Bungaribee Creek and an unnamed drainage depression to the south. The entire site drained to Eastern Creek. Due to the slight relief and low permeability of the soils, much of the low-lying parts of the site were inundated. Relatively light rain periods resulted in extensive surface ponding across the site.

The central portion of the site was unoccupied, whilst Parcel 2 and Parcel 4 had a low density of rented properties. Properties in Parcel 2 were small (low density) residential. Parcel 4 lots were generally rural in nature with some grazing land.

Significant disturbance had taken place in the western potion of the site associated with construction of the M7 Western Sydney Orbital, and construction of an AGL gas pipeline.

Various topographical features of the site are shown in the colour photographs included as Appendix B.

3. PREVIOUS STUDIES

Several previous studies have been undertaken at the sites, though there appears to have been an emphasis on the Parcel 3 and the Parklands Precinct areas. The following documents have been reviewed whilst preparing this report:

- HLA Enviro-Sciences, *Site Audit Report: Former Telstra OTC Eastern Road Doonside*, 26 March 2001.
- Ian Perkins Consultancy Services, *Land and Vegetation Management Plan for three sections of the Western Sydney Regional Parklands,* 23 February 2004.
- URS, *Western Sydney Regional Parklands Management Vision & Concept Plan Options*, March 2004.
- Whelans, *Doonside Land and Acquisition Report*, December 2004.
- Whelans, *Huntingwood and Eastern Creek Land and Acquisition Report*, December 2004.
- Whelans, *Rooty Hill Land and Acquisition Report*, December 2004.

The following summarises the relevant information from the above documents:

Contamination: Historic contamination has been addressed within the former Telstra site up to March 2001 by the unreviewed Australian Site Assessment reports covered by the HLA Audit Report. The audit report notes that the site "*has been remediated and validated to a level that renders it suitable for residential land use with access to soil."* (Ref 1) The HLA audit report also requires the development and implementation of a Management Plan to address "*the unlikely event that contamination is found with site development earthworks".* This plan is to be approved by an NSW EPA accredited auditor. (Ref 1)

The Perkins Report (February 2004) notes that since the audit report, fly-tipping of waste has been an issue on the site. Parcels 2 and 4 have not been the subjects of previous environmental investigations (Ref 2).

Slope Stability: Preliminary slope mapping has been undertaken in the URS report (March 2004) (Ref 3). This information provides a baseline but was not a constraints map, as no criteria were assigned to the various map areas.

Erosion and Sedimentation Hazard: Soil mapping has been undertaken on the site. It appears however, that this mapping has been prepared by referencing the published soils maps. No field investigations or test pitting was previously undertaken to confirm the expected soil landscapes (Ref 2).

Soil Salinity: The Perkins Report (Ref 2) identifies salinity indicators across the site. These were not mapped.

4. PROPOSED DEVELOPMENT

It is understood that the majority of the subject site is proposed for inclusion in the greater parcel of land known as the Western Sydney Parklands; a 5500 ha corridor aligned in the north-south direction. Parcel 2, Parcel 3 and Parcel 4 (known collectively as the interface lands), will be the subject of urban development with Parcels 2 and 3 being residential developments, and Parcel 4 proposed for Employment Lands.

The following sections provide general comment on development constraints relevant to geotechnical factors, soil chemistry, environmental contaminants, mining and alternative potential land uses to assist in the conceptual planning of the proposed development. It is noted that further investigations will need to be undertaken as the planning, design and construction of the subdivision proceeds.

5. REGIONAL SOIL LANDSCAPE, GEOLOGY AND HYDROGEOLOGY

5.1 Soil Landscapes

Reference to the 1:100 000 Soil Landscapes of the Penrith Sheet (Ref 4) indicates that the site includes two soil landscapes which are summarised below and for which the distribution is given in Drawing 2:

Blacktown Soil Landscape - present over most of the eastern and the north-western sections of the site and is characterised by a topography of *"gently undulating rises on Wianamatta Group Shale, with local relief to 30 m and slopes usually less than 5%"*. This is a residual landscape and comprises up to four soil horizons that range from shallow red-brown hard-setting sandy clay soils on crests and upper slopes to deep brown to yellow sand and clay soils overlying grey plastic mottled clay on mid- to lower slopes. These soils are typically of low fertility, are moderately reactive and have a generally low wet bearing strength.

South Creek Soil Landscape – present over most of the western and central sections of the site and is characterised by a topography of *“flat to gently sloping alluvial plain with occasional terraces”.* This is a fluvial landscape and includes often very deep layered sediments. Where pedogenesis has occurred, developed soils include sandy to sandy clay loams, clay loams and brown clays. These soils are typically of low fertility, may be of moderate reactivity and are subject to waterlogging.

5.2 Geology

Reference to the Penrith 1:100 000 Geological Series Sheet (Ref 5) indicates that the site is underlain by Bringelly Shale of the Wianamatta Group of Triassic age. This formation typically comprises shale, carbonaceous claystone, laminite and some minor coal bands. These rock units typically weather to form clays of medium and high plasticity. The bedrock is mantled by Quaternary alluvium within valley floors of the Eastern Creek and Bungarribee Creek system (Drawing 3). The geological sheet also indicates that the site is intersected by the south-easterly trending Penrith Basin Syncline.

Hydrogeology

McNally (2005) describes the general hydrogeological framework relevant to Western Sydney, including the subject site, where the shale terrain is known for saline groundwater (due to connate salt in shales of marine origin or to windblown sea salt) and the salt accumulates by evapo-transpiration (mostly in the B-horizon of residual soils). In areas of urban development, this can lead to damage to building foundations, lower course brickwork, road surfaces and underground services, where these impact on the saline zone or where the salts are mobilised by changing groundwater levels.

Seasonal water level changes of 1 - 2 m can occur in a shallow regolith aquifer or a deeper shale aquifer due to natural causes, however urban development should be carried out with a view to maintaining the natural water balance (between surface infiltration, runoff, lateral throughflow in the regolith, and evapo-transpiration) so that long term rises do not occur in the saline groundwater level.

The Department of Infrastructure Planning and Natural Resources (DIPNR) infers a “high salinity potential” in the lower slopes and drainage areas of Eastern Creek, on their map entitled “Salinity Potential in Western Sydney 2002”. These DIPNR inferences are based on soil types, surface levels and general groundwater considerations but are not in general ground-truthed, hence it is not generally known if actual soil salinities are consistent with the potential salinities of DIPNR.

Whilst a detailed groundwater study was not undertaken as part of the current scope, recent groundwater investigations undertaken by DP in the Blacktown area and previous studies of areas underlain by the Wianamatta Group and Quaternary river alluvium indicate that:

- the shales have a very low intrinsic permeability and groundwater flow is likely to be dominated by fracture flow with resulting typically low yields (< 1 L/s) in bores;
- the groundwater in the Wianamatta Group is typically brackish to saline with total dissolved solids (TDS) in the range 4000 – 5000 mg/L (but with cases of TDS up to 31, 750 mg/L being reported), the dominant ions being sodium and chloride and the water being generally unsuitable for livestock or irrigation.
- groundwater flow in unconsolidated Quaternary deposits is likely to be by porous flow in sandy horizon, typically fresh (TDS < 500 mg/L) and dominated by sodium and bicarbonate ions.

6. SCOPE OF WORKS

From the brief provided by APP, DP identified the following scope of works for the site. For clarity, the scope of works undertaken for the assessment was divided up based upon the individual areas of the site. The level of assessment on each area of land is different and is described in the sections below.

6.1 Whole Site

An assessment of stability, erosion and sedimentation potential covering the entire 650 ha study site was undertaken and incorporated the following steps:

- Collection and review of background information, predominantly from Council files and aerial photographs.
- Field mapping by a senior engineering geologist, to confirm soil landscape mapping, identify potential unstable areas and to nominate locations for additional subsurface investigation.
- Undertaking service location utilising the Dial Before You Dig service;

- Excavation of 50 test pits across the site with a rubber-tyred backhoe to profile the subsurface strata. The pits incorporated the collection of regular soil samples to assist in strata identification and for possible laboratory testing to determine soil plasticity, erosion potential, and salinity.
- The surface levels shown on the test pit logs were interpolated to the nearest 0.5 m from 1 m contour intervals on the basemap provided by the project surveyors.
- Geotechnical testing of selected samples for plasticity (5 Samples) and erosivity characteristics (20 Samples).
- Production of constraint maps showing areas of landslip risk as well as areas of potential erosion and sedimentation hazard.

The salinity investigation comprised the following components:

- A review of all previous documents pertaining to site salinity.
- A site walkover by an experienced hydrogeologist to identify areas of salinity potential based on landform, indicator species and other visual indicators. All areas identified were GPS plotted on a GIS database, logged and photographed.
- Electromagnetic profiling for measurement of in-situ apparent conductivities of the surface and shallow subsurface soils (further detailed in Appendix C),
- Ground-truthing of apparent (insitu) conductivities using soil sampling and laboratory measurement of salinities from collected soil samples.
- Identification of sites for later installation of groundwater bores for salinity (groundwater) monitoring.
- Production of a salinity hazard map for the site.

The provision of an assessment for minerals potential was undertaken by a sub-consultant, Harvest Scientific Pty Ltd, with the reports included as Appendices to this report.

The investigation included an assessment of clay, shale and sandstone as well as coal and coal-bed methane resources.

6.2 Parcel 2 and Parcel 4

Two Phase 1 Contamination Assessments were undertaken, which included the following:

- Site walkover inspection by an environmental engineer.
- A search through the NSW EPA Land Information records to confirm that there are no statutory notices current on any parts of the release area under the *Contaminated Land Management Act* (1997).
- A review of historical aerial photography for the area through the Land Information Section of the Department of Infrastructure, Planning and Natural Resources (DIPNR).
- A review of previous site ownership records including land title records archived at the Land Titles Office.
- Interviews with past and present local residents and land owners (where possible) to obtain anecdotal information regarding the potential nature and extent contaminating activities (including filling) across the site.
- Inspection of test pits excavated as part of the stability assessment.

At the conclusion of the Phase 1 assessments a contamination risk rating was assigned to each existing lot (high, medium or low). This formed the basis for recommendations regarding the need for further environmental investigation.

6.3 Parcel 3 and Parklands Precinct

Contamination assessments were based upon the following:

- a thorough review of all previous documents pertaining to site contamination.
- a site walkover by an experienced Environmental Engineer to identify areas of additional contamination across the site.
- Identification of illegal tipping sites which were GPS plotted on a GIS database, logged and photographed.

6.4 Horizontal and Vertical Control

The coordinates of the field tests and other pertinent features were determined by use of a GPS receiver. This enabled positioning of features in relation to digital aerial photographs and basemaps for generation of the drawings within this report. GPS location allowed for accuracy within 3 m, which was considered sufficient accuracy for the location of field tests. Where greater accuracy was required (ie location of EM31 readings) differential GPS (DGPS) was used. A Trimble DGPS backpack mounted system was used which provided sub-metre accuracy.

All field measurements and mapping for this project have been carried out using the Geodetic Datum of Australia 1994 (GDA94) and the Map Grid of Australia 1994 (MGA94), Zone 56. Digital mapping has been carried out in a Geographic Information System (GIS) environment using MapInfo software. All reduced levels are given in relation to Australian Height Datum (AHD).

7. FIELD WORK RESULTS

7.1 Site Observations

7.1.1 Geotechnical

The principal geotechnical observations made during inspections of the site on 26 August and 16 September 2005 are summarised below and further detailed in Drawing 5:

- rock outcrop was limited to a single exposure of fine grained sandstone within a midslope location in a road cut of Eastern Road within the north-western section of the site (Drawing 5).
- the bedrock is mantled by extensive alluvial deposits about Eastern Creek, Bungarribee Creek and associated minor un-named tributary gullies. Within the flatter footslope sections, the alluvium boundary is commonly indistinct and grades into residual soil profiles.

- gully erosion locally entrenches the alluvium infilled bases of creek lines (Drawing 5). Erosion depths ranged from 0.3 m to 2.5 m.
- erosion along the courses of Eastern Creek and Bungarribee Creek is generally limited to the immediate banks and stream bases. The erosion is discontinuous and appears to generally occur during flood flows. Most of the banks are densely penetrated by tree roots and grasses which protect against erosion and associated slumping of undercut sections.
- salt scalding and efflorescence are present along two small side gullies within the north-eastern section of the site (Locations 1 – 4 and 9) and along the edges of waterlogged areas (Locations 13 and 15) in the east-central section of the site.
- areas of possible surface ponding are present upslope of road embankments (Locations 21 and 22) within the south-eastern section of the site.
- The soils have been exposed in many localised areas, mainly for the provision of access tracks, during the past landuse.

7.1.2 Environmental

Environmental inspections were undertaken as three independent assessments, namely:

- Stage 1 Preliminary Inspection of Parcel 2 – Rooty Hill,
- Stage 1 Preliminary Inspection of Parcel 4 – West Huntingwood,
- Surface Contamination Mapping of the Parklands Precinct to update the earlier HLA Audit report.

Inspection of the subject site was made on six occasions between 8 and 28 September 2005. As before, locations of features were logged using a GPS unit according to the GDA 94-MGA 94 format. These were transferred to GIS environment and logged, Drawings 9 - 11 show contamination observations.

Parcel 2 – Rooty Hill

The principal observations made during the inspection included:

- A number of soil stockpiles, building rubble and dumped material located at the northern most portion of the site. This dumping may be associated with the construction of the M7 Western Sydney Orbital.
- Dumped waste close to the creek line in the north-eastern portion of the site, including car bodies, building rubble and other scrap metal. (E300753, N6260947)
- General rubbish and waste in the western portion of the creek, mainly due to stormwater outlets, as opposed to actual dumping.
- Dumped fibrous material on the southern creek bank (possible asbestos). (E300826, N6260985).
- Earth stockpile resulting from fly-tipping (E300983, N6260919)
- Dumped scrap and rubbish Western Portion of the site (surrounding E301120, N6260771).
- Demolished house, (floor slab still in place) fibreboard sheeting on ground surface, possible asbestos. (E301120, N6260771).
- Several (possibly asbestos) fibreboard structures were noted during the investigation (As indicated on Drawing 9.)
- Septic tanks were in use across the site.

The identified areas of environmental concern (AEC) are indicated in Drawing 9.

Parcel 4 – West Huntingwood

- A number of soil stockpiles, building rubble and dumped material located at the south-eastern portion of the site.
- A service station located in the north-eastern portion of the site.
- Six (possibly asbestos) fibreboard structures across the site in various states of repair (some partially demolished)

- Farm machinery and several empty 1000 L plastic tanks were located on a concrete pavement in front of a farm shed.
- The whole area is used for horse grazing and training. A training track which may have used imported fill lies just beyond the site boundary.
- Septic tanks were in use across the site.

The identified areas of environmental concern (AEC) are indicated in Drawing 10.

Parklands Precinct and Parcel 3 - Doonside

The principal observations made during the inspection included:

- Numerous dumped soil stockpiles, building rubble and scrap metal from illegal dumping in the northern portion of the site, near to the intersection of Doonside Road and Eastern Road. (E302870, N6261170)
- Numerous car bodies, concrete blocks and general scrap metal dumped in depressions near illicit motorbike track in the central portion of the site. (E302710, N6260930)
- Building rubble and soil stockpiles in the central portion of Parcel three. (E302660, N6260790)
- Asbestos piping and dumped soil near road way loop between gates on Parcel 3. (E303036, N6260699)
- Numerous dumped stockpiles and rubbish including asbestos on the path between Eastern Road and the telecommunications tower (E302315, N626148)
- Dumped rubbish beneath power lines in the northern portion of the site (E302242, N6261356).
- Soil stockpile near demolished building at hill crest in central southern portion of the site. (E302517, N6259519)

The identified areas of environmental concern (AEC) are indicated in Drawing 11.

7.2 Subsurface Investigation

Details of the subsurface conditions encountered are given on the test pit logs in Appendix D which should be read in conjunction with the accompanying notes defining classification methods and descriptive terms.

Relatively uniform conditions were noted underlying the site, with the succession of strata broadly summarised as follows:

SILTY CLAY:	typically dry, brown clayey silt, silt and silty clay to depths of 0.1 – 0.4 m;
CLAY:	stiff to hard (but generally very stiff to hard) silty clay, clay, gravely clay to depths of 0.55 – 3 m;
BEDROCK:	variably extremely low to very low strength shale, extremely low to low strength sandstone and siltstone below depths of 0.65 – 3 m.

Depth of clay was generally found to be greatest in the lower slopes and Eastern Creek flood plain. Hill top locations revealed only very shallow residual soils before encountering bedrock.

No free groundwater was encountered within the pits during excavation. It is noted however that the test pits were immediately backfilled following excavation which precluded long term monitoring of groundwater levels. Further, it is anticipated that some groundwater would have been present within the limits of excavation at some of the locations and as such, longer term seepage inflow should be anticipated.

8. LABORATORY RESULTS

Selected samples from the test pits were tested in the laboratory for measurement of field moisture content, Atterberg limits, Emerson Class Number and Electrical Conductivity in a 1:5 soil:water extract.

The detailed test report sheets are given in Appendix E. The results indicate that the soils tested are of an intermediate to high plasticity, with field moisture contents in the range of 14% dry to 7% wet of the plastic limit (which is roughly equivalent to the standard optimum moisture content). As such, the clays would be moderately to highly susceptible to shrinkage and swelling movements with changes in soil moisture content. The results of the Emerson crumb tests indicate that the soils tested are slightly to non-dispersive.

The mechanical and chemical testing data is summarised in Tables 3 and 4. Discussion of the results and implications for the proposed development are given in Section 9.3.3.

Table 1 - Results of Laboratory Testing (Mechanical Properties)

Pit No.	Depth (m)	FMC (%)	PL (%)	LL (%)	PI (%)	ECN
3	0.6	19.1	17	59	42	4
7	0.5	-	-	-	-	4
17	0.5	-	-	-	-	4
21	1.0	-	-	-	-	4
22	1.0	23.3	20	83	63	4
24	0.8	-	-	-	-	4
25	0.4	-	-	-	-	4
27	0.4	-	-	-	-	4
35	0.8	20.5	34	58	24	4
36	0.8	-	-	-	-	4
39	0.5	-	-	-	-	4
40	0.4	11.3	14	30	16	4
41	0.5	-	-	-	-	4
42	0.3	-	-	-	-	4
44	1.0	19	12	41	29	4
46	1.0	13.7	17	63	46	4
50	1.3	-	-	-	-	4

Where FMC = Field moisture content
PL = Plastic limit
LL = Liquid limit
PI = Plasticity index
ECN = Emerson Class No.

Table 2 – Results of Laboratory Testing (Salinity)

TP	Depth (m)	$EC_{1:5}$ (dS/m)	Moisture (%)	M (Texture)	EC_e (dS/m)	TP	Depth (m)	$EC_{1:5}$ (dS/m)	Moisture (%)	M (Texture)	EC_e (dS/m)
1	0.6	0.54	24	7	3.78	30	0.7	1.1	17	7	7.7
2	0.6	0.56	15	7	3.92	31	0.5	0.03	16	7	0.21
2	0.6	0.56		7	3.92	32	0.6	0.61	14	7	4.27
3	0.6	0.57	14	8.5	4.845	32	0.6	0.61		7	4.27
4	0.6	0.066	8.8	7	0.462	33	0.1	0.038	9.8	8.5	0.323
5	0.4	0.11	6.5	7	0.77	33	0.8	0.91	13	7	6.37
7	0.5	0.28	11	7	1.96	33	1.6	1.7	12	7	11.9
8	0.5	0.29	15	7	2.03	33	2	1.2	13	7	8.4
9	0.6	0.78	11	7	5.46	34	0.4	0.23	10	7	1.61
10	0.5	0.077	17	7	0.539	35	0.2	0.034	7	7	0.238
11	0.2	0.17	22	7	1.19	35	0.4	0.33	15	7	2.31
11	0.5	0.56	15	7	3.92	35	0.4	0.33		7	2.31
11	0.8	1.6	14	7	11.2	35	0.6	0.79	17	7	5.53
11	0.8	1.6		7	11.2	35	0.8	0.73	16	7	5.11
11	1.1	0.72	9.8	14	10.08	35	1	0.89	15	7	6.23
11	1.9	0.64	11	10	6.4	35	2	0.78	11	7	5.46
12	0.5	0.28	15	7	1.96	36	0.8	0.056	14	7	0.392
13	0.4	0.48	13	7	3.36	37	0.8	0.33	8.8	7	2.31
14	0.5	0.11	14	8.5	0.935	38	0.4	0.22	13	7	1.54
15	0.6	0.049	8.9	7	0.343	39	0.5	0.097	11	7	0.679
16	0.7	0.039	12	7	0.273	40	0.2	0.066	16	7	0.462
17	0.5	0.24	10	7	1.68	40	0.4	0.091	4.7	7	0.637
18	1	0.46	16	7	3.22	40	1.2	0.073	5.8	7	0.511
19	0.4	0.023	12	7	0.161	40	1.2	0.06		7	0.42
20	0.2	0.05	18	8.5	0.425	40	2.8	0.055	5.4	7	0.385
20	0.4	0.071	20	9	0.639	41	0.5	0.052	9.1	8.5	0.442
20	0.7	0.29	28	7	2.03	42	0.3	0.048	14	7	0.336
20	1.6	0.42	18	7	2.94	43	0.5	0.15	13	7	1.05
21	1	0.3	8.8	7	2.1	44	0.2	0.14	18	7	0.98
21	1	0.26		7	1.82	44	1	0.32	12	7	2.24
22	1	0.26	12	7	1.82	44	1.8	0.13	13	7	0.91
23	0.4	0.03	11	7	0.21	44	2.4	0.32	12	7	2.24
24	0.8	0.26	8.5	7	1.82	45	1	1.3	14	7	9.1
25	0.4	0.037	8.2	7	0.259	46	1	0.18	13	7	1.26
26	0.8	0.54	13	7	3.78	47	0.5	0.33	12	7	2.31
27	0.4	0.57	8.7	7	3.99	48	0.6	0.99	16	7	6.93
28	0.6	0.14	9.9	7	0.98	49	0.4	0.5	14	7	3.5
29	0.7	0.22	3.1	7	1.54	50	0.3	0.21	14	7	1.47

Where $EC_{1:5}$ = Electrical conductivity   M = Soil texture factor (Ref. 8)
EC_e = Electrical conductivity of a saturated extract
Bold values indicate saline conditions.

9. SALINITY DATA: ANALYSIS AND PRESENTATION

Soil salinity is often assessed with respect to electrical conductivity of a 1:5 soil:water extract (EC 1:5). This value can be converted to ECe (electrical conductivity of a saturated extract) by multiplication with a factor dependent of soil texture ranging from 6 for shale to 17 for sand (Ref. 8).

Based on the requirements of DIPNR's Booklet (Ref 8, 2003) *Salinity Investigations* soil salinity is classified as follows:

Table 3 - Soil Salinity Classification

Class	ECe (dS/m)	Implication
Non Saline	<2	Salinity effects mostly negligible
Slightly Saline	2 – 4	Yields of sensitive crops effected
Moderately Saline	4 – 8	Yields of many crops effected
Very Saline	8 – 16	Only tolerate crops yield satisfactorily
Highly Saline	>16	Only a few very tolerant crops yield satisfactorily

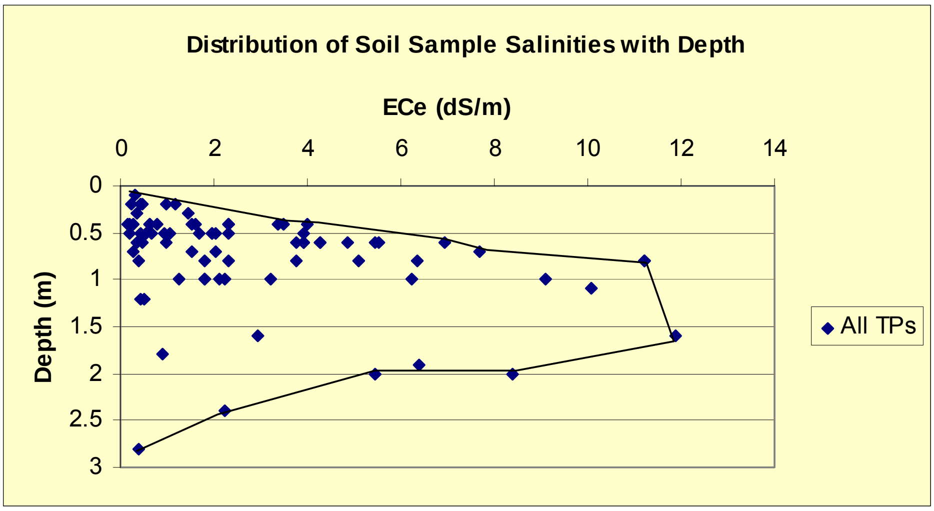
The salinity measurements on test pit samples from the Western Sydney Parklands are distributed throughout the salinity classes as shown below.

Table 4 - Ranges of Test Pit Sample Salinities

Class	ECe (dS/m)	% of measurements
Non Saline	<2	51
Slightly Saline	2 – 4	25
Moderately Saline	4 – 8	16
Very Saline	8 – 16	8
Highly Saline	>16	0

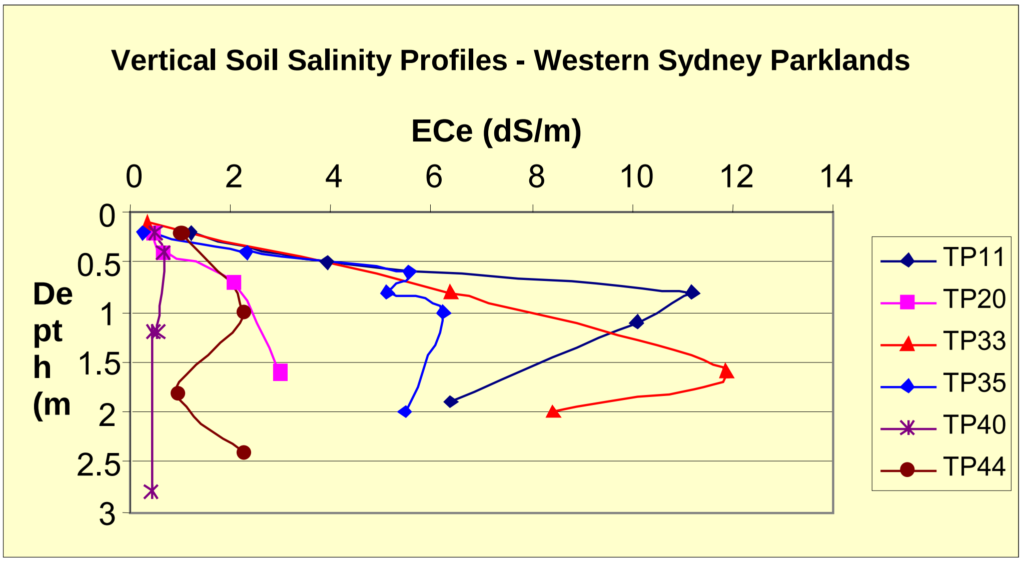
The implication of these results, to the extent that the 76 test pit samples are representative of the study area, is that non-saline to moderately saline conditions can be expected throughout the study area, with only minor occurrences of very saline conditions. These results are, however, dominated by salinity measurements within the upper 1 m of soils, as indicated by the salinity-depth scattergram shown in Figure 1, showing all measurements from all test pits, together with an overall envelope.

Figure 1 - Distribution of Soil Sample Salinities with Depth



At six locations (selected on the basis of initial apparent conductivity results to cover the full range of salinities within the area), test pits were sampled at several depths to a maximum of 2.8 m below ground surface. This enabled the construction of vertical soil salinity profiles (see Figure 2).

Figure 2 - Vertical Soil Salinity Profiles



From these profiles it is inferred that where soils become moderately or very saline, these salinities are reached in the 0.5 – 2.0 m depth zone, corresponding in general to the B soil horizon. A number of test pits were sampled at the top of this horizon, however the distribution of salinities derived from test pit samples alone is expected to slightly underestimate salinities throughout the greater depth range of urban development.

9.1 Processing and Interpretation of Electromagnetic Data

On completion of EM31 profiling, field data were corrected for the conductivity response of the quad bike and were filtered with a moving average operator to reduce the noise induced by irregular quad bike motion (changes in height of the coils above the ground conductor). Details of these corrections and subsequent processing steps are presented in Appendix C.

The histogram and table below show that of the 42 000 corrected and filtered apparent conductivity measurements over the study area, 57% fall in the non-saline to slightly saline classes of Chhabra (1996), with 39% in the moderately saline class and 4% in the very to extremely saline classes.

Figure 3: Distribution of Salinities from EM 31 Profiling

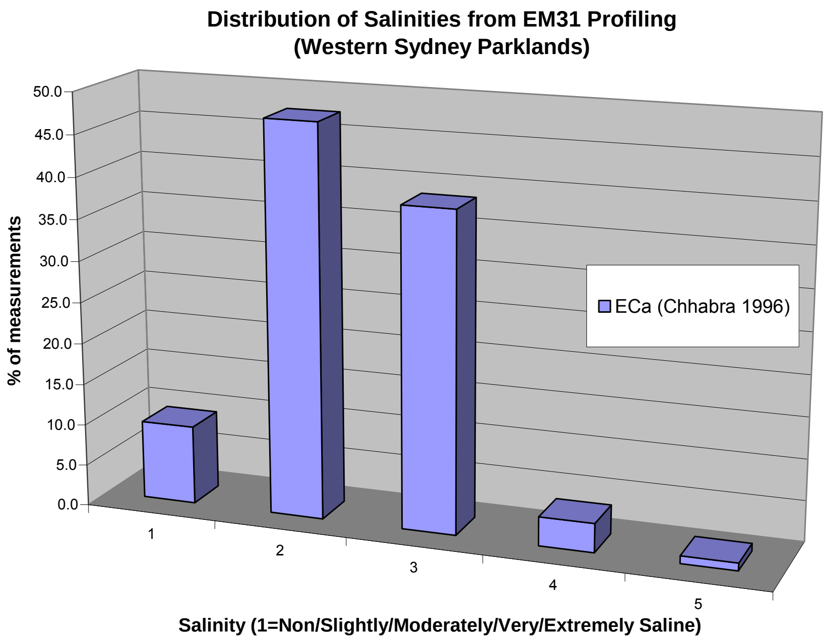


Table 5 - Distribution of Salinities from EM 31 Profiling

ECa Range (mS/m)	<50	50-100	100-150	150-200	>200
Salinity Class (Chhabra 1996)	Non-saline	Slightly saline	Moderately saline	Very saline	Extremely saline
%ECa data	10	47	39	3	1

Apparent conductivity data was added to the GIS database for interpolation of apparent conductivities onto a regular grid throughout the area surveyed. Drawing 6 presents the apparent conductivity image with a continuous colour spectral scale in mS/m. Areas of most interest are those coloured orange to red. Using the classifications of Chhabra (1996), these colours may indicate moderately saline to extremely saline ground conditions. It should be noted however that some of the highest apparent conductivities were unrelated to soil salinities, being measured immediately adjacent to steel fencing materials in the east of Parcel 3.

To achieve a consistent classification from both test pit samples and EM profiling data, a form of calibration of the latter was carried out as described in Appendix C.

A linear regression on the EC_e/EC_a scattergram provided a factor of 2.55 by which to multiply apparent conductivities (in dS/m) to estimate EC_e values throughout the EM31 data set.

The factor was applied to all data, which was then re-gridded for presentation as an apparent salinity image (Drawing 7) with a continuous colour spectral scale in dS/m, based on the Richards (1954, Ref 9) classification scheme. The histogram and table below show that of the re-scaled data points, 97% fall in the non-saline to slightly saline classes of Richards, and 3% fall in the moderately saline class.

Figure 4: Distribution of Salinities

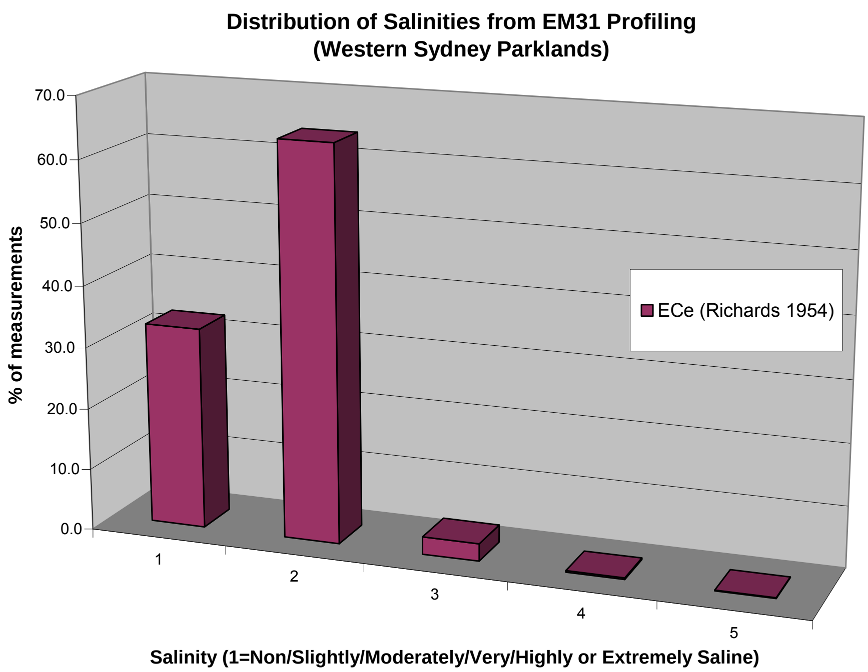


Table 6 - Distribution of Salinities

ECe Range (mS/m)	<2	2-4	4-8	8-16	>16
Salinity Class (Richards 1954)	Non-saline	Slightly saline	Moderately saline	Very saline	Highly saline
%ECe data	33	64	3	~0	~0

Contours were added to the image, corresponding to the 4 dS/m boundary of the salinity classes of Richards, providing a direct subdivision of the study area into non-saline to slightly saline classes versus moderately saline to very saline classes.

It can be seen that areas inferred to be moderately saline or greater occur as a small subset of the EC_a classes, generally to the east of Eastern Creek, or along the western site boundary within 500 m north and 500 m south of the Great Western Highway.

10. DISCUSSION

10.1 Slope Instability

No evidence of hillslope instability (landslip) has been observed within the site.

The steepest section of the site lies immediately to the north of Eastern Road within the north-western section of the site. The section has previously been developed for rural and residential use and has obscured any surface evidence of soil creep (if present). Other than erosion-triggered localised slumping from the low height banks of Eastern Creek and Bungarribee Creek, there does not appear to be a significant risk of stream bank instability. It is considered that hillslope and stream bank instability do not impose significant constraints on the proposed site development.

A stability hazard map has not been prepared as no stability hazard was apparent within the site.

10.2 Erosion Potential

Water erosion hazard forms a landscape limitation for the South Creek Soil Landscapes (Ref. 4). Soils of the Blacktown Soil Landscape are typically of moderate erodibility (K values of 0.02 – 0.04). The more sodic or saline soils of the Blacktown soil landscape can have high erodibility and the erosion hazard for this landscape is estimated as moderate to very high (Ref. 4).

It is considered that the erosion hazard within the areas proposed for residential and industrial would be within usually accepted limits which could be managed by good engineering and land management practices.

The site inspections identified several shallow gullies entrenching recent alluvial deposits within stream courses and the residual soil profiles. Localised areas of sheet erosion are also noted in areas of previous surface disturbance.

It is anticipated that the treatment of the existing gullies as part of an overall site development would include:

- filling using select materials (i.e. non–dispersive or erodible) placed under controlled conditions;
- provision of temporary surface cover (e.g. pegged matting) during the period of gully floor revegetation;
- channel lining in sections of rapid change in gully floor grade;
- piping of flow where appropriate;
- the re-establishment of a zone of tree cover along gully banks.

10.3 Soil Salinity

10.3.1 Assessment of Salinity Risks

Three means of assessment of soil salinity were adopted:

- Visible indicators of salinity mapped during a geological inspection;
- EC_e measurements of soil samples from test pits; and
- EC_e estimates derived from 42,000 EM31 apparent conductivity measurements at 2.5 m sample spacings on an approximate 100 m x 100 m grid over the investigation area.

It is considered that no single means of assessment is sufficient due to spatial sampling and other limitations. However, a joint assessment can provide a practical means of defining areas where there is a risk that urban development will be affected by soil salinity, or will adversely affect the salinity of the environment.

Drawing 8 presents the topographic contours overlain with:

- locations of visible salinity indicators;
- test pit locations (with moderate and high salinity locations classified by colour); and
- 4 dS/m apparent EC_e contours (enclosing zones of moderate or greater apparent salinity).

On the basis of these factors, areas of moderate or greater salinity risk have been inferred and outlined. When considering the results, it should be noted that high apparent salinities to the east of Pits 11, 12 and 13 result from steel fences and are not included in risk assessment.

Within the areas identified in Drawing 8, it is recommended that strategies be employed for the management of moderate or greater salinity.

10.3.2 Salinity Management Strategies

In general the salinity study indicates that the high salinity potential inferred by DIPNR (2003, Ref 10) for the lower slopes and drainage areas of Eastern Creek is not realised, with only moderate salinity expected in limited areas, generally east of Eastern Creek.

Elsewhere within the investigation area, non-saline to slightly saline conditions predominate. Efforts should be made however throughout the area to prevent or restrict changes to the water balance that will result in rises in groundwater levels, bringing more saline water closer to the ground surface. As a precaution, development must be planned to mitigate against the effects of any potential salinisation that could occur.

These efforts need to be directed at all levels of the development process including:

- site design, vegetation and landscaping;
- commercial building and infrastructure construction.

In general, the following strategies are directed at:

- maintaining the natural water balance;
- maintaining good drainage;
- avoiding disturbance or exposure of sensitive soils;
- retaining or increasing appropriate native vegetation in strategic areas;
- implementing building controls and engineering responses where appropriate.

10.3.3 Site Design, Vegetation and Landscaping

Planning for the development of the site requires careful management with a view to controlling drainage and infiltration of both surface waters and groundwater to prevent rises in groundwater levels and minimise the potential for erosion.

Precautionary measures to reduce the potential for salinity problems include:

- Avoiding water ponding in low-lying areas along shallow creeks, floodways, in ponds, depressions, or behind fill embankments or near trenches on the uphill sides of roads. This can lead to water logging of the soils, evaporative concentration of salts, and eventual breakdown in soil structure resulting in accelerated erosion.

- Roads and the shoulder areas should also be designed to be well drained, particularly with regard to drainage of surface water. There should not be excessive concentrations of runoff or ponding that would lead to waterlogging of the pavement or additional recharge to the groundwater. Road shoulders should be included in the sealing program.

- Surface drains should generally be provided along the top of batter slopes of greater than 2.5 m height to reduce the potential for concentrated flows of water down slopes possibly causing scour. Well graded subsoil drainage should be provided at the base of all slopes where there are road pavements below the slope to reduce the risk of waterlogging.

- With regard to regrading within the development footprint, a minimum surface slope of 1V:40H is suggested in order to improve surface drainage and reduce ponding and waterlogging, which can lead to evaporation and salinisation. Consideration should also be given to regrading (steepening) of natural slopes outside the development footprint, where this will improve overall drainage without creating additional erosion hazards.

- Where possible, materials and waters used in the construction of roads and fill embankments should be selected to contain minimal or no salt. This may be difficult for cuts and fills in lower areas where saline soils are exposed in cut or excavated then placed as filling. Under these circumstances and where salinisation could be a problem, a capping layer of either topsoil or sandy materials should be placed to reduce capillary rise, which will also act as a drainage layer and reduce the potential for dispersive behaviour in any sodic soils.

- Gypsum should be mixed into filling containing sodic soils and cuts where sodic soils are exposed on slopes to improve soil structure.

- Salt tolerant grasses and trees should be considered if re-planting close to creeks and in areas of moderate and greater salinity to reduce soil erosion and maintain the existing evapotranspiration and groundwater levels. Reference should be made to an experienced landscape planner or agronomist.

10.3.4 Commercial Building and Infrastructure Construction

The extent of measures adopted during construction, in particular the concrete, masonry and steel requirements, should depend on the level of salinity, aggressivity or corrosivity at the site.

Soil from specific building sites or services alignments which are impacted by Salinity Risk (as shown on Drawing 8) should be sampled, tested and classified for soil salinity, aggressivity and corrosivity to the proposed depth of excavation. Additional investigation should include analysis of pH, electrical conductivity, TDS, sodicity, and sulphates and chlorides. At least one groundwater bore per risk area must be installed. This investigation will identify any highly saline sites not identified in this preliminary study.

If any potentially highly saline or aggressive areas are identified in the above investigations, higher than normal strength concrete or sulphate resistant cement may need to be considered in order to reduce the risk reinforcement corrosion in concrete slabs. A minimum of 65 mm of concrete cover on slab reinforcement, appropriate compaction and curing of concrete are also suggested to produce a dense, low-permeability concrete.

In general, for the construction of buildings or infrastructure (buried services) in areas of Salinity Risk (as shown on Drawing 8), the following are suggested:

- Use of a thick layer of sand (say 100 mm minimum) followed by a membrane of thick plastic is recommended under the concrete slab to act as a moisture barrier and drainage layer to restrict capillary rise under the slab.

- As an alternative to slab on ground construction, suspended slab or pier and beam construction should be considered, particularly on sloping sites as this will minimise exposure to potentially aggressive/corrosive soils and reduce the potential cut and fill on site which could alter subsurface flows.

- Other measures that can be considered to improve the durability of concrete in saline environments include reducing the water cement ratio (hence increasing strength), minimising cracks and joins in plumbing on or near the concrete, reducing turbulence of any water flowing over the concrete and using a quality assurance supplier.

- It is essential that in all masonry buildings that a brick damp course be installed so that it cannot be bridged either internally or externally. This will prevent moisture moving into brickwork.

- There are various exposure classifications and durability ratings for the wide range of masonry available. Reference should be made to the supplier in choosing suitable bricks of an appropriate exposure quality. Water proofing agents can also be added to mortar to further restrict potential water movement.

- In areas of elevated salinity, bricks that are not susceptible to damage from salt water should be used. These are generally less permeable, do not contain salts during their construction, and have good internal strength so that they can withstand any stress imposed on them by any salt encrustation.

- Consideration could be given to use of infrastructure service lines (that will be deeper than say 1.2 m), to promote subsurface drainage by incorporating slotted drainage pipes fitting into the stormwater pits in lower areas where pipe invert levels are within about 1 m of existing groundwater levels.

- Service connections and stormwater runoffs should be checked to avoid leaky pipes which may affect off site areas lower down the slope and increase groundwater recharge resulting in increases in groundwater levels.

- Where moderately saline conditions are mapped and site-specific tests confirm aggressive/corrosive conditions, consideration should be given to use of higher grade (more resistant) materials in all underground service lines.

10.4 Soil Contamination Potential

Phase 1 environmental assessments were undertaken by DP on Parcel 2 Rooty Hill and Parcel 4: West Huntingwood, details of which are given in separate reports (Project 40465-1, 40465-2) which are provided in Appendix F.

In summary, the site history and walkover inspections indicated that the sites had been used primarily for rural, intensive agricultural and residential purposes. Uses included poultry farming and market gardening, which may have resulted in widespread contamination. Numerous fibreboard structures were noted on site which may have resulted in asbestos contamination.

Due to the early subdivision of the lots and large number of lots on each site (25 and 23 for Parcels 2 and 4 respectively), assessment was made on a lot-by-lot basis. Based on the results of the site walk-over and site history investigations, each lot was assigned a contamination risk factor as shown in Table 7 and Table 8.

Any further contamination-based work on Parcel 2 and Parcel 4 must be undertaken in accordance with all of the recommendations made in the individual Stage 1 Environmental Assessments (Project 40465-1 and 40465-2, respectively).

The following sections summarise the contamination related findings for each of the relevant Parcels.

10.4.1 Parcel 2 – Rooty Hill

Based on the results of the site walk over and site history investigations each lot was assigned a contamination risk factor of high, medium or low. Taking into account the proposed residential reuse of the land suitable management strategies were developed based on the contamination risk.

Table 7 - Risk Categories: Parcel 2

Low Risk		Medium Risk		High Risk	
Lot 7, DP 806052	1.03 ha	Lot 54, DP 8995	0.32 ha	Lot 11, DP 806052	0.13 ha
Lot 8, DP 806052	0.34 ha	Lot 57, DP 8995	0.32 ha	Lot 12, DP 806052	0.47 ha
Lot 9, DP 806052	Inc with 9	Lot 30, DP 8995	2.4 ha	Lot 13, DP 806052	0.47 ha
Lot 53, DP 8995	0.32 ha	Lot 31, DP 8995	Inc with 30	Lot 14, DP 806052	Inc with
Lot 34, DP 8995	0.48 ha	Lot 32, DP 8995	Inc with 30	Lot 55, DP 8995	0.32 ha
Lot 35, DP 8995	0.48 ha	Lot 33, DP 8995	Inc with 30	Lot 56, DP 8995	0.32 ha
Lot 45, DP 8995	0.48 ha	Lot 36, DP 8995	1.9 ha		
Lot 46, DP 8995	0.48 ha	Lot 43, DP 8995	0.48 ha		
		Lot 44, DP 8995	0.48 ha		
		Lot 5, DP 806052	0.63 ha		
		Lot 6, DP 806052	Inc with 5		
		Lot 10, DP 806052	0.46 ha		
Total 8 lots (3.61 ha)		Total 12 lots (6.99 ha)		Total 6 lots (1.71 ha)	
Percentage of Lots 31%		Percentage of Lots 46%		Percentage of Lots 23%	
Percentage of Area 29 %		Percentage of Area 57%		Percentage of Area 14 %	

Inc with – Included with lot number listed as a total area.

Taking into account the proposed residential reuse of the land, the following management strategies are recommended:

Low Risk: Low risk sites will be sampled on a grid basis at a rate of 6 test locations per hectare. Investigations would involve the excavation of test pits and sample collection at regular depth intervals. Samples will be analysed for the full EPA suite of contaminants.

Medium Risk: Medium risk sites will be sampled on a judgemental basis at a rate of 6 test locations per hectare. Investigations would involve the excavation of test pits and sample collection at regular depth intervals. Samples will be analysed for the full EPA suite of contaminants including asbestos.

High Risk: lots designated high risk will be subjected to full EPA density sampling across the site as well as judgemental sampling in areas around identified AEC. Investigations would involve the excavation of test pits and sample collection at regular depth intervals. Samples will be analysed for the full EPA suite of contaminants including asbestos.

10.4.2 Parcel 4 – West Huntingwood

Based on the results of the site walk over and site history investigations each lot was assigned a contamination risk factor of high, medium or low. Taking into account the proposed residential reuse of the land suitable management strategies were developed based on the contamination risk.

Table 8 - Risk Categories: Parcel 4

Low Risk		Medium Risk		High Risk	
Lot 4, DP 327540	0.75 ha	Lot 99 DP1030393	1.4 ha	Lot 1, DP 802277	4.4 ha
Lot 5, DP 327540	0.75 ha	Lot 100 DP1030393	Inc with	Lot 7, DP 913820	4.0 ha
Lot 5, DP 913789	3.9 ha	Lot 101 DP1030393	1.1 ha		
Lot 8A DP 391499	2.0 ha	Lot 1, DP976165			
Lot 8B DP 391499	2.0 ha	Lot 4, DP976165	3.8 ha		
Lot 2, DP244378	9.6 ha	Lot 17, DP 666798	2.0 ha		
Lot 1, DP 171732	3.8 ha	Lot 1, DP 916147	2.0 ha		
		Lot 1, DP 915115	4.0 ha		
		Lot B DP 108398	1.8 ha		
		Lot4A DP 378122	2.1 ha		
		Lot B, DP 371678	3.7 ha		
		Lot C, DP 371678	1.9 ha		
		Lot AX, DP 374284	0.94 ha		
		Lot AY, DP 374284	0.93 ha		
Total 7 lots (22.9 ha)		Total 14 lots (10.3 ha)		Total 2 lots (8.4 ha)	
Percentage of Lots 30%		Percentage of Lots 61%		Percentage of Lots 9%	
Percentage of Area 55%		Percentage of Area 25%		Percentage of Area 20%	

inc with – Included with lot number listed as a total area.

Based on the findings of this Phase 1 Environmental Site Assessment, each lot has been classified as high, medium or low risk. Taking into account the proposed commercial reuse of the land, the following management strategies are recommended:

Low Risk: Low risk sites will be sampled on a grid basis at a rate of 4 test locations per hectare. Investigations would involve the excavation of test pits and sample collection at regular depth intervals. 50% of samples will be analysed for the full EPA suite of contaminants, and the remainder will be analysed for heavy metals and OC/OP Pesticides.

Medium Risk: Medium risk sites will be sampled on a judgemental basis at a rate of 4 test locations per hectare. Investigations would involve the excavation of test pits and sample collection at regular depth intervals. Samples will be analysed for the full EPA suite of contaminants including asbestos.

High Risk: lots designated high risk will be subjected to full EPA density sampling across the site as well as judgemental sampling in areas around identified AEC. Investigations would involve the excavation of test pits and sample collection at regular depth intervals. Samples will be analysed for the full EPA suite of contaminants including asbestos.

10.4.3 Parklands Precinct and Parcel 3 (Doonside)

This site has been signed off for residential reuse (and less sensitive, ie parks and open space) under a separate audit report. Current assessment examined only contaminating activities since the finalisation of the previous report. Numerous stockpiles of building rubble were noted in the site walkover as documented within. Clean up of the site will therefore be required prior to redevelopment. The amount of dumping on site should not present a constraint to development.

Logged stockpiles and waste dumps will require removal to a suitably licensed waste facility and validation testing prior to site development.

10.5 Preliminary Minerals Assessment

Harvest Scientific Services were commissioned to undertake a preliminary minerals assessment of the site. The results of this work are given in detail in the report (Reference 200624) included in Appendix G. A summary of the principal findings is given below.

The site is underlain by the Illawarra Coal Measures which provide a commercially viable resource elsewhere in the Sydney Basin. However, these coal seams are located deep below the site (in the order of 600 m), and it is highly unlikely that they would become commercially viable. It is understood that there are no proposals (by BHP-Billiton) or others to mine coal in this area within the next 30 years or so, and the lack of exploration in the area suggests that there is a low level of interest in it as a potential resource.

Similarly, resources of coal-bed methane are present within the underlying coal seams but are currently not subject to plans for extraction. The feasibility of extraction however, would depend upon detailed exploration and analysis which take into consideration economic, environmental and technical aspects. The potential for petroleum extraction, has also received some attention in the Western Sydney area, again, it is highly unlikely that viable quantities are present beneath the site.

Another potential mineral resource within the site is in clay and shale for brick making. The Bringelly Shale that underlies the site is used elsewhere in Western Sydney as a source of material for this industry. Furthermore, the site is located close to brick manufacturing plants and a ready market for the finished product. It is suggested that the use of this resource could be considered before releasing the land for other uses. Volcanic material with potential value as concrete aggregate may also be present near Parcel 2, but is not considered to be present on site in viable quantities.

10.6 General Development Considerations

10.6.1 Site Classification

Classification of residential lots within the site should comply with the requirements of AS 2870 – 1996 *"Residential Slabs and Footings"* (Ref. 11). Based on the limited work for the current investigation, the subsurface profiles at most locations are as would be expected for Class M (moderately reactive) and Class H (highly reactive) sites.

The investigation has indicated the presence of ironstone gravel and saturated silt at 1 m depth within Pit 11 (in the vicinity of a watercourse), and as such, would also result in a P classification. Notwithstanding this, residential construction would be relatively straightforward utilising the underlying stiff clays or weathered rock for foundation support. However, as stiff clays/rock was below termination depths of Pit 11, additional investigation should be undertaken at the appropriate time to determine depths to a suitable founding strata.

10.6.2 Footings

All footing systems should be designed and constructed in accordance with AS 2870 – 1996 (Ref. 11) for the appropriate classification. Conventional high level footing systems would be appropriate for M or H sites. Suitable foundation systems for Class P lots could include (depending on the depth of suitable founding stratum and the presence of groundwater) backhoe excavated blockdowns, pier and beam, screw piles or possibly driven timber piles founding on the underlying stiff clays or weathered rock.

10.6.3 Site Preparation and Earthworks

Site preparation for the construction of residential structures should include the removal of topsoils and other deleterious materials from the proposed building areas.

In areas that require filling, the stripped surfaces should be proof rolled in the presence of a geotechnical engineer. Any areas exhibiting significant deflections under proof rolling should be appropriately treated by over-excavation and replacement with low plasticity filling placed in near horizontal layers no thicker than 250 mm compacted thickness. Each layer should be compacted to a minimum dry density ratio of 98% relative to standard compaction with placement moisture contents maintained within 2% of standard optimum. The upper 0.5 m in areas of pavement construction should achieve a minimum dry density ratio of 100% relative to standard compaction.

All batters should be constructed no steeper than 3:1 (horizontal:vertical) and appropriately vegetated to reduce the effects of erosion.

To validate site classifications, sufficient field inspections and in-situ testing of future earthworks should be undertaken in order to satisfy the requirements of a Level 1 inspection and testing service as defined in AS 3798 – 1996 (Ref. 12).

Earthworks required for pavement construction will need to be based on batters formed no steeper than 3:1 (H:V) in the residual clays. All batters should be suitable protected against erosion with toe and spoon drains constructed as a means of controlling surface flows on the batters.

10.6.4 Site Maintenance and Drainage

The developed residential lots should be maintained in accordance with the CSIRO publication *"Guide to Home Owners on Foundation Maintenance and Footing Performance"*, a copy of which is included in Appendix H. Whilst it must be accepted that minor cracking in most structures is inevitable, the guide describes suggested site maintenance practices aimed at minimising foundation movement to keep cracking within acceptable limits.

Adequate surface drainage should be installed and maintained at the site. All collected stormwater, groundwater and roof runoff should be discharged into the stormwater disposal system.

10.6.5 Pavements

Preliminary Thickness Designs:

Table 9 summarises a range of pavement thickness designs based on the procedures given in APRG – SR 21 (Ref. 13) for varying traffic loadings and subgrade CBR values.

Table 9 – Preliminary Pavement Thickness Design

Traffic Loading (ESA)	Total Pavement Thickness (mm)			
	CBR <3%	CBR 3%	CBR 4%	CBR 5%
5×10^4	440 (590)	440	370	320
1×10^5	470 (625)	470	395	340
1×10^6	550 (700)	550	470	390

Bracketed figures in Table 9 indicate total boxing depth, taking into account 150 mm of subgrade replacement with granular material with CBR ≥ 20%

The pavement should be placed and compacted in layers no thicker than 150 mm with control exercised over placement moisture contents. If layer thicknesses greater than 150 mm are proposed, it may be necessary to test the top and bottom of the layer to ensure that the minimum level of compaction has been achieved through the layer.

Suggested material quality and compaction requirements are given in Table 10.

Table 10 – Materials and Compaction

Layer	Material Quality	Minimum Compaction
Wearing Course	To conform to APRG requirements	To conform to APRG requirements
Base Course	To conform to APRG requirements Soaked CBR ≥ 80%, PI ≤ 6% or Council requirements	Minimum dry density ratio of 98% Modified (AS 1289 Test 5.2.1)
Sub-base Course	To conform to APRG requirements Soaked CBR ≥ 50%, PI ≤ 12% or Council requirements	Minimum dry density ratio of 95% Modified (AS 1289 Test 5.2.1)
Subgrade		Minimum dry density ratio of 100% Standard (AS 1289 Test 5.1.1)

Where PI = plasticity index

Whilst the use of lesser quality pavement materials than that detailed in Table 10 may be feasible, some compromise in either performance and/or pavement life must be anticipated and accepted. It is also suggested that advice be sought from Council if lesser quality pavement materials are proposed.

Drainage: Adequate surface and subsoil drainage should be installed and maintained to protect the pavement and subgrade. The subsoil drains should be located at a minimum of 0.5 m depth below the excavation level. Guidelines on the arrangement of subsoil drainage are given on Page 20 of ARRB – SR41 (Ref. 14).

11. SUMMARY OF LAND CAPABILITY FOR SITE DEVELOPMENT

No evidence of hillslope instability was observed within the site. It is considered that hillslope and stream bank instability do not impose significant constraints on the proposed site development.

The presence of erosive soils on site should not present significant constraints to development provided they are well managed during earthworks and site preparation stages. Gully erosion already present on site should be remediated during site works as discussed earlier in Section 10.2.

Salinity Risk across the site is generally low with some areas of salinity risk noted. Development within identified Risk Areas should be undertaken in accordance with the guidance given in Sections 10.3.2 to 10.3.4.

Soil contamination risk across the site is generally low. However, a range of further investigations in Parcel 2 and 4 will be required to assess the actual degree of contamination present on site. That said, it is not anticipated that soil contamination will present a constraint to development and any areas of contamination identified, once remediated, will be suitable for the proposed land use. Illegal dumping of waste material and soil across Parcel 3 and the Parklands Precinct will require removal to a suitably licensed waste facility and validation testing prior to site development.

The presence of an economic coal resource underlying the site indicates that future coal mining activity may form a constraint to development. The likelihood of mining is very low, and at current knowledge of mining activity within the region it is anticipated that it would not occur for in excess of 30 years, if ever.

12. FURTHER INVESTIGATION

Further investigation will be required as conceptual design/planning progresses together with additional work during the construction phase. Specific investigation would include (but not necessarily limited to):

- Removal of dumped material and validation from Parcel 3 and Parklands Precinct.
- Preparation of a Contamination Management Plan in accordance with the HLA audit report
- Detailed environmental investigation (comprising subsurface sampling and laboratory testing) in the nominated areas of environmental concern, primarily in those areas which lie within the proposed “development footprint”. The purpose of this work would be to quantify the level of contamination (if any) and delineate contaminated areas in order to facilitate the preparation of remediation action plans (RAP).
- Remediation and validation monitoring of areas subject to an RAP, to render such areas appropriate for the proposed land use, from the contamination viewpoint.
- Additional investigation should be undertaken in development areas which are impacted by salinity risk. Investigations should include installation of at least one permanent monitoring bore per risk area, as well as analysis of soil and water pH, electrical conductivity, TDS, sodicity, and sulphates and chlorides.
- Installation of groundwater bores well in advance of construction and monitoring/sampling/analysis before, during and after construction, to assess changes in soil water quality as a result of the development. The bores would be strategically located at exit points from the site into the Eastern Creek system.
- Routine inspections and earthworks monitoring during construction.
- Detailed geotechnical investigations on a stage-by-stage basis for determination of pavement thickness designs and lot classifications.

13. LIMITATIONS OF THIS REPORT

DP's assessment is necessarily based upon the result of a site history search and limited site inspection that was set out in the original proposal. Neither DP, nor any other reputable consultant, can provide unqualified warranties nor does DP assume any liability for site conditions not observed, or accessible during the time of the investigations.

Despite all reasonable care and diligence, site characteristics may change at any time in response to variations in natural conditions, chemical reactions and other events, e.g. groundwater movement and or spillages of contaminating substances. These changes may occur subsequent to DP's investigations and assessment.

This report and associated documentation have been prepared for the use of Landcom and DIPNR, owners of the site. The report was prepared in accordance with a specific scope of works. It is the responsibility of any third parties to investigate fully to their satisfaction if any information prepared by DP is suitable for their specific objective.

Before passing on to a third party any information or a report prepared by DP, the Client is to inform fully the third party of the objective and the scope, and all limitations and conditions, under which the reports were prepared.

Any reliance assumed by third parties on this report outside of the stated scope shall be at such parties' own risk. Any ensuing liability resulting from this use of the report by third parties cannot be transferred to DP.

DOUGLAS PARTNERS PTY LTD — Reviewed by:

C C Kline
Project Engineer

pp: **T J Wiesner**
Principal

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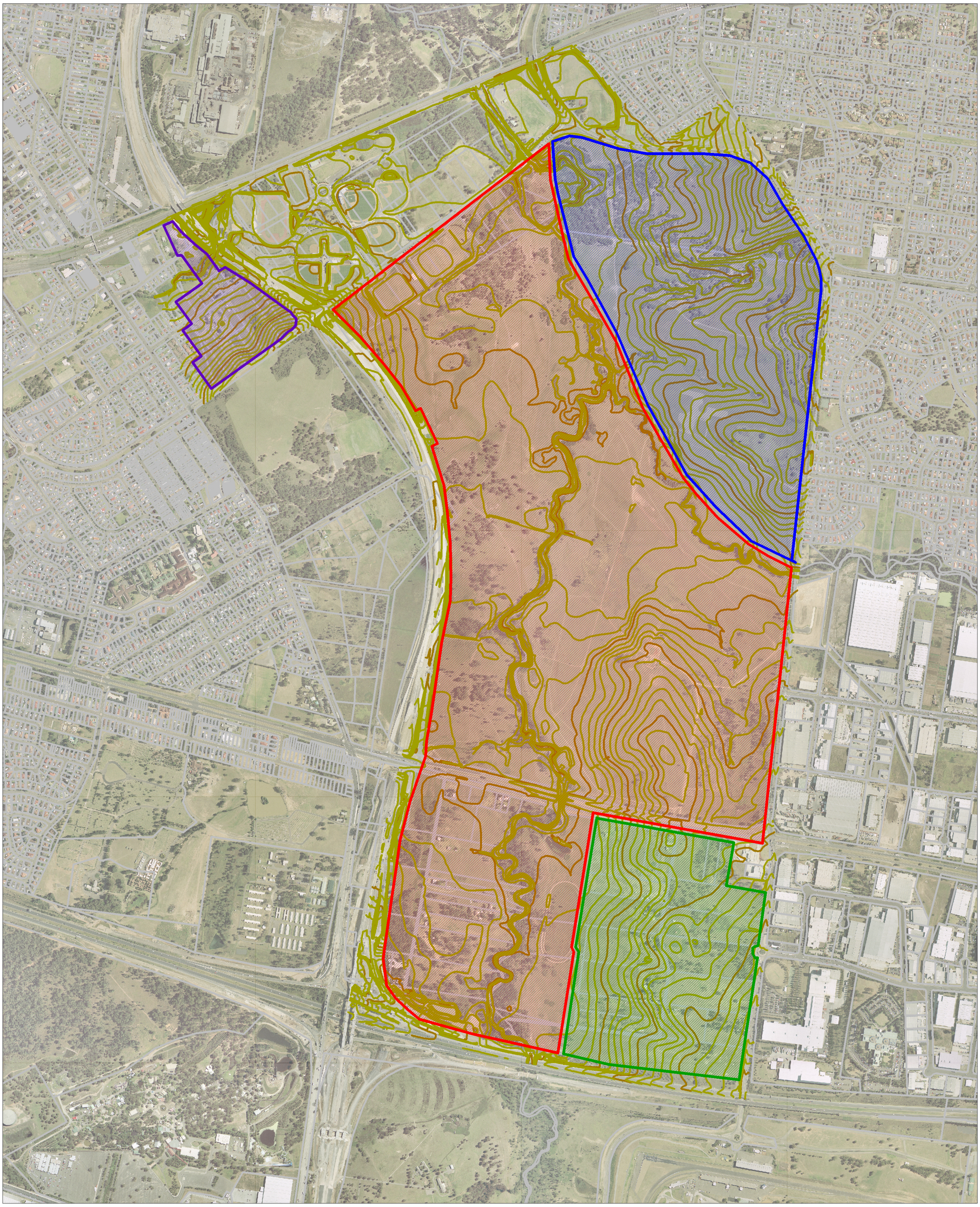


LEGEND

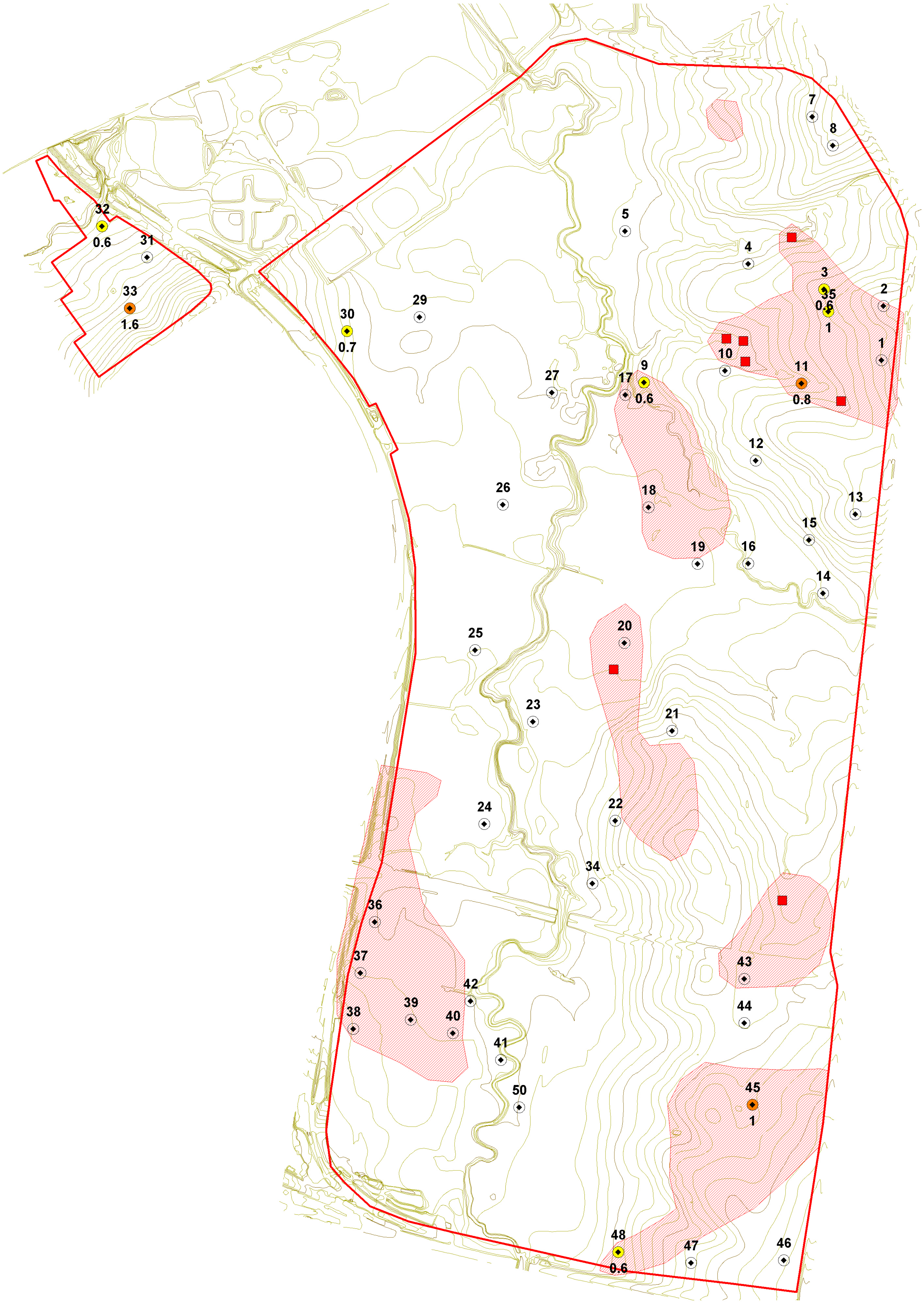
- Parcel 2 Boundary
- Parcel 3 Boundary
- Parcel 4 Boundary
- Parklands Precinct Boundary
- Major Contour (5m)

Douglas Partners
Geotechnics · Environment · Groundwater

Sydney, Newcastle, Brisbane, Melbourne, Perth, Wyong, Campbelltown, Townsville Cairns, Wollongong

NORTH

TITLE: Site Boundaries Land Capability Assessment, Proposed Development, Western Sydney Parklands			
CLIENT: Landcom			
DRAWN BY: CCK	SCALE: 1:15 000	PROJECT No: 40465	OFFICE: WOLLONGONG
APPROVED BY:		DATE: 26 October 2005	DRAWING No: 1



LEGEND

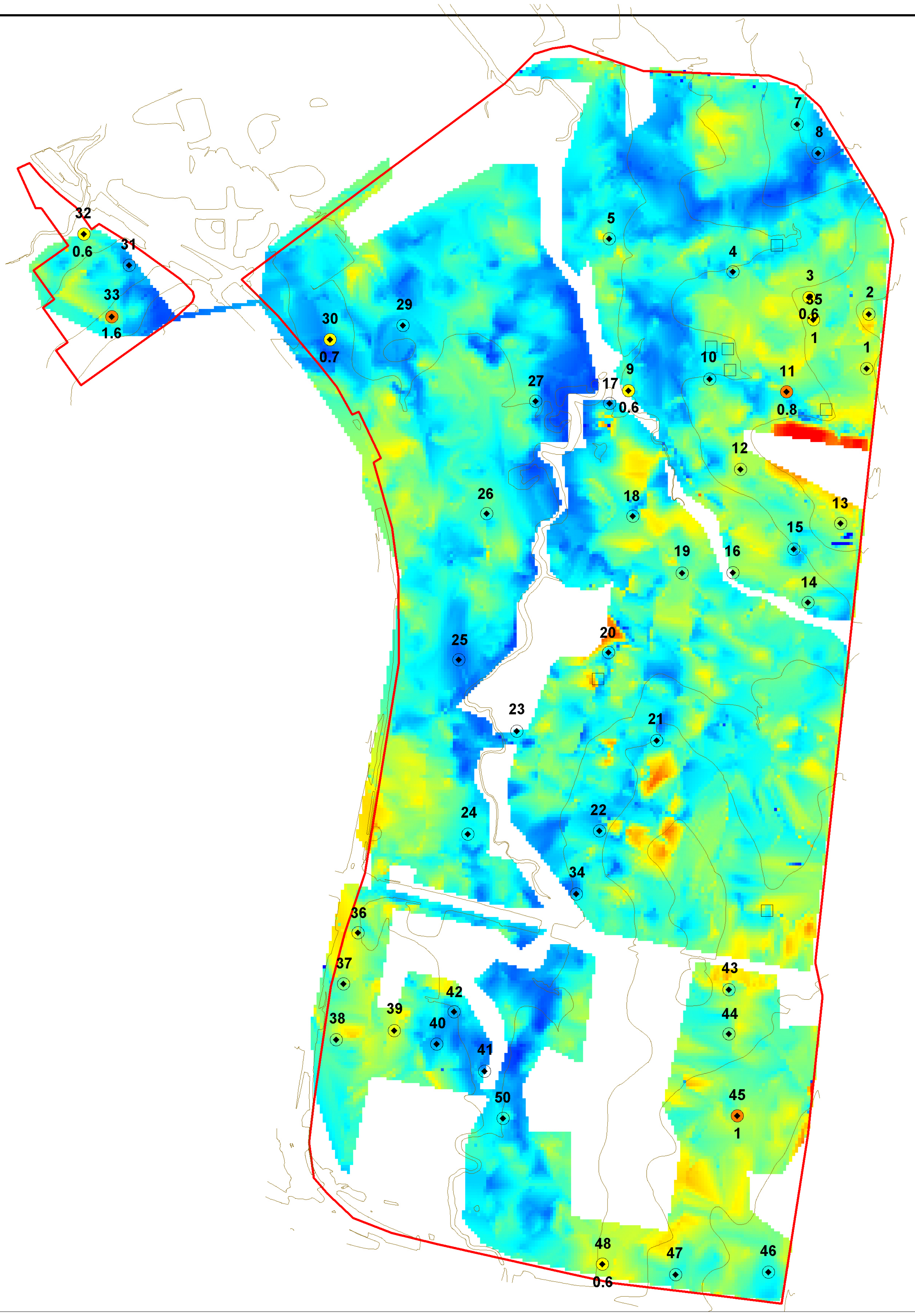
- Salinity Risk Area
- Saline Scald
- Test Pit Location
- Saline Test Pit Location
- Highly Saline Test Pit Lcoation

Douglas Partners
Geotechnics • Environment • Groundwater

Sydney, Newcastle, Brisbane, Melbourne, Perth, Wyong, Campbelltown, Townsville Cairns, Wollongong

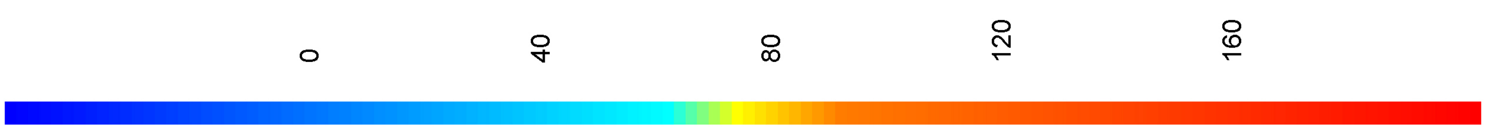
TITLE: Salinity Risk Areas
Land Capability Assessment,
Proposed Development,
Western Sydney Parklands

CLIENT:	Landcom						
DRAWN BY:	CCK	SCALE:	1:12000	PROJECT No:	40465	OFFICE:	WOLLONGONG
APPROVED BY:				DATE:	26 October 2005	DRAWING No:	8



Apparent Conductivity Grid Image Interpolated from EM31 Data

mS/m



LEGEND

Salinity Risk Area

Saline Scald

Test Pit Location

Saline Test Pit Location

Highly Saline Test Pit Lcoation

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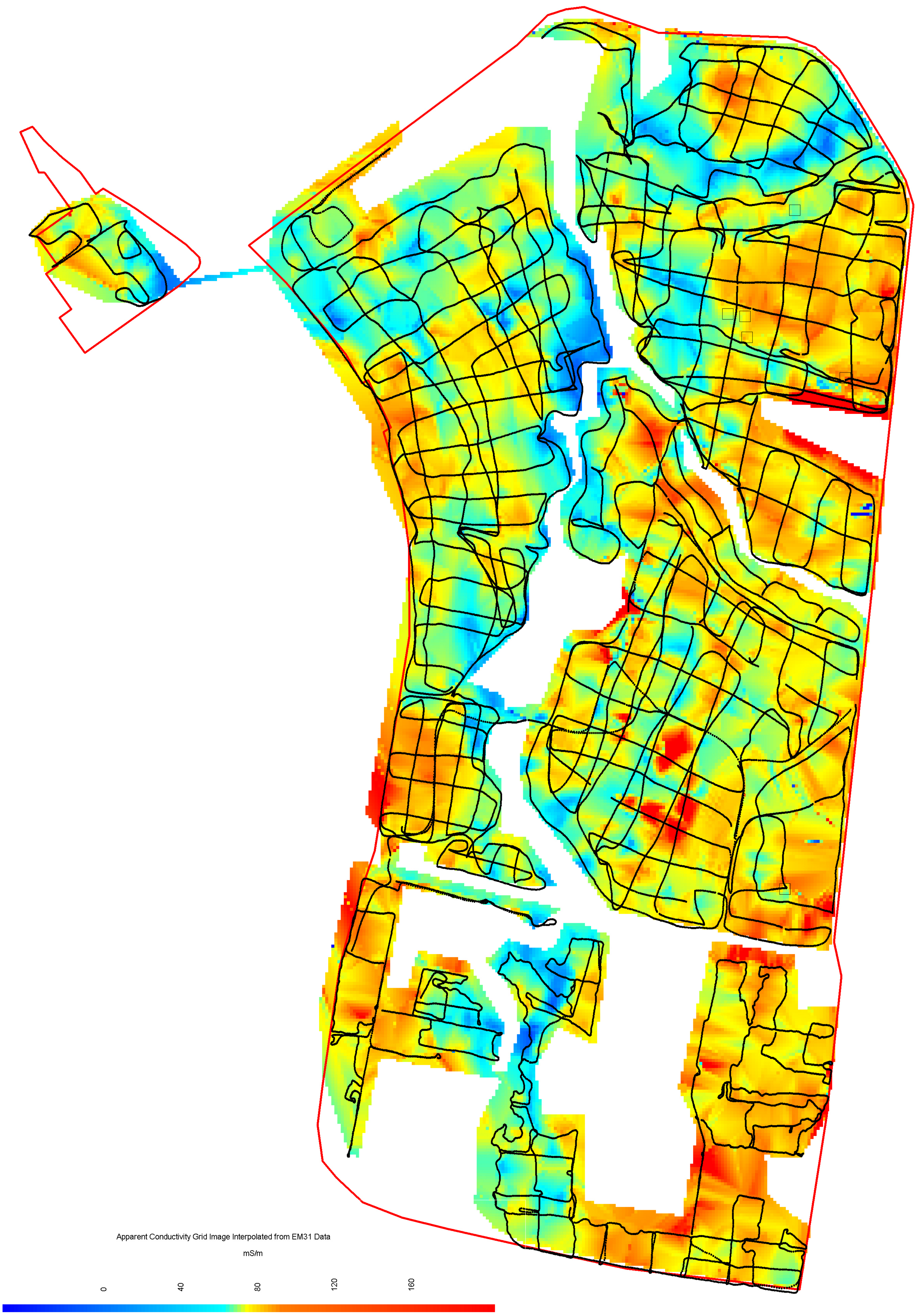
Sydney, Newcastle, Brisbane, Melbourne, Perth, Wyong, Campbelltown, Townsville Cairns, Wollongong

TITLE: Salinity Risk Areas
Land Capability Assessment,
Proposed Development,
Western Sydney Parklands

CLIENT: Landcom			
DRAWN BY: CCK	SCALE: 1: 12000	PROJECT No: 40465	OFFICE: WOLLONGONG
APPROVED BY:		DATE: 26 October 2005	DRAWING No: 7



LEGEND

Site Boundary

Path of Quadbike

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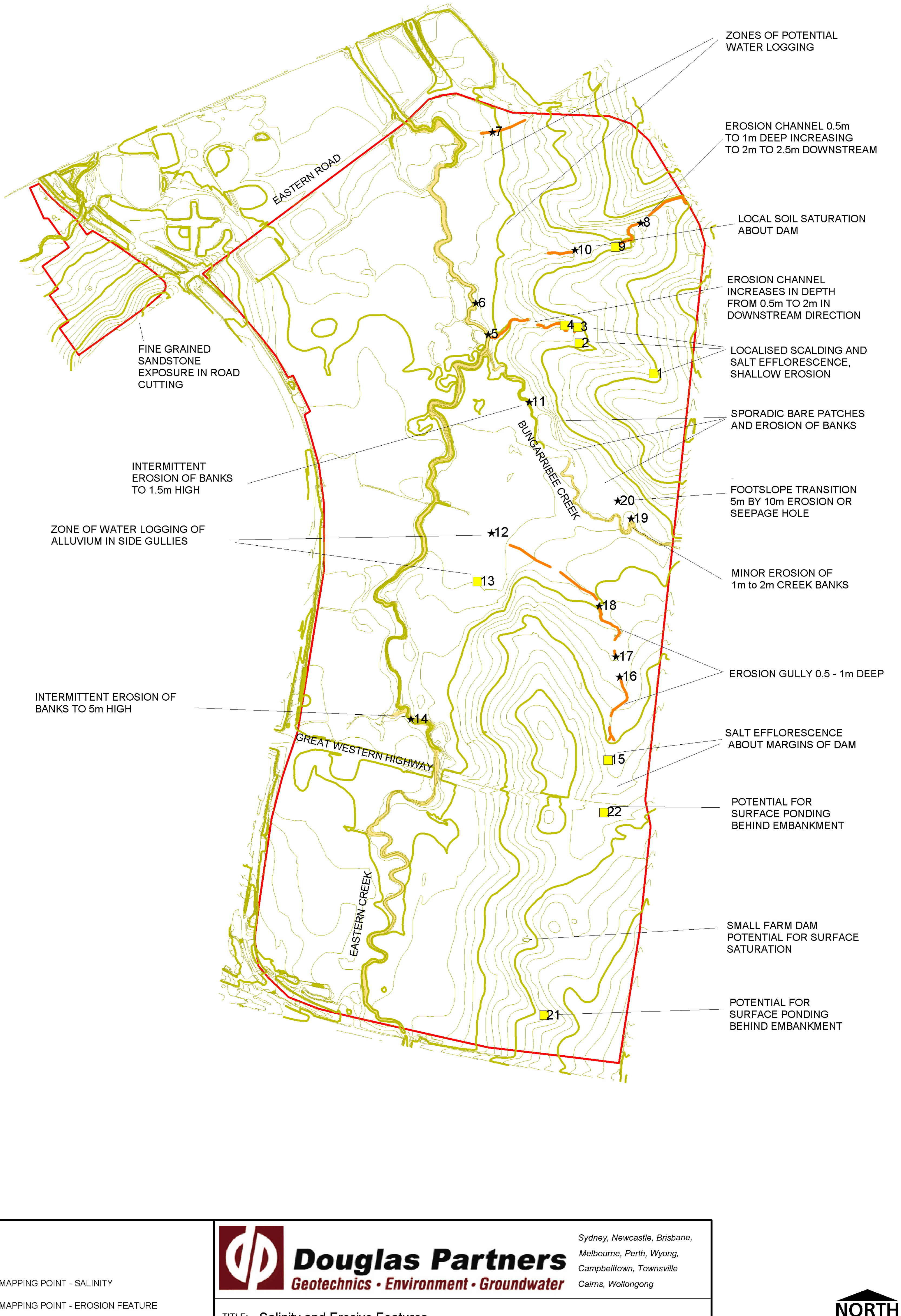
Geotechnics · Environment · Groundwater

Sydney, Newcastle, Brisbane, Melbourne, Perth, Wyong, Campbelltown, Townsville Cairns, Wollongong

TITLE: Apparent Electrical Conductivity and Track Plot
Land Capability Assessment,
Proposed Development,
Western Sydney Parklands

CLIENT: Landcom			
DRAWN BY: CCK	SCALE: 1:12000	PROJECT No: 40465	OFFICE: WOLLONGONG
APPROVED BY:		DATE: 26 October 2005	DRAWING No: 6



LEGEND

- MAPPING POINT - SALINITY
- ★ MAPPING POINT - EROSION FEATURE
- EROSION CHANNEL IN SIDE GULLY
- DISCONTINUOUS EROSION OF CREEK BANKS
- SITE BOUNDARY

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Sydney, Newcastle, Brisbane, Melbourne, Perth, Wyong, Campbelltown, Townsville Cairns, Wollongong

TITLE: Salinity and Erosive Features
Land Capability Assessment,
Proposed Development,
Western Sydney Parklands

CLIENT: Landcom			
DRAWN BY: CCK	SCALE: 1:15000	PROJECT No: 40465	OFFICE: WOLLONGONG
APPROVED BY:		DATE: 26 October 2005	DRAWING No: 5

LEGEND

Site Boundary

Test Pit Location

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TITLE: Test Pit Locations
Land Capability Assessment,
Proposed Development,
Western Sydney Parklands

CLIENT: Landcom			
DRAWN BY: CCK	SCALE: 1:15 000	PROJECT No: 40465	OFFICE: WOLLONGONG
APPROVED BY:		DATE: 26 October 2005	DRAWING No: 4

NORTH

LEGEND

Rwb - Bringelly Shale

Qal - Quaternary Alluvium

Jvs - Jurrasic Volcanics

Minor Contour (1m)

Major Contour (5m)

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Sydney, Newcastle, Brisbane, Melbourne, Perth, Wyong, Campbelltown, Townsville Cairns, Wollongong

TITLE: Geology

Land Capability Assessment,
Proposed Development,
Western Sydney Parklands

CLIENT: Landcom			
DRAWN BY: CCK	SCALE: NTS	PROJECT No: 40465	OFFICE: WOLLONGONG
APPROVED BY:		DATE: 26 October 2005	DRAWING No: 3

NORTH

LEGEND

- Bt - Blacktown Soil landscape
- SC - South Creek Soil landscape
- Minor Contour (1m)
- Major Contour (5m)

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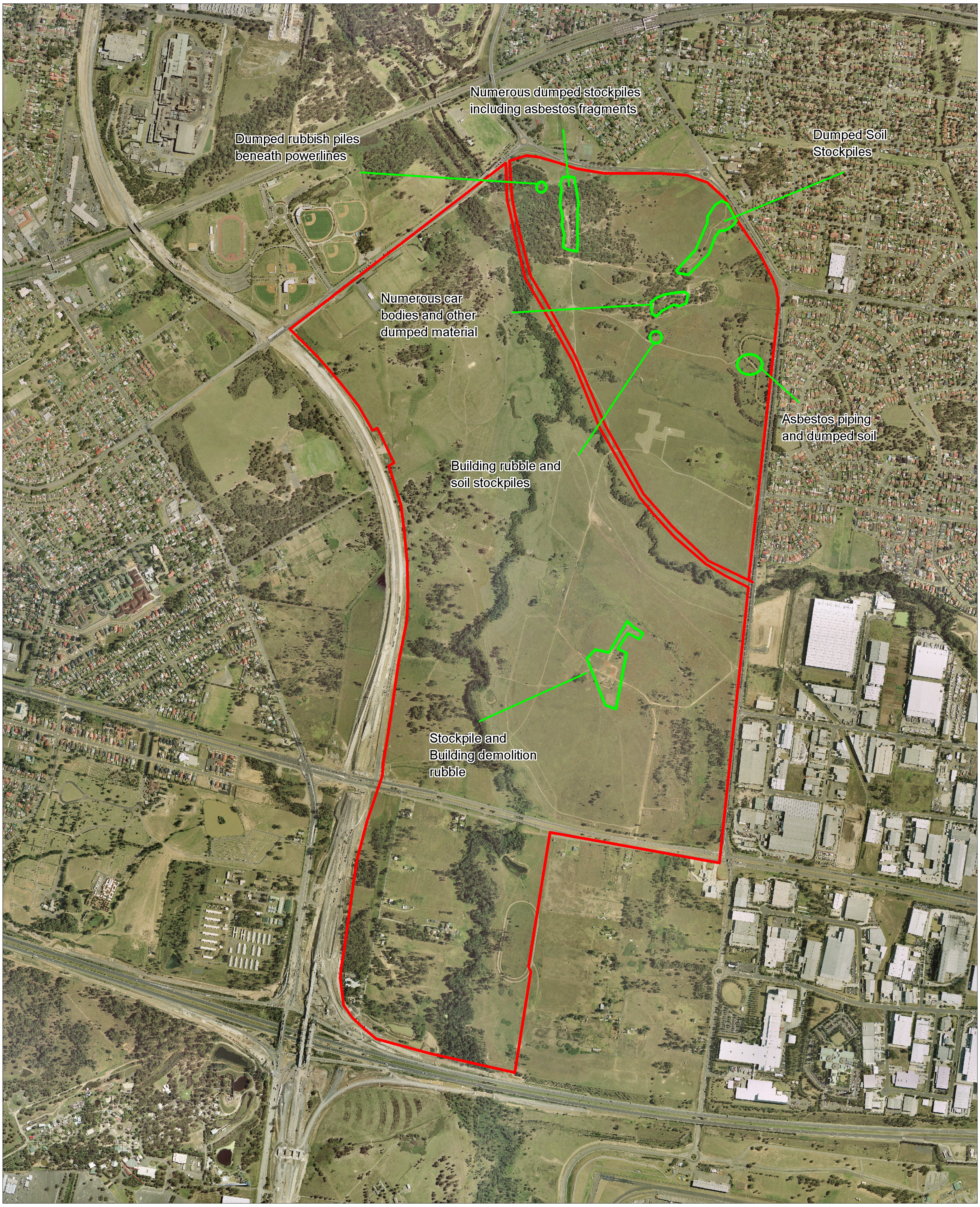
Sydney, Newcastle, Brisbane, Melbourne, Perth, Wyong, Campbelltown, Townsville Cairns, Wollongong

TITLE: Soil Landscapes
Land Capability Assessment,
Proposed Development,
Western Sydney Parklands

CLIENT: Landcom					
DRAWN BY: CCK	SCALE: NTS	PROJECT No:	40465	OFFICE:	WOLLONGONG
APPROVED BY:		DATE:	26 October 2005	DRAWING No:	2

NORTH



LEGEND

Parcel Boundary

Identified Contamination

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Sydney, Newcastle, Brisbane, Melbourne, Perth, Wyong, Campbelltown, Townsville Cairns, Wollongong

TITLE: Contamination Mapping - Parkland and Parcel 3
Land Capability Assessment,
Proposed Development,
Western Sydney Parklands

CLIENT:	Landcom						
DRAWN BY:	CCK	SCALE:	1:15 000	PROJECT No:	40465	OFFICE:	WOLLONGONG
APPROVED BY:				DATE:	26 October 2005	DRAWING No:	11

NORTH

PHOTO 1: Parcel 3. Grass vegetated, with remnant trees, gently undulating.

PHOTO 2: Drainage lines through the grass plains vegetated with salt resistant vegetation. Parcel 3.

PHOTO 3: Spiny Rush growing in salt affected area. Parcel 4.

PHOTO 4: Salt Efflorescence and salt resistant vegetation.

PHOTO 5: Spiny Rush growing in drainage depression. Parcel 3.

PHOTO 6: Spiny Rush and salt scalds. Western portion of the Parklands Precinct.

PHOTO 7: Infestation of Spiny Rush in a water logged, saline area. Parklands Precinct.

PHOTO 8: Water ponding and salt resistant vegetation. Parklands Precinct.

PHOTO 9: Eroded bank showing soil horizons A and B.

PHOTO 10: Possible asbestos pipe and small stockpiles. Parcel 3.

PHOTO 11: Disturbed area and soil stockpiles at crest of hill in Parklands Precinct.

PHOTO 12: Dumped cars and scrap. Parcel 3.

PHOTO 13: Dumped building rubble. Central portion of Parcel 3.

PHOTO 14: Dumped building rubble and scrap metal. Central portion of Parcel 3.

PHOTO 15: General dumped material. Central portion of Parcel 3.

PHOTO 16: Soil stockpiles. Northern portion of Parklands Precinct.

PHOTO 17: Soil stockpiles. Northern portion of Parklands Precinct.

PHOTO 18: Dumped rubbish western portion of Parklands Precinct, beneath powerlines.

PHOTO 19: Soil stockpiles, western portion of the Parklands Precinct.

PHOTO 20: Dumped asbestos sheeting, Central portion of Parklands Precinct.

PHOTO 21: Remnant slabs and asbestos sheeting, from building demolition, Parcel 2.

PHOTO 22: Dumped lagging, possible asbestos or other synthetic mineral fibre (SMF), Parcel 2.

PHOTO 23: General building rubble, near M7 alignment, Parcel 2

PHOTO 24: Dumped scrap and soil stockpiles, Parcel 2.

PHOTO 25: Small soil stockpile, Parcel 2.

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PHOTO 27: Creek running through Parcel 2.

PHOTO 28: Soil stockpiles near M7 Alignment

PHOTO 29: Soil stockpiles, Parcel 4.

PHOTO 30: Fibre board structure (possible asbestos). Parcel 4.

PHOTO 31: Soil stockpile, Parcel 4.

PHOTO 32: Dumped building rubble, Parcel 4.

PHOTO 33: Numerous soil stockpiles. Parcel 4.

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Geotechnical Environmental and Resource Consultants

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MINERALS ASSESSMENT FOR THE WESTERN SYDNEY PARKLANDS

Prepared for:

Douglas Partners Pty Ltd

Report Date: 28/9/2005

Job Reference: 200624

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MINERALS ASSESSMENT FOR THE WESTERN SYDNEY PARKLANDS

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Figure 1

Figure 2

Figure 3

MINERALS ASSESSMENT FOR THE WESTERN SYDNEY PARKLANDS

EXECUTIVE SUMMARY

Harvest Scientific Services was commissioned by Douglas Partners Pty Ltd to complete an assessment of mineral resources within three parcels of land (Parcels 2, 3 and 4) located at Eastern Creek known as “Parklands.” Mineral resources in this context includes coal, coal bed methane (CBM), natural gas and/or petroleum and extractive minerals such as clay and shale.

A number of data sources were reviewed, with most being attributable to publications of the Geological Survey of NSW.

The assessment found that whilst the subject area was underlain by a stratigraphic sequence conducive to the occurrence of the above type of resources, the potential for their development was considered to be remote. This was due either to the location of the subject site and/or the quality of the resources.

The Bringelly Shale which underlies all three parcels traditionally has provided clay and shale for the brick manufacturing industry and the potential for parcels 3 and 4 as a future source of this material should be considered given their size and strategic location within Western Sydney.

The assessment of the subject land in this report suffers from specific lack of technical information. Assumptions and inferences regarding any resource within the subject area is based on extrapolating proximal data and surface mapping carried out by the NSW Geological Survey.

MINERALS ASSESSMENT FOR THE WESTERN SYDNEY PARKLANDS

1.0 PROJECT BACKGROUND

Harvest Scientific Services was commissioned by Douglas Partners Pty Ltd to complete a review of mineral resources located within the Western Sydney Parklands (WSP) project area. "Minerals" in the context of this assessment refers to:

- Extractive minerals such as clay and shale;
- Coal deposits; and
- Coal Bed Methane (CBM).

The WSP consists of three separate parcels of lands designated as:

West Huntingwood – Parcel 4 (55Ha)
Doonside – Parcel 3 (50 Ha - approx)
Rooty Hill – Parcel 2 (13 Ha)

2.0 SITE DESCRIPTION

2.1. Overview

The three parcels of land are located in an area that extends from the M4 Motorway in the south to the main east-west railway connecting Rooty Hill and Doonside Stations to the north and is bounded by Rooty Hill Road-Wallgrove Road to the west and Brabham Drive/Doonside Road to the east (Figure 1).

2.2. Biophysical Features

2.2.1. Geology

Based on the 1:100,000 Penrith geological map series, the site is underlain entirely by Bringelly Shale - Rwb (Figure 2). Within the valley floor, Quaternary sand, silt and clay (Qal) overlies the Bringelly Shales. The Bringelly Shale is a member of the Wianamatta Group of sediments and consists of shale, carbonaceous claystone, laminate and coal in parts.
Located immediately south of the Rooty Hill parcel, is the remnants of Jurrasic Age volcanic diatreme.

2.2.2. Soil Landscape Group

Based on the 1:100,000 Soil Landscapes of Penrith Map Sheet, the Blacktown Soil Landscape Group predominates within the three nominated parcels within the subject area (Bannerman, SM and Hazelton, PA. 1990). Located adjacent to each parcel are soils of the South Creek Soil Landscape Group (Figure 3).

2.2.3. Topography

The topography at all three parcels is flat with relative elevations varying on the whole by less than 10 metres.
Based on available topographic data, elevations range from approximately 40 metres AHD for the major part of the study area to around 60 metres AHD in the southeastern corner of Parcel 4.

2.2.4 Other biophysical features

All three parcels of land overlook the flood valley that is Eastern Creek.

3.0 MINERALS ASSESSMENT

3.1. COAL RESOURCES

3.1.1. Overview

The whole study area is probably underlain by coal. However, because of the great depth of cover, it is unlikely that any coal will be mined in the foreseeable future. Information regarding the nature and quality of any coal found within the study area is relatively scarce and can only be assessed by extrapolating data from nearby drill hole data. Basic information has been drawn from the Geological Survey of NSW (Jones, DC and Clark, NR, 1991). This section describes the nature and extent of the deposits and considers the latest available information regarding their future development.

3.1.2. Technical Aspects

Geology

Based on regional drilling data, it is known that the study area is underlain by the Illawarra Coal Measures. These coal measures are likely to occur at relatively deep levels within the subject area. However, data specific to the subject area is not available due to a lack of drilling information. The nearest drilling data relevant to coal exploration is related to several bores that were completed during the early 1970 s'(Metals Investigations Pty Ltd, 1971 & 1972). The South Colah 1 drill hole (Coal bore) was drilled at the corner of Hastings Road and New Line Road, Pennant Hills and is located approximately 12 kilometres to the north-east of the study area. Seventeen coal seams were intersected commencing from a depth of 609 metres below the ground surface. The coal seams occur over a vertical interval of approximately 100 metres.

Approximately 22 kilometres to the south, a line of east-west drilling in the Catherine Fields area indicates the presence of the Illawarra Coal Measures at depths from surface ranging from 451 metres to 788 metres (Jones, DC and Clark, NR, 1991). Data from petroleum wells also suggests the presence of coal seams at similar depths.

Mining Technique

Should underground mining ever be contemplated under the subject area, the technique likely to be used is known as Longwall Mining. This feature of the mining technique is translated to the surface as mine subsidence. Traditional mining techniques include Bord and Pillar and continuous miner and pillar extraction. However, these have proved uneconomic and are now rarely used.

3.1.3. Economic Aspects

Over the last decade, the traditional mining depth within the Sydney Basin has been approximately 600 metres. However, it is likely that coal depths underneath the subject area are significantly deeper than this limit. It has however been noted (Jones, DC and Clark, NR, 1991) that coal is mined to depths of 1000 metres in other countries. Such mining depths are ultimately subject to coal quality and coal prices at any given time.

It should further be noted , that should coal mining ever be considered as an option, a significant time lag is expected as it is not part of any current mining plan at this stage. For example, BHP-Billiton's mine plan for the next 30 years ends at Camden (Mineral Resources, 2003 – Figure 3).

In general terms, it is considered highly unlikely that coal resources beneath the subject area will ever be considered as a serious mining option within the next 50 years.

3.1.4 Potential Impacts of Underground Coal Mining

The primary impact that underground coal mining has relates to subsidence of the overlying rock strata after mining of the coal seam has been completed. Other impacts relate to the provision of surface infrastructure requirements.

Mine subsidence is a major issue where underground coal mining is conducted by the longwall mining method. The magnitude of subsidence at the surface depends on a range of parameters including the thickness of the coal seam being mined and the width of the mining panel. In addition, the nature of the existing landform can also enhance or reduce the magnitude of these impacts.

It is noted that there has never been any exploration licences or coal authorizations lodged over the study area. This together with the general lack of drilling data, suggests that the coal industry and the Department of Primary Industry rates the subject area very low in terms of future coal potential.

3.2. COAL BED METHANE

3.2.1. Nature of Coal Bed Methane

Coal Bed Methane ("CBM") is the natural gas formed during the coalifaction process whereby peat and other organic matter is turned into coal by compaction and heat associated with the depth of burial. Methane is adsorbed on the surfaces of micropores within the coal, and also as free gas within fractures in a coal seam. It is generally regarded as an unconventional source of natural gas, the 'traditional' source being derived from sandstone reservoirs.

The composition of Coal Bed Methane is, as the name suggests, predominantly methane (>95%) with minor amounts of carbon dioxide and other gases (such as ethane) including water vapour.

3.2.2. Outline of CBM Resources within the Sydney Basin

It has been estimated, that the Sydney Basin may contain up to 130,000 PJ of energy in coal seam methane (Weber, C and Bocking, M. 1993). The subject area is located within this basin. However, to ascribe any potential CBM to coal seams that may lie beneath the subject area is premature at this stage as there is no available drilling data that could be used to determine potential resources within the subject area.

During the late 1980's and early 1990's, a number of drill holes were completed throughout the Sydney Basin with a number of bore holes demonstrating "strong gas showings". The Basin in general was the focus of relatively intense exploration during this time (Amoco, 1991). However, as exploration failed to find any commercial sources, subsequent exploration efforts have been focused elsewhere.

Current tenure over much of the Sydney Basin CBM resource is held entirely by Sydney Gas Operations Pty Ltd under Petroleum Exploration Licence 2. This Company's plans for the development of CBM is currently focused on their Stage II Project, which encompasses an area to the south of Camden (Sydney Gas Operations, 2003). Discussions with Sydney Gas personnel indicates that exploration (let alone development) outside of their Stage II area – particularly in the vicinity of the subject site is unlikely to occur for many years – if at all.

At this stage it is impossible to define the total content of CBM likely to occur within the subject area as the total amount of coal available is also unknown. However, based on existing data, there is no question that large quantities of CBM are locked up in the various coal seams that occur in the Sydney Basin. Extraction of CBM from these seams will depend upon further exploration followed by feasibility studies which take into account economic, environmental as well as technical issues.

3.3. PETROLEUM

Exploration for petroleum in the Sydney Basis has been sporadically attempted since 1917. However, only during the last two decades has there been any serious attempt to explore and develop oil and gas fields. The potential for oil and gas (conventional) to occur in the Sydney Basin ought to be relatively good (Jones, DC and Clark, NR, 1991). This is based on the observation that the Basin contains dominantly terrestrial sediments, an abundance of coal bearing strata and an appropriate maturity level. Shale units (which can act as seals) in conjunction with geological structures are also conducive to the formation of suitable traps within the Basin.

However, the exploration record indicates that very little of substance has been discovered. Oil and gas 'shows' have been found to be associated with a number of potential reservoir sands within the Late Permian (Illawarra Coal Measures) and Early Triassic (Narrabeen Group). These have manifested as oil bleeding from core and/or bore hole cuttings and gas 'shows' from sandstones or coal bearing sediments.

Several bores were completed within approximately 10 kilometres of the subject area. To the north, Berkshire Park DH-1 was completed in 1968 to a depth of 1091 metres. Minor occurrences of hydrocarbons were noted but host rock porosities and permeability were both very low. To the south, Cecil Park DH-1 was completed to a depth of 698 metres and Lee Home DH-1 to a depth of 665 metres. Small gas flows were detected at depth of around 614 and 622 metres respectively.

The most recent exploration effort for petroleum within the Sydney Basin was conducted by Amadeus Asia Pacific Pty Ltd. In 2000, the Fairlight 1 was completed to a depth of approximately 700 metres. The bore is located approximately 17 kilometres to the south-west of the subject area. No significant hydrocarbons were detected.

In summary, whilst the Sydney Basin presents properties which allow for the accumulation of hydrocarbons, none have yet been discovered in any commercial quantities. The subject area is furthermore, significantly distant from those areas that have seen active exploration efforts and it appears likely that the potential for hydrocarbons within the subject area is very low.

3.4. GEOTHERMAL ENERGY

Much of the western part of the Sydney Basin (including the subject area) is currently subject to an exploration licence for "Geothermal Substances". The licence holder is Longreach Oil Limited which in conjunction with Hot Rock Energy Pty Ltd (as Operator) have applied for a large part of the Sydney Basin for the purposes of "hot rock" exploration. The companies claim that this energy source can be readily utilised for electricity generation.
The explorers are aiming to tap into the heat of energy-providing "hot rocks" – in this case buried igneous masses. This is done by drilling into the igneous body, followed by hydraulic stimulation, creating fracture paths between water injection wells and hot steam producing wells drilled nearby.
The implications of this exploration effort for the subject site are currently unknown.

3.5. SURFACE EXTRACTIVE MINERALS

3.5.1 Introduction

This section deals with those materials that are commonly exploited from near surface deposits and include clay, shale, and aggregates. The three parcels within the subject area are located entirely on Bringelly Shale, but are located adjacent to other lithologies (Figure 2).

3.5.2 Clay and Shale

The Bringelly Shale is composed of claystones and siltstones, laminates, sandstone, coal and carbonaceous clay and tuffs. However, it is the claystones, siltstones and laminates which dominate. The Bringelly units are a source of material for an extensive brick making industry in the Western Sydney Basin and has superseded the Ashfield Shale for the following reasons:

- It is a more versatile material in that it can be fired for a variety of colours;
- Its plasticity makes it more suitable to modern extrusion brickmaking methods; and
- Use of selective mining enables high value material to be extracted.

"The Bringelly Shale is the most important source of structural brick making shale in the Sydney region. In future, more emphasis should be placed on setting aside suitable areas for the extraction of this shale." – Herbert, C. 1979.

During 2002, Austral Brick Company Pty Ltd assessed an area to the immediate south of the subject area for clay and shale resources (Austral Brick Company Pty Ltd, 2002). It was this Company s'view that surface clay and shale are commodities in short supply in areas near to their manufacturing plants at Wallgrove Road. However, the Company decided not to pursue with any work in this area as they considered that obtaining approval for extraction would be difficult and other options were available for obtaining the necessary raw materials.

Given that no specific geological data (such as drilling data) has been found for the site, it may be prudent to assess the nature of the shale within parcels 3 and 4 to determine their potential for development as a source of shale for brick making. The large size of these two parcels and their location in an industrial type of area suggests that these two parcels may be suitable for such development. Furthermore, given the location of these parcels within close proximity to existing manufacturing plants and an ever increasing residential development market, demand for raw materials for future brick making in this general area should be assessed before releasing the land for other uses.

3.5.3 Aggregates and Other Materials

It is noted that a small occurrence of Jurrasic volcanics is located immediately to the south of Parcel 2. Material similar to this occurrence has been mined elsewhere for concrete aggregates and is a valuable resource if supplies of good quality of material can be found. The above occurrence, which has been identified as a potential diatreme (Rooty Hill Diatreme – see Jones, DC and Clark, NR. 1991) has virtually no surface expression. The potential for this type of material to occur elsewhere within the subject area appears to be remote.

4 CONCLUSIONS

It is concluded that the potential for "minerals" to occur within the three parcels located within the study area is rather limited. Coal resources appear to be too deep and of suspect quality to warrant any attention at this stage. There is some potential for coal based CBM gas as well as gas located in sandstone reservoirs. However, given the remoteness of the subject area to those resources currently or likely to be developed in the foreseeable future, it is unlikely that these types of resources would ever be developed within these land parcels.

Clay and shale remain as resources which may have some potential for development within the subject area. The Bringelly Shale has considerable merit as a source for brick making and it remains to be determined whether the shales located in Parcels 3 and 4 have the necessary qualities. Furthermore, the location and nature of these parcels suggests that consideration should be given to undertaking a preliminary assessment as to their strategic value within the Western Sydney resource pool.

Mart Rampe BSc (Applied Geology)
Principal Consultant

28/09/2005

5.0 REFERENCES

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Disclaimer

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The findings contained in this report are the result of discrete/specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site in question. Under no circumstances, however, can it be considered that these findings represent the actual state of the site/sites at all points.

In preparing this report, Harvest Scientific Services has relied upon certain verbal information and documentation provided by the client and/or third parties. Harvest Scientific Services did not attempt to independently verify the accuracy or completeness of that information. To the extent that the conclusions and recommendations in this report are based in whole or in part on such information, they are contingent on its validity. Harvest Scientific Services assume no responsibility for any consequences arising from any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to Harvest Scientific Services.

SGS

23 September 2005 **TEST REPORT**

Douglas Partners Pty Ltd
1 / 1 Luso Drive
UNANDERRA
NSW 2526

Your Reference: 40465, Parklands Conductivity
Report Number: 40108

Attention: Chris Kline

Dear Chris
The following samples were received from you on the date indicated.

Samples:	Qty.	70 Soils
Date of Receipt of Samples:		15/09/05
Date of Receipt of Instructions:		15/09/05
Date Preliminary Report Faxed:		Not Issued

These samples were analysed in accordance with your written instructions.
A copy of the instructions is attached with the analytical report.

The results and associated quality control are contained in the following pages of this report. Unless otherwise stated, solid samples are expressed on a dry weight basis (moisture has been supplied for your information only), air and liquid samples as received.

Should you have any queries regarding this report please contact the undersigned.

Yours faithfully
SGS ENVIRONMENTAL SERVICES

Dong Liang
Supervisor

Inorganics Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-1 1/0.6 Soil	40108-2 2/0.6 Soil	40108-3 3/0.6 Soil	40108-4 4/0.6 Soil	40108-5 5/0.4 Soil
Electrical Conductivity 1:5 soil:water	µS/cm	540	560	570	66	110

Inorganics Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-6 7/0.5 Soil	40108-7 8/0.5 Soil	40108-8 9/0.6 Soil	40108-9 10/0.5 Soil	40108-10 11/0.2 Soil
Electrical Conductivity 1:5 soil:water	µS/cm	280	290	780	77	170

Inorganics Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-11 11/0.5 Soil	40108-12 11/0.8 Soil	40108-13 11/1.1 Soil	40108-14 11/1.9 Soil	40108-15 12/0.5 Soil
Electrical Conductivity 1:5 soil:water	µS/cm	560	1,600	720	640	280

Inorganics Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-16 13/0.4 Soil	40108-17 14/0.5 Soil	40108-18 15/0.6 Soil	40108-19 16/0.7 Soil	40108-20 17/0.5 Soil
Electrical Conductivity 1:5 soil:water	µS/cm	480	110	49	39	240

Inorganics Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-21 18/1.0 Soil	40108-22 19/0.4 Soil	40108-23 20/0.2 Soil	40108-24 20/0.4 Soil	40108-25 20/0.7 Soil
Electrical Conductivity 1:5 soil:water	µS/cm	460	23	50	71	290

Inorganics Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-26 20/1.6 Soil	40108-27 21/1.0 Soil	40108-28 22/1.0 Soil	40108-29 23/0.4 Soil	40108-30 24/0.8 Soil
Electrical Conductivity 1:5 soil:water	µS/cm	420	300	260	30	260

Inorganics Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-31 25/0.4 Soil	40108-32 26/0.8 Soil	40108-33 27/0.4 Soil	40108-34 28/0.6 Soil	40108-35 29/0.7 Soil
Electrical Conductivity 1:5 soil:water	µS/cm	37	540	570	140	220

Inorganics Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-36 30/0.7 Soil	40108-37 31/0.5 Soil	40108-38 32/0.6 Soil	40108-39 33/0.1 Soil	40108-40 33/0.8 Soil
Electrical Conductivity 1:5 soil:water	µS/cm	1,100	30	610	38	910

Inorganics **Our Reference:** **Your Reference** **Sample Type**	**UNITS** **-------------** **------------**	**40108-41** **33/1.6** **Soil**	**40108-42** **33/2.0** **Soil**	**40108-43** **34/0.4** **Soil**	**40108-44** **35/0.2** **Soil**	**40108-45** **35/0.4** **Soil**
Electrical Conductivity 1:5 soil:water	µS/cm	1,700	1,200	230	34	330

Inorganics Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-46 35/0.6 Soil	40108-47 35/0.8 Soil	40108-48 35/1.0 Soil	40108-49 35/2.0 Soil	40108-50 36/0.8 Soil
Electrical Conductivity 1:5 soil:water	µS/cm	790	730	890	780	56

Inorganics Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-51 37/0.8 Soil	40108-52 38/0.4 Soil	40108-53 39/0.5 Soil	40108-54 40/0.2 Soil	40108-55 40/0.4 Soil
Electrical Conductivity 1:5 soil:water	µS/cm	330	220	97	66	91

Inorganics Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-56 40/1.2 Soil	40108-57 40/2.8 Soil	40108-58 41/0.5 Soil	40108-59 42/0.3 Soil	40108-60 43/0.5 Soil
Electrical Conductivity 1:5 soil:water	µS/cm	73	55	52	48	150

Inorganics Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-61 44/0.2 Soil	40108-62 44/1.0 Soil	40108-63 44/1.8 Soil	40108-64 44/2.4 Soil	40108-65 45/1.0 Soil
Electrical Conductivity 1:5 soil:water	µS/cm	140	320	130	320	1,300

Inorganics Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-66 46/1.0 Soil	40108-67 47/0.5 Soil	40108-68 48/0.6 Soil	40108-69 49/0.4 Soil	40108-70 50/0.3 Soil
Electrical Conductivity 1:5 soil:water	µS/cm	180	330	990	500	210

Moisture Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-1 1/0.6 Soil	40108-2 2/0.6 Soil	40108-3 3/0.6 Soil	40108-4 4/0.6 Soil	40108-5 5/0.4 Soil
Moisture	%	24	15	14	8.8	6.5

Moisture Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-6 7/0.5 Soil	40108-7 8/0.5 Soil	40108-8 9/0.6 Soil	40108-9 10/0.5 Soil	40108-10 11/0.2 Soil
Moisture	%	11	15	11	17	22

Moisture Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-11 11/0.5 Soil	40108-12 11/0.8 Soil	40108-13 11/1.1 Soil	40108-14 11/1.9 Soil	40108-15 12/0.5 Soil
Moisture	%	15	14	9.8	11	15

Moisture Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-16 13/0.4 Soil	40108-17 14/0.5 Soil	40108-18 15/0.6 Soil	40108-19 16/0.7 Soil	40108-20 17/0.5 Soil
Moisture	%	13	14	8.9	12	10

Moisture Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-21 18/1.0 Soil	40108-22 19/0.4 Soil	40108-23 20/0.2 Soil	40108-24 20/0.4 Soil	40108-25 20/0.7 Soil
Moisture	%	16	12	18	20	28

Moisture Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-26 20/1.6 Soil	40108-27 21/1.0 Soil	40108-28 22/1.0 Soil	40108-29 23/0.4 Soil	40108-30 24/0.8 Soil
Moisture	%	18	8.8	12	11	8.5

Moisture Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-31 25/0.4 Soil	40108-32 26/0.8 Soil	40108-33 27/0.4 Soil	40108-34 28/0.6 Soil	40108-35 29/0.7 Soil
Moisture	%	8.2	13	8.7	9.9	3.1

Moisture Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-36 30/0.7 Soil	40108-37 31/0.5 Soil	40108-38 32/0.6 Soil	40108-39 33/0.1 Soil	40108-40 33/0.8 Soil
Moisture	%	17	16	14	9.8	13

Moisture **Our Reference:** **Your Reference** **Sample Type**	**UNITS** **-------------** **------------**	**40108-41** **33/1.6** **Soil**	**40108-42** **33/2.0** **Soil**	**40108-43** **34/0.4** **Soil**	**40108-44** **35/0.2** **Soil**	**40108-45** **35/0.4** **Soil**
Moisture	%	12	13	10	7.0	15

Moisture Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-46 35/0.6 Soil	40108-47 35/0.8 Soil	40108-48 35/1.0 Soil	40108-49 35/2.0 Soil	40108-50 36/0.8 Soil
Moisture	%	17	16	15	11	14

Moisture Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-51 37/0.8 Soil	40108-52 38/0.4 Soil	40108-53 39/0.5 Soil	40108-54 40/0.2 Soil	40108-55 40/0.4 Soil
Moisture	%	8.8	13	11	16	4.7

Moisture Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-56 40/1.2 Soil	40108-57 40/2.8 Soil	40108-58 41/0.5 Soil	40108-59 42/0.3 Soil	40108-60 43/0.5 Soil
Moisture	%	5.8	5.4	9.1	14	13

Moisture Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-61 44/0.2 Soil	40108-62 44/1.0 Soil	40108-63 44/1.8 Soil	40108-64 44/2.4 Soil	40108-65 45/1.0 Soil
Moisture	%	18	12	13	12	14

Moisture Our Reference: Your Reference Sample Type	UNITS ------------- ------------	40108-66 46/1.0 Soil	40108-67 47/0.5 Soil	40108-68 48/0.6 Soil	40108-69 49/0.4 Soil	40108-70 50/0.3 Soil
Moisture	%	13	12	16	14	14

Method ID	Methodology Summary
SEI-010	Conductivity and Salinity - measured using a conductivity cell and dedicated meter, in accordance with APHA2510 20th ED.
SEP-001	Air Dry - Cover air drying at 40 C, moisture content at 103 C - 105 C, wet slurrying, compositing and preparation of a 1:5 soil suspension.

QUALITY CONTROL Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD
Electrical Conductivity 1:5 soil:water	µS/cm	1	SEI-010	<1.0	40108-2	560 || 560 || RPD: 0

QUALITY CONTROL Moisture	UNITS	PQL	METHOD	Blank
Moisture	%		SEP-001	[NT]

QUALITY CONTROL Inorganics	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Electrical Conductivity 1:5 soil:water	µS/cm	40108-12	1600 || 1600 || RPD: 0

QUALITY CONTROL Inorganics	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Electrical Conductivity 1:5 soil:water	µS/cm	40108-27	300 || 260 || RPD: 14

QUALITY CONTROL Inorganics	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Electrical Conductivity 1:5 soil:water	µS/cm	40108-38	610 || 610 || RPD: 0

QUALITY CONTROL Inorganics	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Electrical Conductivity 1:5 soil:water	µS/cm	40108-45	330 || 330 || RPD: 0

QUALITY CONTROL Inorganics	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Electrical Conductivity 1:5 soil:water	µS/cm	40108-56	73 || 60 || RPD: 20

Result Codes

[INS]	:	Insufficient Sample for this test	[HBG]	:	Results not Reported due to High Background Interference
[NR]	:	Not Requested	*	:	Not part of NATA Accreditation
[NT]	:	Not tested	[N/A]	:	Not Applicable

Result Comments

Date Organics extraction commenced: N/A
NATA Corporate Accreditation No. 2562, Site No 4354
Note: Test results are not corrected for recovery (excluding Dioxins/Furans* and PAH in XAD and PUF).

Quality Control Protocol

Reagent Blank: Sample free reagents carried through the preparation/extraction/digestion procedure and analysed at the beginning of every sample batch analysis. For larger projects, a reagent blank is prepared and analysed with every 20 samples.
Duplicate: A separate portion of a sample being analysed which is treated the same as the other samples in the batch. A duplicate is prepared at least every 20 samples.
Matrix Spike Duplicates: Sample replicates spiked with identical concentrations of target analyte(s). The spiking occurs during the sample preparation and prior to the extraction/digestion procedure. They are used to document the precision and bias of a method in a given sample matrix. Where there is not enough sample available to prepare a spiked sample, another known soil/sand or water (or Milli-Q water) may be used. A duplicate spiked sample is prepared at least every 20 samples.
Surrogate Spike: Added to all samples requiring analysis for organics (where relevant) prior to extraction. Used to determine the extraction efficiency. They are organic compounds which are similar to the target analyte(s) in chemical composition and behaviour in the analytical process, but which are not normally found in environmental samples.
Internal Standard: Added to all samples requiring analysis for organics (where relevant) after the extraction process; the compounds serve to give a standard of retention time and response, which is invariant from run-to-run with the instruments.
Control Standards: Prepared from a source independent of the calibration standards. At least one control standard is included in each run to confirm calibration validity.
Additional QC Samples: A calibration standard and blank are run after every 20 samples of an instrumental analysis run to assess analytical drift.

TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 49
EASTING: 303060
NORTHING: 6260583
DIP/AZIMUTH: 90°/--

PIT No: 1
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
49		SILTY CLAY - dark brown silty clay		D	0.4				
	0.5	CLAY - very stiff, yellow brown clay with some silt and a trace of ironstone sand		D	0.6				
				pp	0.7		pp = 400kPa		
	0.8	CLAY - stiff, red mottled white clay		D	1.5				
				pp	1.9		pp = 200kPa		
47	2.0	Pit discontinued at 2.0m - Target Depth Reached							

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:CCK
Date:10/11

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 51
EASTING: 303066
NORTHING: 6260737
DIP/AZIMUTH: 90°/--

PIT No: 2
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
51		SILTY CLAY - brown silty clay		D	0.3				
	0.4	CLAY - stiff, yellow brown clay with some silt and traces of ironstone sand		D	0.6				
				pp	0.7		pp = 180kPa		
50	1								
		- becoming white							
	1.8	SILTSTONE - light brown siltstone		D	1.9				
49	2 / 2.0	Pit discontinued at 2.0m - Target Depth Reached							
48	3								

Dynamic Penetrometer Test scale: 5, 10, 15, 20

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 46
EASTING: 302897
NORTHING: 6260784
DIP/AZIMUTH: 90°/--

PIT No: 3
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
46		SILTY CLAY - brown silty clay		D	0.3				
	0.4	CLAY - white mottled red clay with some silt		D	0.6				
				pp	0.7				
45	1								
	1.4	SILTSTONE - extremely weathered, low strength, siltstone							
44	2			D	2.0				
	2.5	Pit discontinued at 2.5m - Target Depth Reached							
43	3								

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 40.5
EASTING: 302681
NORTHING: 6260857
DIP/AZIMUTH: 90°/--

PIT No: 4
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
		SILTY CLAY - dark brown silty clay		D	0.2				
40	0.4	SILTY CLAY - red brown silty clay		D	0.8				
	1.1	CLAY - very stiff, yellow mottled grey clay with ironstone		pp	1.5		pp = 300kPa		
39				D	1.8				
		- becoming light grey (extremely weathered shale)							
38	2.0	Pit discontinued at 2.0m - Target Depth Reached							

Depth scale: 1, 2, 3; RL scale: 40, 39, 38, 37; DPT scale: 5, 10, 15, 20

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep
		▼	Water level

CHECKED
Initials: CCK
Date: 10/11

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 34
EASTING: 302331
NORTHING: 6260950
DIP/AZIMUTH: 90°/--

PIT No: 5
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
34		SILTY CLAY - yellow brown silty clay		D	0.2				
	0.3	CLAY - light black/grey clay with a trace of peat		D	0.4				
	0.6	CLAY - very stiff, yellow brown clay with some ironstone		D	0.8				
				pp	0.9		pp = 250kPa		
33	1								
32	2								
	2.5	SILTY SANDY CLAY - light grey and yellow silty sandy clay, damp, soft		D	2.7				
31	3 / 3.0	Pit discontinued at 3.0m - Target Depth Reached							

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

Douglas Partners
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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 37
EASTING: 302482
NORTHING: 6261229
DIP/AZIMUTH: 90°/--

PIT No: 6
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
37		SILT - light brown silt (topsoil)		D	0.1				
	0.2	CLAY - hard, brown clay with some ironstone		D	0.4				
				pp	0.8		pp>500kPa		
36	1 1.0	Pit discontinued at 1.0m - Target Depth Reached							1
35	2								2
34	3								3

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⊻ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 50
EASTING: 302863
NORTHING: 6261275
DIP/AZIMUTH: 90°/--

PIT No: 7
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
50		SILTY CLAY - dark brown silty clay topsoil (possible filling)		D	0.2				
	0.4	CLAY - very stiff, red clay		D	0.5				
				pp	0.6		pp = 300kPa		
49	1								
	1.4	SHALE - extremely weathered, low strength, shale		D	1.5				
48	2.0	Pit discontinued at 2.0m - Target Depth Reached							
47	3								

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 51
EASTING: 302922
NORTHING: 6261193
DIP/AZIMUTH: 90°/--

PIT No: 8
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
51		SILTY CLAY (topsoil) - dark brown silty clay (possible filling)		D	0.2				
	0.3	CLAY - very stiff, red clay with some ironstone		pp	0.4		pp = 350kPa		
				D	0.5				
				pp	0.8		pp = 450kPa		
50	1 1.0	SHALE - slightly weathered, medium strength, shale		D	1.1				1
	1.2	Pit discontinued at 1.2m (refusal in shale)							
49	2								2
48	3								3

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 35.5
EASTING: 302385
NORTHING: 6260520
DIP/AZIMUTH: 90°/--

PIT No: 9
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

Depth (m)	Description of Strata	Sampling Type	Sampling Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	SILT - light brown silt, dry, loose	D	0.3				
0.4	CLAY - hard, yellow clay	pp	0.5		pp = 350kPa		
		D	0.6				
		pp	0.7		pp>500kPa		
2.3	SILTY SANDY CLAY - yellow grey silty sandy clay, soft, damp						
3.8	Pit discontinued at 3.8m (limit of excavator)						

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⊻ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 40
EASTING: 302615
NORTHING: 626051
DIP/AZIMUTH: 90°/--

PIT No: 10
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
40		SILTY CLAY - brown silty clay (topsoil)		D	0.3				
	0.4	CLAY - very stiff, red brown clay		D	0.5				
				pp	0.6		pp = 300kPa		
39	1								1
	1.6	SILTY SANDY CLAY - stiff to very stiff, yellow and grey silty sandy clay, damp		D	1.8				
				pp	1.9		pp = 250kPa		
38	2	- ironstone gravel band							2
				pp	2.5		pp = 400kPa		
	2.8	Pit discontinued at 2.8m - Target Depth Reached							
37	3								3

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 42
EASTING: 302833
NORTHING: 6260517
DIP/AZIMUTH: 90°/--

PIT No: 11
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
42		SILT - brown silt, humid		D	0.2				
	0.4	CLAY - light grey clay, damp		D	0.5				
	0.7	CLAY - yellow grey clay		D	0.8				
41	1.0	GRAVEL - ironstone gravel and silt, saturated		D	1.1				
	1.8	CLAY - yellow grey clay with some gravel, damp		D	1.9				
40	2.4	Pit discontinued at 2.4m - Target Depth Reached							
39	3								

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: Water entering pit at 1.2m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 41.5
EASTING: 302703
NORTHING: 6260298
DIP/AZIMUTH: 90°/--

PIT No: 12
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
		SILTY CLAY - brown silty clay		D	0.2				
	0.3	CLAY - yellow brown clay with some silt, stiff		pp	0.4		pp = 200kPa		
41				D	0.5				
	0.7	CLAY - very stiff, red mottled grey clay		pp	0.8		pp = 350kPa		
	1			D	1.0				
40									
	1.9	SHALE - black low strength shale		D	1.9				
	2.0	Pit discontinued at 2.0m - Target Depth Reached							
39	3								
38									

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 48
EASTING: 302986
NORTHING: 6260145
DIP/AZIMUTH: 90°/--

PIT No: 13
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
48		SILTY CLAY - dark brown silty clay		D	0.2				
	0.3	CLAY - very stiff, red mottled grey clay		D	0.4				
				pp	0.5		pp = 400kPa		
		- becoming grey							
47	1								
	1.2	SHALE - grey brown shale							
	1.8	Pit discontinued at 1.8m (refusal on shale)							
46	2								
45	3								

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 38
EASTING: 302894
NORTHING: 6259921
DIP/AZIMUTH: 90°/--

PIT No: 14
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
38		SILTY CLAY - brown silty clay (topsoil)		D	0.2				
	0.3	SILTY CLAY - very stiff, yellow silty clay, damp		pp	0.4		pp = 310kPa		
				D	0.5				
	0.8	CLAY - hard, yellow grey clay		pp	0.9		pp = 500kPa		
37	1			D	1.0				1
36	2								2
	2.4	Pit discontinued at 2.4m - Target Depth Reached							
35	3								3

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 39.5
EASTING: 302854
NORTHING: 6260072
DIP/AZIMUTH: 90°/--

PIT No: 15
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		SILTY CLAY - brown silty clay		D, pp	0.2		pp = 200kPa		
39	0.3	CLAY - very stiff, yellow brown clay with iron nodules		D	0.6				
				pp	0.7		pp = 300kPa		
	0.9	CLAY - hard, red brown clay		D	1.0				
38				pp	1.5		pp = 500kPa		
	1.9	Pit discontinued at 1.9m - Target Depth Reached							
37, 36	1, 2, 3								1, 2, 3

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Change in slope

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date:10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 37
EASTING: 302631
NORTHING: 6260005
DIP/AZIMUTH: 90°/--

PIT No: 16
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
37		SILTY CLAY - brown silty clay		D	0.4				
	0.5	CLAY - yellow clay		D	0.7				
36	1								1
	1.3	SILTY CLAY - yellow mottled grey clay with some sand		D	2.0				2
35	2								
34	3 3.0	Pit discontinued at 3.0m - Target Depth Reached							3

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 35
EASTING: 302332
NORTHING: 6260484
DIP/AZIMUTH: 90°/--

PIT No: 17
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
35		SILTY CLAY - brown silty clay		D	0.2				
	0.4	CLAY - hard, yellow brown clay		D	0.5				
				pp	0.6		pp>500kPa		
34	1								1
		- with ironstone nodules							
33	2 2.0	Pit discontinued at 2.0m - Target Depth Reached							2
32	3								3

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 36
EASTING: 302398
NORTHING: 6260165
DIP/AZIMUTH: 90°/--

PIT No: 18
PROJECT No: 40465
DATE: 08 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
36		SILTY CLAY - dark brown silty clay		D	0.2				
	0.5	CLAY - red mottled grey clay							
35	1			D	1.0				1
34	2								2
	2.4	SILTY SANDY CLAY - yellow and grey silty sandy clay, damp		D	2.8				
33	3 3.0	Pit discontinued at 3.0m - Target Depth Reached							3

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 37
EASTING: 302537
NORTHING: 6260004
DIP/AZIMUTH: 90°/--

PIT No: 19
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
37		FILLING - light brown silt filling (natural origin)							
	0.3	CLAY - stiff, light grey clay with ironstone nodules		D	0.4				
				pp	0.5		pp = 200kPa		
	0.7	CLAY - hard, yellow brown clay		pp	0.8		pp = 500kPa		
				D	0.9				
36	1								
	1.1	CLAY - orange mottled grey clay		D	1.2				
35	2 2.0	Pit discontinued at 2.0m - Target Depth Reached							
34	3								

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 37
EASTING: 302329
NORTHING: 6259779
DIP/AZIMUTH: 90°/--

PIT No: 20
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
37		GRAVELLY CLAY - orange brown gravelly clay, wet		D	0.2				
	0.3	CLAY - light grey clay, with some gravel, wet		D	0.4				
	0.5	CLAY - yellow grey clay, wet		D	0.7				
36	1								
	1.5	CLAY - orange mottled grey clay with a trace of gravel		D	1.6				
35	2 / 2.0	Pit discontinued at 2.0m - Target Depth Reached							
34	3								

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 45
EASTING: 302465
NORTHING: 6259530
DIP/AZIMUTH: 90°/--

PIT No: 21
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
45		FILLING - brown silty clay filling							
	0.2	FILLING - white mottled red clay filling with scrap metal			0.2		cut and fill local origin		
	0.6	CLAY - white mottled red clay			0.6		metal on original ground surface		
44	1			D	1.0				1
43	2								2
	2.1	SHALE - ironstained yellow brown shale							
	2.6	Pit discontinued at 2.6m (refusal in shale)							
42	3								3

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 43.5
EASTING: 302303
NORTHING: 6259274
DIP/AZIMUTH: 90°/--

PIT No: 22
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		SILTY CLAY - brown silty clay		D	0.2				
43	0.4	CLAY - very stiff, red brown clay		D	1.0				1
	1			pp	1.1		pp = 300kPa		
42	1.6	CLAY - very stiff, red mottled grey clay		D	1.8				
				pp	1.9		pp = 400kPa		
	2								2
41	2.5	Pit discontinued at 1.6m - Target Depth Reached							
	3								3
40									

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 38.5
EASTING: 302069
NORTHING: 6259556
DIP/AZIMUTH: 90°/--

PIT No: 23
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
		SILTY CLAY - brown silty clay		D	0.2				
	0.2	CLAY - brown clay, soft		D	0.4				
38	0.5	CLAY - yellow brown clay, firm		D	1.0				
36	2.5	CLAY - grey mottled yellow clay		D	2.8				
35	3.5	Pit discontinued at 3.5m - Target Depth Reached							

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 38.5
EASTING: 301931
NORTHING: 6259265
DIP/AZIMUTH: 90°/--

PIT No: 24
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
		SILTY CLAY - brown silty clay		D	0.2				
38	0.4	CLAY - yellow brown clay with a trace of silt		D	0.8				
37	1								
	2								
	2.1	- becoming SILTY CLAY		D	2.2				
36	2.4	Pit discontinued at 2.4m - Target Depth Reached							
35	3								

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⊻ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 38
EASTING: 301905
NORTHING: 6259759
DIP/AZIMUTH: 90°/--

PIT No: 25
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
38		SILTY CLAY - red brown silty clay		D	0.1				
	0.2	SILTY CLAY - yellow brown silty clay		D	0.4				
	0.6	CLAY - yellow brown clay with a trace of silt							
37	1			D	1.5				1
36	2								2
		- gravel band (ironstone)							
	2.6	Pit discontinued at 2.6m - Target Depth Reached							
35	3								3

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date:10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 36.5
EASTING: 301984
NORTHING: 6260172
DIP/AZIMUTH: 90°/--

PIT No: 26
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		SILTY CLAY - light grey silty clay		D	0.1				
	0.2	CLAY - hard, yellow brown clay		pp	0.4		pp>500kPa		
36		- mottled red		D	0.8				
	1								1
35		- mottled grey		D	1.6				
	2								2
	2.4	Pit discontinued at 2.4m - Target Depth Reached							
34									
	3								3
33									

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 34.5
EASTING: 302123
NORTHING: 6260491
DIP/AZIMUTH: 90°/--

PIT No: 27
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
		SILTY CLAY - brown silty clay		D	0.1				
	0.3	CLAY - hard, yellow brown clay		D	0.4				
34				pp	0.6		>500kPa		
	1								1
33									
		- becoming stiff		pp	1.8		pp = 200kPa		
	2								2
	2.3	CLAY - firm, brown mottled grey clay with some gravel, damp		D	2.4				
32									
	3 3.0	Pit discontinued at 3.0m - Target Depth Reached		pp	3.0		pp = 100kPa		3
31									

Dynamic Penetrometer Test scale: 5, 10, 15, 20

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⩡ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 36
EASTING: 301864
NORTHING: 6260544
DIP/AZIMUTH: 90°/--

PIT No: 28
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
36		SILTY CLAY - brown silty clay		D	0.1				
	0.4	CLAY - hard, yellow brown clay		D	0.6				
				pp	0.8		pp>500kPa		
35	1 1.0	Pit discontinued at 1.0m - Target Depth Reached							1
34	2								2
33	3								3

Dynamic Penetrometer Test scale: 5, 10, 15, 20

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 34.5
EASTING: 301747
NORTHING: 6260705
DIP/AZIMUTH: 90°/--

PIT No: 29
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
		SILTY CLAY - grey-brown silty clay		D	0.1				
	0.3	CLAY - yellow brown clay		D	0.7				
	1.1	CLAY - brown mottled grey clay		D	1.4				
	2.1	Pit discontinued at 2.1m - Target Depth Reached							

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 36.5
EASTING: 301541
NORTHING: 6260665
DIP/AZIMUTH: 90°/--

PIT No: 30
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
		SILTY CLAY - brown silty clay		D	0.1				
	0.2	CLAY - very stiff, brown mottled ornage clay		D	0.7				
				pp	0.8		pp = 400kPa		
	1.2	CLAY - very stiff, orange brown mottled grey clay		D	1.5				
				pp	1.6		pp = 350kPa		
	1.9	SHALE - brown shale, slightly weathered, low strength, shale							
	2.0	Pit discontinued at 2.0m (refusal on shale)							

RL scale: 36, 35, 34, 33. Depth scale: 1, 2, 3. DCP scale: 5, 10, 15, 20.

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 42.5
EASTING: 300972
NORTHING: 6260875
DIP/AZIMUTH: 90°/--

PIT No: 31
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
0.0	SILTY CLAY - brown silty clay, hard	pp	0.2		pp>500kPa	
		D	0.3			
0.4	CLAY - very stiff, orange brown clay	D, pp	0.5		pp = 400kPa	
0.6	CLAY - hard, yellow brown clay		0.7		pp>500kPa	
		D	0.8			
0.9	CLAY - grey mottled brown clay	D	1.0			
1.2	SHALE - extremely weathered, low strength, light grey and brown shale					
2.3	Pit discontinued at 2.3m - Target Depth Reached					

Dynamic Penetrometer Test (blows per mm): 5 10 15 20 — no data recorded.

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep; ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 37.5
EASTING: 300844
NORTHING: 6260964
DIP/AZIMUTH: 90°/--

PIT No: 32
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
		SILTY CLAY - brown silty clay		D	0.2				
37	0.4	CLAY - yellow brown clay		D	0.6				
36	1.2	SILTY CLAY - yellow mottled grey silty clay, damp		D	2.0				
35	2.5	Pit discontinued at 2.5m - Target Depth Reached							

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 46
EASTING: 300923
NORTHING: 6260230
DIP/AZIMUTH: 90°/--

PIT No: 33
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
46		SILTY CLAY - hard, brown silty clay		D	0.1				
				pp	0.2		pp>500kPa		
	0.3	CLAY - hard, yellow brown clay							
				D	0.8				
				pp	0.9		pp>500kPa		
45	1								
	1.4	CLAY - very stiff, grey and red clay (weathered shale)							
				pp	1.5		pp = 400kPa		
				D	1.6				
44	2 / 2.0	Pit discontinued at 2.0m		D	2.0				
43	3								

Dynamic Penetrometer Test scale: 5, 10, 15, 20

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT:	Landcom	**SURFACE LEVEL:**	40	**PIT No:**	34
PROJECT:	Land Capability Assessment	**EASTING:**	302238	**PROJECT No:**	40465
LOCATION:	Western Sydney Parklands	**NORTHING:**	6259096	**DATE:**	09 Sep 05
		DIP/AZIMUTH:	90°/--	**SHEET**	1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
40	0	SILTY CLAY - brown silty clay		D	0.1				
	0.3	CLAY - yellow brown clay		D	0.4				
39	1			D	1.3				
	1.4	CLAY - red brown clay							
38	2 / 2.0	Pit discontinued at 2.0m							
37	3								

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3

☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 46
EASTING: 302909
NORTHING: 6260721
DIP/AZIMUTH: 90°/--

PIT No: 35
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
46		SILTY CLAY - brown silty clay		D	0.2				
	0.3	CLAY - yellow brown clay		D	0.4				
	0.5	CLAY - grey mottled red clay		D	0.6				
				D	0.8				
45	1			D	1.0				1
		- extremely weathered shale inclusion							
44	2			D	2.0				2
	2.3	SHALE - brown shale							
	2.4	Pit discontinued at 2.4m - Target Depth Reached							
43	3								3

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 40
EASTING: 301620
NORTHING: 6258986
DIP/AZIMUTH: 90°/--

PIT No: 36
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
40		SILTY CLAY - brown silty clay		D	0.2				
	0.3	CLAY - stiff, yellow brown clay		D	0.8				
39	1			pp	1.5		pp = 150kPa		1
	1.7	CLAY - firm, grey mottled yellow brown silty clay with a trace of sand		D	2.0				
38	2			pp	2.1		pp = 80kPa		2
	2.5	Pit discontinued at 2.5m - Target Depth Reached							
37	3								3

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 41
EASTING: 301579
NORTHING: 6258841
DIP/AZIMUTH: 90°/--

PIT No: 37
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
41		SILTY CLAY - brown silty clay		D	0.2				
	0.3	CLAY - hard, yellow brown clay		pp	0.7		pp>500kPa		
				D	0.8				
40	1								1
	1.3	CLAY - very stiff, grey mottled yellow brown silty clay		D	1.4				
				pp	1.5		pp = 300kPa		
39	2								2
	2.3	Pit discontinued at 2.3m - Target Depth Reached							
38	3								3

Dynamic Penetrometer Test scale: 5, 10, 15, 20

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 43
EASTING: 301558
NORTHING: 6258683
DIP/AZIMUTH: 90°/--

PIT No: 38
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
43		SILTY CLAY - brown silty clay		D	0.1				
	0.2	CLAY - very stiff, yellow brown clay		D	0.4				
				pp	0.45		pp = 300kPa		
	0.5	CLAY - very stiff, grey mottled red brown clay		D	0.8				
42	1								
				pp	1.3		pp = 250kPa		
41	2 2.0	SHALE - highly weathered, low strength, dark grey shale							
	2.5	Pit discontinued at 2.5m - Target Depth Reached							
40	3								

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⊻ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 41.5
EASTING: 301722
NORTHING: 6258709
DIP/AZIMUTH: 90°/--

PIT No: 39
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		SILTY CLAY - brown silty clay		D	0.2				
	0.3	CLAY - yellow brown clay		D	0.5				
41									
	1								1
	1.3	CLAY - very stiff, grey mottled yellow brown clay							
40				D	1.7				
				pp	1.8		pp = 400kPa		
	2 2.0	Pit discontinued at 2.0m - Target Depth Reached							2
39									
	3								3
38									

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 40.5
EASTING: 301842
NORTHING: 6258671
DIP/AZIMUTH: 90°/--

PIT No: 40
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
		SILTY CLAY - brown silty clay		D	0.2				
	0.3	CLAY - hard, yellow brown clay		D	0.4				
40				pp	0.5		pp>500kPa		
	0.7	CLAY - hard, yellow brown mottled grey clay with a trace of silt		pp	1.0		pp>500kPa		
				D	1.2				
38	2.5	SILTY SANDY CLAY - red brown mottled grey silty sandy clay with ironstone bands		D	2.8				
	3.1	Pit discontinued at 3.1m - Target Depth Reached							

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 39.5
EASTING: 301978
NORTHING: 6258594
DIP/AZIMUTH: 90°/--

PIT No: 41
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
		SILTY CLAY - brown silty clay							
	0.1	SILTY CLAY - yellow brown silty clay							
39				D	0.5				
	1								
38				D	1.5				
	2								
37	2.5	CLAY - stiff, yellow brown mottled grey clay with a trace of silt		pp D	2.55 2.6		pp = 200kPa		
	2.7	Pit discontinued at 2.7m - Target Depth Reached							
	3								
36									

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 40
EASTING: 301892
NORTHING: 6258762
DIP/AZIMUTH: 90°/--

PIT No: 42
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
40		SILTY CLAY - brown silty clay							
	0.1	CLAY - red brown clay		D	0.3				
	0.5	CLAY - yellow brown clay		D	0.8				
39	1								
	1.1	SILTY CLAY - yellow brown mottled grey silty clay with ironstone bands		D	1.5				
38	2								
	2.3	Pit discontinued at 2.3m - Target Depth Reached							
37	3								

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 48.5
EASTING: 302670
NORTHING: 6258825
DIP/AZIMUTH: 90°/--

PIT No: 43
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		CLAY - dark brown clay with some silt		D	0.2				
48	0.3	CLAY - orange brown clay with a trace of gravel (ironstone)		D	0.5				
	0.6	CLAY - stiff, yellow brown mottled grey clay		pp	0.8		pp = 110kPa		
	1			D	1.0				1
47									
	1.7	SILTY CLAY - stiff, red brown mottled grey silty clay with ironstone gravel bands		D	2.0				2
	2			pp	2.2		pp = 120kPa		
46									
	2.7	SHALE - extremely weathered, low strength, yellow brown shale							
	2.8	Pit discontinued at 2.8m - Target Depth Reached							
	3								3
45									

RIG: Backhoe - 600mm bucket
LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 49
EASTING: 302670
NORTHING: 6258699
DIP/AZIMUTH: 90°/--

PIT No: 44
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
49		SILTY CLAY - brown silty clay		D	0.2				
	0.3	CLAY - stiff, yellow brown clay		pp	0.6		pp = 150kPa		
48	1			D	1.0				
				pp	1.5		pp = 200kPa		
	1.6	CLAY - yellow brown clay with some gravel, wet		D	1.8				
47	2								
	2.2	SILTY CLAY - very stiff, grey mottled red brown silty clay		pp	2.3		pp = 400kPa		
				D	2.4				
	2.6	SHALE - extremely weathered, grey to brown shale							
46	3								
	3.2	Pit discontinued at 3.2m - Target Depth Reached							

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:CCK
Date:10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 51.5
EASTING: 302693
NORTHING: 6258467
DIP/AZIMUTH: 90°/--

PIT No: 45
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
51.5	0	SILTY CLAY - brown silty clay		D	0.3				
50.9	0.6	CLAY - stiff, yellow brown mottled red-brown and grey clay		D	1.0				
				pp	1.1		pp = 180kPa		
49.6	1.9	SILTY CLAY - stiff, yellow brown mottled grey silty clay with some gravel, wet		pp	2.0		pp = 200kPa		
				D	2.1				
48.7	2.8	Pit discontinued at 2.8m - Target Depth Reached							

RL scale: 51, 50, 49, 48. Depth scale: 1, 2, 3. Dynamic Penetrometer Test scale: 5, 10, 15, 20.

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:CCK
Date:10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 57.5
EASTING: 302782
NORTHING: 6258025
DIP/AZIMUTH: 90°/--

PIT No: 46
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		SILTY CLAY - brown silty clay		D	0.1				
	0.3	CLAY - hard, red brown clay							
57		- becoming mottled grey		pp	0.6		pp>500kPa		
	1			D	1.0				1
56									
	1.6	SILTY CLAY - yellow brown silty clay (residual rock)		D	1.8				
	2								2
	2.1	SHALE -							
	2.3	Pit discontinued at 2.3m (refusal on shale)							
55									
	3								3
54									

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 52.5
EASTING: 302519
NORTHING: 6258018
DIP/AZIMUTH: 90°/--

PIT No: 47
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		SILTY CLAY - brown silty clay		D	0.1				
	0.2	CLAY - stiff, red brown clay		D	0.5				
52				pp	0.6		pp = 200kPa		
	0.7	CLAY - hard, yellow brown clay (residual rock)		pp	0.9		pp>500kPa		
	1			D	1.0				1
	1.1	SANDSTONE - weathered, light brown sandstone							
51	1.6	Pit discontinued at 1.6m (refusal in sandstone)							
	2								2
50									
	3								3
49									

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 45.5
EASTING: 302312
NORTHING: 6258048
DIP/AZIMUTH: 90°/--

PIT No: 48
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
0.0–0.4	SILTY CLAY - brown silty clay	D	0.2			
0.4–1.0	CLAY - stiff, yellow brown clay	pp	0.5		pp = 200kPa	
		D	0.6			
1.0–2.2	CLAY - very stiff, grey mottled yellow brown clay (residual rock)	pp	1.2		pp = 300kPa	
		D	1.5			
2.2–2.3	SHALE - dark grey shale					
2.3	Pit discontinued at 2.3m (refusal in shale)					

RL scale: 45, 44, 43, 42. Depth scale: 1, 2, 3.

Dynamic Penetrometer Test (blows per mm): 5, 10, 15, 20

RIG: Backhoe - 600mm bucket

LOGGED: C Kline

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 41.5
EASTING: 302041
NORTHING: 6258099
DIP/AZIMUTH: 90°/--

PIT No: 49
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		SILTY CLAY - brown silty clay		D	0.1				
	0.2	CLAY - hard, yellow brown clay		D	0.4				
41									
	1			pp	1.1		PP>500kPa		1
	1.4	SILTY CLAY - very stiff, yellow brown mottled grey silty clay							
40				D	1.6				
	2 2.0	- becoming CLAYEY SILT		pp	2.0		pp = 350kPa		2
39									
				D	2.9				
	3 3.0	Pit discontinued at 3.0m - Target Depth Reached							3
38									

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: CCK
Date: 10/11

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TEST PIT LOG

CLIENT: Landcom
PROJECT: Land Capability Assessment
LOCATION: Western Sydney Parklands

SURFACE LEVEL: 40
EASTING: 302030
NORTHING: 6258460
DIP/AZIMUTH: 90°/--

PIT No: 50
PROJECT No: 40465
DATE: 09 Sep 05
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
40		SILTY CLAY - brown silty clay							
	0.2	CLAY - dark yellow brown clay		D	0.3				
	0.5	CLAY - grey clay		D	0.6				
39	1.0	SILTY CLAY - light grey mottled yellow silty clay							
	1.9	- becoming CLAYEY SILT		D	2.2				
	2.4	Pit discontinued at 2.4m - Target Depth Reached							

RIG: Backhoe - 600mm bucket
LOGGED: C Kline
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:CCK
Date: 10/11

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APPENDIX C
ELECTROMAGNETIC SURVEY – FIELD AND PROCESSING METHODS

1. ELECTROMAGNETIC SURVEY

An electromagnetic survey was undertaken as part of the assessment of soil salinity potential, enabling rapid "continuous" measurement of apparent conductivity to supplement the laboratory electrical conductivity testing of discrete samples collected from the test pits.

Apparent conductivity is variously referred to as ground conductivity, terrain conductivity, bulk conductivity or bulk electrical conductivity and is generally designated as σ_a or EC_a. Measured, apparent conductivities can include contributions from a variety of sources including groundwater, conductive soil and rock minerals and metals. It has been estimated (Baden Williams in Spies and Woodgate: 2004-Ref. 6) that in 75 - 90% of cases in Australia, apparent conductivity anomalies can be explained by the presence of soluble salts. Apparent conductivity can therefore be considered, in the majority of cases, a reliable indicator of soil salinity.

Typically, portable instruments measure apparent conductivity in milliSiemens per metre (mS/m) and typical measurement ranges (Table 1) have been suggested as indicative of salinity classes (Chhabra 1996-Ref. 7).

Table 1 – Salinity Classes in Relation to Apparent Conductivity

Class	ECa (mS/m)
Non Saline	<50
Slightly Saline	50 – 100
Moderately Saline	100 – 150
Very Saline	150 – 200
Extremely Saline	>200

The survey was undertaken using a Geonics EM 31 ground conductivity meter mounted 1 m above the ground surface with traversing undertaken using a project-modified all terrain vehicle (ATV). The EM 31 was operated in the vertical dipole (horizontal coil) mode for a maximum depth of investigation of approximately 6 m. In this configuration approximately 50% of the system response arises within a depth of 3 m below the coils (ie: from material at depths of up to 2 m below ground surface). Other EM systems and configurations can be employed for greater near-surface resolution, however a system responding to material within 2 m of surface is considered appropriate given excavation for proposed urban development is likely to extend to those depths.

EC_a data was acquired at a 1 second repetition rate and logged to a Geonics Polycorder digital data logger. A Trimble AgGPS114 differential GPS (DGPS) receiver, antenna and iPAQ hand-held field computer were employed to digitally record grid coordinates and apparent conductivities at 1 second intervals as the quad bike was navigated around the survey area.

Data was obtained along 109 km of traverse in accessible parts of the site, with an average data point spacing using 2.5 m. Locked gates, electrified fences and existing development prevented access to some areas (particularly in the Huntingwood precinct) and both fences and some creeks prevented a regular grid of primary survey lines 100 m apart as proposed. However, an equivalent density of survey lines was achieved in the accessible areas as shown by the track of the ATV shown as Drawing 6.

2. GROUND CONDUCTIVITY PROFILING

Ground conductivity profiling is an electromagnetic (EM) survey method which employs a transmitter coil above the ground surface to generate an electromagnetic field and induce subsurface current flow in electrically conductive materials. A receiver coil measures the secondary EM field generated by the ground current and the strength of this secondary field, measured in the frequency domain, is converted to an apparent ground conductivity (EC_a). This apparent conductivity is a response to all electrically conductive materials within the depth of investigation and footprint of the EM system, and does not discriminate between sources such as saline soil, groundwater, clays and other conductive minerals, and buried metallic objects.

2.1 EM System Employed

For this investigation, the following equipment was employed:-

- Geonics EM31 Ground Conductivity Meter with Polycorder digital data logger;
- Trimble AgGPS114 Differential Global Positioning System (DGPS), iPAQ hand-held computer (digital data logger); and
- 4WD quad bike.

The EM31 was mounted 1 m above ground surface in a non-conductive frame cantilevered 0.5 m from the side of the quad bike and was operated in the vertical dipole (horizontal coil) mode with a coil separation of 4 m, for a maximum depth of investigation of approximately 6 m. The photograph below shows a system similar to that used on this project.

EM31 measurements of apparent conductivity were logged at 1 second intervals, as were MGA94 coordinates of the measurement locations, as the bike proceeded along the survey lines. On completion of sections of profiling, data were uploaded from the data loggers to a laptop, for subsequent merging of navigation and apparent conductivity data using common time tags.

2.2 Quad Bike Effects

The radiation pattern of the EM31 transmitter coil is not completely unidirectional, and secondary fields will be generated in close adjacent conductors as well as subsurface conductors. The metallic mass of the quad bike therefore has an effect on the apparent ground conductivity reading. To determine the magnitude of this effect, data were acquired on a trial profile obtained in the absence of the bike and with the bike present.

A steep gradient in apparent conductivity was produced within a distance of 1 m from the side of the bike. The non-conductive mounting system for the EM31 was constructed with an adjustable cantilever distance and was fixed for the investigation at a distance of 0.5 m, leading to an apparent conductivity contribution (bike effect) of 8 milliSiemens/m (mS/m) or 0.08 deciSiemens/m (dS/m). Reduced effects could have been obtained at greater cantilever distances, however 0.5 m was maintained for optimum physical stability and minimum total vehicle width for passing through gates throughout the investigation area. At this cantilever distance, a correction of -8 mS/m was applicable to all apparent conductivities obtained from the quad bike.

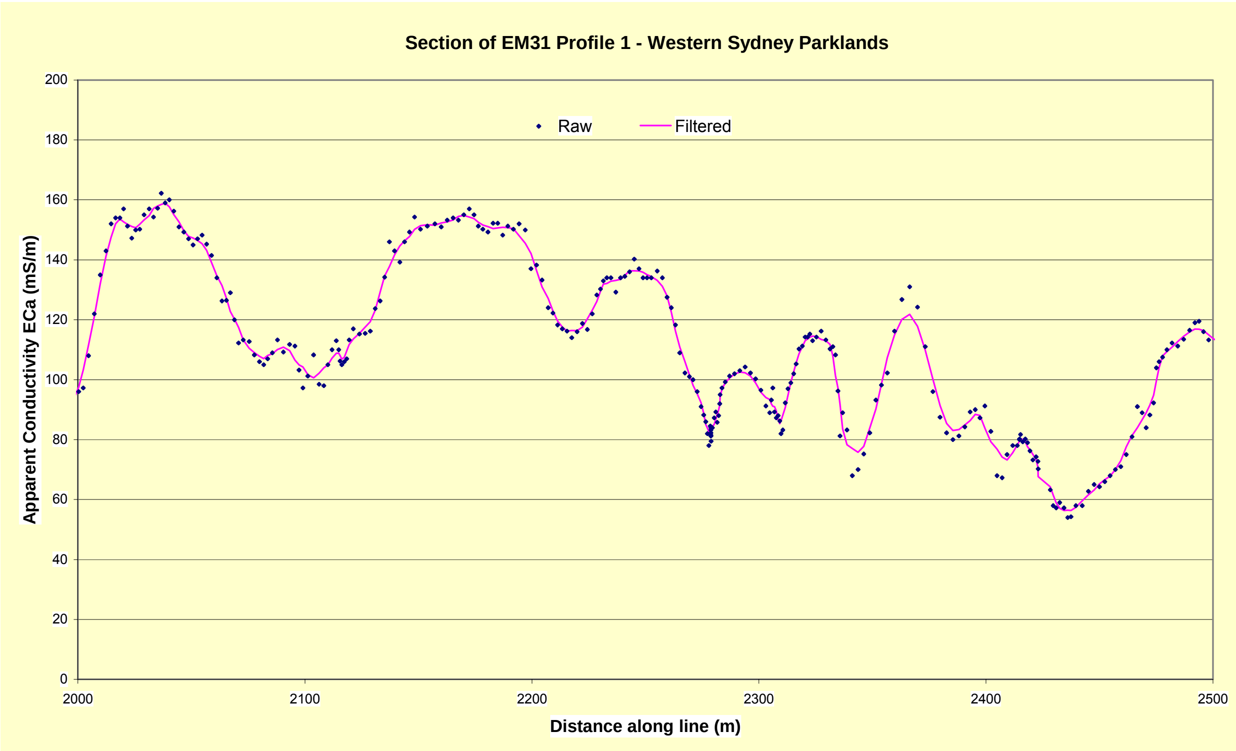
3. DATA PROCESSING

3.1 Quality Control and Filtering

Raw field data were regularly uploaded to a laptop in ASCII file format. Files were then opened as spreadsheets in Excel, for application of the quad bike correction, initial graphical display of DGPS coordinates (plan of data point locations) and EC_a profiles and for quality control checks. Macros were also run to enable line detection and calculation of average station spacings and line lengths. During the investigation, over 42 000 data points were obtained on profiles with a total length of 109 line km and an average station spacing of approximately 2.5 m.

Figure 1 below shows a typical EC_a profile obtained from the quad bike. Raw data shows apparent conductivity anomalies with a superimposed noise envelope of ±5 mS/m (±0.05 dS/m) due to bumping and vertical movement of the quad bike and EM31 coils. Although this noise envelope is of small amplitude, all data were filtered with a 5-point running average prior to further processing.

Figure 1 – EM31 Profile



3.2 Apparent Conductivity (EC_a) Mapping

Filtered EC_a data were opened in the MapInfo/Vertical Mapper GIS environment for spatial analysis and display, overlain on a digital topographic contour map, georeferenced in the AGD94/MGA94 coordinate system.

Drawing 1 shows the locations of the apparent conductivity measurement stations forming the track of the quad bike. Using a triangular interpolation network, the EC_a data set was gridded and displayed on this drawing as a colour image with a continuous colour spectral scale in mS/m. The principal colours represent the boundaries of the Chhabra (1996) salinity classification scheme as follows (Table 1):

Table 1 – Colour Spectrum for Apparent Conductivity Image (Chhabra classification)

Blue	0 mS/m	
		Non-saline
Cyan	50 mS/m	
		Slightly saline
Yellow	100 mS/m	
		Moderately saline
Orange	150 mS/m	
		Very saline
Red	200 mS/m	
		Extremely saline

The 100 mS/m contour and locations of visible salinity indicators were added to Drawing 1 to enable an initial assessment of areas of moderate or greater soil salinity.

3.3 Correlation

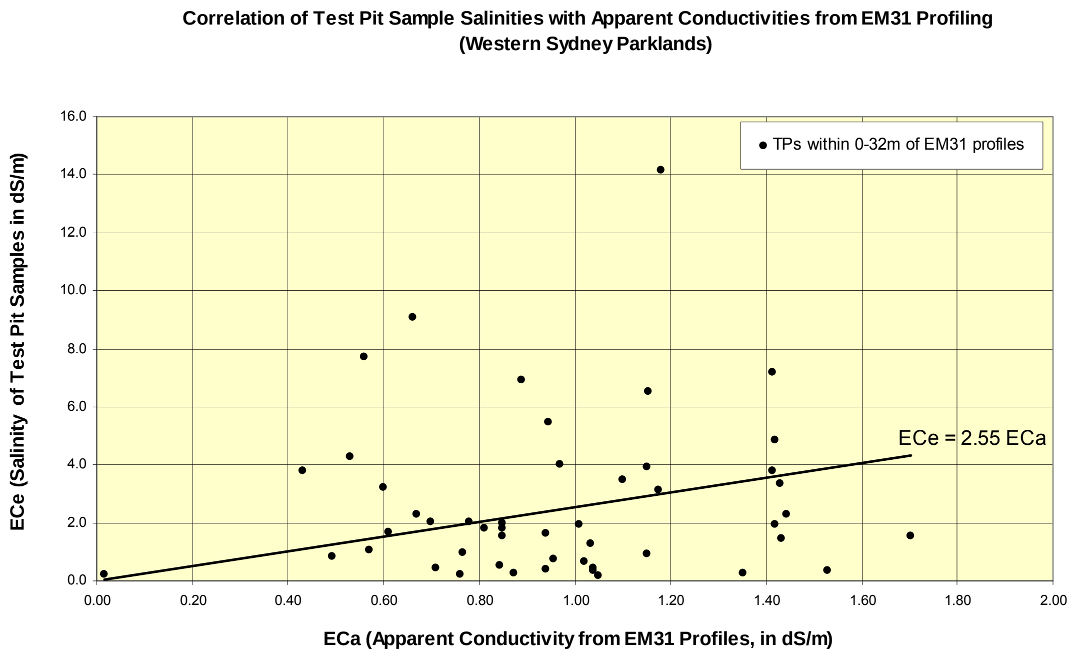
After observation of reasonable qualitative correlations between locations of high EC_a values, some high EC_e values from soil sample tests and visible indicators of salinity, quantitative correlations were carried out aimed at re-scaling the apparent conductivities and re-presentation as "apparent salinities" or estimated EC_e values (in dS/m) over the area of the EM survey.

For this correlation (Figure 2 below), all measured EC_e values from soil samples were plotted on a scattergram against apparent conductivities from the EM31 measurement point closest to the relevant test pit. Forty nine test pits were used for the correlation, distant 0 – 32 m from EM31 lines. For six of these test pits, where samples were obtained at several depths, a bulk EC_e value was first calculated for the test pit, using:

EC_e (bulk) = $\Sigma(EC_e * dZ)/\Sigma dZ$, where dZ is the thickness of the sampled soil layer.

This bulk value is considered analogous to the volume measurement of the EM31 system.

Figure 2 – Correlation of Salinities with Apparent Conductivities



The linear regression performed on the scattergram indicate a factor of 2.55 by which to multiply apparent conductivities (in dS/m) to estimate EC_e values throughout the EM31 data set. The scatter in the correlation plot is considered due to the diverse “sample” volumes of 43 of the 49 plotted points, and possibly to the influence of soil moisture content on the EM31 data in the vicinity of the relatively deeply incised Eastern Creek. In the zone alongside this creek, a depressed water table would reduce the measured apparent conductivities, not due to reduced soil salinities but due to reduced moisture content, causing scatter in the correlation.

3.4 Apparent Salinity (Estimated EC_e) Mapping

The derived correlation factor was applied to all data, which were then re-gridded for presentation as an apparent salinity image with a continuous colour spectral scale in dS/m (Drawing 2). The principal colours represent the boundaries of the Richards (1954) salinity classification scheme as follows (Table 2):

Table 2 – Colour Spectrum for Apparent Salinity Image (Richards classification)

Blue	0 dS/m	
		Non-saline
Cyan	2 dS/m	
		Slightly saline
Yellow	4 dS/m	
		Moderately saline
Orange	8 dS/m	
		Very saline
Red	16 dS/m	
		Highly saline

The 4 dS/m contours were added to the image to assist in the assessment of areas of moderate or greater soil salinity.

Foundation Maintenance and Footing Performance: A Homeowner's Guide

BTF 18 replaces Information Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay sites, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

Tree root growth
Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation
Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

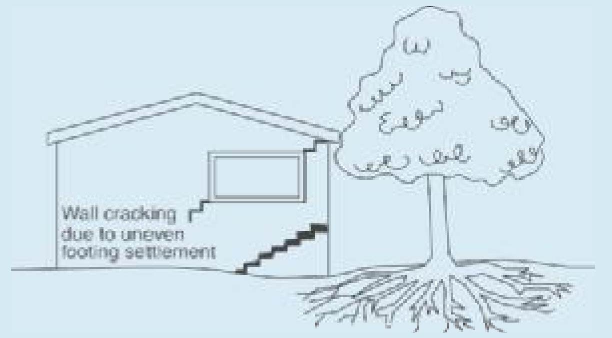
Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

Seasonal swelling/shrinkage in clay
Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

Trees can cause shrinkage and damage



As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots
In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself
Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures
Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures
Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures
Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.
Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing
Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage
In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

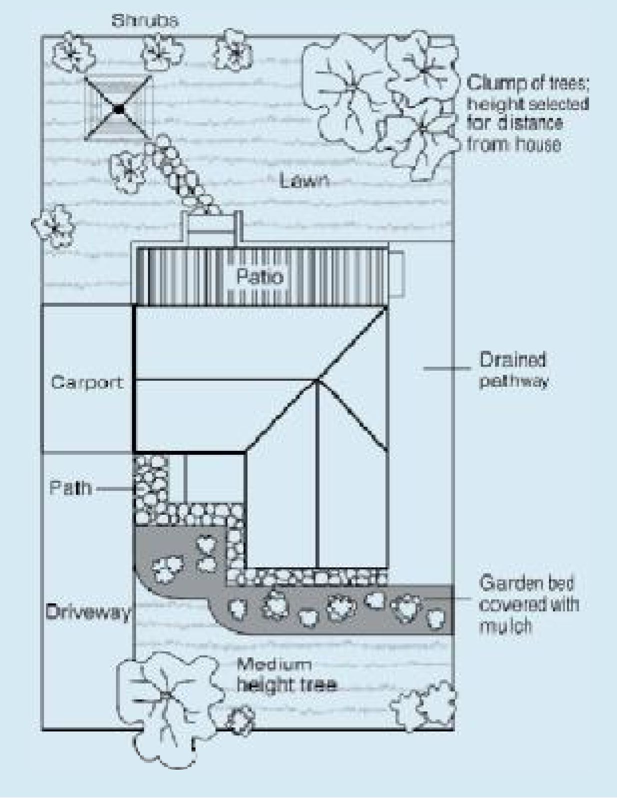
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted	15–25 mm but also depend on number of cracks	4

Gardens for a reactive site



should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation
In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden
The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees
Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs
State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation
Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

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