STRUCTURE PLAN

PORTION OF LOT 16 MCDONALD ROAD, BALDIVIS

SEPTEMBER 2016

ROCK/2016/01

TOWN PLANNING
URBAN DESIGN AND HERITAGE

Document Control

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Issue	Date	Status	Prepared by		Approved by	
			Name	Initials	Name	Initials
1	08.02.16	Draft	Alison Healey		Gary McCullough	
2	12.02.16	Final	Alison Healey		Gary McCullough	
3	16.09.16	Final for WAPC	Alison Healey		Matt Raymond	
4	28.11.16	Amd Final for WAPC	Alison Healey		Matt Raymond	

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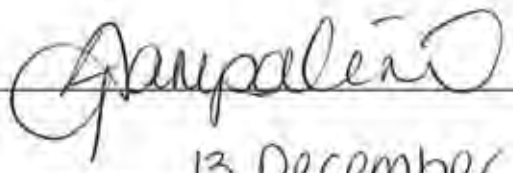
This structure plan is prepared under the provisions of the City of Rockingham Town Planning Scheme No.2

IT IS CERTIFIED THAT THIS STRUCTURE PLAN WAS APPROVED BY RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION ON: 13 December 2016

Signed for and on behalf of the Western Australian Planning Commission

an officer of the Commission duly authorised by the Commission pursuant to Section 16 of *the Planning and Development Act 2005* for that purpose, in the presence of:



Witness

13 December 2016

Date

Date of Expiry: 13 December 2026

Table of Amendments

Amendment No.	Summary of the Amendment	Amendment Type	Date approved by WAPC

Executive Summary

Purpose

This Structure Plan has been prepared under the provisions of the *Planning and Development (Local Planning Schemes) Regulations 2015* and the City of Rockingham Town Planning Scheme No. 2 (TPS 2), to guide the zoning and development of a portion of Lot 16 McDonald Road, Baldivis within the City of Rockingham municipality.

The Structure Plan has been prepared on behalf of Defence Housing Australia by the following specialist consulting team:

- TPG Town Planning, Urban Design and Heritage – town planning, urban design
- Emerge Associates – environmental, local water management, bushfire management
- Pritchard Francis – infrastructure servicing
- Shawmac – traffic assessment
- Galt – geotechnical
- Fyfe - survey

Project Overview

This Structure Plan provides a guiding planning framework to facilitate the zoning and development of approximately 1.8 hectares of land in the north Baldivis area for residential purposes. The Structure Plan ensures that development will be undertaken in an integrated and orderly manner and is anticipated to provide 29 residential lots.

Item	Data	Structure Plan Ref (Section No.)
Total area covered by the structure plan	1.5803 hectares	Part Two – Section 1.2
Area of each land use proposed: Zones • Residential Reserves • Road Reserves	 1.1841 hectares 0.3962 hectares	Part Two – Section 3
Total estimated lot yield	29 lots	Part Two – Section 3.3
Estimated number of dwellings	29 dwellings	
Estimated population	70 people @ 2.4 people/household	
Estimated dwellings per gross hectare of Urban zoned land	18 dwellings per gross hectare of Urban zoned land	
Estimated residential site density	24 dwellings per residential site hectare	
Public Open Space	0 hectares	Part Two – Section 3.5

List of Plans, Figures and Appendices

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PART ONE - IMPLEMENTATION

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Implementation

1. Structure Plan Area

This Structure Plan applies to a portion of Lot 16 McDonald Road, Baldivis, being the land contained within the inner edge of the line denoting the structure plan boundary on the Structure Plan (Plan 1). This Structure Plan is identified as *'Portion of Lot 16 McDonald Road, Baldivis Structure Plan'*.

2. Operation

The date this Structure Plan comes into effect is the date this Structure Plan is approved by the Western Australian Planning Commission (WAPC).

3. Staging

Staging does not apply to this Structure Plan.

4. Subdivision and Development Requirements

Element	Requirement
4.1 Land Use Zones and Reserves	(a) The Zones and Reserves of the Structure Plan area are shown on Plan 1. (b) Land use permissibility within the Structure Plan area shall be in accordance with the corresponding Zone under TPS 2..
4.2 Residential Densities	(a) Subdivision and development within the Structure Plan area is to be in accordance with the nominated R25 density code shown on Plan 1.
4.3 Bushfire Protection	(a) This Structure Plan is supported by a Bushfire Hazard Assessment and Bushfire Management Plan (BMP) contained within Appendix 5.
4.4 Movement Network	(a) The movement network within the Structure Plan area is to be provided generally in accordance with Plan 1. (b) The McDonald Road closure is to be progressed generally in accordance with Plan 1.
4.5 Notifications of Title	(a) In respect of subdivision of the land, the City of Rockingham shall recommend to the WAPC that a condition be imposed on the grant of subdivision approval for a notification to be placed on the Certificate(s) of Title to advise the following: i). That a BMP exists for lots deemed to be affected by a recognised bushfire hazard, as identified within the BMP contained within Appendix 5.
4.6 Public Open Space	Subject to the agreement of the WAPC and the City of Rockingham, a minimum of 10 percent public open space is to be provided by way of a payment of money-in-lieu of land in accordance with the relevant provision of the *Planning and Development Act 2005*.

5. Local Development Plans

Local Development Plan(s) (LDP) are required to be prepared prior to development approval for lots comprising one or more of the following attributes:

(a) Lots with a side boundary abutting McDonald Road. LDP(s) should prohibit vehicular access onto McDonald Road; and/or

(b) Lots deemed to be affected by a recognised bushfire hazard, as identified spatially in Figure 13 of the accompanying BMP, contained within Appendix 5. LDP(s) should prescribe an appropriate Asset Protection Zone and associated dwelling setbacks to street frontages and/or lot boundaries, and any other matters considered necessary to mitigate bushfire risk in accordance with the BMP contained within Appendix 5.

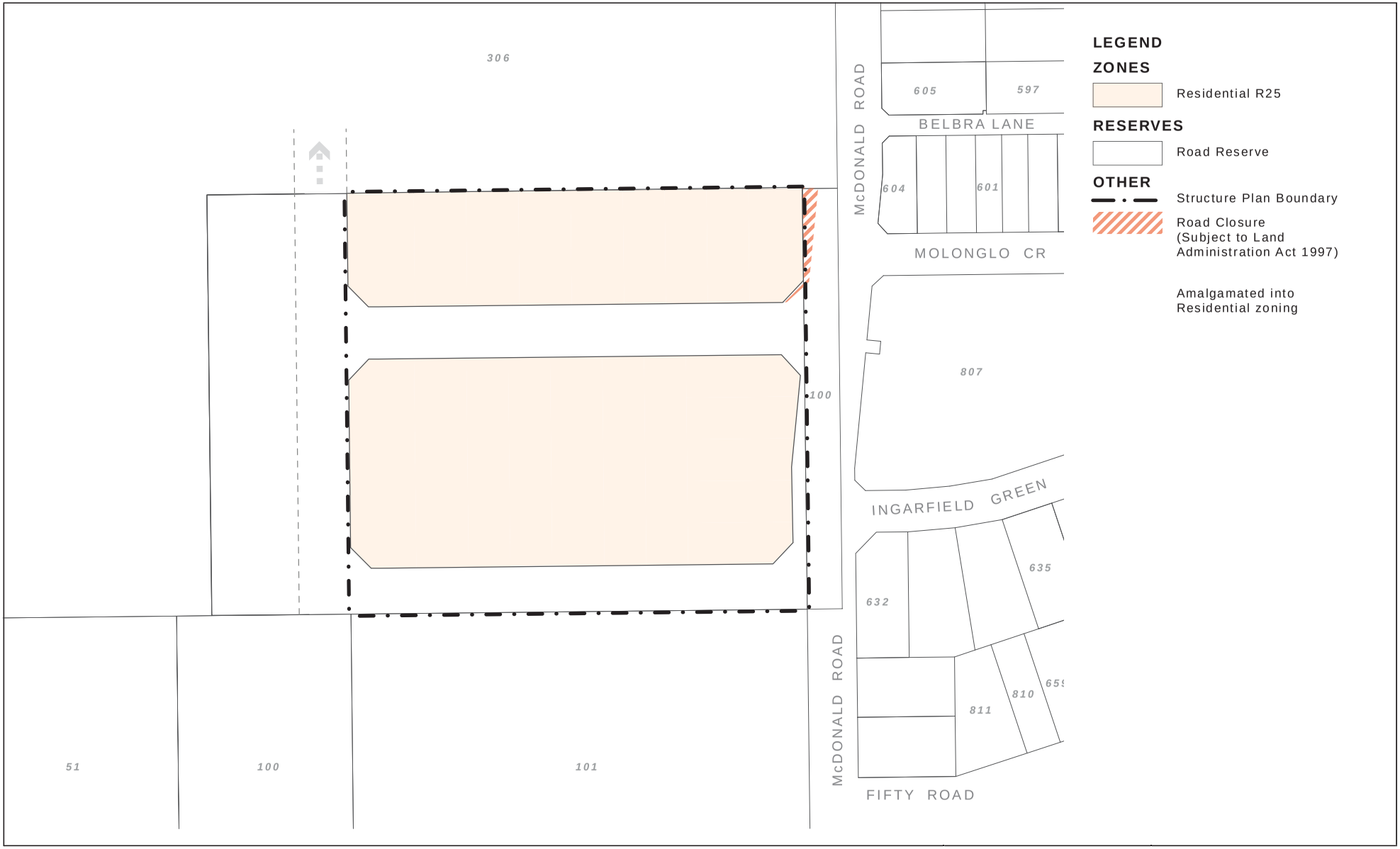
6. Other Requirements

The Structure Plan is subject to the City of Rockingham Development Contribution Area No. 2. The developer is to make satisfactory arrangements with the City of Rockingham to provide proportional contributions towards those items of development infrastructure defined in Schedule No. 12 of the TPS 2.

7. Additional Information

Additional Information	Approval Stage	Consultation Required
Urban Water Management Plan	Subdivision	City of Rockingham
Bushfire Attack Level Assessment	Development	City of Rockingham

Plan 1 – Portion of Lot 16 McDonald Road, Baldivis Structure Plan



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PART TWO – EXPLANATORY SECTION AND TECHNICAL APPENDICES

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1. Planning Background

1.1 Introduction and Purpose

This Structure Plan provides the basis for zoning (including residential density) and development of a portion of Lot 16 McDonald Road, Baldivis zoned 'Urban' under the Metropolitan Region Scheme (MRS) and 'Development' under the City of Rockingham Town Planning Scheme No.2 (TPS 2) (the subject site). The Structure Plan identifies the general pattern of development by identifying movement networks and residential densities.

Part Two has been prepared in accordance with the Western Australian Planning Commission's (WAPC's) Structure Plan Framework (August 2015).

1.2 Land Description

1.2.1 Location

The Structure Plan area is located approximately 38 kilometres south of Perth City and 3 kilometres north of the Baldivis Town Centre. The subject site is positioned generally to the east of a ridgeline that separates it from Mandurah Road and Lake Cooloongup.

The subject site is bound by McDonald Road to the east, privately owned allotments to the south and west and the draft Portion of Lot 306 McDonald Road, Baldivis Structure Plan to the north.

Refer to Figure 1 – Location Plan

1.2.2 Area and Land Use

Lot 16 has an area of approximately 2 hectares and a frontage to McDonald Road in the order of 120m, however the Structure Plan covers approximately 1.58 hectares being the portion of Lot 16 zoned 'Urban' under the Metropolitan Region Scheme (refer to Section 1.3.1.1 of this report). The subject site currently comprises two dwellings and numerous outbuildings. Historical aerial photographs indicate that the site may have previously been used as orchards, developed with the existing southern dwelling in the 1960s. The existing northern single dwelling was established on the subject site in 2007.

Refer to Figure 2 – Aerial Photograph

1.2.3 Legal Description and Ownership

The land subject of this application is described as a portion of Lot 16 on Diagram 37055. The particulars of the Certificate of Title are summarised in Table 1:

Table 1 – Particulars of Certificate of Title

Lot	Diagram	Volume/ Folio	Area	Registered Owner
Pt 16	37055	2827/169	2.0639ha	Defence Housing Australia

Refer to Appendix 1 – Certificate of Title

1.3 Planning Framework

1.3.1 Zonings and Reservations

1.3.1.1 Metropolitan Region Scheme

Under the provisions of the MRS, the Structure Plan area is currently zoned 'Urban'. A 'Rural' zone adjoins the Structure Plan area to the west, and forms the remainder of Lot 16. There are no regional reservations that affect the Structure Plan area.

Refer to Figure 3 – Extract of Metropolitan Region Scheme

Figure 1. Location Plan

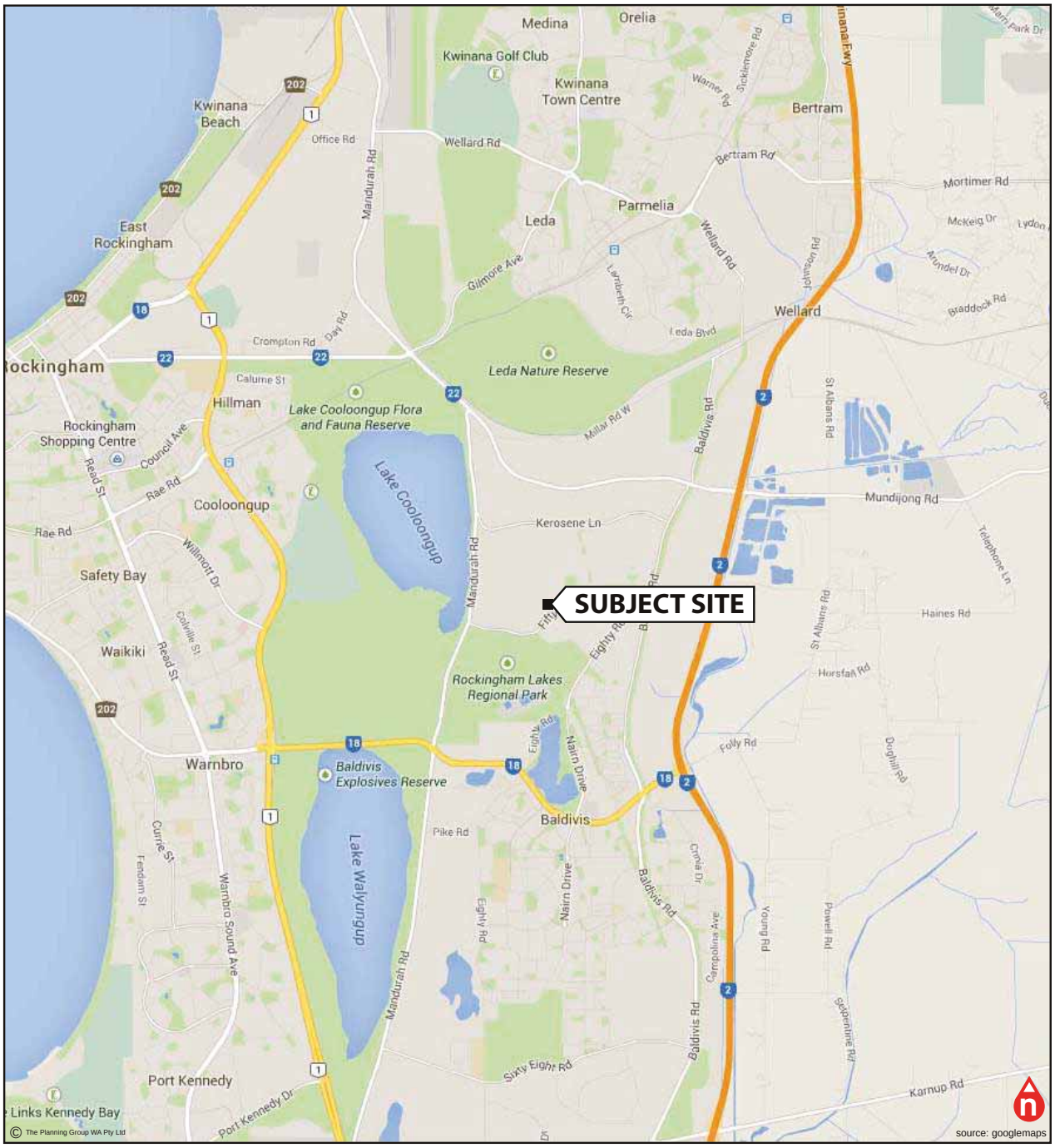
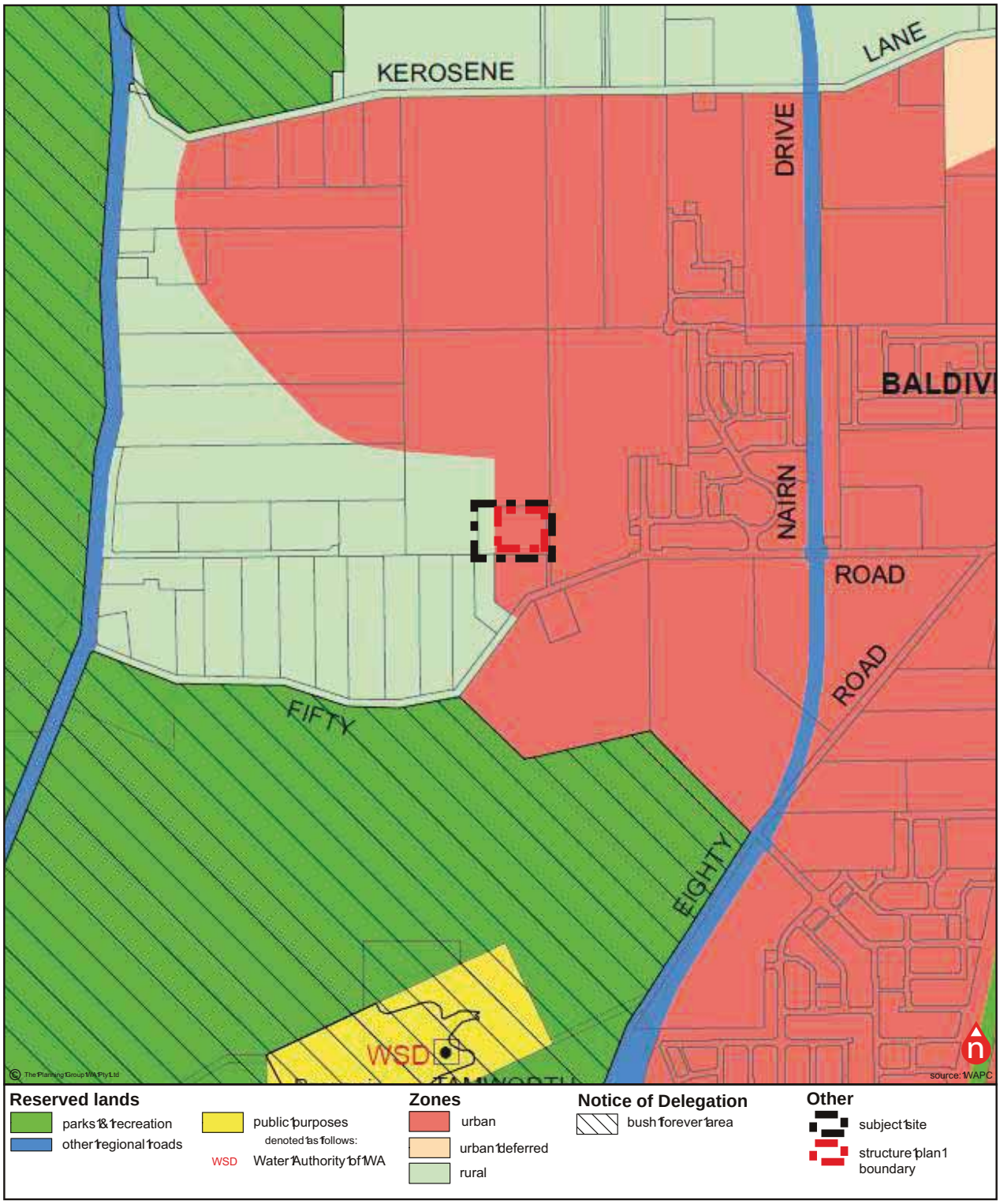


Figure 2. Aerial Photograph

Figure 3. Extract of Metropolitan Region Scheme



1.3.1.2 City of Rockingham Town Planning Scheme No. 2

Under the provisions of the City of Rockingham's TPS 2, the Structure Plan area is currently zoned 'Development' and identified within 'Development Area No. 9'. According to TPS 2, the purpose of the 'Development' zone is to:

(a) identify areas requiring comprehensive planning prior to subdivision and development.

(b) coordinate subdivision, land use and development in areas requiring comprehensive planning.

Pursuant to clause 4.2.4 of TPS 2 and the *Planning and Development (Local Planning Schemes) Regulations 2015*, Schedule 2, Part 4, subdivision and development of land that is zoned 'Development' under TPS 2 is to be generally in accordance with an approved Structure Plan.

The Structure Plan area is also located within 'Environmental Conditions (Area) No. 2'. Schedule 8 of TPS 2 contains the environmental conditions set by the Minister for the Environment as conditions of Amendment 300 to the City's then TPS 1. The conditions require a number of environmental management plans to be prepared (these matters are addressed in Section 1.3.5 and Section 2 of this report).

The subject site is also located within the catchment area of Development Contribution Area No. 2 (DCA2). DCA2 seeks to provide for the equitable sharing of the costs of community infrastructure and administrative costs between landowners. Cost contributions are required as a result of subdivision or development of land within the DCA2 area. The calculation of the cost contribution is provided within Schedule 12 of TPS 2 and is based on dwelling yields.

The Structure Plan proposes the subject site be zoned 'Residential' under TPS 2. All subdivision, development and land use is to be in accordance with the provisions of the Residential zone under TPS 2. A scheme amendment to TPS 2 will eventually be required to 'normalise' this Structure Plan (i.e. transfer the relevant zonings and R-Codes of the Structure Plan into TPS 2).

Refer to Figure 4 – Extract of City of Rockingham Town Planning Scheme No. 2

1.3.2 Regional and Sub-regional Structure Plans

1.3.2.1 Baldivis (North) District Structure Plan

The Baldivis (North) District Structure Plan (DSP) was endorsed by the WAPC in August 2000 and was last modified in September 2006. The DSP guides the preparation of future, more detailed (local) structure plans by setting out broad land uses, open space and road networks. The Structure Plan area is located within 'Precinct 2' of the DSP. The DSP has been given due regard in the preparation of this Structure Plan.

Refer to Figure 5 - Baldivis (North) District Structure Plan (as amended)

1.3.3 Planning Strategies

1.3.3.1 Directions 2031 and Beyond

Directions 2031 and Beyond (Directions 2031) is a spatial planning framework; a high level strategic plan that establishes a vision for the future growth of the Perth and Peel region. It provides a framework to guide the detailed planning and delivery of housing, infrastructure and services necessary to accommodate that growth.

The subject site is located within the 'South Metropolitan Peel Sub-region' which by 2031, is anticipated to reach a total population of 278,000 – a growth of 70,000 people and requiring an additional 41,000 dwellings. The Structure Plan assists in delivering new dwellings to reach this target.

1.3.3.2 Outer Metropolitan Perth and Peel Sub-regional Strategy

The Sub-regional strategies provide a framework for delivering the objectives of Directions 2031. The Structure Plan area is identified as 'Urban Zoned Undeveloped' under the Outer Metropolitan Perth and Peel Sub-regional Strategy as depicted on the South-west Sub-regional Spatial Framework Map. The wider north Baldivis area is projected to yield 3,900+ dwellings by 2031 based on 15 dwellings per gross urban zoned hectare. This Structure Plan aims to achieve approximately 18 dwellings per gross hectare and therefore meets the target set under Directions 2031 and the Sub-regional Strategy.

Figure 4. Extract of City of Rockingham Town Planning Scheme No. 2

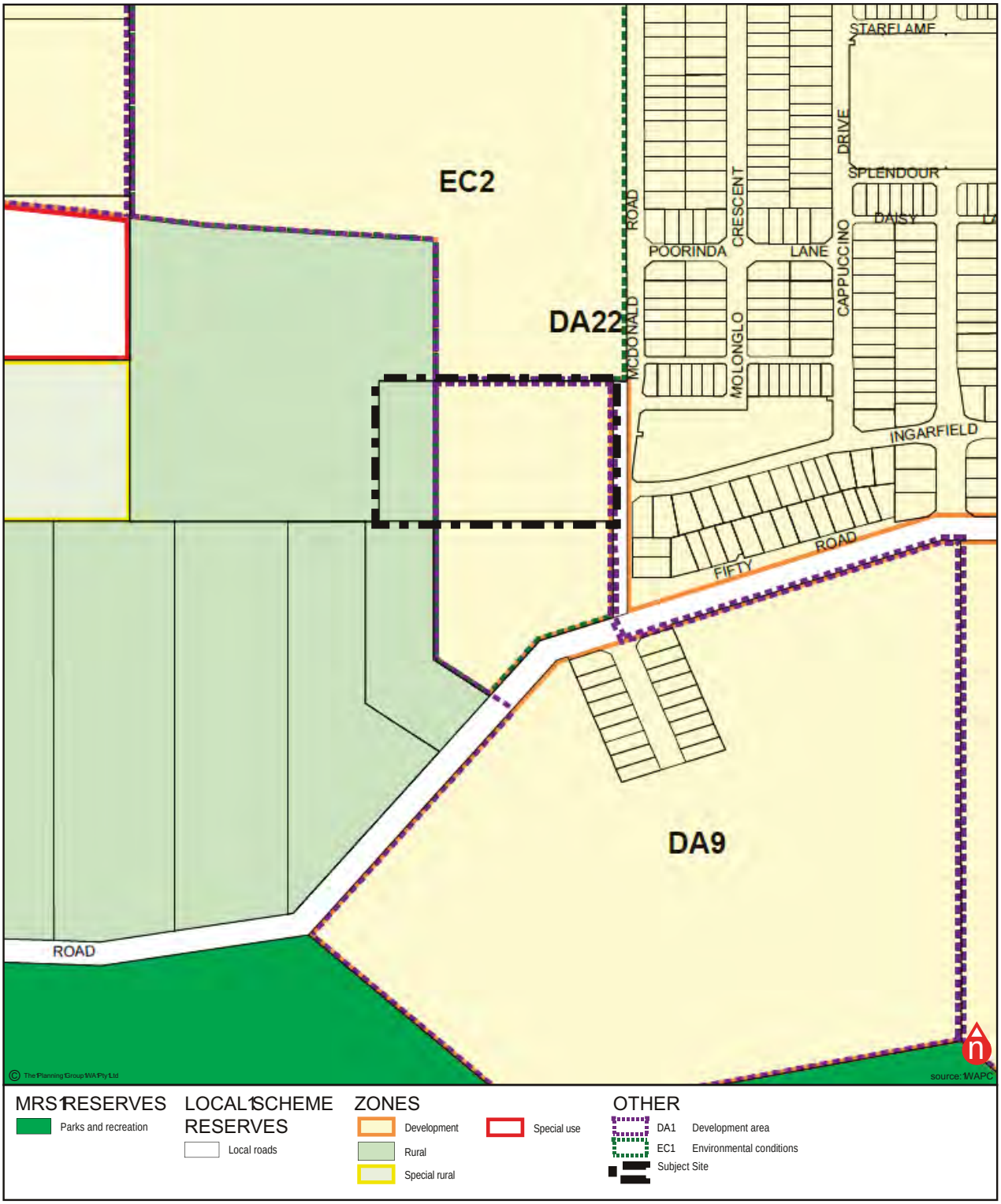
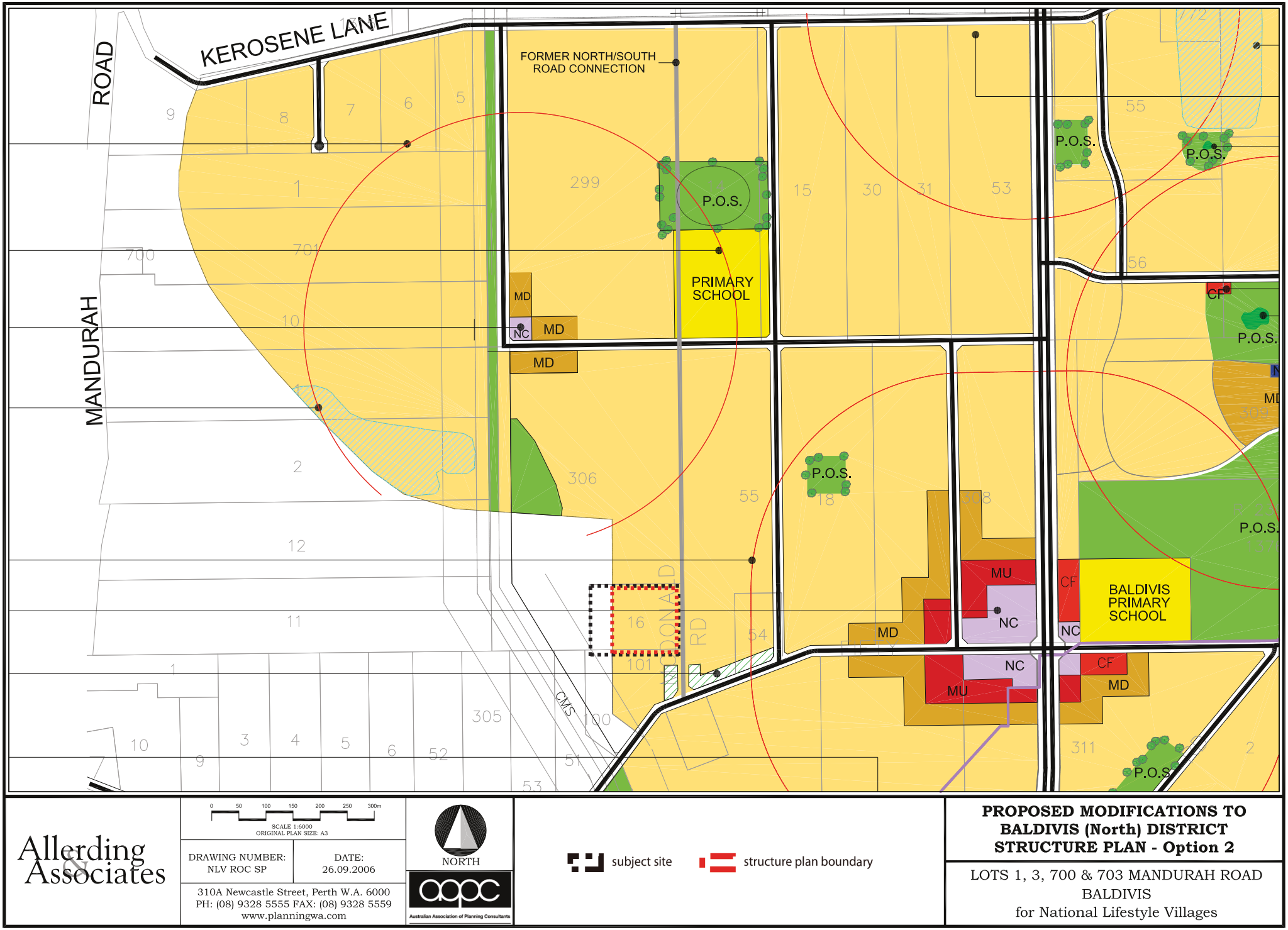


Figure 5. Baldivis (North) District Structure Plan (as amended)



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1.3.3.3 Draft Perth and Peel @ 3.5 Million

The Draft Perth and Peel @ 3.5 Million framework (the Framework) is an overarching document building on the vision laid down by Directions 2031. It aims to achieve a more consolidated urban form to meet long–term housing needs and strengthen key activity centres and employment nodes as the Perth and Peel population grows to 3.5 million. The Framework guides infill development to increase residential housing choice and to reduce the need for people to commute long distances for work. The Structure Plan area is identified as 'Urban' under the South Metropolitan Peel Sub-regional Planning Framework.

The Framework sets a residential site density target of 26 dwellings per residential site hectare. This Structure Plan aims to achieve approximately 24 dwellings per residential site hectare and therefore generally satisfies the intent of the Draft Perth and Peel @ 3.5 Million framework.

1.3.3.4 City of Rockingham Urban Growth Programme (2009)

The City of Rockingham's Urban Growth Programme assists in understanding the likely pattern of urban growth to 2031. The Growth Mapping identifies the Structure Plan area as being developed for future urban purposes. This Structure Plan provides the guiding framework to facilitate future urban development.

1.3.4 Planning Policies

1.3.4.1 State Planning Policy 2.1 – Peel Harvey Coastal Plain Catchment

The Structure Plan area is located within the catchment of the Peel-Harvey estuarine system. State Planning Policy 2.1 (SPP2.1) provides guidance regarding planning requirements for land use changes within this catchment. The relevant objectives of State Planning Policy 2.1 are to:

- Improve the social, economic, ecological, aesthetic, and recreational potential of the Peel - Harvey coastal plain catchment;
- Ensure that changes to land use within the catchment to the Peel – Harvey estuarine system are controlled so as to avoid and minimise environmental damage; and
- Balance environmental protection with the economic viability of the primary sector.

This Structure Plan incorporates principles of Water Sensitive Urban Design and Best Management Practice as demonstrated in the accompanied Local Water Management Strategy (LWMS) (Refer to Section 3.6 of this report).

1.3.4.2 State Planning Policy 3 – Urban Growth and Settlement

SPP3 provides high-level objectives relating to the desired pattern of urban development in the State. SPP 3 provides the following objectives being of relevance to the future development of the Structure Plan area:

- To build on existing communities having established local and regional economies, concentrating investment in the improvement of services and infrastructure and enhancing the quality of life in those communities;
- To manage the growth and development of urban areas in response to the social and economic needs of the community in recognition of relevant climatic, environmental, heritage and community values and constraints; and
- To promote the development of a sustainable and liveable neighbourhood form which reduces energy, water and travel demand whilst ensuring safe and convenient access to employment and services by all modes, provides choice and affordability of housing and creates an identifiable sense of place for each community.

The Structure Plan area would present an opportunity to provide family housing options where future residents would benefit greatly from the range of employment, services, shopping, entertainment and sustainable transport opportunities in the locality, with new dwellings optimising the use of established infrastructure networks.

1.3.4.3 State Planning Policy 3.1 Residential Design Codes

The Residential Design Codes (R-Codes) provide the comprehensive basis for the control of residential development through the State. The future subdivision and development of the Structure Plan area will be required to satisfy the relevant provisions of the R-Codes. In this regard, the Structure Plan proposes a residential density of, as described by the R-Codes, of R25.

1.3.4.4 State Planning Policy 3.7 Planning for Bushfire Risk Management and Planning for Bushfire Risk Management Guidelines

SPP3.7 intends to assist in reducing the risk of bushfire to people, property and infrastructure by taking a risk-minimisation approach to development proposed in bushfire prone areas.

A designated Bushfire prone area is an area that has been identified and designated by the *Fire and Emergency Services Act 1998* (as amended). Such areas are identified on the *Map of Bush Fire Prone Areas*.

The Structure Plan area is designated as being Bushfire Prone. In accordance with SPP3.7 and the associated Guidelines, the Structure Plan road and lot layout has been influenced by the outcomes of an indicative Bushfire Attack Level (BAL) contour plan and associated Bushfire Management Plan (BMP) (refer to Section 2.7 of this report).

Part One of the Structure Plan report lists the situations where Local Development Plans are required to be prepared at subdivision stage to ensure bushfire risk is addressed.

1.3.4.5 Development Control Policy 2.3 Public Open Space in Residential Areas

The main component of Development Control Policy 2.3 (DC2.3) is the requirement for 10 percent of the gross subdivisional area of a residential subdivision to be provided as public open space (guided by Liveable Neighbourhoods, see below). Clause 4.3 of DC2.3 allows for a cash payment to be made by the subdivider in lieu of providing land for open space, particularly if the land area is such that a 10 percent land contribution would be too small to be of practical use or open space is planned in a nearby location. Refer to Section 3.5 of this report.

1.3.4.6 Liveable Neighbourhoods 2009

Liveable Neighbourhoods is an operational policy, adopted by the WAPC, for the design and assessment of structure plans and subdivisions for residential development. The elements of Liveable Neighbourhoods primarily relate to large-scale, greenfield structure planning and subdivision and accordingly a detailed assessment of the structure plan is not provided. Rather, a simple assessment against the relevant elements and objectives of Liveable Neighbourhoods is provided in Section 3.7 of this report.

1.3.4.7 Planning Bulletin No. 87 – High Pressure Gas Transmission Pipelines in the Perth Metropolitan Region

WAPC Planning Bulletin No. 87 provides guidance for planning and development proposals that are located within the vicinity of regional gas pipelines, including the Parmelia Gas Pipeline. Table 1 of the Bulletin provides for a 65m setback between residential development and the gas pipeline easement 'as of right'. The Structure Plan area is in excess of this setback distance however is located within the 'notification area' to ensure consultation occurs with the pipeline owners for any planning proposal.

1.3.4.8 Planning Bulletin No.112 - Medium-Density Single House Development Standards - Structure Plan Areas

In May 2015, the WAPC released Planning Bulletin No. 112 to introduce new standard residential-medium density deemed-to-comply R-Code provisions within Structure Plans. Whilst this approach is now inconsistent with the requirements of the WAPC's Structure Plan Framework (August 2015), and cannot be included in this structure plan, future development may be guided by applicable local planning policies and/or local development plans adapted by the City that incorporate the objectives of the Planning Bulletin.

1.3.5 Other Planning Approvals and Decisions

The Structure Plan area comprised part of Amendment No. 300 to the City of Rockingham's previous Town Planning Scheme No. 1, which was initiated to rezone the Structure Plan area and surrounding land from 'Rural' to 'Development' in line with the underlying MRS 'Urban' zoning. The rezoning application was assessed by the Environmental Protection Authority (EPA) in 2001 and it was determined that the proposal could be implemented subject to conditions. The approval and associated conditions are outlined in Ministerial Statement No. 580 (dated 19th December 2001) which has been attached as Appendix 2. The conditions require preparation of various management plans. A brief outline of the conditions and how they have been addressed by this Structure Plan has been provided below:

- Condition 1 - Drainage and Nutrient Management Plan has been addressed through the Local Water Management Strategy prepared in accordance with the Department of Water's (DoW) Better Urban Water Management Guidelines (refer to Section 2.3.6 of this report).

- Condition 2 - Soil and Groundwater Investigation and Remediation Plan has been addressed through the Preliminary Site Investigation undertaken as part of the Geotechnical and Preliminary Environmental Study (refer to Section 2 of this report).
- Condition 3 - Pipeline Protection Plan is not relevant to this site as the Structure Plan area is located outside the pipeline buffer.
- Condition 4 - Spray Drift Investigation and Management Plan is not relevant to this site as no active market garden operations occur in the vicinity of the Structure Plan area.
- Condition 5 - Vegetation Management Plan is not relevant to this site as no regionally significant vegetation (i.e. Bush Forever Site 356) occurs in the vicinity of the Structure Plan area.

1.3.6 Pre-lodgement Consultation

Pre-lodgement consultation is summarised in the table below. It should be noted that the project team has also had various discussions with the City of Rockingham via telephone that have not been documented.

Table 2 – Pre-lodgement Consultation

Agency	Date of Consultation	Method of Consulttion	Comments/ Outcome
CoR	1 September 2015	Meeting	TPG - initial meeting to discuss expectations and format of the Structure Plan. Applicant made aware of recent draft Structure Plan over Portion of Lot 306 to the north. Key technical studies advised to be water and drainage, bushfire, traffic and contamination. Acknowledged Environmental Conditions under TPS 2 Schedule 8. Density suitable at R25.
CoR	20-30 November 2015	Email correspondence	Emerge - query regarding water management approach, potential to discharge offsite and/or store subsurface beneath road reserves. Response from CoR indicating acceptance of subsurface beneath road reserves and suggesting investigating roadside bio retention areas.
CoR	25 November 2015	Meeting	TPG - progress meeting to discuss outcomes of BAL assessment, design elements of revised subdivision concept plan and technical studies underway.
CoR	21 December 2015	Email correspondence	TPG - CoR provided in-principle support for the proposed road closure of a portion of McDonald Road considered surplus to needs.
CoR	5 January 2016	Email correspondence	Emerge – obtaining existing information regarding adjacent areas.
CoR	12-15 January 2016	Email correspondence	Shawmac - obtaining traffic data for report.
CoP	8 February 2016	Email correspondence	Review of draft Part One - Implementation
DoP	15 December 2015	Email correspondence	TPG - query regarding the rural balance lot to the east of the Structure Plan area and the proposed subdivision concept/road location. DoP (Paul Sewell) superficially confirmed that the response to the Rural/Urban demarcation appears logical and appropriate.
DoP	15 December 2015	Email correspondence	Emerge - to DoP.
DoP	9-10 February 2015	Email correspondence	Review of draft Part One - Implementation
WC	6 March 2015	Email correspondence/ telephone	Pritchard Francis - confirmation within existing network planning.
DoW	11 December 2015	Telephone discussion	Emerge – discussions with Brett Dun regarding approval process and groundwater levels.
DoW	11-14 December 2015	Email correspondence	Emerge – query to and subsequent response from Brett Dun confirming that groundwater level monitoring at the site is not required.

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2. Site Conditions and Constraints

The following section provides a summary of the key findings from the various consultant reports, including:

- Geotechnical and Preliminary Environmental Study (Appendix 3);
- Environmental Assessment and Management Strategy (Appendix 4)
- Bushfire Management Plan (Appendix 5); and
- Infrastructure Servicing Report (Appendix 6).

2.1 Landform and Soils

The site ranges in height from 4.2m Australian Height Datum (AHD) to 7.2mAHD. The highest levels are located in the west of the site, providing an easterly aspect. The lowest parts of the site are located along McDonald Road.

A geotechnical assessment was undertaken for the site by Galt Geotechnics which found ground conditions to be generally as expected based on the regional mapping, with the following observations noted specific to the site:

- Sand, medium to coarse grained, sub-angular to sub-rounded, brown becoming yellow with depth, trace limestone cobbles and gravel, typically loose to dense, present from surface to depth of between 1m extending to the maximum depth investigation (2.5m).
- Limestone, present below the sand layer, rockhead varying from depths between about 1m and more than the maximum depth of investigation (2.5m). Imported fill was found to occur in the north-west of the site, associated with the existing residence in this portion of the site.

Refer to Appendix 3 - Geotechnical and Preliminary Environmental Study

2.1.1 Acid Sulfate Soils

Mapping from the geotechnical report shows the site having no known risk of Acid Sulfate Soils occurring at depths less than 3m from the surface. The nearest high risk area is located approximately 50-100m to the south west of the site, likely associated with wetlands in this area (discussed below).

2.2 Biodiversity and Natural Assets

2.2.1 Flora and Vegetation

The site has been historically cleared of remnant vegetation to support agricultural land uses and now supports areas of grassland dominated by weeds, with a small number of planted non-native trees in the western extent of the site. Due to the complete removal of remnant vegetation from the site, based on a site inspection by Emerge botanists, vegetation is considered to be in 'Completely Degraded' condition.

Given the extent of historic disturbance within the site, there is unlikely to be any significant flora species present within the site. It is also highly unlikely that any areas of Threatened or Priority Ecological Communities should occur within the site. There are no declared Environmentally Sensitive Areas within the site.

2.2.2 Fauna

Given the extent of historic disturbance within the site, any fauna species present would be generally common and widespread species with non-specific requirements that allow them to persist in highly disturbed habitats. There are no known black cockatoo roosting or breeding sites located within or in the vicinity of the site, and while areas of remnant vegetation west of the site are mapped as potential foraging habitat, there is none within the site.

Refer to Appendix 4 - Environmental Assessment and Management Strategy

2.3 Hydrology

2.3.1 Groundwater

Recent groundwater monitoring data from the residential subdivision to the east ('The Chimes') indicate that a maximum groundwater level of 1.38mAHD was recorded in a bore located approximately 30m from the south eastern corner of the site in July 2012. Depth to the maximum groundwater level (MGL) therefore ranges between 2.82m below ground level (BGL) and 5.82m BGL. Recent groundwater monitoring data from the draft Part Lot 306 McDonald Road, Baldivis Structure Plan to the north of the site indicate that a MGL of 1.82mAHD was recorded in a bore located approximately 20m from the north-western corner of the site in September 2014. Refer to Section 3.6 of this report.

2.3.2 Surface Water

No surface water features have been observed within the site, and no external surface water catchments direct surface water flows into the Structure Plan area. Rainfall would infiltrate freely across the site due to the high permeability of the underlying sands.

2.3.3 Wetlands

Based on a desktop search of the Department of Parks and Wildlife's Geomorphic Wetlands series mapping within Landgate's Shared Land Information Portal, there are no wetlands located within the Structure Plan area. A Dampland Conservation Category Wetland is located approximately 75m southwest of the site. The Structure Plan area is located outside of any buffer distance requirement.

Refer to Appendix 4 - Environmental Assessment and Management Strategy

2.4 Historical Land Uses and Potential Contamination

Based on a review of historic aerial photography the site was cleared of native vegetation prior to 1953 (earliest available aerial image) for agricultural purposes and to allow for subsequent market garden land uses. Market garden land uses are generally considered to have a low risk of contamination but are listed in the DER's Potentially Contaminating Activities, Industries and Landuses guideline.

As part of the geotechnical investigation undertaken for the site, limited contamination investigations were also undertaken, involving a desktop assessment and review of historic aerial photography, excavation of test pits and bore holes, and the laboratory testing of soil samples for heavy metals and pesticides. These investigations indicated that there was no evidence of soil contamination within the site as a result of historic market garden land uses and therefore it is unlikely that soils within the site have been impacted to an extent that would restrict development for urban purposes.

A search of the Department of Environment Regulation's (DER) Contaminated Sites Database and Register found there to be no registered contaminated sites within or immediately adjacent to the site.

2.5 Surrounding Land Uses

2.5.1 Poultry Farm

An existing poultry farm is situated approximately 850 m south-east of the site. Based on the EPA's Guidance Statement No. 3 Separation Distances between Industrial and Sensitive Land Uses there is a recommended generic separation distance of 300-1000m (depending on the size of the operation) between poultry farming facilities and sensitive land uses.

A detailed and site specific odour impact assessment was undertaken for the poultry farm, as part of local structure planning for the landholdings east of Baldivis Road. The assessment indicated an off-site odour impact of up to 100m in any direction from the poultry sheds. This recommended separation distance will not result in any consideration for the Structure Plan area.

2.5.2 Market Gardens

Landholdings to the north of the site have been subject to extensive historic market garden activities. This area is zoned 'Urban' under the MRS and is intended for future urban development under the Baldivis (North) DSP. It is understood that the landowner is currently progressing planning for the urban development of this area, therefore this historic land use is not a key consideration or constraint to urban development within the site.

2.6 Bushfire Hazard

A BMP has been prepared to provide guidance on how to plan for and manage the potential bushfire threat to the Structure Plan area and its future development. The BMP identifies the BAL and subsequently addresses requirements expected of local governments, the developer and property owners, and details the specific fire management requirements that will be implemented within the development and design.

The BMP demonstrates that mitigation of the bushfire risk to the Structure Plan area can be achieved as follows:

- Providing appropriate vehicular access options (proposed loop roads);
- Providing sufficient water supply to ensure emergency services are able to respond to a bushfire event (reticulated water supply);
- Siting development to ensure buildings are not exposed to an unacceptable level of radiant flux, without appropriate mitigation measures (implemented through subsequent LDP(s));
- The BMP concludes that the proposed design of subdivision and modified vegetation are such that with the implementation of the BMP, the fire threat to persons and property within the Structure Plan area is reduced to an acceptable level;
- Dwellings located within 100m of identified classified vegetation will have bushfire risk mitigated through the use of an appropriate asset protection zone (APZ) and construction standards via compliance with AS3959; and
- The indicative BAL assessment demonstrates that BAL-29 would not be exceeded and an APZ can be accommodated within the proposed future road reserves in the south and west of the site, in response to the adjacent bushfire hazards.

Further, the Bushfire Prone areas determined for the site (as shown within Figure 9 of the BMP) could be used by the City to update the *Map of Bush Fire Prone Areas.*

Refer to Figure 6 – Indicative Bushfire Attack Levels

Refer to Appendix 5 - Bushfire Management Plan

2.7 Infrastructure Servicing and Utilities

An Infrastructure Servicing Report (ISR) has been prepared to address various servicing requirements for the indicative subdivision concept. The ISR concludes that the future development of the Structure Plan area is not constrained by service capacities or upgrades with all services in close proximity to the site.

Note: infrastructure within the McDonald Road reserve subject to the proposed road closure will be relocated at the developer's expense.

Refer to Appendix 6 - Infrastructure Servicing Report

2.7.1 Stormwater Drainage

An underground pit and pipe network is intended for the site and will be disposed of into underground tanks, allowing for infiltration and attenuation of the critical 1:100 year ARI event (refer to Section 3.6 of this report).

2.7.2 Sewerage

A 150mm diameter sewer has been allowed for to service the expected lots. This can then gravity feed into the 150mm diameter sewer running along the west side of McDonald Road and then to the existing wastewater pump station adjacent to the lot. The sewerage catchment has been confirmed by the Water Corporation and the system has sufficient capacity for the 29 lot development (plus the rural balance lot).

2.7.3 Water Supply

The site currently has a 150mm water main on the eastern side of McDonald Road. It is likely that connections into the 150mm main will be able to supply the site with water, which has been indicated by the Water Corporation. Connection will need to be bored under McDonald Road. It is assumed internal water reticulation mains will be 100mm.

2.7.4 Power

Existing electrical infrastructure adjacent to the site includes high and low voltage cables along both sides of McDonald Road, and an existing transformer directly opposite the Structure Plan area on McDonald Road.

Regional mapping indicates the site will have 15-20MVA capacity in 2020 hence it is not anticipated capacity will be an issue.

2.7.5 Communication

There is existing Telstra network located in McDonald Road, which is the existing service currently servicing the dwellings on site. It is expected there will be capacity to service this site. Optic fibre currently exists along Fifty Road.

2.7.6 Gas

There is existing 110mm high pressure gas pipelines on the east side of McDonald Road. 40mm high pressure mains connect into this larger main to service the existing residential area to the east. It is expected this network will have capacity to service the development.

Figure 6. Indicative Bushfire Attack Levels

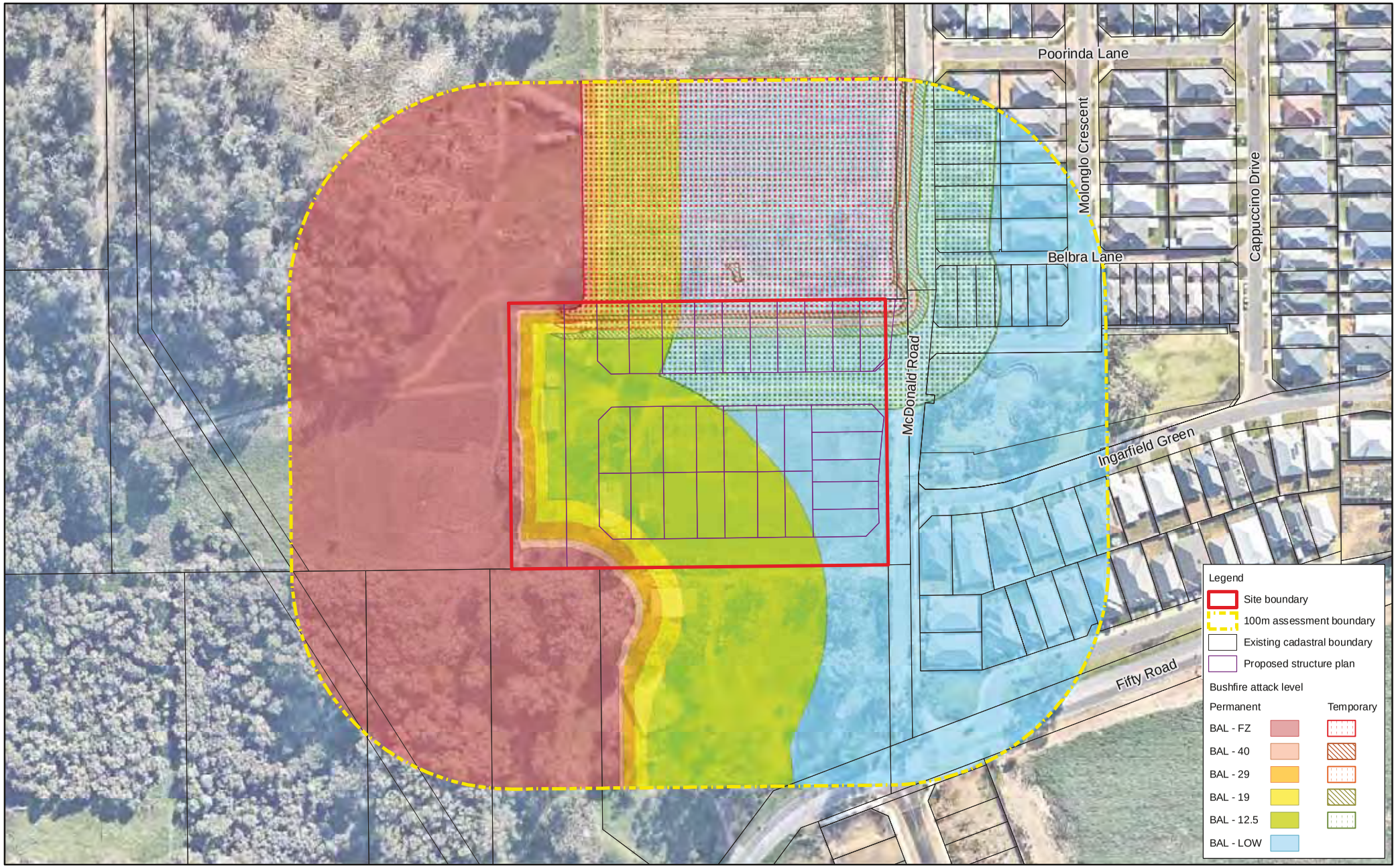

Figure 12:	**Indicative Bushfire Attack Levels**	0	**Plan Number: EP15-057(03)--F15c**
Project:	Bushfire Management Plan Portion of Lot 16 McDonald Road, Baldivis		Drawn: KNM Date: 05/09/2016 Approved: JDH Date: 07/09/2016 Checked: VMK Scale: 1:2,250@A4
Client:	Defence Housing Australia		0 20 40 80 Metres

Bushfire Safety Consulting

emerge ASSOCIATES Integrated Science & Design

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3. Structure Plan

The following section provides the rationale for the proposed subdivision concept plan, which forms the basis for the Structure Plan zoning.

Refer to Figure 7 – Subdivision Concept Plan

3.1 Context

The immediate area is in transition from historically rural land (market gardens and poultry farms) to new residential estates. A number of larger lots in this area have undertaken coordinated planning to provide a variety of lot sizes, including new local centres and public open space. The Peet and Co. estate of 'The Chimes' is located directly adjacent and east of the site. A National Lifestyle Village and a number of public assembly uses are located to the northwest and west of the site.

A neighbourhood centre, including primary school, is located within an 800m walkable catchment of the Structure Plan area; to the east on Fifty Road. District open space is provided throughout the Baldivis (North) DSP, including an organised recreation reserve adjacent to the neighbourhood centre and a lineal parkway following the Parmelia gas pipeline corridor to the west of the site.

3.2 Interface with Surrounding Land

At the time of writing this report, structure planning was being progressed over Lot 306 to the north of the site, which has been given due regard in the preparation of the subdivision concept plan. The subdivision concept plan includes the following interface design elements:

- Residential lots abut the northern lot boundary of the Structure Plan area, consistent with the draft Portion of Lot 306 McDonald Road, Baldivis Structure Plan so as to not create dual-frontage lots;
- The proposed road layout comprises a north-south access road that generally connects into the proposed road layout of the draft Portion of Lot 306 McDonald Road, Baldivis Structure Plan;
- A road closure is proposed to the portion of McDonald Road surplus to the required 18m wide road reserve. The road closure will facilitate the orderly development of the site in accordance with the Structure Plan and the draft structure plan for portion of Lot 306 McDonald Road, Baldivis to the north by rationalising or 'neatening up' the cadastral boundary anomaly with Lot 306, which will result in a better urban design outcome for the streetscape and the future corner lot; and
- An area of local public open space is provided adjacent to the Structure Plan area on the opposite side of McDonald Road. The subdivision concept plan positions smaller lots fronting McDonald Road to take advantage of the outlook and amenity.

3.3 Residential Densities and Dwelling Forecasts

The Structure Pan provides for residential development at a density, as described by the R-Codes, of R25. The subdivision concept plan suggests the Structure Plan area can yield 29 lots, which equates to a density of 24 dwellings per residential site hectare and approximately 18 dwellings per gross hectare of urban zoned land. The Structure Plan generally provides for the achievement of the residential density targets set by the WAPC in its State strategic planning documents.

3.4 Movement Network

A Transport Assessment has been prepared to support the subdivision concept plan and the key findings are outlined below.

Refer to Appendix 7 - Transport Assessment

3.4.1 Access

Access to the Structure Plan area is proposed via two local access roads from McDonald Road. All roads within the subdivision area will be constructed as access roads, with cross section details, line marking, intersection control and local area traffic management measures to be addressed during the detailed subdivision design stages.

3.4.2 Road Hierarchy

'Road 1' comprises a 15m wide road reserve, designed for short, low volume and low parking demand access streets. 'Road 2' also comprises a 15m wide road reserve, with 13m contained within the Structure Plan area and the additional 2m contained on adjoining Lot 101. This arrangement is justified on the basis that 'Road 2' will only be serving one side of the road in the short-medium term and any future development of adjoining Lot 101 may utilise the constructed road, having regard for the need for a 15m wide road reserve.

Refer to Figure 8 – Internal Road Hierarchy

Refer to Figure 9 -Road Cross Sections

3.4.3 Pedestrian and Cycle Network

Footpaths with a minimum width of 1.5 m are recommended to be provided on at least one side of each of the internal access roads with connections to the established pedestrian and cycling network external to the area, as well as to future urban development north and east of the subject site.

Due to the expected low volumes of traffic and the low speed environment on the internal access roads, on-road cycle lanes are not required and cyclists are able to safely share the roadway with motorised vehicles. There is a 2.5m concrete path on the north side of the road, east of McDonald Road however there are no formal facilities from McDonald Road to Mandurah Road in the west for cyclists or pedestrians.

3.4.4 Public Transport

There are limited public transport services in the area. A bus route travelling along McDonald Road is identified in the Baldivis (North) DSP (refer to Figure 13 of the Transport Assessment) and it is expected that that bus routes will better service the wider Baldivis area in the future.

3.4.5 Traffic Generation

A trip generation and distribution exercise was completed as part of the Transport Assessment and determined that the proposed subdivision would generate 240 vehicular trips per day. The majority of the trips would permeate through the local road network to McDonald Road north to Kerosene Lane and south to Fifty Road. A future road connection via the eastern access road to the northern subdivision will also permeate through the road network.

The Transport Assessment modelled traffic flows for the internal road network, as shown in Table 3 (refer to Section 5.2 of the Transport Assessment).

Table 3 – Internal Roads Future Daily Traffic Volumes

Road Name	Predicted Traffic Volumes (vpd)
Road 1	139
Road 2	62
Road 3	15
McDonald Road	168

The predicted subdivision traffic flows were added to the estimated volumes of traffic for McDonald Road upon the ultimate development of the surrounding site, as shown in Table 4 (refer to Section 5.5 of the Transport Assessment).

Table 4 – Existing Road Network Predicted Flows

Road Name	Curent/ Predicted External Traffic Volumes (vpd)	Predicted Traffic Volumes (vpd)	Change in Traffic
McDonald Road	2,500	2,668	+ 168 vpd
Fifty Road	2,500	2,668	+ 168 vpd

The traffic generated was not large enough to warrant any intersection analysis, under the Table 6.1 of Austroads Guide to Traffic Management Part 3 - Traffic Studies and Analysis, and as such there are no safety or operational issues expected.

3.5 Public Open Space

Public open space has not been provided within the Structure Plan due to the relative size and location of the Structure Plan area in relation to surrounding local and district open space. A cash-in-lieu payment is considered acceptable in this instance.

The provision of 10 percent public open space in this instance would yield an area of approximately 1,850 sqm, which is considered impractical in terms of use and / or ongoing maintenance due to its size. Public open space has been provided directly adjacent to the Structure Plan area and other public open space is planned within the adjoining draft Portion of Lot 306 McDonald Road, Baldivis Structure Plan.

Figure 7. Subdivision Concept Plan

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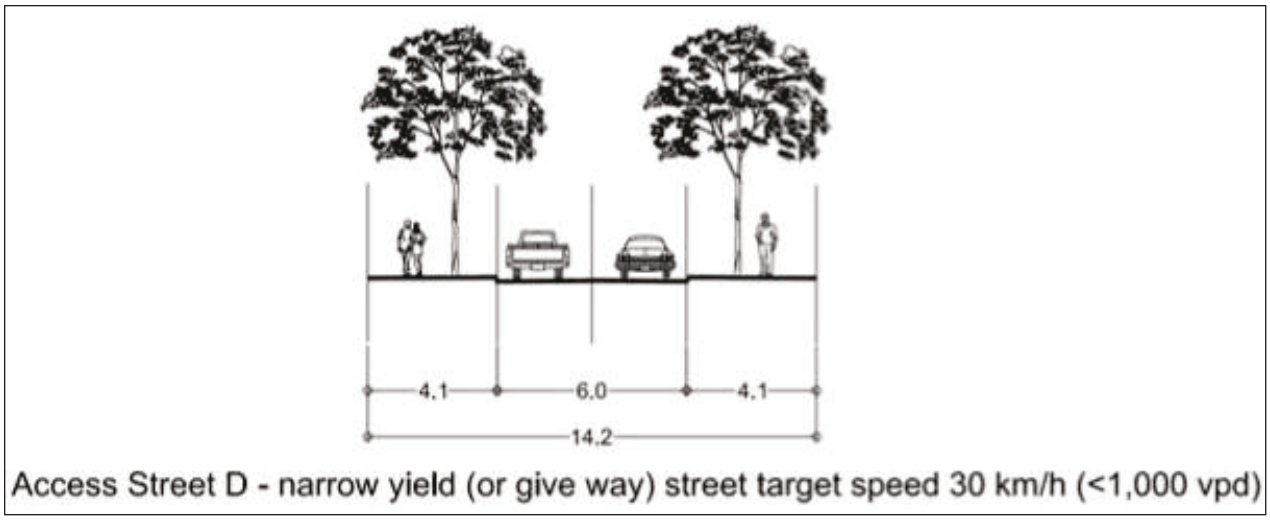
Figure 8. Internal Road Hierarchy

Figure 9. Road Cross Sections



3.6 Local Water Management Strategy

A LWMS has been prepared to support the future urban development of the Structure Plan. The LWMS has been prepared in accordance with the WAPC's Better Urban Water Management, State Planning Policy 2.9 Water Resources, and Planning Bulletin 92 Urban Water Management.
Water will be managed using an integrated water cycle management approach, which has been development using the philosophies and best practice design described in the Department of Water's Stormwater Management Manual for Western Australia.

The LWMS addresses the following:

- Water conservation and water efficiency;
- Stormwater management; runoff quantity and quality; and
- Groundwater management.

Of note however is the stormwater management approach. The project team, in consultation with the City, determined that the drainage basin constructed within the adjacent residential estate, 'The Chimes', may not have sufficient capacity to accommodate stormwater from the Structure Plan area. The development drainage system for the Structure Plan area therefore *allows* for sub-surface storage to be utilised that is designed to treat minor event runoff and retain major event runoff (i.e. the 100 year ARI event) within the site. Water will be pre-treated before entering the subsurface storage cells via a lined pre-treatment chamber.

Subsurface storage will be used to retain up to the 100 year ARI event runoff from the road network and
10 percent of residential lots (i.e. front driveways) resulting in no offsite discharge. Indicative locations of subsurface storage are provided in Figure 6 of the LWMS. Subsurface storage cells maintain sufficient clearance from maximum groundwater levels. Stormwater within individual residential lots will be contained on-site within soak wells.

Note: The rural balance lot to the west of the Structure Plan area (and within Lot 16) will retain and infiltrate runoff up to the 100 year ARI event on-lot. This approach is consistent with the existing hydrology of the site which is characterised by the high permeability of underlying soils.

It is anticipated that a more detailed water management plan, in the form of an Urban Water Management Plan, will be required as a condition of subdivision approval.

Notwithstanding the above stormwater approach, the LWMS notes that an alternate surface retention-based approach will be investigated as part of detailed civil design. This includes investigating the initialisation of the planned drainage basin located in adjoining Lot 306 (20) McDonald Road, Baldivis.

Refer to Appendix 8 - Local Water Management Strategy

3.7 Basic Liveable Neighbourhoods Assessment

The subdivision concept plan has been assessed against the objectives of the WAPC's Liveable Neighbourhoods and its various design elements. The subdivision concept plan incorporates the following attributes in accordance with Liveable Neighbourhoods:

Element 1: Community Design

- Connects new urban areas to existing or proposed urban areas ensuring permeability and provides for a safe, convenient, permeable and legible pedestrian network. Regard has been given to the draft structure plan over adjoining Lot 306 to the north in terms of lot placement and future opportunities to connect the road network.

Element 2: Movement Network

- The internal access road network is site responsive and highly connected (bushfire considerations, connections to Lot 306);
- The access road layout provides lots with a continuous street frontage that is safe and efficient for pedestrians, cyclists and vehicles, including emergency vehicles;
- Footpaths are provided for on at least one side of the local access roads;
- Kerb radii is appropriate for the relevant road hierarchies;
- Verge design to accommodate space for utility services, street trees, paths and landscaping; and
- Stormwater management infrastructure has been designed to take into account the access road network and catchment characteristics.

Element 3: Lot Design

- The proposed street and lot layout facilitates climate responsive design and acknowledges bushfire risk;
- Lots are of a size, width and shape that provides for solar orientation, usable private outdoor space, and garaging that does not dominate the street;
- A range of residential lot sizes are provided for and are suitable for a variety of housing types;
- Connection to underground power, reticulated water and wastewater can be provided for each lot, with reticulated water being provided for emergency service use in the event of a bushfire event; and
- Stormwater is anticipated to be retained within the Structure Plan area via subsurface storage cells and on-lot retention/detention.

Technical Studies Appendices

No.	Technical Study	Nature of Document	Assessing Agency	Status
1	Certificate of Title	Information Only	N/A	N/A
2	Ministerial Statement No. 580	Information Only	N/A	N/A
3	Geotechnical and Preliminary Environmental Study	Information Only	N/A	N/A
4	Environmental Assessment and Management Strategy	Supporting document	CoR, WAPC, DPaW, DER	
5	Bushfire Management Plan	Supporting document	CoR, WAPC, DPaW, DFES	
6	Infrastructure Servicing Report	Information Only	N/A	N/A
7	Traffic Assessment	Supporting document	CoR, WAPC	
8	Local Water Management Strategy	Supporting document	CoR, WAPC, DPaW, DoW	

Abbreviations

AHD Australian Height Datum

ASS Acid Sulfate Soils

BAL Bushfire Attack Level

BMP Bushfire Management Plan

CoR City of Rockingham

DER Department of Environment Regulation

DoW Department of Water

DFES Department of Fire and Emergency Services

DPaW Department of Parks and Wildlife

DSP District Structure Plan

EPA Environmental Protection Authority

LDP Local Development Plan

LWMS Local Water Management Strategy

MRS Metropolitan Region Scheme

TPS Town Planning Scheme

WAPC Western Australian Planning Commission

WC Water Corporation

WP Western Power

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Appendix 1

Certificate of Title

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WESTERN AUSTRALIA

REGISTER NUMBER	
16/D37055	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

VOLUME 2827 FOLIO 169

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 16 ON DIAGRAM 37055

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

DEFENCE HOUSING AUSTRALIA OF 26 BRISBANE AVENUE BARTON ACT 2600
(T N205053) REGISTERED 16 DECEMBER 2015

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: 181-75A (16/D37055).
PREVIOUS TITLE: 181-75A.
PROPERTY STREET ADDRESS: 16 MCDONALD RD, BALDIVIS.
LOCAL GOVERNMENT AREA: CITY OF ROCKINGHAM.

NOTE 1: DUPLICATE CERTIFICATE OF TITLE NOT ISSUED AS REQUESTED BY DEALING L874122

Appendix 2

Ministerial Statement No. 580

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MINISTER FOR THE ENVIRONMENT AND HERITAGE

Statement No.

000580

STATEMENT THAT A SCHEME MAY BE IMPLEMENTED (PURSUANT TO THE PROVISIONS OF DIVISION 3 OF PART IV OF THE ENVIRONMENTAL PROTECTION ACT 1986)

CITY OF ROCKINGHAM TOWN PLANNING SCHEME NO. 1 AMENDMENT NO. 300 ("DEVELOPMENT" ZONE, PT LOTS 306 & 16, AND LOTS 313 & 774, FIFTY ROAD, BALDIVIS)

Scheme Purpose: To rezone Pt Lot 306, Pt Lot 16, and Lots 313 and 774 Fifty Road, Baldivis from "Rural" to "Development" zone.

Responsible Authority: City of Rockingham

Responsible Authority Address: PO Box 2142, Rockingham WA 6967

Assessment Number: 1227

Report of the Environmental Protection Authority: Bulletin 1018

Subject to the following conditions, there is no known environmental reason why the town planning scheme amendment to which the above report of the Environmental Protection Authority relates should not be implemented:

CONDITIONS TO BE INCORPORATED INTO THE SCHEME BY INSERTION OF PROVISIONS IN SCHEME TEXT

1 Environmental Management Plans

1-1 The following Environmental Management Plans shall be prepared in accordance with the specifications set out in Attachment 1 in the Minister for the Environment and Heritage's "Statement that a Scheme may be Implemented" No. [insert relevant Statement Number] published on [insert date], and shall be subsequently implemented in accordance with the provisions of the Plans:

Published on

19 DEC 2001

29th FLOOR, ALLENDALE SQUARE, 77 ST. GEORGE'S TERRACE, PERTH 6000 TELEPHONE: (08) 9220 5050 FACSIMILE: (08) 9221 4665/8
E-MAIL: judy-edwards@dpc.wa.gov.au

- Drainage and Nutrient Management Plan;
- Soil and Groundwater Contamination Investigation and Remediation Plan;
- Pipeline Protection Plan;
- Spray Drift Investigation and Management Plan; and
- Vegetation Management Plan.

2 High Pressure Natural Gas Pipeline

2-1 The following activities, land uses and developments are prohibited within the high pressure natural gas pipeline easement:

- Ground-disturbing activities, other than for the purposes for which the easement was created, and for uses and developments that comply with condition 2-2 below;
- Temporary residence (including caravans, camping and similar);
- Storage of materials and equipment;
- Fires and barbecues;
- Explosives, inflammables and corrosives (including storage of liquefied petroleum gas and fuel oil);
- Refuse disposal and landfill;
- Service stations, fuel lines and storage of fuel;
- Vegetation with an expected growth exceeding one metre in height, and plantings within one metre of the centre of the pipeline (with the exception of lawn); and
- Large obstructions to the line of sight along the easement.

Note: For the high pressure natural gas pipeline easement, the relevant Australian Standard is AS 2885.3.

2-2 The following land uses and developments may be permitted within the high pressure natural gas pipeline easement, with the written approval of the local government on advice of the pipeline operator, subject to compliance with the Pipeline Protection Plan referred to in condition 1-1 above:

- Cycleways and footpaths;
- Road crossings and services (with minimum depth of cover over the pipeline of 1.2 metres);
- Public open space;
- Signage and other facilities that are necessary to comply with the Pipeline Protection Plan referred to in condition 1-1 above; and
- Car parking during the time that the adjoining land is being developed (with minimum depth of cover over the pipeline of 1.2 metres).

2-3 Minimum setbacks for land uses and developments from the centre of the high pressure natural gas pipeline shall be:

- 96 metres, in the case of sensitive development as determined by the local government on advice of the Department of Environmental Protection and the pipeline operator, and including aged persons' accommodation, child care centres, schools and hospitals;
- 32 metres to the boundary of each residential lot, in the case of residential development; and
- at the local government's discretion, following consultation with the Department of Environmental Protection and the pipeline operator, in the case of all other land uses and developments which facilitate the gathering of people, within 96 metres of the centre of the pipeline.

3 Development in Proximity to Market Gardens

3-1 If the market gardens adjacent to Pt Lots 306 and 16 are continuing to operate at the time of subdivision, noise attenuation measures shall be designed and implemented so that noise impacts on the amendment area are in accordance with the *Environmental Protection (Noise) Regulations 1997*.

CONDITIONS TO BE INCORPORATED INTO THE SCHEME BY MODIFICATIONS TO THE SCHEME MAP

4 Scheme Map

4-1 The Scheme Map for the City of Rockingham Town Planning Scheme No. 1 shall be amended by inserting the symbol EC and an appropriate modification to the legend of the Scheme Map, to show that environmental conditions apply to part of Pt Lot 306, part of Lot 16, Lots 774 and 313 Fifty Road, Baldivis.

ATTACHMENT 1 - OF STATEMENT THAT A SCHEME MAY BE IMPLEMENTED - CITY OF ROCKINGHAM TOWN PLANNING SCHEME NO. 1 AMENDMENT NO. 300

SPECIFICATIONS FOR ENVIRONMENTAL MANAGEMENT PLANS

1 Drainage and Nutrient Management Plan

1-1 Prior to commencement of site works for subdivision or development, the subdivider or developer shall prepare a Drainage and Nutrient Management Plan to ensure that the rate, quantity and quality of water leaving the Amendment area will not adversely impact on Opwin and Spot Swamps, the Rockingham Groundwater Area groundwater supply, and the Peel-Harvey Estuarine System, to the requirements of the local government and on advice of the Water and Rivers Commission.

1-2 This Plan shall:

- Define the catchment of Opwin and Spot Swamps in relation to the Amendment area;
- Provide measures to facilitate the removal of pollutants and nutrients in accordance with the Water Sensitive Urban Design Best Practices;
- Incorporate Best Practice Water Sensitive Urban Design principles to maximise onsite water infiltration generally;
- Provide measures to prevent surface water runoff from entering the Opwin or Spot Swamps;
- Provide mechanisms to minimise erosion during and after the development phase;
- Provide a monitoring program, including definition of performance criteria and analysis procedures, to measure the performance of the Plan against objectives and performance criteria;
- Provide contingency plans in the event that criteria are not achieved; and
- Identify responsibilities for implementation of the Plan.

2 Soil and Groundwater Contamination Investigation and Remediation Plan

2-1 Prior to the commencement of site works for subdivision or development on any land that has previously been used for horticultural purposes, the subdivider or developer shall prepare and implement a Soil and Groundwater Contamination Investigation and Remediation Plan to the requirements of the local government and on advice of the Department of Environmental Protection.

2-2 This Plan shall

- Include soil and groundwater investigation procedures to define the nature and extent of any soil or groundwater contamination, and identify areas where

contamination levels exceed criteria recognised by the Department of Environmental Protection; and

- In the event that the investigation finds unacceptable soil or groundwater contamination, describe procedures for further investigation of contamination, a detailed methodology for remediation prior to development, the standards to which any contaminated soil or groundwater will be remediated, and a management plan for contaminated areas, where necessary.

3 Pipeline Protection Plan

3-1 Prior to subdivision or development on any land within or abutting the high pressure natural gas pipeline easement, the subdivider or developer shall prepare a Pipeline Protection Plan to ensure protection of the pipeline during construction activities, to the requirements of local government, on advice of the Department of Mineral and Petroleum Resources and the pipeline operator.

3-2 This Plan shall

- Detail measures to ensure public safety and protection of the high pressure natural gas pipeline in accordance with the *Petroleum Pipelines Act 1969-70*, the Australian Pipeline Code AS 2885-1997, SAA HB105 and the Environmental Protection Authority guidance statement for achieving its risk criteria for development in proximity to existing and proposed high pressure gas transmission pipelines, or the most recent equivalents recognised by the Environmental Protection Authority; and

- Identify responsibilities for implementation of the Plan.

4 Spray Drift Investigation and Management Plan

4-1 Prior to the approval of subdivision or development, the subdivider or developer shall prepare and implement a Spray Drift Investigation and Management Plan to the requirements of the local government, on advice of the Department of Health, the Department of Agriculture and the Department of Environmental Protection.

4-2 This Plan shall

- Require undertaking investigations of spray drift from all rural or semi-rural activities occurring within the proximity of the Amendment area, to clearly define impacts on the health and amenity of future residents; and

- In the event that the investigations find that unacceptable health or amenity impacts are likely to affect the residents within the Amendment area, provide

management strategies to ensure that impacts on the health and amenity of future residents are acceptable.

5 Vegetation Management Plan

5-1 Prior to subdivision approval, the subdivider shall prepare a Vegetation Management Plan that protects the regionally significant vegetation abutting the Amendment area, particularly *Bush Forever* Site No. 356, from direct and indirect impacts associated with the development, through the provision of a hard edge along the amendment boundary and the implementation of appropriate construction and access management measures.

5-2 The Vegetation Management Plan shall be prepared to the satisfaction of the local government and on advice of the Department of Conservation and Land Management and the Department of Environmental Protection.

Dr Judy Edwards MLA
MINISTER FOR THE ENVIRONMENT AND HERITAGE

19 DEC 2001

Appendix 3

Geotechnical and Preliminary Environmental Study

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Report on

GEOTECHNICAL AND PRELIMINARY ENVIRONMENTAL STUDY PROPOSED RESIDENTIAL SUBDIVISION 16 MCDONALD ROAD, BALDIVIS

Submitted to:
Defence Housing Australia
C/- Pritchard Francis
Level 1, 430 Roberts Road
SUBIACO WA 6008

www.galtgeo.com.au
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T: +61 (8) 6272-0200
F: +61 (8) 9285-8444

J1501070 001 R Rev0

30 April 2015

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TABLES (WITHIN TEXT)

FIGURES

APPENDICES

1. INTRODUCTION

This report presents the outcomes of Galt Geotechnics Pty Ltd (Galt's) geotechnical and preliminary environmental study for the proposed residential subdivision at 16 McDonald Road, Baldivis ("the site"). The location of the site relative to the surrounding area is shown on Figure 1, Site and Location Plan.

The investigation was requested by Lachlan Harris of Pritchard Francis and authorised by Jody Fisher of Defence Housing Australia in a signed client authorisation dated 13 April 2015 and email correspondence dated 14 April 2015.

2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

Based on the supplied information, the site is rectangular in plan and covers an area of 2.06 ha. Based on publicly available contour mapping, the current surface elevation is understood to vary from about RL 5.0 m AHD in the north west corner, peaking in the middle of the site at about RL 7.0 m AHD, and falling to around RL 6.0 m AHD in the east of the site.

The site is currently occupied by several existing residential dwellings and structures, generally on the western third of the site, with scattered large, established trees and bushes. A track runs from McDonald Road, east to west along the centre of the site to the existing structures. The balance of the site is cleared and grassed, with some areas evidently used as a laydown area. We understand that part of the eastern half of the site has been used as market gardens.

We understand that the end client, Defence Housing Australia, has concerns about possible previous uncontrolled filling of the site.

It is understood that the proposed development will comprise a residential subdivision. The latest concept plan for the proposed residential subdivision shows the development comprising 25 residential sized lots, ranging in size from 342 m^2 up to 570 m^2 and 3 roads, with the balance of the lot (5,976m^2) to consist of a rural zone, in which the existing residential dwelling will be retained.

We have not being given specific details regarding proposed structures on the site; however, we assume these will be typical single or double storey masonry structures, with shallow footings and slabs-on-ground

3. OBJECTIVES

The objectives of the study, based on the request from Pritchard Francis, were to:

Geotechnical

- assess subsurface soil and groundwater conditions across the site, including possible presence of rock / limestone and the possible presence of uncontrolled fill;
- provide recommendations on suitable footing systems for the proposed development;
- provide allowable bearing pressure and settlement estimates for shallow foundations;
- provide a site classification(s) in accordance with AS 2870-2011 "Residential Slabs and Footings";
- specify remediation work required to ensure that the site will have a site classification of "Class A", if required;
- provide recommendations and geotechnical design parameters for earth retaining structures;
- assess the appropriate site subsoil class for the site in accordance with AS 1170.4-2007;
- recommend appropriate site preparation procedures including compaction criteria, re-use of in-situ soil and specifications and preparations for filling the site;
- assess the suitability of excavated material for re-use as fill;

- assess the permeability of the soils at the site for potential on-site disposal of stormwater by infiltration, including design permeability rates;
- provide guidance on preparation of soil under pavements, roads and car parking areas, including providing a subgrade California bearing ratio (CBR) value for pavement thickness design by others.

Environmental

- conduct a desk study assessment and comment on the possible presence of acid sulfate soils (ASS) and other environmentally sensitive issues apparent from geotechnical investigation that may need further detailed investigation;
- assess the nature and extent of soil contamination in areas of the site where market gardening activities are known to have occurred (if any); and
- determine if soil contamination (if any) represents a risk to human health or the environment.

4. FIELDWORK

Fieldwork was completed on 20 April 2015 and comprised

- excavation of test pits at sixteen locations, TP01 to TP16, extending to depths of up to 2.5 m;
- testing with Perth sand penetrometer (PSP) adjacent to each test pit location and at an additional 3 locations, extending to depths of up to 2.1 m;
- drilling of hand auger boreholes at 3 locations, HA01 to HA03, extending to depths of between 0.6 m and 0.8 m below ground;
- infiltration tests using the 'inverse auger hole' method at 3 locations, P1 to P3, at depths of between 0.6 m and 0.8 m below ground;
- collection of representative samples from the former market gardening area for inspection and laboratory testing; and
- a site walkover to inspect for potential environmental issues.

General

The tests were positioned and located by a geotechnical engineer and environmental scientist from Galt using a handheld GPS accurate to within about 5 m in the horizontal plane. Our personnel observed the test pitting, excavated the hand augered boreholes, logged the materials encountered in the test pits and boreholes, conducted the penetrometer and infiltration testing, collected representative samples for inspection and laboratory testing and conducted a site walkover.

The test locations are shown on Figure 1, Site and Location Plan. Photographs of the site are presented in Appendix A, Site Photographs. Test pit and hand auger borehole details are summarised in Table 1.

Table 1: Summary of Tests

Test Name	Test Depth (m)	Fill Thickness (m)	Depth to Limestone (m)[1,2]	Reason for Termination	Stratigraphy
TP01	2.5	-	1.9	Refusal on limestone	SAND, overlying Limestone
TP02	2.2	-	1.6	Refusal on limestone	
TP03	2.2	1.0	1.5	Refusal on limestone	FILL, SAND; overlying SAND, overlying limestone
TP04	2.3	-	NE[3]	Test pit collapse	SAND
TP05	1.9	-	1.4	Refusal on limestone	SAND, overlying Limestone
TP06	1.4	-	1.3	Refusal on limestone	
TP07	2.5	0.4	NE	Test pit collapse	FILL, SAND; overlying SAND
TP08	0.6	0.4		Refusal on limestone	
TP09	2.3	-	1.0	Refusal on limestone	SAND, overlying Limestone
TP10	2.4	-	2.3	Test pit collapse	
TP11	1.8	0.6	1.8	Refusal on limestone	FILL, SAND; overlying SAND, overlying limestone
TP12	0.7	0.1		Target depth	FILL, SAND; overlying SAND
TP13	2.0	0.8		Target depth	
TP14	2.5	-		Target depth	SAND, overlying Limestone
TP15	2.4	-		Target depth	
TP16	2.3	-		Refusal on limestone	
HA01	0.8	-		Target depth	SAND
HA02	0.7	-		Target depth	
HA03	0.6	-		Target depth	

Notes: [1] Depth at which limestone was first encountered. Limestone is typically in the form of pinnacles.

[2.] The term "limestone" as used in the report refers to a carbonate cemented rock and does not infer a specific rock strength, carbonate content, grain size, etc.

[3] NE – Not Encountered

Test Pits

Test pits were excavated using a 6 tonne John Deere 310D tractor mounted backhoe equipped with a 600 mm wide toothed bucked supplied and operated by Eddie's Backhoe Hire. Test pit reports are presented in Appendix B, Test Pit Reports along with a method of soil description and a list of explanatory notes and abbreviations used in the reports. Test pit photographs are included for selected test pits.

Hand Auger Boreholes

Hand auger borehole reports are presented in Appendix C, Hand Auger Borehole Reports. The method of soil description used in the reports is included in Appendix B.

Penetrometer Tests

Perth sand penetrometer (PSP) tests were conducted in accordance with AS 1289.6.3.3 although to a greater depth than the 0.45 m covered in the standard. The results of the penetrometer tests are presented in Appendix D, Perth Sand Penetrometer Test Results. Blow counts are reported per 150 mm increment.

Permeability Testing

The permeability testing was undertaken using the inverse auger hole method described by Cocks[1]. The results of the permeability testing are presented in Appendix E, Permeability Test Results and the results are summarised in Table 2.

Table 2: Summary of Permeability Test Results

Test Number	Test Location	Soil Description	Test Depth (m)	Minimum Unsaturated Permeability[1], k (m/day)		
				Test 1	Test 2	Test 3
P1	HA01	SAND	0.8	31	> 50	> 50
P2	HA02	SAND	0.7	17	14	17
P3	HA03	SAND	0.6	> 50	> 50	> 50

Note: 1 – The minimum unsaturated permeabilities were typically measured near the end of the test, with head typically varying between 0 m (dry) and 0.6 m.

Environmental Soil Sampling

Soil samples for the preliminary environmental assessment were collected from the former market gardening area in accordance with Australian Standard 4482.1 (2005) *Guide to the Investigation and Sampling of Sites with Potentially Contaminated Soil – Non Volatile and Semi Volatile Compounds*.

Samples were collected at the surface and at 0.3m using dedicated nitrile gloves and placed in laboratory supplied glass jars. The samples were then placed in an ice chilled cooler until submission to the laboratory for analysis.

5. ENVIRONMENTAL LABORATORY TESTING

Soil samples collected from the surface were analysed by Eurofins in their national association of testing agencies (NATA) accredited laboratory for the following contaminants of potential concern (COPC) commonly associated with market gardening activities;

- heavy metals; and
- organochlorine and organophosphate (OC/OP) pesticides.

All laboratory analysis was undertaken using NATA-accredited methods of analysis. Laboratory test results are presented in Appendix F, Environmental Laboratory Certificates. The environmental test results are discussed in Section 8.2

[1] Cocks, G (2007), "Disposal of Stormwater Runoff by Soakage in Perth Western Australia", Journal and News of the Australian Geomechanics Society, Volume 42 No. 3, pp 101-114

6. SITE CONDITIONS

6.1 Geology

The Rockingham sheet of the 1:50,000 scale Environmental Geology series map indicates that the area is underlain by sand derived from Tamala limestone. The sand is described as *"SAND – pale yellowish brown, medium to coarse grained, sub-angular to well-rounded quartz, trace of feldspar, shell debris, variably lithified, surface kankar, of eolian origin"*.

The geological mapping shows limestone outcrop about 100 m to the north west of the site, and peaty clay about 100 m to the south west of the site.

The findings of the site investigation are consistent with the geological mapping, with typically a thin layer of sand present over limestone. No peaty soils were encountered at the test locations on the site.

6.2 Subsurface Conditions

The subsurface conditions are broadly consistent across the site. The typical soil profile from the supplied information and the current investigation can be summarised as:

- SAND (SP): medium to coarse grained, sub-angular to sub-rounded, brown becoming yellow with depth, trace limestone cobbles and gravel, typically loose to dense, present from surface to depth of between 1.0 m extending to the maximum depth investigation (2.5 m); overlying
- LIMESTONE, present below the sand layer, rockhead varying from depths between about 1.0 m and more than the maximum depth of investigation (2.5 m).

The topsoil across the site is typically about 100 mm thick, but this increases to about 500 mm thick across the former market garden area (refer to Figure 1).

The north western quarter of the site (in the location of the existing residence) has a layer of FILL overlying the natural sands. This material can be described as:

- FILL, SAND (SP): fine to coarse grained, sub-angular to sub-rounded, pale yellow/brown, trace gravel (brick and limestone fragments), trace organics, trace fines, present from surface to depth of between 0.1 m and 1.0 m.

Several test pits encountered limestone pinnacles within the excavation. Although limestone was typically encountered below 1.0 m depth, it is possible that the limestone is present at shallower depths on the site (due to the undulating nature of pinnacles). We would, however, expect any rock encountered within the top 1 m to be localised, and likely to be excavatable with the use of an excavator and rock breaker attachment.

6.3 Groundwater

The Perth Groundwater Atlas (1997) does not extend to the site, but nearby data suggests that the maximum historical groundwater level at the site would be around RL 4 m AHD. This is between about 1 m and 3 m below the current ground surface.

7. GEOTECHNICAL ASSESSMENT

7.1 Site Classification

We consider the site geotechnically capable of supporting the proposed development.

We have assessed the site in accordance with AS2870 (2011) "Residential Slabs and Footings". We consider that a site classification of "Class A" would be appropriate provided that normal site preparation as presented in Section 7.3 is undertaken prior to construction.

7.2 Site Subsoil Class

We have assessed the site subsoil class in accordance with AS1170.4-2007, "Earthquake Design Actions – Australia". We consider that a site subsoil class of 'Ce' is appropriate for the site.

7.3 Site Preparation

The site preparation measures outlined below are aimed at preparation of the site prior to construction of buildings and pavement subgrades. Landscaped areas (if any) will not require this preparation. The site preparation procedures provided below have been prepared on the basis of improving the density of the loose to medium dense zone.

The following site preparation measures must be followed:

- Remove any deleterious material from site including surficial rubbish, existing structures and buried services, soak-wells, etc.
- Strip and stockpile topsoil from across the entire site (including market garden area) for potential re-use in non-structural applications or for possible blending with clean sand (only a thin layer of topsoil was noted at the time of our investigation over the majority of the site). Topsoil strip is only necessary to remove roots. We recommend a 100 mm topsoil strip or as otherwise necessary to remove all roots from the soil. The topsoil can potentially be screened and blended with clean sand and re-used as structural fill.
- Excavate to the required level, if required.
- Rip areas of shallow limestone to at least 1.0 m below finished level (this is intended to produce a relatively excavatable soil mass within the upper 1.0 m at the site for installation of footings and buried services – if a greater depth is required, the depth of ripping may need to be increased). It may be necessary to engage us to inspect the site and conduct additional shallow test pitting to assess the presence of shallow limestone in uncertain areas.
- Remove any oversize boulders (>200 mm) not responding to ripping or compaction.
- Proof compact the exposed sandy ground to achieve the level of compaction specified in Section 7.4 to a depth of at least 0.9 m below the compacted surface – any areas of loose sand or unsuitable material must be removed and replaced with approved fill.
- Fill to the proposed design surface level using approved fill (refer Section 7.5), placed and compacted (refer Section 7.4) in layers of no greater than 300 mm loose thickness.
- Compact the footing bases to achieve the required level of compaction to a depth of at least 0.9 m below the footing base – any areas of loose sand or unsuitable material must be removed and replaced with approved fill.

Note: The topsoil layer (identifiable as the brown sand, as compared with underlying natural yellow sand) at the location of the former market gardens is up to about 500 mm thick, however rootlets were typically only present in the top 100 mm. We consider that the topsoil present below 0.1 m depth can potentially be re-used as structural fill without the need for screening or blending, however permeability testing of a trial pad of the material must be conducted prior to its use. Where permeability testing is not conducted, the full thickness of the material (0.5 m) must be stripped for re-use in non-structural areas or removed offsite.

7.4 Compaction

Approved granular fill and the *in situ* sands must be compacted using suitable compaction equipment to achieve a dry density ratio of at least 95% MMDD (maximum modified dry density) as determined in accordance with AS 1289 5.2.1.

Where sand is used as fill and the Perth sand penetrometer (PSP) is used for compaction control, the following PSP blow counts may be assumed to correlate to the required dry density ratio of 95% MMDD:

- Depth range 0.15 m to 0.45 m 8 blows
- Depth range 0.45 m to 0.75 m 10 blows
- Depth range 0.75 m to 1.05 m 12 blows (or 0.75 m to 0.9 m: 6 blows).

If difficulties are experienced in achieving the required blow count, an on-site PSP calibration should be undertaken to determine the site-specific blow count correlating to the required dry density ratio.

Over-excavation and replacement of loose materials must be done where the minimum dry density ratio cannot be achieved.

Fill must be placed in horizontal layers of not greater than 0.3 m loose thickness. Each layer must be compacted by suitable compaction equipment, and carefully controlled to ensure even compaction over the full area and depth of each layer.

Care will need to be taken when compacting in the vicinity of existing services. This is particularly important if vibratory compaction is being carried out. Tynan (1973)[2] provides assistance with the selection of compaction equipment for use adjacent to structures and services. Of particular concern are adjacent existing services.

TESTING

After compaction, verify that the required level of compaction has been achieved by testing at the base of excavation and through the full depth of any fill and to a minimum depth of 0.9 m below foundations:

- on each lift of fill at the rate of 1 test per 500 m^3;
- at each spread footing location;
- at 7.5 m centres below on-ground slabs;
- at 10 m centres along gravity retaining wall footings and strip footings (where present); and
- at 10 m centres on pavement subgrades (on the road centreline or on a grid below car parks).

7.5 Approved Fill

Imported granular fill must comply with the material requirements as stated in AS 3798-2007, "Guidelines on Earthworks for Commercial and Residential Developments".

[2] Tynan (1973) Ground Vibration and Damage Effects on Buildings, Australia Road Research Board, Special Report No. 11.

The sand (including the sand fill) present at the site will be suitable for re-use as inert structural fill. Any organic-rich sand or sand containing significant proportions of fines (material less than 0.075 mm in size) must not be used.

Organic rich material (i.e. topsoil) may be considered for re-used as structural fill provided that it is screened and blended with clean sand such that the total organic content is less than 2% and the fines content is less than 5%. Due to the lower permeability of such blends, permeability testing must be undertaken on a trial pad of the blended material to assess its design permeability prior to use as structural fill. We can provide further assistance with this if required.

Where doubt exists, a geotechnical engineer must be engaged to inspect and approve the use of potential fill materials.

7.6 Excavation

We expect that excavations on site to about 1.0 m through the sand will be readily achievable using conventional earthmoving equipment (i.e. with a 5 tonne or larger excavator). Localised areas of shallower limestone may be present. However, the depth to limestone is expected to be at greater than 1 m depth below the existing surface. Excavation of any limestone may require the use of a larger excavator (20 tonne) and rock breaker.

Excavations below 2 m depth are expected to encounter massive limestone and are likely to require the use of a larger excavator (20 tonne) and rock breaker. Ripping prior to excavation is also likely to be required, e.g. with a large (D9 or D10) bulldozer with a single tine ripper.

Excavations in sand are particularly prone to instability unless support is provided. Care must be exercised in such excavations and appropriate safety measures adopted where necessary. Where possible excavations must be battered at slopes no steeper than 1V:2H for temporary slopes and 1V:3H for permanent slopes above the groundwater table. Even at these slope angles erosion and rilling may occur.

A geotechnical engineer must be consulted where there is any doubt regarding the stability or safety of unsupported excavations.

7.7 Retaining Structures

Retaining structures may be designed in accordance with AS 4678-2002 “Earth-Retaining Structures”. For the design of retaining structures, the parameters in Table 3 are appropriate.

Table 3: Retaining Structures Design Parameters

Soil Type	Bulk Density (t/m^3)	Angle of Internal Friction (deg.)	Wall Friction = 0°		Wall Friction = 0.5Φ	
			Coefficient of Active Earth Pressure, K_a	Coefficient of Passive Earth Pressure, K_p	Coefficient of Active Earth Pressure, K_a	Coefficient of Passive Earth Pressure, K_p
Medium dense sand	17	34	0.28	3.5	0.25	5.7
Dense or well compacted sand	18	36	0.26	3.9	0.22	6.5

Notes: Earth pressure coefficients are provided in this table for conditions of zero friction between the wall and the soil and with wall friction of 0.5Φ’. The retaining wall designer should make an independent assessment of the parameters appropriate to the construction method to be used, including alternative values of wall friction. A horizontal ground surface behind the wall has been assumed.

Compaction plant can augment the lateral earth pressure acting on retaining walls. Hand operated compaction equipment is recommended within 2 m of any retaining walls to minimise compaction pressures.

It is important to note that some ground movement will occur behind any soil retaining system, including gravity retaining walls.

Retaining walls can move and rotate under imposed soil loading resulting in settlement behind the wall. This must be considered during the design and construction of the retaining walls in order that adjacent properties are not adversely affected. Particular care should be exercised when forming excavations so as not to affect neighbouring properties. Account must be taken of the effect of both temporary and permanent works on neighbouring properties. Anchoring or strutting of retaining walls may be required.

Detailed design of retaining structures should be undertaken using methods appropriate to the proposed retention system.

7.8 Shallow Footings

The structure may be founded on shallow spread footings placed within the sand which occurs from surface, provided the site preparation recommendations outlined in Section 7.3 are followed. Table 4 and Table 5 give allowable bearing pressures and estimated settlements for pad footings and strip footings at an embedment depth of at least 0.5 m.

Table 4: Pad Footing Allowable Bearing Pressures and Estimated Settlements

Min. Footing Embedment (m)	Minimum Footing Dimension (m)	Allowable Bearing Pressure (kPa)	Estimated Settlement (mm)
0.5	0.5	150	<5
	1.0	200	<5
	1.5	225	5 - 10
	2.0	250	10 - 15
1.0	0.5	200	<5
	1.0	250	<5
	1.5	250	5 - 10
	2.0	250	10 - 15

Table 5: Strip Footing Allowable Bearing Pressures and Estimated Settlements

Min. Footing Embedment (m)	Minimum Footing Dimension (m)	Allowable Bearing Pressure (kPa)	Estimated Settlement (mm)
0.5	0.5	150	< 5
	1.0	180	5 - 10
	1.5	220	15 - 20
	2.0	250	20 - 25
1.0	0.5	200	5 - 10
	1.0	250	10 - 15
	1.5	250	15 - 20
	2.0	250	20 - 25

Allowable bearing pressures for footings of intermediate plan dimensions to those tabulated can be interpolated. Footings that have a plan dimension either smaller or larger than those covered by the tables above will need to be considered individually along with other embedment depths. Footings carrying significant eccentric loading must be assessed separately.

The settlement of the proposed structure will depend upon a number of factors including the applied pressures, footing size and base preparation. The estimates of settlement provided above assume that the site preparation measures detailed in Section 7.3 have been completed. The estimated settlements are for the working bearing pressure values shown. Differential settlements of up to half of the total estimated settlement values are likely between footings of similar sizes, loads and elevations. About 70% of the settlement is expected to occur during construction.

7.9 Pavement Thickness Design

Where design of flexible pavements is undertaken, a subgrade California bearing ratio (CBR) of 12% may be assumed for pavement thickness design. This CBR assumes that the site preparation requirements outlined in Section 7.3 have been carried out in pavement subgrade areas.

7.10 Stormwater Disposal

The results of infiltration tests carried out are included in Appendix D, Permeability Test Results. The minimum measured permeability are as follows:

- P1 – 31 m/day
- P2 – 14 m/day
- P3 - >50 m/day

We consider that the natural and fill sands at the site are suitable for the disposal of stormwater by infiltration by means of soak wells. For preliminary design, we recommend a design value of permeability (k) not greater than 5 m/day for the *in situ* sand below 1 m to allow for the variability in materials and reduced permeability as a consequence of:

- densification of sand during site preparation works;
- natural variation in sands; and
- clogging of the sand around soak wells over time with fines.

Soak wells should be placed outside a line of 1V:2H extending below the edge of the nearest footing subject to local council regulations. Discharge from soak wells has been known to promote densification of loose sandy soils, leading to settlements of footings and slabs. Soak wells should be carefully wrapped with geotextile to prevent migration of sand and fines into the soak well.

The topsoil layer present at the location of the former market gardens (present from surface to 0.5 m) is likely to have a lower permeability than the design value presented above due to a higher fines content. We consider that the topsoil present below 0.1 m depth can potentially be re-used as structural fill without the need for screening or blending, however permeability testing of a trial pad (at least 1 m thick) must be conducted prior to its re-use to assess the design permeability is within the acceptable limits.

We note that limestone is present at shallow depth (locally within 1 m of the ground surface), which may hinder drainage from the site. Some moderately to well cemented limestone can be relatively impermeable. This must be taken into account when undertaking the civil design. Some suggestions are:

- raising site surface levels with sand fill where limestone is relatively shallow (but cutting from areas of the site with more sand);
- ripping the limestone to a greater depth to ensure it is broken up and more permeable (we suggest that in-situ large scale permeability testing be done if there is a reliance on this); or
- off-site disposal of stormwater (probably not necessary, but a logical extension of not relying on on-site disposal into limestone).

8. ENVIRONMENTAL ASSESSMENT

8.1 Desktop Assessment

8.1.1 Acid Sulfate Soils

The Department of Environment Regulation (DER) on-line risk-mapping database of ASS shows the site as having no known risk of ASS occurrence at depths less than 3 m. The nearest high risk area is located approximately 50 m to the south west of the site. The DER ASS risk mapping is shown in Figure 2.

8.1.2 Geomorphic Wetlands

The Department of Parks and Wildlife (DPaW) geomorphic wetlands database indicates that there are no wetlands located on the site. The nearest conservation category wetland (Opwin Swamp Dampland #6400) is located approximately 600 m to the south west of the site. The location of geomorphic wetlands are shown on Figure 2.

8.1.3 Environmentally Sensitive Areas

There are no environmental sensitive areas (ESAs) mapped as existing on the site. The nearest ESA is located approximately 200 m to the south west of the site and is associated with the Opwin Swamp Dampland. The location of ESAs are shown on Figure 2.

8.1.4 Historical Aerial Photographs

A summary of the site features visible in the available historical aerial photographs are presented in Table 6 with the historical aerial photographs presented in Figures 3a to 3d.

Table 6: Current and Historical Aerial Photographs

Year	Site Features	Surrounding Land Use
1953	The whole site is cleared.	The surrounding area is cleared
1965	Evidence of a market gardening occurring to the southern portion of the site, A building is also noted south of the site, in the middle of the site and north of the site.	No change.
1974	Vegetation to the north of the site has been cleared.	A road is noted to the east of the site. Buildings are noted to the north of the site.
1979	No change.	No change.
1981	No change.	No change.
1985	No change.	No change.

Year	Site Features	Surrounding Land Use
1995	No change.	No change.
2006	A smaller building is noted to the west of the site.	No change.
2008	An additional building is noted in the north west corner of the site.	No change.
Current	No change.	No change.

8.1.5 Contaminated Sites Database

The publicly available DER contaminated sites database was searched for known contaminated sites (sites classified as *Contaminated-restricted use*, *Remediated for restricted use* or *Contaminated-remediation required*) in proximity to the site. The site is not listed as a contaminated site. The nearest site classified as *Remediated for Restricted Use* and is located approximately 350 m east of the site.

8.1.6 Heritage

The Aboriginal Heritage Act 1972 is the Western Australian legislation in place to protect places and objects customarily used by or traditional to, the original inhabitants of Australia. Such places and objects are maintained in a register under the Act; however, all sites are protected under the Act whether or not they have been registered.

A search of the Aboriginal Heritage database shows that there are no heritage sites located within a 500 m radius of the site. Heritage sites are shown in Figure 2.

European heritage is also protected and a search of the Heritage Council of Western Australia (HCWA) database of culturally significant sites in Western Australia was undertaken for the area. No European heritage sites were found at or nearby the site (HCWA, 2015).

8.2 Detailed Site Inspection

A detailed site inspection was undertaken by a representative of Galt on 20 April 2015. The following observations were made:

- The site contains a house, three sheds, a caravan, miscellaneous building material and farm equipment.
- There was no evidence of hazardous chemical storage or spills on the site.
- No asbestos containing material (ACM) was identified within any of the building material or farm equipment.
- There was no evidence of plant stress that would indicate potential contamination.

We note that our inspection did not include a detailed assessment of the materials used in the construction of the onsite buildings. As such, no assessment can be made on the presence of hazardous material present within these buildings.

8.3 Contamination Testing Results

Soil concentrations were compared with the following criteria adopted from the National Environmental Protection Council (NEPC) (2013) *National Environmental Protection (Assessment of Site Contamination) Measure* guideline document.

- Ecological investigation levels (EIL)
- Health investigation levels – Residential (HIL-A)

In order to obtain site-specific EIL values, soil pH values were recorded for each sample. Given the preliminary nature of the assessment, the most conservative EIL for zinc, copper, lead nickel and chromium using the relevant soil pH has been adopted.

Soil analytical results are presented in Table 7 and Table 8 and are discussed below.

- Metal concentrations were below the laboratory LOR and/or conformed to the adopted criteria.
- Concentrations of all OC/OP pesticides were below the laboratory LOR and/or conformed to the adopted criteria.

Table 7: Soil Analysis Results – Metals

	Soil pH	Arsenic (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Nickel (mg/kg)	Zinc (mg/kg)
Assessment Criteria								
HIL-A	-	100	20	100	6000	300	400	7400
Site Specific EIL[3]	-	100	-	190	280	1100	30	230
Sample ID								
SS01/0.0	6.3	3.4	<0.4	15	14	5.6	<5	38
SS02/0.0	6.8	2.8	<0.4	15	19	6.9	<5	68
SS03/0.0	6.6	2.7	<0.4	16	19	6.8	<5	50
SS04/0.0	6.5	2.3	<0.4	16	17	6.0	<5	42
SS05/0.0	6.3	4.4	<0.4	15	16	6.4	<5	43
SS06/0.0	6.4	3.7	<0.4	15	17	6.8	<5	42
SS07/0.00	6.5	2.9	<0.4	16	19	6.3	<5	41
SS08/0.0	6.8	2.3	<0.4	17	26	6.9	<5	51
SS09/0.0	6.4	4.1	<0.4	19	32	8.2	<5	110
SS10/0.0	6.4	4.7	<0.4	19	<5	<5	<5	<5

[3] EIL value calculated in accordance with NEPM 2013 guideline using soil pH value of 6.0

Table 8: Soil Analysis Results – Pesticides

	DDT+DDE+DDD	Aldrin and Dieldrin	Chlordane	Heptachlor	Endrin	Methoxychlor	Toxaphene	Chlorpyrifos
HIL-A	240	6	50	270	10	300	20	160
Sample ID								
SS01/0.0	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS02/0.0	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS03/0.0	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS04/0.0	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS05/0.0	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS06/0.0	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS07/0.00	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS08/0.0	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS09/0.0	<0.05	0.07	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS10/0.0	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2

8.4 Summary

Based on the results of the desktop environmental assessment, we consider that there are unlikely to be any significant environmental aspects that will adversely impact on the proposed development. Furthermore, the contamination testing results indicate that is it unlikely that soils within the area of the site formally used for market gardening activities has been impacted by COPC at concentrations that would represent a risk to human health or the environment.

We note our preliminary contamination testing did not include an assessment of groundwater quality at the site. As such, no comment can be made on the suitability of groundwater at the site for irrigation or drinking water purposes.

9. CLOSURE

We would like to draw your attention to Appendix G of this report, "Understanding your Report". The information provided within is intended to inform you as to what your realistic expectations of this report should be. Guidance is also provided on how to minimise risks associated with groundworks for this project. This information is provided not to reduce the level of responsibility accepted by Galt, but to ensure that all parties who rely on this report are aware of the responsibilities each assumes in so doing.

GALT GEOTECHNICS PTY LTD

Owen Woodland CPEng

Geotechnical Engineer

Brad Palmer

Environmental Scientist

O:\Jobs\2015\J1501070 - PF SI McDonald Rd Baldivis\03 Correspondence\J1501070 001 R Rev0.docx

Figures

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2/39 Flynn St, WEMBLEY WA 6014

ABN: 73 292 586 155

Legend

- Site Boundary
- Former Market Garden Area
- Hand Auger Borehole / Permeability Test
- Perth Sand Penetrometer
- Soil Sample
- Test Pit

NOTES: Concept plan of subdivision from The Planning Group WA Pty Ltd, Drawing no. 715-377 CP-01A, dated 17 Feb 2015

0 10 20 30 40 50
Meters

SCALE	1:750	(A3)
DRAWN	DAC	
DATE DRAWN	30/04/2015	
CHECKED	PCW	
DATE CHECKED	30/04/2015	
PROJECTION	GDA 1994 MGA Zone 50	

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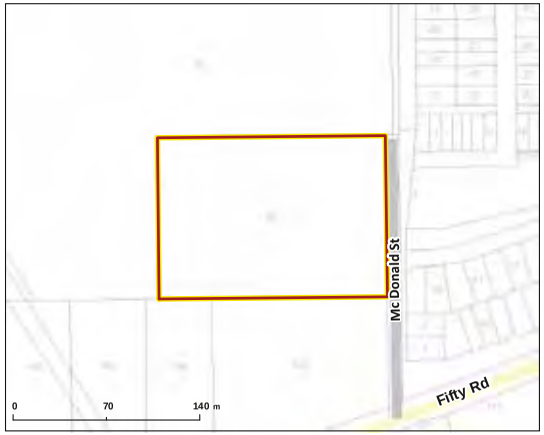
CLIENT	**PRITCHARD FRANCIS**
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	16 MCDONALD ROAD BALDIVIS
TITLE	SITE & LOCATION PLAN
Job No	J1501070
Fig No	FIGURE 1
Rev	A

MAP 1 - AERIAL



MAP 2 - STREET

MAP 3 - CONTOURS

MAP 4 - ACID SULFATE SOIL RISK

MAP 5 - ENVIRONMENTALLY SENSITIVE AREAS

MAP 6 - GEOMORPHIC WETLANDS

MAP 7 - CONTAMINATED SITES

MAP 8 - HERITAGE SITES

MAP 9 - GROUNDWATER CONTOURS AND WINSITES

MAP 4 - ACID SULFATE SOIL RISK

High to moderate risk
Moderate to low risk

MAP 5 - ENVIRONMENTALLY SENSITIVE AREAS

Environmentally Sensitive Area

MAP 6 - GEOMORPHIC WETLANDS

Multiple Use
Conservation
Not Applicable
Resource Enhancement
Not Assessed

MAP 7 - CONTAMINATED SITES

Contaminated - remediation required
Remediated for restricted use
Contaminated - restricted use

Contaminated sites information is taken from the publicly availably Department of Environment Regulation (DER) Contaminated Sites Database. Only sites classified as 'Contaminated – remediation required', 'Contaminated – restricted use' and 'Remediated – restricted use' are shown. Sites with other classifications under the Contaminated Sites Act 2003 are identified through a basic or detailed summary of records search request though DER.

MAP 8 - HERITAGE SITES

Heritage Site

MAP 9 - GROUNDWATER CONTOURS AND WINSITES

Maximum	Minimum	WINSITES
5	5	Ground, Borehole or Well
1	1	Other

0 30 60 90 120 150
Meters

SCALE	1:2,000 (A3)
DRAWN	DAC
DATE DRAWN	30/04/2015
CHECKED	SS
DATE CHECKED	30/04/2015
PROJECTION	GDA 1994 MGA Zone 50

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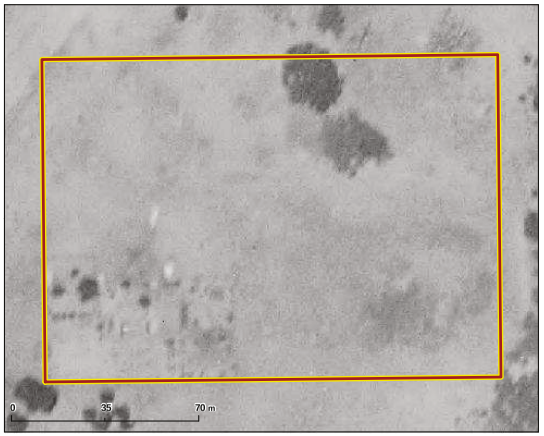
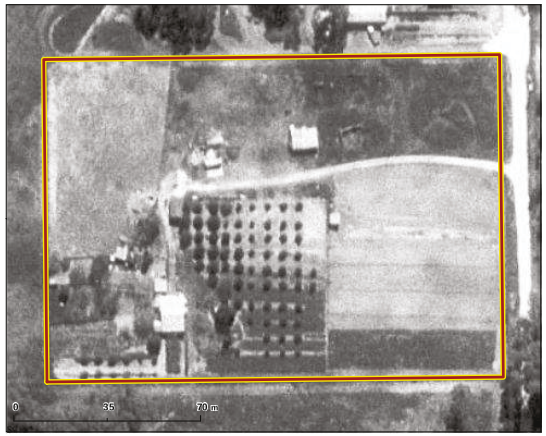
CLIENT	**PRITCHARD FRANCIS**
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	16 MCDONALD ROAD BALDIVIS
TITLE	INDICATIVE ENVIRONMENTAL ASPECTS
Job No	J1501070
Fig No	FIGURE 2
Rev	A



MAP 1 - 1953

MAP 2 - 1965



MAP 3 - 1974

MAP 4 - 1979

MAP 5 - 1981

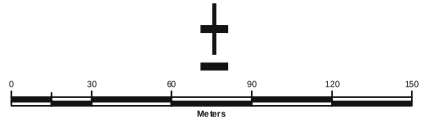
MAP 6 - 1985

MAP 7 - 1995

MAP 8 - 2000

MAP 9 - 2001

Legend



SCALE	1:2,000 (A3)
DRAWN	DAC
DATE DRAWN	30/04/2015
CHECKED	SS
DATE CHECKED	30/04/2015
PROJECTION	GDA 1994 MGA Zone 50

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CLIENT	PRITCHARD FRANCIS
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	16 MCDONALD ROAD BALDIVIS
TITLE	HISTORICAL AERIAL IMAGERY (1953 - 2001)
Job No	J1501070
Fig No	FIGURE 3A
Rev	A

MAP 10 - 2002

MAP 11 - 2003

MAP 12 - 2004

MAP 13 - 2005

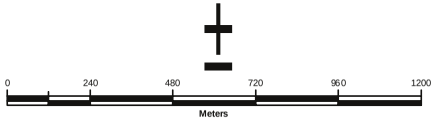
MAP 14 - 2006

MAP 15 - 2007

MAP 16 - 2008

MAP 17 - 2009

MAP 18 - 2010



SCALE	1:2,000	(A3)
DRAWN	DAC	
DATE DRAWN	30/04/2015	
CHECKED	SS	
DATE CHECKED	30/04/2015	
PROJECTION	GDA 1994 MGA Zone 50	

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CLIENT	**PRITCHARD FRANCIS**
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	16 MCDONALD ROAD BALDIVIS
TITLE	HISTORICAL AERIAL IMAGERY (2002 - 2010)
Job No	J1501070
Fig No	FIGURE 3B
Rev	A

MAP 19 - 2011(March)

MAP 20 - 2011(August)

MAP 21 - 2012(February)

MAP 22 - 2012(September)

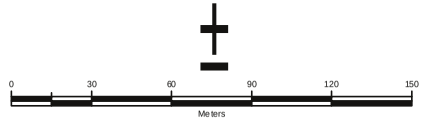
MAP 23 - 2013(January)

MAP 24 - 2013(September)

MAP 25 - 2014(February)

MAP 26 - 2014(May)

MAP 27 - 2014(August)



SCALE	1:2,000 (A3)
DRAWN	DAC
DATE DRAWN	30/04/2015
CHECKED	SS
DATE CHECKED	30/04/2015
PROJECTION	GDA 1994 MGA Zone 50

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CLIENT	PRITCHARD FRANCIS
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	16 MCDONALD ROAD BALDIVIS
TITLE	HISTORICAL AERIAL IMAGERY (2011(MARCH) - 2014(AUGUST))
Job No	J1501070
Fig No	FIGURE 3C
Rev	A

MAP 28 - 2014(November)

0 30 60 90 120 150

Meters

SCALE	1:2,000 (A3)
DRAWN	DAC
DATE DRAWN	30/04/2015
CHECKED	SS
DATE CHECKED	30/04/2015
PROJECTION	GDA 1994 MGA Zone 50

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CLIENT	**PRITCHARD FRANCIS**
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	16 MCDONALD ROAD BALDIVIS
TITLE	HISTORICAL AERIAL IMAGERY (2014(NOVEMBER) - ONWARDS)
Job No	J1501070
Fig No	FIGURE 3D
Rev	**A**

Appendix A: Site Photographs

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ABN: 73 292 586 155

Photograph 1: At TP05 facing south, facing towards a former market garden

Photograph 2: At TP10 facing north

Photograph 3: At TP02 facing south

Photograph 4: At TP04 facing west, note the higher elevation at TP04 compared to the western land

Photograph 5: At TP08 facing west

Photograph 6: Current development located nearby the site at the corner of McDonald Road and Fifty Road. Note the presence of shallow massive limestone

Appendix B: Test Pit Reports

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ABN: 73 292 586 155

METHOD OF SOIL DESCRIPTION
BOREHOLE AND TEST PIT REPORTS

GRAPHIC LOG & UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) SYMBOLS

Graphic	USCS	Soil Name
		FILL (various types)
		COBBLES
		BOULDERS
	GP	GRAVEL (poorly graded)
	GW	GRAVEL (well graded)
	GC	Clayey GRAVEL
	SP	SAND (poorly graded)
	SW	SAND (well graded)
	SC	Clayey SAND

Graphic	USCS	Soil Name
	SM	Silty SAND
	ML	SILT (low liquid limit)
	MH	SILT (high liquid limit)
	CL	CLAY (low plasticity)
	CI	CLAY (medium plasticity)
	CH	CLAY (high plasticity)
	OL	Organic SILT (low liquid limit)
	OH	Organic SILT (high liquid limit)
	Pt	PEAT

RESISTANCE TO EXCAVATION

Symbol	Term	Description
VE	Very easy	All resistances are relative to the selected method of excavation
E	Easy	
F	Firm	
H	Hard	
VH	Very hard	

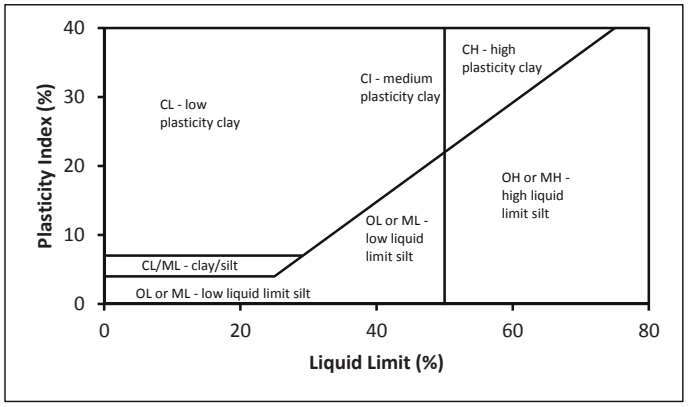
SOIL CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil descriptions are based on AS1726-1993, Appendix A. Material properties are assessed in the field by visual/tactile methods in combination with field testing techniques (where used).

PARTICLE SIZE

Soil Name		Particle Size (mm)
BOULDERS		>200
COBBLES		63 to 200
GRAVEL	Coarse	20 to 63
	Medium	6 to 20
	Fine	2 to 6
SAND	Coarse	0.6 to 2.0
	Medium	0.2 to 0.6
	Fine	0.075 to 0.2
FINES	SILT	0.002 to 0.075
	CLAY	<0.002

PLASTICITY PROPERTIES



MOISTURE CONDITION

AS1726-1993

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays and silts may be brittle or friable and powdery.
M	Moist	Soils are darker than in the dry condition and may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sands and gravels tend to cohere.

CONSISTENCY AND DENSITY

AS1726-1993 and HB160-2006

Symbol	Term	Undrained Shear Strength (kPa)	SPT "N"	DCP blows per 100 mm
VS	Very Soft	0 to 12	0 to 2	<1
S	Soft	12 to 25	2 to 4	<1
F	Firm	25 to 50	4 to 8	1 to 2
St	Stiff	50 to 100	8 to 15	3 to 4
VSt	Very Stiff	100 to 200	15 to 30	5 to 10
H	Hard	>200	>30	>10

Symbol	Term	Density Index (%)	SPT "N"	DCP blows per 100 mm	PSP Blows per 300 mm
VL	Very Loose	<15	0 to 4	<1	0 to 2
L	Loose	15 to 35	4 to 10	1 to 2	2 to 6
MD	Medium Dense	35 to 65	10 to 30	2 to 3	6 to 8
D	Dense	65 to 85	30 to 50	4 to 8	8 to 15
VD	Very Dense	>85	>50	>8	>15

Note: PSP correlations only valid to 450 mm depth

Consistency and density may also be inferred from excavation performance and material behaviour.

EXPLANATORY NOTES TO BE READ WITH BOREHOLE AND TEST PIT REPORTS

METHOD OF DRILLING OR EXCAVATION

AC	Air Core	E	Excavator	PQ3	PQ3 Core Barrel
AD/T	Auger Drilling with TC-Bit	EH	Excavator with Hammer	PT	Push Tube
AD/V	Auger Drilling with V-Bit	HA	Hand Auger	R	Ripper
AT	Air Track	HMLC	HMLC Core Barrel	RR	Rock Roller
B	Bulldozer Blade	HQ3	HQ3 Core Barrel	SON	Sonic Rig
BH	Backhoe Bucket	N	Natural Exposure	SPT	Driven SPT
CT	Cable Tool	NMLC	NMLC Core Barrel	WB	Washbore
DT	Diatube	PP	Push Probe	X	Existing Excavation

SUPPORT

T	Timbering

PENETRATION EFFORT (RELATIVE TO THE EQUIPMENT USED)

VE	Very Easy	E	Easy	F	Firm
H	Hard	VH	Very Hard		

WATER

►	Water Inflow	▼	Water Level
◄	Water Loss (complete)		
◁	Water Loss (partial)		

SAMPLING AND TESTING

B	Bulk Disturbed Sample	P	Piston Sample
BLK	Block Sample	PBT	Plate Bearing Test
C	Core Sample	U	Undisturbed Push-in Sample
CBR	CBR Mould Sample		U50: 50 mm diameter
D	Small Disturbed Sample	SPT	Standard Penetration Test
ES	Environmental Soil Sample		Example: 3, 4, 5 N=9
EW	Environmental Water Sample		3,4,5: Blows per 150 mm
G	Gas Sample		N=9: Blows per 300 mm after
HP	Hand Penetrometer		150 mm seating interval
LB	Large Bulk Disturbed Sample	VS	Vane Shear; P = Peak
M	Mazier Type Sample		R = Remoulded (kPa)
MC	Moisture Content Sample	W	Water Sample

ROCK CORE RECOVERY

TCR = Total Core Recovery (%) $= \frac{CRL}{TCL} \times 100$

SCR = Solid Core Recovery (%) $= \frac{CCR}{TCL} \times 100$

RQD = Rock Quality Designation (%) $= \frac{ALC>100}{TCL} \times 100$

TCL	Length of Core Run
CRL	Recovered Length of Core
CCR	Total Length of Cylindrical Pieces of Core Recovered
ALC>100	Total Length of Axial Lengths of Core Greater than 100 mm Long

TEST PIT: TP01

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387816 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424917 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	M	L	Topsoil and rootlets in top 100 mm
			0.5										
			1.0								D	L - MD	
			1.5										
			2.0							Trace gravel and cobbles comprising limestone			Limestone outcrop at 1.9 m comprising approximately 30% of test pit face
			2.5							Hole terminated at 2.50 m Refusal on limestone Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP02

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387784 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424920 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, ~~brown~~ Yellow	M	L	
			0.5										
			1.0								D	MD	Below 1.6 m, limestone comprising approximately 30% of test pit face
			1.5							With some gravel and cobbles comprising limestone			
			2.0										
			2.5							Hole terminated at 2.20 m Refusal on limestone Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP03

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387742 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424921 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, ~~brown~~ Yellow	M	L - MD	
			0.5										
			1.0								D	MD	
			1.5							Trace gravel and cobbles comprising limestone			
			2.0							With some gravel and cobbles comprising limestone			
			2.5							Hole terminated at 2.20 m Refusal on limestone Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP04

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387655 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424917 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	FILL: SAND, fine grained, sub-angular to sub-rounded, pale yellow-brown, trace gravel comprising limestone and brick fragments	M	MD	
			0.5										
			1.0						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	D	L	
			1.5									MD	
			2.0										
			2.5							Hole terminated at 2.30 m Terminated due to test pit collapse Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP05

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387823 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424873 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND (TOPSOIL): medium to coarse grained, sub-rounded, brown, trace organics			
			0.5						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	M	L	
			1.0										
			1.5							With some gravel and cobbles comprising limestone	D	L - MD	
			2.0							Hole terminated at 1.90 m Refusal on limestone Groundwater not encountered			
			2.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP06

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387781 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424839 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND (TOPSOIL): medium to coarse grained, sub-rounded, brown, with some organics			
			0.5						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	M	L	
			1.0							With some gravel and cobbles comprising limestone	D	L - MD	
			1.5							Hole terminated at 1.40 m Refusal on limestone Groundwater not encountered			
			2.0										
			2.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP07

Job Number:	J1501070	**Easting:**	387752 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424867 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	FILL: SAND, medium to coarse grained, sub-rounded, brown, with some organics	M	L	
			0.5						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	D	L - MD	
			1.0										
			1.5										
			2.0										
			2.5							Hole terminated at 2.50 m Terminated due to test pit collapse Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP08

Job Number:	J1501070	**Easting:**	387691 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424869 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	FILL: SAND, fine grained, sub-angular to sub-rounded, pale brown	M	MD	
			0.5						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow			
			1.0							Hole terminated at 0.60 m Refusal on limestone Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

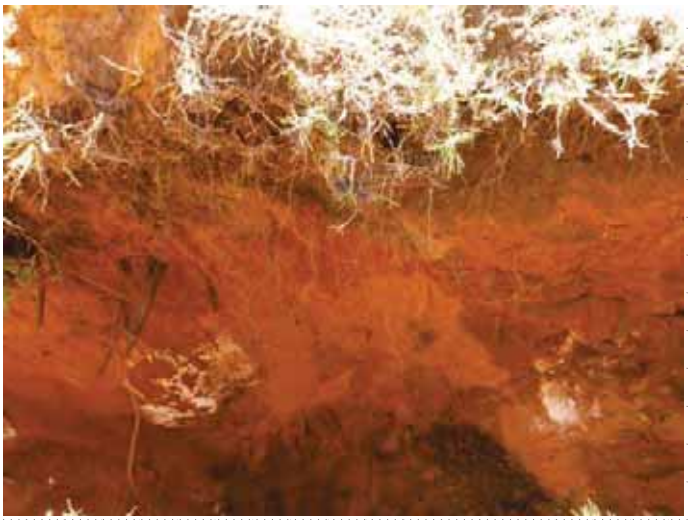
TEST PIT: TP09

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387685 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424828 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND: fine to coarse grained, sub-angular to sub-rounded, brown	M	L - MD	At 1.0 m, one limestone boulder excavated. Below 1.0 m, limestone outcrop comprising approximately 30% of test pit face.
			0.5										
			1.0							Trace gravel and cobbles comprising limestone			
			1.5										
			2.0										
			2.5							Hole terminated at 2.30 m Refusal on limestone Groundwater not encountered			

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP10

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387737 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424121 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND (TOPSOIL): medium to coarse grained, sub-rounded, brown, with some organics	M	L	
			0.5						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow			
			1.0								D	L - MD	
			1.5										
			2.0							With some gravel and cobbles comprising limestone			
			2.5							Hole terminated at 2.40 m Terminated due to test pit collapse Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP11

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387679 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424872 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	FILL: SAND, fine grained, sub-angular to sub-rounded, pale yellow-brown	M	MD	Limestone pinnacle at 1.0 m
			0.5						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	D		
			1.0										
			1.5										
			2.0							Hole terminated at 1.80 m Refusal on limestone Groundwater not encountered			
			2.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP12

Job Number:	J1501070	**Easting:**	387710 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424867 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0						SP	FILL: SAND, fine to coarse grained, sub-angular to sub-rounded, pale yellow, comprising limestone			
BH	E								SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	M	MD	
			0.5										
			1.0							Hole terminated at 0.70 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP13

Job Number:	J1501070	**Easting:**	387714 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424927 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	FILL: SAND, fine grained, sub-angular to sub-rounded, pale yellow-brown	M	L	
			0.5										
			1.0						SP	SAND: fine to coarse grained, sub-angular to sub-rounded, yellow	D	L - MD	
			1.5										
			2.0							Hole terminated at 2.00 m Target depth Groundwater not encountered			
			2.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP14

Job Number:	J1501070	**Easting:**	387797 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424903 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	M	L	
			0.5										
			1.0										
			1.5							With some gravel and cobbles comprising limestone	D	L - MD	At 1.5 m, limestone pinnacle
			2.0										
			2.5							Hole terminated at 2.50 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP15

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387800 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424883 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, brown	M	L	
										Yellow			
			0.5										
			1.0							Trace gravel and cobbles comprising limestone	D		At 1.0 m, limestone pinnacle
			1.5									MD	At 1.7 m, limestone pinnacle
			2.0										
			2.5							Hole terminated at 2.40 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP16

Job Number:	J1501070	**Easting:**	287829 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424833 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND (TOPSOIL): medium to coarse grained, sub-rounded, brown			
			0.5							SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	M	L	
			1.0						SP	With some gravel and cobbles comprising limestone	D	MD	At 1.0 m, limestone pinnacle comprising approximately 30% of test pit face
			1.5										
			2.0										
			2.5							Hole terminated at 2.30 m Refusal on limestone Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

Appendix C: Hand Auger Borehole Reports

www.galtgeo.com.au
2/39 Flynn St, WEMBLEY WA 6014
ABN: 73 292 586 155

HAND AUGER BOREHOLE: HA01

Job Number:	J1501070	**Easting:**	387738 m	**Operator:**	EY	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424898 m	**Inclination:**	-90°	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50			**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis					**Checked By:**	PCW

Drilling					Sampling			Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	E		0.0						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, brown Yellow	M	L	
			0.5										
			1.0							Hole terminated at 0.80 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

HAND AUGER BOREHOLE: HA02

Job Number: J1501070
Client: Pritchard Francis
Project: Proposed Residential Subdivision
Location: 16 McDonald Road, Baldivis

Easting: 387806 m
Northing: 6424924 m
Datum: MGA94 Zone 50

Operator: EY
Inclination: -90°

Date: 20/04/2015
Logged: EY
Checked Date: 30/04/2015
Checked By: PCW

Drilling					Sampling			Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	E		0.0						SP	SAND: medium to fine grained, sub-angular to sub-rounded, brown Yellow	M	L	
			0.5										
			1.0							Hole terminated at 0.70 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

HAND AUGER BOREHOLE: HA03

Job Number: J1501070
Client: Pritchard Francis
Project: Proposed Residential Subdivision
Location: 16 McDonald Road, Baldivis

Easting: 387695 m
Northing: 6424832 m
Datum: MGA94 Zone 50

Operator: EY
Inclination: -90°

Date: 20/04/2015
Logged: EY
Checked Date: 30/04/2015
Checked By: PCW

Drilling					Sampling			Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	E		0.0						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, brown Yellow	M	L	
			0.5										
										Hole terminated at 0.60 m Target depth Groundwater not encountered			
			1.0										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

Appendix D: Perth Sand Penetrometer Results

www.galtgeo.com.au
2/39 Flynn St, WEMBLEY WA 6014

ABN: 73 292 586 155

PERTH SAND PENETROMETER FIELD TEST DATA (Standard Depth 900mm)
(AS12896.3.3)

Client:	Pritchard Francis	**Job No:**	J1501070
Project:	Proposed Residential Subdivision	**Date:**	20/04/2015
Location:	16 McDonald Road, Baldivis	**Engineer:**	EY

Test No:	1	2	3	4	5	6	7	8
Location:	TP01	TP02	TP03	TP04	TP05	TP06	TP07	TP08
Depth (mm)	**N° of Penetrometer Blows per 150 mm Depth Interval**							
0-150	Seat	Seat	Seat	Seat	Seat	Seat	Seat	Seat
150-300	2	2	5	5	3	2	2	7
300-450	2	1	5	6	3	3	2	7
450-600	3	2	4	5	3	2	1	8
600-750	2	1	5	5	4	1	2	11
750-900	2	2	5	4	3	2	1	8
900-1050	4	3	4	2	3	2	2	8
1050-1200		4	5	3				
1200-1350		5	6	6				
1350-1500		6	6	6				
1500-1650		6	5	5				
1650-1800		7	5	5				
1800-1950		8	5	4				
1950-2100		8	5	4				

Test No:	9	10	11	12	13	14	15	16
Location:	TP09	TP10	TP11	TP12	TP13	TP14	TP15	TP16
Depth (mm)	**N° of Penetrometer Blows per 150 mm Depth Interval**							
0-150	Seat	Seat	Seat	3	Seat	Seat	Seat	Seat
150-300	3	2	3	4	4	2	3	2
300-450	4	2	4	3	5	4	4	3
450-600	3	2	3	2	5	2	5	2
600-750	4	2	6	3	5	2	4	2
750-900	3	2	6	3	5	3	3	3
900-1050	3	4	4	3	5	3	4	3
1050-1200							5	
1200-1350							5	
1350-1500							6	
1500-1650							6	
1650-1800							7	
1800-1950							8	
1950-2100							8	

Test No:	17	18	19					
Location:	PSP01	PSP02	PSP03					
Depth (mm)	**N° of Penetrometer Blows per 150 mm Depth Interval**							
0-150	Seat	Seat	Seat					
150-300	3	2	2					
300-450	3	1	1					
450-600	3	2	3					
600-750	3	2	2					
750-900	3	4	2					
900-1050	4	6	4					
1050-1200	4	7	4					
1200-1350	5	6	5					
1350-1500	7	6	5					
1500-1650	7	4	4					
1650-1800	6	5	5					
1800-1950	8	6	5					
1950-2100	8	7	7					

Perth Sand Penetrometer tests done in accordance with AS 1289.6.3.3 (except blow counts are reported per 150 mm, rather than 300 mm)
HB: Hammer bounce (refusal)
0 = Penetration due to hammer weight only
R: Refusal

Appendix E: Permeability Test Results

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2/39 Flynn St, WEMBLEY WA 6014
ABN: 73 292 586 155

Permeability Calculation - Inverse Auger Hole Method

Galt Geotechnics

Spreadsheet author:	ORW	17-Oct-09	

Job No:	J1501070	
Client:	Pritchard Francis	
Site:	16 McDonald Road	
Location:	Baldivis	
Calc by:	EY	22-Apr-15
BH Name:	HA01/P1	
Test Depth:	0.8	m

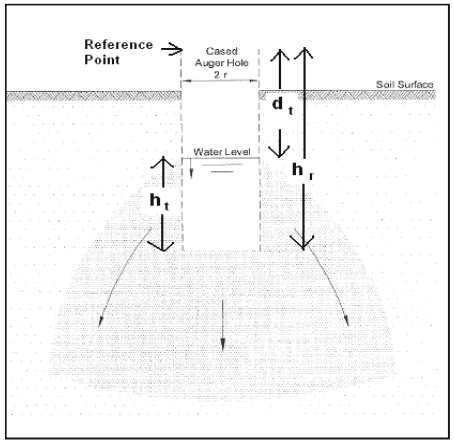
$$K = 1.15r\,\frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Spreadsheet Legend

	Required input
	Calculated field
	Comment field
	Field not used
	Fixed field

Parameter	Description	Value	Units
K	Permeability		m/s
r	radius of test hole	0.04	m
t	time since start of measurement		s
h_r	reference point height above base	0.8	m
d_t	depth from reference point to water at time t		m
h_t	Water column height at time t		m
h_0	h_t at t=0		m



Test 1

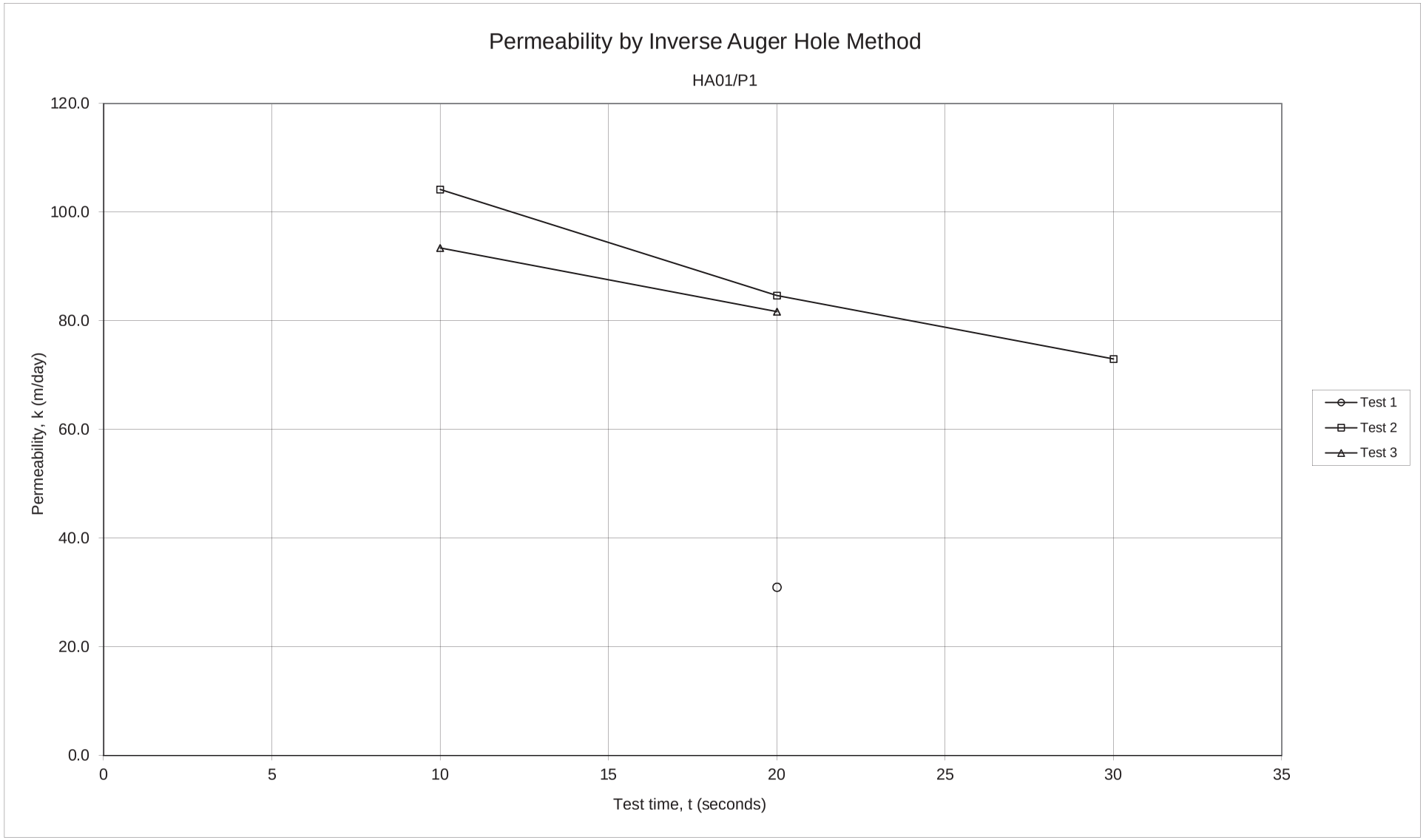
t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.19	0.61		
20	0.38	0.42	3.6E-04	31.0
		AVERAGE	3.6E-04	31.0

Test 2

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.18	0.62		
10	0.47	0.33	1.2E-03	104.2
20	0.58	0.22	9.8E-04	84.6
30	0.64	0.16	8.4E-04	73.0
		AVERAGE	1.0E-03	87.3

Test 3

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.15	0.65		
10	0.43	0.37	1.1E-03	93.4
20	0.56	0.24	9.5E-04	81.7
		AVERAGE	1.0E-03	87.5


Permeability by Inverse Auger Hole Method
HA01/P1
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Permeability, k (m/day)
0
5
10
15
20
25
30
35
Test time, t (seconds)
Test 1
Test 2
Test 3

Permeability Calculation - Inverse Auger Hole Method

Galt Geotechnics

Spreadsheet author:	ORW	17-Oct-09

Job No:	J1501070	
Client:	Pritchard Francis	
Site:	16 McDonald Road	
Location:	Baldivis	
Calc by:	EY	22-Apr-15
BH Name:	HA02/P2	
Test Depth:	0.7	m

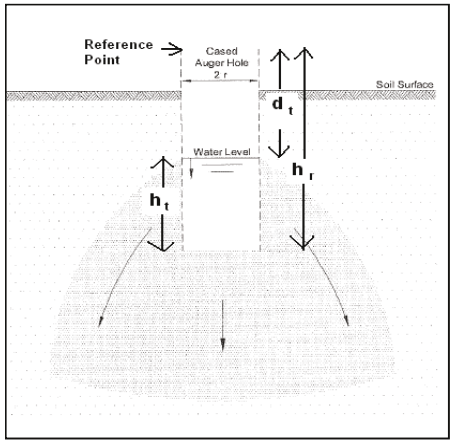
$$K = 1.15r\,\frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Spreadsheet Legend

	Required input
	Calculated field
	Comment field
X	Field not used
	Fixed field

Parameter	Description	Value	Units
K	Permeability	X	m/s
r	radius of test hole	0.04	m
t	time since start of measurement	X	s
h_r	reference point height above base	0.7	m
d_t	depth from reference point to water at time t	X	m
h_t	Water column height at time t	X	m
h_0	h_t at t=0	X	m



Test 1

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.08	0.62	X	X
20	0.27	0.43	3.5E-04	30.4
40	0.36	0.34	2.9E-04	24.8
60	0.43	0.27	2.6E-04	22.8
80	0.485	0.215	2.5E-04	21.6
100	0.52	0.18	2.3E-04	20.1
120	0.56	0.14	2.3E-04	19.9
140	0.57	0.13	2.1E-04	17.9
		AVERAGE	2.6E-04	22.5

Test 2

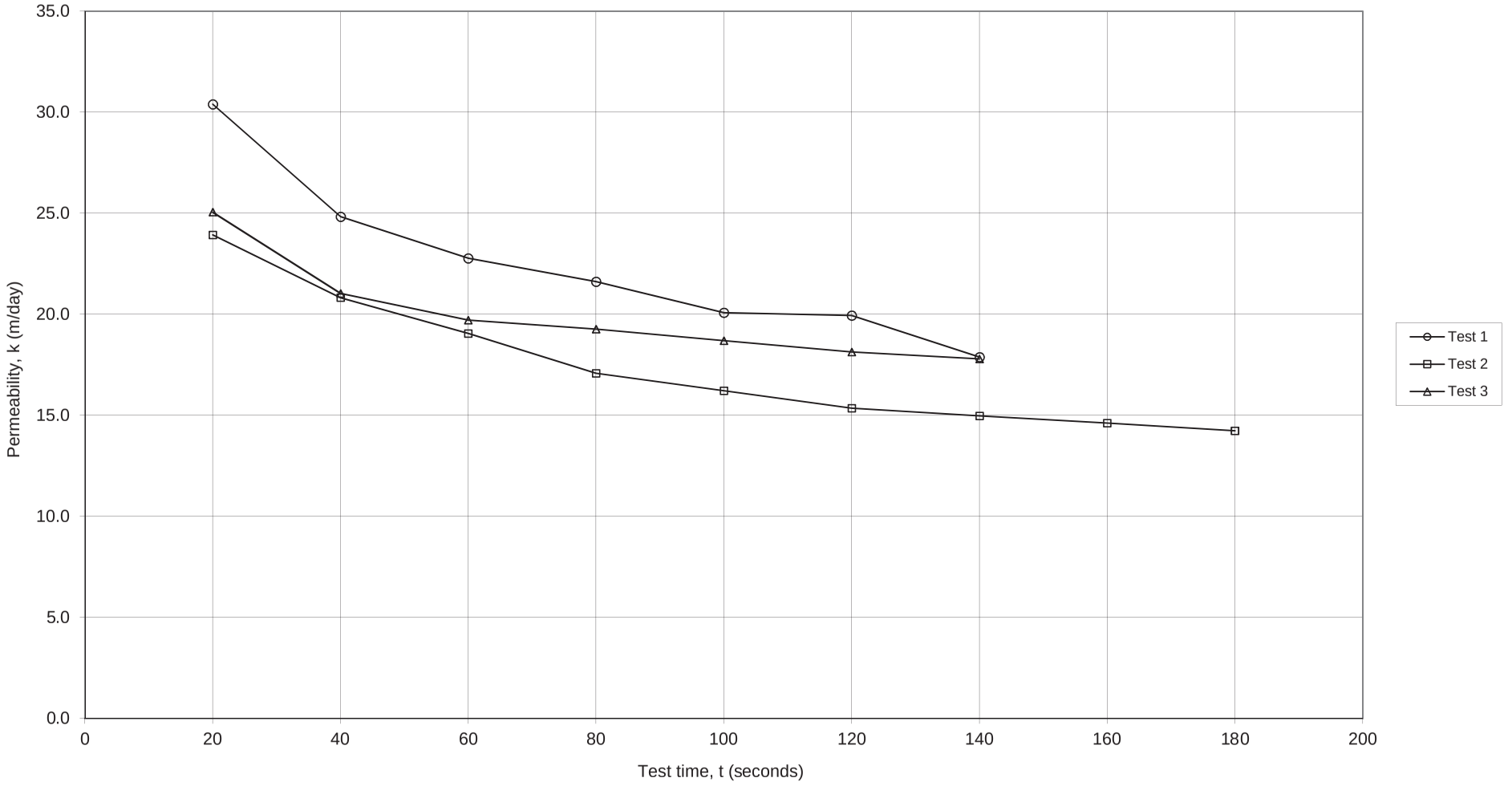
t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.08	0.62	X	X
20	0.235	0.465	2.8E-04	23.9
40	0.325	0.375	2.4E-04	20.8
60	0.39	0.31	2.2E-04	19.1
80	0.43	0.27	2.0E-04	17.1
100	0.47	0.23	1.9E-04	16.2
120	0.5	0.2	1.8E-04	15.4
140	0.53	0.17	1.7E-04	15.0
160	0.555	0.145	1.7E-04	14.6
180	0.575	0.125	1.6E-04	14.2
		AVERAGE	2.0E-04	17.4

Test 3

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.085	0.615	X	X
20	0.245	0.455	2.9E-04	25.1
40	0.33	0.37	2.4E-04	21.0
60	0.4	0.3	2.3E-04	19.7
80	0.46	0.24	2.2E-04	19.3
100	0.505	0.195	2.2E-04	18.7
120	0.54	0.16	2.1E-04	18.1
140	0.57	0.13	2.1E-04	17.8
		AVERAGE	2.3E-04	20.0

Permeability by Inverse Auger Hole Method

HA02/P2



Permeability Calculation - Inverse Auger Hole Method

Galt Geotechnics

Job No:	J1501070	
Client:	Pritchard Francis	
Site:	16 McDonald Road	
Location:	Baldivis	
Calc by:	EY	22-Apr-15
BH Name:	HA03/P3	
Test Depth:	0.6	m

Spreadsheet author:	ORW	17-Oct-09

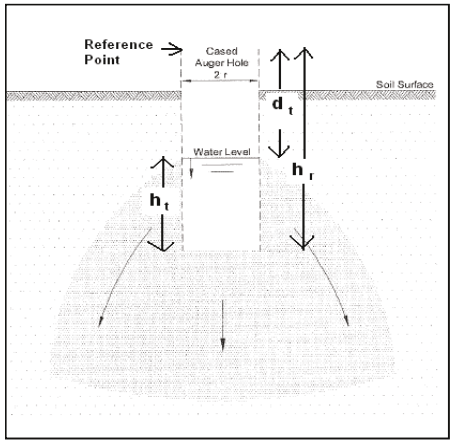
$$K = 1.15r \frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Spreadsheet Legend

	Required input
	Calculated field
	Comment field
X	Field not used
	Fixed field

Parameter	Description	Value	Units
K	Permeability	X	m/s
r	radius of test hole	0.04	m
t	time since start of measurement	X	s
h_r	reference point height above base	0.6	m
d_t	depth from reference point to water at time t	X	m
h_t	Water column height at time t	X	m
h_0	h_t at t=0	X	m



Test 1

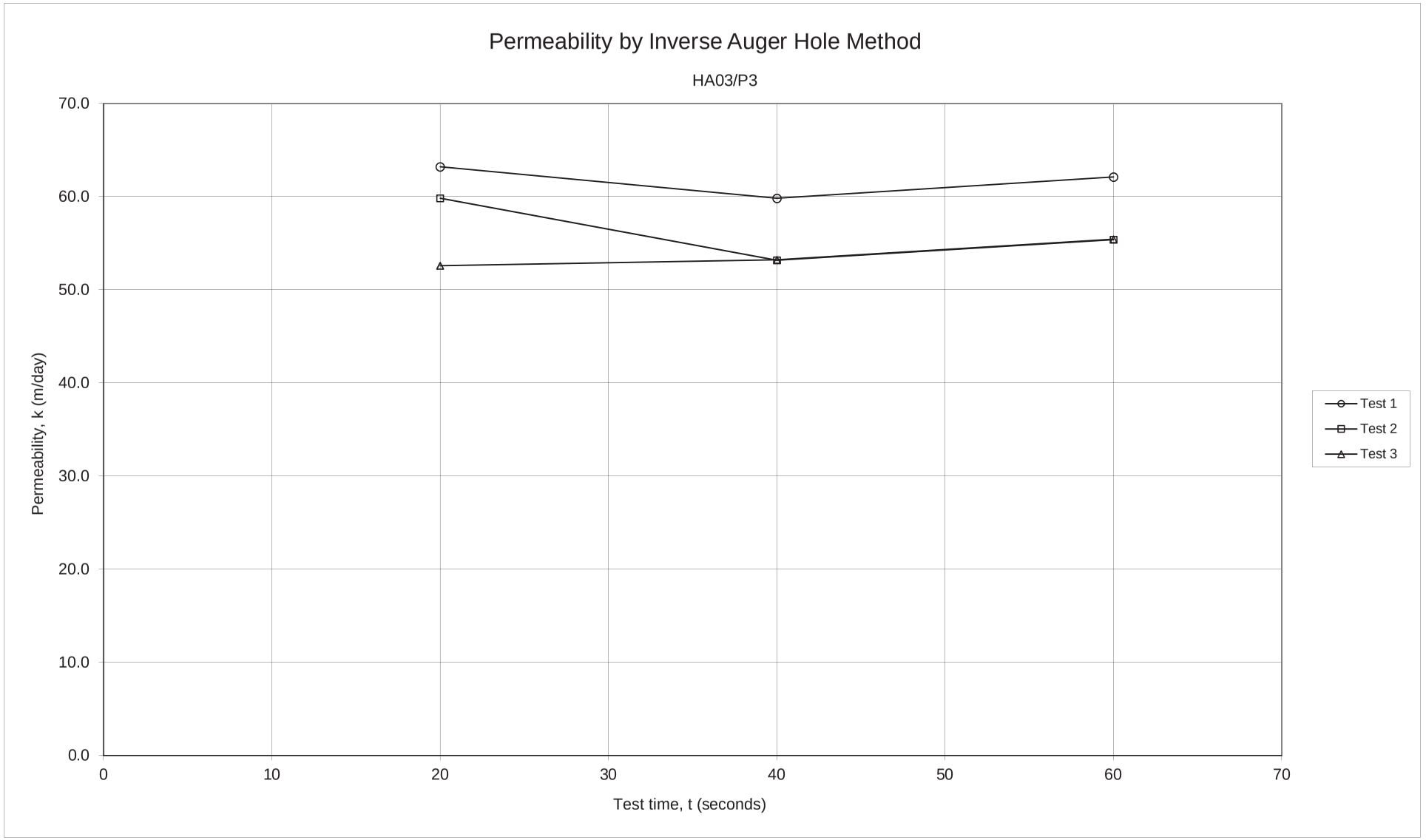
t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.1	0.5	X	X
20	0.37	0.23	7.3E-04	63.2
40	0.49	0.11	6.9E-04	59.8
60	0.56	0.04	7.2E-04	62.1
		AVERAGE	7.1E-04	61.7

Test 2

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.14	0.46	X	X
20	0.38	0.22	6.9E-04	59.8
40	0.48	0.12	6.2E-04	53.2
60	0.55	0.05	6.4E-04	55.4
		AVERAGE	6.5E-04	56.1

Test 3

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.105	0.495	X	X
20	0.34	0.26	6.1E-04	52.6
40	0.47	0.13	6.2E-04	53.2
60	0.545	0.055	6.4E-04	55.4
		AVERAGE	6.2E-04	53.7


Permeability by Inverse Auger Hole Method
HA03/P3
Permeability, k (m/day)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
10
20
30
40
50
60
70
Test time, t (seconds)
Test 1
Test 2
Test 3

Appendix F: Environmental Laboratory Certificates

www.galtgeo.com.au
2/39 Flynn St, WEMBLEY WA 6014
ABN: 73 292 586 155

Certificate of Analysis

Galt Environment P/L
2/39 Flynn St
Wembley
WA 6014

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025. The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Attention: **Brad Palmer**

Report **454842-S**
Project name BALDIVIS
Project ID J1501070
Received Date Apr 22, 2015

Client Sample ID			**SS01/0.0**	**SS02/0.0**	**SS03/0.0**	**SS04/0.0**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins | mgt Sample No.			**M15-Ap16245**	**M15-Ap16246**	**M15-Ap16247**	**M15-Ap16248**
Date Sampled			**Apr 20, 2015**	**Apr 20, 2015**	**Apr 20, 2015**	**Apr 20, 2015**
Test/Reference	LOR	Unit				
Organochlorine Pesticides						
Chlordanes - Total	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
4.4'-DDD	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
4.4'-DDE	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
4.4'-DDT	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
a-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Aldrin	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
b-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
d-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Dieldrin	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endosulfan I	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endosulfan II	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endosulfan sulphate	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endrin	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endrin aldehyde	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endrin ketone	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
g-BHC (Lindane)	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Heptachlor	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Heptachlor epoxide	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Hexachlorobenzene	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Methoxychlor	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Toxaphene	1	mg/kg	< 1	< 1	< 1	< 1
Dibutylchlorendate (surr.)	1	%	90	87	91	75
Tetrachloro-m-xylene (surr.)	1	%	79	79	83	73
Organophosphorous Pesticides						
Bolstar	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Chlorpyrifos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Demeton-O	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Diazinon	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Dichlorvos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Disulfoton	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Ethion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Ethoprop	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Fenitrothion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Fensulfothion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Fenthion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2

Client Sample ID			SS01/0.0	SS02/0.0	SS03/0.0	SS04/0.0
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins | mgt Sample No.			M15-Ap16245	M15-Ap16246	M15-Ap16247	M15-Ap16248
Date Sampled			Apr 20, 2015	Apr 20, 2015	Apr 20, 2015	Apr 20, 2015
Test/Reference	LOR	Unit				
Organophosphorous Pesticides						
Merphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Methyl azinphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Methyl parathion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Mevinphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Naled	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Phorate	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Ronnel	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Tokuthion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Trichloronate	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Triphenylphosphate (surr.)	1	%	55	61	63	65
Heavy Metals						
Arsenic	2	mg/kg	3.4	2.8	2.7	2.3
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	15	15	16	16
Copper	5	mg/kg	14	19	19	17
Lead	5	mg/kg	5.6	6.9	6.8	6.0
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	< 5
Zinc	5	mg/kg	38	68	50	42
% Moisture	0.1	%	2.6	3.6	3.1	3.1

Client Sample ID			SS05/0.0	SS06/0.0	SS07/0.0	SS08/0.0
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins | mgt Sample No.			M15-Ap16249	M15-Ap16250	M15-Ap16251	M15-Ap16252
Date Sampled			Apr 20, 2015	Apr 20, 2015	Apr 20, 2015	Apr 20, 2015
Test/Reference	LOR	Unit				
Organochlorine Pesticides						
Chlordanes - Total	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
4.4'-DDD	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
4.4'-DDE	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
4.4'-DDT	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
a-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Aldrin	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
b-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
d-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Dieldrin	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endosulfan I	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endosulfan II	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endosulfan sulphate	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endrin	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endrin aldehyde	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endrin ketone	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
g-BHC (Lindane)	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Heptachlor	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Heptachlor epoxide	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Hexachlorobenzene	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Methoxychlor	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05

Client Sample ID			SS05/0.0	SS06/0.0	SS07/0.0	SS08/0.0
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins | mgt Sample No.			M15-Ap16249	M15-Ap16250	M15-Ap16251	M15-Ap16252
Date Sampled			Apr 20, 2015	Apr 20, 2015	Apr 20, 2015	Apr 20, 2015
Test/Reference	LOR	Unit				
Organochlorine Pesticides						
Toxaphene	1	mg/kg	< 1	< 1	< 1	< 1
Dibutylchlorendate (surr.)	1	%	88	93	95	88
Tetrachloro-m-xylene (surr.)	1	%	82	83	83	77
Organophosphorous Pesticides						
Bolstar	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Chlorpyrifos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Demeton-O	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Diazinon	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Dichlorvos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Disulfoton	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Ethion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Ethoprop	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Fenitrothion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Fensulfothion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Fenthion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Merphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Methyl azinphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Methyl parathion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Mevinphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Naled	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Phorate	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Ronnel	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Tokuthion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Trichloronate	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Triphenylphosphate (surr.)	1	%	58	62	77	77
Heavy Metals						
Arsenic	2	mg/kg	4.4	3.7	2.9	2.3
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	15	15	16	17
Copper	5	mg/kg	16	17	19	26
Lead	5	mg/kg	6.4	6.8	6.3	6.9
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	< 5
Zinc	5	mg/kg	43	42	41	51
% Moisture	0.1	%	2.7	2.3	3.1	3.7

Client Sample ID			SS09/0.0	SS10/0.0	QC1
Sample Matrix			Soil	Soil	Soil
Eurofins | mgt Sample No.			M15-Ap16253	M15-Ap16254	M15-Ap16255
Date Sampled			Apr 20, 2015	Apr 20, 2015	Apr 20, 2015
Test/Reference	LOR	Unit			
Organochlorine Pesticides					
Chlordanes - Total	0.1	mg/kg	< 0.1	< 0.1	< 0.1
4.4'-DDD	0.05	mg/kg	< 0.05	< 0.05	< 0.05
4.4'-DDE	0.05	mg/kg	< 0.05	< 0.05	< 0.05
4.4'-DDT	0.05	mg/kg	< 0.05	< 0.05	< 0.05
a-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05

Client Sample ID			SS09/0.0	SS10/0.0	QC1
Sample Matrix			Soil	Soil	Soil
Eurofins | mgt Sample No.			M15-Ap16253	M15-Ap16254	M15-Ap16255
Date Sampled			Apr 20, 2015	Apr 20, 2015	Apr 20, 2015
Test/Reference	LOR	Unit			
Organochlorine Pesticides					
Aldrin	0.05	mg/kg	< 0.05	< 0.05	< 0.05
b-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05
d-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Dieldrin	0.05	mg/kg	0.07	< 0.05	< 0.05
Endosulfan I	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Endosulfan II	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Endosulfan sulphate	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Endrin	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Endrin aldehyde	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Endrin ketone	0.05	mg/kg	< 0.05	< 0.05	< 0.05
g-BHC (Lindane)	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Heptachlor	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Heptachlor epoxide	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Hexachlorobenzene	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Methoxychlor	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Toxaphene	1	mg/kg	< 1	< 1	< 1
Dibutylchlorendate (surr.)	1	%	77	85	98
Tetrachloro-m-xylene (surr.)	1	%	74	72	80
Organophosphorous Pesticides					
Bolstar	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Chlorpyrifos	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Demeton-O	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Diazinon	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Dichlorvos	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Disulfoton	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Ethion	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Ethoprop	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Fenitrothion	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Fensulfothion	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Fenthion	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Merphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Methyl azinphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Methyl parathion	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Mevinphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Naled	0.5	mg/kg	< 0.5	< 0.5	< 0.5
Phorate	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Ronnel	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Tokuthion	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Trichloronate	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Triphenylphosphate (surr.)	1	%	71	75	86
Heavy Metals					
Arsenic	2	mg/kg	4.1	4.7	4.9
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	19	19	18
Copper	5	mg/kg	32	< 5	6.3
Lead	5	mg/kg	8.2	< 5	< 5
Mercury	0.1	mg/kg	0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5
Zinc	5	mg/kg	110	< 5	12

Client Sample ID			SS09/0.0	SS10/0.0	QC1
Sample Matrix			**Soil**	**Soil**	**Soil**
Eurofins | mgt Sample No.			**M15-Ap16253**	**M15-Ap16254**	**M15-Ap16255**
Date Sampled			**Apr 20, 2015**	**Apr 20, 2015**	**Apr 20, 2015**
Test/Reference	LOR	Unit			
% Moisture	0.1	%	3.5	2.9	1.5

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Eurofins | mgt Suite 14			
Organochlorine Pesticides	Melbourne	Apr 23, 2015	14 Day
- Method: USEPA 8081 Organochlorine Pesticides			
Organophosphorous Pesticides	Melbourne	Apr 23, 2015	14 Day
- Method: USEPA 8270 Organophosphorus Pesticides			
Metals M8	Melbourne	Apr 23, 2015	28 Day
- Method: USEPA 6010/6020 Heavy Metals & USEPA 7470/71 Mercury			
% Moisture	Melbourne	Apr 22, 2015	14 Day
- Method: LTM-GEN-7080 Moisture			

Company Name:	Galt Environment P/L	**Order No.:**	J1501070	**Received:**	Apr 22, 2015 9:54 AM
Address:	2/39 Flynn St Wembley WA 6014	**Report #:**	454842	**Due:**	Apr 29, 2015
		Phone:	08 6272 0200	**Priority:**	5 Day
		Fax:	08 9285 8444	**Contact Name:**	Brad Palmer
Project Name:	BALDIVIS				
Project ID:	J1501070				

Eurofins | mgt Client Manager: Natalie Krasselt

Sample Detail					Metals M8	Eurofins | mgt Suite 14	Moisture Set
Laboratory where analysis is conducted							
Melbourne Laboratory - NATA Site # 1254 & 14271					X	X	X
Sydney Laboratory - NATA Site # 18217							
Brisbane Laboratory - NATA Site # 20794							
External Laboratory							
Sample ID	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**			
SS01/0.0	Apr 20, 2015		Soil	M15-Ap16245	X	X	X
SS02/0.0	Apr 20, 2015		Soil	M15-Ap16246	X	X	X
SS03/0.0	Apr 20, 2015		Soil	M15-Ap16247	X	X	X
SS04/0.0	Apr 20, 2015		Soil	M15-Ap16248	X	X	X
SS05/0.0	Apr 20, 2015		Soil	M15-Ap16249	X	X	X
SS06/0.0	Apr 20, 2015		Soil	M15-Ap16250	X	X	X
SS07/0.0	Apr 20, 2015		Soil	M15-Ap16251	X	X	X
SS08/0.0	Apr 20, 2015		Soil	M15-Ap16252	X	X	X
SS09/0.0	Apr 20, 2015		Soil	M15-Ap16253	X	X	X

Company Name:	Galt Environment P/L	**Order No.:**	J1501070	**Received:**	Apr 22, 2015 9:54 AM
Address:	2/39 Flynn St Wembley WA 6014	**Report #:**	454842	**Due:**	Apr 29, 2015
		Phone:	08 6272 0200	**Priority:**	5 Day
		Fax:	08 9285 8444	**Contact Name:**	Brad Palmer
Project Name:	BALDIVIS				
Project ID:	J1501070				

Eurofins | mgt Client Manager: Natalie Krasselt

Sample Detail					Metals M8	Eurofins | mgt Suite 14	Moisture Set
Laboratory where analysis is conducted							
Melbourne Laboratory - NATA Site # 1254 & 14271					X	X	X
Sydney Laboratory - NATA Site # 18217							
Brisbane Laboratory - NATA Site # 20794							
External Laboratory							
SS10/0.0	Apr 20, 2015		Soil	M15-Ap16254	X	X	X
QC1	Apr 20, 2015		Soil	M15-Ap16255	X	X	X

Eurofins | mgt Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
4. Results are uncorrected for matrix spikes or surrogate recoveries.
5. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
6. Samples were analysed on an 'as received' basis. 7. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the Sample Receipt Advice.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

****NOTE:** pH duplicates are reported as a range NOT as RPD

UNITS

mg/kg: milligrams per Kilogram

ug/l: micrograms per litre

ppb: Parts per billion

org/100ml: Organisms per 100 millilitres

MPN/100mL: Most Probable Number of organisms per 100 millilitres

mg/l: milligrams per litre

ppm: Parts per million

%: Percentage

NTU: Nephelometric Turbidity Units

TERMS

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery
CRM	Certified Reference Material - reported as percent recovery
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands. In the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
Batch Duplicate	A second piece of analysis from a sample outside of the clients batch of samples but run within the laboratory batch of analysis.
Batch SPIKE	Spike recovery reported on a sample from outside of the clients batch of samples but run within the laboratory batch of analysis.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
ASLP	Australian Standard Leaching Procedure (AS4439.3)
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within
TEQ	Toxic Equivalency Quotient

QC - ACCEPTANCE CRITERIA

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries : Recoveries must lie between 50-150% - Phenols 20-130%.

QC DATA GENERAL COMMENTS

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxophene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxophene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Arochlor 1260 in Matrix Spikes and LCS's.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPD's are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Organochlorine Pesticides							
Chlordanes - Total	mg/kg	< 0.1			0.1	Pass	
4.4'-DDD	mg/kg	< 0.05			0.05	Pass	
4.4'-DDE	mg/kg	< 0.05			0.05	Pass	
4.4'-DDT	mg/kg	< 0.05			0.05	Pass	
a-BHC	mg/kg	< 0.05			0.05	Pass	
Aldrin	mg/kg	< 0.05			0.05	Pass	
b-BHC	mg/kg	< 0.05			0.05	Pass	
d-BHC	mg/kg	< 0.05			0.05	Pass	
Dieldrin	mg/kg	< 0.05			0.05	Pass	
Endosulfan I	mg/kg	< 0.05			0.05	Pass	
Endosulfan II	mg/kg	< 0.05			0.05	Pass	
Endosulfan sulphate	mg/kg	< 0.05			0.05	Pass	
Endrin	mg/kg	< 0.05			0.05	Pass	
Endrin aldehyde	mg/kg	< 0.05			0.05	Pass	
Endrin ketone	mg/kg	< 0.05			0.05	Pass	
g-BHC (Lindane)	mg/kg	< 0.05			0.05	Pass	
Heptachlor	mg/kg	< 0.05			0.05	Pass	
Heptachlor epoxide	mg/kg	< 0.05			0.05	Pass	
Hexachlorobenzene	mg/kg	< 0.05			0.05	Pass	
Methoxychlor	mg/kg	< 0.05			0.05	Pass	
Toxaphene	mg/kg	< 1			1	Pass	
Method Blank							
Organophosphorous Pesticides							
Bolstar	mg/kg	< 0.2			0.2	Pass	
Chlorpyrifos	mg/kg	< 0.2			0.2	Pass	
Demeton-O	mg/kg	< 0.2			0.2	Pass	
Diazinon	mg/kg	< 0.2			0.2	Pass	
Dichlorvos	mg/kg	< 0.2			0.2	Pass	
Disulfoton	mg/kg	< 0.2			0.2	Pass	
Ethion	mg/kg	< 0.2			0.2	Pass	
Ethoprop	mg/kg	< 0.2			0.2	Pass	
Fenitrothion	mg/kg	< 0.2			0.2	Pass	
Fensulfothion	mg/kg	< 0.2			0.2	Pass	
Fenthion	mg/kg	< 0.2			0.2	Pass	
Merphos	mg/kg	< 0.2			0.2	Pass	
Methyl azinphos	mg/kg	< 0.2			0.2	Pass	
Methyl parathion	mg/kg	< 0.2			0.2	Pass	
Mevinphos	mg/kg	< 0.2			0.2	Pass	
Naled	mg/kg	< 0.5			0.5	Pass	
Phorate	mg/kg	< 0.2			0.2	Pass	
Ronnel	mg/kg	< 0.2			0.2	Pass	
Tokuthion	mg/kg	< 0.2			0.2	Pass	
Trichloronate	mg/kg	< 0.2			0.2	Pass	
Method Blank							
Heavy Metals							
Arsenic	mg/kg	< 2			2	Pass	
Cadmium	mg/kg	< 0.4			0.4	Pass	
Chromium	mg/kg	< 5			5	Pass	
Copper	mg/kg	< 5			5	Pass	
Lead	mg/kg	< 5			5	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Mercury	mg/kg	< 0.1			0.1	Pass	
Nickel	mg/kg	< 5			5	Pass	
Zinc	mg/kg	< 5			5	Pass	
LCS - % Recovery							
Organochlorine Pesticides							
4.4'-DDD	%	98			70-130	Pass	
4.4'-DDE	%	95			70-130	Pass	
4.4'-DDT	%	88			70-130	Pass	
a-BHC	%	126			70-130	Pass	
Aldrin	%	95			70-130	Pass	
b-BHC	%	111			70-130	Pass	
d-BHC	%	97			70-130	Pass	
Dieldrin	%	96			70-130	Pass	
Endosulfan I	%	94			70-130	Pass	
Endosulfan II	%	98			70-130	Pass	
Endosulfan sulphate	%	104			70-130	Pass	
Endrin	%	90			70-130	Pass	
Endrin aldehyde	%	99			70-130	Pass	
Endrin ketone	%	105			70-130	Pass	
g-BHC (Lindane)	%	87			70-130	Pass	
Heptachlor	%	96			70-130	Pass	
Heptachlor epoxide	%	94			70-130	Pass	
Hexachlorobenzene	%	91			70-130	Pass	
Methoxychlor	%	82			70-130	Pass	
LCS - % Recovery							
Organophosphorous Pesticides							
Diazinon	%	83			70-130	Pass	
Ethion	%	102			70-130	Pass	
Fenitrothion	%	81			70-130	Pass	
Methyl parathion	%	82			70-130	Pass	
Mevinphos	%	92			70-130	Pass	
LCS - % Recovery							
Heavy Metals							
Arsenic	%	80			80-120	Pass	
Cadmium	%	95			80-120	Pass	
Chromium	%	96			80-120	Pass	
Copper	%	98			80-120	Pass	
Lead	%	98			80-120	Pass	
Mercury	%	101			75-125	Pass	
Nickel	%	100			80-120	Pass	
Zinc	%	98			80-120	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Spike - % Recovery									
Organochlorine Pesticides				Result 1					
4.4'-DDD	M15-Ap16246	CP	%	88			70-130	Pass	
4.4'-DDE	M15-Ap16246	CP	%	89			70-130	Pass	
4.4'-DDT	M15-Ap16246	CP	%	82			70-130	Pass	
a-BHC	M15-Ap16246	CP	%	95			70-130	Pass	
Aldrin	M15-Ap16246	CP	%	81			70-130	Pass	
b-BHC	M15-Ap16246	CP	%	96			70-130	Pass	
d-BHC	M15-Ap16246	CP	%	84			70-130	Pass	
Dieldrin	M15-Ap16246	CP	%	87			70-130	Pass	
Endosulfan I	M15-Ap16246	CP	%	81			70-130	Pass	
Endosulfan II	M15-Ap16246	CP	%	85			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Endosulfan sulphate	M15-Ap16246	CP	%	94			70-130	Pass	
Endrin	M15-Ap16246	CP	%	83			70-130	Pass	
Endrin aldehyde	M15-Ap16246	CP	%	86			70-130	Pass	
Endrin ketone	M15-Ap16246	CP	%	95			70-130	Pass	
g-BHC (Lindane)	M15-Ap16246	CP	%	74			70-130	Pass	
Heptachlor	M15-Ap16246	CP	%	84			70-130	Pass	
Heptachlor epoxide	M15-Ap16246	CP	%	87			70-130	Pass	
Hexachlorobenzene	M15-Ap16246	CP	%	78			70-130	Pass	
Methoxychlor	M15-Ap16246	CP	%	85			70-130	Pass	
Spike - % Recovery									
Organophosphorous Pesticides				Result 1					
Diazinon	M15-Ap16250	CP	%	90			70-130	Pass	
Ethion	M15-Ap16250	CP	%	73			70-130	Pass	
Fenitrothion	M15-Ap16250	CP	%	71			70-130	Pass	
Methyl parathion	M15-Ap16250	CP	%	72			70-130	Pass	
Mevinphos	M15-Ap16250	CP	%	90			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Arsenic	M15-Ap16251	CP	%	78			75-125	Pass	
Cadmium	M15-Ap16251	CP	%	97			75-125	Pass	
Chromium	M15-Ap16251	CP	%	97			75-125	Pass	
Copper	M15-Ap16251	CP	%	103			75-125	Pass	
Lead	M15-Ap16251	CP	%	98			75-125	Pass	
Mercury	M15-Ap16251	CP	%	85			70-130	Pass	
Nickel	M15-Ap16251	CP	%	99			75-125	Pass	
Zinc	M15-Ap16251	CP	%	85			75-125	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
Organochlorine Pesticides				Result 1	Result 2	RPD			
Chlordanes - Total	M15-Ap16245	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
4.4'-DDD	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
4.4'-DDE	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
4.4'-DDT	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
a-BHC	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Aldrin	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
b-BHC	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
d-BHC	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Dieldrin	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endosulfan I	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endosulfan II	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endosulfan sulphate	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endrin	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endrin aldehyde	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endrin ketone	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
g-BHC (Lindane)	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Heptachlor	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Heptachlor epoxide	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Hexachlorobenzene	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Methoxychlor	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Toxaphene	M15-Ap16245	CP	mg/kg	< 1	< 1	<1	30%	Pass	

Duplicate									
Organophosphorous Pesticides				Result 1	Result 2	RPD			
Bolstar	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Chlorpyrifos	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Demeton-O	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Diazinon	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Dichlorvos	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Disulfoton	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Ethion	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Ethoprop	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Fenitrothion	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Fensulfothion	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Fenthion	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Merphos	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Methyl azinphos	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Methyl parathion	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Mevinphos	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Naled	M15-Ap16249	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Phorate	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Ronnel	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Tokuthion	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Trichloronate	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Arsenic	M15-Ap16250	CP	mg/kg	3.7	3.2	17	30%	Pass	
Cadmium	M15-Ap16250	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	M15-Ap16250	CP	mg/kg	15	15	2.0	30%	Pass	
Copper	M15-Ap16250	CP	mg/kg	17	17	1.0	30%	Pass	
Lead	M15-Ap16250	CP	mg/kg	6.8	6.2	10	30%	Pass	
Mercury	M15-Ap16250	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Nickel	M15-Ap16250	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Zinc	M15-Ap16250	CP	mg/kg	42	46	7.0	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Arsenic	M15-Ap16251	CP	mg/kg	2.9	2.6	10	30%	Pass	
Cadmium	M15-Ap16251	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	M15-Ap16251	CP	mg/kg	16	16	1.0	30%	Pass	
Copper	M15-Ap16251	CP	mg/kg	19	19	<1	30%	Pass	
Lead	M15-Ap16251	CP	mg/kg	6.3	6.7	6.0	30%	Pass	
Mercury	M15-Ap16251	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Nickel	M15-Ap16251	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Zinc	M15-Ap16251	CP	mg/kg	41	45	9.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
% Moisture	M15-Ap16252	CP	%	3.7	3.2	12	30%	Pass	
Duplicate									
Organochlorine Pesticides				Result 1	Result 2	RPD			
Chlordanes - Total	M15-Ap16255	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
4.4'-DDD	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
4.4'-DDE	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
4.4'-DDT	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
a-BHC	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Aldrin	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
b-BHC	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
d-BHC	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Dieldrin	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	

Duplicate									
Organochlorine Pesticides				Result 1	Result 2	RPD			
Endosulfan I	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endosulfan II	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endosulfan sulphate	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endrin	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endrin aldehyde	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endrin ketone	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
g-BHC (Lindane)	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Heptachlor	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Heptachlor epoxide	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Hexachlorobenzene	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Methoxychlor	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Toxaphene	M15-Ap16255	CP	mg/kg	< 1	< 1	<1	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised By

Natalie Krasselt	Analytical Services Manager
Carroll Lee	Senior Analyst-Organic (VIC)
Emily Rosenberg	Senior Analyst-Metal (VIC)
Huong Le	Senior Analyst-Inorganic (VIC)

Glenn Jackson
National Laboratory Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Uncertainty data is available on request

Appendix G: Understanding Your Report

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UNDERSTANDING YOUR GEOTECHNICAL ENGINEERING REPORT

GALT FORM PMP11 Rev1

1. EXPECTATIONS OF A GEOTECHNICAL ENGINEERING REPORT

This document has been prepared to clarify what is and is not provided in your geotechnical report. It is intended to inform you of what your realistic expectations of this report should be and how to manage your risks associated with geotechnical conditions.

Geotechnical engineering is a less exact science than other engineering disciplines. We include this information to help you understand where our responsibilities as geotechnical engineers begin and end, to help the client recognise his responsibilities and risks. You should read and understand this information. Please contact us if you do not understand the report or this explanation. We have extensive experience in a wide variety of geotechnical problems and we can help you to manage your risk.

2. THIS REPORT RELATES TO PROJECT-SPECIFIC CONDITIONS

This report was developed for a unique set of project-specific conditions to meet the needs of the nominated client. It took into account the following :

- The project objectives as we understood them and as described in this report;
- the specific site mentioned in this report; and
- the current and proposed development at the site.

It should not be used for any purpose other than that indicated in the report. You should not rely on this geotechnical report if any of the following conditions apply:

- the report was not written for you;
- the report was not written for the site specific to your development;
- the report was not written for your project (including a development at the correct site but other than that listed in the report); or
- the report was written before significant changes occurred at the site (such as a development or a change in ground conditions).

You should always inform us of changes in the proposed project (including minor changes) and request an assessment of their impact.

Where we are not informed of developments relevant to your geotechnical engineering report, we cannot be held responsible or liable for problems that may arise as a consequence.

Where design is to be carried out by others using information provided by us, we recommend that we be involved in the design process by being engaged for consultation with other members of the design team and by being able to review work produced by other members of the design team which relies on geotechnical information provided in our report.

3. GEOTECHNICAL ENGINEERING LOGS

Our reports often include logs of intrusive and non-intrusive geotechnical investigation techniques. These logs are based on our interpretation of field data and laboratory results. The logs should only be read in conjunction with the report they were issued with and should not be re-drawn for inclusion in other documents not prepared by us.

4. THIRD PARTY RELIANCE

We have prepared this report for use by the client. This report must be regarded as confidential to the client and the client's professional advisors. We do not accept any responsibility for contents of this document from any party other than the nominated client. We take no responsibility for any damages suffered by a third party as a consequence of any decisions or actions they may make based on this report. Any reliance or decisions made by a third party based on this report are the responsibility of the third party and not of us.

5. CHANGE IN SUBSURFACE CONDITIONS

The geotechnical recommendations in this report are based on the ground conditions that existed at the time when the study was undertaken. Changes in ground conditions can occur in numerous ways including as a result of anthropogenic events (such as construction on or adjacent to the site) or natural events (such as floods, groundwater fluctuations or earthquakes). We should be consulted prior to use of this report so that we can comment on its reliability. It is important to note that where ground conditions have changed, additional sampling, testing or analysis may be required to fully assess the changed conditions.

6. SUBSURFACE CONDITIONS DURING CONSTRUCTION

Practical constraints mean that we cannot know every minute detail about the subsurface conditions at a particular site. We use engineering judgement to form an opinion about the subsurface conditions at the site. Some variation to our evaluated conditions is likely and significant variation is possible. Accordingly, our report should not be considered as final as it is developed from engineering judgement and opinion.

The most effective means of dealing with unanticipated ground conditions is to engage us for construction support. We can only finalise our recommendations by observing actual subsurface conditions encountered during construction. We cannot accept liability for a report's recommendations if we cannot observe construction.

7. ENVIRONMENTAL ISSUES

Unless specifically mentioned otherwise in our report, environmental considerations are not included. The investigation techniques used by us in developing our report differ from those for an environmental investigation. Our report was not prepared with environmental considerations in mind and it is the client's responsibility to satisfy himself that environmental considerations have been taken into account for the site. If you require guidance on how to proceed on evaluating environmental risk at the site, we can provide further information and contacts.

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UNDERSTANDING YOUR ENVIRONMENTAL REPORT

GALT FORM PMP29 Rev1

1. EXPECTATIONS OF AN ENVIRONMENTAL REPORT

This document has been prepared to clarify what is and is not provided in your environmental report. It is intended to inform you of what your realistic expectations of this report should be and how to manage your risks associated with environmental conditions. You should read and understand this information. Please contact us if you do not understand the report or this explanation. We have extensive experience in a wide variety of environmental problems and we can help you to manage your risk.

2. THIS REPORT RELATES TO PROJECT-SPECIFIC CONDITIONS

This report was developed for a unique set of project-specific conditions to meet the needs of the nominated client. It took into account the following:

- The project objectives as we understood them and as described in this report;
- the specific site mentioned in this report; and
- the current and proposed development at the site.

It should not be used for any purpose other than that indicated in the report. You should not rely on this report if any of the following conditions apply:

- the report was not written for you;
- the report was not written for the site specific to your development;
- the report was not written for your project (including a development at the correct site but other than that listed in the report); or
- the report was written before significant changes occurred at the site (such as a development or a change in ground conditions).

You should always inform us of changes in the proposed project (including minor changes) and request an assessment of their impact.

Where we are not informed of developments relevant to your environmental report, we cannot be held responsible or liable for problems that may arise as a consequence.

Where design is to be carried out by others using information provided by us, we recommend that we be involved in the project planning process by being engaged for consultation with members of the project team and by being able to review work produced by other members of the project team which relies on environmental information provided in our report.

3. ENVIRONMENTAL LOGS

Our reports often include logs of intrusive and non-intrusive environmental investigation techniques. These logs are based on our interpretation of field data and laboratory results. The logs should only be read in conjunction with the report they were issued with and should not be re-drawn for inclusion in other documents not prepared by us.

4. THIRD PARTY RELIANCE

We have prepared this report for use by the client. This report must be regarded as confidential to the client and the client's professional advisors. We do not accept any responsibility for contents of this document from any party other than the nominated client. We take no responsibility for any damages suffered by a third party as a consequence of any decisions or actions they may make based on this report. Any reliance or decisions made by a third party based on this report are the responsibility of the third party and not of us.

5. CHANGE IN SITE CONDITIONS

The environmental recommendations in this report are based on the site conditions that existed at the time when the study was undertaken. Changes in site conditions can occur in numerous ways including as a result of anthropogenic events (such as potentially contaminating activities or action on or adjacent to the site) or natural events (such as floods, groundwater fluctuations or earthquakes). We should be consulted prior to use of this report so that we can comment on its reliability. It is important to note that where site conditions have changed, additional sampling, testing or analysis may be required to fully characterise the changed conditions.

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Appendix 4

Environmental Assessment and Management Strategy

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emerge ASSOCIATES
Integrated Science & Design

ENVIRONMENTAL ASSESSMENT AND MANAGEMENT STRATEGY

PORTION OF LOT 16 MCDONALD ROAD BALDIVIS

Project Number EP15-057 01

Prepared for Defence Housing Australia
September 2016

Document Control

DOC NAME	ENVIRONMENTAL ASSESSMENT AND MANAGEMENT STRATEGY				
DOC NO.	EP15-057(01)--005				
REVISION	DATE	AUTHOR		REVIEWER	
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	□pdated follo□ing feed□ack from client and changes to Structure Plan.				
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Executive Summary

The Planning Group (TPG) on behalf of Defence Housing Australia has prepared a Structure Plan for the future residential development of a portion of Lot 16 McDonald Road Baldivis. Lot 16 (herein referred to as the site) is located approximately 38 km south of the Perth Central Business District within the City of Rockingham. Emerge Associates were engaged to provide a suite of environmental consultancy services to support the preparation of the Structure Plan which has included various investigations to identify and assess the environmental attributes and any constraints within the site.

The Structure Plan covers only the portion of Lot 16 that is zoned for urban land use under the Metropolitan Region Scheme (as shown in **Appendix A**) and has been prepared by TPG to provide a framework for the implementation of the urban/residential land use. The Structure Plan incorporates the inputs from a multi-disciplinary project team and the outcomes from various technical studies. Emerge Associates has undertaken an assessment of the environmental attributes of the site (the whole of Lot 16) in order to contribute to the preparation of the Structure Plan.

The site has historically been completely cleared of remnant vegetation for agricultural land uses. As such existing remnant environmental values are limited. The environmental attributes identified within the site have been outlined in **Section 2** and include:

- The site has been historically cleared for agricultural purposes primarily associated with market gardening. The site now supports grassland with scattered mature trees in the vicinity of an existing residence in the western portion of the site.
- Based on site inspections undertaken by Emerge Botanists remnant vegetation within the site is generally in 'Completely Degraded' or 'Degraded' condition (based upon the Bush Forever Condition Scale (Government of Western Australia 2000)).
- Given the extent of historic disturbance and subsequent condition of vegetation within the site it is highly unlikely that any 'Threatened Flora or Priority Flora species' 'Threatened Ecological Communities or Priority Ecological Communities occur within the site.
- There are no Bush Forever sites or Environmentally Sensitive Areas occurring within the site.
- Based on the degraded nature of vegetation the site supports limited fauna habitat values and is unlikely to be utilised by fauna other than common species adapted to disturbed environments or mobile or opportunistic fauna species.
- Landholdings immediately north of the site were historically used for market garden purposes however based a review of available historic aerial photographs this land use ceased around 2014.
- Some areas of native vegetation west of the site present a permanent bushfire hazard to future residential development.

The Structure Plan has responded to the environmental attributes of the site and this report outlines an environmental management framework that will be implemented either as part of the future residential planning and development process.

Overall the environmental attributes and values/constraints of the site have been accommodated within the Structure Plan layout or can be managed through the future subdivision and development stages in accordance with relevant federal state and local government legislation policies and guidelines and best management practices. As such the proposed future development of the site is not expected to significantly impact on the environment.

Based on the information contained within this report the following key recommendations should be considered for the implementation of the Structure Plan:

- There are no fundamental environmental constraints for the proposed urban development of the site and the proposed development should be considered environmentally acceptable.
- The site has been historically cleared of remnant vegetation and utilised for agricultural land uses. It is therefore highly unlikely that the site supports any significant flora and vegetation values.
- The site does not experience high groundwater levels or seasonal inundation. The Structure Plan aims to maintain clearance between groundwater and the proposed drainage infrastructure as outlined in the LWMS (Emerge Associates 2016).
- Surface and stormwater runoff infiltrates freely across the site due to the high permeability of underlying sands. The stormwater management strategy for the development aims to mimic the existing hydrology by infiltrating onsite as close to source as practicable. For high rainfall events the Structure Plan has accommodated appropriate treatment and drainage infrastructure within the proposed road network as detailed in the LWMS (Emerge Associates 2016).
- Permanent bushfire hazards occur west of the site within adjacent rural landholdings which require the accommodation of an appropriate APZ and increased construction standards. The Structure Plan has addressed this through the placement of the internal road network to provide an appropriate setback from the adjacent bushfire hazard and by undertaking an indicative BAL assessment to ensure there are no portions of the proposed development exposed to an unacceptable level of bushfire risk.

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Portion of Lot 16 McDonald Road□Baldivis Structure Plan

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Ministerial Statement No. 580 □Decem□er 2001□

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1 Introduction

1.1 Background

The Planning Group (TPG) on behalf of Defence Housing Australia has prepared a Structure Plan for the future residential development of a portion of Lot 16 McDonald Road, Baldivis, within the City of Rockingham. Lot 16 is herein referred to as the site and is approximately 10 hectares situated 38 km south of the Perth Central Business District (CBD) as shown in **Figure 1**. The site is bound by McDonald Road and existing urban development to the east, vacant Rural and Urban zoned landholdings to the north and west and an existing residential property to the south as shown in **Figure 2**.

The Structure Plan has been prepared for a portion of the site to support residential development in accordance with the City of Rockingham's Baldivis North District Structure Plan (DSP) and the land use zoning over the site. A copy of the Structure Plan has been provided in **Appendix A**.

1.2 Purpose of this report

This report provides a synthesis of information regarding the environmental attributes and values of the site. It is based on a range of information sources including local and regional reports, databases and publically available mapping and where necessary site specific surveys and investigations. Together this information has been used to inform the Structure Plan and the preparation of supporting documentation. Emerge Associates has undertaken an assessment of the environmental attributes of the site (the whole of Lot 16) in order to contribute to the preparation of the Structure Plan over a portion of the site.

The primary purpose of this report is to present the information that has used to inform the Structure Plan, outline the potential environmental impacts that could arise from the implementation of the Structure Plan, and in response to this and where required, outline responses in the Structure Plan to accommodate the environmental attributes of the site, and collectively provide an environmental management framework for the future residential subdivision and development process.

1.3 Environmental and site specific investigations

Emerge Associates were engaged to provide a suite of environmental services to support the preparation of the Structure Plan. This has included numerous site specific technical investigations to identify and assess the environmental attributes and values/constraints present within the broader site and those portions of the site which the Structure Plan formally covers.

To date these services include:

- Desktop environmental investigation and site visit to confirm environmental attributes of the site.
- Preparation of a *Local Water Management Strategy* (LWMS) (Emerge Associates 2016).
- Preparation of a *Bushfire Management Plan* (BMP) (Emerge Associates and Bushfire Safety Consulting 2016).

In addition to the above a *Geotechnical and Preliminary Environmental Study* (Galt Geotechnics 2015) has been undertaken over the site.

2 Existing Environment

2.1 Local context

The site is approximately two hectares and is bound by McDonald Road and existing urban development to the east and undeveloped landholdings to the north south and west as shown in **Figure 2**.

The majority of the site is zoned Urban under the Metropolitan Region Scheme (MRS) and 'Development' under the City of Rockingham's Local Planning Scheme (LPS) No. 2 with a small portion in the west of the site zoned for 'Rural' land use under both the MRS and LPS No. 2. The portion of the site covered by the Structure Plan is intended for urban development in accordance with the City of Rockingham's Baldivis North DSP and its MRS zoning. The current MRS zones and reserves for the site and surrounding area are shown in **Figure 3**.

2.2 Climate

The climate of the site which applies to the broader south west region of Western Australia is described as Mediterranean with hot dry summers and moderately wet mild winters. The majority of rainfall within the region occurs between May and October each year and on average is between 600 to 1000 mm per year. However in the last 40 years there has been a marked decrease in rainfall between 10 to 15% decrease with a noticeable shift to a drier climate across the south-west of Western Australia (CSIRO 2009).

The closest inland weather station to the site is the Medina Research Centre located approximately 8 km north of the site. Temperature and rainfall statistics recorded at the Medina Research Centre between 1983 and 2015 (Bureau of Meteorology 2015) is summarised in **Table 1** (below).

Table 1: Rainfall and temperature averages for the Medina Research Centre weather station (1983 to 2015) (BoM 2015)

STATISTICS	J	F	M	A	M	J	J	A	S	O	N	D
Mean Maximum Temperature (°C)	30.7	31.5	29.3	25.7	22.1	19.4	18.3	18.9	20.3	22.7	26.0	28.2
Mean Minimum Temperature (°C)	17.1	17.6	16.0	13.4	10.5	9.0	8.2	8.2	9.2	10.4	13.4	15.1
Mean Rainfall (mm)	11.5	18.8	19.3	39.4	98.5	140.8	145.9	113.0	78.2	40.1	31.4	11.4

2.3 Landform and soils

2.3.1 Topography

Topographical contours indicate that the site is generally flat with elevation ranging from approximately 4 metres Australian Height Datum (m AHD) in north-west corner and 5 m AHD in the

south-east of the site, with a high point of approximately 7 m AHD located in the centre of the site, as shown in **Figure 4**.

2.3.2 Regional geomorphology

The site is located on the Swan Coastal Plain, which forms the central portion of the Perth Basin. The Perth Basin extends from the Darling Fault in the east to the continental slope west of Rottnest Island, and from the Murchison River in the north and the Southern Ocean in the south. The Perth Basin is sedimentary in original and is marginal to the west of the Australian Shield (Seddon 2004).

The Swan Coastal Plain is generally flat and is approximately 20 to 30 km wide, consisting of a series of geomorphic entities running parallel to the coastline. The youngest and most western of these geomorphic entities is the Quindalup Dunes, followed by the Spearwood Dunes and at the most eastern extent the Bassendean Dunes. The site is situated within the Spearwood Dunes system.

2.3.3 Landform and soils

Regional landform mapping by Churchward and McArthur (1980) indicates that the site is comprised of the Cottesloe formation. The Cottesloe formation is described as a low hill landscape with shallow brown sand over limestone, with much exposed limestone (Churchward and McArthur 1980).

Environmental geology (surface soils) across the site has been mapped by the Geological Survey of Western Australia (Gozzard 1983). The geological units are listed in **Table 2** below.

Table 2: Geological units located within the site (Gozzard 1983).

GEOLOGICAL UNIT	EQUIVALENT ON GEOLOGICAL MAPS	DESCRIPTION
S_r	Sand	Sand derived from Tamala Limestone dunes Pale yellowish brown medium to coarse-grained subangular quartz, trace of feldspar, moderately sorted, of residual origin

A geotechnical assessment was undertaken for the site by Galt Geotechnics (2015), which found ground conditions to be generally as expected based on the regional mapping outlined above, with the following observations noted specific to the site (Galt Geotechnics 2015):

- Sand, medium to coarse grained, sub-angular to sub-rounded, brown becoming yellow, with depth, trace limestone cobbles and gravel, typically loose to dense, present from surface to depth of between one (1) metre extending to the maximum depth investigation (2.5 m).
- Limestone, present below the sand layer, rockhead varying from depths between about one (1) metre and more than the maximum depth of investigation (2.5 m).

Imported fill was found to occur in the north-west of the site, associated with the existing residence in this portion of the site (Galt Geotechnics 2015). Further details are provided within the report titled *Geotechnical and Preliminary Environmental Study* (Galt Geotechnics 2015) provided as an attachment to the Structure Plan.

2.3.4 Acid sulfate soils

Acid sulfate soils (ASS) is the name commonly given to naturally occurring soils and sediment containing iron sulphide (iron pyrite) materials. In their natural state ASS are generally present in waterlogged anoxic conditions and do not present an risk to the environment. When oxidised, ASS

produce sulphuric acid which can pose risks to the surrounding environment infrastructure and human health.

Available information (DER 2006) indicates that the site has been classified as having no known risk of ASS occurring within three metres of the natural soil surface. An area of moderate to high risk is mapped south-west of the site as shown in **Figure 5** likely associated with wetlands in this area.

2.4 Biodiversity and natural assets

2.4.1 Flora and vegetation

2.4.1.1 Regional vegetation context

The site lies within the Swan Coastal Plain Interim Biogeographic Regionalisation for Australia (IBRA) region (Thackway and Cresswell 1995). The Swan Coastal Plain IBRA region is broadly compatible with the Swan Coastal Plain (Drummond Botanical Sub district) Phytogeographical Sub region as described by Beard (1990). This region is characterised by *Banksia* low woodlands on leached sands, woodlands of tuart *Eucalyptus gomphocephala* jarrah *Eucalyptus marginata* and marri *Corymbia calophylla* on less leached soils and Melaleuca swamps.

At a local level vegetation complex mapping for the Swan Coastal Plain (Heddle *et al.* 1980) indicates that the site is characteristic of the Cottesloe Central and South complex. Vegetation complex mapping is based on soil geomorphology and water availability patterns. The Cottesloe Central and South complex is described as a mosaic of woodland of *Eucalyptus gomphocephala* and open forest of *Eucalyptus gomphocephala - Eucalyptus marginata - Corymbia calophylla* closed heath on the limestone outcrops (DEC 1980).

Remnant vegetation extent remaining according to vegetation complexes have been published by the Local Biodiversity Program through the Western Australian Local Government Association (WALGA). This indicates that the pre-European extent of the Cottesloe Central and South complex on the Swan Coastal Plain was 44 900 ha. As of 2013, 15 816 ha (35%) of this remains and 18% of the complex's original extent is under formal or informal protection (PBP 2013).

On the Swan Coastal Plain portion of the Perth Metropolitan Region EPA Guidance Statement No. 10 (*Level of assessment for proposals affecting natural areas within the System 6 region and Swan Coastal Plain portion of System 1 region* (EPA 2006) specifies that a biodiversity objective is to retain at least 10% of the pre-European settlement extent of the Heddle et al. 1980 vegetation Complexes.

2.4.1.2 Extent and condition of remnant vegetation

The site has been historically cleared of remnant vegetation to support agricultural land uses and now supports areas of grassland dominated by weeds with a small number of planted non-native trees in the western extent of the site as shown in **Plate 1** and **Plate 2** below.

Due to the complete removal of remnant vegetation from the site based on a site inspection by Emerge botanists vegetation is considered to be in Completely Degraded condition based on the Keighery (1994) condition scale and is considered no longer representative of the Cottesloe Central and South complex.

Plate 1: Planted non-native trees over weedy grassland in the west of the site

Plate 2: Planted, non-native trees over weedy grassland in the west of the site

2.4.1.3 *Significant Flora*

Species of flora acquire Threatened Flora (TF) or Priority Flora (PF) conservation status where populations are restricted geographically or threatened by local processes. The Department of Parks and Wildlife (DPaW) recognises these threats and subsequently applies regulations towards population protection and species conservation. The DPaW enforces regulations under the *Wildlife Conservation Act 1950* (WC Act) to conserve TF species and protect significant populations. PF are described as potentially rare or threatened species and are classified in order of threat.

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) promotes the conservation of biodiversity by providing statutory protection for plants at a species level. Some TF species listed under the WC Act are also listed at a Federal level. Section 178 and 179 of the EPBC Act provides for the lists and categories of threatened species under the Act. Priority flora species are potentially rare or threatened and are classified in order of threat however are not afforded direct statutory protection.

Given the extent of historic disturbance within the site there is unlikely to be any significant flora species present within the site.

2.4.1.4 *Threatened and/or Priority Ecological Communities*

In Western Australia Threatened Ecological Communities (TECs) are defined by the Western Australian Threatened Ecological Communities Scientific Advisory Committee (WATECSAC). Generally these can be described as vegetation communities that are assemblages of species that occur together in a particular type of habitat. They are the sum of species within an ecosystem and as a whole provide many of the processes which support a specific ecosystem. TECs are recognised as specific ecological communities that are rare or under threat.

TECs are not afforded direct statutory protection at a State level but their significance is acknowledged through other State environmental approval processes (i.e. environmental impact assessment pursuant to Part IV of the *Environmental Protection Act 1986* (EP Act)). Under the State process the Department of Parks and Wildlife (DPaW) has been identifying potential TECs since 1994 using a range of definitions to indicate the level of threat to the TEC in question and providing recommendations to the WATECSAC. In addition to being listed at a state level some TECs are afforded federal protection under Section 181 of the EPBC Act.

A community may be listed as a Priority Ecological Community (PEC) which is an ecological community that is under consideration for listing as a TEC but does not yet meet survey criteria or has not been adequately defined.

Given the extent of historic disturbance within the site it is highly unlikely that any areas of TEC or PEC should occur within the site.

2.4.2 Bush Forever and conservation reserves

The Government of Western Australia's *Bush Forever Policy* is a strategic plan for conserving regionally significant bushland within the Swan Coastal Plain portion of the Perth Metropolitan Region. The objective of Bush Forever is to protect comprehensive representations of all original ecological communities by targeting a minimum of 10 % of each vegetation complex for protection (Government of Western Australia 2000). Bush Forever Sites are representative of regional ecosystems and habitat and have a key role in the conservation of Perth's biodiversity.

There are no Bush Forever Sites within the site. The nearest Bush Forever site is situated approximately 370 m south of the site as shown in **Figure 6**.

2.4.3 Ecological Linkages

Ecological linkages allow the movement of fauna flora and genetic material between areas of fragmented remnant habitat. The movement of fauna and the exchange of genetic material between vegetation remnants improve the viability of those remnants by allowing greater access to breeding partners food sources refuge from disturbances such as fire and maintenance of genetic diversity of plant communities and populations. Ecological linkages are often continuous or near-continuous as the more fractured a linkage is the less ease flora and fauna have in moving within the corridor (Molloy *et al.* 2009).

Ecological linkages have been generally identified by the State Government in Bush Forever Perth's Green Plans and the System 6 study and have been published by the Perth Biodiversity Project. These identified linkages reflect the on-ground linkages throughout the Perth Metropolitan area (Molloy *et al.* 2009). The dataset is employed as a conservation tool aimed to conserve and enhance our regional ecological linkages.

There are no mapped ecological linkages within or in the vicinity of the site. Regional ecological connectivity is maintained by large areas of remnant vegetation retained within Bush Forever sites and other conservation reserves south and west of the site as shown in **Figure 6**.

2.4.4 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are prescribed under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* and have been identified to protect native vegetation values of areas surrounding significant threatened or scheduled flora vegetation communities or ecosystems. Exemptions under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* do not apply within declared ESAs and the presence of an ESA would indicate that the site potentially supports significant environmental values. However exemptions under Schedule 6 of the *Environmental Protection Act 1986* still apply including any clearing in accordance with a subdivision approval under the *Planning and Development Act 2005* a recognised exemption under the Schedule 6 of the *Environmental Protection Act 1986*.

There are no declared ESAs within the site. An ESA occurs south-west of the site likely to be associated with a wetland in this area as shown in **Figure 6**.

2.4.5 Terrestrial fauna

Given the extent of historic disturbance within the site any fauna species present would be generally common and widespread species with non-specific requirements which allow them to persist in highly disturbed habitats.

Based on publically available regional black cockatoo habitat mapping prepared by DPaW previously Department of Environment and Conservation (DEC) the Baldivis area supports potential black cockatoo foraging habitat as well as known roosting and breeding sites (DEC 2011). There are no known roosting or breeding sites located within or in the vicinity of the site and while areas of remnant vegetation west of the site are mapped as potential foraging habitat (DEC 2011) as shown in **Figure 7** there is none within the site. Large areas of black cockatoo habitat are known to already be

reserved within conservation areas (i.e. Bush Forever) such as the Rockingham Lakes Regional Park network south of the site.

2.5 Hydrology

2.5.1 Groundwater

A Local Water Management Strategy (LWMS) (Emerge Associates 2016) has been prepared that describes the hydrological setting and in particular groundwater conditions within the site. As outlined in the LWMS (Emerge Associates 2016) recent groundwater monitoring data from the adjacent (eastern) residential subdivision (Chimes) indicate that a maximum groundwater level of 1.38 m AHD was recorded in a bore located approximately 30 m from the south eastern corner of the site in July 2012 (Cardno 2013).

It is inferred that depth to MGL ranges between 2.38 m below ground level (BGL) in the north western corner of the site (i.e. beneath a corner of the future rural area) and 5.38 m BGL in the proposed residential (south eastern) portion of the site (as outlined in the LWMS (Emerge Associates 2016).

Information on groundwater from the Department of Water (Online Water Register (DoW) 2016) indicates that groundwater beneath the site is a multi-layered system comprised of the following:

- Perth (Superficial Swan)
- Perth (Leederville)
- Perth (Yarragadee North).

The site is located in the Stakehill groundwater area (within the Tamworth Swamp sub-area. The DoW (Online Water Register) indicates that there is allocation available (within the Perth-Superficial Swan aquifer (DoW 2016). There is currently no existing groundwater licences for abstraction within the site.

2.5.2 Surface water

No surface water features have been observed within the site and no external surface water catchments direct surface water flows into the site. Any rainfall would infiltrate freely across the site due to the high permeability of the underlying sands.

2.5.3 Wetlands

Based on Department of Parks and Wildlife's (DPaW) Geomorphic Wetland series mapping (DPaW 2014) there are no wetlands within the site. A Conservation Category Wetland (FI 6400) occurs approximately 75m south-west of the site as shown in **Figure 8**.

2.5.4 Public Drinking Water Sources

Public Drinking Water Source Areas (PDWSAs) are surface water catchments or groundwater recharge areas that have been identified as drinking water sources proclaimed as water reserves (in the DoW) (DoW 2009) and protected (by government legislation. PDWSAs provide the majority of Western Australia's drinking water supplies and can be vulnerable to contamination from a range of land uses and water based activities (DoW 2009a) therefore consideration needs to be given to the intended land use and associated activities to ensure that they are appropriate in meeting the water protection qualityobjectives of the area.

The site is not located within an proclaimed PDWSA.

2.6 Heritage

2.6.1 Indigenous heritage

Based on a review of the Department of Aboriginal Affairs Aboriginal Heritage Inquiry System online database (DAA 2016) there are no registered Indigenous heritage sites within or immediately adjacent to the site.

2.6.2 Non-Indigenous heritage

A desktop search of the City of Rockingham's local municipal heritage list (City of Rockingham 2015) the State Heritage Office database (Heritage Council 2012) and the Australian Heritage Database (Department of Environment 2013) indicated there are no registered European heritage sites within or in close proximity to the site.

2.7 Land use considerations

2.7.1 Historical land uses and potential contamination

A search of the Department of Environment Regulation's (DER) Contaminated Sites Database and Register found there to be no registered contaminated sites within or immediately adjacent to the site (DER 2016).

Based on a review of historic aerial photographs the site was cleared of native vegetation prior to 1953 (earliest available aerial image) for agricultural purposes and to allow for subsequent market garden land uses. Market garden land uses are generally considered to have a low risk of contamination but are listed in *Potentially Contaminating Activities, Industries and Landuses* guideline (DER 2004).

As part of the geotechnical investigation undertaken for the site (Galt Geotechnics 2015) limited contamination investigations were also undertaken involving a desktop assessment and review of historic aerial photographs excavation of test pits and bore holes and the laboratory testing of soil samples for heavy metals and organochlorine and organophosphate pesticides (Galt Geotechnics 2015). These investigations indicated that there was no evidence of soil contamination within the site as a result of historic market garden land uses and therefore it is unlikely that soils within the site have been impacted to an extent that would restrict development for urban purposes (Galt Geotechnics 2015).

2.7.2 Surrounding land uses

2.7.2.1 Parmelia high pressure gas pipeline

The Parmelia high pressure natural gas pipeline easement occurs approximately 100m south-west of the site. The WAPC's Planning Bulletin No. 87 *High Pressure Gas Transmission Pipelines in the Perth Metropolitan Region* (Planning Bulletin No. 87) specifies a minimum 65 m setback between the Parmelia gas pipeline and residential lots therefore there will be no impact on development within the site from the gas pipeline.

2.7.2.2 Poultry farm

An existing poultry farm is situated approximately 850 m south-east of the site. Based on EPA Guidance Statement No. 3 *Separation Distances between Industrial and Sensitive Land Uses* (EPA)

2005 there is a recommended generic separation distance of 300-1000m depending on the size of the operation et een poultr farming facilities and sensitive land uses.

A detailed and site specific odour impact assessment The Odour nit A Pt Ltd 2010 as undertaken for the poultr farm as part of local structure planning for the landholdings ithin the East Baldivis DSP area east of Baldivis Road. The purpose of this assessment as to understand the e tent to hich this land use could impact on proposed ur an development and to derive recommended uffer re uirements The Odour nit A Pt Ltd 2010 . The assessment indicated an off-site odour impact of up to 100m in an direction from the poultr sheds ased on the specific operations of the poultr farm and the e isting site conditions. This recommended separation distance ill not result in an consideration for the site or Structure Plan area.

2.7.2.3 *Market gardens*

Based on a revie of pu licall availa le historic aerial photograph landholdings to the north of the site have een su ect to e tensive historic market garden activities. This area is zoned r an under the MRS and is intended for future ur an development under the Cit of Rockingham s Baldivis North DSP. It is understood that the lando ner is curentl progressing planning for the ur an development of this area therefore this historic land use is not a ke consideration or constraint to ur an development ithin the site.

2.8 Natural hazards

2.8.1 Bushfire hazards

Portions of the site have een identified as Bushfire Prone Areas under the state- ide *Map of Bushfire Prone Areas* recentl released the Office of Bushfire Risk Management OBRM as sho n in **Figure 9**. The identification of Bushfire Prone Areas ithin an portion of the site re uires a further assessment of the ushfire hazard implications on development proposed ithin the site to e undertaken in accordance ith the *Guidelines for Planning in Bushfire Prone Areas* APC *et al.* 2015 . This has een addressed through the preparation of a *Bushfire Management Plan* Emerge Associates and Bushfire Safet Consulting 2016 in accordance ith the APC s *Guidelines for Planning in Bushfire Prone Areas* and the Australian Standard *AS3959-2009 Construction of buildings in bushfire prone areas* AS 3959 Standards Australia 2009 . The Bushfire Management Plan BMP aims to address ushfire management issues ithin the Structure Plan and through this minimise the impact of ushfires ithin and surrounding the site there reducing the threat to life propert and the environment.

All areas ithin the site and surrounding 100 m have een assessed for the presence of ushfire prone vegetation and here it occurs its classification as per Ta le 2.4.3 of AS 3959 Standards Australia 2009 to determine the associated ushfire hazard rating levels.

The permanent ushfire hazard features hich are relevant for the site include vegetation ithin rural landholdings east of the site. All areas ithin 100m of these determined permanent hazards are considered Bushfire Prone Areas of the site and ill re uire further assessment as part of future su division. The ushfire hazard assessment is outlined in detail ithin the BMP Emerge Associates and Bushfire Safet Consulting 2015 .

3 Structure Plan and Planning Approval Framework

3.1 Historical planning and environmental assessment context

The site formed part of the City of Rockingham's Town Planning Scheme No. 1 Amendment No. 300 which was initiated to rezone the site and surrounding area from 'Rural' to 'Development' in line with the MRS. The amendment was formally assessed by the EPA in 2001 and it was determined that the proposal could be implemented subject to conditions. The approval and associated conditions are outlined in Ministerial Statement No. 580 dated 19th December 2001 which has been attached as **Appendix B**.

The conditions outlined in Ministerial Statement No. 580 relate to the development of the following management plans as part of the land use planning process:

- Drainage and Nutrient Management Plan – addressed through the preparation of an LWMS (Emerge Associates 2016) in accordance with the Department of Water's 'Do's & Better Urban Water Management Guidelines' (Do's 2008).
- Soil and Groundwater Investigation and Remediation Plan – addressed through the preliminary assessment undertaken as part of the *Geotechnical and Preliminary Environmental Study* (Galt Geotechnics 2015).
- Pipeline Protection Plan – not relevant for the site as the site falls outside of the setback distances required under DAPC's Planning Bulletin No. 87 and the Ministerial Statement No.580.
- Spray Drift Investigation and Management Plan – not relevant for the site as no active market garden operations occur in the vicinity of the site.
- Vegetation Management Plan – not relevant for the site as the site is not located in the vicinity of regionally significant vegetation (i.e. Bush Forever Site 356).

3.2 Portion of Lot 16 McDonald Road Structure Plan

The Structure Plan has been prepared for a portion of the site to provide a framework for the implementation of the proposed residential land use. The Structure Plan incorporates the inputs from a multi-disciplinary project team and the outcomes from various technical studies. The Structure Plan is attached in **Appendix A** provides a framework for the future development of:

- 29 low density residential lots
- Road reserves to service the 29 residential lots.

The remainder of the site will retain its rural zoning and will be used for long term rural/rural residential land uses in accordance with its land use zoning.

Emerge has undertaken various environmental investigations and obtained information from previous site investigations in order to determine the environmental attributes and values within the site as outlined in **Section 2**. This information has been used to ensure that any identified environmental attributes and values were appropriately accommodated in the Structure Plan.

3.3 Future planning approval process

Follo□ ing the lodgement and approval of the Structure Plan□ residential development □ ill □ e progressed in accordance □ ith the Structure Plan□ as provided in **Appendix A**. It is usual for the residential su□division and development process to involve the imposition of su□division approval conditions□ in accordance □ ith the □ APC□s *Model Subdivision Conditions Schedule* □ APC 2012□□ and these generall□ cover the follo□ing relevant areas□

- Amenit□
- Buildings and use
- Drainage and site □ orks
- Electricit□ and gas pipelines
- Environmental conditions
- Fire and emergenc□
- Lot design
- Reserves
- Transport roads and access
- □ ater and se□ers.

This condition frame□ ork provides a future environmental management frame□ ork for the Structure Plan area throughout su□division and development□ and is discussed further in **Section 4**.

3.4 Relevant environmental factors and considerations

Table 3 lists the full suite of environmental factors that have □ een investigated for the site□ and summarises those that re□ uire further specific attention in **Section 4**.

Table 3: Relevant environmental factors and considerations for the Structure Plan

ENVIRONMENTAL FACTOR	RELEVANT CONSIDERATIONS
Climate	No issues posed and therefore no further consideration is re□uired□
Topograph□	No issues posed and therefore no further consideration is re□uired.
Geolog□	No issues posed and therefore no further consideration is re□uired
Landforms and soils	No issues posed and therefore no further consideration is re□uired.
Acid Sulfate Soils	There is current□ □no kno□n risk□of ASS occurring □ithin three metres of the natural soil surface. No further consideration is re□uired.
Flora and vegetation	The site has historicall□ □een complete□ cleared of remnant vegetation□and is high□ unlikel□ to support an□ remnant flora and vegetation values. No further consideration is re□uired.
Bush Forever and conservation reserves	No Bush Forever sites occur □ithin or in close pro□imit□ to the site□and therefore no further consideration is re□uired.
Ecological linkages	No ecological linkages occur □ithin or in close pro□imit□ to the site□and therefore no further consideration is re□uired.
Environmentall□ Sensitive Areas (ESAs□	The site does not fall □ithin a declared ESA□and therefore no further consideration is re□uired.
Terrestrial fauna	The site has historicall□ □een complete□ cleared of remnant vegetation□and is

ENVIRONMENTAL FACTOR	RELEVANT CONSIDERATIONS
	highly unlikely to support any significant fauna habitat values. No further consideration is required.
Groundwater	Pre-development groundwater levels and quality will need to be maintained throughout and post residential development. This is addressed further in **Section 4**.
Surface water	There are no surface water features within the site therefore no further consideration is required. Post development stormwater flows will be managed as part of future residential development and is addressed in the LWMS (Emerge Associates 2016). This is addressed further in **Section 4**.
Wetlands	The site does not contain any areas of wetland and development will not impact on wetlands surrounding the site. No further consideration is required.
Public Drinking Water Source Areas (PDWSAs)	The site is not located within a declared PDWSA and therefore no further consideration is required
Indigenous heritage	There are no known Indigenous heritage values within or in close proximity to the site and therefore no further consideration is required
Non-Indigenous heritage	There are no known non-Indigenous heritage values within or in close proximity to the site and therefore no further consideration is required.
Historic land uses	Preliminary contamination investigations at the site indicated that there was no evidence of soil contamination within the site as a result of historic market garden land uses and therefore it is unlikely that soils within the site have been impacted to an extent that would restrict development for urban purposes (Galt Geotechnics 2015). No further consideration is required.
Surrounding land uses	A poultry farm and a high pressure gas pipeline are located in the vicinity of the site, however the site is located outside of the recommended separation distances for these land uses therefore no further consideration is required.
Bushfire hazard	Classified vegetation surrounding the site poses Moderate to Extreme bushfire hazard considerations for future residential development. This is addressed further in **Section 4**

4 Environmental Assessment and Management Framework

This section discusses in detail the spatial response of the Structure Plan to the environmental attributes and values/constraints within the site and also outlines any future environmental management considerations that will be required as part of future residential subdivision and development within the Structure Plan area. This section addresses only those environmental aspects that require specific consideration based on their relevance to the site and Structure Plan in accordance with applicable legislation and policy requirements and were identified in **Section 3**.

4.1 Hydrology – groundwater

4.1.1 Policy framework and management objective

The EPA's *Environmental Assessment Guideline No. 8 Environmental factors and objectives* (EPA 2015) outlines the following key objectives for the management of groundwater:

- To maintain the hydrological regimes of groundwater so that existing and potential uses including ecosystem maintenance are protected.
- To maintain the quality of groundwater, sediment and biota so that the environmental values both ecological and social are protected.

State Planning Policy 2.9 Water Resources (WAPC 2006) outlines the following key policy objectives:

- Protect, conserve and enhance water resources that are identified as having significant economic, social, cultural and/or environmental values.
- Assist in ensuring the availability of suitable water resources to maintain essential requirements for human and all other biological life with attention to maintaining or improving the quality and quantity of water resources.
- Promote and assist in the management and sustainable use of water resources.

The City of Rockingham's *Planning Procedure 1.8 Water Sensitive Urban Design* aims to provide direction for the protection and conservation of all water resources within the City of Rockingham as well as wetland and bushland areas (including the Peel Harvey Estuary). The City of Rockingham requires different types of water management plans at the various levels of development planning in order to address groundwater level and quality management as part of land use planning and development.

4.1.2 Structure Plan considerations for groundwater

The groundwater management strategy for the site is documented within the LWMS (Emerge Associates 2016) prepared in accordance with the above policies. The groundwater management approach is passive and aims to avoid any intersection with groundwater and therefore any modification or manipulation of existing groundwater levels. Depth to groundwater across the site is significant and no subsoil drains are proposed.

The main objective for the management of the groundwater quality is to maintain or improve the existing groundwater quality. This can be achieved by reducing the total nutrient load into the groundwater that originates from the development compared to historic and existing land uses. Improving groundwater quality can be achieved by the treatment of surface runoff prior to infiltrating to

ground ater and this ill e undertaken through the development of the site as descri ed in the L MS Emerge Associates 2016.

Further information is provided in the L MS Emerge Associates 2016.

4.1.3 Future groundwater management requirements

As part of implementing the future residential land use ithin the site an r an ater Management Plan MP ill e re uired to support su division in order to address APC s standard model su division condition D2 APC 2012 hich states

Prior to the commencement of subdivisional works, an urban water management plan is to be prepared and approved, in consultation with the Department of Water, consistent with any approved Local Water Management Strategy. (Local Government).

The MP ill provide information on the implementation of the L MS through detailed civil and landscape design.

In addition to the a ove a ground ater licence ill e re uired for non-pota le ater supplies to manage dust associated ith residential su division ithin the site and an ground ater a straction for orks ithin the site ill e undertaken in accordance ith the approved licence. There are no areas of pu lic open space proposed ithin the site and therefore no future irrigation re uirements.

4.1.4 Predicted environmental outcomes

The L MS provides the frame ork for the management of ground ater levels and ualit in a contemporar est-practice approach utilising ater sensitive ur an design o ectives and in accordance ith the APC and EPA guidelines and polic frame orks. The preparation of a MP to satisf su division approval ill provide design details that ill ensure the sustaina le use of ground ater resources.

4.2 Hydrology – surface water

4.2.1 Policy framework and management objective

The *State Water Strategy* Government of A 2003 and *Better Urban Water Management* APC 2008 endorse the promotion of integrated ater c cle management and application of ater sensitive ur an design S D principles to provide improvements in the management of storm ater and to increase the efficient use of other e isting ater supplies.

The ke principles of integrated ater c cle management include

- Considering all ater sources including aste ater storm ater and ground ater.
- Integrating ater and land use planning.
- Allocating and using ater sustaina l and e uita l.
- Integrating ater use ith natural ater processes.
- Adopting a hole of catchment integration of natural resource use and management.

The EPA s *Environmental Assessment Guideline No. 8 Environmental factors and objectives* EPA 2015 outlines the follo ing ke o ectives for the management of surface ater

- To maintain the hydrological regimes of surface water so that existing and potential uses including ecosystem maintenance are protected.
- To maintain the quality of surface water sediment and biota so that the environmental values both ecological and social are protected

State Planning Policy 2.9 Water Resources (WAPC 2006) outlines the following key policy objectives:

- Protect conserve and enhance water resources that are identified as having significant economic social cultural and/or environmental values.
- Assist in ensuring the availability of suitable water resources to maintain essential requirements for human and all other biological life with attention to maintaining or improving the quality and quantity of water resources.
- Promote and assist in the management and sustainable use of water resources

The City of Rockingham's *Planning Procedure 1.8 Water Sensitive Urban Design* aims to provide direction for the protection and conservation of all water resources within the City of Rockingham as well as wetland and bushland areas including the Peel Harvey Estuary. The City of Rockingham requires different types of water management plans at the various levels of development planning in order to address groundwater level and quality management as part of land use planning and development.

4.2.2 Structure Plan considerations for surface water

The surface water/stormwater management strategy for the site is documented within the LWMS (Emerge Associates 2016). The main focus for surface water management is to maintain the existing hydrology by retaining surface flows and to infiltrate stormwater runoff within the site as close to source as possible.

There will be no runoff from the development up to the 100 year average recurrence interval (ARI) event consistent with the pre-development environment. Further non-structural measures will also be adopted and will be detailed in the future Urban Water Management Plan (UWMP). Runoff from lots up to the 1 year 1 hour ARI event will either infiltrate directly at-source or in large rainfall events (i.e. approximately a 5 year ARI event) may discharge to the road network. Runoff from impervious areas will be directed to soakwells where it will infiltrate into the sand fill and ultimately to groundwater. Infiltration of runoff through the underlying soils will provide treatment through adsorption of nutrients to sand particles prior to reaching groundwater (Emerge Associates 2016).

Further information is provided in the LWMS (Emerge Associates 2016).

4.2.3 Future management requirements for surface water

As part of implementing the future residential land use within the site an UWMP will be required for subdivision stage in order to address WAPC's standard model subdivision condition D2 (WAPC 2012) which states:

Prior to the commencement of subdivisional works, an urban water management plan is to be prepared and approved, in consultation with the Department of Water, consistent with any approved Local Water Management Strategy. (Local Government).

The UWMP will provide information on the implementation of the LWMS through detailed civil and landscape design.

4.2.4 Predicted environmental outcomes

The LWMS provides the framework for the Structure Plan to manage surface water including stormwater flows in a contemporary best-practice approach utilising WSUD objectives and in accordance with the DoP and EPA guidelines and policy frameworks. The preparation of a UWMP to satisfy subdivision approval will provide design details that will ensure the sustainable use of surface water resources.

4.3 Natural hazards – bushfire management

4.3.1 Policy framework and management objective

The *Guidelines for Planning in Bushfire Prone Areas* (WAPC *et al.* 2015) have been prepared by the WAPC and DFES and provide the foundation for bushfire risk management planning on private land in Western Australia. These guidelines have superseded the previous *Planning for Bush Fire Protection Guidelines – Edition 2* (WAPC et al. 2010). The guidelines address important bushfire risk management and planning issues and set out performance criteria and acceptable solutions to minimise the risk of bushfires in new subdivisions and developments. The guidelines also address management issues including location, design, the development site, setback requirements, Bushfire Attack Level (BAL) ratings, vehicular access and water requirements.

The DoP and WAPC have recently released *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (December 2015) (SPP 3.7). For planning provisions specifically relating to bushfire, SPP 3.7 is intended to supersede SPP 3.4 *Natural Hazards and Disasters* and aims to inform and guide decision makers, referral authorities and proponents to achieve acceptable bushfire protection outcomes, including expectations at the different stages of the planning process. SPP 3.7 makes provision for further detailed bushfire hazard assessment to be undertaken for areas identified as bushfire prone areas within the state *Map of Bushfire Prone Areas* in order to provide a complete and site specific bushfire risk assessment for proposed development of vulnerable land uses.

Vegetation within and surrounding the site has been classified according to AS 3959. Vegetation that is to be permanently retained surrounding the site will pose permanent bushfire hazard considerations. In the same way, vegetation that is to be cleared for future urban purposes in the short to medium term will pose only temporary bushfire management considerations.

4.3.2 Structure Plan considerations for bushfire management

A Bushfire Management Plan (BMP) has been prepared which aims to address bushfire management issues within the Structure Plan and through this minimise the impact of bushfires within and surrounding the site, thereby reducing the threat to life, property and the environment. As outlined in the BMP (Emerge Associates and Bushfire Safety Consulting 2016), the permanent bushfire hazard considerations for the site are associated with woodland, forest and grassland vegetation within rural landholdings west of the site which pose an 'Extreme' bushfire hazard to development within the site.

The Structure Plan has accommodated the surrounding areas of bushfire hazard through the placement of road reserves in the west of the site to provide an appropriate setback or Asset Protection Zone between future dwellings and the adjacent bushfire hazard. In addition to APZ requirements, surrounding vegetation is likely to present increased Bushfire Attack Levels (BALs), which influences building standards for dwellings at the construction stage. An indicative BAL assessment has been undertaken as part of the BMP (Emerge Associates and Bushfire Safety 2016).

4.3.3 Future bushfire management considerations

As outlined above and in the BMP prepared to support the Structure Plan (Emerge Associates and Bushfire Safety Consulting 2016) development within 100 m of an Extreme or Moderate hazard which is not classified as Low Threat will require site-specific AS 3959 BAL assessment prior to dwelling construction. The BMP proposes the BAL assessment be undertaken as part of the subdivision process for the site. By deferring BAL assessment until development the location, structure and slope of any vegetation can be more accurately evaluated and surrounding hazards may have been removed with the development of neighbouring lots, which may reduce the hazard and subsequent AS 3959 construction requirements.

In addition to the above the WAPC model subdivision conditions relating to bushfire hazard management (model subdivision conditions F2 and F3) WAPC 2012 include the following requirements:

- *A fire management plan being prepared, approved and relevant provisions implemented during subdivisional works, in accordance with the WAPC's* Guideline Planning for Bushfire Protection Edition 2, May 2010 *(in particular Appendix 3) to the specifications of the local government and/or the Fire and Emergency Services Authority. (Fire and Emergency Services Authority) OR (Local Government).*
- *A notification, pursuant to Section 70A of the* Transfer of Land Act 1893 *is to be placed on the certificate(s) of title of the proposed lot(s). Notice of this notification is to be included on the diagram or plan of survey (deposited plan). The notification is to state as follows: "The lot(s) is/are subject to a fire management plan." (Local Government).*

4.3.4 Predicted environmental outcomes

By utilising the BMP at this early stage of planning process the Structure Plan has been able to incorporate bushfire hazard management considerations into the design of the development ensuring that if there is a bushfire within or near the site the threat to residents property and emergency response personnel will be reduced.

5 Summary and Recommendations

5.1 Summary

TPG on behalf of Defence Housing Australia has prepared a Structure Plan for the proposed residential development of a portion of the site within the City of Rockingham. Emerge Associates have been engaged to provide a suite of environmental consultancy services to support the preparation of the Structure Plan which has included various investigations to identify and assess the environmental attributes and any constraints within the site.

The Structure Plan attached in **Appendix A** has been prepared by TPG to provide a framework for the implementation of the urban/residential land use. The Structure Plan incorporates the inputs from a multi-disciplinary project team and the outcomes from various technical studies.

The environmental attributes and values identified within the site have been outlined in **Section 2** and include:

- The site has been historically cleared for agricultural purposes primarily market gardening. The site now supports grassland with scattered mature trees in the vicinity of the existing residence in the west of the site.
- Based on site inspections undertaken by Emerge botanists remnant vegetation within the site is generally in Completely Degraded or Degraded condition based upon the Bush Forever Condition Scale Government of Western Australia 2000.
- Given the extent of historic disturbance and subsequent condition of vegetation within the site it is highly unlikely that any Threatened Flora or Priority Flora species Threatened Ecological Communities or Priority Ecological Communities occur within the site.
- There are no Bush Forever sites or Environmentally Sensitive Areas occurring within the site.
- Based on the degraded nature of vegetation the site supports limited fauna habitat values and is unlikely to be utilised by fauna other than common species adapted to disturbed environments or mobile or opportunistic fauna species.
- Landholdings immediately north of the site were historically used for market garden purposes however based a review of available historic aerial photographs this land use ceased around 2014. These areas are currently undergoing separate structure planning processes to support urban development.
- Some areas of native vegetation west of the site present a permanent bushfire hazard to future residential development.

The Structure Plan has responded to the relevant environmental values and attributes of the site and this report outlines an environmental management framework that will be implemented either as part of the future residential planning and development process.

The WAPC's *Model Subdivision Conditions Schedule* WAPC 2012 provide a planning framework for the management of environmental factors throughout the implementation of the Structure Plan at future subdivision and development stages including:

- Preparation of an Urban Water Management Plan in accordance with model subdivision condition D2 of WAPC 2012.
- Preparation of further detailed bushfire hazard and risk assessment and management plan/s as part of future subdivision or detailed design.

Overall the environmental attributes and values/constraints of the site have been accommodated within the Structure Plan layout or can be managed through the future subdivision and development stages in accordance with relevant federal state and local government legislation policies and guidelines and best management practices. As such the proposed future development of a portion of the site is not expected to significantly impact on the environment.

5.2 Recommendations

Based on the information contained within this report the following key recommendations should be considered for the implementation of the Structure Plan

- There are no fundamental environmental constraints for the proposed urban development of the site and the proposed development should be considered environmentally acceptable.
- The site has been historically cleared of remnant vegetation and utilised for agricultural land uses. It is therefore highly unlikely that the site supports any significant flora and vegetation values.
- The site does not experience high groundwater levels or seasonal inundation. The proposed development aims to maintain clearance between groundwater and the proposed drainage infrastructure as outlined in the LWMS (Emerge Associates 2016).
- Surface and stormwater runoff infiltrates freely across the site due to the high permeability of underlying sands. The stormwater management strategy for the development aims to mimic the existing hydrology by infiltrating onsite as close to source as practical le. For high rainfall events the Structure Plan has accommodated appropriate treatment and drainage infrastructure within the proposed road network as detailed in the LWMS (Emerge Associates 2016).
- Permanent bushfire hazards occur west of the site within adjacent rural landholdings which require the accommodation of an appropriate APZ and increased construction standards. The Structure Plan has addressed this through the placement of the internal road network to provide an appropriate setback from the adjacent bushfire hazard and by undertaking an indicative BAL assessment to ensure there are no portions of the proposed development exposed to an unacceptable level of bushfire risk.

6 References

6.1 General References

Beard, J. S. 1990, *Plant Life of Western Australia*, Kangaroo Press Pty. Ltd., Kenthurst, N.S.W.

Cardno 2013, *The Chimes Fifty Road, Baldivis Urban Water Management Plan.*

Churchward, H. M. and McArthur, W. M. 1980, *'Landforms and Soils of the Darling System, Western Australia'* in Department of Conservation and Environment (ed.), *Atlas of Natural Resources Darling System Western Australia*, Department of Conservation and Environment, Perth.

Department of Conservation and Environment (DEC) 1980, *Atlas of Natural Resources, Darling System, Western Australia. Perth, Pinjarra and Collie Sheets*, Department of Conservation and Environment, Western Australia.

Department of Environment Regulation (DER) 2004, *Potentially Contaminating Activities, Industries and Land uses*, Department of Environment Regulation, Western Australia.

Department of Environment Regulation (DER) 2006, *Acid Sulfate Soil Risk Map, Swan Coastal Plain*, Department of Environment Regulation, Perth.

Department of Water (DoW) 2009a, *Water Quality Protection Note 36. Protecting public drinking water source areas*, Department of Water, Perth.

Department of Water (DoW) 2009, *Water Quality Protection Note No. 75. Proclaimed public drinking water source areas*, Government of Western Australia, Perth.

Environmental Protection Authority (EPA) 2006, *Guidance Statement No. 10. Level of Assessment for Proposals Affecting Natural Areas Within the System 6 Region and Swan Coastal Plain Portion of the System 1 Region*, Environmental Protection Authority, Perth.

Environmental Protection Authority (EPA) 2015, *Environmental Assessment Guideline No. 8. Environmental principles, factors and objectives*, Environmental Protection Authority, Perth.

Government of WA 2003, *A State Water Strategy for Western Australia*, Government of Western Australia, Perth.

Gozzard, J. R. 1983, *Rockingham, Sheets 2033 III and 2033 II*, Geological Survey of Western Australia, Perth.

Heddle, E. M., Loneragan, O. W., and Havel, J. J. 1980, *'Vegetation Complexes of the Darling System Western Australia'* in Department of Conservation and Environment (ed.), *Atlas of Natural Resources Darling System Western Australia*, Department of Conservation and Environment, Perth.

Molloy, S., Wood, J., Hall, S., Wallrodt, S. and Thisson, G. 2009, *South West Regional Ecological Linkages Technical Report*, Western Australian Local Government Association and Department of Environment and Conservation, Perth.

Perth Biodiversity Project (PBP) 2013, *2013 Native Vegetation extent by Vegetation complexes on the Swan Coastal Plain south of Moore River*, Western Australian Local Government Association, Perth.

Seddon, G. 2004, *A Sense of Place: a response to an environment, the Swan Coastal Plain Western Australia*, Blooming Books, Melbourne.

Standards Australia 2009, *AS 3959-2009 Construction of buildings in bushfire-prone areas*, Sydney.

Thack a R. and Cress ell I.D. Eds 1995 *An Interim Biogeographical Regionalisation for Australia: a framework for establishing the national system of reserves, Version 4.0* Australian Nature Conservation Agenc Can erra.

The Odour nit A Pt Ltd 2010 *Odour Impact Assessment & Dispersion Modelling Study: Layertech Services Baldivis WA* Perth estern Australia.

estern Australian Planning Commission APC 2006 *State Planning Policy 2.9: Water Resources* Gazetted in Decem er 2006. estern Australian Planning Commission Perth.

estern Australian Planning Commission APC 2008 *Better Urban Water Management* estern Australian Planning Commission Perth.

estern Australian Planning Commission APC 2012 *Model Subdivision Conditions Schedule* Department of Planning Perth.

6.2 Online References

Bureau of Meteorolog 2015 Climate Averages vie ed April 2015 http // om.gov.au/climate/data/

CSIRO 2009 Ground ater ields in south- est estern Australia Factsheet 2 Availa le orld ide e RL http // .cl .csiro.au/pu lications/ aterforahealth countr /s s /pdf/S SY-Factsheet-Ground ater.pdf

Department of A original Affairs DAA 2014 A original Heritage En uir S stem vie ed April 2015 http // .dia. a.gov.au/AHIS/default.asp

Department of Environment DoE 2013 Australian Heritage Data ase vie ed April 2015 http // .environment.gov.au/heritage/ahd /inde .html

Heritage Council of A 2012 Places Data ase vie ed April 2015 http://register.heritage. a.gov.au/

FIGURES

Figure 1:	**Location Plan**	**Plan Number: EP15-057(01)--F23a**	
Project:	Environmental Assessment and Management Strategy Portion of Lot 16 McDonald Road, Baldivis	Drawn: NM	Date: 11/02/2016
Client:	Defence Housing Australia	Approved: DH	Date: 11/02/2016
		Checked: M	Scale: 1:5,000@A4

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Integrated Science & Design

Figure 2: Site Plan

Pro□ect□ Environmental Assessment and Management Strateg□
Portion of Lot 16 McDonald Road□Baldivis

Client□ Defence Housing Australia

Plan Number: EP15-057(01)--F24a		
Dra□n□	□NM	Date□ 11/02/2016
Approved□	□DH	Date□ 11/02/2016
Checked□	□M□	Scale□1□2□250@A4

0 20 40 80 Metres

emerge ASSOCIATES Integrated Science & Design

□ Note: Emerge Associates makes every □ attempt to ensure the accuracy and completeness of data. Emerge accepts no responsibility for any inaccuracies contained in data used

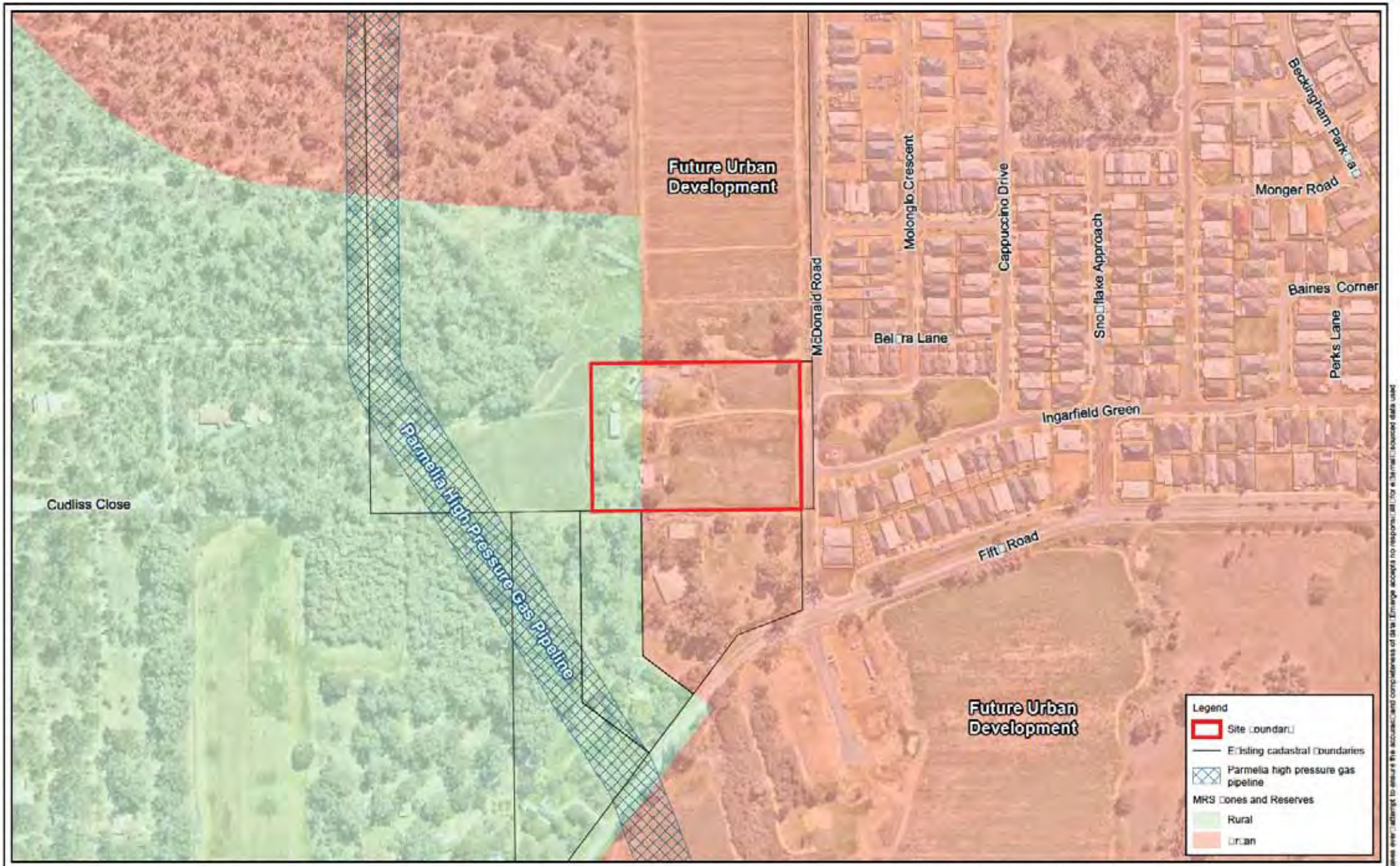

Figure 3: Current Metropolitan Region Scheme Mapping

Project: Environmental Assessment and Management Strategy
Portion of Lot 16 McDonald Road, Baldivis

Client: Defence Housing Australia

Plan Number: EP15-057(01)--F25a		
Drawn	NM	Date: 11/02/2016
Approved	DH	Date: 11/02/2016
Checked	M	Scale: 1:4,000@A4

0 25 50 100 150 Metres

emerge ASSOCIATES Integrated Science & Design

Figure 4:	**Site Topography**
Pro□ect□	Environmental Assessment and Management Strateg□ Portion of Lot 16 McDonald Road□Baldivis
Client□	Defence Housing Australia

Plan Number: EP15-057(01)--F26a		
Dra□n□	□NM	Date□ 11/02/2016
Approved□	□DH	Date□ 11/02/2016
Checked□	□M□	Scale□1□□000@A4

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Figure 5: Acid Sulfate Soil Risk Mapping

Project: Environmental Assessment and Management Strategy
Portion of Lot 16 McDonald Road, Baldivis

Client: Defence Housing Australia

Plan Number: EP15-057(01)--F27a		
Drawn	NM	Date: 11/02/2016
Approved	DH	Date: 11/02/2016
Checked	M	Scale: 1:4,000@A4

0 25 50 100 150 Metres

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Figure 6:	**Bush Forever, ESAs and Ecological Linkages**
Project:	Environmental Assessment and Management Strategy Portion of Lot 16 McDonald Road, Baldivis
Client:	Defence Housing Australia

Plan Number: EP15-057(01)--F28a		
Drawn:	NM	Date: 11/02/2016
Approved:	DH	Date: 11/02/2016
Checked:	M	Scale: 1:7,500@A4

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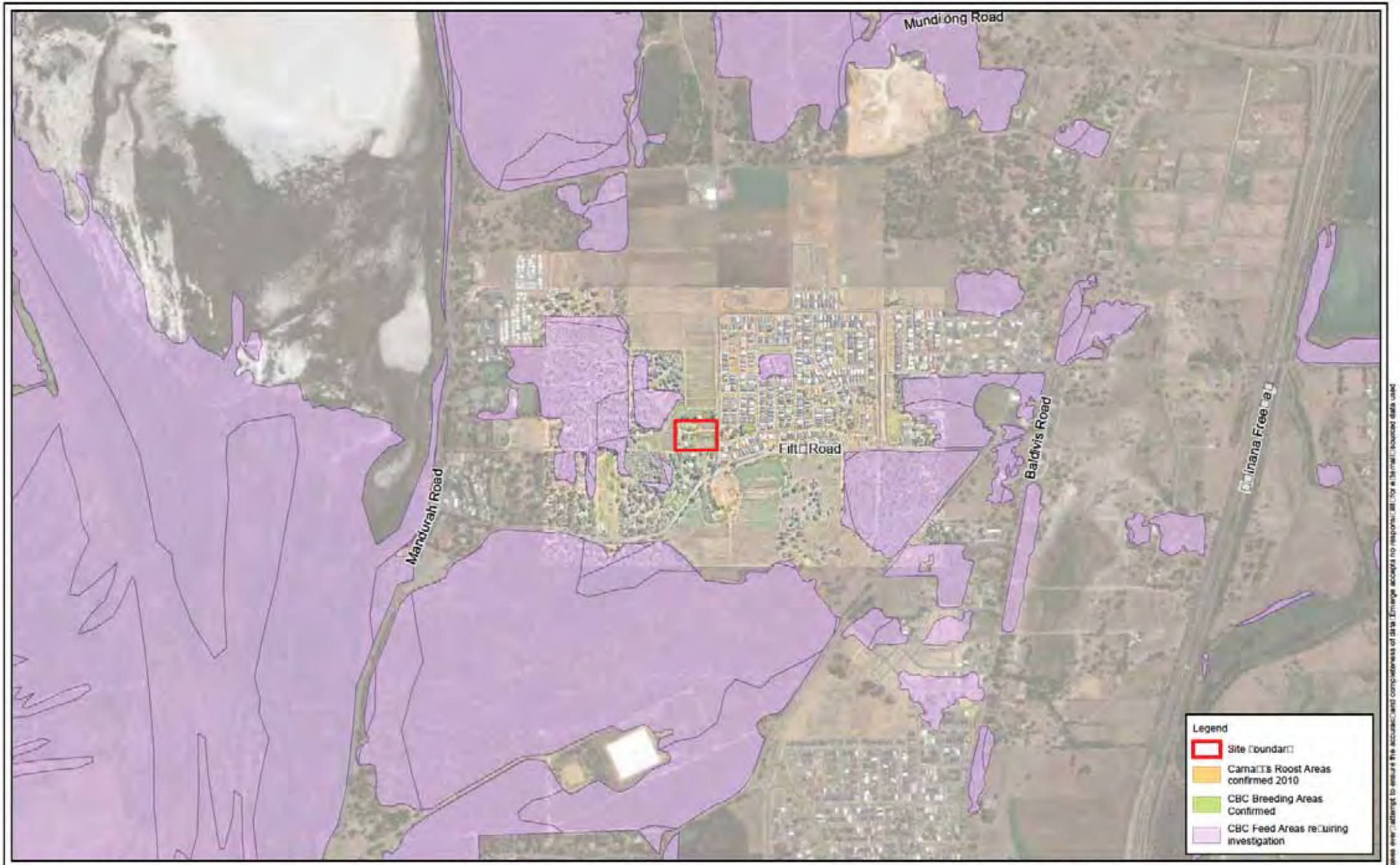

Figure 7: Regional Black Cockatoo Habitat Mapping

Project: Environmental Assessment and Management Strategy
Portion of Lot 16 McDonald Road, Baldivis

Client: Defence Housing Australia

Plan Number: EP15-057(01)--F29a		
Drawn:	NM	Date: 11/02/2016
Approved:	DH	Date: 11/02/2016
Checked:	M	Scale: 1:20,000@A4

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Figure 8: Geomorphic Wetlands

Project: Environmental Assessment and Management Strategy
Portion of Lot 16 McDonald Road, Baldivis

Client: Defence Housing Australia

Plan Number: EP15-057(01)--F30a		
Drawn	NM	Date: 11/02/2016
Approved	DH	Date: 11/02/2016
Checked	M	Scale: 1:4,000@A4

0 25 50 100 150 Metres

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Figure 9:	**Map o□Bush□re Prone Areas**	**Plan Number: EP15-057(01)--F31b**	
Pro□ect□	Environmental Assessment and Management Strateg□ Portion of Lot 16 McDonald Road□Baldivis	Dra□n□ □NM	Date□ 05/09/2016
Client□	Defence Housing Australia	Approved□ □DH	Date□ 05/09/2016
		Checked□ □M□	Scale□1□2□250@A4

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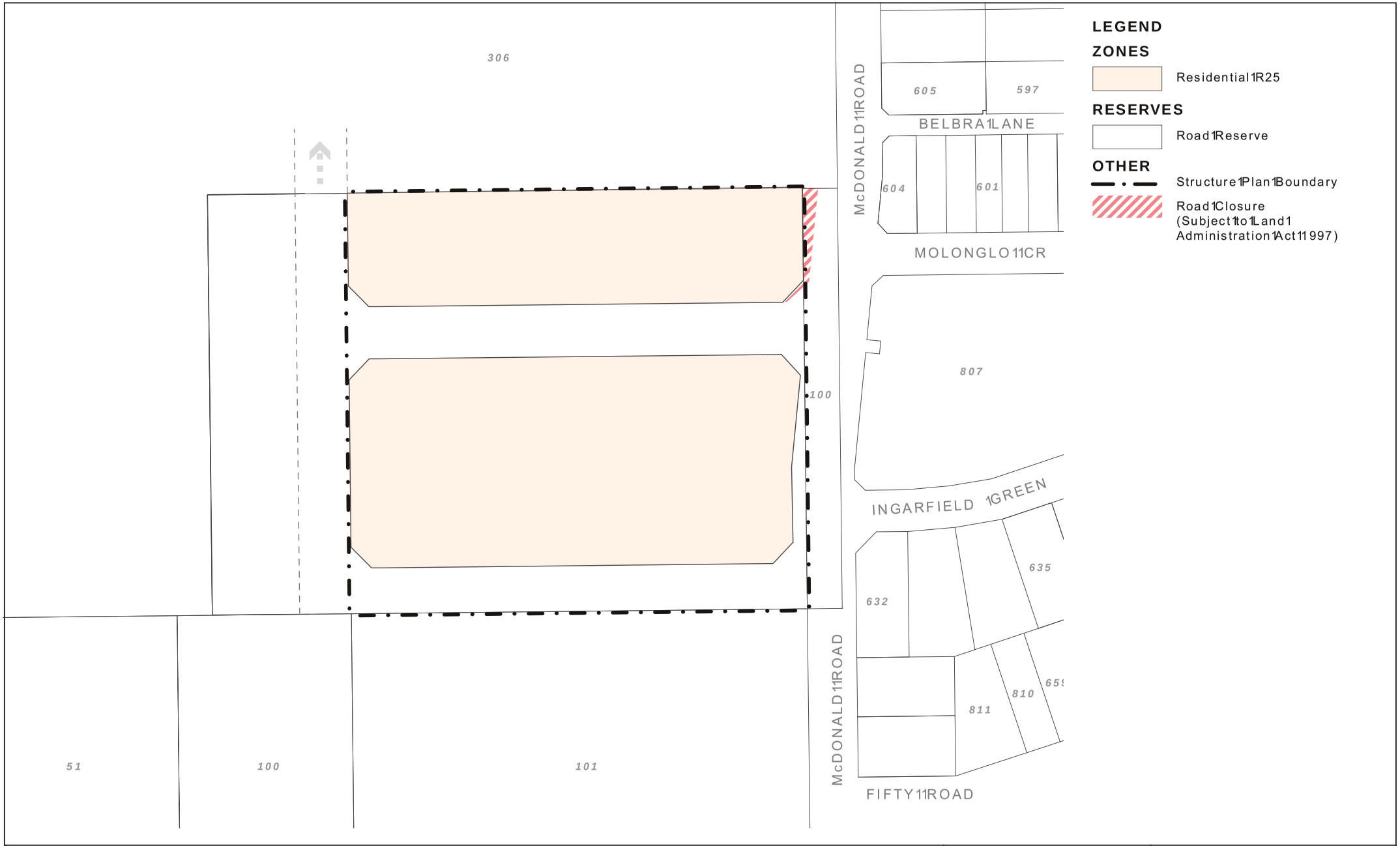
APPENDIX A

PORTION OF LOT 16 MCDONALD ROAD, BALDIVIS STRUCTURE PLAN

TPG (2016)



Plan 1 - Structure Plan

Portion of 116 McDonald Road, Baldivis

Project Manager: GM Date: 10 Feb 2016
Drawn: GW Scale: 1:1,000 @ A3
Checked: MH Drawing No. 716-059 SP-01A

TOWN PLANNING
URBAN DESIGN AND HERITAGE

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Facsimile +61 08 9321 8788
www.tpgwa.com.au

The Planning Group WA Pty Ltd
ABN 68 97 673 922

Subdivision Concept Plan

161 McDonald Road, Baldivis

APPENDIX B

MINISTERIAL STATEMENT NO. 580 (DECEMBER 2001)

MINISTER FOR THE ENVIRONMENT AND HERITAGE

Statement No.

000580

STATEMENT THAT A SCHEME MAY BE IMPLEMENTED (PURSUANT TO THE PROVISIONS OF DIVISION 3 OF PART IV OF THE ENVIRONMENTAL PROTECTION ACT 1986)

CITY OF ROCKINGHAM TOWN PLANNING SCHEME NO. 1 AMENDMENT NO. 300 ("DEVELOPMENT" ZONE, PT LOTS 306 & 16, AND LOTS 313 & 774, FIFTY ROAD, BALDIVIS)

Scheme Purpose: To rezone Pt Lot 306, Pt Lot 16, and Lots 313 and 774 Fifty Road, Baldivis from "Rural" to "Development" zone.

Responsible Authority: City of Rockingham

Responsible Authority Address: PO Box 2142, Rockingham WA 6967

Assessment Number: 1227

Report of the Environmental Protection Authority: Bulletin 1018

Subject to the following conditions, there is no known environmental reason why the town planning scheme amendment to which the above report of the Environmental Protection Authority relates should not be implemented:

CONDITIONS TO BE INCORPORATED INTO THE SCHEME BY INSERTION OF PROVISIONS IN SCHEME TEXT

1 Environmental Management Plans

1-1 The following Environmental Management Plans shall be prepared in accordance with the specifications set out in Attachment 1 in the Minister for the Environment and Heritage's "Statement that a Scheme may be Implemented" No. [insert relevant Statement Number] published on [insert date], and shall be subsequently implemented in accordance with the provisions of the Plans:

Published on

19 DEC 2001

29th FLOOR, ALLENDALE SQUARE, 77 ST. GEORGE'S TERRACE, PERTH 6000 TELEPHONE: (08) 9220 5050 FACSIMILE: (08) 9221 4665/8
E-MAIL: judy-edwards@dpc.wa.gov.au

- Drainage and Nutrient Management Plan;
- Soil and Groundwater Contamination Investigation and Remediation Plan;
- Pipeline Protection Plan;
- Spray Drift Investigation and Management Plan; and
- Vegetation Management Plan.

2 High Pressure Natural Gas Pipeline

2-1 The following activities, land uses and developments are prohibited within the high pressure natural gas pipeline easement:

- Ground-disturbing activities, other than for the purposes for which the easement was created, and for uses and developments that comply with condition 2-2 below;
- Temporary residence (including caravans, camping and similar);
- Storage of materials and equipment;
- Fires and barbecues;
- Explosives, inflammables and corrosives (including storage of liquefied petroleum gas and fuel oil);
- Refuse disposal and landfill;
- Service stations, fuel lines and storage of fuel;
- Vegetation with an expected growth exceeding one metre in height, and plantings within one metre of the centre of the pipeline (with the exception of lawn); and
- Large obstructions to the line of sight along the easement.

Note: For the high pressure natural gas pipeline easement, the relevant Australian Standard is AS 2885.3.

2-2 The following land uses and developments may be permitted within the high pressure natural gas pipeline easement, with the written approval of the local government on advice of the pipeline operator, subject to compliance with the Pipeline Protection Plan referred to in condition 1-1 above:

- Cycleways and footpaths;
- Road crossings and services (with minimum depth of cover over the pipeline of 1.2 metres);
- Public open space;
- Signage and other facilities that are necessary to comply with the Pipeline Protection Plan referred to in condition 1-1 above; and
- Car parking during the time that the adjoining land is being developed (with minimum depth of cover over the pipeline of 1.2 metres).

2-3 Minimum setbacks for land uses and developments from the centre of the high pressure natural gas pipeline shall be:

- 96 metres, in the case of sensitive development as determined by the local government on advice of the Department of Environmental Protection and the pipeline operator, and including aged persons' accommodation, child care centres, schools and hospitals;
- 32 metres to the boundary of each residential lot, in the case of residential development; and
- at the local government's discretion, following consultation with the Department of Environmental Protection and the pipeline operator, in the case of all other land uses and developments which facilitate the gathering of people, within 96 metres of the centre of the pipeline.

3 Development in Proximity to Market Gardens

3-1 If the market gardens adjacent to Pt Lots 306 and 16 are continuing to operate at the time of subdivision, noise attenuation measures shall be designed and implemented so that noise impacts on the amendment area are in accordance with the *Environmental Protection (Noise) Regulations 1997*.

CONDITIONS TO BE INCORPORATED INTO THE SCHEME BY MODIFICATIONS TO THE SCHEME MAP

4 Scheme Map

4-1 The Scheme Map for the City of Rockingham Town Planning Scheme No. 1 shall be amended by inserting the symbol EC and an appropriate modification to the legend of the Scheme Map, to show that environmental conditions apply to part of Pt Lot 306, part of Lot 16, Lots 774 and 313 Fifty Road, Baldivis.

ATTACHMENT 1 - OF STATEMENT THAT A SCHEME MAY BE IMPLEMENTED - CITY OF ROCKINGHAM TOWN PLANNING SCHEME NO. 1 AMENDMENT NO. 300

SPECIFICATIONS FOR ENVIRONMENTAL MANAGEMENT PLANS

1 Drainage and Nutrient Management Plan

1-1 Prior to commencement of site works for subdivision or development, the subdivider or developer shall prepare a Drainage and Nutrient Management Plan to ensure that the rate, quantity and quality of water leaving the Amendment area will not adversely impact on Opwin and Spot Swamps, the Rockingham Groundwater Area groundwater supply, and the Peel-Harvey Estuarine System, to the requirements of the local government and on advice of the Water and Rivers Commission.

1-2 This Plan shall:

- Define the catchment of Opwin and Spot Swamps in relation to the Amendment area;
- Provide measures to facilitate the removal of pollutants and nutrients in accordance with the Water Sensitive Urban Design Best Practices;
- Incorporate Best Practice Water Sensitive Urban Design principles to maximise onsite water infiltration generally;
- Provide measures to prevent surface water runoff from entering the Opwin or Spot Swamps;
- Provide mechanisms to minimise erosion during and after the development phase;
- Provide a monitoring program, including definition of performance criteria and analysis procedures, to measure the performance of the Plan against objectives and performance criteria;
- Provide contingency plans in the event that criteria are not achieved; and
- Identify responsibilities for implementation of the Plan.

2 Soil and Groundwater Contamination Investigation and Remediation Plan

2-1 Prior to the commencement of site works for subdivision or development on any land that has previously been used for horticultural purposes, the subdivider or developer shall prepare and implement a Soil and Groundwater Contamination Investigation and Remediation Plan to the requirements of the local government and on advice of the Department of Environmental Protection.

2-2 This Plan shall

- Include soil and groundwater investigation procedures to define the nature and extent of any soil or groundwater contamination, and identify areas where

contamination levels exceed criteria recognised by the Department of Environmental Protection; and

- In the event that the investigation finds unacceptable soil or groundwater contamination, describe procedures for further investigation of contamination, a detailed methodology for remediation prior to development, the standards to which any contaminated soil or groundwater will be remediated, and a management plan for contaminated areas, where necessary.

3 Pipeline Protection Plan

3-1 Prior to subdivision or development on any land within or abutting the high pressure natural gas pipeline easement, the subdivider or developer shall prepare a Pipeline Protection Plan to ensure protection of the pipeline during construction activities, to the requirements of local government, on advice of the Department of Mineral and Petroleum Resources and the pipeline operator.

3-2 This Plan shall

- Detail measures to ensure public safety and protection of the high pressure natural gas pipeline in accordance with the *Petroleum Pipelines Act 1969-70*, the Australian Pipeline Code AS 2885-1997, SAA HB105 and the Environmental Protection Authority guidance statement for achieving its risk criteria for development in proximity to existing and proposed high pressure gas transmission pipelines, or the most recent equivalents recognised by the Environmental Protection Authority; and

- Identify responsibilities for implementation of the Plan.

4 Spray Drift Investigation and Management Plan

4-1 Prior to the approval of subdivision or development, the subdivider or developer shall prepare and implement a Spray Drift Investigation and Management Plan to the requirements of the local government, on advice of the Department of Health, the Department of Agriculture and the Department of Environmental Protection.

4-2 This Plan shall

- Require undertaking investigations of spray drift from all rural or semi-rural activities occurring within the proximity of the Amendment area, to clearly define impacts on the health and amenity of future residents; and

- In the event that the investigations find that unacceptable health or amenity impacts are likely to affect the residents within the Amendment area, provide

management strategies to ensure that impacts on the health and amenity of future residents are acceptable.

5 Vegetation Management Plan

5-1 Prior to subdivision approval, the subdivider shall prepare a Vegetation Management Plan that protects the regionally significant vegetation abutting the Amendment area, particularly *Bush Forever* Site No. 356, from direct and indirect impacts associated with the development, through the provision of a hard edge along the amendment boundary and the implementation of appropriate construction and access management measures.

5-2 The Vegetation Management Plan shall be prepared to the satisfaction of the local government and on advice of the Department of Conservation and Land Management and the Department of Environmental Protection.

Dr Judy Edwards MLA
MINISTER FOR THE ENVIRONMENT AND HERITAGE

19 DEC 2001

Appendix 5

Bushfire Management Plan

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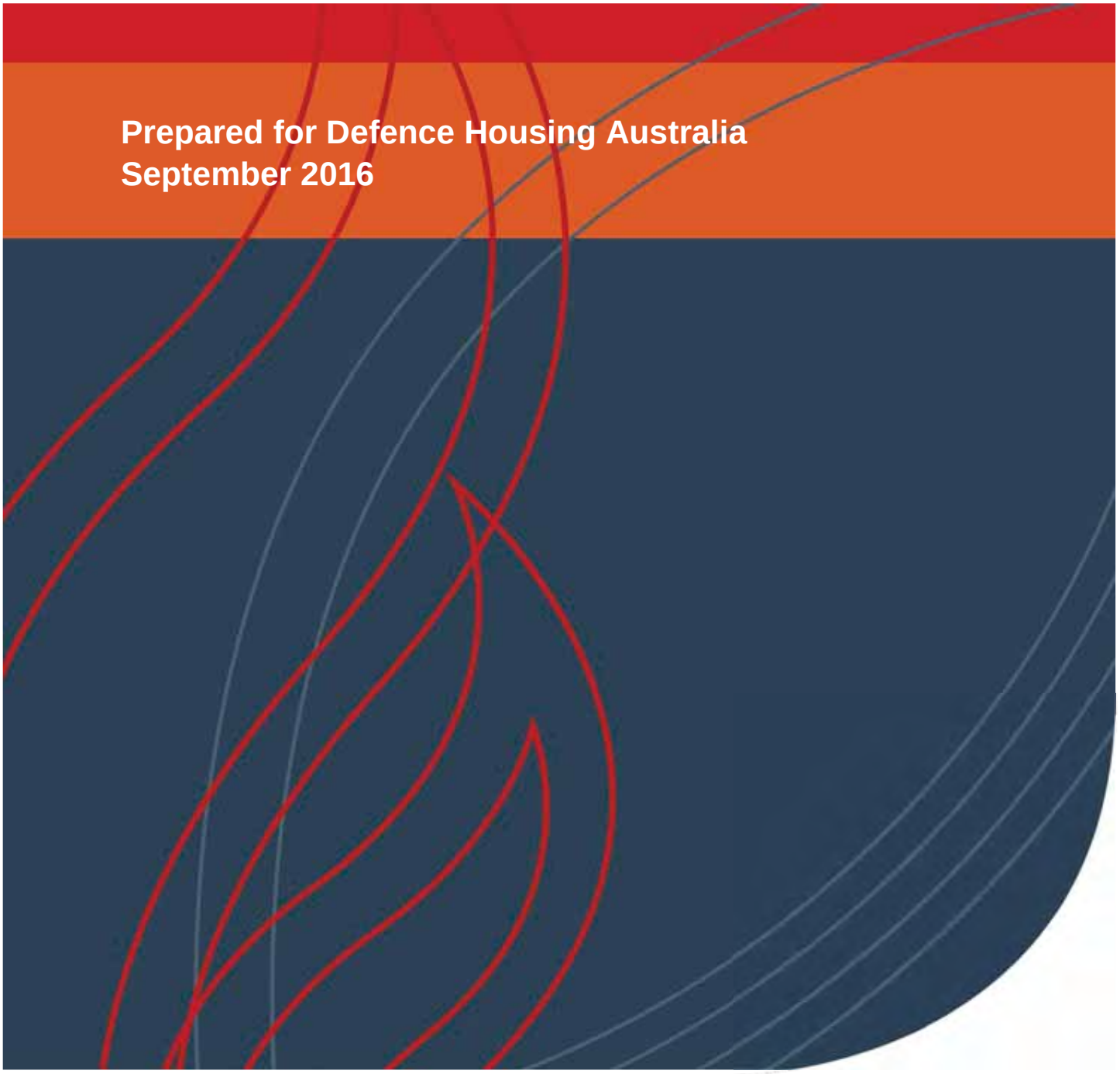
BUSHFIRE MANAGEMENT PLAN

PORTION OF LOT 16 MCDONALD ROAD, BALDIVIS

Project Number EP15-057(03)

Prepared for Defence Housing Australia
September 2016



Document Control

DOC NAME	BUSHFIRE MANAGEMENT PLAN – PORTION OF LOT 16 MCDONALD ROAD, BALDIVIS				
DOC NO.	EP15-057(03)--004				
REVISION	DATE	AUTHOR		REVIEWER	
1	January 2016	Vanessa Keating	VMK	Jason Hick	JDH
				Rohan Carboon	RC
	Report for client review and comment.				
A	February 2016	Vanessa Keating	VMK	Jason Hick	JDH
	Updated following changes to the Structure Plan.				
B	February 2016	Vanessa Keating	VMK	Jason Hick	JDH
	Updated following feedback from the client and changes to the Structure Plan.				
C	September 2016	Vanessa Keating	VMK	Jason Hick	JDH
	Updated following feedback from the City of Rockingham and Department of Planning, and changes to the development layout.				

Disclaimer:

This document has been prepared in good faith and is derived from information sources believed to be reliable and accurate at the time of publication. Nevertheless, it is distributed on the terms and understanding that the author is not liable for any error in or omission in the information sources available or provided to us, or responsible for the outcomes of any actions taken based on the recommendations contained herein. It is also expected that our recommendations will be implemented in their entirety, and we cannot be held responsible for any consequences arising from partial or incorrect implementation of the recommendations provided.

This document has been prepared primarily to consider the layout of development and/or the appropriate building construction standards applicable to development, where relevant. The measures outlined are considered to be prudent minimum standards only based on the standards prescribed by the relevant authorities. The level of bushfire risk mitigation achieved will depend upon the actions of the landowner or occupiers of the land and is not the responsibility of the author. The relevant local government and fire authority (i.e. Department of Fire and Emergency Services or local bushfire brigade) should be approached for guidance on preparing for and responding to a bushfire.

Notwithstanding the precautions recommended in this document, it should always be remembered that bushfires burn under a wide range of conditions which can be unpredictable. An element of risk, no matter how small, will always remain. The objective of the Australian Standard AS 3959-2009 is to “prescribe particular construction details for buildings to reduce the risk of ignition from a bushfire while the front passes” (Standards Australia 2009). Building to the standards outlined in AS 3959 does not guarantee a building will survive a bushfire or that lives will not be lost.

Executive Summary

This Bushfire Management Plan (BMP) has been prepared on behalf of Defence Housing Australia to support the preparation of a Structure Plan for a portion of Lot 16 McDonald Road, Baldivis. The Lot 16 area is herein referred to as "the site", and portion of the site covered by the Structure Plan is referred to as the "Structure Plan area". This BMP includes an assessment of the bushfire hazards within and surrounding the site (within 100 m), to inform the responses required (if any) for proposed development within the Structure Plan area.

The site is approximately two hectares and is located approximately 39 kilometres (kms) south of the Perth CBD, within the City of Rockingham, as shown in **Figure 1**. The site is bound by McDonald Road to the east, rural landholdings to the west, and landholdings zoned for future urban development to the north and south. The site and its immediate surrounds are shown in **Figure 2**.

Portions of the site have been identified as "Bushfire Prone Areas" under the state-wide *Map of Bushfire Prone Areas* recently released by the Office of Bushfire Risk Management (OBRM), as shown in **Figure 3**. The identification of Bushfire Prone Areas within any portion of the site requires a further assessment of the bushfire hazard implications on development proposed within the site, in accordance with the *Guidelines for Planning in Bushfire Prone Areas* (WAPC *et al*. 2015). This BMP has been prepared to assess and identify any potential bushfire risks that are likely to apply to the site, and to outline how the Structure Plan has responded to ensure any bushfire risk is appropriately managed as part of the future development process. The proposed Structure Plan (shown conceptually in **Figure 4**) provides a guide for future urban development within a portion of the site and creates a framework for the future subdivision of the Structure Plan area into residential lots and road reserves.

The aim of the BMP is to assess bushfire hazard levels in the vicinity of the site (within 100 metres) and to ensure the threat posed by the identified bushfire hazard can be mitigated to acceptable levels appropriate with a residential development. In doing so, this BMP aims to minimise the potential impact of bushfires on development within the site, and reduce the threat to life, property and the environment. The bushfire risk will be mitigated to acceptable levels as defined in the *Guidelines for Planning in Bushfire Prone Areas* (WAPC *et al.* 2015).

This BMP sets out the roles and responsibilities of the developer/s, future residents and the City of Rockingham. It is important that the measures and procedures outlined in this BMP are adopted across the various stages of the land use planning and dwelling construction approvals processes. It is expected that the bushfire hazard mitigation measures outlined in this BMP will be largely implemented as part of future residential subdivision and associated development within the site.

All areas within 100 metres (m) of the site boundary have been assessed to determine the presence of bushfire prone vegetation and, where this occurs, associated vegetation classification and bushfire hazard rating levels. Permanent long term bushfire hazard considerations are posed by areas of remnant forest and woodland vegetation within rural landholdings west of the site. An assessment of the classified vegetation and associated bushfire hazard for the site and surrounding area has been undertaken to determine site specific Bushfire Prone Areas, in accordance with *AS 3959 Construction of Buildings in Bushfire Prone Areas* (AS 3959). These determined Bushfire Prone Areas may be used by the City of Rockingham to inform updates to OBRM's state-wide mapping of bushfire prone areas.

Any new dwellings constructed within the Structure Plan area that fall within 100 m of classified bushfire prone vegetation will require consideration of the need for increased construction standards in

accordance with AS 3959. In order to pre-empt this requirement, a detailed and site specific Bushfire Attack Level (BAL) assessment will be undertaken as part of the subdivision process to confirm the ultimate BAL ratings for each individual new lot created. Final BAL ratings **should not** be determined for future lots at the Structure Plan stage, as the ultimate lot locations/boundaries and dwelling setbacks will be determined through the subdivision process, and temporary hazards (or even hazards that were expected to be permanent) may not remain at that time, in particular those landholdings north and south of the site intended for future urban development. An indicative BAL assessment has been undertaken as part of this BMP in order to demonstrate that no areas within the Structure Plan area are exposed to an unacceptable level of bushfire risk (i.e. a BAL rating of greater than BAL-29).

Landholdings north of the site are intended for future urban development and are currently undergoing separate planning and approvals to support development, therefore Grassland vegetation within these landholdings will pose only a temporary bushfire risk to the site. Future detailed BAL assessment/s will outline specific BAL ratings for each stage of subdivision based on the classified vegetation remaining at that time, therefore providing a more accurate assessment of the post development hazards posed to future dwellings than can be achieved at Structure Plan stage.

As part of the subdivision process, any lots deemed to require bushfire management responses through the detailed BAL assessment (i.e. a BAL rating of BAL-12.5 or greater), will be subject to a notification pursuant to section 70A of the *Transfer of Land Act 1893* placed on the certificate(s) of title indicating that the lot is subject to the requirements of a Bushfire Management Plan (i.e. increased construction standards to meet increased BAL ratings).

The indicative BAL assessment provided in this BMP has been undertaken in accordance with Section 2 of AS 3959, which provides a basic assessment of radiant heat flux to calculate the required setback to achieve an acceptable level of radiant heat exposure (i.e. BAL-29). Based on the results of this indicative BAL assessment, the maximum BAL rating to which a small number of future lots within the Structure Plan area are exposed is BAL-19.

The proposed development will be provided with an adequate water supply (through the provision of reticulated water and fire hydrants) and sufficient vehicular access to and from the site, to ensure residents and fire fighters are able to respond appropriately in the event of a bushfire in the vicinity of the site.

It is expected that the implementation of this BMP will reduce the threat posed by bushfires to future residents, visitors and fire fighters in the areas proposed for urban development associated with this BMP.

Therefore, the recommendations from this BMP to inform the Structure Plan preparation process are as follows:

- By implementing this BMP, the bushfire risk to development within the site can be mitigated through the provision of appropriate APZs combined with increased construction standards in accordance with AS 3959.
- The indicative BAL assessment undertaken as part of this BMP indicates that no future lots within the Structure Plan area will be exposed to an unacceptable level of radiant heat flux (i.e. no greater than BAL-29).
- Future BAL assessment/s (undertaken to support future subdivision or development approval stage/s) will enable a more accurate reflection of the bushfire risk posed by surrounding classified vegetation at the time that development progresses within the site. This BAL assessment/s will specify ultimate BAL ratings for each lot as well as APZ requirements (where applicable).

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1 Introduction

1.1 Background

This Bushfire Management Plan (BMP) has been prepared on behalf of Defence Housing Australia to support the preparation of a Structure Plan for a portion of Lot 16 McDonald Road, Baldivis. The Lot 16 area is herein referred to as "the site", and portion of the site covered by the Structure Plan is referred to as the "Structure Plan area". This BMP includes an assessment of the bushfire hazards within and surrounding the site (within 100 m), to inform the responses required (if any) for proposed development within the Structure Plan area.

The site is approximately two hectares and is located approximately 39 km south of the Perth CBD, within the City of Rockingham, as shown in **Figure 1**. The site is bound by McDonald Road to the east, rural landholdings to the west, and landholdings zoned for future urban development to the north and south. The site and its immediate surrounds are shown in **Figure 2**. The site has historically been completely cleared of native vegetation to support agricultural (market garden) land uses, and now consists of weedy grassland with scattered planted non-native trees, an existing residence and several miscellaneous outbuildings.

Portions of the site have been identified as "Bushfire Prone Areas" under the state-wide *Map of Bushfire Prone Areas* recently released by the Office of Bushfire Risk Management (OBRM), as shown in **Figure 3**. The identification of Bushfire Prone Areas within any portion of the site requires a further assessment of the bushfire hazard implications on development proposed within the site to be undertaken in accordance with *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (WAPC 2015) and the *Guidelines for Planning in Bushfire Prone Areas* (WAPC *et al*. 2015), which is provided in this BMP.

1.2 Accreditation

This BMP has been prepared jointly by Emerge Associates and Bushfire Safety Consulting. Bushfire Safety Consulting is owned and operated by Rohan Carboon, an experience bushfire consultant to the urban planning industry. Rohan has provided all technical input and review for the bushfire hazard assessment included within this BMP. Rohan has undergraduate degrees in Environmental Management and postgraduate qualifications in Bushfire Protection and has been providing bushfire risk and hazard assessment and mitigation advice to the urban planning and development industry for more than six years. He first worked professionally in community bushfire safety education in 1999 and has been involved in land management including bushfire suppression since 1993.

Bushfire Safety Consulting is a Corporate Bronze Member of the Fire Protection Association of Australia. Rohan is in the process of obtaining BPAD Level 1 BAL Assessor accreditation under the Fire Protection Association of Australia's new Western Australian accreditation scheme and will also progress to Level 2 and Level 3 accreditation over time as this system is developed.

1.3 Aim of this document

The aim of this BMP is to assess bushfire hazard levels in the vicinity of the site (within 100 m) and to ensure the threat posed by the identified bushfire hazard can be mitigated within the Structure Plan to acceptable levels appropriate for a residential development. In doing so, this BMP aims to minimise

the potential impact of bushfires on development within the Structure Plan area, and reduce the threat to life, property and the environment. The bushfire risk will be mitigated to acceptable levels as defined in the *Guidelines for Planning in Bushfire Prone Areas* (WAPC *et al.* 2015).

This BMP is expected to inform future bushfire assessment/s that will be prepared and implemented as part of the future subdivision, development approval processes and/or building licence.

1.4 Statutory policy and framework

The following key legislation, policies and guidelines are relevant to the preparation of a bushfire management plan.

1.4.1 *Fire and Emergency Services Act 1998*

Areas within Western Australia have been designated as bushfire prone by the Fire and Emergency Services (FES) Commissioner, through the release of the *Map of Bush Fire Prone Areas* (OBRM 2016). The *Fire and Emergency Services Act 1998* (FES Act) enables the statutory delineation of Bushfire Prone Areas, which are areas within 100 m of classified bushfire prone vegetation. In turn, Bushfire Prone Areas enable the implementation of the regulations and guidelines outlined below. The *Map of Bush Fire Prone Areas* (OBRM 2016) as currently mapped for the site is shown in **Figure 3**.

1.4.2 *Bush Fires Act 1954*

The *Bush Fires Act 1954* (Bush Fires Act) sets out provisions to reduce the dangers resulting from bushfires, prevent, control and extinguish bushfires, and for other purposes. The Bush Fires Act addresses various matters including prohibited burning times, enabling Local Government to require landowners and/or occupiers to plough or clear fire breaks to control and extinguish bushfires and to establish and maintain bushfire brigades.

Pursuant to the Bush Fires Act, the City of Rockingham publishes annual firebreak advice that can be accessed from: http://www.rockingham.wa.gov.au/Services/Safety-and-security-services/Fire-safety-and-emergencies#Firebreaks.

1.4.3 *Planning and Development (Local Planning Scheme Amendment) Regulations 2015*

The *Planning and Development (Local Planning Scheme Amendment) Regulations 2015* (WAPC 2015a) (the Regulations) include deemed provisions which reference the FES Commissioner's power to designate bushfire prone areas, and provide a mechanism to apply *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (WAPC 2015) and the related assessment requirements through planning and development decisions.

1.4.4 *Building Regulations 2012*

All building work in Western Australia is required to comply with the requirements of the Building Code of Australia (BCA). The Building Regulations recognise that properties that are located within designated bushfire prone areas (within the *Map of Bush Fire Prone Areas* (OBRM 2016)) may require additional assessment for bushfire risk and for construction of dwellings to be in accordance with *Australian Standard (AS) 3959-2009 Construction of buildings in bushfire prone areas* (Standards Australia 2009).

1.4.5 *State Planning Policy 3.7 Planning in Bushfire Prone Areas*

The Department of Planning and WAPC have released *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (December 2015) (SPP 3.7). SPP 3.7 aims to:

- Avoid any increase in the threat of bushfire to people, property and infrastructure. The preservation of life and the management of bushfire impact are paramount.
- Reduce vulnerability to bushfire through the identification and consideration of bushfire risks in decision-making at all stages of the planning and development process.
- Ensure that higher order strategic planning documents, strategic planning proposals, subdivision and development applications take into account bushfire protection requirements and include specified bushfire protection measures.
- Achieve an appropriate balance between bushfire risk management measures and, biodiversity conservation values and landscape amenity, with consideration of the potential impacts of climate change.

SPP 3.7 (WAPC 2015) makes provision for further detailed bushfire hazard assessment to be undertaken for areas identified as bushfire prone within the *Map of Bush Fire Prone Areas*. It also outlines the information that is required to support the various stages of planning and the potential for bushfire conditions to be applied through the subdivision process.

1.4.6 *Guidelines for Planning in Bushfire Prone Areas* (WAPC et al. 2015)

The *Guidelines for Planning in Bushfire Prone Areas* (WAPC *et al.* 2015) ("the Guidelines") have been prepared by the WAPC and DFES, to assist in the interpretation of SPP 3.7 and provide advice on planning, designing or assessing a proposal within a bushfire prone area. The Guidelines are the predominant document to be used by decision-making authorities and referral agencies when considering the appropriateness of strategic planning proposals, subdivisions, and development applications.

The guidelines address important bushfire risk management and planning issues and outline performance criteria and acceptable solutions to minimise the risk of bushfires in new subdivisions and developments. The guidelines also address management issues including location, siting and design of the development (and consideration of Bushfire Attack Level (BAL) ratings), vehicular access and water requirements.

1.4.7 Australian Standard AS 3959 – 2009 Construction of buildings in bushfire prone areas

The Australian Standard *AS 3959-2009 Construction of buildings in bushfire prone areas* (AS 3959) specifies requirements for the construction of buildings in bushfire prone areas in order to improve their resistance to bushfire attack from embers, radiant heat, flame contact, and combinations of these attack forms.

The objective of AS 3959 is to provide detailed methods for assessing bushfire attack and to prescribe specific construction details for buildings to reduce the risk of ignition from a bushfire, appropriate to the:

- Potential for ignition caused by burning embers, radiant heat or flame generated by a bushfire.
- Intensity of the bushfire attack on the building.

2 Proposal and Objectives

Community bushfire safety is a shared responsibility between state and local governments, fire agencies, communities and individuals. The planning and building controls outlined in this BMP, when implemented, will reduce the risk to people and property within the site. How future residents interpret the risk, prepare and maintain their properties and buildings and what decisions and actions they take (i.e. evacuate early or stay and defend or other) will greatly influence the consequences of any bushfire that occurs in the local area in proximity to the site.

The proposed Structure Plan, as shown conceptually in **Figure 4** (and attached in **Appendix A**), provides a framework for future urban development within a portion of the site, in accordance with the land use zoning within the Structure Plan area. The objective of this BMP is to enable bushfire management issues to be addressed through the Structure Plan. If there is a bushfire within or near the site, implementing this BMP will reduce the threat to residents, property and emergency response personnel.

Achievable and measurable goals of this plan include ensuring:

- Development is located in an area where the bushfire hazard does not present an unreasonable level of risk to life and property.
- Vehicular access to the development is safe if a bushfire occurs.
- Water is available to the development, so that life and property can be protected from bushfire.
- Development is sited and designed to minimise the effects of a bushfire.

This document sets out the roles and responsibilities of the future developer/s, future residents and the City of Rockingham. It is important that the measures and procedures outlined in this BMP are adopted across the various stages of the land use planning and dwelling construction approvals processes.

The bushfire hazard mitigation measures outlined in this BMP will be implemented as part of future residential subdivision within the site, which will be undertaken in accordance with the proposed Structure Plan (provided in **Appendix A**).

This BMP provides:

- Identification of those portions of the site designated as Bushfire Prone Areas under the OBRM's *Map of Bushfire Prone Areas* (WAPC *et al*. 2015)
- A description of the site, the surrounding area, fire climate and bushfire history
- A summary of research into the related effects of a bushfire
- A bushfire hazard assessment
- Identification of determined site specific Bushfire Prone Areas based on the assessment of classified vegetation within the site and surrounding 100 m
- A description of the proposed road network and how this addresses vehicular access for bushfire risk purposes
- An outline of the water supply requirements within the site for firefighting purposes
- An outline of the requirements for the internal siting of buildings to include asset protection zones
- An indicative BAL assessment to outline the acceptable siting and design of the proposed development in accommodating appropriate bushfire hazard mitigation measures.

It is expected that further detailed bushfire hazard and risk assessment/s will be undertaken for the site as part of future subdivision or development stages in order to further assess the bushfire risk and determine specific radiant heat exposure levels for future lots created in line with the Structure Plan.

3 Description of the Area

3.1 General

The site currently supports a residential dwelling and several miscellaneous outbuildings, and has historically been completely cleared of remnant vegetation for agricultural (market garden) purposes. The majority of the site is now dominated by weedy grassland, with scattered planted non-native trees in the west of the site, in the vicinity of the existing residence.

The Chimes residential estate is located immediately east of the site, east of McDonald Road, as shown in **Figure 2**. Landholdings north and south of the site are intended for future urban development in accordance with the City of Rockingham's Baldivis (North) District Structure Plan (DSP) and the land use zoning over the area.

3.2 Climate and fire weather

The behaviour of bushfires is significantly affected by weather conditions. They burn more aggressively when high temperatures combine with low humidity and strong winds. In Perth and surrounding coastal areas, the fire risk is greatest from summer through autumn when the moisture content in vegetation is low. Summer and autumn days with high temperatures, low humidity and strong winds are particularly conducive to the spread of fire. This threat is increased if thunderstorms develop, accompanied by lightning and little or no rain.

Research indicates that virtually all house losses occur during severe, extreme or catastrophic conditions (i.e. when the Fire Danger Index is over 50) (Blanchi et al. 2010). The Bureau of Meteorology (2014) states that extreme fire weather conditions in the Perth region typically occur with strong easterly or north-easterly winds associated with a strong high to the south of the state and a trough offshore. Easterly winds represent approximately 60% of extreme fire weather days (events) compared to fewer than 5% associated with southerly winds. About 15% of Perth events occurred in a westerly flow following the passage of a trough.

Very dangerous fire weather conditions often follow a sequence of hot days and easterly winds that culminate when the trough deepens near the coast and moves inland. Winds can change from easterly to northerly and then to westerly during this sequence of climatic events.

Data from the Medina Research Centre (approximately 8 km north of the study site) indicate the area experiences warm dry summers and cool wet winters (see **Plate 1**), and is classified as a Mediterranean climate. Mean maximum temperatures vary from 31.5°C in February to 18.3°C in July.

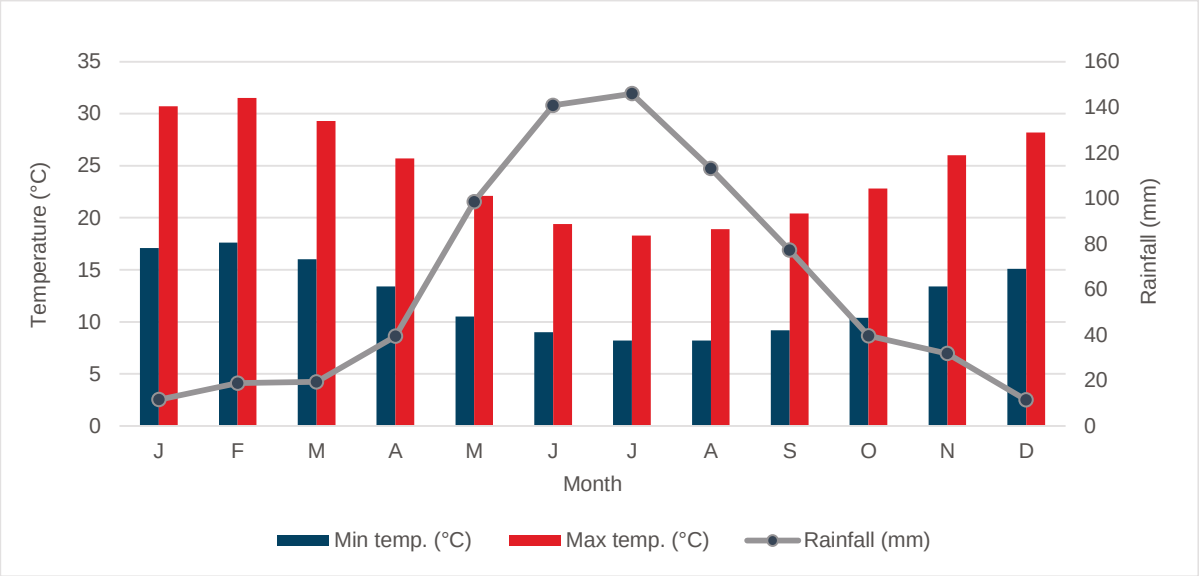

Plate 1: Mean minimum and maximum temperatures and mean rainfall recorded at the Medina Research Centre weather station between 1983 and December 2015 (BoM 2015)

Data from the weather station indicate that the predominant winds near the study site in the summer months at 3 pm are south-westerly (**Plate 2**). Easterly and south-easterly winds are more common in February than the other summer months. Wind strength, direction and frequency from the south-west are dominant and occur 45% to 55% of the time.

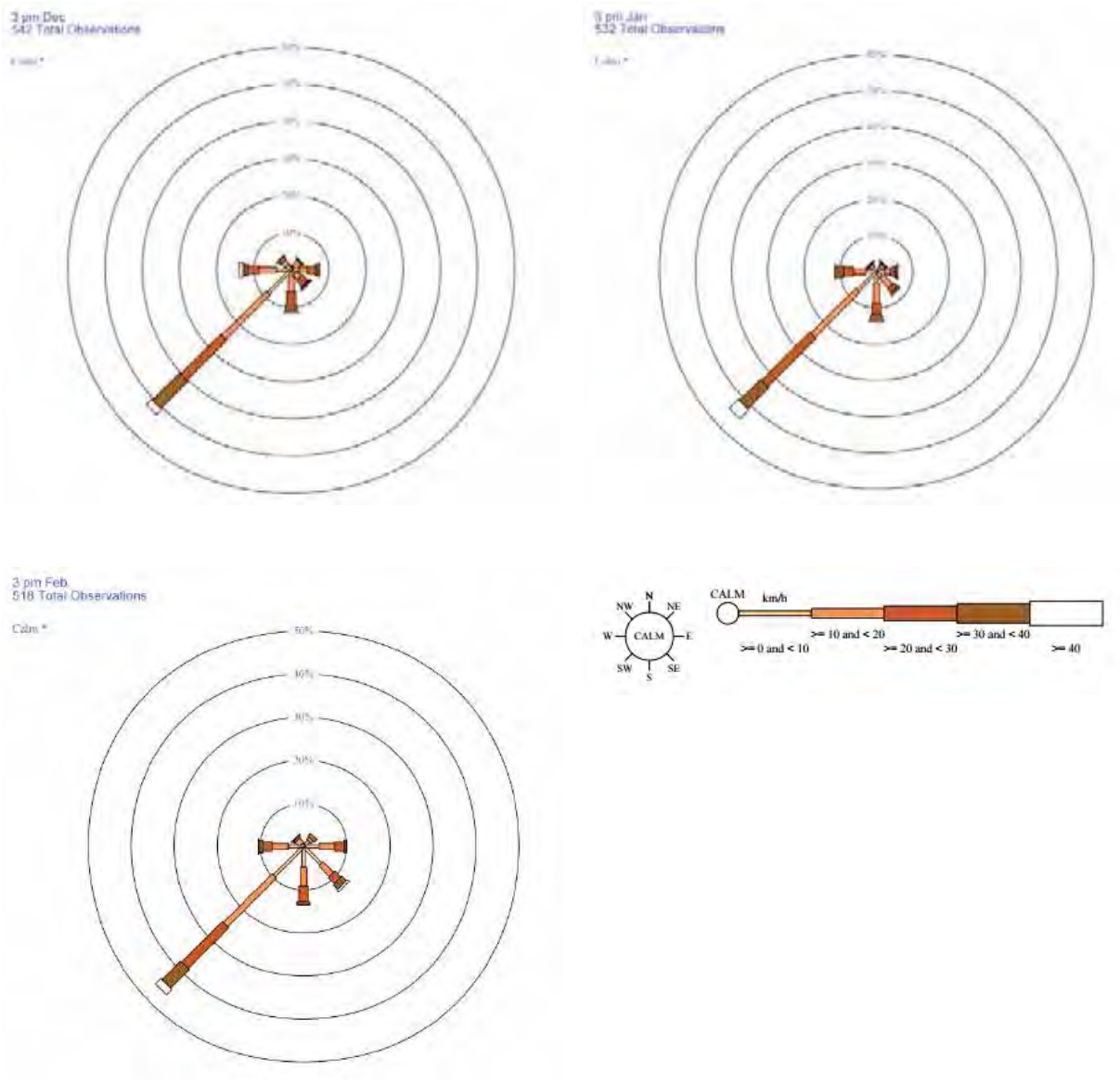

Plate 2: Rose of wind direction and wind speed in km/hr for December, January and February between 1983 – September 2010 at the Medina Research Centre Bureau of Meteorology Station (Bureau of Meteorology 2015)

Wind roses summarise the occurrence of winds at a location, showing their strength, direction and frequency. The percentage of calm conditions is represented by the size of the centre circle - the bigger the circle, the higher the frequency of calm conditions. Each branch of the rose represents wind coming from that direction, with north found at the top of the diagram. Eight directions are used. The branches are divided into segments of different thickness and colour, which represent wind speed ranges in that direction. Speed ranges of 10 km/h are used. The length of each segment within a branch is proportional to the frequency of winds blowing within corresponding range of speeds from that direction (BOM, 2010).

3.3 Topography

Topographical contours indicate that the site is generally flat, with elevation ranging from approximately 4 metres Australian Height Datum (m AHD) in north-west corner and 5 m AHD in the south-east of the site, with a high point of approximately 7 m AHD located in the centre of the site, as shown in **Figure 5**.

3.4 Bushfire fuels

The site is dominated by grassland vegetation with scattered planted non-native trees in the western portion of the site. Remnant vegetation occurs west of the site, within rural landholdings, and consists of forest and woodland dominated by Tuart (*Eucalyptus gomphocephala*) and Marri (*Corymbia calophylla*). The long term bushfire hazard implications for development within the site are discussed further in **Section 4.3** below.

3.5 Land use

The site is currently supports one residence and several miscellaneous outbuildings, and has been historically used for rural land uses, primarily market garden activities. The site has been completely cleared of remnant vegetation and now supports predominantly weedy grassland. The majority of the site is zoned “Urban” under the MRS and “Development” under the City of Rockingham’s LPS No. 2, with the western portion zoned “Rural” under both the MRS and local scheme. Current MRS zoning for the site and surrounding area is shown in **Figure 6**.

3.6 Assets

In accordance with the proposed Structure Plan (attached in **Appendix A**), the site will support the future development of residential lots/dwellings and road reserves. Dwellings exposed to any bushfire hazard will be those located around the perimeter of the Structure Plan area, within 100 m of permanently retained classified vegetation.

3.7 Access

The proposed internal road network shows two direct access points to the existing McDonald Road to the east of the site, and connecting with areas intended for future residential development to the north, as shown in **Figure 4**. The main point of access into the site will be from McDonald Road, east of the site (see **Figure 4**), and all residents and fire fighters will have at least two access options at all times.

While there is no access provided out to the west of the site, the main point of access to the east allows the movement of residents away from the main source of bushfire hazard posed by remnant vegetation west of the site. Access is provided via McDonald Road to Fifty Road in the south, and existing urban development to the east of the site.

3.8 Water supply

Reticulated water will be provided to the entire development. Fire hydrants will be spaced according to Water Corporation and DFES standards and provide emergency services with access to an

adequate water supply. Fire hydrants on land zoned as residential are required to be sited at or within 200 m of residential dwellings (Class 1a).

4 Bushfire Context and Current Situation

4.1 Bushfire history

Fires have been common on the Swan Coastal Plain for thousands of years and the anthropological and historical evidence suggests that Aboriginal people regularly burnt this area (Hallam 1975, Abbott 2003).

A recent study has concluded that bushfires may have been in the Australian landscape for 50 million years longer than previously thought. The adaption of eucalypts that allows them to recover from bushfires has been traced back more than 60 million years (Crisp *et al*., 2011), indicating fire has been in the Australian landscape since that time.

Bushfires are common in the City of Rockingham. As land use intensification occurs and urban development replaces rural land and/or areas of native vegetation, bushfire hazards are removed thereby reducing areas that can carry a bushfire. At the same time however, the number of people and assets in the community increases thereby increasing the risk at the bushland interface.

On 12 January 2014, and 16 March 2014, the Tamworth Swamp fire and Millar Road fire occurred respectively on days with a Low-High Fire Danger Rating (FDR) and typical coastal sea breezes. The Miller Road fire occurred north of the site on the eastern side of the intersection of Millar and Baldivis Roads. The cause of both fires is unknown, however they are suspected to have been started deliberately.

Fire weather conditions were typical coastal south-west sea breezes which pushed the head fires to the north-west. Both fires had ember attack causing spot fires ahead of the head fire and outside of the eventually contained fire ground.

The Tamworth Swamp was difficult for fire fighters to access due to the vegetation for both combat and eventual creation of control lines. The wind direction was favourable for this fire which significantly aided suppression activities. The Millar Road fire had rapid forward rate of spread and the ground fire quickly developed into a canopy fire.

Both fires required multi agency resources and were of a prolonged duration, requiring road closures. No major infrastructure damage or property was lost.

On 27 January 2015 a fire started on the eastern side of Baldivis Road and south of Millar Road (north-east of the site), and moved north towards Johnson Road. The Kwinana Freeway was closed in both directions between the Mortimer Road and Safety Bay Road exits. Flame heights reached approximately 10 metres and over 200 firefighters were involved in supressing the fire.

Given that bushfires are common in the City of Rockingham, this BMP plays an important role in ensuring that the development of the land appropriately mitigates the risk and threat posed from bushfire.

4.2 Bushfire risk

The risk management process described in AS/NZS ISO 31000:2009 *Risk management – Principles and guidelines* is a systematic method for identifying, analysing, evaluating and treating emergency risks.

Bushfire risk is determined by assessing:

- Bushfire hazard (i.e. bushfire prone vegetation)
- Threat level (i.e. proximity of the hazard to assets and people)
- Vulnerability of the asset
- Consequence rating (i.e. a rating for the potential outcome once the 'incident' has occurred)
- Likelihood rating (i.e. the chance of an event).

It is not necessary to undertake a standalone site specific bushfire risk assessment in accordance with AS/NZS ISO 31000:2009 as part of this BMP, as risk has been considered in the context of the bushfire hazard assessment that has been undertaken (as outlined in **Section 4.3**) in accordance with the *Guidelines for Planning in Bushfire Prone Areas* (WAPC et al. 2015) and AS 3959.

The vulnerability of assets such as dwellings is impacted by several factors. Some relate to the way a bushfire behaves at a site, others to the design and construction materials in the building and siting of surrounding elements. Infrastructure, utilities and human behaviour are also factors. Leonard (2009) identified the following factors:

- Terrain (slope)
- Vegetation (overall fuel load, steady state litter load, bark fuels, etc.)
- Weather (temperature, relative humidity and wind speed)
- Distance of building from unmanaged vegetation
- Individual elements surrounding the building that are either a shield or an additional fuel source
- Proximity to surrounding infrastructure
- Building design and maintenance
- Human behaviour (ability to be present and capacity to fight the fire)
- Access to the building and how that influences human behaviour
- Water supply for active and/or passive defence
- Power supply.

Where buildings are lost, this is likely to occur as a result of their vulnerability to the mechanisms of bushfire attack. Buildings constructed to increased standards under AS 3959 are more likely to survive a bushfire than buildings that do not conform to these construction standards, although building survival is not guaranteed.

The OBRM recently released state-wide *Maps of Bushfire Prone Areas*, which designates bushfire prone areas within Western Australia. Portions of the site are identified as bushfire prone (as shown in **Figure 3**) and as such the requirements of AS 3959 apply (as well as the State bushfire management framework in SPP 3.7, discussed in **Section 1.2**).

The vulnerability of people is determined by several factors, including age, fitness levels, gender, level of preparation, and number of occupants who can actively defend a property. The development will be comprised of individual residential dwellings and areas of public open space.

4.3 Bushfire hazard

Assessing bushfire hazards takes into account the classes of vegetation within the site and surrounding area for a minimum of 100 m, in accordance with Table 2.3 of AS 3959, as shown in **Figure 7**. Fuel layers in a typical forest environment can be broken-down into five segments as

illustrated in **Plate 3** below. These defined fuel layers are used in the following descriptions regarding vegetation types, fuel structure and bushfire hazard levels.

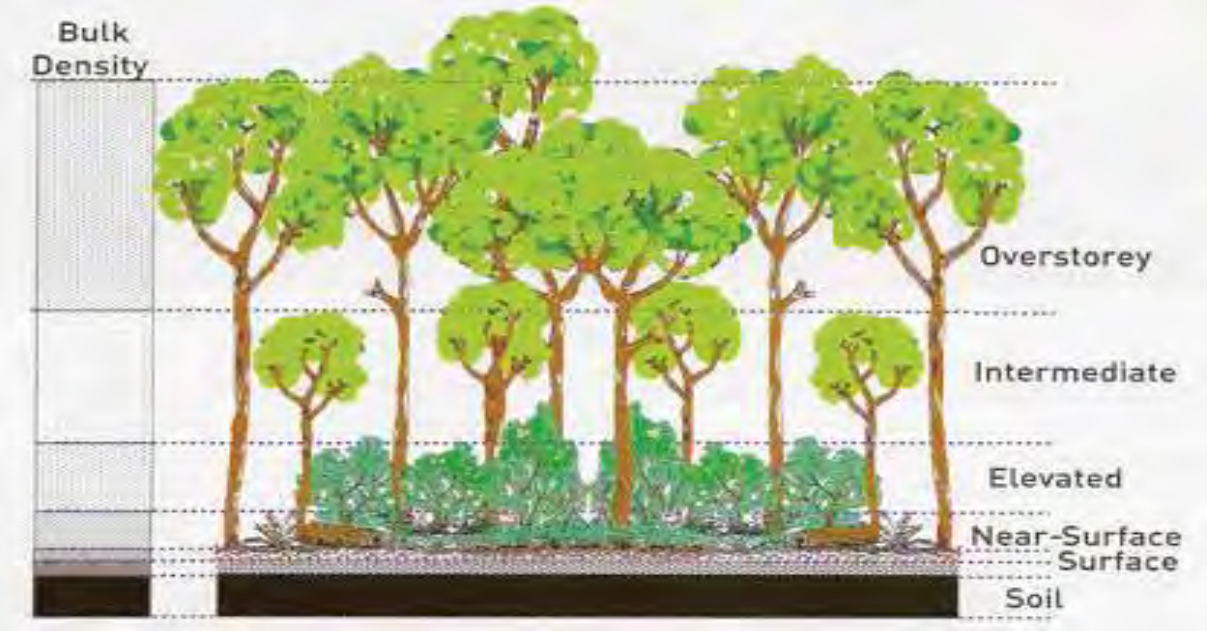

Plate 3: The five fuel layers in a forest environment that could be associated with fire behaviour (Gould et al. 2007)

4.3.1 Vegetation type and structure

4.3.1.1 Vegetation within the site

The site has been historically cleared of remnant vegetation to support agricultural (market garden) land uses and now supports areas of grassland dominated by weeds, with scattered planted non-native trees in the west of the site, as shown in **Plate 4** and **Plate 5** below. These areas have been classified as a mixture of grassland and low threat vegetation (according to Section 2.2.3.2(f) of AS 3959), as shown in **Figure 7**, based on the maintenance of grass fuels observed at the time of the site assessment.

Plate 4: Planted non-native trees over weedy grassland in the west of the site (Photo Point 1)

Plate 5: Planted, non-native trees over managed weedy grassland in the west of the site (Photo Point 2)

4.3.1.2 Vegetation surrounding the site

Landholdings surrounding the site have historically been used for general rural purposes such as livestock grazing, market gardens etc. and as such support mostly grassland vegetation, as shown in **Figure 7**. The majority of fuel loads within the landholding south of the site are managed through ongoing rural residential land uses, as shown in **Plate 6**, and this area is therefore considered low threat under Section 2.2.3.2(f) of AS 3959.

Areas of remnant woodland and forest vegetation occur south and west of the site, consisting of Tuart and Marri overstorey over an elevated layer of Sheoak, Banksia and emergent Jarrah, as shown in **Plate 7** to **Plate 9**. Scattered paddock trees surrounding the site to the north have been classified according to their understorey of grassland, as their distribution and fuel loads to not warrant higher classification under Table 2.3 of AS 3959, as shown in **Plate 10**.

Plate 6: Vegetation south of the site assessed as low threat under Section 2.2.3.2(f) of AS 3959 (Photo Point 3)

Plate 7: Woodland vegetation south of the site (Photo Point 4)

Plate 8: Forest vegetation south-west of the site (Photo Point 5)

Plate 9: Forest vegetation within rural landholdings west of the site (Photo Point 6)

Plate 10: Small patch of mature trees over grassland north of the site, classified according to its grassland understorey (Photo Point 7)

4.3.2 Vegetation in public open space

While there are no areas of public open space proposed within the Structure Plan, there is one area of public open space east of the site, within existing residential development as shown in **Figure 4**. This area of public open space provides a drainage function for the adjacent residential area and contains a number of remnant native trees within a managed open space environment, as shown in **Plate 11** below. This area has been landscaped and designed to a low threat standard in accordance with Section 2.2.3.2 of AS 3959 and will therefore pose no hazard to development within the site.

Plate 11: Managed parkland east of the site, within existing urban development (Photo Point 8)

4.3.3 Bushfire hazard assessment – existing site conditions

The existing site condition vegetation classification across the site and surrounding 100 m are shown in **Figure 7**. Descriptions of the vegetation types, structure and fuel layers are outlined in **Section 4.3.1**.

The bushfire hazard assessment levels were determined using Appendix Two of the *Guidelines for Planning in Bushfire Prone Areas* (WAPC *et al*. 2015).

Most areas within the site and surrounding area have a 'Moderate' bushfire hazard rating associated with the grassland vegetation that covers the site, with 'Extreme' hazard posed by woodland and forest vegetation south and west of the site, as shown in **Figure 8**.

Bushfire hazards surrounding the site are limited to classified vegetation within rural zoned landholdings west of the site, and landholding intended for future urban development north and south of the site, as shown in **Figure 7** and **Figure 8**. 'Low' bushfire hazards surround the site to the east, associated with existing urban development.

Bushfire hazards within urban zoned landholdings north of the site are considered temporary, as this area is currently undergoing a separate urban structure planning process and will be developed for urban purposes. Once these landholdings are cleared to support urban development, the associated hazard will be removed.

4.3.4 Bushfire hazard assessment – post development site conditions

The post development site condition vegetation classifications for the site are shown in **Figure 9**, and outline the dominant vegetation types that will remain within the site and surrounding 100 m after development within the site has been completed.

The bushfire hazard assessment levels were determined using Appendix Two of the *Guidelines for Planning in Bushfire Prone Areas* (WAPC *et al*. 2015). The post-development bushfire hazard rating changes substantially compared to the pre-development conditions due to the removal of most classified vegetation within the site to accommodate the development.

The post development hazard assessment (shown in **Figure 10**) has been based on the assumption that urban development will progress north and south of the site, in accordance with the land use zoning over the area, and the road reserve leading north of the site will continue into this future residential development north of the site once development occurs in this area.

The western portion of the site is not included within the Structure Plan, and is intended to be utilised as a rural/rural residential lot in accordance with its existing land sue zoning. This area will be managed by the proponent and any subsequent owner/s to a low fuel level in accordance with the City of Rockingham's Fire Control Notice, and will pose a long term low bushfire hazard to the Structure Plan area.

In addition to the above, it is assumed that a three metre firebreak will be maintained by adjacent landowner/s within the rural landholding west of the site, in accordance with their requirements under the City of Rockingham's Fire Control Notice.

4.3.5 Effective slope

The effective slope under areas of classified vegetation surrounding the site is shown in **Figure 11**, and ranges from effectively flat or upslope, to downslope zero to five degrees beneath surrounding vegetation.

Classified vegetation on a downslope gradient from the site can influence the movement of a bushfire through surrounding vegetation and towards the site. For this reason, increased setbacks may be required from vegetation at a downslope from the site. This is discussed further in **Section 5.1.2**.

4.4 Summary of bushfire threat

Bushfires are common in the City of Rockingham and there is a possibility of a bushfire impacting the site primarily from vegetation within rural landholdings west of the site, unless these hazards are managed and/or reduced.

The bushfire threat for the Structure Plan area has been determined by undertaking a preliminary BAL assessment (**Section 5.2.4**) to ensure no areas within the Structure Plan are exposed to an unacceptable level of bushfire risk (i.e. greater than BAL-29) .

Based on the preliminary assessment outlined in **Section 5**, the maximum long-term predicted radiant heat flux exposure for a small number of dwellings within the Structure Plan area is BAL-19. Further detailed BAL assessment will be undertaken as part of future subdivision or detailed design stages. This further detailed assessment is likely to provide a more accurate assessment of the surrounding bushfire risk at the time of development within the site.

5 Bushfire Mitigation Strategy

This BMP provides an outline of the mitigation strategies that will ensure that as development progresses in accordance with the Structure Plan, an acceptable solution and/or performance-based system of control is adopted for each bushfire hazard management issue. This approach is consistent with Appendix Four of the *Guidelines for Planning in Bushfire Prone Areas* (WAPC *et al.* 2015).The management issues addressed as part of this BMP are:

- Location of the development
- Siting and design of the development
- Vehicular access
- Water supply.

For the residential development of the Structure Plan area, acceptable solutions are proposed for all four management issues in accordance with the *Guidelines for Planning in Bushfire Prone Areas* (WAPC *et al*. 2015), and each illustrates a means of satisfactorily meeting the corresponding performance criteria, as discussed in **Section 5.1** below.

5.1 Bushfire risk management

As previously discussed, it is not necessary to undertake a specific bushfire risk assessment as per AS/NZS ISO 31000:2009 *Risk management – Principles and guidelines*. Land use planning bushfire risk mitigation and building control strategies are detailed in the following sections and provide responses to the bushfire protection performance criteria outlined in Appendix Four of the *Guidelines for Planning in Bushfire Prone Areas* (WAPC *et al.* 2015). The compliant checklist is attached as **Appendix B**.

5.1.1 Element: Location

5.1.1.1 Intent

To ensure that strategic planning proposals, subdivision and development applications are located in areas with the least possible risk of bushfire to facilitate the protection of people, property and infrastructure.

5.1.1.2 Acceptable Solution A1.1 Development location

The majority of the proposed development will be subject to either ‘Low’ or ‘Moderate’ bushfire hazard, where meeting the acceptable solution. Where development within the site will be progressed within 100 m of areas of ‘Extreme’ bushfire hazard, as shown in **Figure 10**, by addressing the siting and design of development within the site, no portion of the proposed development within the Structure Plan area will be exposed to an unacceptable level of radiant heat flux (i.e. BAL-29 is not exceeded). This is detailed further in **Section 5.1.2**.

5.1.2 Element: Siting and design of development

5.1.2.1 Intent

To ensure the siting and design of development minimises the level of bushfire impact.

5.1.2.2 Background

The extent of post-development classified vegetation (shown in **Figure 9**) is restricted to the Forest, Woodland and Grassland vegetation west of the site, within rural zoned landholdings.

Landholdings north of the site are undergoing separate urban development approvals, therefore Grassland vegetation within this landholding are considered temporary, and will pose only temporary bushfire risk to the site. Once vegetation is removed to accommodate urban development (in line with the relevant subdivision approvals) the bushfire risk posed to the site from this area will also be removed. Temporary bushfire risks have been considered further below.

5.1.2.3 Building siting and potential management considerations

AS 3959 has six categories of Bushfire Attack Level (BAL) which trigger varying degrees of increased construction standards in residential developments within 100 m of classified vegetation.

5.1.2.4 Methodology and assumptions

An indicative BAL assessment has been undertaken in order to determine the maximum level of radiant heat flux to which proposed future dwellings within the Structure Plan area could be exposed, and has been carried out based on the post development vegetation classification and effective slopes outlined in **Section 4**.

The criteria used to undertake the BAL assessment is as follows:

- Designated FDI: 80
- Flame temperature: 1090
- Effective slope: flat/upslope, downslope 0 to 5 degrees
- Vegetation classification: Forest (Class A), Woodland (Class B), Grassland (Class G)
- Distances/setback to classified vegetation: As per Table 2.4.3 of AS 3959, and shown in **Table 1** below.

5.1.2.5 BAL outcome

BAL ratings for the exposed areas of the Structure Plan area were determined using the methodology in Appendix A of AS 3959. This methodology is also outlined in Appendix Four of the *Guidelines for Planning in Bushfire Prone Areas* (WAPC *et al*. 2015). Through the provision of appropriate Asset Protection Zones (discussed further below), there are no areas in the development exposed to a BAL rating above BAL-29.

The outcomes of this indicative BAL assessment are shown in **Table 1**, and **Figure 12**. The BAL implications of both permanent and temporary classified vegetation are outlined below.

Table 1: Results of indicative BAL assessment

AREA OF CLASSIFIED VEGETATION	VEGETATION CLASSIFICATION	EFFECTIVE SLOPE BENEATH CLASSIFIED VEGETATION	DISTANCE / SETBACK FROM CLASSIFIED VEGETATION	BAL RATING
Permanent considerations				
South-west of the site	Forest (Class A)	Downslope 0-5 degrees	<20 m	BAL-FZ
			20-27 m	BAL-40
			27-37 m	BAL-29
			37-50 m	BAL-19
			50-100 m	BAL-12.5
			>100 m	BAL-LOW
South-west of the site	Woodland (Class B)	Downslope 0-5 degrees	<13 m	BAL-FZ
			13-17 m	BAL-40
			17-25 m	BAL-29
			25-35 m	BAL-19
			35-100 m	BAL-12.5
			>100 m	BAL-LOW
West of the site	Grassland (Class G)	Downslope 0-5 degrees	<7 m	BAL-FZ
			7-9 m	BAL-40
			9-14 m	BAL-29
			14-20 m	BAL-19
			20-50 m	BAL-12.5
			>50 m	BAL-LOW
North-west of the site	Grassland (Class G)	Flat/upslope	<6 m	BAL-FZ
			6-8 m	BAL-40
			8-12 m	BAL-29
			12-17 m	BAL-19
			17-50 m	BAL-12.5
			>50 m	BAL-LOW
Temporary considerations				
North of the site	Grassland (Class G)	Flat/upslope	<6 m	BAL-FZ
			6-8 m	BAL-40
			8-12 m	BAL-29

AREA OF CLASSIFIED VEGETATION	VEGETATION CLASSIFICATION	EFFECTIVE SLOPE BENEATH CLASSIFIED VEGETATION	DISTANCE / SETBACK FROM CLASSIFIED VEGETATION	BAL RATING
			12-17 m	BAL-19
			17-50 m	BAL-12.5
			>50 m	BAL-LOW

The BAL ratings occurring within the site include:

- BAL-29, which means there is an increased risk of ember attack and burning debris ignited by windborne embers and a likelihood of exposure to an increased level of radiant heat (AS 3959). The risk is considered to be high. It is expected that the construction elements will be exposed to a heat flux not greater than 29 kW/m^2. In this case, the recommended construction sections in AS 3959 are 3 and 7.
- BAL-19, which means the risk is considered to be moderate. It is expected that the construction elements will be exposed to a radiant heat flux not greater than 19 kW/m^2. There is a risk of ember attack and burning debris ignited by wind borne embers and a likelihood of exposure to radiant heat (AS 3959). The recommended construction sections in AS 3959 are 3 and 6.
- BAL-12.5, which means the risk is considered to be low. It is expected that the construction elements will be exposed to a radiant heat flux not greater than 12.5 kW/m^2. There is a risk of ember attack and burning debris ignited by wind borne embers and a likelihood of exposure to radiant heat (AS 3959). The recommended construction sections in AS 3959 are 3 and 5.
- BAL-LOW, which means the risk from bushfire is considered to be very low. There is insufficient risk to warrant any specific construction requirements but there is still some risk.

Proposed development within the Structure Plan area will require further detailed bushfire hazard and risk assessment to be undertaken as part of future subdivision or development stages, in order to determine the ultimate BAL ratings for future lots, and the subsequent increased construction standards to which future dwellings within these lots must be built. The ultimate BAL ratings **should not** be determined for future lots at the Structure Plan stage, as the ultimate lot locations/boundaries will be determined through the subdivision process, and temporary hazards (or even hazards that were expected to be permanent) may not remain at that time (e.g. temporary grass fuels north of the site).

Landholdings north of the site are intended for future urban development and are currently undergoing separate planning and approvals to support development, therefore Grassland vegetation within these landholdings will pose only a temporary bushfire risk to the site. The BAL implications of temporary vegetation are reflected in **Figure 12**. It is expected that temporary grass fuels will be removed prior to the progression of development within the northern portion of the site, therefore removing any temporary BAL requirements. If temporary grass fuels remain at the time development proceeds within the northern portion of the site, temporary BAL considerations will apply, as shown in **Figure 12**.

Future detailed BAL assessment/s will outline specific BAL ratings for each stage of subdivision based on the classified vegetation remaining at that time, therefore providing a more accurate assessment of the post development hazards posed to future dwellings than can be achieved at Structure Plan stage.

As part of the subdivision process, any lots deemed to require fire management responses through the detailed BAL assessment, will be subject to a notification pursuant to section 70A of the *Transfer*

of Land Act 1893 placed on the certificate(s) of title indicating that the lot is subject to the requirements of a Bushfire Management Plan (i.e. increased construction standards to meet BAL ratings of BAL-12.5 or greater).

5.1.2.6 Acceptable solution A2.1: Asset Protection Zone

One of the most important bushfire protection measures influencing the safety of people and property is to create an Asset Protection Zone (APZ) around buildings. The APZ is a low fuel area immediately surrounding a building. Non-flammable features such as irrigated landscapes, gardens, driveways and roads can form parts of an APZ.

Recent research into land management and house losses during the 'Black Saturday' Victorian bushfires concluded that the action of private landholders who managed fuel loads close to their houses was the single most important factor in determining house survival when compared with other land management practices, such as broad scale fuel reduction burning remote from residential areas (Gibbons et al., 2012).

The provision of a perimeter APZ where the site is adjacent to external bushfire hazard will ensure fuel loads in close proximity to the first row of buildings are managed to reduce the likelihood of ignition fuels adjacent to dwellings.

Managing vegetation in the APZ has two main purposes:

- To reduce direct flame contact and radiant heat from igniting the building during the passage of a fire front.
- To reduce ember attack and provide a safer space for people to defend (if required) before, during and after a fire front passes.

Those portions of the site that are situated in proximity to identified bushfire hazards have an internal (within the site) APZ applied to them as shown in **Figure 13**. Vegetation south and west of the site triggers perimeter APZ requirements for those lots in the west of the site. For the proposed residential lots within the Structure Plan area, this APZ will be accommodated within the proposed road reserve in the west of the site, as shown in **Figure 13**, which will provide a setback of 15 m to 23 m. Additional setback is provided by the three metre firebreak located within the adjacent rural landholdings, as discussed in **Section 4.3**. The fuel managed areas of future road reserves can act as APZ areas because the City of Rockingham roadside maintenance program will ensure hazard remains low. This APZ will be implemented at subdivision stage through the development and application of a Local Development Plan for the subject lots.

Landholdings north of the site are intended for future urban development and are currently undergoing separate planning and approvals to support development, therefore Grassland vegetation within these landholdings will pose only a temporary bushfire risk to the site, as shown in **Figure 9**. The provision of a temporary 8 m APZ in the north of the site will accommodate the minimum setback required to achieve BAL-29 from adjacent temporary Grassland vegetation within landholdings north of the site. This temporary APZ is accommodated within the rear of lots, as shown in **Figure 13**. It is expected that temporary grass fuels will be removed prior to the progression of development within the northern portion of the site, therefore removing any temporary APZ requirements. If temporary grass fuels remain at the time development proceeds within the northern portion of the site, APZ considerations will apply, as shown in **Figure 13**. APZ requirements will be revisited as part of future detailed BAL assessment to support subdivision approval/lot clearances within the site.

For the remaining rural portion of the site (i.e. rural balance lot in the western portion of the site), the required setbacks have been calculated based on the current fuel loads with the adjacent classified vegetation south and west of the site, driven by the AS 3959 framework, as previously outlined in **Section 5.1.2.5**. Should future development be proposed within this portion of the site, setbacks ranging from 8 m to 17 m will be required to achieve an acceptable level of radiant heat flux exposure (i.e. BAL-29) from the adjacent woodland and grassland vegetation. These setbacks can be accommodated through a combination of an internal lot setback within the rural lot and an additional three metre setback from vegetation provided through the firebreak maintained within the adjacent rural landholdings (in accordance with the City of Rockingham's Fire Control Notice). Any future development within this rural lot will be required to comply with the minimum required setbacks to achieve an acceptable level of radiant heat flux exposure (i.e. no greater than BAL-29).

Overall, the provision of an APZ, along with the provision of increased construction standards in accordance with AS 3959 will ensure that Performance Principle P2 under the *Guidelines for Planning in Bushfire Prone Areas* (WAPC et al. 2015) is met.

The APZ/s must be established and maintained to the following standards:

- Width: as identified in **Figure 13** and **Table 2** below
- Fine fuel load: reduced to and maintained at two tonnes per hectare
- Trees (crowns) are a minimum distance of ten metres apart. A small group of trees within close proximity to one another may be treated as one crown provided the combined crowns do not exceed the area of a large or mature crown size for that species
- No tall shrubs or trees located within two metres of a building
- No tree crowns overhang the building
- Fences within the APZ are constructed using non-combustible materials (e.g. iron, brick, limestone, metal post and wire)
- Sheds within the APZ should not contain flammable materials.

It is the responsibility of the developer to ensure that any APZ requirement is established by appropriate design, and that the construction of buildings is restricted within the APZ when it extends into lot areas.

As outlined above, the APZ for the residential lots is provided by the proposed road reserve, as shown in **Figure 13**, therefore the width of the APZ reflects the width of the road reserve, and the subsequent BAL rating that this setback achieves. The APZs for the rural lot in the west of the site, as outlined in **Table 2** below, have been based on the minimum setbacks required to achieve an acceptable level of radiant heat flux (i.e. BAL-29). Both approaches utilise the assumed 3 m firebreak within adjacent rural landholdings, as is required under the City of Rockingham's Fire Control Notice as attached in **Appendix C**.

Table 2: Asset Protection Zone requirements

AREA OF CLASSIFIED VEGETATION	VEGETATION CLASSIFICATION	EFFECTIVE SLOPE	APZ WIDTH	BAL ACHIEVED
Residential lots/Structure Plan area				
South-west of the site	Woodland	Downslope 0-5 degrees	23 m	BAL-19
West of the site	Grassland	Downslope 0-5 degrees	15 m	BAL-12.5

AREA OF CLASSIFIED VEGETATION	VEGETATION CLASSIFICATION	EFFECTIVE SLOPE	APZ WIDTH	BAL ACHIEVED
North-west of the site	Grassland	Flat/upslope	15 m	BAL-19
North of the site	Grassland	Flat/upslope	8 m	BAL-29
Rural lot				
South-west of the site	Woodland	Downslope 0-5 degrees	17 m	BAL-29
West of the site	Grassland	Downslope 0-5 degrees	9 m	BAL-29
North-west of the site	Grassland	Flat/upslope	8 m	BAL-29

Temporary APZ

5.1.2.7 Acceptable solution A2.2: Hazard separation zone

A Hazard Separation Zone (HSZ) is a fuel managed zone to create separation between dwellings and bushfire hazards. This generally extends out to 100 metres from buildings. In the case of subdivision within the site, the provision of a HSZ is not an appropriate method to respond to relevant bushfire hazards.

The need for a HSZ is avoided through the provision of an appropriate Asset Protection Zone (as outlined above) and an increase in construction standards for dwellings (where applicable) in accordance with AS 3959. The indicative BAL assessment within this BMP demonstrates that these provisions will achieve acceptable levels of risk for the development, and BAL-29 is not exceeded.

5.1.3 Element: Vehicular access

5.1.3.1 Intent

To ensure vehicular access serving a subdivision/development is available and safe during a bushfire event.

5.1.3.2 Background

The indicative road network of the proposed Structure Plan is shown in **Figure 4**. The network integrates with the existing McDonald Road to the east, which provides access to Fifty Road to the south and connects with the road network of the existing residential development east of the site. Access will be provided to future residential development north of the site when such development occurs in line with the land use zoning of the area.

5.1.3.3 Acceptable solution A3.1: Two access routes

The proposed road system provides a loop through the site, back to McDonald Road in the east, as shown in **Figure 4**, which provides all residents and fire fighters with two road access options at all times. Additional access will be provided through to future residential development north of the site, at such a time as development progresses in this area (in accordance with the land use zoning shown in **Figure 6**).The Structure Plan shows two access points to McDonald Road in the east, which provides access to Fifty Road in the south, and through the adjacent residential development to the east.

5.1.3.4 Acceptable solution A3.2: Public roads

Surrounding public roads and all new public roads and laneways within the site will comply with the following minimum standards:

- Minimum trafficable surface: 6 metres
- Horizontal clearance: 6 metres
- Vertical clearance: 4.5 metres
- Maximum grades over <50 metres: 1 in 10
- Minimum weight capacity: 15 tonnes
- Maximum crossfall: 1 in 33
- Minimum inner radius of curves: 8.5 metres.

5.1.4 Element: Water

5.1.4.1 Intent

To ensure water is available to the subdivision, development or land use to enable people, property and infrastructure to be defended from bushfire.

5.1.4.2 Acceptable Solution A4.1: Reticulated water

The development is located within an Emergency Services Levy (ESL) Category 3 area, which indicates that emergency bushfire response is provided by a volunteer fire and rescue service brigade, with the assistance of career fire stations. Fire response services require ready access to an adequate water supply during bushfire emergencies.

The development will be provided with a reticulated water supply, together with fire hydrants that will be installed by the developer/s to meet the specifications of Water Corporation (Design Standard DS 63) and DFES. Fire hydrants on land zoned as residential are required to be sited at or within 200 m of residential dwellings (Class 1a).

The Water Corporation would be responsible for all hydrant maintenance and repairs.

5.2 Future development

This BMP is expected to inform future detailed bushfire hazard and risk assessment/s that will be prepared and implemented as part of future subdivision or development stage, undertaken in accordance with the Structure Plan.

5.3 Access and fire breaks

Compliance with the City of Rockingham Fire Control Notice, attached in **Appendix C**, is required across the entire site until such a time as development is completed, and public road access must provide two access options at all stages of development.

It is assumed that a minimum three metre wide firebreak will be maintained (adjacent to the western boundary of the site, as shown in **Figure 9**) by the landholder/s of the adjacent rural landholdings west of the site, in accordance with their requirements under the City of Rockingham's Fire Control Notice.

5.4 Public education

Community bushfire safety is a shared responsibility between individuals, the community, government and fire agencies. DFES has an extensive Community Bushfire Education Program including a range of publications, a website and Bushfire Ready Groups. Prepare. Act. Survive. (DFES, 2012) provides excellent advice on preparing for and surviving the bushfire season. Other downloadable brochures are available from http://www.dfes.wa.gov.au/safetyinformation/fire/bushfire/pages/publications.aspx.

The City of Rockingham provides bushfire safety advice to residents available from their website http://www.rockingham.wa.gov.au/Services/Safety-and-security-services/Fire-safety-and-emergencies. It also provides details on how to become a volunteer at either of the local volunteer Bush Fire Brigades. Professional, qualified consultants also offer bushfire safety advice and relevant services to residents and businesses in high risk areas.

5.5 Assessment of bushfire management strategies

The bushfire hazard that could threaten this development is concentrated to the west of the site, associated with remnant vegetation within rural landholdings. These hazards have been considered through the strategic placement of road reserves to achieve the required APZs, and to ensure that dwellings are not exposed to an unacceptable level of risk (i.e. BAL-29 is not exceeded).

5.6 Implementing the Bushfire Management Plan

The following table outlines the future and/or ongoing responsibilities of the future developer/s, lot owners or residents, and the City of Rockingham relating to bushfire risk mitigation.

As outlined in **Table 3** below, the future owners/occupiers of lots within the site, as created through future subdivision stages, are to maintain a reduced level of risk from bushfire within their properties (where applicable), and will be responsible for undertaking, complying and implementing measures to protect their own assets (and people under their care) from the threat and risk of bushfire.

Table 3: Responsibilities for the implementation of the BMP

MANAGEMENT ACTION	TIMING
DEVELOPER/S	
Undertake further detailed bushfire assessment to determine ultimate BAL ratings for the site, with assessment recommendations to be submitted to the City of Rockingham and accommodated in the lot clearances and/or Detailed Area Plan outcomes.	As part of the subdivision approval or Detailed Area Plan preparation process (whichever comes first).
For each new lot created within areas exposed to a BAL rating exceeding BAL-LOW, lodge a Section 70A Notification on the Certificate of Title in order to alert purchasers and successors in title of the existence of the overarching BMP and specifically the requirements associated with meeting the AS 3959 construction standards.	At the creation of titles within future subdivision stage/s.
Install the public roads to standards outlined in **Section 5.1.3** and ensure two access ways are provided at all times.	As part of subdivision and development.
On all vacant land, comply with the City of Rockingham Fire Control Notices as published.	Ongoing, where applicable.
Install reticulated water supply and hydrants to Water Corporation, DFES and the City of Rockingham standards.	As part of subdivision and development.
Establish and maintain the APZs within the site to standards as specified in this document.	As part of subdivision and development.
Provide detailed hydrant plans to the City of Rockingham and DFES local fire station for monitoring.	At subdivision approval stage.
Make a copy of this BMP available to each lot owner subject to AS 3959 construction standards, along with the *Homeowners Bush Fire Survival Manual, Prepare, Act, Survive* (or similar suitable documentation) and the City of Rockingham's Fire Control Notice.	As part of the sale of lots.
PROPERTY OWNER/OCCUPIER	
Ensuring that all lots comply with the City of Rockingham Fire Control Notices as published.	Ongoing, where applicable.
Maintaining each property in good order to minimise bushfire fuels, and maintaining APZ areas (where applicable) in accordance with the requirements outlined in this BMP.	Ongoing, where applicable.
Ensuring that where hydrants are located, they are not obstructed and remain visible at all times.	Ongoing, where applicable.
Ensuring construction of dwelling/s complies with AS 3959, if required.	As part of dwellings design and construction.
If dwellings are subject to additional construction in the future, such as renovations, AS 3959 compliance is required.	As part of design and construction.
CITY OF ROCKINGHAM	
Providing fire prevention and preparedness advice to landowners upon request, including the *Homeowners Bush Fire Survival Manual, Prepare, Act, Survive* (or similar suitable documentation) and the City of Rockingham's Fire Control Notice.	Ongoing, as requested.
Monitoring bush fuel loads in road reserves and liaising with relevant stakeholders to maintain fuel loads at safe levels.	Ongoing.

MANAGEMENT ACTION	TIMING
Ensuring emergency response is provided via the Baldivis Volunteer Bush Fire Brigade.	Ongoing.
Maintaining public roads to appropriate standards and ensuring compliance with the City of Rockingham Fire Control Notices.	Ongoing.
BALDIVIS VOLUNTEER BUSH FIRE BRIGADE	
The Baldivis Volunteer Bush Fire Brigade is responsible for responding to emergency situations relating to bushfire within the City of Rockingham. Where bushfire threatens the site, the local brigade will utilise the internal road network of the site to protect life and property.	Ongoing, as required.
WATER CORPORATION	
The Water Corporation is responsible for the repair of water hydrants.	Ongoing, when required.

6 Conclusions and Recommendations

6.1 Conclusion

The site is designated as bushfire prone within the state *Map of Bushfire Prone Areas*. This BMP has been prepared to address the requirements of SPP 3.7 and the *Guidelines for Planning in Bushfire Prone Areas* (WAPC *et al.* 2015). It has been demonstrated that the bushfire protection performance criteria outlined in the guidelines (WAPC *et al.* 2015) can be achieved through:

- Providing appropriate vehicular access options, or as an alternative a designated FSA or CFR.
- Providing sufficient water supply to ensure emergency services are able to respond to a bushfire event.
- Siting of development to ensure buildings are not exposed to an unacceptable level of radiant flux, without appropriate mitigation measures.

This BMP is expected to inform future bushfire assessment/s that will be prepared and implemented as part of the future subdivision or development approval process.

Dwellings located within 100 m of identified classified vegetation will have the bushfire risk mitigated through the use of appropriate APZs and via compliance with AS 3959. The indicative BAL assessment included in this BMP demonstrates that BAL-29 would not be exceeded and APZs can be accommodated within the proposed future road reserves in the south and west of the site, in response to the adjacent hazards.

Landholdings north of the site are undergoing separate urban development approvals, therefore Grassland vegetation within this landholding are considered temporary, and will pose only temporary bushfire risk to the site. Once vegetation is removed to accommodate urban development (in line with the relevant subdivision approvals) the bushfire risk posed to the site from this area will also be removed.

Appropriate APZs have been accommodated where required in order to provide an adequate setback to ensure dwellings are not exposed to an unacceptable level of radiant heat flux (i.e. greater than BAL-29) from potential bushfires in adjacent classified vegetation. Loop roads and reticulated water supply and hydrants are provided. The proposed development will fall within the acceptable level of risk.

6.2 Recommendations

Based on the bushfire hazard assessment contained within this BMP, the following key recommendations should be considered for the implementation of the Structure Plan:

- By implementing this BMP, the bushfire risk to development within the site can be mitigated through the provision of appropriate APZs combined with increased construction standards in accordance with AS 3959.
- The indicative BAL assessment undertaken as part of this BMP indicates that no future lots within the site will be exposed to an unacceptable level of radiant heat flux (i.e. no greater than BAL-29).
- Future BAL assessment/s (undertaken to support future subdivision or development approval stage/s) will enable a more accurate reflection of the bushfire risk posed by surrounding classified vegetation at the time that development progresses within the site. This BAL assessment/s will specify ultimate BAL ratings for each lot as well as APZ requirements (where applicable).

7 References

Abbott I. (2003). Aboriginal fire regimes in south-west Western Australia: evidence from historical documents. Pages 119-146 in Abbott I and Burrows N, editors. Fire in ecosystems of south-west Western Australia: impacts and management. Backhuys, Leiden, The Netherlands.

Blanchi R, Lucas C, Leonard J and Finkele K. (2010). Meteorological conditions and wildfire -related house loss in Australia. CSIRO Publishing, Melbourne.

Bureau of Meteorology (BoM). (2015). http://www.bom.gov.au/climate/averages/tables/cw_009194.shtml (accessed April 2015).

Burrows N and Abbott I. (2003). Fire in south-west Western Australia: synthesis of current knowledge, management implications and new research directions. Pages 437-452 in N. Burrows and I. Abbott, editors. Fire in ecosystems of south-west Western Australia: impacts and management. Backhuys, Leiden, The Netherlands.

Cheney P and Sullivan P. (2008). Grassfires. Fuel, Weather and Fire Behaviour. 2nd edition CSIRO Publishing.

Crisp MD, Burrows GE, Cook LG, Thornhill AHl and Bowman D. (2011). Flammable biomes dominated by eucalypts originated at the Cretaceous–Palaeogene boundary. In Nature Communications 2. Article No 193.

Department of Fire and Emergency Services (DFES). (2011). Plant Guide within the Building Protection Zone for the Swan Coastal Plain of Western Australia. http://www.dfes.wa.gov.au/safetyinformation/fire/bushfire/BushfireProtectionPlanningPublications/FESA%20Plant%20Guide-BP%20Zone-Final-w.pdf

DFES. (2014). PREPARE. ACT. SURVIVE. http://www.dfes.wa.gov.au/safetyinformation/fire/bushfire/BushfireManualsandGuides/DFES_Bushfire-Prepare_Act_Survive_Booklet.pdf

DFES. (2013). Submission of Documents to DFES for Assessment. DFES BEB Guideline No: GL-07 http://www.dfes.wa.gov.au/regulationandcompliance/buildingplanassessment/Guidelines/GL-07-SubmissionOfDocumentsToDFESForAssessment.pdf

Gibbons P, van Bommel L, Gill AM, Cary GJ, Driscoll DA, Bradstock RA, Knight E, Moritz MA, Stephens SL and Lindenmayer DB. (2012). Land Management Practices Associated with House Loss in Wildfires. PLoS ONE 7(1): e29212. doi:10.1371/journal.pone.0029212.

Gould JS, McCaw WL, Cheeney NP, Ellis PF, Knight IK, and Sullivan AL. (2007) Project Vesta - Fire in Dry Eucalypt Forest: Fuel Structure, fuel dynamics and fire behaviour. Ensis-CSIRO, Canberra ACT, and Department of Environment and Conservation, Perth WA.

Hallam SJ. (1975). Fire and Hearth: A study of Aboriginal usage and European surpation in south-western Australia. Australian Instititue of Aboriginal Studies, Canberra, Australia.

Leonard J. (2009). Report to the 2009 Victorian Royal Commission Building Performance in Bushfires. CSIRO Sustainable Ecosystems.

NSW Rural Fire Service. (2004). Bushfire Evacuation Plans (see: www.rfs.nsw.gov.au).

Standards Australia. (2009). AS 3959 Construction of buildings in bushfire-prone areas.

Standards Australia. (2009). AS/NZS ISO 31000:2009 Risk management – Principles and guidelines.

Victorian Bushfires Royal Commission (VBRC). (2009). Interim Report. Government Printer for the State of Victoria.

Western Australian Planning Commission (WAPC) and Department of Fire and Emergency Services (DFES) (2015). Guidelines for Planning in Bushfire Prone Areas. Western Australian Planning Commission, Perth.

Western Australian Planning Commission (WAPC), FESA and Department of Planning and Infrastructure. (2010). Planning for Bush Fire Protection - Edition 2. Western Australian Planning Commission, Perth.

Walker J. (1981). Fuel dynamics in Australian vegetation. Pages 101-127 in Gill AM, Groves RH and Noble IR, editors. Fire and the Australian biota. Australian Academy of Science, Canberra, Australia

8 Glossary

AS	Australian Standard
AHD	Australian Height Datum
APZ	Asset Protection Zone
BAL	Bushfire Attack Level
BCA	Building Code of Australia
BMP	Bushfire Management Plan
BOM	Bureau of Meteorology
DFES	Department of Fire and Emergency Services (was FESA)
ESL	Emergency Services Levy
FESA	Fire and Emergency Services (now DFES)
HSZ	Hazard Separation Zone
LPS	Local Planning Scheme
POS	Public Open Space
TPS	Town Planning Scheme
VBRC	Victorian Bushfires Royal Commission
WAPC	Western Australian Planning Commission

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FIGURES

Figure 1:	**Location Plan**	0	**Plan Number: EP15-057(03)--F03b**	
Project:	Bushfire Management Plan Portion of Lot 16 McDonald Road, Baldivis		Drawn: KNM	Date: 31/08/2016
Client:	Defence Housing Australia		Approved: JDH	Date: 07/09/2016
			Checked: VMK	Scale: 1:5,000@A4

0 50 100 200 Metres

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Figure 2:	**Site Plan and Assessment Area**	0	**Plan Number: EP15-057(03)--F04b**
Project:	Bushfire Management Plan Portion of Lot 16 McDonald Road, Baldivis		Drawn: KNM Date: 31/08/2016 Approved: JDH Date: 07/09/2016 Checked: VMK Scale: 1:2,250@A4
Client:	Defence Housing Australia		0 20 40 80 Metres

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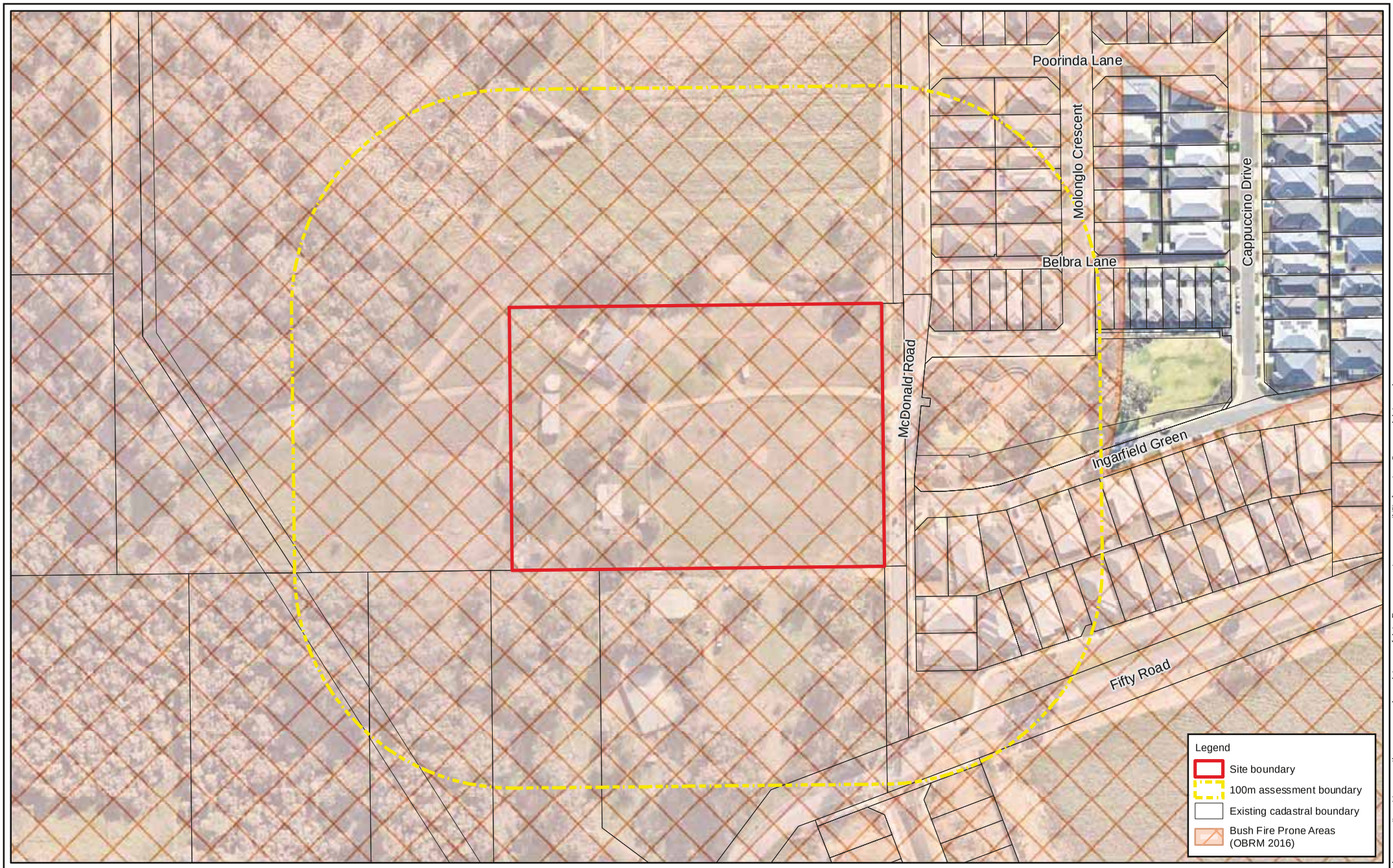

Figure 3: Map of Bushfire Prone Areas

Project: Bushfire Management Plan
Portion of Lot 16 McDonald Road, Baldivis

Client: Defence Housing Australia

0

Plan Number: EP15-057(03)--F05b

Drawn:	KNM	Date:	31/08/2016
Approved:	JDH	Date:	07/09/2016
Checked:	VMK	Scale:	1:2,250@A4

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Figure 4:	**Proposed Structure Plan**	0	**Plan Number: EP15-057(03)--F06c**
Project:	Bushfire Management Plan Portion of Lot 16 McDonald Road, Baldivis		Drawn: KNM Date: 31/08/2016 Approved: JDH Date: 07/09/2016 Checked: VMK Scale: 1:1,500@A4
Client:	Defence Housing Australia		0 15 30 60 Metres

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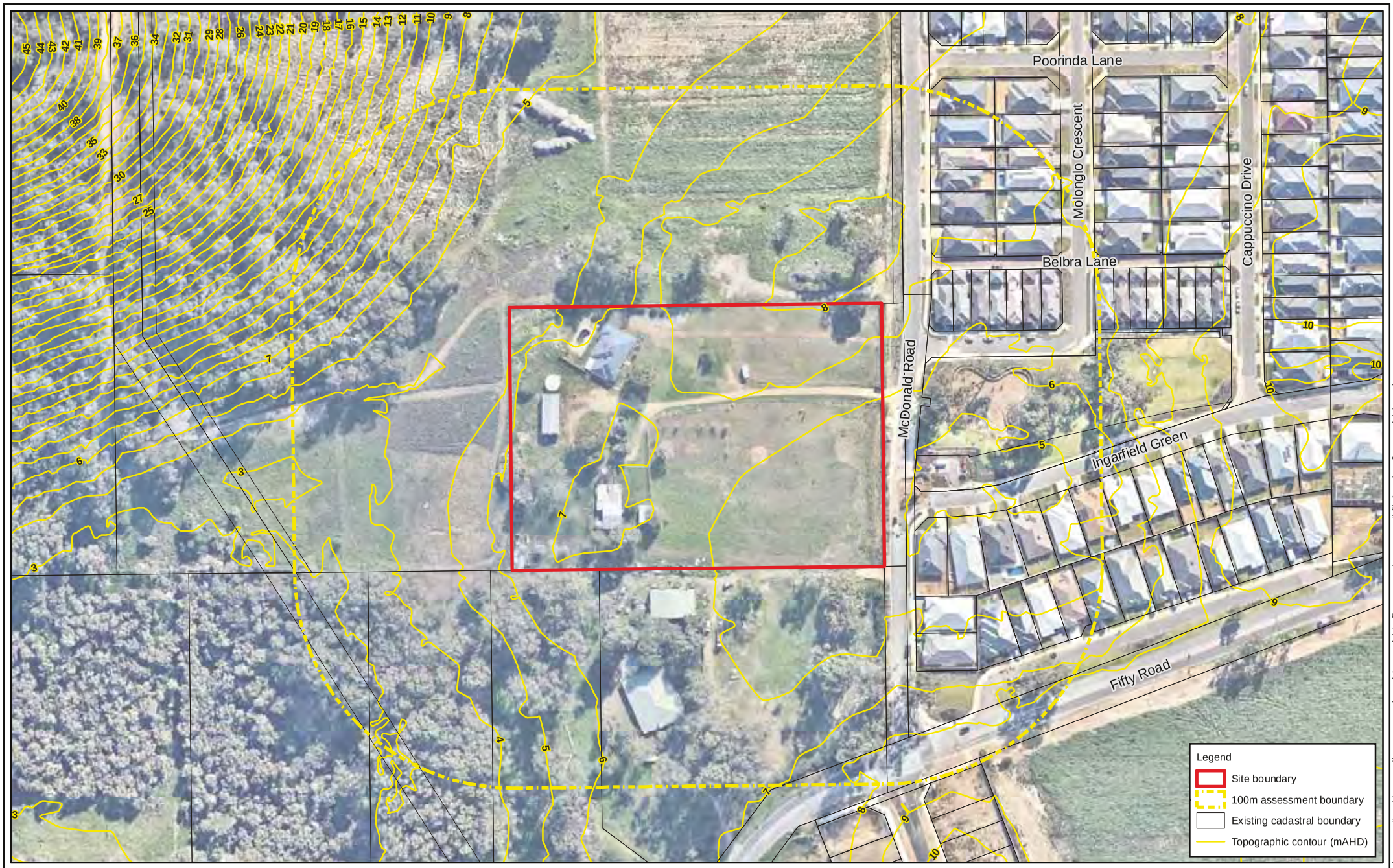

Figure 5:	**Site Topography**	0	**Plan Number: EP15-057(03)--F07b**
Project:	Bushfire Management Plan Portion of Lot 16 McDonald Road, Baldivis		Drawn: KNM Date: 31/08/2016 Approved: JDH Date: 07/09/2016 Checked: VMK Scale: 1:2,250@A4
Client:	Defence Housing Australia		0 20 40 80 Metres

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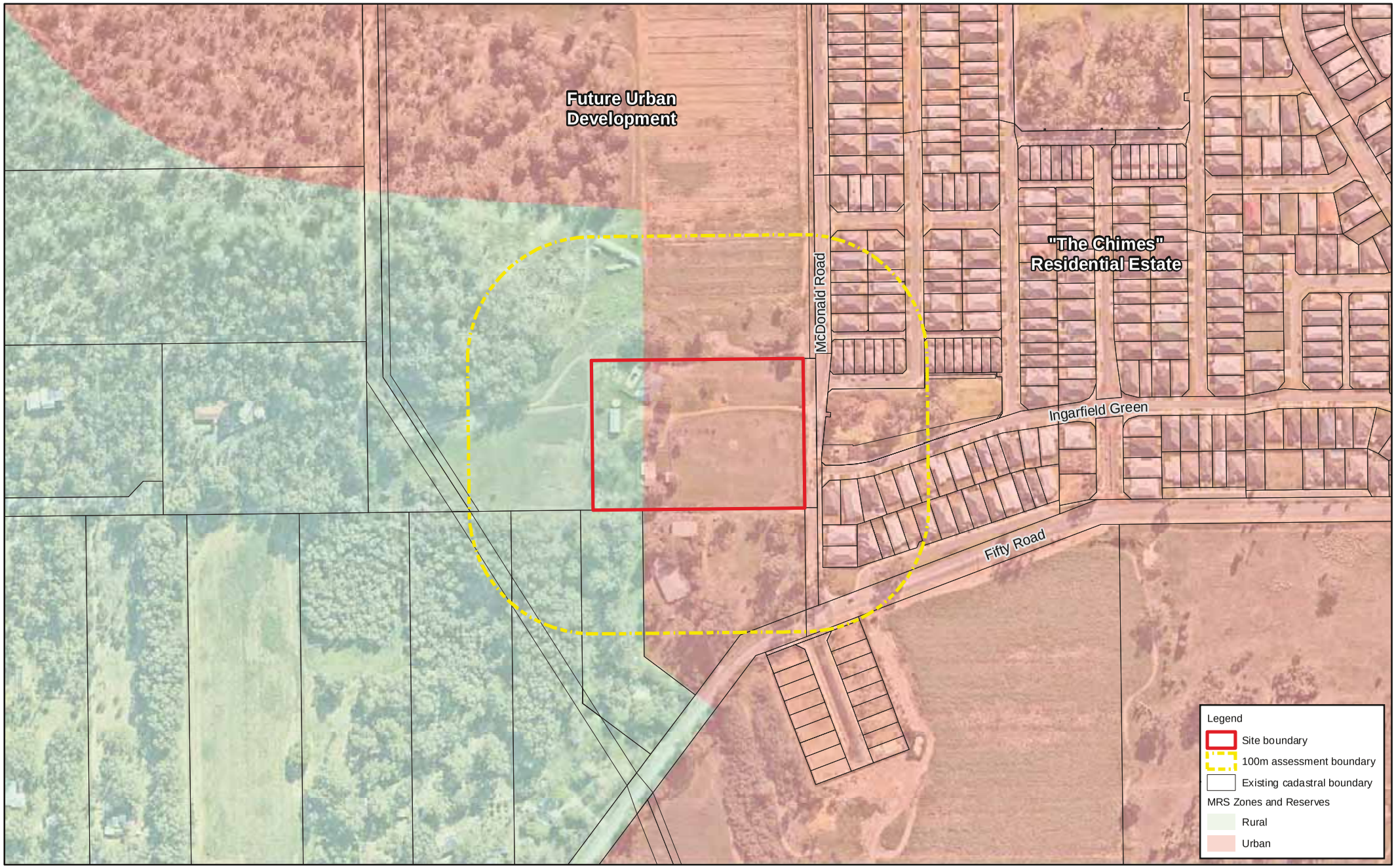

Figure 6: Local Context and Surrounding Land Uses

Project: Bushfire Management Plan
Portion of Lot 16 McDonald Road, Baldivis

Client: Defence Housing Australia

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Plan Number: EP15-057(03)--F08b

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Approved:	JDH	Date:	07/09/2016
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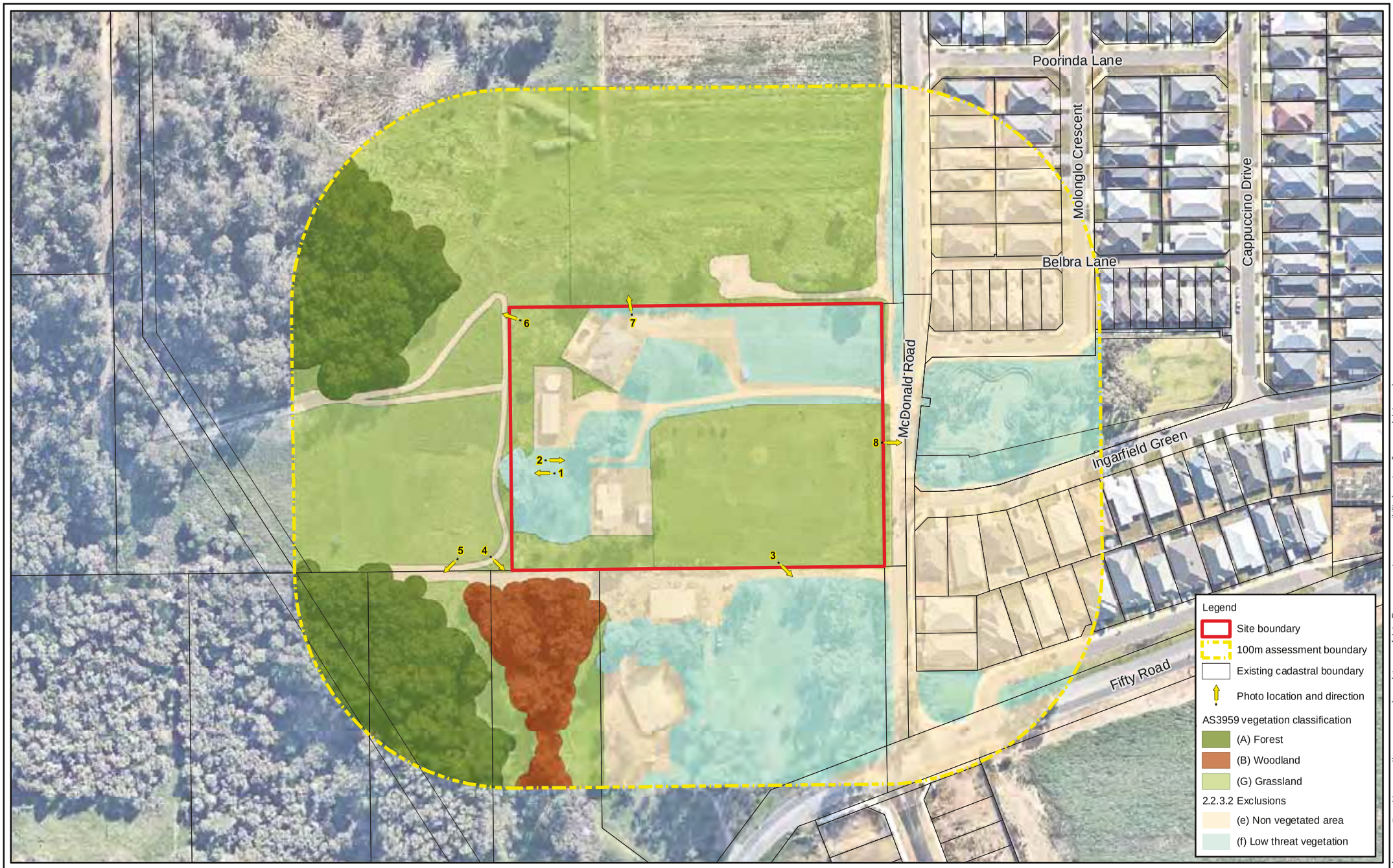

Figure 7:	**Existing Site Conditions – AS 3959 Vegetation Classification**	0	**Plan Number: EP15-057(03)--F09b**
Project:	Bushfire Management Plan Portion of Lot 16 McDonald Road, Baldivis		Drawn: KNM Date: 31/08/2016 Approved: JDH Date: 07/09/2016 Checked: VMK Scale: 1:2,250@A4
Client:	Defence Housing Australia		0 20 40 80 Metres

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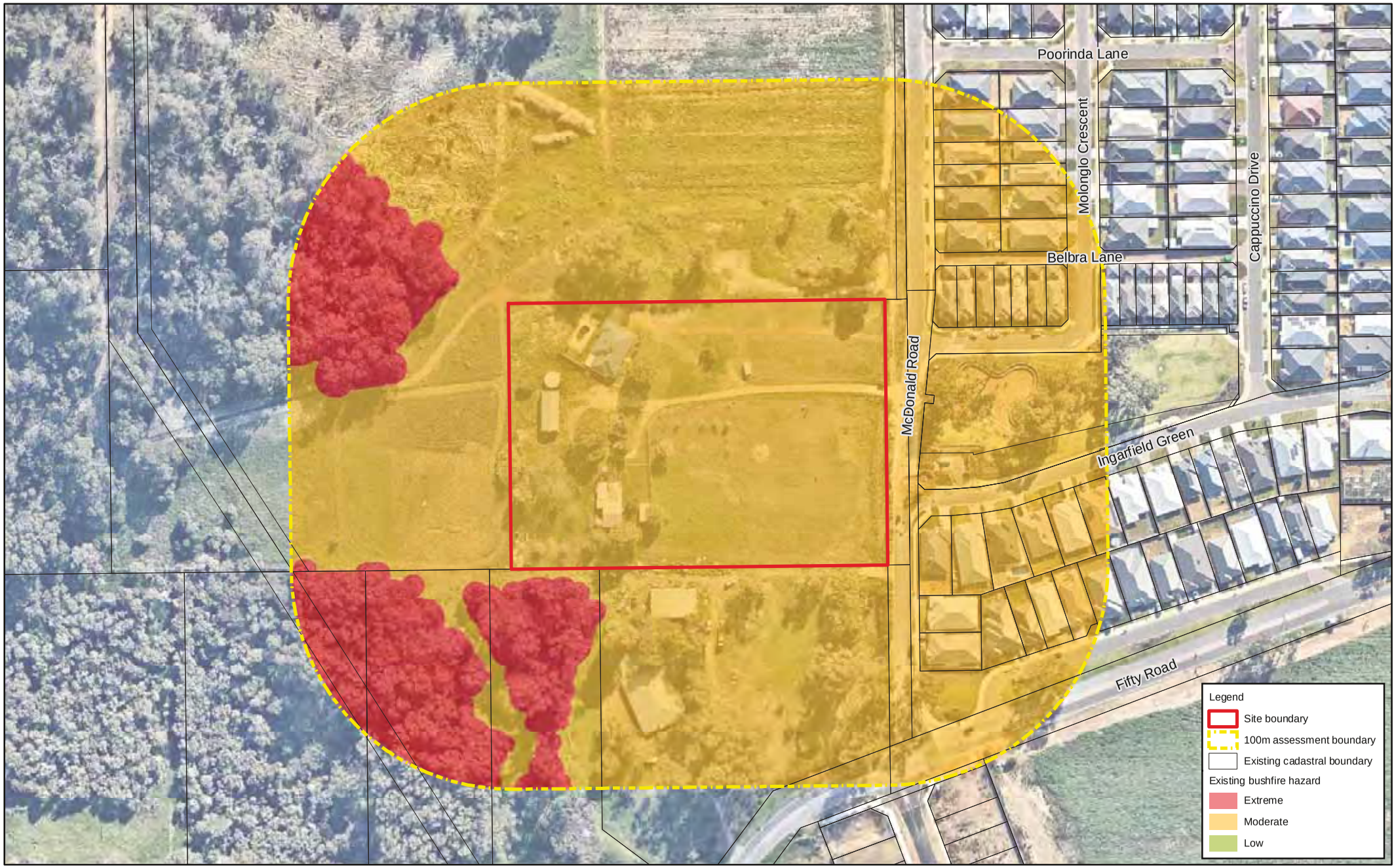

Figure 8:	**Existing Site Conditions – Bushfire Hazard Assessment**	0	**Plan Number: EP15-057(03)--F10b**
Project:	Bushfire Management Plan Portion of Lot 16 McDonald Road, Baldivis		Drawn: KNM Date: 31/08/2016 Approved: JDH Date: 07/09/2016 Checked: VMK Scale: 1:2,250@A4
Client:	Defence Housing Australia		0 20 40 80 Metres

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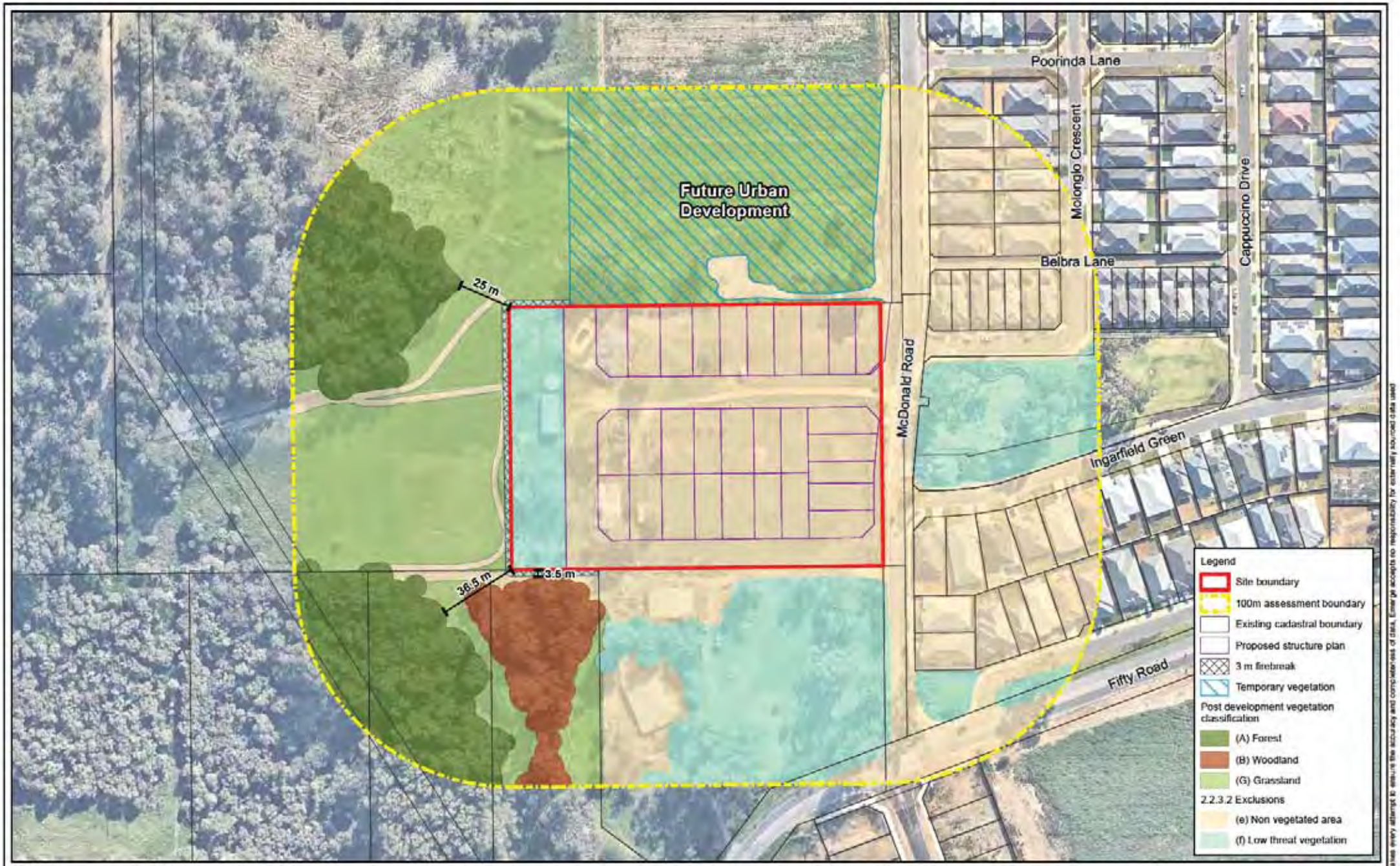

Figure 9: **Post Development Site Conditions – AS 3959 Vegetation Classification**

Project: Bushfire Management Plan
Portion of Lot 16 McDonald Road, Baldivis

Client: Defence Housing Australia

Plan Number: EP15-057(03)--F12c

Drawn:	KNM	Date:	05/09/2016
Approved:	JDH	Date:	07/09/2016
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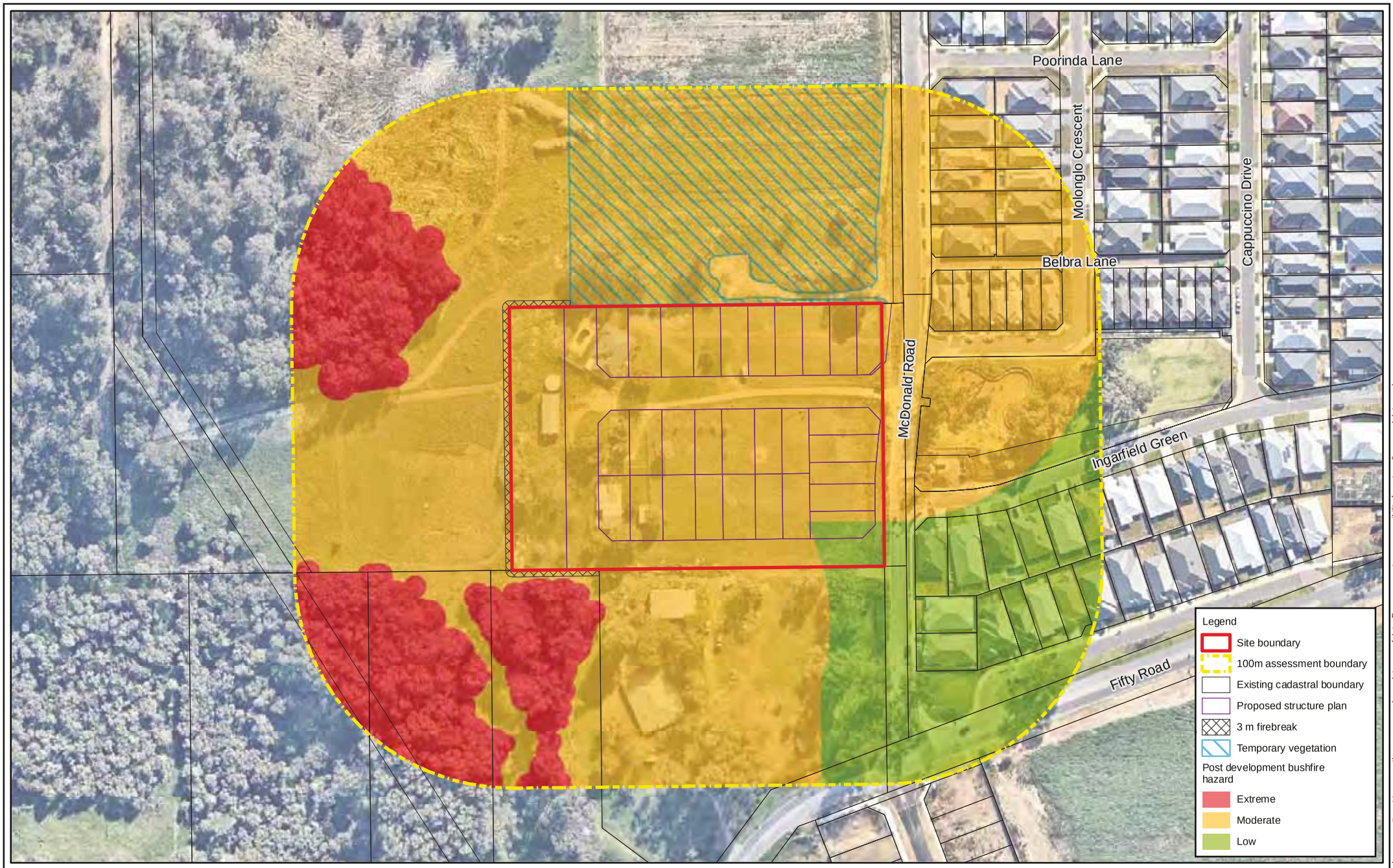

Figure 10:	**Post Development Site Conditions – Bushfire Hazard Assessment**	0	**Plan Number: EP15-057(03)--F13c**
Project:	Bushfire Management Plan Portion of Lot 16 McDonald Road, Baldivis		Drawn: KNM Date: 05/09/2016 Approved: JDH Date: 07/09/2016 Checked: VMK Scale: 1:2,250@A4
Client:	Defence Housing Australia		0 20 40 80 Metres

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Figure 11: Effective Slope

Project:	Bushfire Management Plan Portion of Lot 16 McDonald Road, Baldivis
Client:	Defence Housing Australia

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Plan Number: EP15-057(03)--F14c			
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Approved:	JDH	Date:	07/09/2016
Checked:	VMK	Scale:	1:2,250@A4

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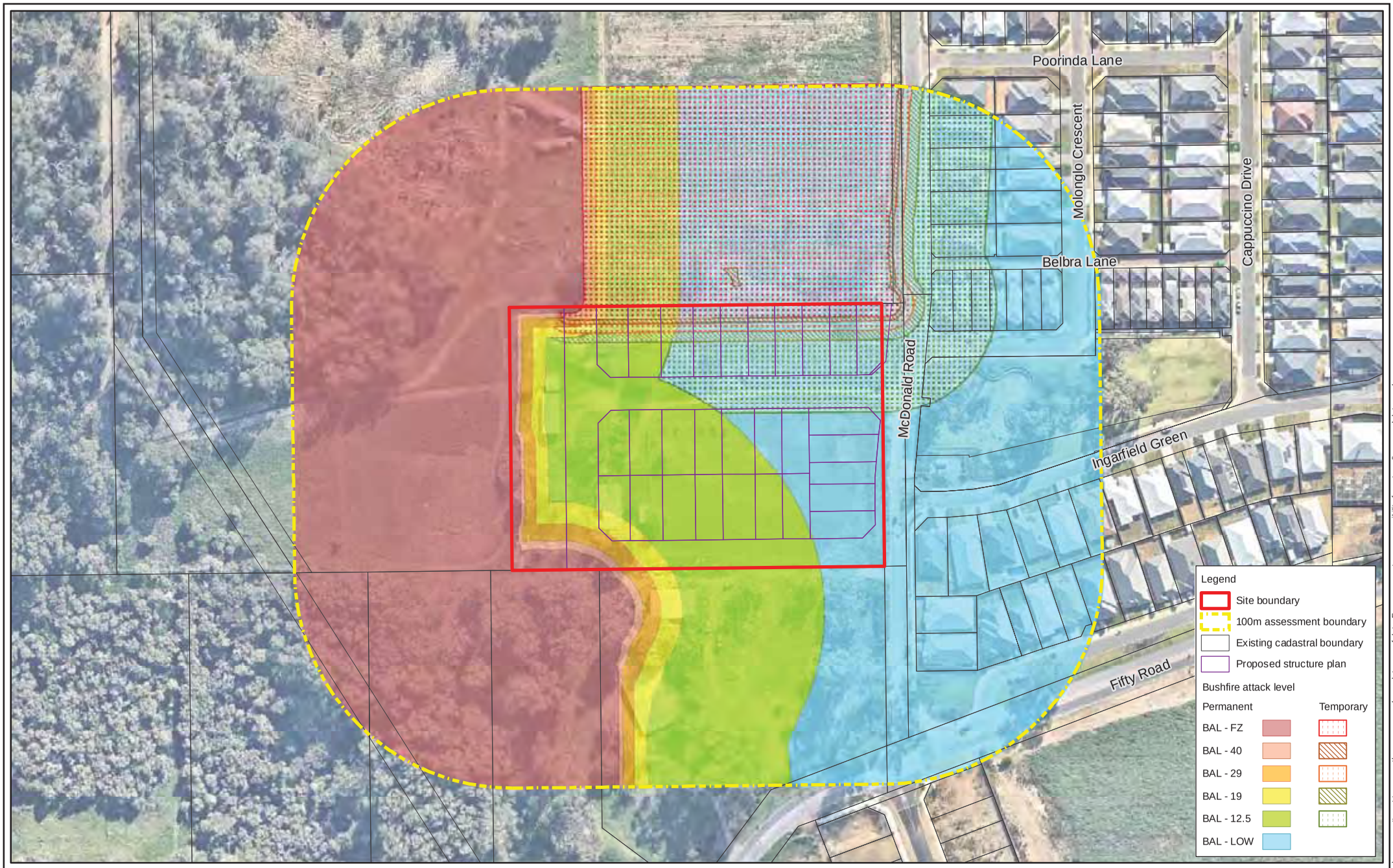

Figure 12: Indicative Bushfire Attack Levels

Project:	Bushfire Management Plan Portion of Lot 16 McDonald Road, Baldivis
Client:	Defence Housing Australia

0

Plan Number: EP15-057(03)--F15c			
Drawn:	KNM	Date:	05/09/2016
Approved:	JDH	Date:	07/09/2016
Checked:	VMK	Scale:	1:2,250@A4

0 20 40 80 Metres

Bushfire Safety Consulting

emerge ASSOCIATES Integrated Science & Design

Figure 12: Asset Protection Zone Requirements

Project:	Bushfire Management Plan Portion of Lot 16 McDonald Road, Baldivis
Client:	Defence Housing Australia

0

Plan Number: EP15-057(03)--F16e			
Drawn:	KNM	Date:	28/11/2016
Approved:	JDH	Date:	28/11/2016
Checked:	VMK	Scale:	1:2,250@A4

0 20 40 80 Metres

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APPENDIX A

PORTION OF LOT 16 MCDONALD ROAD, BALDIVIS STRUCTURE PLAN

TPG (2016)

APPENDIX B

COMPLIANCE CHECKLIST

Appendix B: Compliance Checklist

ELEMENT/QUESTION	RESPONSE
1: Location	
Does the proposal comply with the performance criteria by applying acceptable solution A1.1?	Yes.
2: Siting and design of the Development	
Does the proposal comply with the performance criteria by applying acceptable solution A2.1?	Yes.
Does the proposal comply with the performance criteria by applying acceptable solution A2.2?	No. However the performance criteria P2 is achieved through the provision of a compliant APZ, and the application of increased construction standards in accordance with AS 3959.
3: Vehicular access	
Does the proposal comply with the performance criteria by applying acceptable solution A3.1?	Yes.
Does the proposal comply with the performance criteria by applying acceptable solution A3.2?	Yes.
Does the proposal comply with the performance criteria by applying acceptable solution A3.3?	Not applicable.
Does the proposal comply with the performance criteria by applying acceptable solution A3.4?	Not applicable.
Does the proposal comply with the performance criteria by applying acceptable solution A3.5?	Not applicable.
Does the proposal comply with the performance criteria by applying acceptable solution A3.6?	Not applicable.
Does the proposal comply with the performance criteria by applying acceptable solution A3.7?	Not applicable.
Does the proposal comply with the performance criteria by applying acceptable solution A3.8?	Not applicable.
4: Water	
Does the proposal comply with the performance criteria by applying acceptable solution A4.1?	Yes.
Does the proposal comply with the performance criteria by applying acceptable solution A4.2?	Not applicable.
Does the proposal comply with the performance criteria by applying acceptable solution A4.3?	Not applicable.

Applicant Declaration

I declare that the information provided is true and correct to the best of my knowledge.

Signature:

Name: Rohan Carboon

Date: 8 September 2016

APPENDIX C

CITY OF ROCKINGHAM FIRE CONTROL NOTICE

Fire Control Notice

NOTICE TO OWNERS AND/OR OCCUPIERS OF LAND IN THE CITY OF ROCKINGHAM

As a landowner or occupier you have a legal requirement under Section 33 of the Bush Fires Act 1954 to carry out fire prevention works on your property in accordance with the provisions of this Fire Control Notice.

You are required on or before 30 November 2015, to remove all flammable material or to install three (3) metre wide mineral earth firebreaks (mineral earth in definition being land totally clear of all vegetation living or dead) and any overhanging trees or other vegetation to a clearance height of four (4) metres. These fire prevention works must be maintained up to and including 31 May 2016.

Inspection of properties will be carried out in all areas for compliance with this Notice after 30 November 2015. Persons who fail to comply with the requirements of this Notice will be issued with an infringement notice ($250).

It is the property owner's responsibility to ensure the standard of prevention work is undertaken and maintained as per this Notice

Correct Rural Firebreak

Urban Slashed Property

Rural Land

On or before 30 November 2015 and thereafter up to and including 31 May 2016:

Have **FIREBREAKS** not less than three (3) metres wide immediately inside and along all boundaries, with all overhanging tree branches, tree limbs etc. to be trimmed back clear of the firebreak to a clearance height of four (4) metres.

Maintained and living lawns are acceptable in conjunction with or in lieu of mineral earth firebreaks, provided that the same minimum width and height requirements for a firebreak are maintained.

Buildings/Sheds and Haystacks

Have FIREBREAKS not less than five (5) metres wide so far as to surround all buildings, sheds and haystacks, with all overhanging branches, trees, limbs etc. to be trimmed back clear of the firebreak to a clearance height of four (4) metres.

Fire Management Plans

All properties within subdivisions/developments within the City of Rockingham shall comply with the Fire Management Plans for their estate to the satisfaction of Council or its duly Authorised Officer.

Building Protection Zones

For properties in a bush fire risk area, install a 20m building protection zone. For more information visit the DFES website and search Building Protection Zones.

Urban Areas (Vacant Land)

On or before 30 November 2015 and thereafter up to and including 31 May 2016:

Land less than 2000 m²

Have the entire vacant land clear of all flammable material by slashing, mowing or other means to a height no greater than 50mm.

Land more than 2000 m²

Have FIREBREAKS not less than three (3) metres wide immediately inside and along all boundaries of the vacant land with all overhanging tree branches, trees, limbs etc. to be trimmed back clear of the firebreak area to a clearance height of four (4) metres.

Or

Maintained and living lawns are acceptable in conjunction with or in lieu of mineral earth firebreaks, provided that the same minimum width and height requirements for a firebreak are maintained.

Alternative Situations

Variation applications must be lodged in writing to the City of Rockingham by 16 October 2015. An application to Vary Location and Type of Firebreaks can be downloaded from the City's website or is available from the Emergency Services Administration Officer on 9527 0732.

Fire Control Enquiries

8.30am – 4.30pm Monday to Friday **Phone:** 9527 0732 **Email:** firecontrol@rockingham.wa.gov.au

Appendix 6

Infrastructure Servicing Report

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16 mcdonald road, baldivis

infrastructure servicing report

Project No. 15-046

pritchard francis
civil and structural engineering consultants

table of contents

Revision	Description	Author	Date
0	Due Diligence	Andrew Tucker	7 May 2015
1	For Submission with LSP	Andrew Tucker	5 January 2016
2	Modified Plan / Resubmission with LSP	Andrew Tucker	7 September 2016

1 Introduction

Pritchard Francis has been engaged by Defence Housing Australia (DHA) to undertake an Infrastructure Services Report to support the Structure Plan submission for residential development at a portion of Lot 16 McDonald Road, Baldivis.

This report outlines existing site conditions, adjacent services and likely development constraints. This report is based on the preliminary site layout contained within Appendix One.

2 Site Conditions

The site covers approximately 2.06ha in area and has frontages to McDonald Road to the east and existing rural space to the west, south and north.

This site is currently occupied by existing dwellings and structures on the western side of the lot and it is understood that the eastern half of the site was once used as a market garden.

2.1 Geology

The Perth sheet of the 1:50,000 scale Environmental Geology series maps (included in Appendix Two), indicates the site as having soil profiles as follows:

- SAND (s7) – derived from Tamala Limestone is pale yellowish brown, medium to course grained, sub-angular quartz, trace of feldspar, moderately sorted, of residual origin. Few limitations, some settlement under foundations can be expected, some ability to attenuate pollutants due to small clay content, usually considerable depth to water table due to topography.

The geological mapping shows a limestone outcrop about 100m to the north west of the site and peaty clay about 50-100m to the south west of the site.

The findings of the site from the geotechnical report, included in Appendix Three, are consistent with the geological mapping, with typically a thin layer of sand present over limestone. No peaty soils were encountered on site during the geotechnical investigation.

Limestone was present below the sand layer with rockhead varying from depths between 1.0m and more than the maximum depth of investigation (2.5m).

2.2 Topography

The current surface elevation of the site, in accordance with feature survey from Fyfe 71613/01, shows the site to vary from RL 4.0m AHD in the northwest corner, peaking in the middle of the site at about RL 7.2m and then falling to around RL 5.0m in the south east of the site. The centreline of McDonald Road ranges from RL 6.0m (south) to trapped low of RL 5.5m.

2.3 Groundwater Atlas

The Perth Groundwater Atlas indicates that the groundwater levels across the site range from 1.0m AHD to 2.0m AHD with the historical maximum approximated at 4.0m AHD. An extract from the Perth Groundwater Atlas can be found in Appendix Four.

2.4 Acid Sulphate Soils (ASS)

Mapping from the geotechnical report shown in Appendix Five shows the site having no known risk of ASS occurrence at depths less than 3m from the surface. The nearest high risk area is located approximately 50-100 m to the south west of the site.

2.5 Site Contamination

Galt Geotechnics report states that the nearest site classified as 'Remediated for Restricted Use' is located approximately 350m east of the site. Galt's geotechnical report is included in Appendix Three.

2.6 Demolition

The two most southern structures/dwellings are to be demolished and where required, the soil beneath them remediated due to historical construction techniques. The location of these can be seen in Appendix One, Preliminary Site Layout.

2.7 Earthworks

A topsoil strip of 100mm is required. We have assumed this will then be buried in the southern verge of the site and clean fill excavated will be used on site. Alternatively the topsoil will need to be removed from site.

Based on the historic market garden use for the site 500mm deep topsoil in old market garden area is assumed to be suitable for structure fill following additional compliance testing as per the Galt Geotechnics report.

Pad locations will need to be proof rolled once bulk earthworks have been completed.

It is likely that imported fill will be required across the site to make up the shortfall in material and to ensure overland flow paths and minimum grades.

3 Infrastructure

3.1 Roads

The access to the site will be from McDonald Road. Modifications will be required to the existing road reserve to allow for the construction of the proposed intersections as detailed in the concept plan in Appendix One.

3.2 Stormwater Drainage

An underground pit and pipe network is intended for the site and will be disposed of into underground tanks, most likely a modular plastic system allowing for infiltration and attenuation of the critical 1:100 year ARI event as the capacity of the basin on the east side of McDonald Road is considered to be at capacity in serving The Chimes.

3.3 Sewerage Reticulation

A 150mm diameter sewer has been allowed for to service the expected 30 lots. This can then gravity feed into the 150mm diameter sewer running along the west side of McDonald Road and then to the existing wastewater pump station adjacent to the lot. The sewerage catchment has been confirmed by the Water Corporation and the system has sufficient capacity for the 30 lot development.

Please refer to Appendix Six for Dial-Before-You-Dig information.

3.4 Water Reticulation

The site currently has a 150mm water main on the eastern side of McDonald Road. It is likely that connections into the 150mm main will be able to supply the site with water, which has been indicated by Water Corporation. Connection will need to be bored under McDonald Road. It is assumed internal water reticulation mains will be 100mm.

Please refer to Appendix Six for Dial-Before-You-Dig information.

3.5 Electrical Supply

Existing electrical infrastructure adjacent to the site includes:

- High and Low voltage cables along both sides of McDonald Road.
- Existing transformer directly opposite the site on McDonald Road.

Online mapping indicates the site will have 15-20MVA capacity in 2020 hence it is not anticipated capacity will be an issue.

Please refer to Appendix Six for dial before you dig information.

3.6 Communications

There is existing Telstra network located in McDonald Road, which is the existing service currently servicing the dwellings on site. It is expected there will be capacity to service this site.

Optic fibre currently exists along Fifty Road which is the adjoining road to the south.

Please refer to Appendix Six for dial before you dig information.

3.7 Gas

There is existing 110mm high pressure gas pipelines on the east side of McDonald Road. 40mm high pressure mains connect into this larger main to service the existing residential area to the east. It is expected this network will have capacity to service the development.

Please refer to Appendix Six for dial before you dig information.

4 Conclusion

The development of Lot 16 McDonald Road, Baldivis is not constrained by service capacities or upgrades with all services in close proximity to the site.

It is recommended further site investigations of the eastern portion of the site be undertaken to more accurately map the depth and extents of unsuitable material.

Due to the previous use of the site as a market garden it is recommended further investigations on potential impacts carried out as per the Galt Geotechnics Report.

appendices

Appendix One:	Preliminary Site Layout
Appendix Two:	Geological Mapping
Appendix Three:	Geotechnical Report
Appendix Four:	Groundwater Contours
Appendix Five:	Acid Sulphate Soils
Appendix Six:	Dial-Before-You-Dig Information
Appendix Seven:	Feature Survey

appendix one: preliminary site layout

LEGEND

- Subject Site
- **10m wide frontage single house lot** (300m² approx.)
- **12m wide frontage single house lot** (360m² approx.)
- **15m wide frontage single house lot** (450m² approx.)
- Rural / Urban zoning boundary
- Provisional bushfire setback (17m)
- Existing structure to be deleted
- Portion of road to be closed

LOT SIZES

Average	Range
408sqm*	303-490sqm*

* excluding balance lot

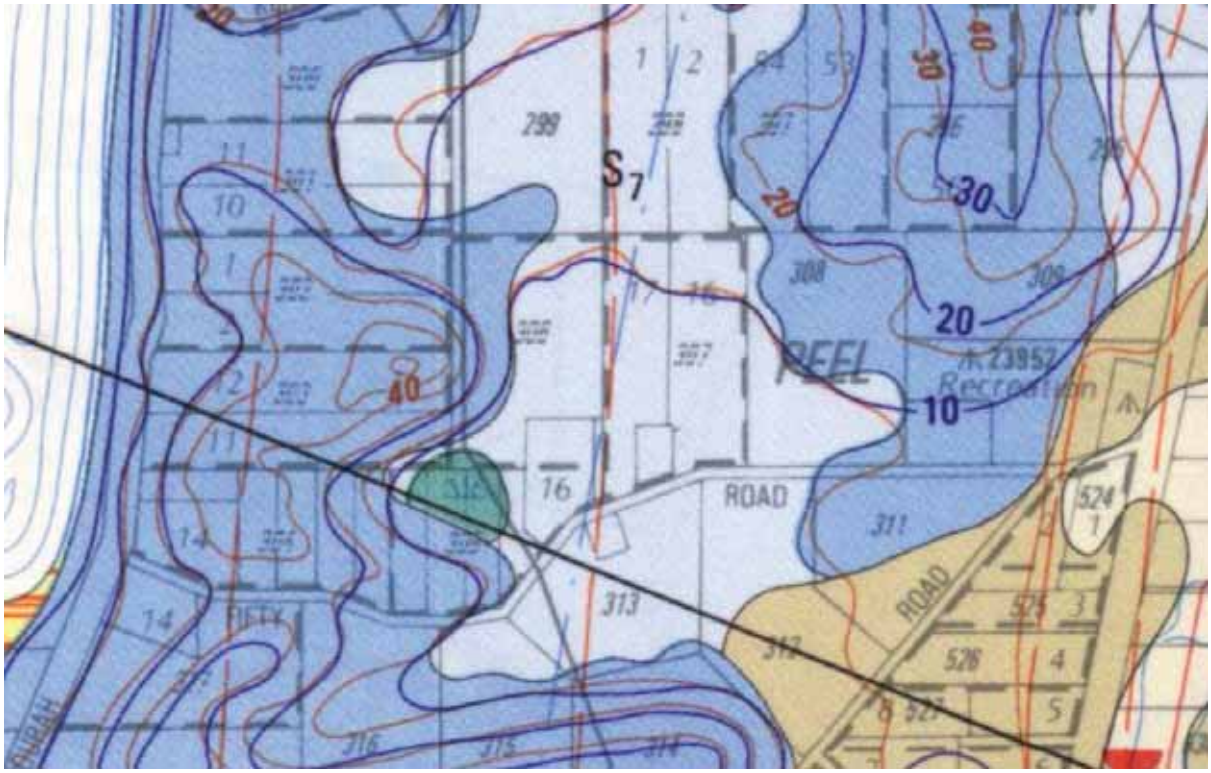
Subdivision Concept Plan

16 McDonald Road, Baldivis

Project Manager: AH Date: 4 August 2016
Drawn: OP Scale: 1:1,000 @ A3
Checked: AH Drawing No. 716-059 CP-1 A

tpg TOWN PLANNING URBAN DESIGN AND HERITAGE
Level 7, 182 St Georges Terrace
Perth Western Australia 6000
Telephone +61 08 9289 8300
Facsimile +61 08 9321 4786
www.tpgwa.com.au
The Planning Group WA Pty Ltd
ABN 36 097 275 222

appendix two: geological mapping


S7
40
30
20
10
PEEL
ROAD
ROAD
Recreation
299
308
309
311
313
524
525
526

appendix three: geotechnical report

Report on

GEOTECHNICAL AND PRELIMINARY ENVIRONMENTAL STUDY PROPOSED RESIDENTIAL SUBDIVISION 16 MCDONALD ROAD, BALDIVIS

Submitted to:
Defence Housing Australia
C/- Pritchard Francis
Level 1, 430 Roberts Road
SUBIACO WA 6008

www.galtgeo.com.au
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T: +61 (8) 6272-0200
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J1501070 001 R Rev0

30 April 2015

TABLE OF CONTENTS

TABLES (WITHIN TEXT)

FIGURES

APPENDICES

1. INTRODUCTION

This report presents the outcomes of Galt Geotechnics Pty Ltd (Galt's) geotechnical and preliminary environmental study for the proposed residential subdivision at 16 McDonald Road, Baldivis ("the site"). The location of the site relative to the surrounding area is shown on Figure 1, Site and Location Plan.

The investigation was requested by Lachlan Harris of Pritchard Francis and authorised by Jody Fisher of Defence Housing Australia in a signed client authorisation dated 13 April 2015 and email correspondence dated 14 April 2015.

2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

Based on the supplied information, the site is rectangular in plan and covers an area of 2.06 ha. Based on publicly available contour mapping, the current surface elevation is understood to vary from about RL 5.0 m AHD in the north west corner, peaking in the middle of the site at about RL 7.0 m AHD, and falling to around RL 6.0 m AHD in the east of the site.

The site is currently occupied by several existing residential dwellings and structures, generally on the western third of the site, with scattered large, established trees and bushes. A track runs from McDonald Road, east to west along the centre of the site to the existing structures. The balance of the site is cleared and grassed, with some areas evidently used as a laydown area. We understand that part of the eastern half of the site has been used as market gardens.

We understand that the end client, Defence Housing Australia, has concerns about possible previous uncontrolled filling of the site.

It is understood that the proposed development will comprise a residential subdivision. The latest concept plan for the proposed residential subdivision shows the development comprising 25 residential sized lots, ranging in size from 342 m^2 up to 570 m^2 and 3 roads, with the balance of the lot (5,976m^2) to consist of a rural zone, in which the existing residential dwelling will be retained.

We have not being given specific details regarding proposed structures on the site; however, we assume these will be typical single or double storey masonry structures, with shallow footings and slabs-on-ground

3. OBJECTIVES

The objectives of the study, based on the request from Pritchard Francis, were to:

Geotechnical

- assess subsurface soil and groundwater conditions across the site, including possible presence of rock / limestone and the possible presence of uncontrolled fill;
- provide recommendations on suitable footing systems for the proposed development;
- provide allowable bearing pressure and settlement estimates for shallow foundations;
- provide a site classification(s) in accordance with AS 2870-2011 "Residential Slabs and Footings";
- specify remediation work required to ensure that the site will have a site classification of "Class A", if required;
- provide recommendations and geotechnical design parameters for earth retaining structures;
- assess the appropriate site subsoil class for the site in accordance with AS 1170.4-2007;
- recommend appropriate site preparation procedures including compaction criteria, re-use of in-situ soil and specifications and preparations for filling the site;
- assess the suitability of excavated material for re-use as fill;

- assess the permeability of the soils at the site for potential on-site disposal of stormwater by infiltration, including design permeability rates;
- provide guidance on preparation of soil under pavements, roads and car parking areas, including providing a subgrade California bearing ratio (CBR) value for pavement thickness design by others.

Environmental

- conduct a desk study assessment and comment on the possible presence of acid sulfate soils (ASS) and other environmentally sensitive issues apparent from geotechnical investigation that may need further detailed investigation;
- assess the nature and extent of soil contamination in areas of the site where market gardening activities are known to have occurred (if any); and
- determine if soil contamination (if any) represents a risk to human health or the environment.

4. FIELDWORK

Fieldwork was completed on 20 April 2015 and comprised

- excavation of test pits at sixteen locations, TP01 to TP16, extending to depths of up to 2.5 m;
- testing with Perth sand penetrometer (PSP) adjacent to each test pit location and at an additional 3 locations, extending to depths of up to 2.1 m;
- drilling of hand auger boreholes at 3 locations, HA01 to HA03, extending to depths of between 0.6 m and 0.8 m below ground;
- infiltration tests using the 'inverse auger hole' method at 3 locations, P1 to P3, at depths of between 0.6 m and 0.8 m below ground;
- collection of representative samples from the former market gardening area for inspection and laboratory testing; and
- a site walkover to inspect for potential environmental issues.

General

The tests were positioned and located by a geotechnical engineer and environmental scientist from Galt using a handheld GPS accurate to within about 5 m in the horizontal plane. Our personnel observed the test pitting, excavated the hand augered boreholes, logged the materials encountered in the test pits and boreholes, conducted the penetrometer and infiltration testing, collected representative samples for inspection and laboratory testing and conducted a site walkover.

The test locations are shown on Figure 1, Site and Location Plan. Photographs of the site are presented in Appendix A, Site Photographs. Test pit and hand auger borehole details are summarised in Table 1.

Table 1: Summary of Tests

Test Name	Test Depth (m)	Fill Thickness (m)	Depth to Limestone (m)[1,2]	Reason for Termination	Stratigraphy
TP01	2.5	-	1.9	Refusal on limestone	SAND, overlying Limestone
TP02	2.2	-	1.6	Refusal on limestone	
TP03	2.2	1.0	1.5	Refusal on limestone	FILL, SAND; overlying SAND, overlying limestone
TP04	2.3	-	NE[3]	Test pit collapse	SAND
TP05	1.9	-	1.4	Refusal on limestone	SAND, overlying Limestone
TP06	1.4	-	1.3	Refusal on limestone	
TP07	2.5	0.4	NE	Test pit collapse	FILL, SAND; overlying SAND
TP08	0.6	0.4		Refusal on limestone	
TP09	2.3	-	1.0	Refusal on limestone	SAND, overlying Limestone
TP10	2.4	-	2.3	Test pit collapse	
TP11	1.8	0.6	1.8	Refusal on limestone	FILL, SAND; overlying SAND, overlying limestone
TP12	0.7	0.1		Target depth	FILL, SAND; overlying SAND
TP13	2.0	0.8		Target depth	
TP14	2.5	-		Target depth	SAND, overlying Limestone
TP15	2.4	-		Target depth	
TP16	2.3	-		Refusal on limestone	
HA01	0.8	-		Target depth	SAND
HA02	0.7	-		Target depth	
HA03	0.6	-		Target depth	

Notes: [1] Depth at which limestone was first encountered. Limestone is typically in the form of pinnacles.

[2.] The term "limestone" as used in the report refers to a carbonate cemented rock and does not infer a specific rock strength, carbonate content, grain size, etc.

[3] NE – Not Encountered

Test Pits

Test pits were excavated using a 6 tonne John Deere 310D tractor mounted backhoe equipped with a 600 mm wide toothed bucked supplied and operated by Eddie's Backhoe Hire. Test pit reports are presented in Appendix B, Test Pit Reports along with a method of soil description and a list of explanatory notes and abbreviations used in the reports. Test pit photographs are included for selected test pits.

Hand Auger Boreholes

Hand auger borehole reports are presented in Appendix C, Hand Auger Borehole Reports. The method of soil description used in the reports is included in Appendix B.

Penetrometer Tests

Perth sand penetrometer (PSP) tests were conducted in accordance with AS 1289.6.3.3 although to a greater depth than the 0.45 m covered in the standard. The results of the penetrometer tests are presented in Appendix D, Perth Sand Penetrometer Test Results. Blow counts are reported per 150 mm increment.

Permeability Testing

The permeability testing was undertaken using the inverse auger hole method described by Cocks[1]. The results of the permeability testing are presented in Appendix E, Permeability Test Results and the results are summarised in Table 2.

Table 2: Summary of Permeability Test Results

Test Number	Test Location	Soil Description	Test Depth (m)	Minimum Unsaturated Permeability[1], k (m/day)		
				Test 1	Test 2	Test 3
P1	HA01	SAND	0.8	31	> 50	> 50
P2	HA02	SAND	0.7	17	14	17
P3	HA03	SAND	0.6	> 50	> 50	> 50

Note: 1 – The minimum unsaturated permeabilities were typically measured near the end of the test, with head typically varying between 0 m (dry) and 0.6 m.

Environmental Soil Sampling

Soil samples for the preliminary environmental assessment were collected from the former market gardening area in accordance with Australian Standard 4482.1 (2005) *Guide to the Investigation and Sampling of Sites with Potentially Contaminated Soil – Non Volatile and Semi Volatile Compounds*.

Samples were collected at the surface and at 0.3m using dedicated nitrile gloves and placed in laboratory supplied glass jars. The samples were then placed in an ice chilled cooler until submission to the laboratory for analysis.

5. ENVIRONMENTAL LABORATORY TESTING

Soil samples collected from the surface were analysed by Eurofins in their national association of testing agencies (NATA) accredited laboratory for the following contaminants of potential concern (COPC) commonly associated with market gardening activities;

- heavy metals; and
- organochlorine and organophosphate (OC/OP) pesticides.

All laboratory analysis was undertaken using NATA-accredited methods of analysis. Laboratory test results are presented in Appendix F, Environmental Laboratory Certificates. The environmental test results are discussed in Section 8.2

[1] Cocks, G (2007), "Disposal of Stormwater Runoff by Soakage in Perth Western Australia", Journal and News of the Australian Geomechanics Society, Volume 42 No. 3, pp 101-114

6. SITE CONDITIONS

6.1 Geology

The Rockingham sheet of the 1:50,000 scale Environmental Geology series map indicates that the area is underlain by sand derived from Tamala limestone. The sand is described as *"SAND – pale yellowish brown, medium to coarse grained, sub-angular to well-rounded quartz, trace of feldspar, shell debris, variably lithified, surface kankar, of eolian origin"*.

The geological mapping shows limestone outcrop about 100 m to the north west of the site, and peaty clay about 100 m to the south west of the site.

The findings of the site investigation are consistent with the geological mapping, with typically a thin layer of sand present over limestone. No peaty soils were encountered at the test locations on the site.

6.2 Subsurface Conditions

The subsurface conditions are broadly consistent across the site. The typical soil profile from the supplied information and the current investigation can be summarised as:

- SAND (SP): medium to coarse grained, sub-angular to sub-rounded, brown becoming yellow with depth, trace limestone cobbles and gravel, typically loose to dense, present from surface to depth of between 1.0 m extending to the maximum depth investigation (2.5 m); overlying
- LIMESTONE, present below the sand layer, rockhead varying from depths between about 1.0 m and more than the maximum depth of investigation (2.5 m).

The topsoil across the site is typically about 100 mm thick, but this increases to about 500 mm thick across the former market garden area (refer to Figure 1).

The north western quarter of the site (in the location of the existing residence) has a layer of FILL overlying the natural sands. This material can be described as:

- FILL, SAND (SP): fine to coarse grained, sub-angular to sub-rounded, pale yellow/brown, trace gravel (brick and limestone fragments), trace organics, trace fines, present from surface to depth of between 0.1 m and 1.0 m.

Several test pits encountered limestone pinnacles within the excavation. Although limestone was typically encountered below 1.0 m depth, it is possible that the limestone is present at shallower depths on the site (due to the undulating nature of pinnacles). We would, however, expect any rock encountered within the top 1 m to be localised, and likely to be excavatable with the use of an excavator and rock breaker attachment.

6.3 Groundwater

The Perth Groundwater Atlas (1997) does not extend to the site, but nearby data suggests that the maximum historical groundwater level at the site would be around RL 4 m AHD. This is between about 1 m and 3 m below the current ground surface.

7. GEOTECHNICAL ASSESSMENT

7.1 Site Classification

We consider the site geotechnically capable of supporting the proposed development.

We have assessed the site in accordance with AS2870 (2011) "Residential Slabs and Footings". We consider that a site classification of "Class A" would be appropriate provided that normal site preparation as presented in Section 7.3 is undertaken prior to construction.

7.2 Site Subsoil Class

We have assessed the site subsoil class in accordance with AS1170.4-2007, "Earthquake Design Actions – Australia". We consider that a site subsoil class of 'Ce' is appropriate for the site.

7.3 Site Preparation

The site preparation measures outlined below are aimed at preparation of the site prior to construction of buildings and pavement subgrades. Landscaped areas (if any) will not require this preparation. The site preparation procedures provided below have been prepared on the basis of improving the density of the loose to medium dense zone.

The following site preparation measures must be followed:

- Remove any deleterious material from site including surficial rubbish, existing structures and buried services, soak-wells, etc.
- Strip and stockpile topsoil from across the entire site (including market garden area) for potential re-use in non-structural applications or for possible blending with clean sand (only a thin layer of topsoil was noted at the time of our investigation over the majority of the site). Topsoil strip is only necessary to remove roots. We recommend a 100 mm topsoil strip or as otherwise necessary to remove all roots from the soil. The topsoil can potentially be screened and blended with clean sand and re-used as structural fill.
- Excavate to the required level, if required.
- Rip areas of shallow limestone to at least 1.0 m below finished level (this is intended to produce a relatively excavatable soil mass within the upper 1.0 m at the site for installation of footings and buried services – if a greater depth is required, the depth of ripping may need to be increased). It may be necessary to engage us to inspect the site and conduct additional shallow test pitting to assess the presence of shallow limestone in uncertain areas.
- Remove any oversize boulders (>200 mm) not responding to ripping or compaction.
- Proof compact the exposed sandy ground to achieve the level of compaction specified in Section 7.4 to a depth of at least 0.9 m below the compacted surface – any areas of loose sand or unsuitable material must be removed and replaced with approved fill.
- Fill to the proposed design surface level using approved fill (refer Section 7.5), placed and compacted (refer Section 7.4) in layers of no greater than 300 mm loose thickness.
- Compact the footing bases to achieve the required level of compaction to a depth of at least 0.9 m below the footing base – any areas of loose sand or unsuitable material must be removed and replaced with approved fill.

Note: The topsoil layer (identifiable as the brown sand, as compared with underlying natural yellow sand) at the location of the former market gardens is up to about 500 mm thick, however rootlets were typically only present in the top 100 mm. We consider that the topsoil present below 0.1 m depth can potentially be re-used as structural fill without the need for screening or blending, however permeability testing of a trial pad of the material must be conducted prior to its use. Where permeability testing is not conducted, the full thickness of the material (0.5 m) must be stripped for re-use in non-structural areas or removed offsite.

7.4 Compaction

Approved granular fill and the *in situ* sands must be compacted using suitable compaction equipment to achieve a dry density ratio of at least 95% MMDD (maximum modified dry density) as determined in accordance with AS 1289 5.2.1.

Where sand is used as fill and the Perth sand penetrometer (PSP) is used for compaction control, the following PSP blow counts may be assumed to correlate to the required dry density ratio of 95% MMDD:

- Depth range 0.15 m to 0.45 m 8 blows
- Depth range 0.45 m to 0.75 m 10 blows
- Depth range 0.75 m to 1.05 m 12 blows (or 0.75 m to 0.9 m: 6 blows).

If difficulties are experienced in achieving the required blow count, an on-site PSP calibration should be undertaken to determine the site-specific blow count correlating to the required dry density ratio.

Over-excavation and replacement of loose materials must be done where the minimum dry density ratio cannot be achieved.

Fill must be placed in horizontal layers of not greater than 0.3 m loose thickness. Each layer must be compacted by suitable compaction equipment, and carefully controlled to ensure even compaction over the full area and depth of each layer.

Care will need to be taken when compacting in the vicinity of existing services. This is particularly important if vibratory compaction is being carried out. Tynan (1973)[2] provides assistance with the selection of compaction equipment for use adjacent to structures and services. Of particular concern are adjacent existing services.

TESTING

After compaction, verify that the required level of compaction has been achieved by testing at the base of excavation and through the full depth of any fill and to a minimum depth of 0.9 m below foundations:

- on each lift of fill at the rate of 1 test per 500 m^3;
- at each spread footing location;
- at 7.5 m centres below on-ground slabs;
- at 10 m centres along gravity retaining wall footings and strip footings (where present); and
- at 10 m centres on pavement subgrades (on the road centreline or on a grid below car parks).

7.5 Approved Fill

Imported granular fill must comply with the material requirements as stated in AS 3798-2007, "Guidelines on Earthworks for Commercial and Residential Developments".

[2] Tynan (1973) Ground Vibration and Damage Effects on Buildings, Australia Road Research Board, Special Report No. 11.

The sand (including the sand fill) present at the site will be suitable for re-use as inert structural fill. Any organic-rich sand or sand containing significant proportions of fines (material less than 0.075 mm in size) must not be used.

Organic rich material (i.e. topsoil) may be considered for re-used as structural fill provided that it is screened and blended with clean sand such that the total organic content is less than 2% and the fines content is less than 5%. Due to the lower permeability of such blends, permeability testing must be undertaken on a trial pad of the blended material to assess its design permeability prior to use as structural fill. We can provide further assistance with this if required.

Where doubt exists, a geotechnical engineer must be engaged to inspect and approve the use of potential fill materials.

7.6 Excavation

We expect that excavations on site to about 1.0 m through the sand will be readily achievable using conventional earthmoving equipment (i.e. with a 5 tonne or larger excavator). Localised areas of shallower limestone may be present. However, the depth to limestone is expected to be at greater than 1 m depth below the existing surface. Excavation of any limestone may require the use of a larger excavator (20 tonne) and rock breaker.

Excavations below 2 m depth are expected to encounter massive limestone and are likely to require the use of a larger excavator (20 tonne) and rock breaker. Ripping prior to excavation is also likely to be required, e.g. with a large (D9 or D10) bulldozer with a single tine ripper.

Excavations in sand are particularly prone to instability unless support is provided. Care must be exercised in such excavations and appropriate safety measures adopted where necessary. Where possible excavations must be battered at slopes no steeper than 1V:2H for temporary slopes and 1V:3H for permanent slopes above the groundwater table. Even at these slope angles erosion and rilling may occur.

A geotechnical engineer must be consulted where there is any doubt regarding the stability or safety of unsupported excavations.

7.7 Retaining Structures

Retaining structures may be designed in accordance with AS 4678-2002 “Earth-Retaining Structures”. For the design of retaining structures, the parameters in Table 3 are appropriate.

Table 3: Retaining Structures Design Parameters

Soil Type	Bulk Density (t/m^3)	Angle of Internal Friction (deg.)	Wall Friction = 0°		Wall Friction = 0.5Φ	
			Coefficient of Active Earth Pressure, K_a	Coefficient of Passive Earth Pressure, K_p	Coefficient of Active Earth Pressure, K_a	Coefficient of Passive Earth Pressure, K_p
Medium dense sand	17	34	0.28	3.5	0.25	5.7
Dense or well compacted sand	18	36	0.26	3.9	0.22	6.5

Notes: Earth pressure coefficients are provided in this table for conditions of zero friction between the wall and the soil and with wall friction of 0.5Φ’. The retaining wall designer should make an independent assessment of the parameters appropriate to the construction method to be used, including alternative values of wall friction. A horizontal ground surface behind the wall has been assumed.

Compaction plant can augment the lateral earth pressure acting on retaining walls. Hand operated compaction equipment is recommended within 2 m of any retaining walls to minimise compaction pressures.

It is important to note that some ground movement will occur behind any soil retaining system, including gravity retaining walls.

Retaining walls can move and rotate under imposed soil loading resulting in settlement behind the wall. This must be considered during the design and construction of the retaining walls in order that adjacent properties are not adversely affected. Particular care should be exercised when forming excavations so as not to affect neighbouring properties. Account must be taken of the effect of both temporary and permanent works on neighbouring properties. Anchoring or strutting of retaining walls may be required.

Detailed design of retaining structures should be undertaken using methods appropriate to the proposed retention system.

7.8 Shallow Footings

The structure may be founded on shallow spread footings placed within the sand which occurs from surface, provided the site preparation recommendations outlined in Section 7.3 are followed. Table 4 and Table 5 give allowable bearing pressures and estimated settlements for pad footings and strip footings at an embedment depth of at least 0.5 m.

Table 4: Pad Footing Allowable Bearing Pressures and Estimated Settlements

Min. Footing Embedment (m)	Minimum Footing Dimension (m)	Allowable Bearing Pressure (kPa)	Estimated Settlement (mm)
0.5	0.5	150	<5
	1.0	200	<5
	1.5	225	5 - 10
	2.0	250	10 - 15
1.0	0.5	200	<5
	1.0	250	<5
	1.5	250	5 - 10
	2.0	250	10 - 15

Table 5: Strip Footing Allowable Bearing Pressures and Estimated Settlements

Min. Footing Embedment (m)	Minimum Footing Dimension (m)	Allowable Bearing Pressure (kPa)	Estimated Settlement (mm)
0.5	0.5	150	< 5
	1.0	180	5 - 10
	1.5	220	15 - 20
	2.0	250	20 - 25
1.0	0.5	200	5 - 10
	1.0	250	10 - 15
	1.5	250	15 - 20
	2.0	250	20 - 25

Allowable bearing pressures for footings of intermediate plan dimensions to those tabulated can be interpolated. Footings that have a plan dimension either smaller or larger than those covered by the tables above will need to be considered individually along with other embedment depths. Footings carrying significant eccentric loading must be assessed separately.

The settlement of the proposed structure will depend upon a number of factors including the applied pressures, footing size and base preparation. The estimates of settlement provided above assume that the site preparation measures detailed in Section 7.3 have been completed. The estimated settlements are for the working bearing pressure values shown. Differential settlements of up to half of the total estimated settlement values are likely between footings of similar sizes, loads and elevations. About 70% of the settlement is expected to occur during construction.

7.9 Pavement Thickness Design

Where design of flexible pavements is undertaken, a subgrade California bearing ratio (CBR) of 12% may be assumed for pavement thickness design. This CBR assumes that the site preparation requirements outlined in Section 7.3 have been carried out in pavement subgrade areas.

7.10 Stormwater Disposal

The results of infiltration tests carried out are included in Appendix D, Permeability Test Results. The minimum measured permeability are as follows:

- P1 – 31 m/day
- P2 – 14 m/day
- P3 - >50 m/day

We consider that the natural and fill sands at the site are suitable for the disposal of stormwater by infiltration by means of soak wells. For preliminary design, we recommend a design value of permeability (k) not greater than 5 m/day for the *in situ* sand below 1 m to allow for the variability in materials and reduced permeability as a consequence of:

- densification of sand during site preparation works;
- natural variation in sands; and
- clogging of the sand around soak wells over time with fines.

Soak wells should be placed outside a line of 1V:2H extending below the edge of the nearest footing subject to local council regulations. Discharge from soak wells has been known to promote densification of loose sandy soils, leading to settlements of footings and slabs. Soak wells should be carefully wrapped with geotextile to prevent migration of sand and fines into the soak well.

The topsoil layer present at the location of the former market gardens (present from surface to 0.5 m) is likely to have a lower permeability than the design value presented above due to a higher fines content. We consider that the topsoil present below 0.1 m depth can potentially be re-used as structural fill without the need for screening or blending, however permeability testing of a trial pad (at least 1 m thick) must be conducted prior to its re-use to assess the design permeability is within the acceptable limits.

We note that limestone is present at shallow depth (locally within 1 m of the ground surface), which may hinder drainage from the site. Some moderately to well cemented limestone can be relatively impermeable. This must be taken into account when undertaking the civil design. Some suggestions are:

- raising site surface levels with sand fill where limestone is relatively shallow (but cutting from areas of the site with more sand);
- ripping the limestone to a greater depth to ensure it is broken up and more permeable (we suggest that in-situ large scale permeability testing be done if there is a reliance on this); or
- off-site disposal of stormwater (probably not necessary, but a logical extension of not relying on on-site disposal into limestone).

8. ENVIRONMENTAL ASSESSMENT

8.1 Desktop Assessment

8.1.1 Acid Sulfate Soils

The Department of Environment Regulation (DER) on-line risk-mapping database of ASS shows the site as having no known risk of ASS occurrence at depths less than 3 m. The nearest high risk area is located approximately 50 m to the south west of the site. The DER ASS risk mapping is shown in Figure 2.

8.1.2 Geomorphic Wetlands

The Department of Parks and Wildlife (DPaW) geomorphic wetlands database indicates that there are no wetlands located on the site. The nearest conservation category wetland (Opwin Swamp Dampland #6400) is located approximately 600 m to the south west of the site. The location of geomorphic wetlands are shown on Figure 2.

8.1.3 Environmentally Sensitive Areas

There are no environmental sensitive areas (ESAs) mapped as existing on the site. The nearest ESA is located approximately 200 m to the south west of the site and is associated with the Opwin Swamp Dampland. The location of ESAs are shown on Figure 2.

8.1.4 Historical Aerial Photographs

A summary of the site features visible in the available historical aerial photographs are presented in Table 6 with the historical aerial photographs presented in Figures 3a to 3d.

Table 6: Current and Historical Aerial Photographs

Year	Site Features	Surrounding Land Use
1953	The whole site is cleared.	The surrounding area is cleared
1965	Evidence of a market gardening occurring to the southern portion of the site, A building is also noted south of the site, in the middle of the site and north of the site.	No change.
1974	Vegetation to the north of the site has been cleared.	A road is noted to the east of the site. Buildings are noted to the north of the site.
1979	No change.	No change.
1981	No change.	No change.
1985	No change.	No change.

Year	Site Features	Surrounding Land Use
1995	No change.	No change.
2006	A smaller building is noted to the west of the site.	No change.
2008	An additional building is noted in the north west corner of the site.	No change.
Current	No change.	No change.

8.1.5 Contaminated Sites Database

The publicly available DER contaminated sites database was searched for known contaminated sites (sites classified as *Contaminated-restricted use*, *Remediated for restricted use* or *Contaminated-remediation required*) in proximity to the site. The site is not listed as a contaminated site. The nearest site classified as *Remediated for Restricted Use* and is located approximately 350 m east of the site.

8.1.6 Heritage

The Aboriginal Heritage Act 1972 is the Western Australian legislation in place to protect places and objects customarily used by or traditional to, the original inhabitants of Australia. Such places and objects are maintained in a register under the Act; however, all sites are protected under the Act whether or not they have been registered.

A search of the Aboriginal Heritage database shows that there are no heritage sites located within a 500 m radius of the site. Heritage sites are shown in Figure 2.

European heritage is also protected and a search of the Heritage Council of Western Australia (HCWA) database of culturally significant sites in Western Australia was undertaken for the area. No European heritage sites were found at or nearby the site (HCWA, 2015).

8.2 Detailed Site Inspection

A detailed site inspection was undertaken by a representative of Galt on 20 April 2015. The following observations were made:

- The site contains a house, three sheds, a caravan, miscellaneous building material and farm equipment.
- There was no evidence of hazardous chemical storage or spills on the site.
- No asbestos containing material (ACM) was identified within any of the building material or farm equipment.
- There was no evidence of plant stress that would indicate potential contamination.

We note that our inspection did not include a detailed assessment of the materials used in the construction of the onsite buildings. As such, no assessment can be made on the presence of hazardous material present within these buildings.

8.3 Contamination Testing Results

Soil concentrations were compared with the following criteria adopted from the National Environmental Protection Council (NEPC) (2013) *National Environmental Protection (Assessment of Site Contamination) Measure* guideline document.

- Ecological investigation levels (EIL)
- Health investigation levels – Residential (HIL-A)

In order to obtain site-specific EIL values, soil pH values were recorded for each sample. Given the preliminary nature of the assessment, the most conservative EIL for zinc, copper, lead nickel and chromium using the relevant soil pH has been adopted.

Soil analytical results are presented in Table 7 and Table 8 and are discussed below.

- Metal concentrations were below the laboratory LOR and/or conformed to the adopted criteria.
- Concentrations of all OC/OP pesticides were below the laboratory LOR and/or conformed to the adopted criteria.

Table 7: Soil Analysis Results – Metals

	Soil pH	Arsenic (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Nickel (mg/kg)	Zinc (mg/kg)
Assessment Criteria								
HIL-A	-	100	20	100	6000	300	400	7400
Site Specific EIL[3]	-	100	-	190	280	1100	30	230
Sample ID								
SS01/0.0	6.3	3.4	<0.4	15	14	5.6	<5	38
SS02/0.0	6.8	2.8	<0.4	15	19	6.9	<5	68
SS03/0.0	6.6	2.7	<0.4	16	19	6.8	<5	50
SS04/0.0	6.5	2.3	<0.4	16	17	6.0	<5	42
SS05/0.0	6.3	4.4	<0.4	15	16	6.4	<5	43
SS06/0.0	6.4	3.7	<0.4	15	17	6.8	<5	42
SS07/0.00	6.5	2.9	<0.4	16	19	6.3	<5	41
SS08/0.0	6.8	2.3	<0.4	17	26	6.9	<5	51
SS09/0.0	6.4	4.1	<0.4	19	32	8.2	<5	110
SS10/0.0	6.4	4.7	<0.4	19	<5	<5	<5	<5

[3] EIL value calculated in accordance with NEPM 2013 guideline using soil pH value of 6.0

Table 8: Soil Analysis Results – Pesticides

	DDT+DDE+DDD	Aldrin and Dieldrin	Chlordane	Heptachlor	Endrin	Methoxychlor	Toxaphene	Chlorpyrifos
HIL-A	240	6	50	270	10	300	20	160
Sample ID								
SS01/0.0	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS02/0.0	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS03/0.0	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS04/0.0	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS05/0.0	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS06/0.0	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS07/0.00	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS08/0.0	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS09/0.0	<0.05	0.07	<0.1	<0.05	<0.05	<0.05	<1	<0.2
SS10/0.0	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<1	<0.2

8.4 Summary

Based on the results of the desktop environmental assessment, we consider that there are unlikely to be any significant environmental aspects that will adversely impact on the proposed development. Furthermore, the contamination testing results indicate that is it unlikely that soils within the area of the site formally used for market gardening activities has been impacted by COPC at concentrations that would represent a risk to human health or the environment.

We note our preliminary contamination testing did not include an assessment of groundwater quality at the site. As such, no comment can be made on the suitability of groundwater at the site for irrigation or drinking water purposes.

9. CLOSURE

We would like to draw your attention to Appendix G of this report, "Understanding your Report". The information provided within is intended to inform you as to what your realistic expectations of this report should be. Guidance is also provided on how to minimise risks associated with groundworks for this project. This information is provided not to reduce the level of responsibility accepted by Galt, but to ensure that all parties who rely on this report are aware of the responsibilities each assumes in so doing.

GALT GEOTECHNICS PTY LTD

Owen Woodland CPEng

Geotechnical Engineer

Brad Palmer

Environmental Scientist

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Figures

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Legend

- Site Boundary
- Former Market Garden Area
- Hand Auger Borehole / Permeability Test
- Perth Sand Penetrometer
- Soil Sample
- Test Pit

NOTES: Concept plan of subdivision from The Planning Group WA Pty Ltd, Drawing no. 715-377 CP-01A, dated 17 Feb 2015

0 10 20 30 40 50
Meters

SCALE	1:750 (A3)
DRAWN	DAC
DATE DRAWN	30/04/2015
CHECKED	PCW
DATE CHECKED	30/04/2015
PROJECTION	GDA 1994 MGA Zone 50

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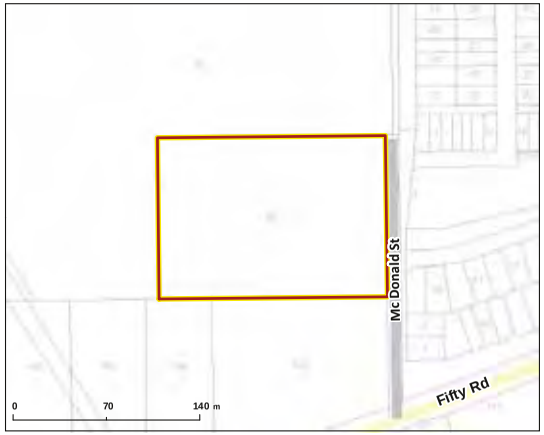
CLIENT	**PRITCHARD FRANCIS**
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	16 MCDONALD ROAD BALDIVIS
TITLE	SITE & LOCATION PLAN
Job No	J1501070
Fig No	FIGURE 1
Rev	A

MAP 1 - AERIAL



MAP 2 - STREET

MAP 3 - CONTOURS

MAP 4 - ACID SULFATE SOIL RISK

MAP 5 - ENVIRONMENTALLY SENSITIVE AREAS

MAP 6 - GEOMORPHIC WETLANDS

MAP 7 - CONTAMINATED SITES

MAP 8 - HERITAGE SITES

MAP 9 - GROUNDWATER CONTOURS AND WINSITES

MAP 4 - ACID SULFATE SOIL RISK

High to moderate risk
Moderate to low risk

MAP 5 - ENVIRONMENTALLY SENSITIVE AREAS

Environmentally Sensitive Area

MAP 6 - GEOMORPHIC WETLANDS

Multiple Use
Conservation
Not Applicable
Resource Enhancement
Not Assessed

MAP 7 - CONTAMINATED SITES

Contaminated - remediation required
Remediated for restricted use
Contaminated - restricted use

Contaminated sites information is taken from the publicly availably Department of Environment Regulation (DER) Contaminated Sites Database. Only sites classified as 'Contaminated – remediation required', 'Contaminated – restricted use' and 'Remediated – restricted use' are shown. Sites with other classifications under the Contaminated Sites Act 2003 are identified through a basic or detailed summary of records search request though DER.

MAP 8 - HERITAGE SITES

Heritage Site

MAP 9 - GROUNDWATER CONTOURS AND WINSITES

Maximum	Minimum	WINSITES
5	5	Ground, Borehole or Well
1	1	Other

0 30 60 90 120 150
Meters

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DRAWN	DAC
DATE DRAWN	30/04/2015
CHECKED	SS
DATE CHECKED	30/04/2015
PROJECTION	GDA 1994 MGA Zone 50

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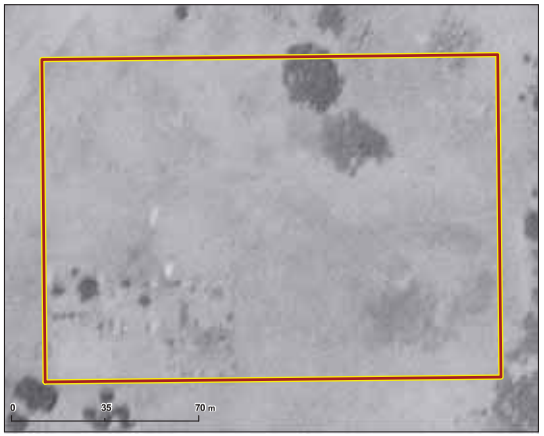
CLIENT	**PRITCHARD FRANCIS**
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	16 MCDONALD ROAD BALDIVIS
TITLE	INDICATIVE ENVIRONMENTAL ASPECTS
Job No	J1501070
Fig No	FIGURE 2
Rev	A



MAP 1 - 1953

MAP 2 - 1965

MAP 3 - 1974

MAP 4 - 1979

MAP 5 - 1981

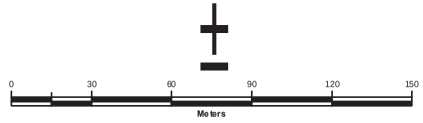
MAP 6 - 1985

MAP 7 - 1995

MAP 8 - 2000

MAP 9 - 2001

Legend



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CHECKED	SS
DATE CHECKED	30/04/2015
PROJECTION	GDA 1994 MGA Zone 50

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CLIENT	PRITCHARD FRANCIS
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	16 MCDONALD ROAD BALDIVIS
TITLE	HISTORICAL AERIAL IMAGERY (1953 - 2001)
Job No	J1501070
Fig No	FIGURE 3A
Rev	A

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MAP 10 - 2002

MAP 11 - 2003

MAP 12 - 2004

MAP 13 - 2005

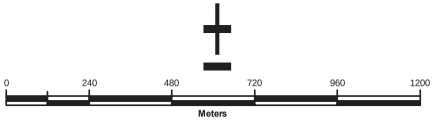
MAP 14 - 2006

MAP 15 - 2007

MAP 16 - 2008

MAP 17 - 2009

MAP 18 - 2010



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DATE DRAWN	30/04/2015	
CHECKED	SS	
DATE CHECKED	30/04/2015	
PROJECTION	GDA 1994 MGA Zone 50	

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CLIENT	PRITCHARD FRANCIS
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	16 MCDONALD ROAD BALDIVIS
TITLE	HISTORICAL AERIAL IMAGERY (2002 - 2010)
Job No	J1501070
Fig No	FIGURE 3B
Rev	A

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MAP 19 - 2011(March)

MAP 20 - 2011(August)

MAP 21 - 2012(February)

MAP 22 - 2012(September)

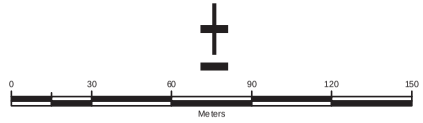
MAP 23 - 2013(January)

MAP 24 - 2013(September)

MAP 25 - 2014(February)

MAP 26 - 2014(May)

MAP 27 - 2014(August)



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DATE CHECKED	30/04/2015
PROJECTION	GDA 1994 MGA Zone 50

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CLIENT	PRITCHARD FRANCIS
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	16 MCDONALD ROAD BALDIVIS
TITLE	HISTORICAL AERIAL IMAGERY (2011(MARCH) - 2014(AUGUST))
Job No	J1501070
Fig No	FIGURE 3C
Rev	A

MAP 28 - 2014(November)

0 30 60 90 120 150

Meters

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DRAWN	DAC
DATE DRAWN	30/04/2015
CHECKED	SS
DATE CHECKED	30/04/2015
PROJECTION	GDA 1994 MGA Zone 50

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CLIENT	**PRITCHARD FRANCIS**
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	16 MCDONALD ROAD BALDIVIS
TITLE	HISTORICAL AERIAL IMAGERY (2014(NOVEMBER) - ONWARDS)

Job No	Fig No	Rev
J1501070	FIGURE 3D	**A**

Appendix A: Site Photographs

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2/39 Flynn St, WEMBLEY WA 6014

ABN: 73 292 586 155

Photograph 1: At TP05 facing south, facing towards a former market garden

Photograph 2: At TP10 facing north

Photograph 3: At TP02 facing south

Photograph 4: At TP04 facing west, note the higher elevation at TP04 compared to the western land

Photograph 5: At TP08 facing west

Photograph 6: Current development located nearby the site at the corner of McDonald Road and Fifty Road. Note the presence of shallow massive limestone

Appendix B: Test Pit Reports

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ABN: 73 292 586 155

METHOD OF SOIL DESCRIPTION
BOREHOLE AND TEST PIT REPORTS

GRAPHIC LOG & UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) SYMBOLS

Graphic	USCS	Soil Name
		FILL (various types)
		COBBLES
		BOULDERS
	GP	GRAVEL (poorly graded)
	GW	GRAVEL (well graded)
	GC	Clayey GRAVEL
	SP	SAND (poorly graded)
	SW	SAND (well graded)
	SC	Clayey SAND

Graphic	USCS	Soil Name
	SM	Silty SAND
	ML	SILT (low liquid limit)
	MH	SILT (high liquid limit)
	CL	CLAY (low plasticity)
	CI	CLAY (medium plasticity)
	CH	CLAY (high plasticity)
	OL	Organic SILT (low liquid limit)
	OH	Organic SILT (high liquid limit)
	Pt	PEAT

RESISTANCE TO EXCAVATION

Symbol	Term	Description
VE	Very easy	All resistances are relative to the selected method of excavation
E	Easy	
F	Firm	
H	Hard	
VH	Very hard	

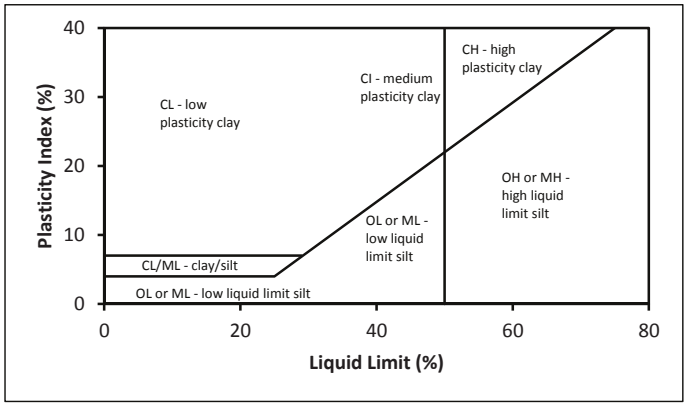
SOIL CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil descriptions are based on AS1726-1993, Appendix A. Material properties are assessed in the field by visual/tactile methods in combination with field testing techniques (where used).

PARTICLE SIZE

Soil Name		Particle Size (mm)
BOULDERS		>200
COBBLES		63 to 200
GRAVEL	Coarse	20 to 63
	Medium	6 to 20
	Fine	2 to 6
SAND	Coarse	0.6 to 2.0
	Medium	0.2 to 0.6
	Fine	0.075 to 0.2
FINES	SILT	0.002 to 0.075
	CLAY	<0.002

PLASTICITY PROPERTIES



MOISTURE CONDITION

AS1726-1993

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays and silts may be brittle or friable and powdery.
M	Moist	Soils are darker than in the dry condition and may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sands and gravels tend to cohere.

CONSISTENCY AND DENSITY

AS1726-1993 and HB160-2006

Symbol	Term	Undrained Shear Strength (kPa)	SPT "N"	DCP blows per 100 mm
VS	Very Soft	0 to 12	0 to 2	<1
S	Soft	12 to 25	2 to 4	<1
F	Firm	25 to 50	4 to 8	1 to 2
St	Stiff	50 to 100	8 to 15	3 to 4
VSt	Very Stiff	100 to 200	15 to 30	5 to 10
H	Hard	>200	>30	>10

Symbol	Term	Density Index (%)	SPT "N"	DCP blows per 100 mm	PSP Blows per 300 mm
VL	Very Loose	<15	0 to 4	<1	0 to 2
L	Loose	15 to 35	4 to 10	1 to 2	2 to 6
MD	Medium Dense	35 to 65	10 to 30	2 to 3	6 to 8
D	Dense	65 to 85	30 to 50	4 to 8	8 to 15
VD	Very Dense	>85	>50	>8	>15

Note: PSP correlations only valid to 450 mm depth

Consistency and density may also be inferred from excavation performance and material behaviour.

EXPLANATORY NOTES TO BE READ WITH BOREHOLE AND TEST PIT REPORTS

METHOD OF DRILLING OR EXCAVATION

AC	Air Core	E	Excavator	PQ3	PQ3 Core Barrel
AD/T	Auger Drilling with TC-Bit	EH	Excavator with Hammer	PT	Push Tube
AD/V	Auger Drilling with V-Bit	HA	Hand Auger	R	Ripper
AT	Air Track	HMLC	HMLC Core Barrel	RR	Rock Roller
B	Bulldozer Blade	HQ3	HQ3 Core Barrel	SON	Sonic Rig
BH	Backhoe Bucket	N	Natural Exposure	SPT	Driven SPT
CT	Cable Tool	NMLC	NMLC Core Barrel	WB	Washbore
DT	Diatube	PP	Push Probe	X	Existing Excavation

SUPPORT

T	Timbering

PENETRATION EFFORT (RELATIVE TO THE EQUIPMENT USED)

VE	Very Easy	E	Easy	F	Firm
H	Hard	VH	Very Hard		

WATER

►	Water Inflow	▼	Water Level
◄	Water Loss (complete)		
◁	Water Loss (partial)		

SAMPLING AND TESTING

B	Bulk Disturbed Sample	P	Piston Sample
BLK	Block Sample	PBT	Plate Bearing Test
C	Core Sample	U	Undisturbed Push-in Sample
CBR	CBR Mould Sample		U50: 50 mm diameter
D	Small Disturbed Sample	SPT	Standard Penetration Test
ES	Environmental Soil Sample		Example: 3, 4, 5 N=9
EW	Environmental Water Sample		3,4,5: Blows per 150 mm
G	Gas Sample		N=9: Blows per 300 mm after
HP	Hand Penetrometer		150 mm seating interval
LB	Large Bulk Disturbed Sample	VS	Vane Shear; P = Peak
M	Mazier Type Sample		R = Remoulded (kPa)
MC	Moisture Content Sample	W	Water Sample

ROCK CORE RECOVERY

TCR = Total Core Recovery (%) $= \frac{CRL}{TCL} \times 100$

SCR = Solid Core Recovery (%) $= \frac{CCR}{TCL} \times 100$

RQD = Rock Quality Designation (%) $= \frac{ALC>100}{TCL} \times 100$

TCL	Length of Core Run
CRL	Recovered Length of Core
CCR	Total Length of Cylindrical Pieces of Core Recovered
ALC>100	Total Length of Axial Lengths of Core Greater than 100 mm Long

TEST PIT: TP01

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387816 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424917 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	M	L	Topsoil and rootlets in top 100 mm
			0.5										
			1.0								D	L - MD	
			1.5										
			2.0							Trace gravel and cobbles comprising limestone			Limestone outcrop at 1.9 m comprising approximately 30% of test pit face
			2.5							Hole terminated at 2.50 m Refusal on limestone Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP02

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387784 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424920 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, ~~brown~~ Yellow	M	L	
			0.5										
			1.0								D	MD	Below 1.6 m, limestone comprising approximately 30% of test pit face
			1.5							With some gravel and cobbles comprising limestone			
			2.0										
			2.5							Hole terminated at 2.20 m Refusal on limestone Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP03

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387742 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424921 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, ~~brown~~ Yellow	M	L - MD	
			0.5										
			1.0								D	MD	
			1.5							Trace gravel and cobbles comprising limestone			
			2.0							With some gravel and cobbles comprising limestone			
			2.5							Hole terminated at 2.20 m Refusal on limestone Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP04

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387655 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424917 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	FILL: SAND, fine grained, sub-angular to sub-rounded, pale yellow-brown, trace gravel comprising limestone and brick fragments	M	MD	
			0.5										
			1.0						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	D	L	
			1.5									MD	
			2.0										
			2.5							Hole terminated at 2.30 m Terminated due to test pit collapse Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP05

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387823 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424873 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND (TOPSOIL): medium to coarse grained, sub-rounded, brown, trace organics			
			0.5						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	M	L	
			1.0										
			1.5							With some gravel and cobbles comprising limestone	D	L - MD	
			2.0							Hole terminated at 1.90 m Refusal on limestone Groundwater not encountered			
			2.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP06

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387781 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424839 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND (TOPSOIL): medium to coarse grained, sub-rounded, brown, with some organics			
			0.5						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	M	L	
			1.0							With some gravel and cobbles comprising limestone	D	L - MD	
			1.5							Hole terminated at 1.40 m Refusal on limestone Groundwater not encountered			
			2.0										
			2.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP07

Job Number:	J1501070	**Easting:**	387752 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424867 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	FILL: SAND, medium to coarse grained, sub-rounded, brown, with some organics	M	L	
			0.5						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	D	L - MD	
			1.0										
			1.5										
			2.0										
			2.5							Hole terminated at 2.50 m Terminated due to test pit collapse Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP08

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387691 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424869 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	FILL: SAND, fine grained, sub-angular to sub-rounded, pale brown	M	MD	
			0.5						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow			
			1.0							Hole terminated at 0.60 m Refusal on limestone Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

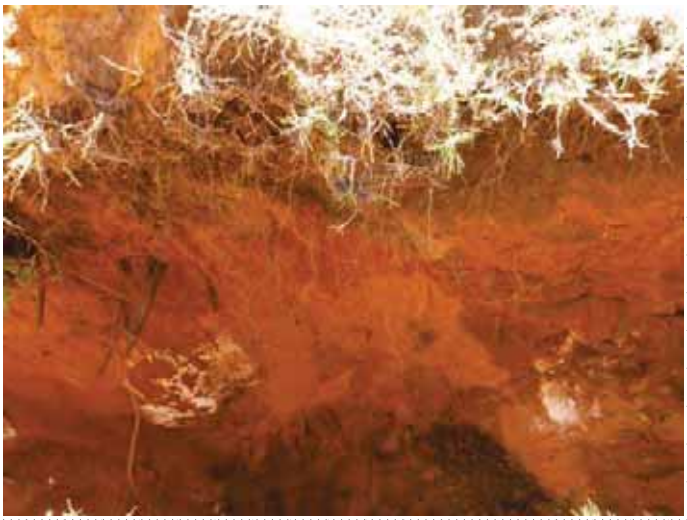
TEST PIT: TP09

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387685 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424828 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND: fine to coarse grained, sub-angular to sub-rounded, brown	M	L - MD	At 1.0 m, one limestone boulder excavated. Below 1.0 m, limestone outcrop comprising approximately 30% of test pit face.
			0.5										
			1.0							Trace gravel and cobbles comprising limestone			
			1.5										
			2.0										
			2.5							Hole terminated at 2.30 m Refusal on limestone Groundwater not encountered			

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP10

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387737 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424121 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND (TOPSOIL): medium to coarse grained, sub-rounded, brown, with some organics	M	L	
			0.5						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow			
			1.0								D	L - MD	
			1.5										
			2.0							With some gravel and cobbles comprising limestone			
			2.5							Hole terminated at 2.40 m Terminated due to test pit collapse Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP11

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387679 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424872 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	FILL: SAND, fine grained, sub-angular to sub-rounded, pale yellow-brown	M	MD	Limestone pinnacle at 1.0 m
			0.5						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	D		
			1.0										
			1.5										
			2.0							Hole terminated at 1.80 m Refusal on limestone Groundwater not encountered			
			2.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP12

Job Number:	J1501070	**Easting:**	387710 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424867 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0						SP	FILL: SAND, fine to coarse grained, sub-angular to sub-rounded, pale yellow, comprising limestone			
BH	E								SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	M	MD	
			0.5										
										Hole terminated at 0.70 m Target depth Groundwater not encountered			
			1.0										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP13

Job Number:	J1501070	**Easting:**	387714 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424927 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	FILL: SAND, fine grained, sub-angular to sub-rounded, pale yellow-brown	M	L	
			0.5										
			1.0						SP	SAND: fine to coarse grained, sub-angular to sub-rounded, yellow	D	L - MD	
			1.5										
			2.0							Hole terminated at 2.00 m Target depth Groundwater not encountered			
			2.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP14

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387797 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424903 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	M	L	
			0.5										
			1.0										
			1.5							With some gravel and cobbles comprising limestone	D	L - MD	At 1.5 m, limestone pinnacle
			2.0										
			2.5							Hole terminated at 2.50 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP15

Sheet 1 OF 1

Job Number:	J1501070	**Easting:**	387800 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424883 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, brown	M	L	
										Yellow			
			0.5										
			1.0							Trace gravel and cobbles comprising limestone	D		At 1.0 m, limestone pinnacle
			1.5									MD	At 1.7 m, limestone pinnacle
			2.0										
			2.5							Hole terminated at 2.40 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

TEST PIT: TP16

Job Number:	J1501070	**Easting:**	287829 m	**Contractor:**	Eddie's Backhoe	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424833 m	**Machine:**	JD 310D	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50	**Operator:**	Eddie	**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis			**Bucket:**	600 mm toothed	**Checked By:**	PCW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	SAND (TOPSOIL): medium to coarse grained, sub-rounded, brown			
			0.5							SAND: medium to coarse grained, sub-angular to sub-rounded, yellow	M	L	
			1.0						SP	With some gravel and cobbles comprising limestone	D	MD	At 1.0 m, limestone pinnacle comprising approximately 30% of test pit face
			1.5										
			2.0										
			2.5							Hole terminated at 2.30 m Refusal on limestone Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

Appendix C: Hand Auger Borehole Reports

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ABN: 73 292 586 155

HAND AUGER BOREHOLE: HA01

Job Number:	J1501070	**Easting:**	387738 m	**Operator:**	EY	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424898 m	**Inclination:**	-90°	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50			**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis					**Checked By:**	PCW

Drilling					Sampling			Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	E		0.0						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, brown Yellow	M	L	
			0.5										
			1.0							Hole terminated at 0.80 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

HAND AUGER BOREHOLE: HA02

Job Number:	J1501070	**Easting:**	387806 m	**Operator:**	EY	**Date:**	20/04/2015
Client:	Pritchard Francis	**Northing:**	6424924 m	**Inclination:**	-90°	**Logged:**	EY
Project:	Proposed Residential Subdivision	**Datum:**	MGA94 Zone 50			**Checked Date:**	30/04/2015
Location:	16 McDonald Road, Baldivis					**Checked By:**	PCW

Drilling					Sampling			Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	E		0.0						SP	SAND: medium to fine grained, sub-angular to sub-rounded, brown Yellow	M	L	
			0.5										
			1.0							Hole terminated at 0.70 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

HAND AUGER BOREHOLE: HA03

Job Number: J1501070
Client: Pritchard Francis
Project: Proposed Residential Subdivision
Location: 16 McDonald Road, Baldivis

Easting: 387695 m
Northing: 6424832 m
Datum: MGA94 Zone 50

Operator: EY
Inclination: -90°

Date: 20/04/2015
Logged: EY
Checked Date: 30/04/2015
Checked By: PCW

Drilling					Sampling			Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	E		0.0						SP	SAND: medium to coarse grained, sub-angular to sub-rounded, brown Yellow	M	L	
			0.5										
										Hole terminated at 0.60 m Target depth Groundwater not encountered			
			1.0										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

Appendix D: Perth Sand Penetrometer Results

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ABN: 73 292 586 155

PERTH SAND PENETROMETER FIELD TEST DATA (Standard Depth 900mm)
(AS12896.3.3)

Client:	Pritchard Francis	**Job No:**	J1501070
Project:	Proposed Residential Subdivision	**Date:**	20/04/2015
Location:	16 McDonald Road, Baldivis	**Engineer:**	EY

Test No:	1	2	3	4	5	6	7	8
Location:	TP01	TP02	TP03	TP04	TP05	TP06	TP07	TP08
Depth (mm)	**N° of Penetrometer Blows per 150 mm Depth Interval**							
0-150	Seat	Seat	Seat	Seat	Seat	Seat	Seat	Seat
150-300	2	2	5	5	3	2	2	7
300-450	2	1	5	6	3	3	2	7
450-600	3	2	4	5	3	2	1	8
600-750	2	1	5	5	4	1	2	11
750-900	2	2	5	4	3	2	1	8
900-1050	4	3	4	2	3	2	2	8
1050-1200		4	5	3				
1200-1350		5	6	6				
1350-1500		6	6	6				
1500-1650		6	5	5				
1650-1800		7	5	5				
1800-1950		8	5	4				
1950-2100		8	5	4				

Test No:	9	10	11	12	13	14	15	16
Location:	TP09	TP10	TP11	TP12	TP13	TP14	TP15	TP16
Depth (mm)	**N° of Penetrometer Blows per 150 mm Depth Interval**							
0-150	Seat	Seat	Seat	3	Seat	Seat	Seat	Seat
150-300	3	2	3	4	4	2	3	2
300-450	4	2	4	3	5	4	4	3
450-600	3	2	3	2	5	2	5	2
600-750	4	2	6	3	5	2	4	2
750-900	3	2	6	3	5	3	3	3
900-1050	3	4	4	3	5	3	4	3
1050-1200							5	
1200-1350							5	
1350-1500							6	
1500-1650							6	
1650-1800							7	
1800-1950							8	
1950-2100							8	

Test No:	17	18	19					
Location:	PSP01	PSP02	PSP03					
Depth (mm)	**N° of Penetrometer Blows per 150 mm Depth Interval**							
0-150	Seat	Seat	Seat					
150-300	3	2	2					
300-450	3	1	1					
450-600	3	2	3					
600-750	3	2	2					
750-900	3	4	2					
900-1050	4	6	4					
1050-1200	4	7	4					
1200-1350	5	6	5					
1350-1500	7	6	5					
1500-1650	7	4	4					
1650-1800	6	5	5					
1800-1950	8	6	5					
1950-2100	8	7	7					

Perth Sand Penetrometer tests done in accordance with AS 1289.6.3.3 (except blow counts are reported per 150 mm, rather than 300 mm)
HB: Hammer bounce (refusal)
0 = Penetration due to hammer weight only
R: Refusal

Appendix E: Permeability Test Results

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ABN: 73 292 586 155

Permeability Calculation - Inverse Auger Hole Method

Galt Geotechnics

Spreadsheet author:	ORW	17-Oct-09	

Job No:	J1501070	
Client:	Pritchard Francis	
Site:	16 McDonald Road	
Location:	Baldivis	
Calc by:	EY	22-Apr-15
BH Name:	HA01/P1	
Test Depth:	0.8	m

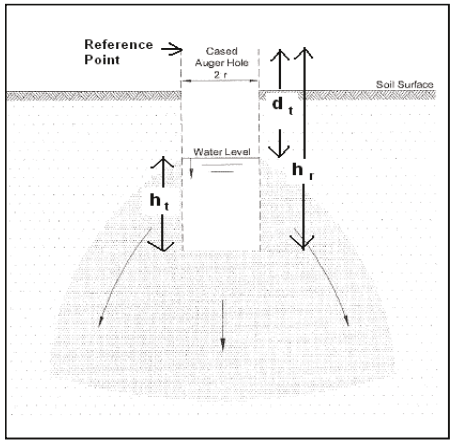
$$K = 1.15r\,\frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Spreadsheet Legend

	Required input
	Calculated field
	Comment field
	Field not used
	Fixed field

Parameter	Description	Value	Units
K	Permeability		m/s
r	radius of test hole	0.04	m
t	time since start of measurement		s
h_r	reference point height above base	0.8	m
d_t	depth from reference point to water at time t		m
h_t	Water column height at time t		m
h_0	h_t at t=0		m



Test 1

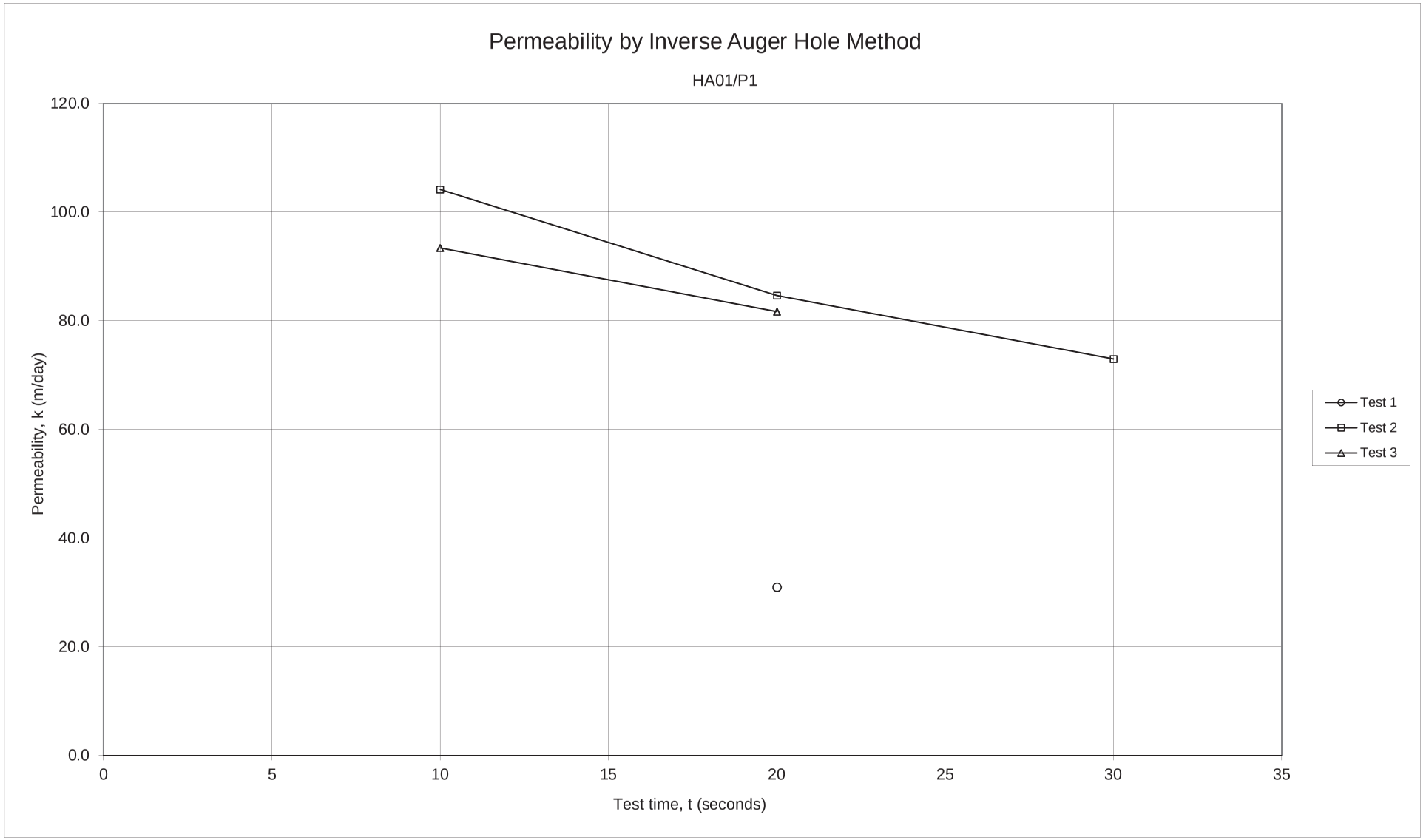
t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.19	0.61		
20	0.38	0.42	3.6E-04	31.0
		AVERAGE	3.6E-04	31.0

Test 2

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.18	0.62		
10	0.47	0.33	1.2E-03	104.2
20	0.58	0.22	9.8E-04	84.6
30	0.64	0.16	8.4E-04	73.0
		AVERAGE	1.0E-03	87.3

Test 3

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.15	0.65		
10	0.43	0.37	1.1E-03	93.4
20	0.56	0.24	9.5E-04	81.7
		AVERAGE	1.0E-03	87.5


Permeability by Inverse Auger Hole Method
HA01/P1
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Permeability, k (m/day)
0
5
10
15
20
25
30
35
Test time, t (seconds)
Test 1
Test 2
Test 3

Permeability Calculation - Inverse Auger Hole Method

Galt Geotechnics

Job No:	J1501070	
Client:	Pritchard Francis	
Site:	16 McDonald Road	
Location:	Baldivis	
Calc by:	EY	22-Apr-15
BH Name:	HA02/P2	
Test Depth:	0.7	m

Spreadsheet author:	ORW	17-Oct-09

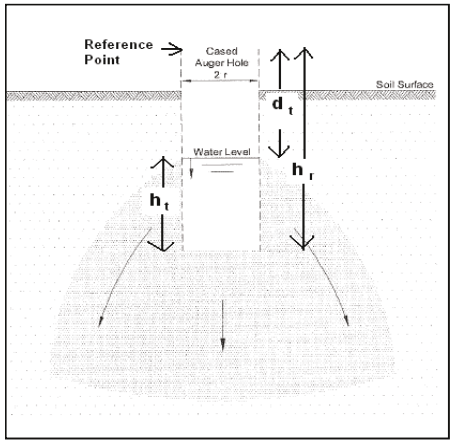
$$K = 1.15r \frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Spreadsheet Legend

	Required input
	Calculated field
	Comment field
X	Field not used
	Fixed field

Parameter	Description	Value	Units
K	Permeability	X	m/s
r	radius of test hole	0.04	m
t	time since start of measurement	X	s
h_r	reference point height above base	0.7	m
d_t	depth from reference point to water at time t	X	m
h_t	Water column height at time t	X	m
h_0	h_t at t=0	X	m



Test 1

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.08	0.62	X	X
20	0.27	0.43	3.5E-04	30.4
40	0.36	0.34	2.9E-04	24.8
60	0.43	0.27	2.6E-04	22.8
80	0.485	0.215	2.5E-04	21.6
100	0.52	0.18	2.3E-04	20.1
120	0.56	0.14	2.3E-04	19.9
140	0.57	0.13	2.1E-04	17.9
		AVERAGE	2.6E-04	22.5

Test 2

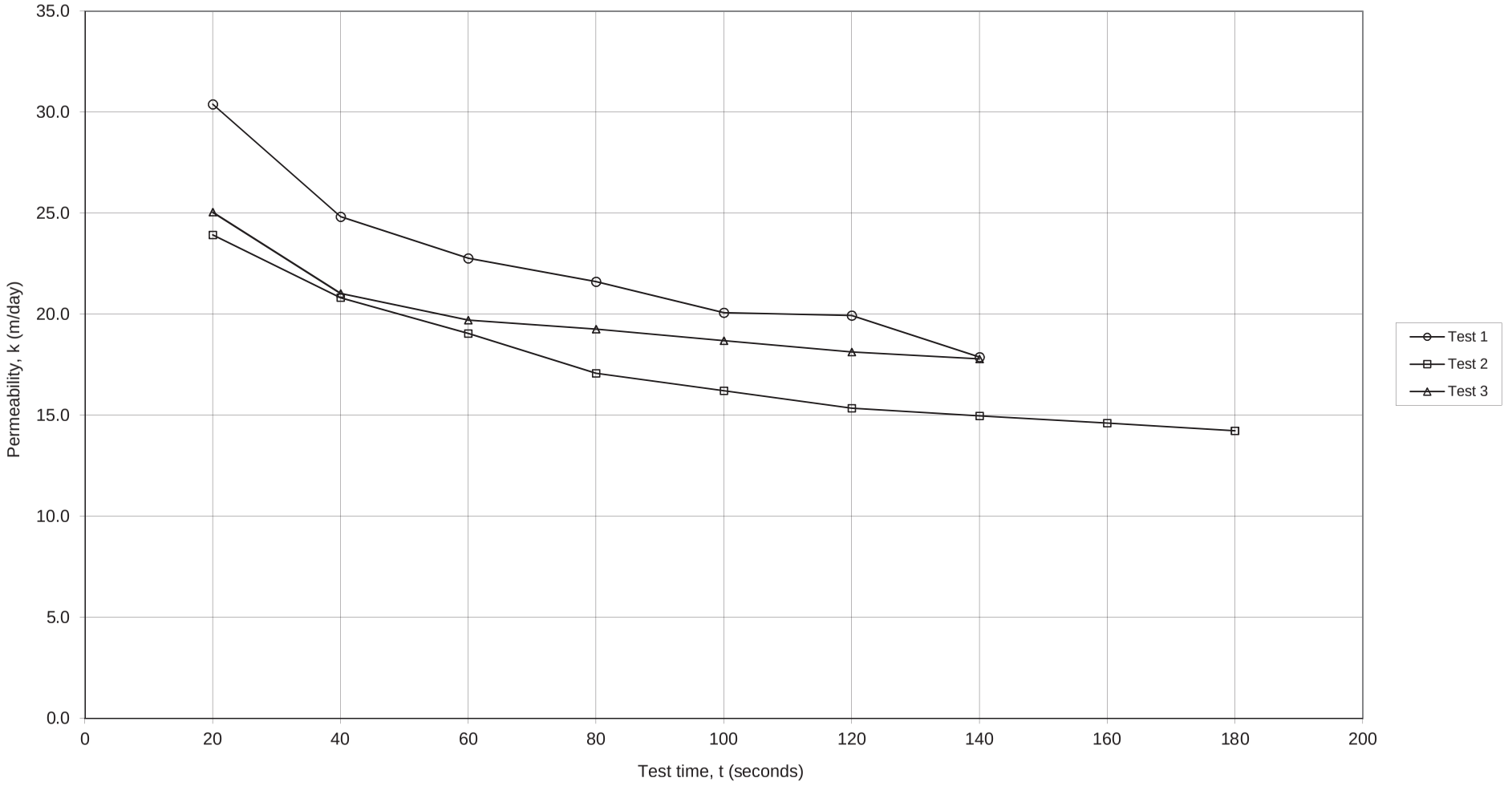
t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.08	0.62	X	X
20	0.235	0.465	2.8E-04	23.9
40	0.325	0.375	2.4E-04	20.8
60	0.39	0.31	2.2E-04	19.1
80	0.43	0.27	2.0E-04	17.1
100	0.47	0.23	1.9E-04	16.2
120	0.5	0.2	1.8E-04	15.4
140	0.53	0.17	1.7E-04	15.0
160	0.555	0.145	1.7E-04	14.6
180	0.575	0.125	1.6E-04	14.2
		AVERAGE	2.0E-04	17.4

Test 3

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.085	0.615	X	X
20	0.245	0.455	2.9E-04	25.1
40	0.33	0.37	2.4E-04	21.0
60	0.4	0.3	2.3E-04	19.7
80	0.46	0.24	2.2E-04	19.3
100	0.505	0.195	2.2E-04	18.7
120	0.54	0.16	2.1E-04	18.1
140	0.57	0.13	2.1E-04	17.8
		AVERAGE	2.3E-04	20.0

Permeability by Inverse Auger Hole Method

HA02/P2



Permeability Calculation - Inverse Auger Hole Method

Galt Geotechnics

Spreadsheet author:	ORW	17-Oct-09

Job No:	J1501070
Client:	Pritchard Francis
Site:	16 McDonald Road
Location:	Baldivis
Calc by:	EY 22-Apr-15
BH Name:	HA03/P3
Test Depth:	0.6 m

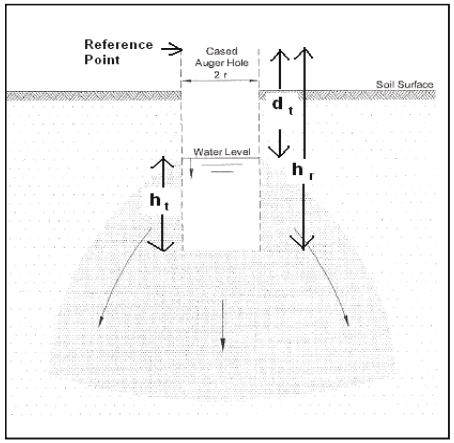
$$K = 1.15r \frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Spreadsheet Legend

	Required input
	Calculated field
	Comment field
X	Field not used
	Fixed field

Parameter	Description	Value	Units
K	Permeability	X	m/s
r	radius of test hole	0.04	m
t	time since start of measurement	X	s
h_r	reference point height above base	0.6	m
d_t	depth from reference point to water at time t	X	m
h_t	Water column height at time t	X	m
h_0	h_t at t=0	X	m



Test 1

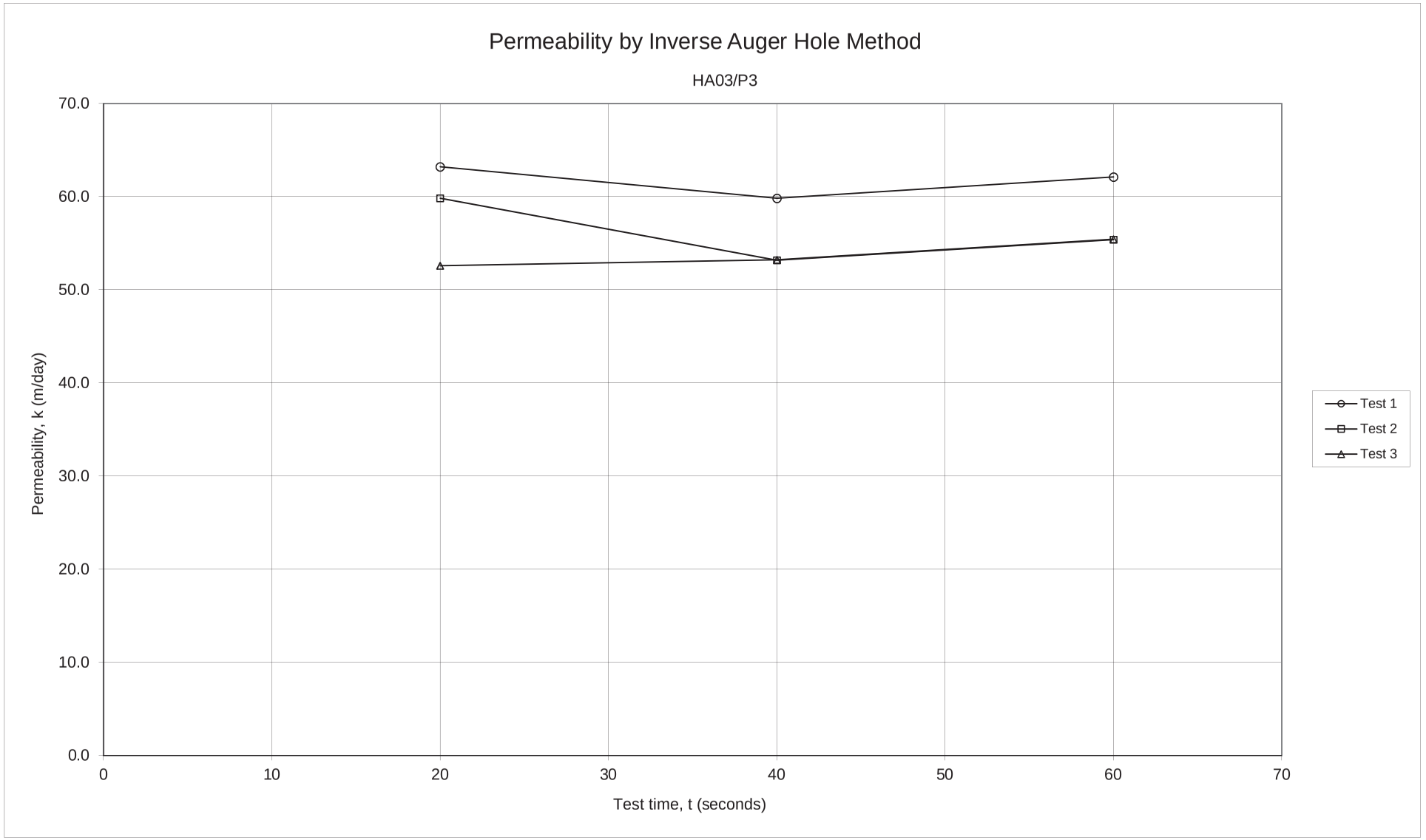
t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.1	0.5	X	X
20	0.37	0.23	7.3E-04	63.2
40	0.49	0.11	6.9E-04	59.8
60	0.56	0.04	7.2E-04	62.1
		AVERAGE	7.1E-04	61.7

Test 2

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.14	0.46	X	X
20	0.38	0.22	6.9E-04	59.8
40	0.48	0.12	6.2E-04	53.2
60	0.55	0.05	6.4E-04	55.4
		AVERAGE	6.5E-04	56.1

Test 3

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.105	0.495	X	X
20	0.34	0.26	6.1E-04	52.6
40	0.47	0.13	6.2E-04	53.2
60	0.545	0.055	6.4E-04	55.4
		AVERAGE	6.2E-04	53.7


Permeability by Inverse Auger Hole Method
HA03/P3
Permeability, k (m/day)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
10
20
30
40
50
60
70
Test time, t (seconds)
Test 1
Test 2
Test 3

Appendix F: Environmental Laboratory Certificates

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ABN: 73 292 586 155

eurofins | mgt

Certificate of Analysis

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025. The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Galt Environment P/L
2/39 Flynn St
Wembley
WA 6014

Attention: **Brad Palmer**

Report **454842-S**
Project name BALDIVIS
Project ID J1501070
Received Date Apr 22, 2015

Client Sample ID			**SS01/0.0**	**SS02/0.0**	**SS03/0.0**	**SS04/0.0**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins | mgt Sample No.			**M15-Ap16245**	**M15-Ap16246**	**M15-Ap16247**	**M15-Ap16248**
Date Sampled			**Apr 20, 2015**	**Apr 20, 2015**	**Apr 20, 2015**	**Apr 20, 2015**
Test/Reference	LOR	Unit				
Organochlorine Pesticides						
Chlordanes - Total	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
4.4'-DDD	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
4.4'-DDE	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
4.4'-DDT	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
a-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Aldrin	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
b-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
d-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Dieldrin	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endosulfan I	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endosulfan II	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endosulfan sulphate	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endrin	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endrin aldehyde	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endrin ketone	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
g-BHC (Lindane)	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Heptachlor	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Heptachlor epoxide	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Hexachlorobenzene	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Methoxychlor	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Toxaphene	1	mg/kg	< 1	< 1	< 1	< 1
Dibutylchlorendate (surr.)	1	%	90	87	91	75
Tetrachloro-m-xylene (surr.)	1	%	79	79	83	73
Organophosphorous Pesticides						
Bolstar	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Chlorpyrifos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Demeton-O	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Diazinon	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Dichlorvos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Disulfoton	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Ethion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Ethoprop	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Fenitrothion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Fensulfothion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Fenthion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2

Client Sample ID			SS01/0.0	SS02/0.0	SS03/0.0	SS04/0.0
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins | mgt Sample No.			M15-Ap16245	M15-Ap16246	M15-Ap16247	M15-Ap16248
Date Sampled			Apr 20, 2015	Apr 20, 2015	Apr 20, 2015	Apr 20, 2015
Test/Reference	LOR	Unit				
Organophosphorous Pesticides						
Merphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Methyl azinphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Methyl parathion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Mevinphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Naled	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Phorate	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Ronnel	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Tokuthion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Trichloronate	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Triphenylphosphate (surr.)	1	%	55	61	63	65
Heavy Metals						
Arsenic	2	mg/kg	3.4	2.8	2.7	2.3
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	15	15	16	16
Copper	5	mg/kg	14	19	19	17
Lead	5	mg/kg	5.6	6.9	6.8	6.0
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	< 5
Zinc	5	mg/kg	38	68	50	42
% Moisture	0.1	%	2.6	3.6	3.1	3.1

Client Sample ID			SS05/0.0	SS06/0.0	SS07/0.0	SS08/0.0
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins | mgt Sample No.			M15-Ap16249	M15-Ap16250	M15-Ap16251	M15-Ap16252
Date Sampled			Apr 20, 2015	Apr 20, 2015	Apr 20, 2015	Apr 20, 2015
Test/Reference	LOR	Unit				
Organochlorine Pesticides						
Chlordanes - Total	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
4.4'-DDD	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
4.4'-DDE	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
4.4'-DDT	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
a-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Aldrin	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
b-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
d-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Dieldrin	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endosulfan I	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endosulfan II	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endosulfan sulphate	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endrin	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endrin aldehyde	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Endrin ketone	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
g-BHC (Lindane)	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Heptachlor	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Heptachlor epoxide	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Hexachlorobenzene	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05
Methoxychlor	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05

Client Sample ID			SS05/0.0	SS06/0.0	SS07/0.0	SS08/0.0
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins | mgt Sample No.			M15-Ap16249	M15-Ap16250	M15-Ap16251	M15-Ap16252
Date Sampled			Apr 20, 2015	Apr 20, 2015	Apr 20, 2015	Apr 20, 2015
Test/Reference	LOR	Unit				
Organochlorine Pesticides						
Toxaphene	1	mg/kg	< 1	< 1	< 1	< 1
Dibutylchlorendate (surr.)	1	%	88	93	95	88
Tetrachloro-m-xylene (surr.)	1	%	82	83	83	77
Organophosphorous Pesticides						
Bolstar	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Chlorpyrifos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Demeton-O	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Diazinon	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Dichlorvos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Disulfoton	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Ethion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Ethoprop	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Fenitrothion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Fensulfothion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Fenthion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Merphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Methyl azinphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Methyl parathion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Mevinphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Naled	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Phorate	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Ronnel	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Tokuthion	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Trichloronate	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Triphenylphosphate (surr.)	1	%	58	62	77	77
Heavy Metals						
Arsenic	2	mg/kg	4.4	3.7	2.9	2.3
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	15	15	16	17
Copper	5	mg/kg	16	17	19	26
Lead	5	mg/kg	6.4	6.8	6.3	6.9
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	< 5
Zinc	5	mg/kg	43	42	41	51
% Moisture	0.1	%	2.7	2.3	3.1	3.7

Client Sample ID			SS09/0.0	SS10/0.0	QC1
Sample Matrix			Soil	Soil	Soil
Eurofins | mgt Sample No.			M15-Ap16253	M15-Ap16254	M15-Ap16255
Date Sampled			Apr 20, 2015	Apr 20, 2015	Apr 20, 2015
Test/Reference	LOR	Unit			
Organochlorine Pesticides					
Chlordanes - Total	0.1	mg/kg	< 0.1	< 0.1	< 0.1
4.4'-DDD	0.05	mg/kg	< 0.05	< 0.05	< 0.05
4.4'-DDE	0.05	mg/kg	< 0.05	< 0.05	< 0.05
4.4'-DDT	0.05	mg/kg	< 0.05	< 0.05	< 0.05
a-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05

Client Sample ID			SS09/0.0	SS10/0.0	QC1
Sample Matrix			Soil	Soil	Soil
Eurofins | mgt Sample No.			M15-Ap16253	M15-Ap16254	M15-Ap16255
Date Sampled			Apr 20, 2015	Apr 20, 2015	Apr 20, 2015
Test/Reference	LOR	Unit			
Organochlorine Pesticides					
Aldrin	0.05	mg/kg	< 0.05	< 0.05	< 0.05
b-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05
d-BHC	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Dieldrin	0.05	mg/kg	0.07	< 0.05	< 0.05
Endosulfan I	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Endosulfan II	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Endosulfan sulphate	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Endrin	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Endrin aldehyde	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Endrin ketone	0.05	mg/kg	< 0.05	< 0.05	< 0.05
g-BHC (Lindane)	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Heptachlor	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Heptachlor epoxide	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Hexachlorobenzene	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Methoxychlor	0.05	mg/kg	< 0.05	< 0.05	< 0.05
Toxaphene	1	mg/kg	< 1	< 1	< 1
Dibutylchlorendate (surr.)	1	%	77	85	98
Tetrachloro-m-xylene (surr.)	1	%	74	72	80
Organophosphorous Pesticides					
Bolstar	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Chlorpyrifos	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Demeton-O	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Diazinon	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Dichlorvos	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Disulfoton	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Ethion	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Ethoprop	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Fenitrothion	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Fensulfothion	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Fenthion	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Merphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Methyl azinphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Methyl parathion	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Mevinphos	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Naled	0.5	mg/kg	< 0.5	< 0.5	< 0.5
Phorate	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Ronnel	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Tokuthion	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Trichloronate	0.2	mg/kg	< 0.2	< 0.2	< 0.2
Triphenylphosphate (surr.)	1	%	71	75	86
Heavy Metals					
Arsenic	2	mg/kg	4.1	4.7	4.9
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	19	19	18
Copper	5	mg/kg	32	< 5	6.3
Lead	5	mg/kg	8.2	< 5	< 5
Mercury	0.1	mg/kg	0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5
Zinc	5	mg/kg	110	< 5	12

Client Sample ID			SS09/0.0	SS10/0.0	QC1
Sample Matrix			**Soil**	**Soil**	**Soil**
Eurofins | mgt Sample No.			**M15-Ap16253**	**M15-Ap16254**	**M15-Ap16255**
Date Sampled			**Apr 20, 2015**	**Apr 20, 2015**	**Apr 20, 2015**
Test/Reference	LOR	Unit			
% Moisture	0.1	%	3.5	2.9	1.5

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Eurofins | mgt Suite 14			
Organochlorine Pesticides	Melbourne	Apr 23, 2015	14 Day
- Method: USEPA 8081 Organochlorine Pesticides			
Organophosphorous Pesticides	Melbourne	Apr 23, 2015	14 Day
- Method: USEPA 8270 Organophosphorus Pesticides			
Metals M8	Melbourne	Apr 23, 2015	28 Day
- Method: USEPA 6010/6020 Heavy Metals & USEPA 7470/71 Mercury			
% Moisture	Melbourne	Apr 22, 2015	14 Day
- Method: LTM-GEN-7080 Moisture			

Company Name: Galt Environment P/L
Address: 2/39 Flynn St
Wembley
WA 6014

Project Name: BALDIVIS
Project ID: J1501070

Order No.: J1501070
Report #: 454842
Phone: 08 6272 0200
Fax: 08 9285 8444

Received: Apr 22, 2015 9:54 AM
Due: Apr 29, 2015
Priority: 5 Day
Contact Name: Brad Palmer

Eurofins | mgt Client Manager: Natalie Krasselt

Sample Detail					Metals M8	Eurofins | mgt Suite 14	Moisture Set
Laboratory where analysis is conducted							
Melbourne Laboratory - NATA Site # 1254 & 14271					X	X	X
Sydney Laboratory - NATA Site # 18217							
Brisbane Laboratory - NATA Site # 20794							
External Laboratory							
Sample ID	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**			
SS01/0.0	Apr 20, 2015		Soil	M15-Ap16245	X	X	X
SS02/0.0	Apr 20, 2015		Soil	M15-Ap16246	X	X	X
SS03/0.0	Apr 20, 2015		Soil	M15-Ap16247	X	X	X
SS04/0.0	Apr 20, 2015		Soil	M15-Ap16248	X	X	X
SS05/0.0	Apr 20, 2015		Soil	M15-Ap16249	X	X	X
SS06/0.0	Apr 20, 2015		Soil	M15-Ap16250	X	X	X
SS07/0.0	Apr 20, 2015		Soil	M15-Ap16251	X	X	X
SS08/0.0	Apr 20, 2015		Soil	M15-Ap16252	X	X	X
SS09/0.0	Apr 20, 2015		Soil	M15-Ap16253	X	X	X

Company Name:	Galt Environment P/L	**Order No.:**	J1501070	**Received:**	Apr 22, 2015 9:54 AM
Address:	2/39 Flynn St Wembley WA 6014	**Report #:**	454842	**Due:**	Apr 29, 2015
		Phone:	08 6272 0200	**Priority:**	5 Day
		Fax:	08 9285 8444	**Contact Name:**	Brad Palmer
Project Name:	BALDIVIS				
Project ID:	J1501070				

Eurofins | mgt Client Manager: Natalie Krasselt

Sample Detail					Metals M8	Eurofins | mgt Suite 14	Moisture Set
Laboratory where analysis is conducted							
Melbourne Laboratory - NATA Site # 1254 & 14271					X	X	X
Sydney Laboratory - NATA Site # 18217							
Brisbane Laboratory - NATA Site # 20794							
External Laboratory							
SS10/0.0	Apr 20, 2015		Soil	M15-Ap16254	X	X	X
QC1	Apr 20, 2015		Soil	M15-Ap16255	X	X	X

Eurofins | mgt Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
4. Results are uncorrected for matrix spikes or surrogate recoveries.
5. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
6. Samples were analysed on an 'as received' basis. 7. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the Sample Receipt Advice.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

****NOTE:** pH duplicates are reported as a range NOT as RPD

UNITS

mg/kg: milligrams per Kilogram

ug/l: micrograms per litre

ppb: Parts per billion

org/100ml: Organisms per 100 millilitres

MPN/100mL: Most Probable Number of organisms per 100 millilitres

mg/l: milligrams per litre

ppm: Parts per million

%: Percentage

NTU: Nephelometric Turbidity Units

TERMS

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery
CRM	Certified Reference Material - reported as percent recovery
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands. In the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
Batch Duplicate	A second piece of analysis from a sample outside of the clients batch of samples but run within the laboratory batch of analysis.
Batch SPIKE	Spike recovery reported on a sample from outside of the clients batch of samples but run within the laboratory batch of analysis.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
ASLP	Australian Standard Leaching Procedure (AS4439.3)
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within
TEQ	Toxic Equivalency Quotient

QC - ACCEPTANCE CRITERIA

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries : Recoveries must lie between 50-150% - Phenols 20-130%.

QC DATA GENERAL COMMENTS

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxophene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxophene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Arochlor 1260 in Matrix Spikes and LCS's.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPD's are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Organochlorine Pesticides							
Chlordanes - Total	mg/kg	< 0.1			0.1	Pass	
4.4'-DDD	mg/kg	< 0.05			0.05	Pass	
4.4'-DDE	mg/kg	< 0.05			0.05	Pass	
4.4'-DDT	mg/kg	< 0.05			0.05	Pass	
a-BHC	mg/kg	< 0.05			0.05	Pass	
Aldrin	mg/kg	< 0.05			0.05	Pass	
b-BHC	mg/kg	< 0.05			0.05	Pass	
d-BHC	mg/kg	< 0.05			0.05	Pass	
Dieldrin	mg/kg	< 0.05			0.05	Pass	
Endosulfan I	mg/kg	< 0.05			0.05	Pass	
Endosulfan II	mg/kg	< 0.05			0.05	Pass	
Endosulfan sulphate	mg/kg	< 0.05			0.05	Pass	
Endrin	mg/kg	< 0.05			0.05	Pass	
Endrin aldehyde	mg/kg	< 0.05			0.05	Pass	
Endrin ketone	mg/kg	< 0.05			0.05	Pass	
g-BHC (Lindane)	mg/kg	< 0.05			0.05	Pass	
Heptachlor	mg/kg	< 0.05			0.05	Pass	
Heptachlor epoxide	mg/kg	< 0.05			0.05	Pass	
Hexachlorobenzene	mg/kg	< 0.05			0.05	Pass	
Methoxychlor	mg/kg	< 0.05			0.05	Pass	
Toxaphene	mg/kg	< 1			1	Pass	
Method Blank							
Organophosphorous Pesticides							
Bolstar	mg/kg	< 0.2			0.2	Pass	
Chlorpyrifos	mg/kg	< 0.2			0.2	Pass	
Demeton-O	mg/kg	< 0.2			0.2	Pass	
Diazinon	mg/kg	< 0.2			0.2	Pass	
Dichlorvos	mg/kg	< 0.2			0.2	Pass	
Disulfoton	mg/kg	< 0.2			0.2	Pass	
Ethion	mg/kg	< 0.2			0.2	Pass	
Ethoprop	mg/kg	< 0.2			0.2	Pass	
Fenitrothion	mg/kg	< 0.2			0.2	Pass	
Fensulfothion	mg/kg	< 0.2			0.2	Pass	
Fenthion	mg/kg	< 0.2			0.2	Pass	
Merphos	mg/kg	< 0.2			0.2	Pass	
Methyl azinphos	mg/kg	< 0.2			0.2	Pass	
Methyl parathion	mg/kg	< 0.2			0.2	Pass	
Mevinphos	mg/kg	< 0.2			0.2	Pass	
Naled	mg/kg	< 0.5			0.5	Pass	
Phorate	mg/kg	< 0.2			0.2	Pass	
Ronnel	mg/kg	< 0.2			0.2	Pass	
Tokuthion	mg/kg	< 0.2			0.2	Pass	
Trichloronate	mg/kg	< 0.2			0.2	Pass	
Method Blank							
Heavy Metals							
Arsenic	mg/kg	< 2			2	Pass	
Cadmium	mg/kg	< 0.4			0.4	Pass	
Chromium	mg/kg	< 5			5	Pass	
Copper	mg/kg	< 5			5	Pass	
Lead	mg/kg	< 5			5	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Mercury	mg/kg	< 0.1			0.1	Pass	
Nickel	mg/kg	< 5			5	Pass	
Zinc	mg/kg	< 5			5	Pass	
LCS - % Recovery							
Organochlorine Pesticides							
4.4'-DDD	%	98			70-130	Pass	
4.4'-DDE	%	95			70-130	Pass	
4.4'-DDT	%	88			70-130	Pass	
a-BHC	%	126			70-130	Pass	
Aldrin	%	95			70-130	Pass	
b-BHC	%	111			70-130	Pass	
d-BHC	%	97			70-130	Pass	
Dieldrin	%	96			70-130	Pass	
Endosulfan I	%	94			70-130	Pass	
Endosulfan II	%	98			70-130	Pass	
Endosulfan sulphate	%	104			70-130	Pass	
Endrin	%	90			70-130	Pass	
Endrin aldehyde	%	99			70-130	Pass	
Endrin ketone	%	105			70-130	Pass	
g-BHC (Lindane)	%	87			70-130	Pass	
Heptachlor	%	96			70-130	Pass	
Heptachlor epoxide	%	94			70-130	Pass	
Hexachlorobenzene	%	91			70-130	Pass	
Methoxychlor	%	82			70-130	Pass	
LCS - % Recovery							
Organophosphorous Pesticides							
Diazinon	%	83			70-130	Pass	
Ethion	%	102			70-130	Pass	
Fenitrothion	%	81			70-130	Pass	
Methyl parathion	%	82			70-130	Pass	
Mevinphos	%	92			70-130	Pass	
LCS - % Recovery							
Heavy Metals							
Arsenic	%	80			80-120	Pass	
Cadmium	%	95			80-120	Pass	
Chromium	%	96			80-120	Pass	
Copper	%	98			80-120	Pass	
Lead	%	98			80-120	Pass	
Mercury	%	101			75-125	Pass	
Nickel	%	100			80-120	Pass	
Zinc	%	98			80-120	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Spike - % Recovery									
Organochlorine Pesticides				Result 1					
4.4'-DDD	M15-Ap16246	CP	%	88			70-130	Pass	
4.4'-DDE	M15-Ap16246	CP	%	89			70-130	Pass	
4.4'-DDT	M15-Ap16246	CP	%	82			70-130	Pass	
a-BHC	M15-Ap16246	CP	%	95			70-130	Pass	
Aldrin	M15-Ap16246	CP	%	81			70-130	Pass	
b-BHC	M15-Ap16246	CP	%	96			70-130	Pass	
d-BHC	M15-Ap16246	CP	%	84			70-130	Pass	
Dieldrin	M15-Ap16246	CP	%	87			70-130	Pass	
Endosulfan I	M15-Ap16246	CP	%	81			70-130	Pass	
Endosulfan II	M15-Ap16246	CP	%	85			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Endosulfan sulphate	M15-Ap16246	CP	%	94			70-130	Pass	
Endrin	M15-Ap16246	CP	%	83			70-130	Pass	
Endrin aldehyde	M15-Ap16246	CP	%	86			70-130	Pass	
Endrin ketone	M15-Ap16246	CP	%	95			70-130	Pass	
g-BHC (Lindane)	M15-Ap16246	CP	%	74			70-130	Pass	
Heptachlor	M15-Ap16246	CP	%	84			70-130	Pass	
Heptachlor epoxide	M15-Ap16246	CP	%	87			70-130	Pass	
Hexachlorobenzene	M15-Ap16246	CP	%	78			70-130	Pass	
Methoxychlor	M15-Ap16246	CP	%	85			70-130	Pass	
Spike - % Recovery									
Organophosphorous Pesticides				Result 1					
Diazinon	M15-Ap16250	CP	%	90			70-130	Pass	
Ethion	M15-Ap16250	CP	%	73			70-130	Pass	
Fenitrothion	M15-Ap16250	CP	%	71			70-130	Pass	
Methyl parathion	M15-Ap16250	CP	%	72			70-130	Pass	
Mevinphos	M15-Ap16250	CP	%	90			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Arsenic	M15-Ap16251	CP	%	78			75-125	Pass	
Cadmium	M15-Ap16251	CP	%	97			75-125	Pass	
Chromium	M15-Ap16251	CP	%	97			75-125	Pass	
Copper	M15-Ap16251	CP	%	103			75-125	Pass	
Lead	M15-Ap16251	CP	%	98			75-125	Pass	
Mercury	M15-Ap16251	CP	%	85			70-130	Pass	
Nickel	M15-Ap16251	CP	%	99			75-125	Pass	
Zinc	M15-Ap16251	CP	%	85			75-125	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
Organochlorine Pesticides				Result 1	Result 2	RPD			
Chlordanes - Total	M15-Ap16245	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
4.4'-DDD	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
4.4'-DDE	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
4.4'-DDT	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
a-BHC	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Aldrin	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
b-BHC	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
d-BHC	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Dieldrin	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endosulfan I	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endosulfan II	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endosulfan sulphate	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endrin	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endrin aldehyde	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endrin ketone	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
g-BHC (Lindane)	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Heptachlor	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Heptachlor epoxide	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Hexachlorobenzene	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Methoxychlor	M15-Ap16245	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Toxaphene	M15-Ap16245	CP	mg/kg	< 1	< 1	<1	30%	Pass	

Duplicate									
Organophosphorous Pesticides				Result 1	Result 2	RPD			
Bolstar	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Chlorpyrifos	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Demeton-O	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Diazinon	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Dichlorvos	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Disulfoton	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Ethion	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Ethoprop	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Fenitrothion	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Fensulfothion	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Fenthion	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Merphos	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Methyl azinphos	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Methyl parathion	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Mevinphos	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Naled	M15-Ap16249	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Phorate	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Ronnel	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Tokuthion	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Trichloronate	M15-Ap16249	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Arsenic	M15-Ap16250	CP	mg/kg	3.7	3.2	17	30%	Pass	
Cadmium	M15-Ap16250	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	M15-Ap16250	CP	mg/kg	15	15	2.0	30%	Pass	
Copper	M15-Ap16250	CP	mg/kg	17	17	1.0	30%	Pass	
Lead	M15-Ap16250	CP	mg/kg	6.8	6.2	10	30%	Pass	
Mercury	M15-Ap16250	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Nickel	M15-Ap16250	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Zinc	M15-Ap16250	CP	mg/kg	42	46	7.0	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Arsenic	M15-Ap16251	CP	mg/kg	2.9	2.6	10	30%	Pass	
Cadmium	M15-Ap16251	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	M15-Ap16251	CP	mg/kg	16	16	1.0	30%	Pass	
Copper	M15-Ap16251	CP	mg/kg	19	19	<1	30%	Pass	
Lead	M15-Ap16251	CP	mg/kg	6.3	6.7	6.0	30%	Pass	
Mercury	M15-Ap16251	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Nickel	M15-Ap16251	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Zinc	M15-Ap16251	CP	mg/kg	41	45	9.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
% Moisture	M15-Ap16252	CP	%	3.7	3.2	12	30%	Pass	
Duplicate									
Organochlorine Pesticides				Result 1	Result 2	RPD			
Chlordanes - Total	M15-Ap16255	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
4.4'-DDD	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
4.4'-DDE	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
4.4'-DDT	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
a-BHC	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Aldrin	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
b-BHC	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
d-BHC	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Dieldrin	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	

Duplicate									
Organochlorine Pesticides				Result 1	Result 2	RPD			
Endosulfan I	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endosulfan II	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endosulfan sulphate	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endrin	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endrin aldehyde	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endrin ketone	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
g-BHC (Lindane)	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Heptachlor	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Heptachlor epoxide	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Hexachlorobenzene	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Methoxychlor	M15-Ap16255	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Toxaphene	M15-Ap16255	CP	mg/kg	< 1	< 1	<1	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised By

Natalie Krasselt	Analytical Services Manager
Carroll Lee	Senior Analyst-Organic (VIC)
Emily Rosenberg	Senior Analyst-Metal (VIC)
Huong Le	Senior Analyst-Inorganic (VIC)

Glenn Jackson
National Laboratory Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Uncertainty data is available on request

Appendix G: Understanding Your Report

www.galtgeo.com.au
2/39 Flynn St, WEMBLEY WA 6014
ABN: 73 292 586 155

UNDERSTANDING YOUR GEOTECHNICAL ENGINEERING REPORT

GALT FORM PMP11 Rev1

1. EXPECTATIONS OF A GEOTECHNICAL ENGINEERING REPORT

This document has been prepared to clarify what is and is not provided in your geotechnical report. It is intended to inform you of what your realistic expectations of this report should be and how to manage your risks associated with geotechnical conditions.

Geotechnical engineering is a less exact science than other engineering disciplines. We include this information to help you understand where our responsibilities as geotechnical engineers begin and end, to help the client recognise his responsibilities and risks. You should read and understand this information. Please contact us if you do not understand the report or this explanation. We have extensive experience in a wide variety of geotechnical problems and we can help you to manage your risk.

2. THIS REPORT RELATES TO PROJECT-SPECIFIC CONDITIONS

This report was developed for a unique set of project-specific conditions to meet the needs of the nominated client. It took into account the following :

- The project objectives as we understood them and as described in this report;
- the specific site mentioned in this report; and
- the current and proposed development at the site.

It should not be used for any purpose other than that indicated in the report. You should not rely on this geotechnical report if any of the following conditions apply:

- the report was not written for you;
- the report was not written for the site specific to your development;
- the report was not written for your project (including a development at the correct site but other than that listed in the report); or
- the report was written before significant changes occurred at the site (such as a development or a change in ground conditions).

You should always inform us of changes in the proposed project (including minor changes) and request an assessment of their impact.

Where we are not informed of developments relevant to your geotechnical engineering report, we cannot be held responsible or liable for problems that may arise as a consequence.

Where design is to be carried out by others using information provided by us, we recommend that we be involved in the design process by being engaged for consultation with other members of the design team and by being able to review work produced by other members of the design team which relies on geotechnical information provided in our report.

3. GEOTECHNICAL ENGINEERING LOGS

Our reports often include logs of intrusive and non-intrusive geotechnical investigation techniques. These logs are based on our interpretation of field data and laboratory results. The logs should only be read in conjunction with the report they were issued with and should not be re-drawn for inclusion in other documents not prepared by us.

4. THIRD PARTY RELIANCE

We have prepared this report for use by the client. This report must be regarded as confidential to the client and the client's professional advisors. We do not accept any responsibility for contents of this document from any party other than the nominated client. We take no responsibility for any damages suffered by a third party as a consequence of any decisions or actions they may make based on this report. Any reliance or decisions made by a third party based on this report are the responsibility of the third party and not of us.

5. CHANGE IN SUBSURFACE CONDITIONS

The geotechnical recommendations in this report are based on the ground conditions that existed at the time when the study was undertaken. Changes in ground conditions can occur in numerous ways including as a result of anthropogenic events (such as construction on or adjacent to the site) or natural events (such as floods, groundwater fluctuations or earthquakes). We should be consulted prior to use of this report so that we can comment on its reliability. It is important to note that where ground conditions have changed, additional sampling, testing or analysis may be required to fully assess the changed conditions.

6. SUBSURFACE CONDITIONS DURING CONSTRUCTION

Practical constraints mean that we cannot know every minute detail about the subsurface conditions at a particular site. We use engineering judgement to form an opinion about the subsurface conditions at the site. Some variation to our evaluated conditions is likely and significant variation is possible. Accordingly, our report should not be considered as final as it is developed from engineering judgement and opinion.

The most effective means of dealing with unanticipated ground conditions is to engage us for construction support. We can only finalise our recommendations by observing actual subsurface conditions encountered during construction. We cannot accept liability for a report's recommendations if we cannot observe construction.

7. ENVIRONMENTAL ISSUES

Unless specifically mentioned otherwise in our report, environmental considerations are not included. The investigation techniques used by us in developing our report differ from those for an environmental investigation. Our report was not prepared with environmental considerations in mind and it is the client's responsibility to satisfy himself that environmental considerations have been taken into account for the site. If you require guidance on how to proceed on evaluating environmental risk at the site, we can provide further information and contacts.

UNDERSTANDING YOUR ENVIRONMENTAL REPORT

GALT FORM PMP29 Rev1

1. EXPECTATIONS OF AN ENVIRONMENTAL REPORT

This document has been prepared to clarify what is and is not provided in your environmental report. It is intended to inform you of what your realistic expectations of this report should be and how to manage your risks associated with environmental conditions. You should read and understand this information. Please contact us if you do not understand the report or this explanation. We have extensive experience in a wide variety of environmental problems and we can help you to manage your risk.

2. THIS REPORT RELATES TO PROJECT-SPECIFIC CONDITIONS

This report was developed for a unique set of project-specific conditions to meet the needs of the nominated client. It took into account the following:

- The project objectives as we understood them and as described in this report;
- the specific site mentioned in this report; and
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- the report was written before significant changes occurred at the site (such as a development or a change in ground conditions).

You should always inform us of changes in the proposed project (including minor changes) and request an assessment of their impact.

Where we are not informed of developments relevant to your environmental report, we cannot be held responsible or liable for problems that may arise as a consequence.

Where design is to be carried out by others using information provided by us, we recommend that we be involved in the project planning process by being engaged for consultation with members of the project team and by being able to review work produced by other members of the project team which relies on environmental information provided in our report.

3. ENVIRONMENTAL LOGS

Our reports often include logs of intrusive and non-intrusive environmental investigation techniques. These logs are based on our interpretation of field data and laboratory results. The logs should only be read in conjunction with the report they were issued with and should not be re-drawn for inclusion in other documents not prepared by us.

4. THIRD PARTY RELIANCE

We have prepared this report for use by the client. This report must be regarded as confidential to the client and the client's professional advisors. We do not accept any responsibility for contents of this document from any party other than the nominated client. We take no responsibility for any damages suffered by a third party as a consequence of any decisions or actions they may make based on this report. Any reliance or decisions made by a third party based on this report are the responsibility of the third party and not of us.

5. CHANGE IN SITE CONDITIONS

The environmental recommendations in this report are based on the site conditions that existed at the time when the study was undertaken. Changes in site conditions can occur in numerous ways including as a result of anthropogenic events (such as potentially contaminating activities or action on or adjacent to the site) or natural events (such as floods, groundwater fluctuations or earthquakes). We should be consulted prior to use of this report so that we can comment on its reliability. It is important to note that where site conditions have changed, additional sampling, testing or analysis may be required to fully characterise the changed conditions.

O:\Administration\Standard Forms and Documents\PMP29 Understanding your Environmental Report.docx

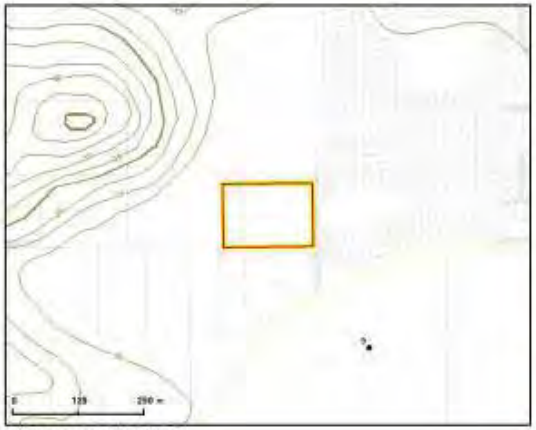
appendix four: groundwater contours

Perth Groundwater Atlas - Groundwater contours

appendix five: acid sulphate soils

MAP 1 - AERIAL

MAP 2 - STREET



MAP 3 - CONTOURS

MAP 4 - ACID SULFATE SOIL RISK

MAP 5 - ENVIRONMENTALLY SENSITIVE AREAS

MAP 6 - GEOMORPHIC WETLANDS

MAP 7 - CONTAMINATED SITES

MAP 8 - HERITAGE SITES

MAP 9 - GROUNDWATER CONTOURS AND WINSITES

MAP 4 - ACID SULFATE SOIL RISK

High to moderate risk | Moderate to low risk

MAP 5 - ENVIRONMENTALLY SENSITIVE AREAS

Environmentally Sensitive Area

MAP 6 - GEOMORPHIC WETLANDS

Multiple Use | Conservation | Not Applicable | Resource Enhancement | Not Assessed

MAP 7 - CONTAMINATED SITES

Contaminated - remediation required | Remediated for restricted use | Contaminated - restricted use

Contaminated Sites information is taken from the publicly available Department of Environment Regulation (DER) Contaminated Sites Database. Only sites classified as 'Contaminated – remediation required', 'Contaminated – restricted use' and 'Remediated – restricted use' are shown. Sites with other classifications under the Contaminated Sites Act 2003 are identified through a basic or detailed summary of records search request through DER.

MAP 8 - HERITAGE SITES

Heritage Site

MAP 9 - GROUNDWATER CONTOURS AND WINSITES

Maximum Minimum WINSITES

5 5 Ground, Borehole or Well

1 1 Other

N

0 30 60 90 120 150

Metres

SCALE	1:2,000 (A3)
DRAWN	DAC
DATE DRAWN	30/04/2015
CHECKED	SS
DATE CHECKED	30/04/2015
PROJECTION	GDA 1994 MGA Zone 50

Galt Environmental Pty Ltd
ACN 161 708 998
Tel +61 (08) 6272-0200
Fax +61 (08) 9285 8444
Address Lv2, 39 Flynn Street, Wembley, WA, 6014

CLIENT	PRITCHARD FRANCIS
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	16 MCDONALD ROAD BALDIVIS
TITLE	INDICATIVE ENVIRONMENTAL ASPECTS
JOB NO	J1501070
FIG NO	FIGURE 2
REV	A

appendix six: dial-before-you-dig information

DBYD Enquiry Response

For your immediate information **'THERE IS AN APA HIGH PRESSURE NATURAL GAS TRANSMISSION PIPELINE'** in the area of your proposed works. Please **do not** proceed until the next steps below are completed.

Date: 19/02/2015

From: Land Officer, APA group

Phone: 1800 103 452

Email: HELM@apa.com.au

Scale: 1: 50000

0 0.6km

To: Mr Lachlan Harris

Company: Pritchard Francis

Phone: 0891928015

Email: lachlan.h@pfeng.com.au

Fax: 0891928038

RE:

DBYD Seq No: 44003106

Utility ID: 70850

Address: Mcdonald Road Baldivis

Map: Streetsmart :611E1

Next step:

Please contact an APA Group Lands Officer immediately on **1800 103 452** to discuss the exact nature and extent of your works.

There is to be **NO ATTEMPT TO PHYSICALLY LOCATE THE PIPELINE**. Although the route of the pipeline is marked out by warning signs it shall not be inferred that the pipe is buried under and in a straight line between signs. No depths on the pipeline should be assumed. Only an **APA representative** can locate the pipeline and is required to be scheduled for locations. APA Group advises that information supplied in this response is only valid for 30 days.

Damage to a high pressure natural gas transmission pipeline could result in:-

- possible explosion and fire;
- possible injury or loss of life;
- substantial repair and gas restoration liability damage costs;
- gas escaping at pressures of up to 15,000 kPa;
- loss of gas to thousands of customers.

Thank you for your interest in maintaining a safe and secure gas pipeline network.

Please note that this is **not** an approval to carry out work within APA Group's pipeline easement.

Legend

N DBYD Requests

N APA Transmission Pipelines

Scale: 1: **10000**

0 0.1km

N
W E
S

APA DBYD Transmissions Project

Dial Before You Dig Enquiry

DATE: **19/02/2015**

SEQUENCE NO: **44003106**

DATA SOURCE:

Pipeline Data Copyright APA Group and NT Gas Distribution Pty. Ltd., Property Parcels Copyright respective State Governments, mapping data Copyright OpenStreetMap contributors and Google ©2014, DBYD Dig Location provided by DBYD.

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MCDONALD
RD
150PVC-U
120
150P-12
100P-12
63HDPE
LB41
632
667
605
604
607
817
H3
H4
H5
H6
5
6
7
9
5.83
AD4761
9.5 AN
9.4 FW
5.84
AD4765
16.5 AW
3.0 FS
MS
5.80
AD4756
4.0 AW
3.2 FS
8.38
AD4764
6.0 AW
MFM
MPB
MCDONALD RD
OVERFLOW
225PVC-U
AC422B
CO-ORDS
-99.90
-99.95
79.2
94.8
23.6
39.1
2.01
1.92
2.66
2.99
1.76
2.33
0.34
1.64
18.0
17.4
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16.0
27.0
9.4
2.77
3.4 U3.5
17.3
15.1 U2.3
26.3
15.1 U2.4
41.2
15.1 U2.4
150PVC-U
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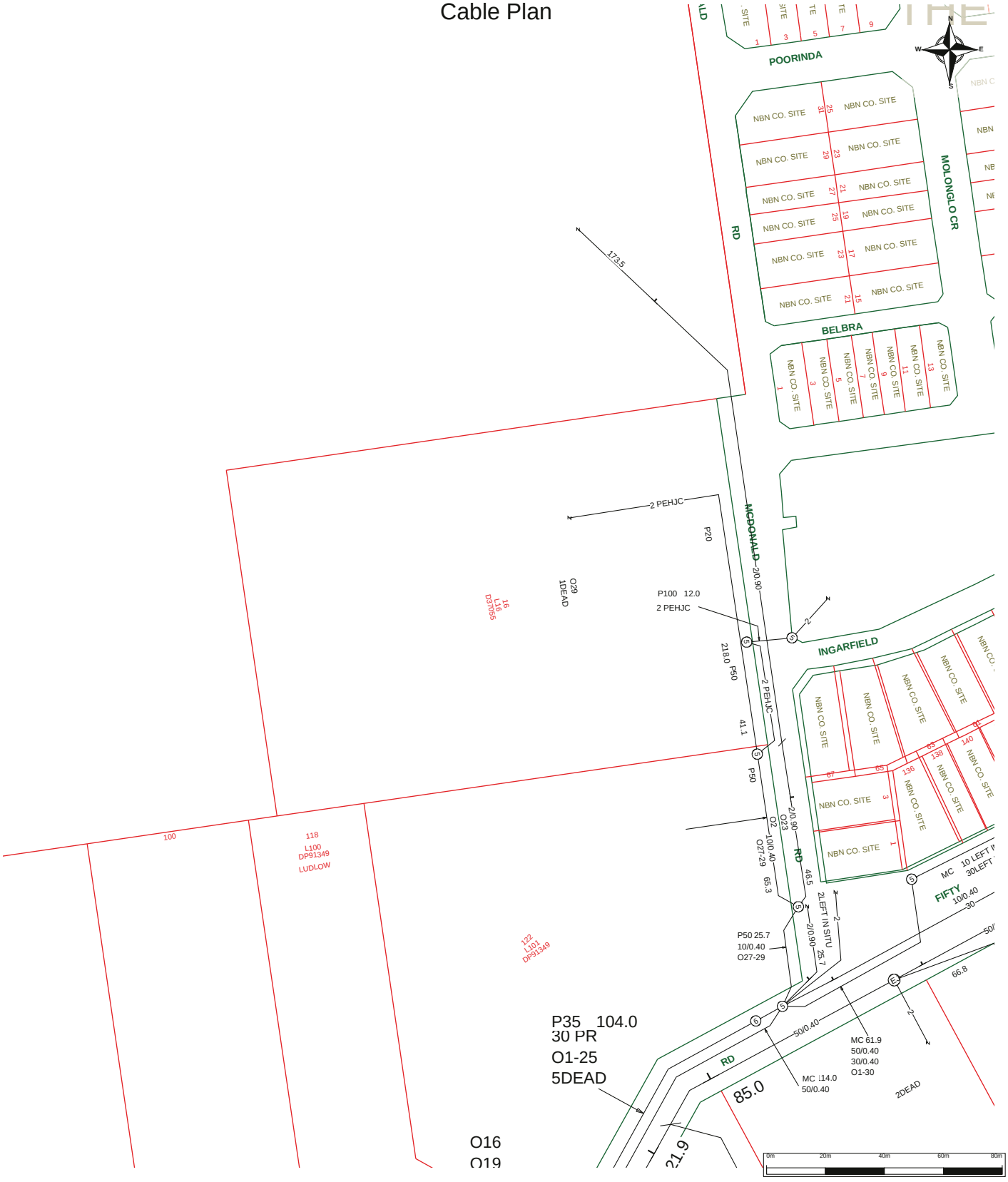
1.2 FN
U3.1
U3.2
U3.4
U3.5
U2.3
U2.4

Cable Plan



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email - Telstra.Plans@team.telstra.com
For urgent onsite contact only - ph 1800 653 935 (bus hrs)

TELSTRA CORPORATION LIMITED A.C.N. 051 775 556

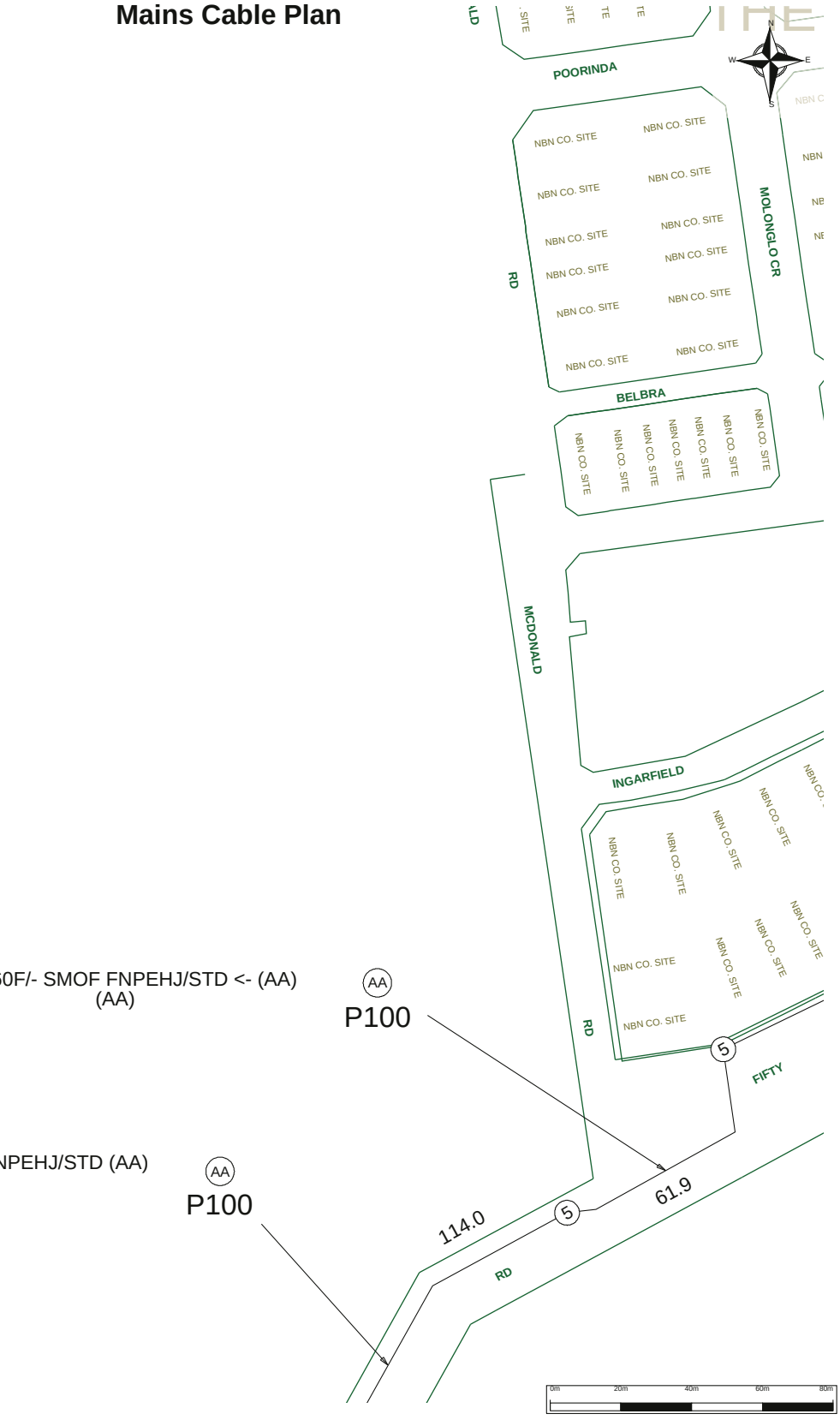
Generated On 19/02/2015 16:16:12

Sequence Number: 44003105

CAUTION: Fibre optic and/ or major network present in plot area. Please read the Duty of Care and contact Telstra Plan Services should you require any assistance.

The above plan must be viewed in conjunction with the Mains Cable Plan on the following page

Mains Cable Plan



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westernpower

UNDERGROUND LEGEND

Structures

- P Pillar
- Metal Pole
- # Transformer Site
- UG Crossing *
- Ring Main Unit
- LV Distribution Frame

Distribution Cables

- High Voltage Cable (1kV - 33kV)
- Low Voltage Cable (< 1kV)
- Street Light Circuit (< 1kV)
- Street Light Pilot (< 1kV)
- Earth Wire

Cable Pole Terminations

- HV Termination
- # LV Termination

Proposed Construction Assets

- Design Area *
- High Voltage Underground Cable
- Low Voltage Underground Cable
- Metal Pole
- HV Termination
- P Pillar
- # LV Termination
- # Transformer site

State Underground Power Project

- CURRENT Work Area *
- COMPLETED Area *

Feature

- Area of Interest

*** Please refer to coversheet**

Privately owned cables NOT SHOWN (including house services)

This map is INDICATIVE ONLY. Hand exposure via pothole method is MANDATORY.

Telephone Support: 1300 769 345
Mon to Fri - 08:00 to 16:30

Information valid for 30 days from date of issue

A4 | Scale : 1:1500

WARNING! Look out for overhead power lines

Sequence Number: 44003104

Date of Issue: 19/02/2015

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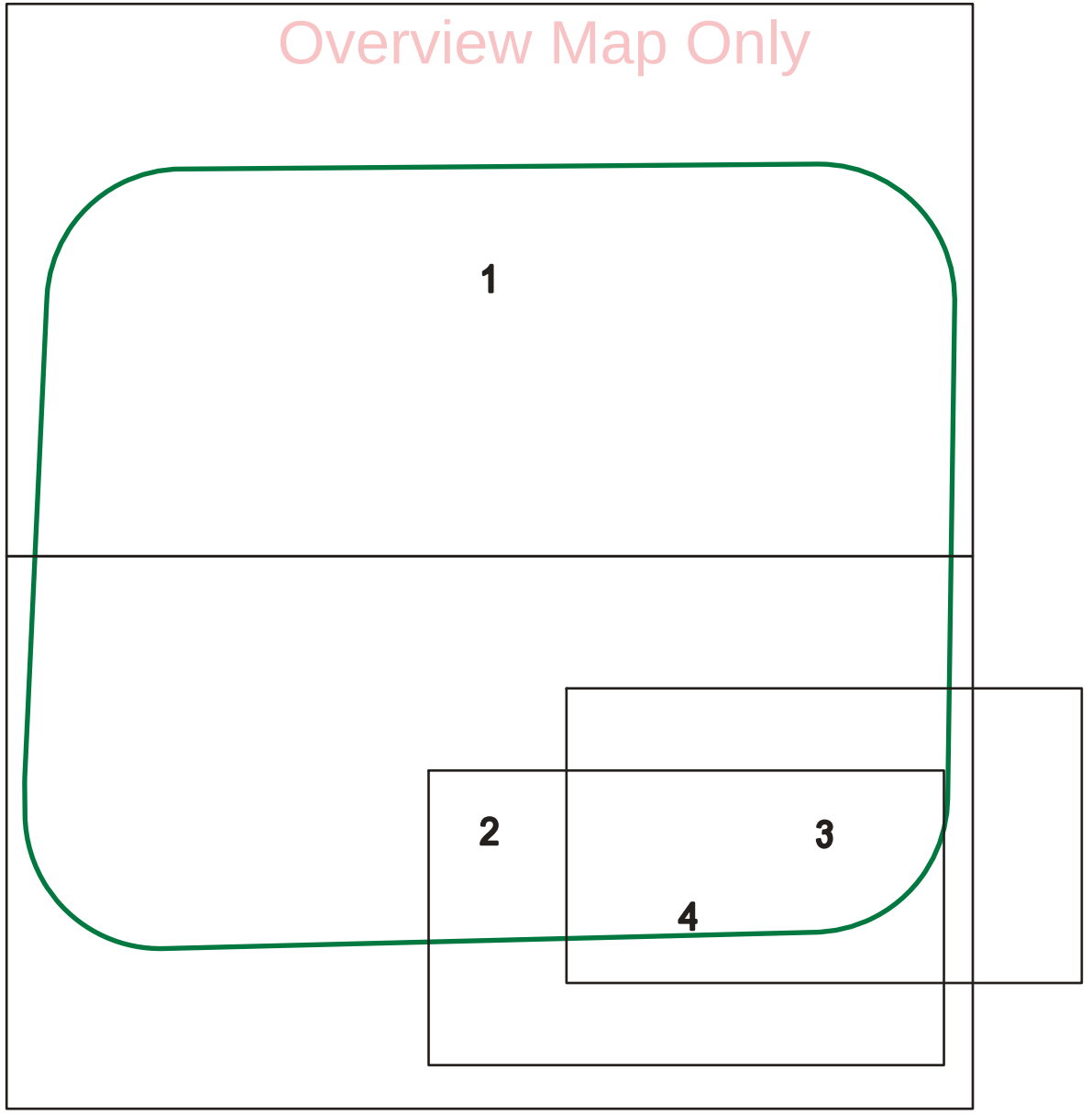

Sequence No: 44003107 Map Tile: Scale: 1:3075

Job No: 8854518 Date:19/02/2015 Location: Mcdonald Road, Baldivis 6171

N
W E
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ATCO Gas AUSTRALIA

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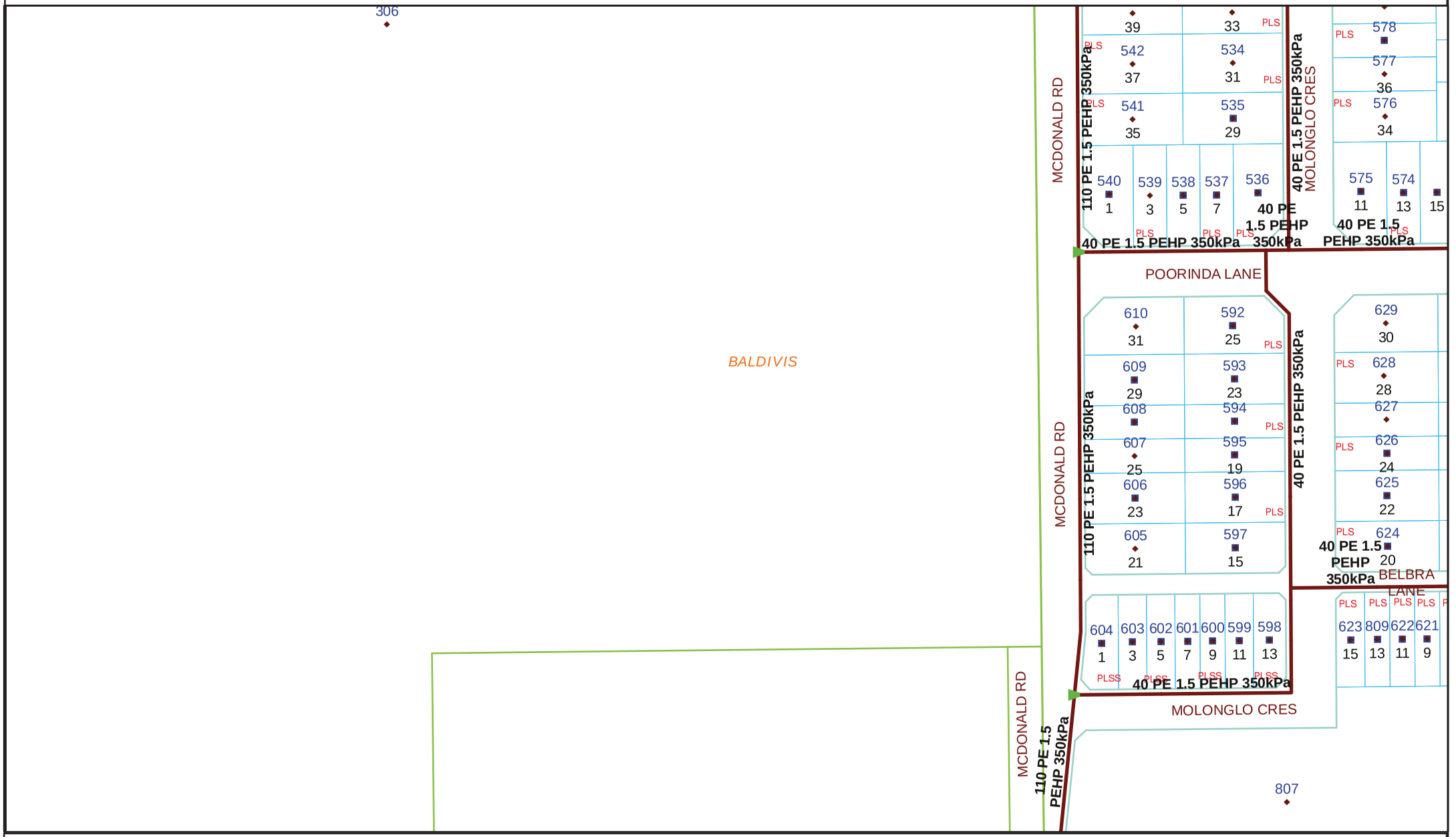

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Job No: 8854518 | Date:19/02/2015 | Location: Mcdonald Road, Baldivis 6171

N W E S

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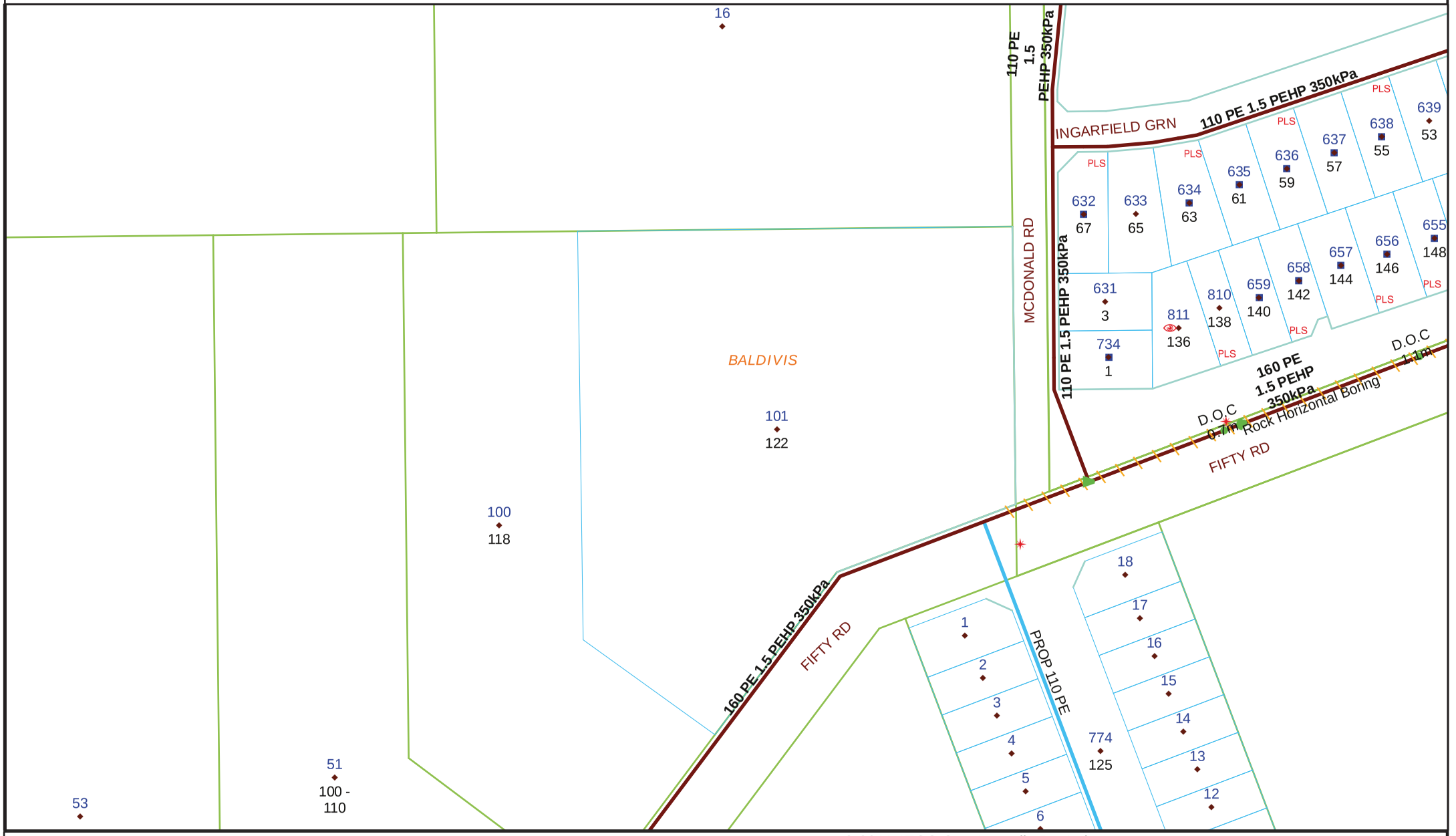

Sequence No: 44003107 Map Tile: 2 Scale: 1:1500

Job No: 8854518 Date:19/02/2015 Location: Mcdonald Road, Baldivis 6171

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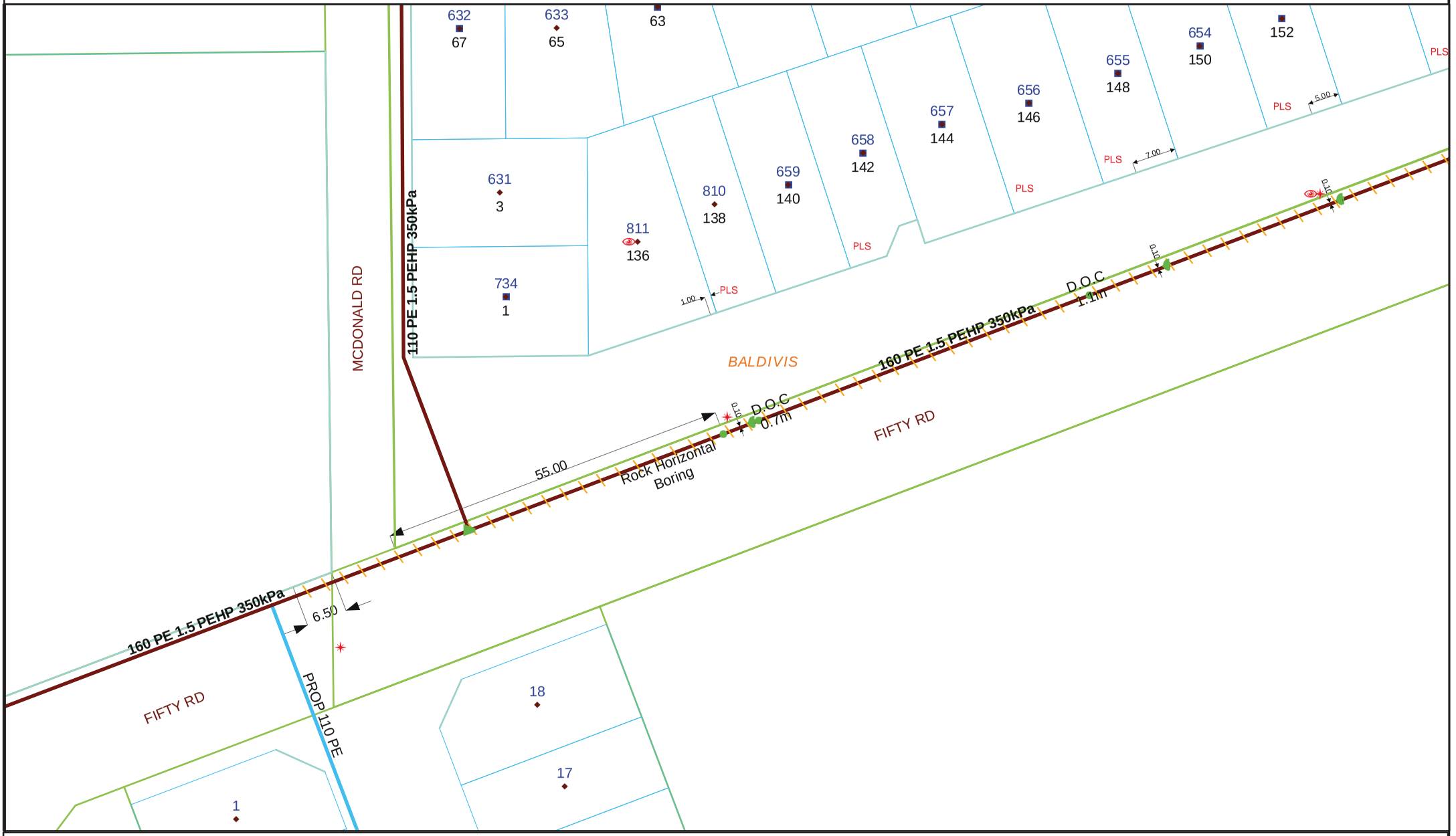

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Job No: 8854518 Date:19/02/2015 Location: Mcdonald Road, Baldivis 6171

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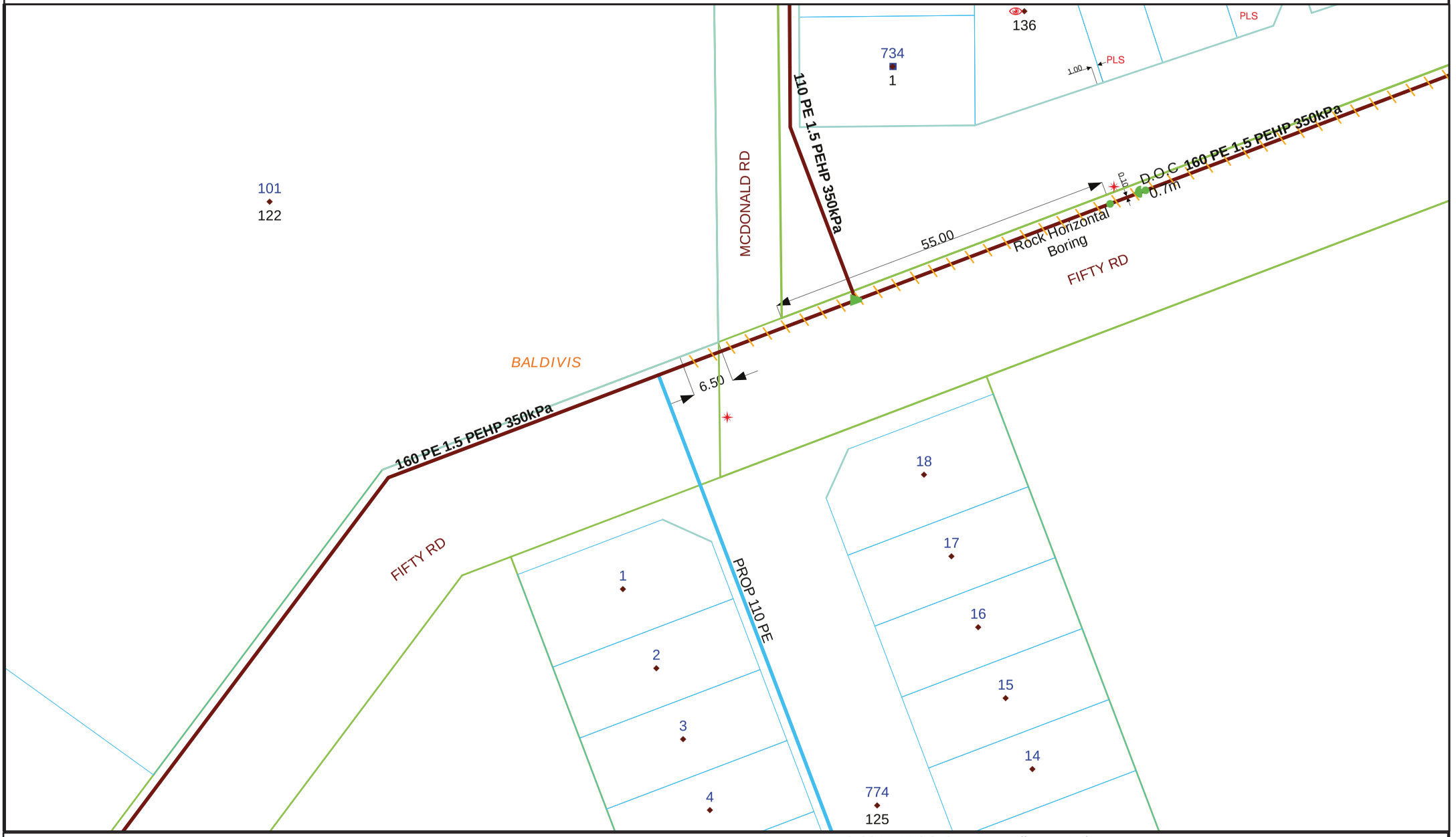

Sequence No: 44003107 | Map Tile: 4 | Scale: 1:800

Job No: 8854518 | Date: 19/02/2015 | Location: Mcdonald Road, Baldivis 6171

N W E S

ATCO Gas AUSTRALIA

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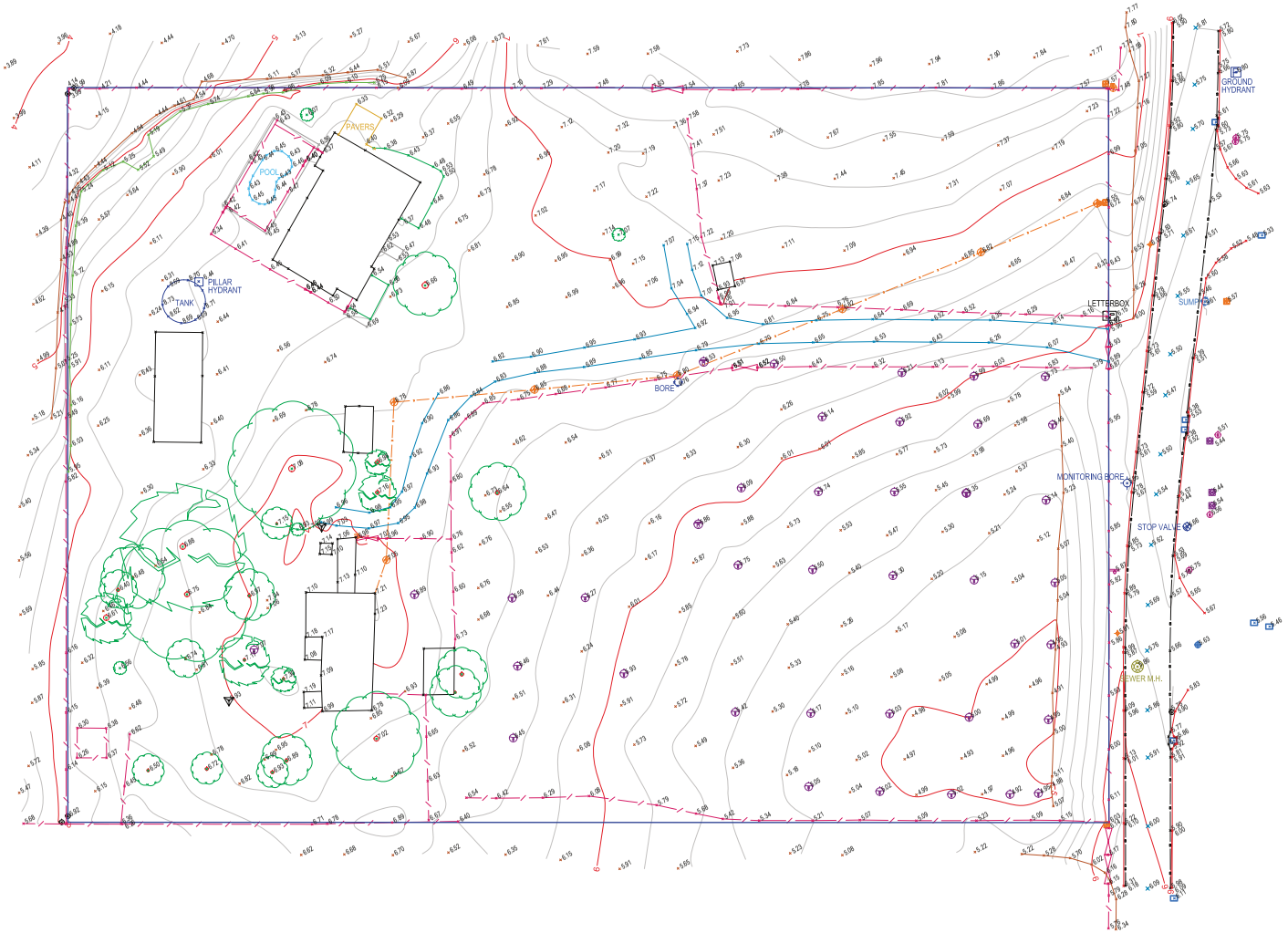
appendix seven: feature survey



LEGEND

- FENCE
- GATE
- EDGE OF BITUMEN
- MOUNTABLE KERB
- BOUNDARY
- TOP OF BANK
- UNSEALED ROAD
- OVERHEAD POWER
- POWER POLE
- LIGHT POLE (WITH ROAD SIGN)
- ELEC. PILLAR
- FUSEBOARD
- FLOOD LIGHT
- DRAINAGE M.H.
- S.E.P. / GRATED SUMP
- COMMS. PIT
- COMMS. MARKER
- IRRIGATION VALVE
- IRRIGATION TAP
- SPRINKLER
- CONTOUR
- INDEX CONTOUR

NO.	REVISION	STAFF	CHECK	DATE

NOTES :

10 0 10 20 metres

SCALE 1: 400

LEVEL DATUM :	AHD	SURVEYOR :	G.J.T. 23/12/2015
LEVEL AUTHORITY :	(PSMs)	DRAFTSMAN :	B.Z.S. 24/12/2015
CO-ORD DATUM :	Perth Coastal Grid 94 (PCG94)	CHECKED :	G.J.T.

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DETAIL SURVEY
LOT 16
BALDIVIS
MACDONALD ROAD
WESTERN AUSTRALIA

CLIENT	D.H.A.
DATE	24/12/2015
SHEET	1 OF 1
PLAN NO.	71613 / 01
REV.	0

ORIGINAL SIZE A1

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Appendix 7

Traffic Assessment

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CONSULTING CIVIL & TRAFFIC ENGINEERS, RISK MANAGERS.

Project:	16 McDonald Road, Baldivis Transport Assessment
Client:	Defence Housing Australia
Author:	Angela Wetton
Signature:	
Date:	05/09/2016

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Document Status

Version No.	Author	Reviewed by	Date	Document status	Signature	Date
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1	A Wetton	S Millen	9/02/15	Review		9/02/15
2	A Wetton	E Wilks	05/09/16	Design Change		05/09/16

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CONTENTS

FIGURES

TABLES

1. Summary

TPG Town Planning has developed a Subdivision Concept Plan on behalf of Defence Housing Australia for 16 McDonald Road, Baldivis. The subject site is located in the City of Rockingham, approximately 7.5 kilometres south-east from the Rockingham Town Centre, and 40 kilometres south of the Perth CBD.

This Transport Assessment has been prepared by Shawmac Pty Ltd to support the Subdivision Concept Plan and outlines the likely impact of the proposed subdivision on network traffic flows, safe access, pedestrian and cycle facilities and local amenity.

The eastern section of subject site is currently zoned "Development" under the City of Rockingham *Town Planning Scheme No 2 (TPS 2).* The subdivision proposes 29 single dwellings with a series of local access roads servicing the properties. The western section of the site is zoned "Rural" under TPS 2 and will accommodate an access road and remain a surplus lot.

McDonald Road forms the eastern boundary to the site, with future urban development to the north, east and south, and rural or bush land to the west. A 4 metre road-reservation widening is proposed for McDonald Road adjacent to the southern section of the subdivision and the ultimate development of the site to the north will include an extension of McDonald Road to Kerosene Lane.

There are currently concrete paths on the eastern side of McDonald Road and on the northern side of Fifty Road, east of McDonald Road. The site is currently serviced by Transperth Route 568, with the nearest stop 800m from the site on Fifty Road. The Baldivis (North) District Structure Plan suggests a bus route between Kerosene Lane and Fifty Road to Baldivis via McDonald Road.

A trip generation and distribution exercise was completed and determined that the proposed subdivision would generate 240 vehicular trips per day. The majority of the trips would permeate through the local road network to McDonald Road north to Kerosene Lane and south to Fifty Road. A future road connection via the eastern access road to the northern subdivision will also permeate through the road network.

The traffic generated was not large enough to warrant any intersection analysis, under the Table 6.1 of Austroads Guide to Traffic Management Part 3 - Traffic Studies and Analysis, and there are no safety or operational issues expected.

A footpath is currently provided on the eastern side of McDonald Street and should be provided on at least one side of each of the internal local roads.

A review of the overall transport proposal for the site did not identify any specific issues that present unacceptable risks to the road user or that cannot be managed through appropriate design protocols.

The proposed development is not likely to generate any traffic noise or result in any vibration issues

2. Introduction and Background

2.1. General

This Transport Assessment has been prepared by Shawmac Pty Ltd, on behalf of Defence Housing Australia to support a Subdivision Concept Plan for 16 McDonald Road, Baldivis, in the City of Rockingham.

2.2. Transport Statement Objective

This Transport Assessment outlines the likely impact of the proposed subdivision on network traffic flows, safe access, pedestrian and cycle facilities and local amenity. As part of the assessment, Shawmac considered the likely traffic demand that would be generated through the proposed development.

The assessment considers aspects associated with:

- Generation of traffic including impacts on roads;
- Integration with the surrounding land uses;
- Use of public and other transport modes such as walking and cycling; and
- Safety and access issues.

2.3. Site Location

The subject site is located approximately 44 kilometres south of the Perth CBD and 7.5km south-east of the Rockingham Town Centre. Figure 1 below shows the broad location of the site.

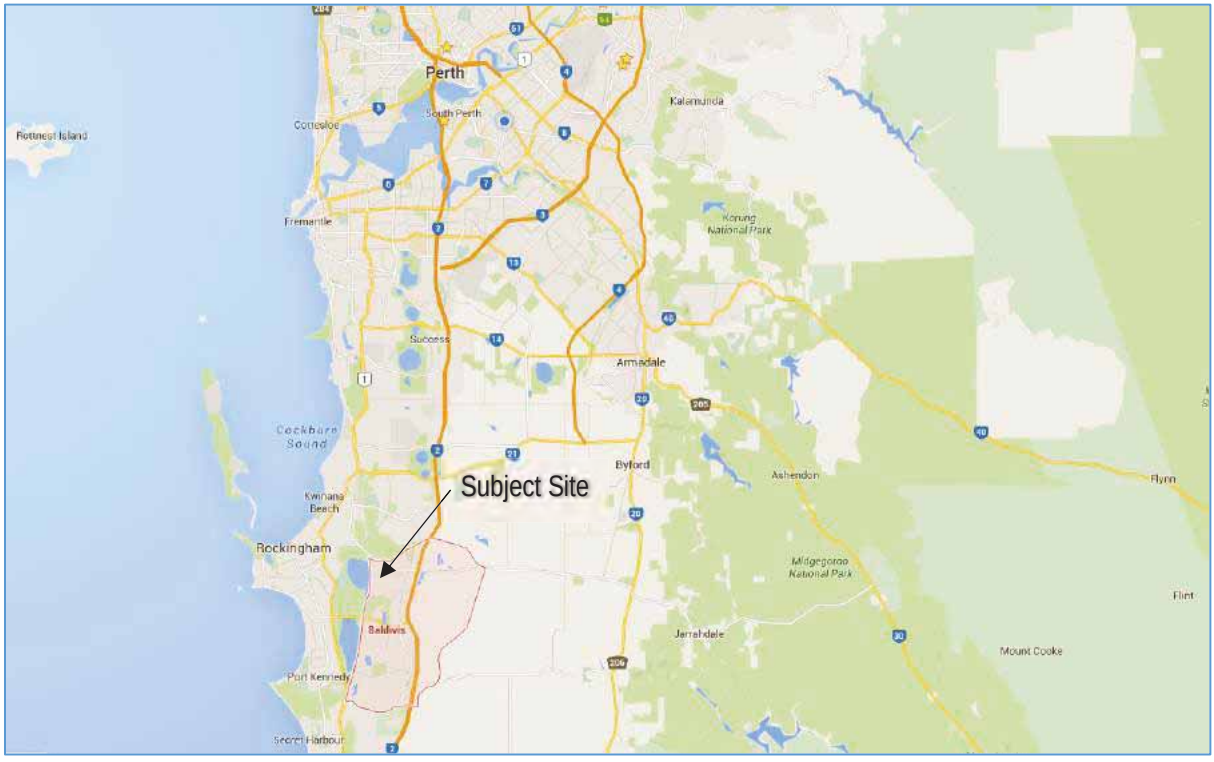

Figure 1 - Regional Context

The subject site is located on the western side of McDonald Road, approximately 100m north of Fifty Road.

There are rural properties to the north and south, undeveloped bush land to the west and existing and future urban development to the east.

Figure 2 shows the location of the site in the context of the local area.

Figure 2 - Local Context

2.4. Surrounding Major Attractors and Generators

The main attractors and generators expected to influence traffic flows to and from the site include:

- Baldivis Primary School
- Rockingham Town Centre
- Kwinana and surrounding Industrial Areas
- Kwinana Freeway via Mundijong Road
- Local shops and community facilities

Figure 3 shows the location of these attractors and generators with respect to the site.

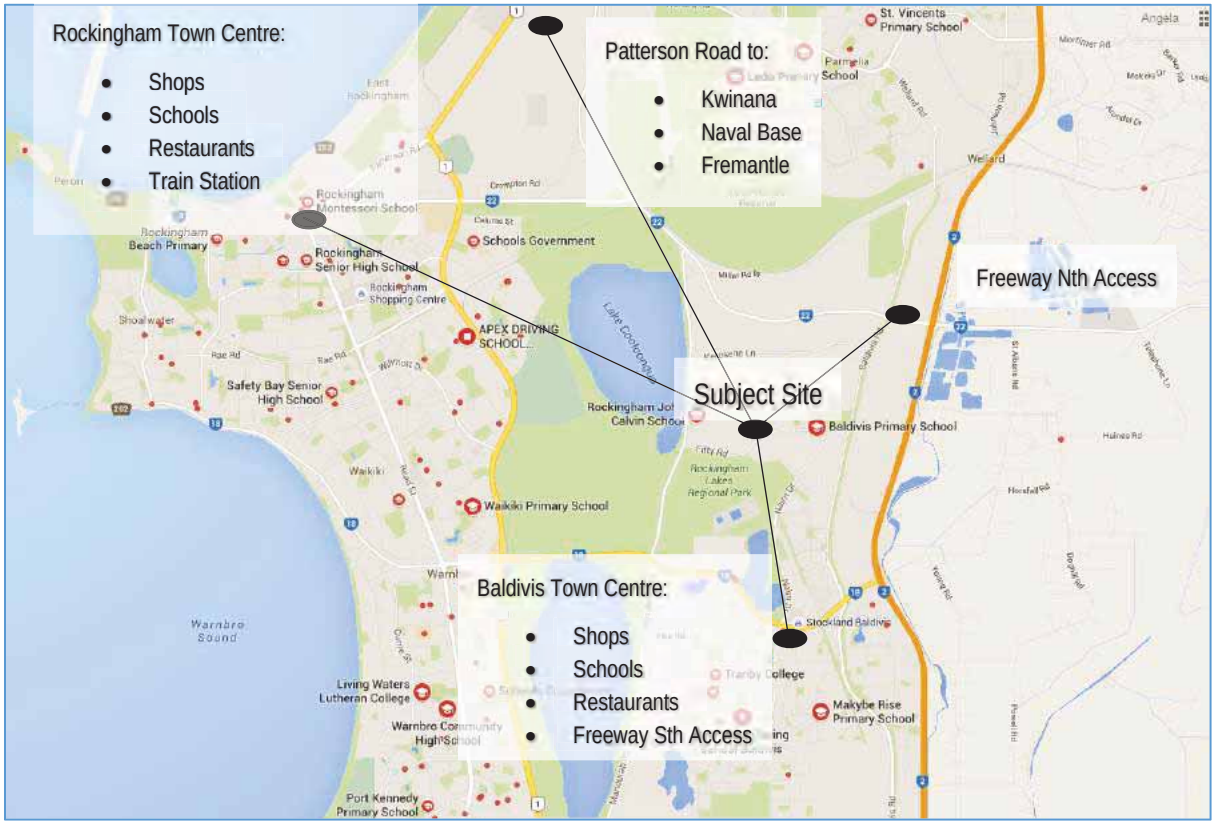

Figure 3 - Attractors and Generators

3. Existing Situation

3.1. Land Use

The subject site is semi-rural, with a single dwelling and swimming pool, a water tank and three sheds on the western side of the lot. There is cleared land to the west and north of the site with bushland broadly to the west and south beyond the cleared land. New residential development is to the broader east and south of the site.

3.2. Zoning

The subject site is currently zoned "Development" under the City of Rockingham *Town Planning Scheme No 2 (TPS 2).* A portion of the site is zoned "Rural" under the TPS2 as shown in the extract from the planning scheme in Figure 4.

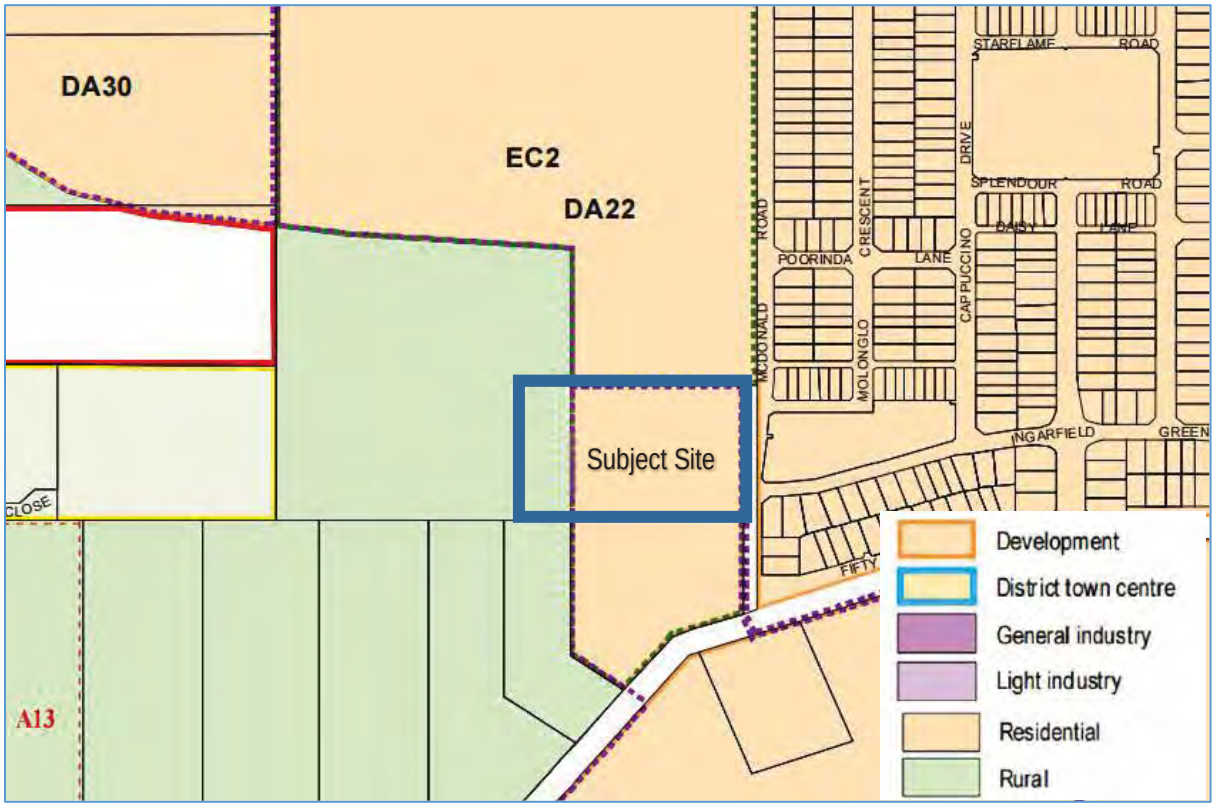

Figure 4 - Extract of City of Rockingham TPS 2

3.3. Existing Road Network

McDonald Road forms the eastern boundary to the site and provides an access to the existing rural properties and the new subdivisions north of Fifty Road. McDonald Road is classified as an *Access Road* under the MRWA regional hierarchy and has a speed limit of 50 km/hr. In the vicinity of the subject site, McDonald Road is described

as a single undivided carriageway with a 7 metre wide seal and 4 metre wide verges. There is a 2.5 metre wide concrete footpath on the eastern side of the road.

McDonald Road connects with Fifty Road, 85m south of the site with a priority controlled T-intersection.

The road classification for the road network surrounding the proposed development site is shown on Figure 5.

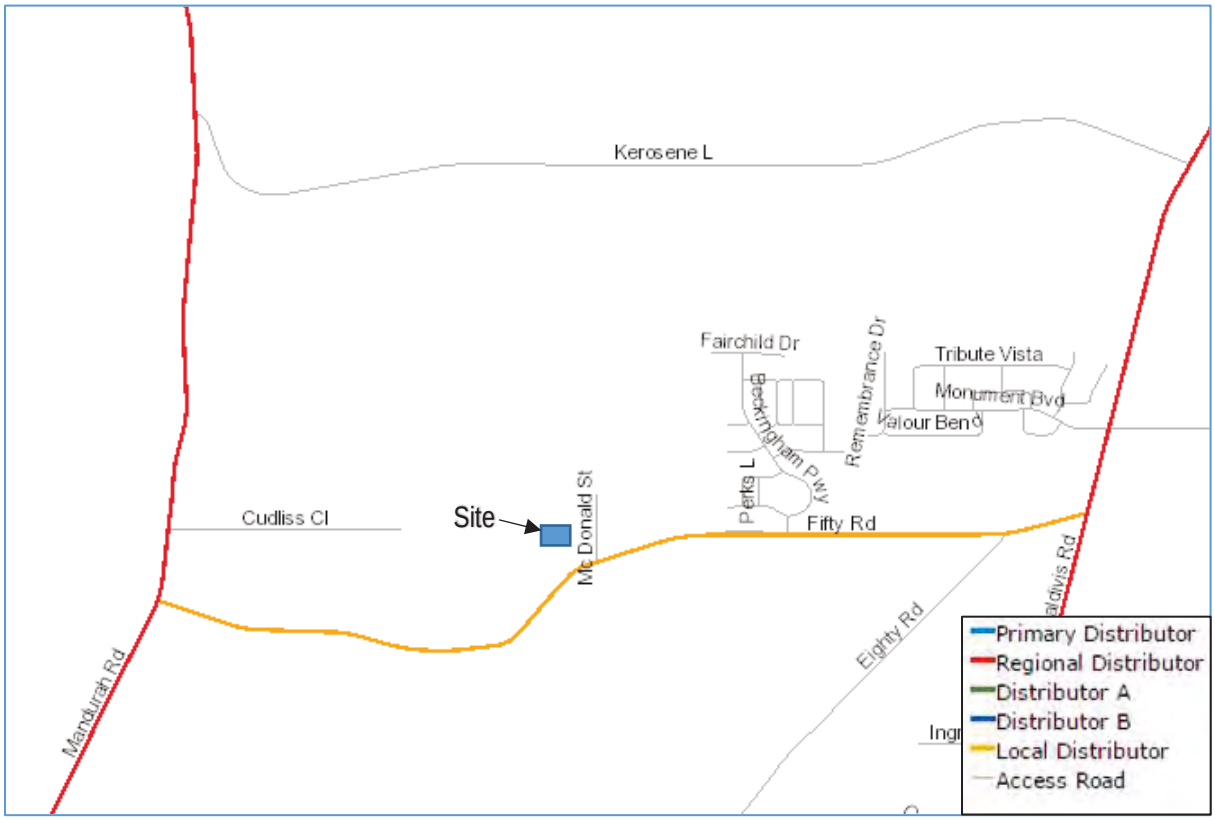

Figure 5 - Road Hierarchy (Source: MRWA Road Information Mapping)

3.4. Road Hierarchy vs Actual Flows

Traffic count data was unavailable for McDonald Road. Based on the lot yield from the ultimate development of the surrounding area, the traffic volume on McDonald Road, adjacent to the site was estimated to be 2,500 vpd.

The current traffic volumes are predicted as less than 500 vpd.

3.5. Public Transport Facilities

There are currently no public transport facilities within a 400m walkable catchment of the subject site. The nearest bus service is the Transperth Route 568 which operates between Wanbro Train Station and Baldivis. The closest bus stop is located on Fifty Road, approximately 800 metres from the subject site and is the terminus for the service, which operates through Baldivis south to Warnbro Train Station.

3.6. Existing Pedestrian and Cycling Network

Figure 6 illustrates the existing pedestrian and cycling network in the vicinity of the subject site. Fifty Road is shown on the *Perth Bicycle Network Map* extract as providing a good road riding environment.

There is a 2.5m wide concrete path on the eastern side of McDonald Road and on the northern side of Fifty Road, between McDonald Road and Baldivis Road.

Figure 6 - Cycling network

4. Development Proposal

4.1. Subdivision Proposal

The proposed subdivision concept plan is attached in Appendix A and an extract is shown in Figure 7.

Figure 7 - Proposed Subdivision Concept Plan

4.2. Proposed Land Use

The proposed subdivision as shown in Figure 7 consists of 29 dwellings and a rural lot (Lot 30). The proposed subdivision is R20 with lot sizes range from 303m^2 to 490m^2 with an average lot size of 408m^2, excluding Lot 30.

4.3. Changes to External Transport Networks

McDonald Road will be extended north to Kerosene Lane as other subdivisions to the north of the site are constructed.

The Metropolitan Region Scheme (MRS) depicts Nairn Drive as a blue road, or other regional road. Nairn Drive is approximately 650m to the east of McDonald Road and will ultimately run north-south between Kerosene Lane and Paganoni Road in Karnup.

5. Transport Assessment

5.1. Assessment Period

The time periods for assessment were chosen based on the full development of the proposed subdivision.

5.2. Traffic Generation

Trip Generation rates were applied using the Institute of Transportation Engineers (ITE) *Trip Generation Manual 8th Edition.*

Assessed generation is shown on Table 1 and is based on Traffic Assessment Zones (TAZ's) shown in Figure 8.

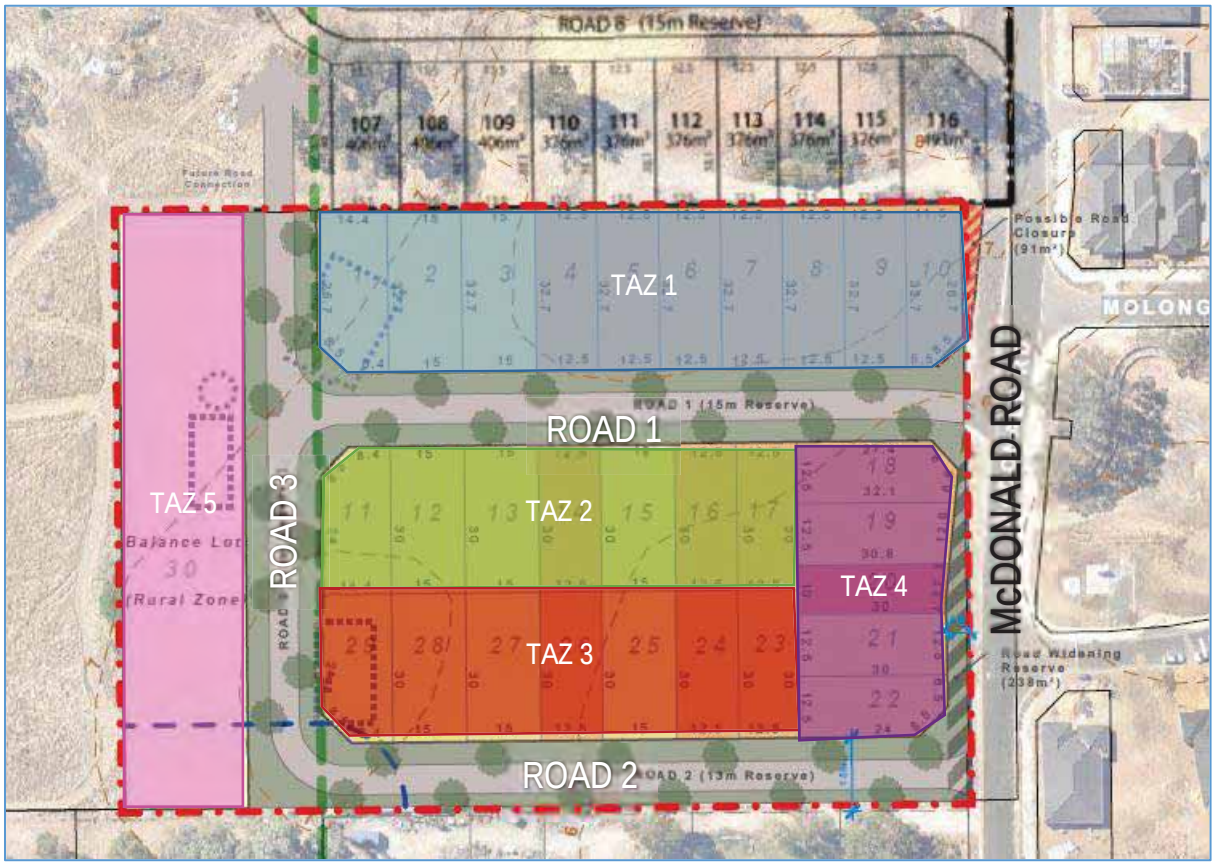

Figure 8 - **Traffic Assessment Zones (TAZ's)**

Table 1 - Trip Generation

Trip Assessment Zone	Land Use	Dwellings	trips per dwelling	Daily Trips
TAZ 1	R25	10	8	80
TAZ 2	R25	7	8	56
TAZ 3	R25	7	8	56
TAZ 4	R25	5	8	40
TAZ 5	Rural	1	8	8
TOTAL		30		240

5.3. Traffic Distribution

Based on the location and connectivity of the surrounding network and the major attractors / generators discussed in Section 2.4, the following assumptions have been made for the distribution of the site-generated traffic:

- 30% will enter and exit from the north:
  - 27.5% to and from the north via McDonald Road; and
  - 2.5% to and from the north via the new internal road connection to the west of the site.
- 70 % will enter and exit from the south via McDonald Road:
  - 45% to the west via Kerosene Lane towards the Freeway or Baldivis Town Centre; and
  - 25% to the east via Kerosene Lane towards Rockingham or Baldivis Town Centre.

5.4. Design Traffic Flows

The traffic flows of the network were modelled using QRS II software as shown in Figure 9. Table 2 lists the predicted traffic flows for the internal road network.

in Figure 8.

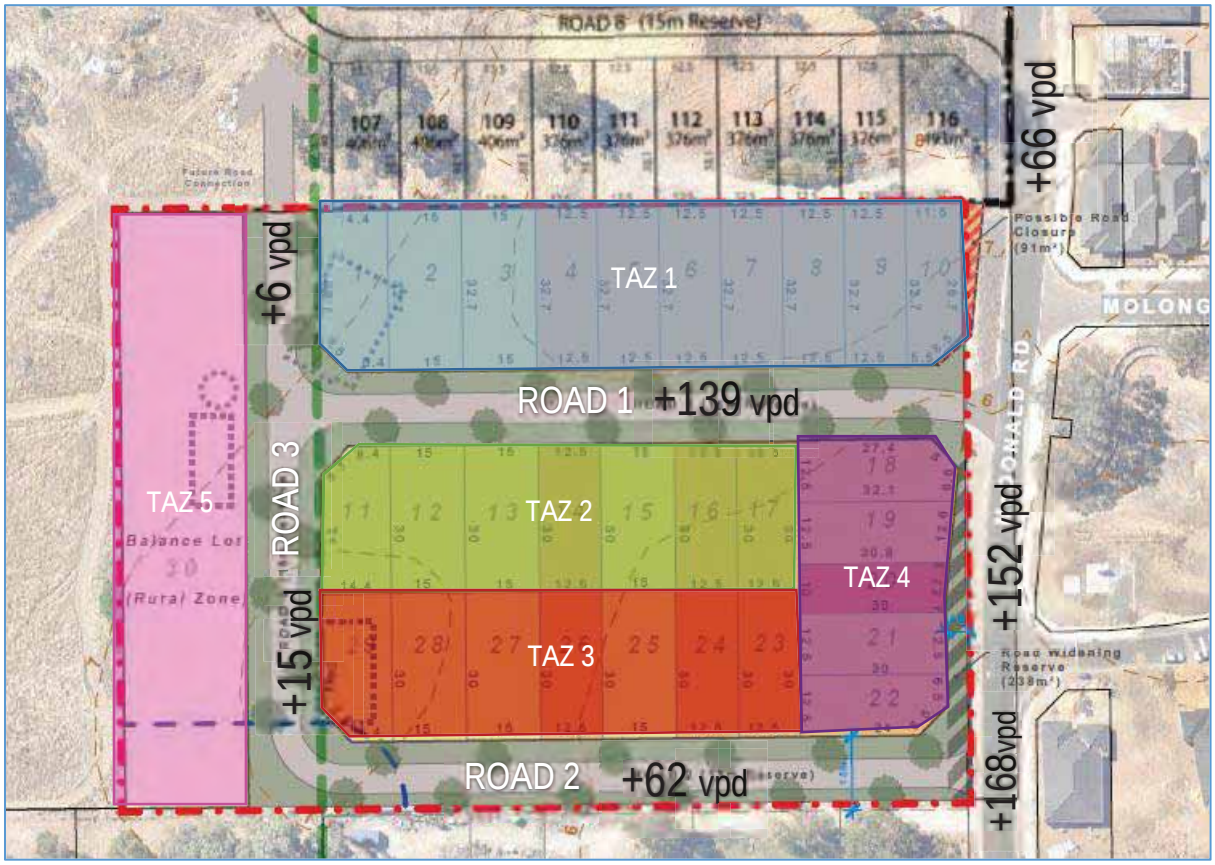

Figure 9 - Future Daily Traffic Volumes

Table 2 - Internal Roads - Future Daily Traffic Volumes

Road Name.	Predicted Traffic Volumes (vpd)
Road 1	139
Road 2	62
Road 3	15
McDonald Road	+168

5.5. External Traffic Flows

The predicted subdivision traffic flows were added to the estimated volumes of traffic for McDonald Road upon the ultimate development of the surrounding site. This is shown in Table 3 below.

McDonald Road may require upgrading to a Local Distributor or Neighbourhood Connector when it is extended through to Kerosene Lane.

Table 3 - Existing Road Network - Predicted Flows

Road Name.	Desirable Max. Traffic Volume. (vpd)	Current / Predicted external Traffic Volumes (vpd)	Predicted Traffic Volumes (vpd)	Change in Traffic
McDonald Road	3,000	2,500	2,668	+ 168 vpd
Fifty Road	3,000	2,200	2,368	+ 168 vpd

6. Roads and Intersections

6.1. Proposed Internal Transport Networks

Figure 10 indicates the proposed internal transport routes which have been developed based on the predicted traffic volumes.

Figure 10 - Proposed Transport Network

The intersections of Road 1-McDonald Road; Road 2-McDonald Road; Road 1-Road 3 are recommended as priority-controlled T-intersections. Road 3 is proposed to connect to the future subdivision north of the site. Details regarding signage and design of intersections should be developed during the detailed design phases in consultation with the City of Rockingham.

6.2. Road Hierarchy and Reserves

The road cross section requirements have been based on recommendations contained within Liveable Neighborhoods and the Austroads Guide to Traffic Engineering Practice which is attached in Appendix C.

Table 4 - Proposed Road Hierarchy and Road Reservations

Road Name.	Predicted Traffic Volumes (vpd)	Proposed Road Reservation (metres)	Liveable Neighbourhoods Road Classification	Indicative Carriageway Width
Road 1	139	15	Access Street D	7.2 (7.0 – 7.5) metre lane.
Road 2	62	15	Access Street D	5.5 – 6.0 metre lane
Road 3	15	15	Access Street D	7.2 (7.0 – 7.5) metre lane.
McDonald Road	2,668	18	Neighbourhood Connector B	11.2 metres including parking plus shared path on one verge.

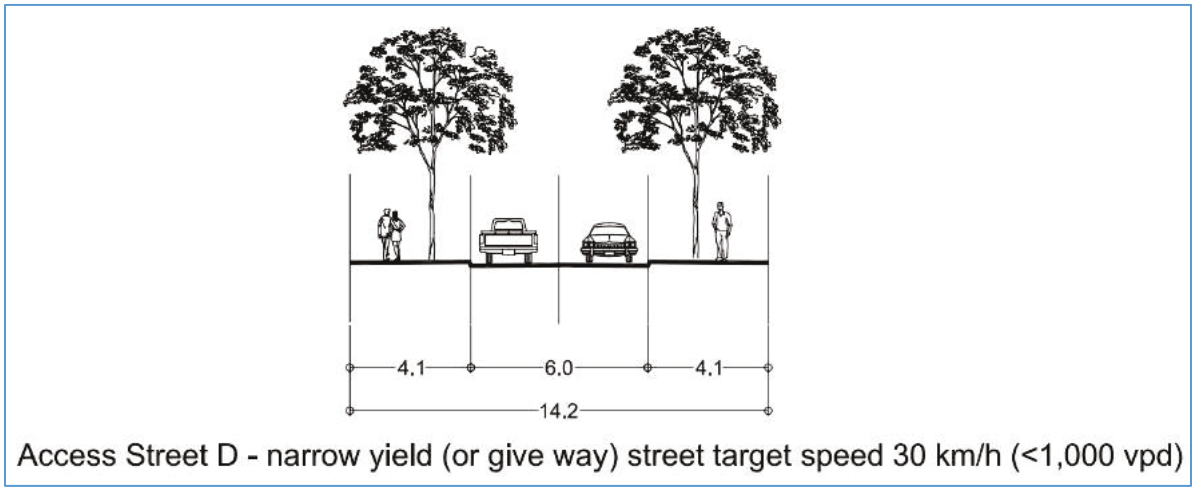

Figure 11 - Access Street D indicative cross section.

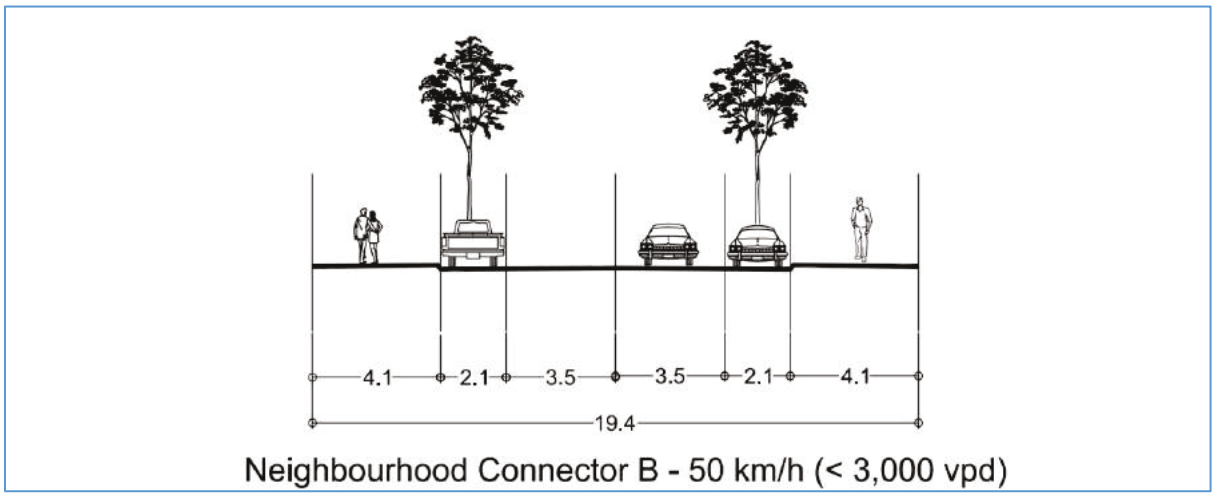

Figure 12 - Neighbourhood Connector B indicative cross section

6.2.1. Intersection Analysis

Internal peak hour traffic volumes within the development are generally small and as such negligible impacts are predicted. Warrants for analysis for each intersection as shown in Table 6.1 of Austroads Guide to Traffic

Management Part 3, Traffic Studies and Analysis, shown below as Table 5, were applied and determined that no intersections required capacity analysis. Peak hour traffic volumes were assumed to be approximately 10% of predicted daily traffic.

Table 5 - Intersection Analysis Warrants

Intersection	Hourly volume major road	Hourly volume minor road	Comment.
Warrants as per Table 6.1 of Austroads Guide to Traffic Management Part 3, Traffic Studies and Analysis - Two Lane Major Road Cross Road	400 vph 500 vph 650 vph	250 vph 200 vph 100 vph	Table details flows that initiate intersection analysis. As major flows increase, there is reduced capacity to accept minor flows.
Fifty Road - McDonald Road	220	130	3 way intersection - Analysis not required
McDonald Road - Road 1	260	128	3 way intersection – Analysis not required.
McDonald Road - Road 2	260	<100	3 way intersection – Analysis not required.
All other intersections	<100	<100	Analysis not required.

6.3. Pedestrian/ Cyclist Access

Footpaths should be provided on at least one side of each of the internal local roads with connections to the established pedestrian and cycling network external to the area as well as to future urban development north and east of the subject site. It is recommended that all footpaths are constructed with a minimum width of 1.5 metres.

Due to the low volumes of traffic and the low speed environment on the internal access roads, on-road cycle lanes are not required and cyclists are able to safely share the roadway with motorised vehicles.

Fifty Road is described as a good road riding environment under the Department of Transport *Cycling Maps.* There is a 2.5m concrete path on the north side of the road, east of McDonald Road however there are no formal facilities from McDonald Road to Mandurah Road in the west for cyclists or pedestrians.

6.4. Public Transport Access

As discussed in Section 3.5, there are limited public transport services in the area. As shown in Figure 13, a bus route travelling along McDonald Road was identified in the Baldivis (North) District Structure Plan. It is recommended that the Public Transport Authority review the requirements for this area as urban development progresses.

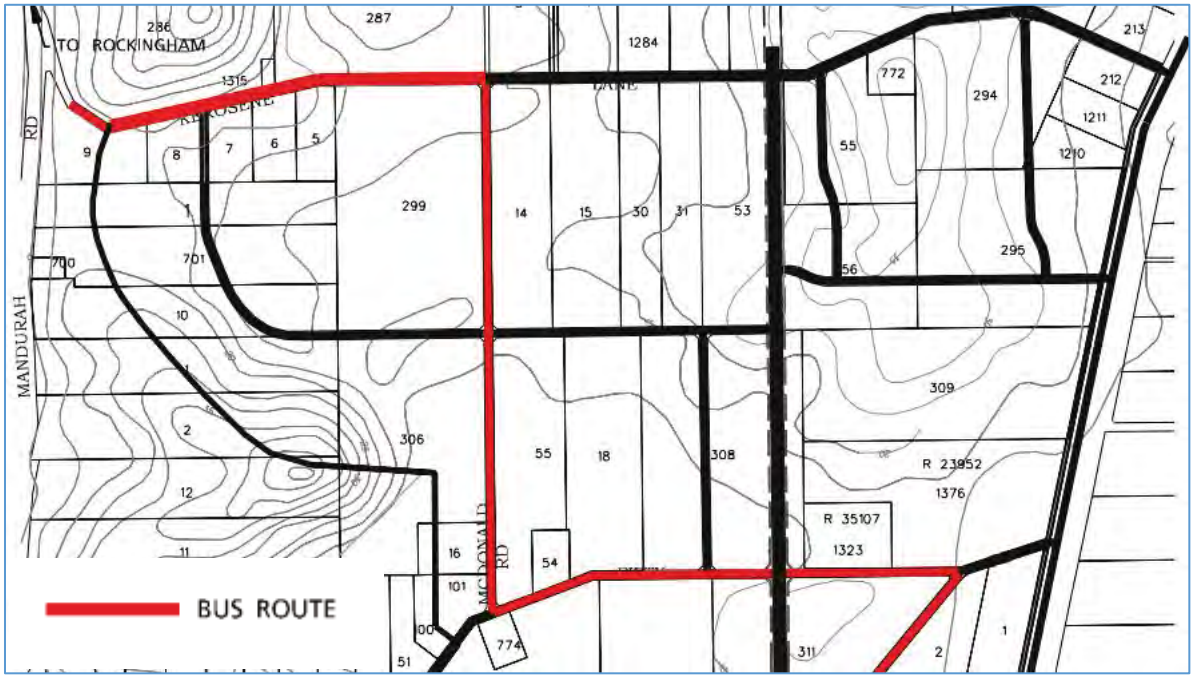

Figure 13 - Suggested Bus Route (Extract from City of Rockingham *Baldivis (North) District Structure Plan*)

6.5. Safety issues

A review of the overall transport proposal for the site did not identify any specific issues that present unacceptable risks to the road user or that cannot be managed through appropriate design protocols.

Road hazards are typically present at intersections and may occur due inadequate sight distance, inappropriate geometry or substandard capacity that promotes undesirable and potentially hazardous movements.

For the new roads, the allocation of adequate road reservation width and truncation of corners will generally allow sight distance requirements to be accommodated in the detailed design phase of the project. Geometric standards prescribed by Austroads and Main Roads WA guidelines will ensure that no unacceptable risk is introduced into the road environment. Assessment of the operational performance of intersections undertaken in this study prescribes appropriate geometry and lane allocation to minimise delay and optimise performance.

Detailed design undertaken as part of the Development Application process would need to define at least the following elements:

- Road cross sections including lane widths, on-road cycle lanes, path widths and provisions for people with disabilities;
- Intersection geometries; and
- Pedestrian and cycle facilities (cross sections, crossing requirements and ramps).

6.6. Noise

The proposed development is not likely to generate any traffic noise or result in any vibration issues.

7. Conclusions

With respect to the proposed Subdivision Concept Plan area, the following is concluded;

- Under the ultimate development of the subdivision, the subdivision will yield 29 dwellings with the capacity for an additional dwelling on the rural balance lot;
- The predicted traffic flows are predicted to be 240 vehicles per day;
- Due to low predicted daily traffic, the intersections did not meet the warrants for analysis and are expected to operate satisfactorily;
- All roads within the subdivision area will be constructed as *Access Roads* with cross section details, line marking, intersection control and local area traffic management measures to be addressed during the detailed subdivision design stages;
- Pedestrian and cyclist facilities should be provided within the subdivision and along McDonald Road; and
- Public Transport services should be considered for the area as it becomes increasingly urbanised.

Appendix A – Subdivision Concept Plan

Appendix B - Fifty Road Traffic Counts

Weekly Vehicle Counts

WeeklyVehicle-1136
Site: SITE-29.0.0EW
Description: **Fifty Rd - west of McDonald Rd**
Filter time: **16:53 Monday, 15 September 2014 => 14:07 Tuesday, 30 September 2014**
Scheme: Vehicle classification (ARX)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Averages	
	15 Sep	16 Sep	17 Sep	18 Sep	19 Sep	20 Sep	21 Sep	1 - 5	1 - 7
Hour									
0000-0100	*	5	2	2	6	13	9	3.8	6.2
0100-0200	*	1	4	2	4	13	10	2.8	5.7
0200-0300	*	2	3	5	9	3	9	4.8	5.2
0300-0400	*	6	9	6	5	6	11	6.5	7.2
0400-0500	*	13	17	10	9	6	4	12.3	9.8
0500-0600	*	50	54	57	51	24	4	53.0	40.0
0600-0700	*	94	105	98	107	44	15	101.0	77.2
0700-0800	*	140	136	126	123	65	17	131.3	101.2
0800-0900	*	**216<**	**213<**	**202<**	**238<**	111	63	**217.3<**	**173.8<**
0900-1000	*	145	126	143	124	135	71	134.5	124.0
1000-1100	*	120	135	143	145	153	78	135.8	129.0
1100-1200	*	149	157	152	146	**166<**	**110<**	151.0	146.7
1200-1300	*	125	105	145	142	**149<**	87	129.3	125.5
1300-1400	*	109	107	107	139	133	95	115.5	115.0
1400-1500	*	150	168	159	167	93	87	161.0	137.3
1500-1600	*	215	**243<**	213	196	114	**107<**	**216.8<**	**181.3<**
1600-1700	31	**221<**	210	**230<**	**213<**	123	71	181.0	157.0
1700-1800	170	199	181	207	186	140	67	188.6	164.3
1800-1900	76	102	111	107	129	95	50	105.0	95.7
1900-2000	48	49	50	67	72	58	23	57.2	52.4
2000-2100	28	39	51	42	43	39	18	40.6	37.1
2100-2200	20	20	23	34	33	23	16	26.0	24.1
2200-2300	10	10	11	12	19	22	7	12.4	13.0
2300-2400	4	10	3	4	16	15	8	7.4	8.6
Totals									
0700-1900	*	1891	1892	1934	1948	1477	903	1866.8	1650.8
0600-2200	*	2093	2121	2175	2203	1641	975	2091.7	1841.7
0600-0000	*	2113	2135	2191	2238	1678	990	2111.5	1863.3
0000-0000	*	2190	2224	2273	2322	1743	1037	2194.4	1937.3
AM Peak	*	0800	0800	0800	0800	1100	1100		
	*	216	213	202	238	166	110		
PM Peak	*	1600	1500	1600	1600	1200	1500		
	*	221	243	230	213	149	107		

*** - No data.**

Weekly Vehicle Counts

WeeklyVehicle-1136
Site: SITE-29.0.0EW
Description: **Fifty Rd - west of McDonald Rd**
Filter time: **16:53 Monday, 15 September 2014 => 14:07 Tuesday, 30 September 2014**
Scheme: Vehicle classification (ARX)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Averages	
	22 Sep	23 Sep	24 Sep	25 Sep	26 Sep	27 Sep	28 Sep	1 - 5	1 - 7
Hour									
0000-0100	6	4	4	5	4	9	7	4.6	5.6
0100-0200	1	2	4	6	5	7	9	3.6	4.9
0200-0300	3	4	1	4	1	8	5	2.6	3.7
0300-0400	5	3	10	6	7	5	7	6.2	6.1
0400-0500	12	15	11	11	10	6	3	11.8	9.7
0500-0600	58	56	60	56	59	13	11	57.8	44.7
0600-0700	100	110	92	109	98	27	11	101.8	78.1
0700-0800	110	130	130	112	125	48	15	121.4	95.7
0800-0900	**232<**	**206<**	**209<**	**202<**	**204<**	75	55	**210.6<**	**169.0<**
0900-1000	99	120	97	137	126	101	81	115.8	108.7
1000-1100	101	130	113	124	124	120	92	118.4	114.9
1100-1200	126	136	92	144	160	**132<**	**102<**	131.6	127.4
1200-1300	120	132	123	138	143	**112<**	**103<**	131.2	124.4
1300-1400	118	114	124	119	124	71	78	119.8	106.9
1400-1500	145	177	148	160	196	70	79	165.2	139.3
1500-1600	**223<**	189	**214<**	203	**211<**	89	83	**208.0<**	**173.1<**
1600-1700	221	**189<**	205	202	192	87	89	201.8	169.3
1700-1800	195	187	213	**228<**	190	77	77	202.6	166.7
1800-1900	86	77	115	130	110	57	40	103.6	87.9
1900-2000	104	51	58	56	51	38	42	64.0	57.1
2000-2100	205	30	47	46	47	37	22	75.0	62.0
2100-2200	70	26	28	24	40	18	24	37.6	32.9
2200-2300	9	17	22	23	20	16	22	18.2	18.4
2300-2400	3	4	8	11	14	17	9	8.0	9.4
Totals									
0700-1900	1776	1787	1783	1899	1905	1039	894	1830.0	1583.3
0600-2200	2255	2004	2008	2134	2141	1159	993	2108.4	1813.4
0600-0000	2267	2025	2038	2168	2175	1192	1024	2134.6	1841.3
0000-0000	2352	2109	2128	2256	2261	1240	1066	2221.2	1916.0
AM Peak	0800	0800	0800	0800	0800	1100	1100		
	232	206	209	202	204	132	102		
PM Peak	1500	1600	1500	1700	1500	1200	1200		
	223	189	214	228	211	112	103		

*** - No data.**

Appendix C - Road Hierarchy Criteria

Indicative volume.	Liveable Neighbourhoods Classification	MRWA equivalent classification	Indicative Reserve Width.	Indicative Carriageway Width.
50,000.	Primary Distributor.	Primary Distributor		Determined by Main Roads WA
35,000.	Primary Distributor.	Primary Distributor		Determined by Main Roads WA
15,000 to 35,000.	Integrator Arterial A (District Distributor A).	Primary Distributor/ District Distributor A	50.6 – 52.6 metres.	2 x 8.2 metre carriageways including bike lane and 2 x 5.5 metre service roads containing parking.
<25,000	Integrator Arterial A (District Distributor A).	District Distributor A	35.6 metres.	2 x 10.7 metre carriageways including combined on street parking and bike lane.
7,000 to 15,000.	Integrator Arterial B (District Distributor B).	District Distributor A/ District Distributor B	29.2 metres.	2 x 7.5 metre carriageways with on street parking and bike lane.
15,000.	Integrator Arterial B (District Distributor B).	District Distributor B	25.2 metres.	2 x 7.5 metre carriageways with on street parking.
7,000.	Neighborhood Connector A.	Local Distributor	24.4 metres	2 x 7.1 metres including parking, on street bike lane, median plus shared path on one verge.
3,000.	Neighborhood Connector B.	Local Distributor	19.4 metres	11.2 metres including parking plus shared path on one verge.
3,000.	Access Street A (Avenue).	Local Distributor/ Access Road	20 - 24 metres.	2 x 3.5 metre lanes plus indented parking.
3,000.	Access Street B (Wider street).	Local Distributor/ Access Road	16.5 - 18 metres.	9.7 metre lane.
3,000.	Access Street C (Yield or give way street).	Access Road	15.4 - 16 metres.	7.2 (7.0 – 7.5) metre lane.
1,000.	Access Street D (Narrow yield or give way street).	Access Road	14.2 metres.	5.5 – 6.0 metre lane.
150	Access Street D (Narrow yield or give way street).	Access Road	14.2 metres.	3.5 metre lane plus parking indents.
3,000.	Access Street D (Wider street).	Access Road	16.5 - 18 metres.	9.7 metre lane.

Appendix 8

Local Water Management Strategy

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emerge ASSOCIATES
Integrated Science & Design

LOCAL WATER MANAGEMENT STRATEGY

PORTION OF LOT 16 MCDONALD ROAD BALDIVIS

Project Number EP15-057

Prepared for Defence Housing Australia
September 2016

Document Control

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DOC NO.	EP15-057(02)-003C DPC				
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1	January 2016	Shane Fudge	SF	Dave Coremans	DPC
	For issue to project team				
A	February 2016	Shane Fudge	SF	Dave Coremans	DPC
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B	July 2016	Shane Fudge	SF	Dave Coremans	DPC
	For issue to City of Rockingham				
C	September 2016	Shane Fudge	SF	Dave Coremans	DPC
	Final including amended Structure Plan				

Executive Summary

Defence Housing Australia (the 'proponent') proposes to develop a portion of Lot 16 McDonald Road, Baldivis (A for residential purposes. Lot 116 ('the site') is located approximately 38 km south of Perth Central Business District within the City of Rockingham (CoR). The site is bound by McDonald Road/existing urban development to the east and undeveloped landholdings to the north, south and west.

The majority of the site is zoned "Urban" under the Metropolitan Region Scheme (MRS) and "Development" under the City of Rockingham's Local Planning Scheme (LPS) No. 2, with a small portion of Lot 16 zoned for "Rural" land use under both the MRS and LPS No. 2.

This Local Water Management Strategy (LWMS) has been prepared to support the Portion of Lot 16 McDonald Road Structure Plan (SP) and has been developed in accordance with *Better Urban Water Management* (WAPC 2008a), *State Planning Policy 2.9 Water Resources* (WAPC 2006) and *Planning Bulletin 92 Urban Water Management* (WAPC 2008). Water will be managed using an integrated water cycle management approach, which has been developed using the philosophies and design approaches described in the *Stormwater Management Manual for Western Australia* (DoW 2007).

The first step in applying integrated water cycle management to the site is to establish agreed environmental values for receiving waters and their ecosystems. Characteristics of the existing environment within the site have been investigated and indicate that:

- The site receives 764 mm of rainfall on average, predominantly occurring between June and August.
- Topography of the site ranges from 4.2 m to 7.2 m Australian height datum (AHD).
- The site is underlain by sand derived from Tamala limestone.
- There is no known risk of acid sulfate soils (ASS) being present within 3.0 m of the natural surface across the site.
- There are no wetlands located within the site.
- A conservation category wetland is located approximately 80 m south west of the site.
- The site experiences a maximum groundwater level (MGL) of 1.82 m AHD. Depth to water across the site varies between 2.38 m below ground level (BGL) and 5.38 m BGL.
- Groundwater in the region contains varied nutrient concentrations consistent with the historical land use of market gardening.

The water conservation approach is to reduce the amount of water required within the development at both a lot and an estate scale. Water conservation measures proposed include water efficient fixtures. Additional water efficient practices including waterwise gardens (WG) installation of water efficient appliances and rainwater tanks (RWTs) are to be promoted at point of sale to further reduce lot scale scheme water usage.

Stormwater management focuses on stormwater runoff quantity and quality. The guiding principle for stormwater quantity is to maintain the existing hydrology by retaining surface flows and to infiltrate stormwater runoff within the site as close to source as possible. There will be no runoff from the development up to the 100 year average recurrence interval (ARI) event consistent with the pre-development environment. Further non-structural measures will also be adopted and will be detailed in the future Urban Water Management Plan (UWMP).

The ground ater management approach is passive and aims to avoid an intersection ith ground ater and therefore an modification or manipulation of e isting ground ater levels. Depth to ground ater across the site is significant and no su soil drains are proposed.

The proposed criteria and the manner in hich the are proposed to e achieved are presented in **Table E1**. This ta le provides a readil audita le summar of the re uired outcomes hich can e used in the future detailed design stage to demonstrate that the agreed o ectives for ater management at the site have actuall een achieved.

This L MS demonstrates that follo ing the recommendations detailed in the report the site is capa le of eing developed.

Table E 1 Water management criteria and compliance summary

Management Aspect	Criteria Number	Criteria Description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
ater Conservation	C1	se fit for purpose ater sources throughout the development	Scheme water will be supplied by Water Corporation's Integrated ater suppl scheme SS	Proponent	Civil design
			Promotion of R Ts to lot o ners	Proponent	Point of sale
			se of R Ts principles ithin lots	Lot o ner	Building construction
	C2	Consumption target of 100 kL/person/ ear ith no more than 40-60 kL/person/ ear of scheme ater	Mandated use of ater efficient fittings	Lot o ner	Building construction
			Promotion of ater efficient appliances R Ts and G to lot o ners	Proponent	Point of sale
			se of ater efficient appliances R Ts and G principles ithin lots	Lot o ner	Building construction
Storm ater management	S 1	Retain runoff from the 100 ear ARI event ithin the site	Residential lots ill retain and infiltrate 90 of runoff up to the 100 ear ARI event runoff ithin soak ells and pervious garden areas. The remaining 10 ill e conve ed to the road net ork.	Lot o ner	Building construction
			The retained rural lot ill retain and infiltrate runoff up to the 100 ear ARI event	Lot o ner	Construction
			Runoff up to the 100 ear ARI event from the road net ork and 10 of residential lots ill e retained ithin su surface storage	Proponent	Detailed drainage design
	S 2	Minor roads are to remain passa le in a 5 ear ARI event	The development pipe net ork ill e designed to conve the 5 ear ARI event hich ill ensure roads ill remain passa le	Proponent	Detailed drainage design
	S 3	Design infiltration areas to avoid creating mos uito ha itat	Su surface storage ill infiltrate the 100 ear ARI event in 5.5 hours ie 96 hours	Proponent	Detailed drainage design
	S 4	Retain and treat the first 15mm of runoff at source or as close as practica le	Runoff from the 1 ear 1 hour ARI event ithin lots ill e retained in lot soak ells or permea le garden areas	Lot o ner	Building construction

Management Aspect	Criteria Number	Criteria Description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
			Runoff from the 1 year 1 hour ARI event within road reserves and front of lots will be retained within the 'primary' filtration' cell of the subsurface storage located beneath road verges as shown in **Appendix B**	Proponent	Detailed drainage design
	S 5	Appl appropriate structural and non-structural measures to reduce nutrient loads	Education of residents regarding G fertiliser use and nutrient absorbing vegetation species within lots	Proponent	Point of sale
			Street sweeping to reduce particulate and sediment loads	Proponent then CoR	Ongoing
			Inspection and maintenance of subsurface storage infrastructure	Proponent then CoR	Ongoing
Groundwater management	G 1	Infiltration structures will have inverts at least 500 mm above maximum groundwater level (MGL)	Drainage infrastructure inverts will be set at least 500 mm above MGL. Detailed design of drainage basins and subsurface storage will be provided in the future LWMP	Proponent	Detailed drainage design

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1 Introduction

1.1 Background

Defence Housing Australia (the 'proponent') proposes to develop a portion of Lot 16 McDonald Road, Baldivis, WA for residential purposes. Lot 16 (referred to herein as the 'site') is located approximately 38 km south of Perth Central Business District within the City of Rockingham (CoR). The site is bound to McDonald Road/existing urban development to the east and undeveloped landholdings to the north, south and west.

The site location is shown on **Figure 1** with the cadastral boundaries shown on **Figure 2**.

1.2 Town planning context

The majority of the site is zoned 'Urban' under the Metropolitan Region Scheme (MRS) (Department of Planning 2015) and 'Development' under the CoR Local Planning Scheme (LPS) No. 2 (CoR 2004), with a small portion of Lot 16 zoned for 'Rural' land use under both the MRS and LPS No. 2.1

1.3 Purpose of this report

This Local Water Management Strategy (LWMS) is intended to support the structure plan (SP) which proposes development of the 'Urban' portion of the site. The LWMS presents pre-development existing environmental information related to the site which ensures that the water management within the development is addressed in a holistic and integrated manner.

1.4 Guiding documents

There are a number of State and Local Government policies of relevance to the development of the site. These policies include:

- *State Water Strategy* (Government of WA 2003)
- *State Water Plan* (Government of WA 2007)
- *Draft Guidance Statement No. 33: Environmental Guidance for Planning and Development* (EPA 2008)
- *State Planning Policy 2.9: Water Resources* (WAPC 2006)
- *Liveable Neighbourhoods* (4th Edition) (WAPC 2007)
- *Planning Policy 3.4.1 - Public Open Space* (CoR 2011)
- *Planning Procedure 1.8 - Water Sensitive Urban Design* (CoR 2010)

In addition to the above policies, there are a number of published guidelines and standards available that provide direction regarding the water discharge characteristics that urban developments should aim to achieve. These are key inputs that relate either directly or indirectly to the site and include:

- *Better Urban Water Management* (WAPC 2008a)
- *Decision Process for Stormwater Management in Western Australia* (DoW 2009)
- *Stormwater Management Manual for Western Australia* (DoW 2007)
- *Australian Runoff Quality* (Engineers Australia 2006)
- *Australian Rainfall and Runoff* (Engineers Australia 1987)

1.5 Previous studies

There are no overarching □ater management strategies that this L□ MS □ill need to compl□ □ith.

1.6 LWMS objectives

This L□ MS has □een developed in consideration of the o□□ectives and principles detailed in *Better Urban Water Management* □□ APC 2008a□. It is intended to support the SP and is further □ased on the follo□ing ma□or o□ectives□

- Provide a □road level storm□ater management frame□ork to support future ur□an development.
- Protect underl□ing ground□ater resources and do□nstream sensitive environments.
- Protect infrastructure □roads and horses□from undue flooding from ma□or runoff events.
- Incorporate appropriate □est management practices □BMPs□into the drainage s□stems that address the environmental and storm□ater management issues identified.
- Minimise development construction costs□□hich □ill result in reduced land costs for future home o□ners.
- Minimise ongoing operation and maintenance costs for the land o□ners and CoR.
- Develop a □ater conservation strateg□for the site.
- Gain support from Department of □ ater □Do□ □and CoR for the proposed method to manage storm□ater □ithin the site and potential impacts on do□nstream areas.

Detailed o□□ectives for □ater management □ithin the site are further discussed in **Section 4**.

2 Proposed Development

The Portion of Lot 16 McDonald Road SP □ill include development of□

- 29 lo□ densit□□residential lots
- Road reserves to service the 29 lots
- Su□surface drainage infrastructure located □ithin road reserves.

The Portion of Lot 16 McDonald Road SP is provided in **Appendix A**.

3 Existing Environment

3.1 Sources of information

The following sources of information were used to provide a broad regional environmental context for the site:

- *Regional 1:50 000 Geology Map Sheet* (Gozzard 1983a)
- *WA Atlas* (Landgate 2016)
- *Weather and Climate Statistics* (Bureau of Meteorology 2016)
- *Perth Groundwater Atlas* (DoW 2016a)
- *Water Register* (DoW 2016)
- *The Chimes – Fifty Road Baldivis UWMP* (Cardno 2013)
- *Lot 306 McDonald Road, Baldivis LWMS* (Coterra Environmental 2015)

The sources detailed have been reviewed to determine existing hydrological constraints. This is important as it can have implications for the stormwater management measures and the extent of earthworks that may be required to facilitate subdivision.

3.2 Climate

The site experiences a dry Mediterranean climate of hot dry summers and cool wet winters. Long term climatic averages indicate that the site is located in an area of moderate to high rainfall receiving 764 mm on average annually (Bureau of Meteorology 2016) with the majority of rainfall received between June and August. The region experiences rainfall an average of 90 days per annum.

3.3 Geotechnical conditions

3.3.1 Topography

The site ranges in height from 4.2 m Australian height datum (AHD) to 7.2 m AHD. The highest levels are located in the west of the site providing an easterly aspect. The lowest parts of the site are located along McDonald Road. Topographic contours are shown on **Figure 3**.

3.3.2 Soils and geology

Regional mapping indicates the site is underlain by sand derived from Tamala limestone (S7) which is described as white to pale yellowish brown and olive-yellow medium- to coarse-grained sub-angular quartz with some trace of feldspar moderately sorted of residual origin (Gozzard 1983).

A geotechnical report prepared by Galt Geotechnics (2015) provides a typical sub-surface profile for the site as follows (Galt Geotechnics 2015):

- Sand (SP) medium to coarse grained sub-angular to sub-rounded brown becoming yellow with depth, trace limestone cobbles and gravel, typically loose to dense, present from surface to depth of between 1.0 extending to the maximum depth investigation (2.5 m), overlying
- Limestone present below the sand layer varying from depths between about 1.0 m and more than the maximum depth of investigation (2.5 m).

It is noted that an area containing fill overlying the natural sands is located in the north western corner of the site and that several test pits encountered limestone pinnacles (Galt Geotechnics 2015). In-situ permeability testing was also carried out with infiltration rates of between 14 m/day and greater than 50 m/day recorded (Galt Geotechnics 2015).

Soil mapping, test pits and infiltration testing locations are shown on **Figure 4**.

3.3.3 Acid sulfate soils

The *WA Atlas* acid sulfate soil (ASS) risk mapping (Landgate 2016) classifies the whole site as having no known risk of ASS being present within 3.0 m of the natural surface.

3.4 Wetlands

The *Geomorphic Wetlands of the Swan Coastal Plain dataset* (DPaW 2013) indicates that there are no wetlands located within the site. There is a conservation category wetland (CCW) located approximately 80 m to the south west of the site (FI 6400). However, given that the site slopes to the east, the CCW is not in the downstream surface runoff catchment. The location of the wetland is shown in **Figure 5**.

There are no *Environmental Protection (Swan Coastal Plain Lakes) Policy* wetlands on site (Government of WA 1992).

3.5 Hydrology

3.5.1 Surface water

There are no defined surface water channels within the site. Runoff infiltrates freely across the site due to the high permeability of underlying sands, as discussed in **Section 3.3.2**.

3.5.2 Surface water quality

There are no defined surface water channels within the site, hence there is no information regarding pre-development surface water quality.

3.5.3 Groundwater levels

Information on groundwater from the DoW1*Online Water Register*' indicates that groundwater beneath the site is a multi-layered system comprised of the following (DoW 2015a):

- Perth - Superficial Swan
- Perth - Leederville
- Perth - Yarragadee North.

A review of the *Perth Groundwater Atlas* indicates that historical maximum groundwater level (MGL) contours do not adequately cover the site (DoW 2015a). Minimum groundwater level contours provide coverage of the site and indicate that groundwater flows in a west south-westerly direction.

Groundwater monitoring data from the adjacent eastern residential subdivision 'The Chimes' indicate that a MGL of 1.38 m AHD was recorded in a bore (BP1) located approximately 30 m from the south eastern corner of the site in July 2012 (Cardno 2013). Recent groundwater monitoring data from the adjacent northern local structure plan 'Lot 306 McDonald Road, Baldivis' indicate that a

MGL of 1.82 m AHD was recorded in a bore (MW 3) located approximately 20 m from the north western corner of the site in September 2014 (Coterra Environmental 2015).

It is inferred that depth to MGL ranges between 2.38 m below ground level (BGL) in the north western corner of the site (i.e. beneath a corner of the future rural area') and 5.38 m BGL in the proposed residential (south eastern) portion of the site. The locations of the adjacent bores are shown on **Figure 3**.

3.5.4 Groundwater quality

No groundwater quality information exists for the site.

However as discussed in **Section 3.5.3** groundwater quality data from adjacent eastern bores can be reviewed to develop a regional context for the site. The location of bores 'BP1' and 'BP5' from 'The Chimes' are shown in **Figure 3** with average groundwater quality data shown in **Table 1.** The default triggers from the *National Water Quality Management Strategy* (NWQMS) (ANZECC 2000) guidelines for fresh and marine water quality are also provided for reference.

Table 1 Groundwater quality data from adjacent bores

Bore	TN (mg/L)	TP (mg/L)	FRP (mg/L)	NH4 (mg/L)	NOx (mg/L)	TKN (mg/L)
NWQMS	*1.2*	*0.065*		*0.08*	*0.15*	
BP1*	7.10	0.86	<0.01	0.09	3.35	3.76
BP5*	0.85	0.68	<0.01	0.13	0.35	0.50

*(Cardno 2013)

The elevated total nitrogen (TN) and total phosphorous (TP) presented in **Table 1** are consistent with the regional historical land use of market gardening. A change of land use from market gardening to urban residential will reduce the nutrient loading to groundwater.

Note that due to the inferred west south-westerly direction of groundwater flow as discussed in **Section 3.5.3** bore BP1 is not hydrologically upstream of the site.

3.6 Summary of existing environment

In summary the environmental investigations conducted to date indicate that:

- The site receives 764 mm of rainfall on average predominantly occurring between June and August.
- Topography of the site ranges from 4.2 m to 7.2 m AHD.
- The site is underlain by sand derived from Tamala limestone.
- There is no known risk of ASS being present within 3.0 m of the natural surface across the site.
- There are no wetlands located within the site.
- A CCW is located approximately 80 m south west of the site.
- The site experiences an MGL of 1.82 m AHD. Depth to water across the site varies between 2.38 m BGL and 5.38 m AHD.
- Groundwater in the region contains elevated nutrients (TN and TP) consistent with the historical land use of market gardening.

4 Design Criteria and Objectives

This section outlines the o□ectives and design criteria that the development must achieve. The design criteria for □ater management □ithin the ur□an Portion of Lot 16 McDonald Road have □een guided □ □the guidance documents listed in **Section 1.4**.

4.1 Water conservation

The design criteria for □ater conservation management include□

Criteria WC1 □se fit for purpose □ater sources throughout the development.

Criteria WC2 Consumption target for □ater of 100 kL/person/□ear□including not more than 40-60 kL/person/□ear scheme □ater.

The manner in □hich these o□ectives □ill □e achieved is further detailed in **Section 5**.

4.2 Stormwater management

The design criteria for storm□ ater management include□

Criteria SW1 Retain runoff from the 100 □ear average recurrence interval □ARI□event onsite.

Criteria SW2 Minor roads are to remain passa□le in a 5 □ear ARI event.

Criteria SW3 Design infiltration areas to avoid creating mos□uito ha□itat.

Criteria SW4 Retain and treat the first 15 mm of runoff at source or as close as practica□le.

Criteria SW5 Appl□ appropriate non-structural measures to reduce nutrient loads.

The manner in □hich these o□ectives □ill □e achieved is further detailed in **Section 6.**

4.3 Groundwater management

The design criteria for ground□ater management include□

Criteria GW3 Infiltration structures □ill have inverts at least 500 mm a□ ove ma□ imum ground□ ater level.

The manner in □hich this o□ective □ill □e achieved is further detailed in **Section 7**.

5 Water Source Allocation, Infrastructure and Fit-for-Purpose Use

5.1 Fit-for-purpose water use

Conservation of water through fit-for-purpose use and best management practices is encouraged so that scheme water is not wasted. Fit-for-purpose principles have been utilised in the water conservation strategy for the SP area.

5.1.1 Scheme water

Scheme water will be supplied by the Water Corporation's Integrated Water Supply Scheme (IWSS). The residential lots will connect to existing mains located within McDonald Road (A. Tucker 2015 pers. comm. 15 December).

5.1.2 Groundwater

The DoW *Online Water Register* indicates that the site is located in the Stakehill groundwater area within the Tamworth Swamp sub-area and that there is allocation available within the Perth-Superficial aquifer (DoW 2015).

No public open space (POS) is proposed within the site and hence no groundwater is required for ongoing irrigation. A temporary licence may be required for construction purposes (i.e. dust suppression) and if required details of this licence will be provided within the future LWMP.

5.1.3 Rainwater tanks

Rainwater tanks will not be mandated for the McDonald Road development however educational literature detailing their implementation and use for in-lot and irrigation purposes will be made available to lot owners at point of sale. It is assumed that 90% of future residents will utilise rainwater tanks based on typical uptake rates taken from Australian Bureau of Statistics (ABS) published data (ABS 2013a).

The use of the above water sources will help to achieve **Criteria WC1** and **WC2**.

5.2 Water conservation measures

The development will utilise water wise garden (WWG) principles (DPC 2003) for lot scale gardens and water efficient fixtures and appliances (WEFA) within lots to ensure that the development minimises the use of water. These measures are further discussed in the following Sections.

5.2.1 Water efficient fixtures and appliances

Significant reduction in in-house water uses can be achieved with the use of WEFA. Use of WEFA can result in a reduction in water use of between 35% and 50% (Melbourne Water 2003). Water use rates consistent with water saving devices have been used in the lot scale water balance analysis detailed in **Section 5.3**.

The water conservation strategy proposes that all dwellings use WEFA. Water efficient fixtures will be mandated through the building licence while uptake of water efficient appliances can be encouraged by state and local government rebates as well as education from the proponent at point of sale. It is

assumed that 35% of future residents will utilise water efficient appliances, based on typical uptake rates provided by ABS (ABS 2013).

The above measures will assist in achieving **Criteria WC1** and **WC3**.

5.2.2 Water wise gardens

The extent of landscaping that may be provided within private residential lots is yet to be determined. Where landscaping is provided (either in private lots or road verges) a variety of measures will be adopted to limit water use, including:

- The adoption of water wise species, with a focus on using local native water wise species or if necessary species from regions with similar climates.
- Existing site soil may be improved with soil conditioner certified to Australian Standard AS 4454 to a minimum depth of 50 mm where turf is to be planted and a minimum depth of 75 mm for garden beds.
- The irrigation system is proposed to be designed and installed according to best water efficient practices including consideration of hydro zone design solutions.
- Garden beds will be mulched to 75 mm with a product certified to AS 4454.

Details regarding the use of WSUD principles within lot gardens will be made available to purchasers on sale of lots. It is therefore assumed that overall 50% of lot gardens will utilise WSUD, based on typical uptake rates taken from ABS (ABS 2013).

The above measures will assist in achieving **Criteria WC2**.

5.3 Lot water balance

The water balance analysis has been based on the rates and calculation methodology in the Water Corporation spreadsheet *AltWaterSupply_Water_Use_Model.xls*. The analysis assumes an average of 2.6 people per lot (ABS 2013a).

The results of the water balance indicate that if households adopt the proposed water conservation measures at typical uptake rates they will use on average 59.4 kL/year/person with a total usage of 4.3 ML. This achieves the state water consumption target of no more than 100 kL/year/person and the *Better Urban Water Management* aspirational goal of 40-60 kL/year/person and satisfies **Criteria WC2**.

5.4 Estate scale water usage

No POS is proposed within the SP and therefore there are no estate scale water usage requirements.

5.5 Water conservation criteria compliance summary

A summary of the proposed water conservation design criteria and how these are addressed is provided in **Table 2**.

Table 2 Water conservation criteria compliance

Criteria Number	Criteria Description	Manner in which compliance will be achieved
□ C1	□se fit for purpose □ater sources throughout the development	Scheme□water□will□be□supplied□by□Water□Corporation's□1 l□ SS
		Promotion of R□ Ts and □ □ G to lot o□ners
		□se of R□ Ts and □ □ G principles □ithin lots
□ C2	Consumption target of 100 kL/person/□ear □ith no more than 40-60 kL/person/□ear of scheme □ater	Mandated use of □ater efficient fittings
		Promotion of □ater efficient appliances□R□ Ts and □ □ G to lot o□ners
		□se of □ater efficient appliances□R□ Ts and □ □ G principles □ithin lots

6 Stormwater Management

6.1 Stormwater management approach

The principles □ehind the storm□ater management strateg□aim to mimic the e□isting h□drolog□ □ infiltrating onsite as close to source as practica□ le.

The development drainage s□stem has □een designed to achieve the o□□ectives and criteria stated in **Section 4.2**. The storm□ ater management measures proposed are discussed □elo□ □ ith conceptual earth□orks designs provided in **Appendix B**.

6.1.1 Lot drainage system

6.1.1.1 Residential lots

Residential lots □ill retain the 100 □ear ARI event runoff onsite for 90□ of the total lot area. The remaining 10□ □ i.e. front drive□a□s □ ill contri□ ute to runoff □ ithin the road net□ ork.

The runoff from roof and impervious areas □ill □e directed to soak□□ells □here it □ill infiltrate into the sand□fill and ultimatel□to ground□ ater. The specific soak□□ell configuration □ill □e dependent on the lot configuration and an□ other storage elements proposed on lot □i.e. rain□ ater tanks□. Lot soak□ ells □ould nominall□□ e sized to capture the first 12 mm of rainfall □i.e. 20 □ear□5 minute ARI event□ consistent □ith Building Code of Australia re□ uirements for gutter and do□npipe sizing. Runoff □hich e□ ceeds the capacit□ of soak□ ells is assumed to soak into the permea□ le areas of lots. This is a reasona□le assumption given that lot sizes range from appro□imatel□342 m^2 to 514 m^2 □ith an average size of 413 m^2 □e□cluding the rural lot□. Provision of ade□ uate retention volumes on lot is the responsi□ilit□of the lot o□ner and □ill □e revie□ed □□CoR as part of the □uilding approvals process.

Infiltration of runoff through the underl□ing soils □ill provide treatment through adsorption of nutrients to sand particles□ prior to reaching ground□ ater.

Retention of runoff on lot □ ill help to achieve **Criteria SW1** and **SW4**.

6.1.1.2 Rural lot

The rural lot in the □est of the site □ill retain and infiltrate runoff up to the 100 □ear ARI event on lot. This approach is consistent □ith the e□isting h□drolog□of the site □hich is characterised □□the high permea□ilit□of underl□ing soils □as discussed in **Section 3.3.2**□

6.1.2 Development drainage system

The development drainage s□ stem utilises su□-surface storage designed to treat minor event runoff □i.e. the first 15 mm□and retain ma□or event runoff □i.e. the 100 □ear ARI event□□ithin the site. □ ater □ill □e pre-treated □efore entering the su□surface storage cells via a lined pre-treatment cham□er than can □ e readil□ educted via a manhole. Follo□ ing pre-treatment□ ater □ ill □ e directed to a catch-all ro□□and this ro□ □ill □e underlain □□an appropriate soil media to address concerns regarding nutrients. All side entr□ pits in the s□ stem □ill have an additional 600 mm depth to provide an additional measure of protection to the su□ surface storage cells. Runoff volumes e□ ceeding the pre-treatment and catch-all ro□ □ill □e directed to the remainder of the ecoAID storage.

Su surface storage ill e used to retain up to the 100 ear ARI event runoff from the road net ork and 10 of residential lots i.e. front drive a s resulting in no offsite discharge. Indicative locations of su surface storage are provided in **Figure 6**.

hile detailed designs are et to e prepared one possi le design solution is ecoAID su surface cells. An e ample specification of ecoAID su surface cells is provided in **Appendix D**.

The ecoAID storage calculator has een used to calculate the re uired storage volumes assuming

- An infiltration rate of 2.5 m/da for the northeast corner here closest to ground ater to 3 m/da here clearance to ground ater is greater
- Road reserves are comprised of 70 impervious i.e. carriage a footpaths and drive a crossovers and 40 pervious verges.

Catchment oundaries and ecoAID calculations are provided in **Appendix B**. Storage volumes for su surface storage infrastructure ithin Catchments 1 2 and 3 are provided in **Table 3**.

Table 3 Subsurface storage details

Catchment	Catchment 1 (Northeast)			Catchment 2 (Southeast)			Catchment 3 Northwest)		
Rainfall event ARI	1 ear 1 hour	5 ear	100 ear	1 ear 1 hour	5 ear	100 ear	1 ear 1 hour	5 ear	100 ear
olume m³	33	53	90	32	48	83	6.4	9	15

As indicated at this stage the rand of su surface storage has not een selected and the detailed design ma include more than one t pe of su surface storage. The important thing ill e that the 100 ear ARI event su surface storage volumes provided in **Table 3** are provided for in some form. The volumes re uired and the assumptions used to calculate this ill e revie ed at detailed design stage to ensure that su surface storage is appropriatel sized.

As ith lot soak ells infiltration of runoff through the under ing soils ill provide treatment through adsorption of nutrients to sand particles prior to reaching ground ater. The installation of su surface storage infrastructure ill e conducted such that a clearance to MGL of 500 mm is maintained.

Based on an infiltration rate of 2.5 to 3 m/da and the depth of the e ample su surface storage product provided in **Appendix D** the su surface storage cells ill infiltrate the 100 ear ARI event ithin 5.5 hours. The infiltration rate considers the depth to MGL discussed in **Section 7.1**. This easil meets the guideline value of 96 hours the critical time for utilisation of surface ater for mos uito reeding as detailed in *Guidance Statement for Management of Mosquitoes for Land Proponents* EPA 2003.

Su surface storage cells ill e configured ith a primar filtration cell prior to the main storage cells and ill e underlain ith high phosphorus retention inde PRI soil or media for treatment of first flush runoff. An e ample schematic of this configuration is provided in **Appendix B**.

The use and design of su -surface storage ill achieve **Criteria SW1 SW3 SW4** and **GW1**.

6.2 Stormwater criteria compliance summary

A summar of the proposed storm ater design criteria and ho these are addressed are sho n in **Table 4**.

Table 4 Stormwater criteria compliance summary

Criteria Number	Description	Manner in which compliance is achieved
S□ 1	Retain runoff from the 100 □ear ARI event □ithin the site	Residential lots □ill retain and infiltrate 90□ of runoff up to the 100 □ear ARI event runoff □ithin soak□ells and pervious garden areas. The remaining 10□ □ill □e conve□ed to the road net□ork
		The retained rural lot □ill retain and infiltrate runoff up to the 100 □ear ARI event
		Runoff up to the 100 □ear ARI event from the road net□ork and 10□ of residential lots □ill □e retained □ithin su□surface storage
S□ 2	Minor roads are to remain passa□le in a 5 □ear ARI event	The development pipe net□ork □ill □e designed to conve□the 5 □ear ARI event □hich □ill ensure roads □ill remain passa□le
S□ 3	Design infiltration areas to avoid creating mos□uito ha□itat	Su□surface storage □ill infiltrate the 100 □ear ARI event in 5.5 hours (i.e. □96 hours□
S□ 4	Retain and treat the first 15 mm of runoff at source or as close as practica□le	Runoff from the 1 □ear 1 hour ARI event □ithin lots □ill □e retained in lot soak□ells or permea□le garden areas
		Runoff from the 1 □ear 1 hour ARI event □ithin road reserves and front of lots □ill □e retained □ithin the 'primary filtration' cell1 of the su□surface storage located □eneath road verge□as sho□n in **Appendix B**
S□ 5	Appl□appropriate structural and non-structural measures to reduce nutrient loads	Education of residents regarding □ □ G□ertilıser use and nutrient a□sor□ing vegetation species □ithin lots
		Street s□eeping to reduce particulate and sediment loads
		Inspection and maintenance of su□surface storage infrastructure

7 Groundwater Management

7.1 Groundwater management approach

The drainage s□stem has □een designed to achieve the o□□ectives and criteria stated in **Section 4.3**. The primar□ o□ □ective of the ground□ ater management plan is to maintain clearance □ et□ een MGL and the inverts of infiltration structures □e.g. su□surface storage cells□

As detailed in **Section 3.5.3**□ MGL □ eneath the site is a ma□ imum of appro□ imatel□ 1.8 m AHD □north□est□□ and appro□imatel□ 1.3 m AHD □at the eastern □oundar□□. For the purposes of design□ and based□on□the□City's□recommendation,□an□MGL□of□1.82□has□been□adopted.□Preliminar□ earth□ ork levels □provided in **Appendix B**□for the development are at around 6.0 m AHD □at the su□surface storage for Catchments 1 and 2□□ and therefore lots □ill achieve a minimum clearance to ground□ ater of 4.18 m.

As discussed in **Section 6.1.2**□ the inverts of su□ surface storage structures □ ill □ e re□ uired to maintain a minimum clearance to MGL of 500 mm. Given the height of the ecoAID s□stem □ill □e appro□imatel□ 1.3m□ the inverts of storm□ ater infrastructure □ ill easil□ meet this re□ uirement□ and □ ill most likel□ provide 2.88 m clearance to the adopted MGL. An indicative schematic detailing the clearances of su□surface storage structure inverts to MGL is provided in **Appendix B**. Note that the infiltration rates adopted and descri□ed in **Section 6.1.2** are intended to account for the a□ ove descri□ ed clearance to ground□ ater.

The a□ ove approach □ill ensure that **Criteria GW1** is achieved.

7.2 Groundwater criteria compliance summary

A summar□ of the proposed ground□ ater management design criteria and ho□ these are addressed is provided in **Table 5**.

Table 5 Groundwater management criteria compliance

Criteria Number	Criteria description	Manner in which compliance will be achieved
G□1	Infiltration structures □ill have inverts at least 500 mm a□ ove MGL	Inverts □ill □e set at least 500 mm a□ ove MGL. Detailed design of drainage □asins and su□surface storage □ill □e provided in the future □□ MP

8 Subdivision and Urban Water Management Plan

The re□uirement to undertake preparation of more detailed □ater management plans to support su□ division is generall□ imposed as a condition of su□ division.

□ hile strategies have □een provided □ithin this L□ MS that address planning for □ater management □ithin the site□it is a logical progression that future su□division designs and the supportive □□ MP □ill clarif□details not provided □ithin the L□ MS addendum. The main areas that □ill re□uire further clarification □ithin the future □□ MP include□

- Potential alternative treatment approaches
- Detailed drainage design
- Non-structural □ater □ualit□improvement measures
- Management and maintenance re□uirements
- Construction period management strateg□
- Monitoring and evaluation program.

These are further detailed in the follo□ing sections.

8.1 Alternative water quality treatment approaches

The proponent □ill investigate alternative and potential □ater □ualit□treatment approaches □hich adopt a surface retention-□ased approach to □ater □ualit□management. □ here possi□le and/or appropriate these □ill □e included in the detailed civil design. This ma□include directing runoff from the North□est Catchment to Lot 306 should it □e possi□le and □here timing of implementation of □oth developments allo□s. Regardless of inclusion or e□clusion of surface □ased □ S□D approaches□the rationale □ehind the approach proposed □ill □e included in the future □□ MP.

8.2 Detailed drainage design

It is possi□le that the drainage catchments could undergo some change to accommodate stakeholder feed□ack prior to final su□division design. It is also e□pected that the civil drainage designs □ill □e progressed to a level that provides detailed cross-sections□ sizes of storage areas□ pipe sizes□ inverts□ etc.

The design of the drainage s□stem to date has □een undertaken at an appropriate level for local structure planning. More detailed calculations or runoff-routing computer modelling of the storm□ater drainage s□stem ma□□e re□uired to support detailed drainage design. The e□act location and configuration of the storm□ater management infrastructure □ill need to □e specified and presented □ithin the future □□ MP. This □ill include consideration of directing runoff to the □asin storage in Lot 306 immediatel□to the north.

The e□ception to the re□uirement to revise the surface runoff modelling is if the catchment details and su□surface storage cell designs are consistent □ith the assumptions made in this L□ MS. If this □ere the case it □ould □e accepta□le to provide design calculations for the concrete pipe and su□surface infiltration areas to demonstrate compliance □ith the L□ MS.

8.3 Non-structural water quality improvement measures

Some non-structural water quality improvement measures will be more appropriately implemented by local government such as street sweeping however many can be implemented relatively easily within the design and maintenance of the subdivision. It is expected that the future LWMP will provide reference to measures such as public education through measures such as signage that may be implemented to raise awareness.

8.4 Management and maintenance requirements

The management measures to be implemented to address surface water quality will require ongoing maintenance. It is therefore expected that the future LWMP will provide detailed management and maintenance plans that will set out maintenance actions (e.g. gross pollutant removal) timing (e.g. how often it will occur) locations (e.g. exactly where it will occur) and responsibilities (e.g. who will be responsible for carrying out the actions). Given that approval from the CoR and DoW will be sought for the proposed measures it is anticipated that consultation with these agencies will be undertaken and referral to guiding policies and documents will be made.

8.5 Construction period management strategy

It is anticipated that the construction stage will require some management of various aspects (e.g. dust surface runoff noise traffic etc.). The management measures undertaken for construction management will be addressed either in future LWMP or a separate Construction Management Plan (CMP).

8.6 Monitoring

There will be no POS provided within the SP area and therefore POS condition monitoring is not proposed. Due to the depth to groundwater and exclusion of POS there is no proposed pre or post-development groundwater monitoring.

Monitoring that will occur post-development will be undertaken as a part of routine maintenance of the drainage system with the aim of guiding ongoing maintenance. Monitoring will therefore occur within inspection access areas for the subsurface storage infrastructure (e.g. ecoAID subsurface cells) for sediment and gross pollutants. The frequency of monitoring and responsive actions will be further detailed in the LWMP.

9 Implementation Plan

9.1 Roles and responsibilities

This L□ MS provides a frame□ork that the proponent can utilise to assist in implementing an integrated ▯ater c▯cle management strateg▯ that has ▯een ▯ased upon site-specific investigations and is consistent □ith relevant State and Local Government policies. The responsi□ilit□ for □orking □ithin the frame□ork esta□lished □ithin this L□ MS rests □ith the proponent and their contractors□although it is anticipated that future monitoring□management and maintenance actions □e□ond construction and su□se□uent maintenance period □ill □e the responsi□ilit□ of the CoR.

9.2 Funding

The site is a single landholding o▯ned ▯▯ the proponent and therefore all ▯orks ▯ill ▯e funded ▯▯ the proponent.

9.3 Review

The surface runoff calculations contained herein □ould not need to □e revised unless additional land parcels/lots are added to the SP area prior to su□division□or the SP undergoes significant change post-lodgement of the L▯ MS. If the SP is su▯stantiall▯ modified runoff calculations provided in this L□ MS □ill need to □e revie□ed and the criteria proposed revised to ensure that all are still appropriate.

The ne▯t stages of ▯ater management are anticipated to ▯e lot planning through su▯ division. Su□division approvals □ill □e supported □▯a □□ MP. The □□ MP is largel□an e□tension of the L▯ MS as it should provide detail to the designs proposed ▯ithin this L▯ MS▯ and ▯ill demonstrate compliance ▯ith the criteria proposed in **Section 4**. On this ▯asis it is not anticipated that this L▯ MS □ill □e revie□ed.

10 References

10.1 General references

Australian Bureau of Statistics (ABS) 2013a, *4130.0 - Housing Occupancy and Costs 2011-12*, Australian Bureau of Statistics, Canberra.

Australian Bureau of Statistics (ABS) 2013, *4602.0.55.003 - Environmental Issues: Water Use and Conservation, March 2013*, Australian Bureau of Statistics, Canberra.

Australian and New Zealand Environment and Conservation Council (ANZECC) 2000, *Australia and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy* Australian and New Zealand Environment and Conservation Council.

Cardno 2013, *The Chimes Fifty Road, Baldivis Urban Water Management Plan*.

City of Rockingham (CoR) 2004, *Town Planning Scheme No. 2 (TPS2)*, City of Rockingham, Rockingham.

City of Rockingham (CoR) 2010, *Planning Procedure 1.8 - Water Sensitive Urban Design*, City of Rockingham, Rockingham.

City of Rockingham (CoR) 2011, *Planning Policy 3.4.1 - Public Open Space*, City of Rockingham, Rockingham.

Coterra Environmental 2015, *Local Water Management Strategy - Lot 306 McDonald Road, Baldivis*.

Department of Water (DoW) 2007, *Stormwater Management Manual for Western Australia*, Department of Water, Perth.

Department of Water (DoW) 2009, *Decision Process for Stormwater Management in Western Australia*, Department of Water, Perth.

Department of Parks and Wildlife (DPaW) 2013, *Geomorphic Wetlands on the Swan Coastal Plain dataset*, Department of Parks and Wildlife, Perth.

Engineers Australia 1987, *Australian Rainfall and Runoff*, National Committee for Water Engineering, Canberra.

Engineers Australia 2006, *Australian Runoff Quality: A guide to Water Sensitive Urban Design*, National Committee for Water Engineering, Engineers Australia, Canberra.

Environmental Protection Authority (EPA) 2008, *Guidance Statement No. 33: Environmental Guidance for Planning and Development*, Environmental Protection Authority, Perth.

Galt Geotechnics 2015, *Geotechnical and Preliminary Environmental Study Proposed Residential Subdivision 16 McDonald Road, Baldivis*.

Government of WA 1992, *Environmental Protection (Swan Coastal Lakes) Policy*.

Government of WA 2003, *A State Water Strategy for Western Australia*, Government of Western Australia, Perth.

Government of WA 2007, *State Water Plan*, Perth.

Gozzard, J. R. 1983a, *Fremantle Part Sheets 2033 I & 2033 IV*, Geological Survey of Western Australia, Perth.

Gozzard, J. R. 1983, *Rockingham, Sheets 2033 III and 2033 II*, Geological Survey of Western Australia, Perth.

Melbourne Water 2003, *Household Water Use Calculator*, Melbourne Water, Melbourne.

Western Australian Planning Commission (WAPC) 2006, *State Planning Policy 2.9: Water Resources*, Gazetted in December 2006, Western Australian Planning Commission, Perth.

Western Australian Planning Commission (WAPC) 2007, *Liveable Neighbourhoods (Edition 4)*, Western Australian Planning Commission and Department for Planning and Infrastructure, Perth.

Western Australian Planning Commission (WAPC) 2008a, *Better Urban Water Management*, Western Australian Planning Commission, Perth.

Western Australian Planning Commission (WAPC) 2008, *Planning Bulletin 92: Urban Water Management*, Western Australian Planning Commission, Perth.

Water Corporation (WC) 2003, *Domestic Water Use Study in Perth, Western Australia 1998-2001*, Water Corporation, Perth.

10.2 Online references

Bureau of Meteorology 2016, *Climate Averages*, viewed January 2016, http://www.bom.gov.au/climate/data/.

Landgate 2015, *WA Atlas*, viewed January 2016, https://www2.landgate.wa.gov.au/mvf/app/waatlas/.

Department of Parks and Wildlife (DPaW) 2013, *Geomorphic Wetlands, Swan Coastal Plain*, viewed March 2015, https://www2.landgate.wa.gov.au/mvf/app/waatlas/.

Department of Planning 2015, *Metropolitan Region Scheme mapping Map Sheet 31 Baldivis*, viewed August 2015, http://www.planning.wa.gov.au.

Department of Water (DoW) 2016a, *Perth Groundwater Atlas 2004 Edition 2*, Department of Water, Perth. Accessed from http://www.water.wa.gov.au/idelve/gwa/.

Department of Water (DoW) 2016, *Water Register*, Perth. Accessed from http://www.water.wa.gov.au/Tools/Maps+and+atlases/Water+Register/default.asp, 1.

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FIGURES

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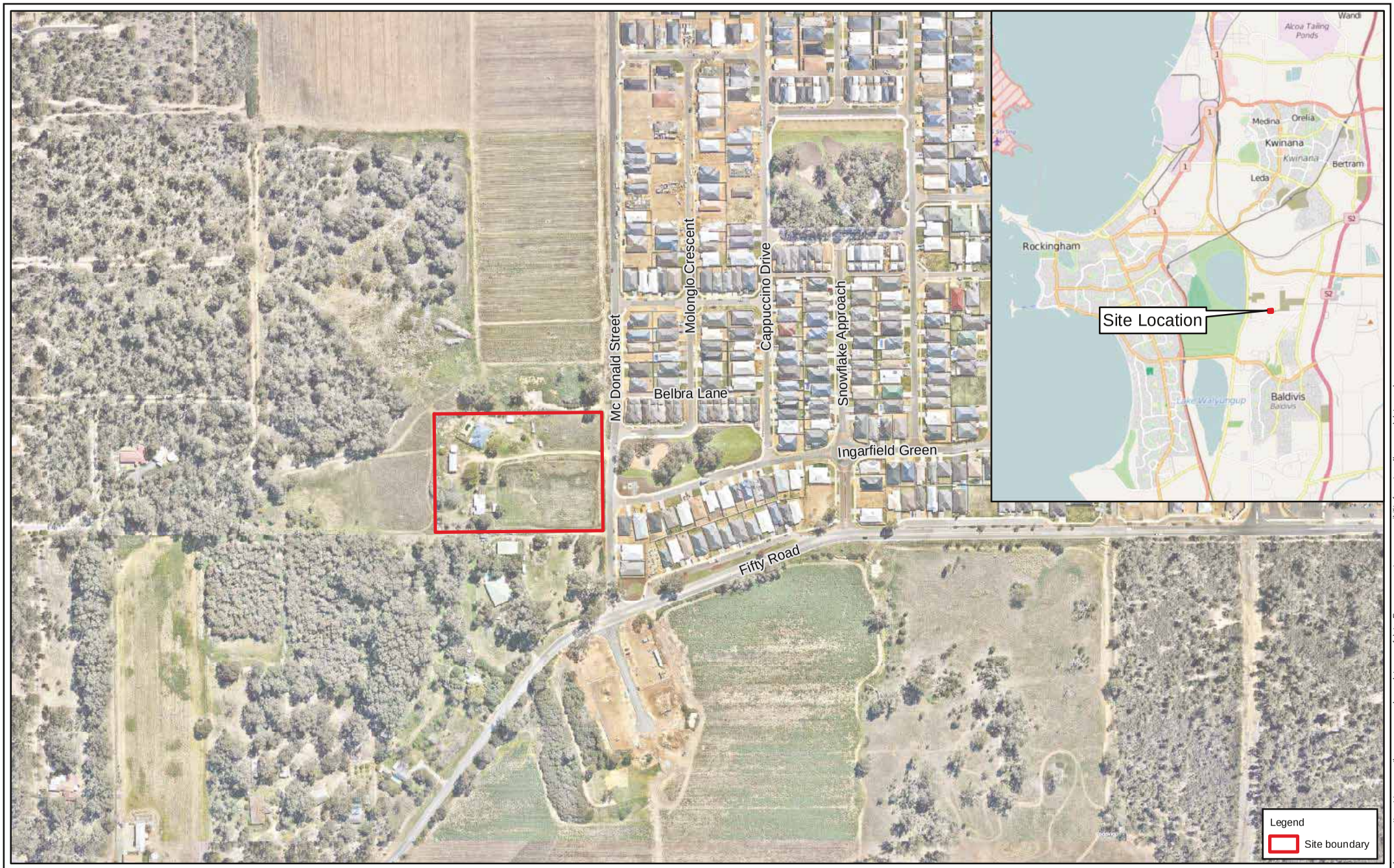

Figure 1:	**Site Location**	0	
Project:	Portion of Lot 16 McDonald Road, Baldivis LWMS		
Client:	Defence Housing Australia		

Plan Number: EP15-057(02)--F17a			
Drawn:	KNM	Date:	11/02/2016
Approved:	DPC	Date:	11/02/2016
Checked:	SMF	Scale:	1:5,000@A4

0 50 100 200 Metres

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Figure 2:	**Site Boundary**	0	**Plan Number: EP15-057(02)--F18a**
Project:	Portion of Lot 16 McDonald Road, Baldivis LWMS		Drawn: KNM Date: 11/02/2016
Client:	Defence Housing Australia		Approved: DPC Date: 11/02/2016
			Checked: SMF Scale: 1:2,250@A4
			0 20 40 80 Metres

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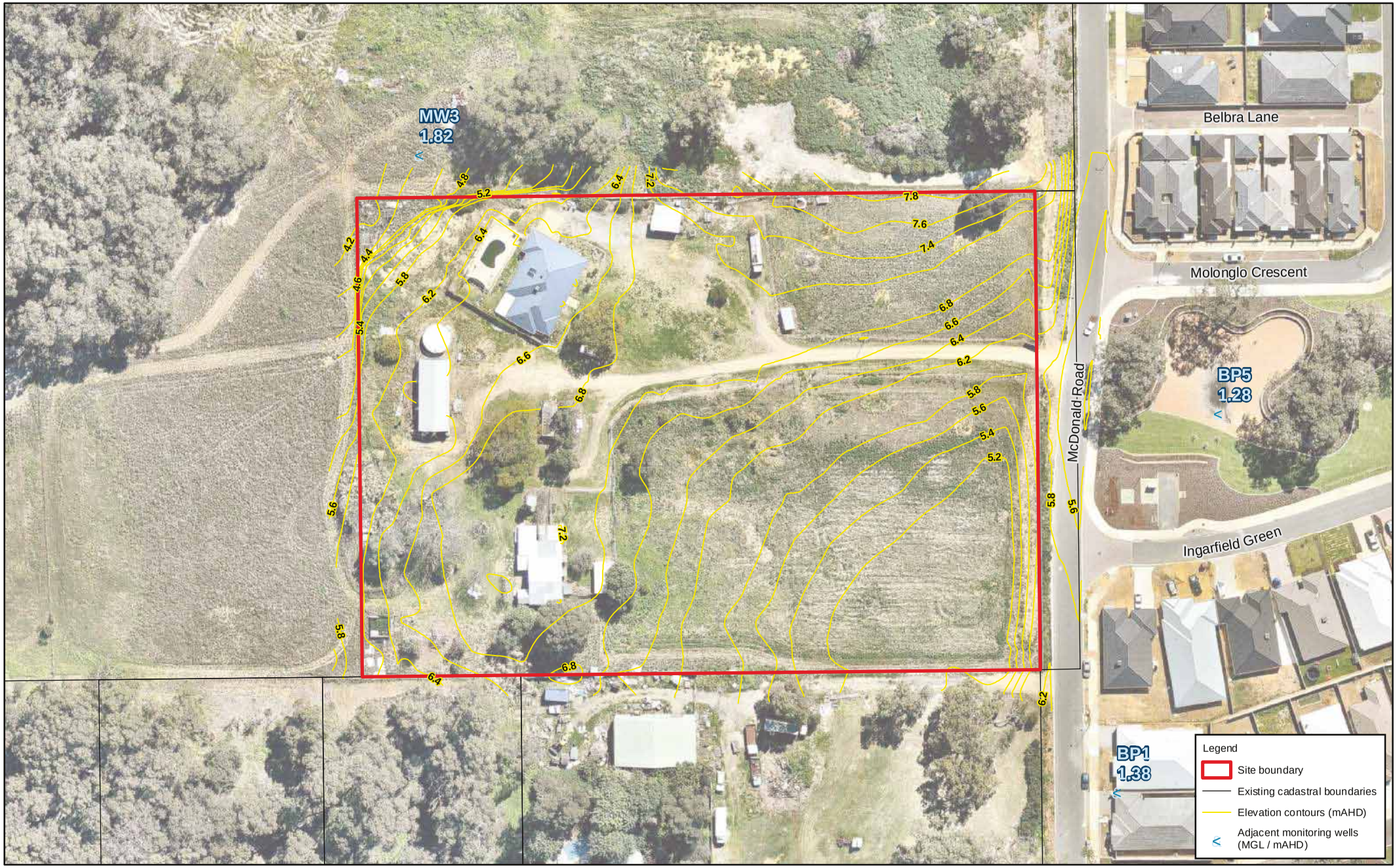

Figure 3:	**Pre-development Topography and Maximum Groundwater Level**	0	
Project:	Portion of Lot 16 McDonald Road, Baldivis LWMS		
Client:	Defence Housing Australia		

Plan Number: EP15-057(02)--F19a			
Drawn:	KNM	Date:	11/02/2016
Approved:	DPC	Date:	11/02/2016
Checked:	SMF	Scale:	1:1,250@A4

0 12.5 25 50 Metres

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Figure 4:	**Geological Mapping and Test Pit Locations**	0	
Project:	Portion of Lot 16 McDonald Road, Baldivis LWMS		
Client:	Defence Housing Australia		

Plan Number: EP15-057(02)--F20a			
Drawn:	KNM	Date:	11/02/2016
Approved:	DPC	Date:	11/02/2016
Checked:	SMF	Scale:	1:2,500@A4

0 25 50 100 Metres

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Figure 5: Hydrological Features

Project: Portion of Lot 16 McDonald Road, Baldivis LWMS

Client: Defence Housing Australia

0

Plan Number: EP15-057(02)--F21a

Drawn:	KNM	Date:	11/02/2016
Approved:	DPC	Date:	11/02/2016
Checked:	SMF	Scale:	1:2,500@A4

0 25 50 100 Metres

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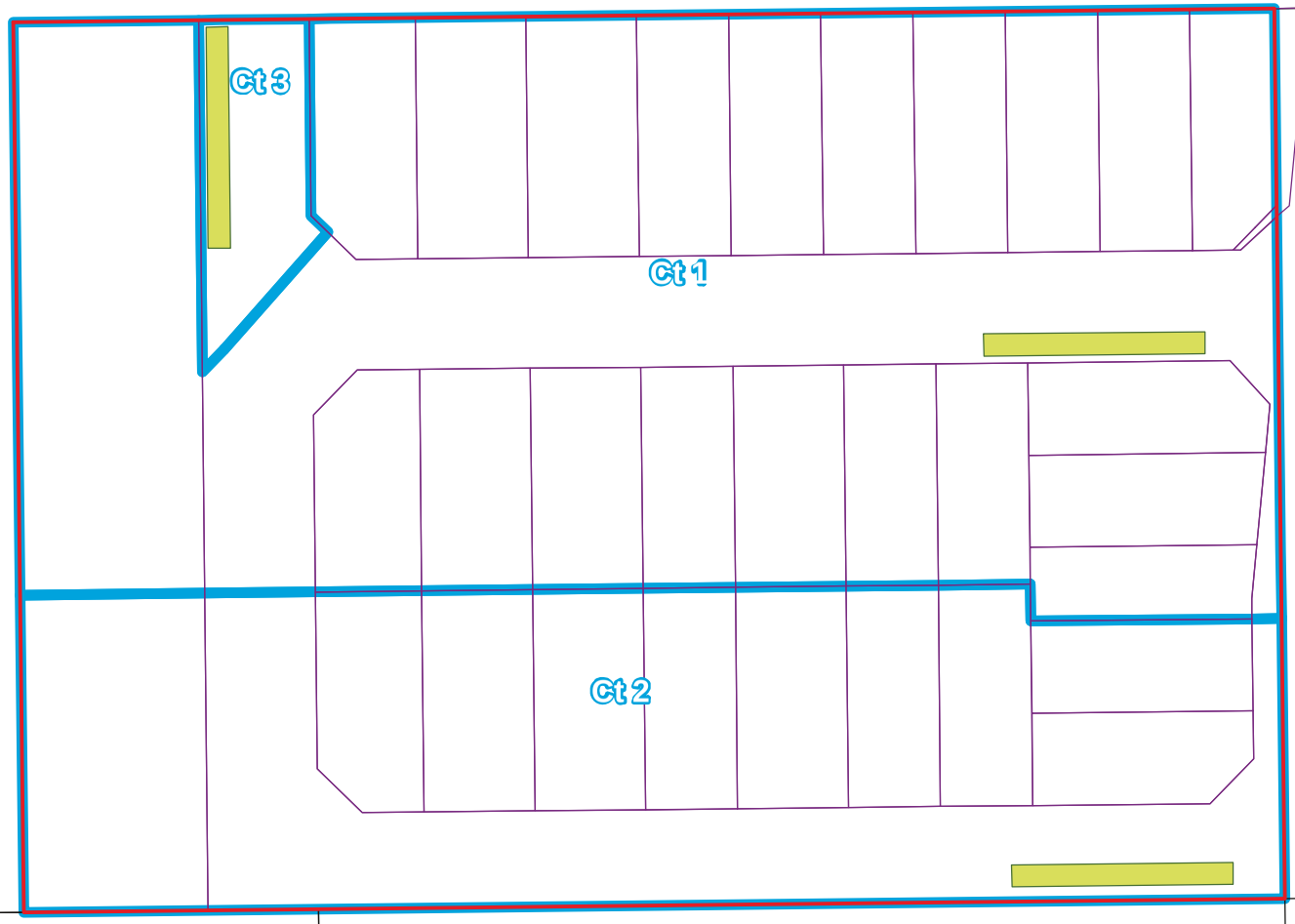

Legend
- Site boundary
- Catchment boundary
- Subsurface storage
- LSP
- Existing cadastral boundaries

Figure 6:	**Stormwater Management Features**	0	**Plan Number: EP15-057(02)--F22b**
Project:	Portion of Lot 16 McDonald Road, Baldivis LWMS		Drawn: KNM Date: 05/09/2016
Client:	Defence Housing Australia		Approved: DPC Date: 05/09/2016
			Checked: ASC Scale: 1:1,000@A4

0 10 20 40 Metres

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APPENDIX A

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STRUCTURE PLAN

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LEGEND

- Subject Site
- **10m wide frontage single house lot** (300m² approx.)
- **12m wide frontage single house lot** (360m² approx.)
- **15m wide frontage single house lot** (450m² approx.)
- Rural / Urban zoning boundary
- Provisional bushfire setback (17m)
- Existing structure to be deleted
- Portion of road to be closed

LOT SIZES

Average	Range
408sqm*	303-490sqm*

* excluding balance lot

Subdivision Concept Plan

16 McDonald Road, Baldivis

Project Manager: AH
Drawn: OP
Checked: AH
Date: 4 August 2016
Scale: 1:1,000 @ A3
Drawing No. 716-059 CP-1 A

TOWN PLANNING
URBAN DESIGN AND HERITAGE

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The Planning Group WA Pty Ltd
ABN 36 097 273 222

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APPENDIX B

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INDICATIVE DRAINAGE AND EARTHWORKS STRATEGY

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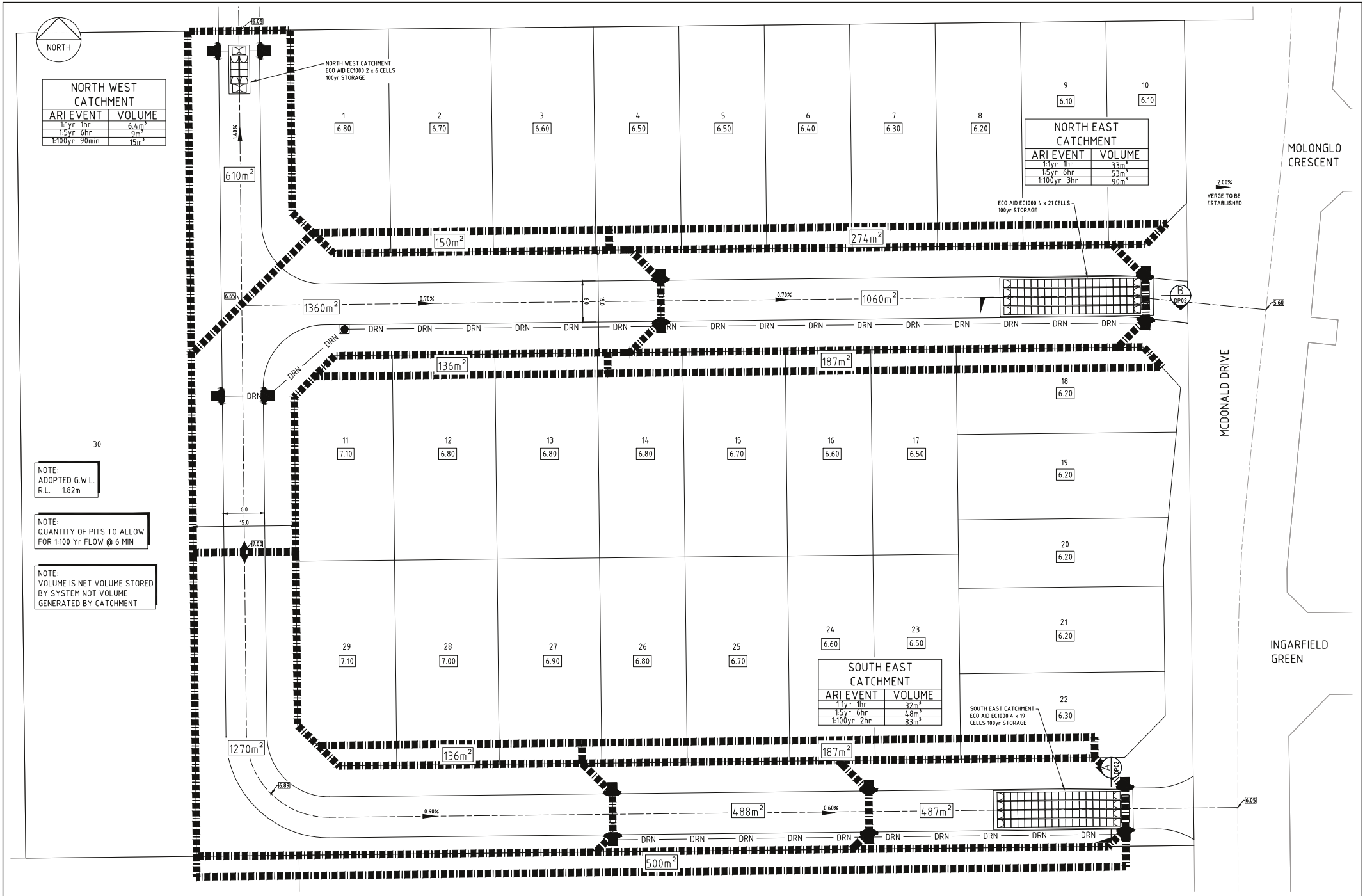

REV	BY	CHKR	DATE	DESCRIPTION
E	RW	AT	07.09.16	CADASTRAL LAYOUT REVISED
D	RW	AT	08.07.16	CATCHMENTS AMENDED/NOTES ADDED
C	RW	AT	29.01.16	CADASTRAL/ROAD LAYOUT REVISED
B	RW	AT	27.01.16	ISSUED FOR LWMS
A	SM	AT	22.01.16	PRELIMINARY ISSUE

CONCEPT ONLY

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admin@pfeng.com.au
ACN. 008 691 094

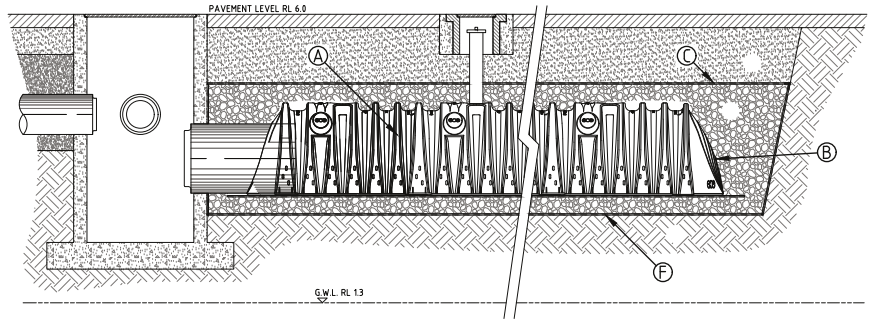
SCALE U.N.O. 5m 0m 5m 10m — 1:250
DATE: JANUARY 2016
DESIGNED: AT
DRAWN: SM
CHECKED: AT
HORIZONTAL COORDINATE SYSTEM: PCG94
VERTICAL COORDINATE SYSTEM: AHD

CLIENT & JOB: DEFENCE HOUSING AUSTRALIA
LOT 16 MCDONALD ROAD, BALDIVIS
TITLE: DRAINAGE CATCHMENT PLAN

SHEET SIZE: A1
DRG No.: 15046-C3-DP-01
REVISION: E

LEVEL RELATIONSHIP

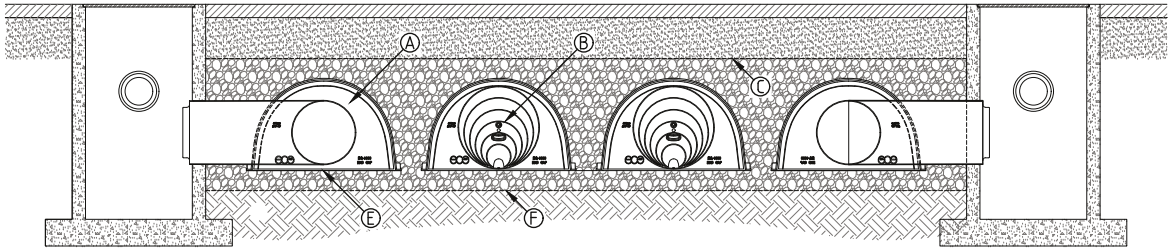
Abs.	Rel.	Δ h
6.00	+1.50	-
5.48	+0.98	0.52
5.33	+0.83	0.15
4.65	+0.15	0.68
4.50	+0.00	0.15
1.30	-3.20	3.20



SECTION A
SCALE NTS
DP01

LEGEND
SUPPLIED SYSTEMS COMPONENTS

A. EC-1000 CHAMBER
B. EC-1000 END CAP
C. BIDIM A24, NON-WOVEN GEOTEXTILE
D. BIDIM A19, NON-WOVEN GEOTEXTILE (-2 WIDE)
E. BONTEC SG40, WOVEN GEOTEXTILE
F. BIDIM A44 NONWOVEN GEOTEXTILE (NEEDLE FREE)



SECTION B
SCALE NTS
DP01

REV	BY	CHKR	DATE	DESCRIPTION
B	RW	AT	29.01.16	DETAIL AMENDED
A	SM	AT	27.01.16	PRELIMINARY ISSUE

CONCEPT ONLY

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ACN. 008 691 094

SCALE U.N.O. 5m 0m 5m 10m
1:250
DATE JANUARY 2016
DESIGNED AT
DRAWN SM
CHECKED AT
HORIZONTAL COORDINATE SYSTEM PCG94
VERTICAL COORDINATE SYSTEM AHD

CLIENT & JOB DEFENCE HOUSING AUSTRALIA
LOT 16 MCDONALD ROAD, BALDIVIS

TITLE DRAINAGE CATCHMENT DATA SHEET

SHEET SIZE A1
DRG No. 15046-C3-DP-02
REVISION B

APPENDIX C

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GEOTECHNICAL REPORT

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APPENDIX D

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EXAMPLE SUBSURFACE STORAGE SPECIFICATION

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EC-1000 CHAMBER SUBGRADE, BEDDING, EMBEDMENT AND COVER REQUIREMENTS

(C) FILL Requirements, ZONE A

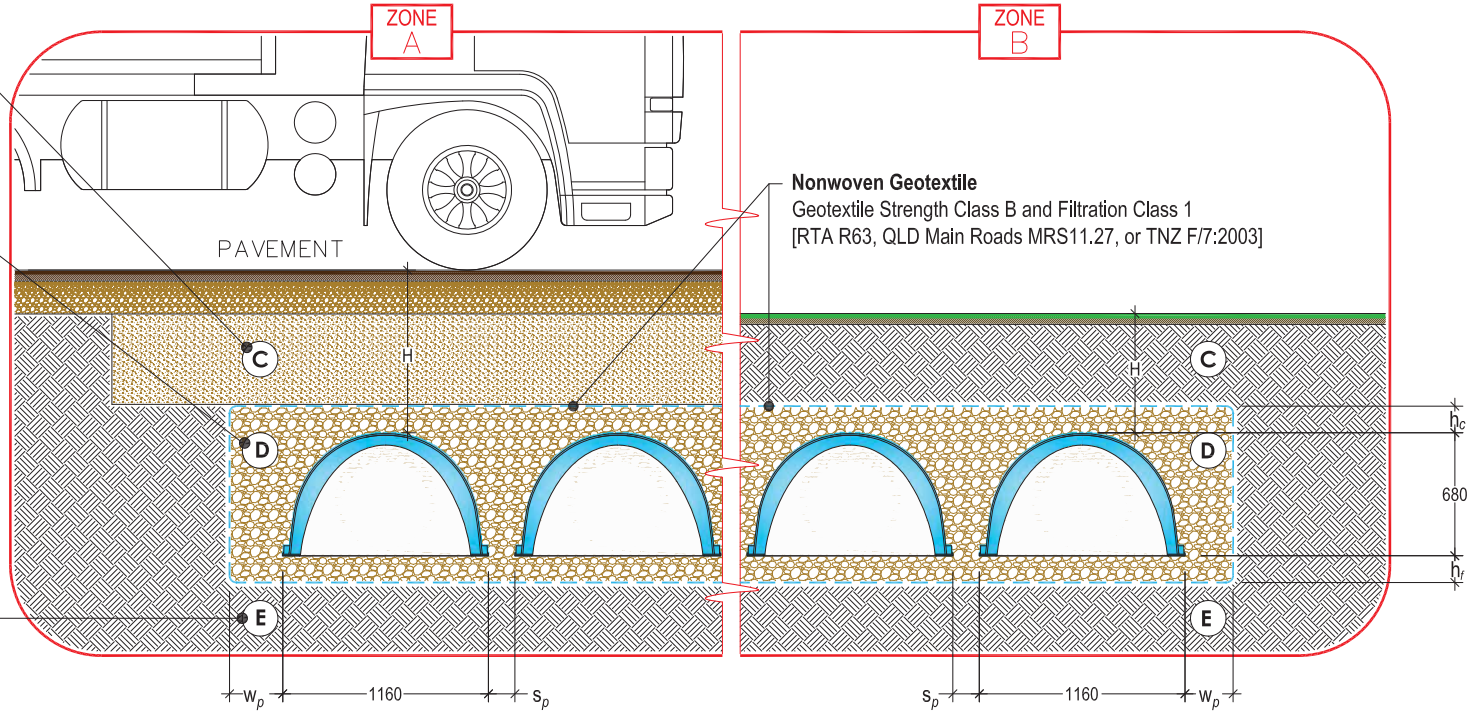
- Granular, well-graded sub-base material, less than 35% fines, compacted in 150mm lifts typically to >95% Standard Proctor Density (eg. Class 1 or 2 crushed rock or RCC).

(D) EMBEDMENT AGGREGATE/ ROCK BACKFILL Requirements, ZONES A and B

- The chamber system foundation layer (h_f), embedment and cover layer (h_c) must be clean, angular rock with a particle size grading between 20 and 50mm. The total fines content must be less than 2% by weight for detention and infiltration applications.
- The rock used shall be fresh to slightly weathered, and from very high to extremely high strength as defined in AS 1726. Rock that is laminated, fractured, physically weak or prone to weathering actions of air and water is unacceptable. Flat slab-like rock pieces, with the breadth or thickness that is less than one third its length should be avoided due to poor interlocking, although up to 30% by weight is acceptable.
- Sub-rounded or rounded rock or aggregate is not acceptable.
- The Wet-Dry Strength Variation (AS 1141.22) of the embedment material must be less than 35%.
- If recycled crushed concrete (RCC) or brick is used, the foreign material content must be less than 5% (less than 2% for Foreign Material Types II and III) according to RTA test method T276. RCC should not be used in applications under pavements / roads, unless the strength and suitability has been confirmed by the Design Engineer.

(E) SUBGRADE Requirements, ZONE A

- The Design Engineer is responsible for checking the required bearing capacity of the subgrade soil. ASTM F2787 is a suitable reference.
- If the subgrade strength is inadequate, then the Design Engineer may increase the foundation layer thickness (h_f), chamber spacing (s_p), and/or include reinforcing geogrids in the bedding layer to meet project specific requirements.



CHAMBER EC-1000	ZONE A - Subject to Vehicle Loading					
	h_c	h_f	w_p	s_p	H	
not in roadway	150	150	300	150	450	2500
in sealed roadway	150	150	300	150	600^	2500
under unsealed roadway	150	150	300	150	750^	2500

ZONE B - Not Subject to Vehicle Loading					
h_c	h_f	w_p	s_p	H	
150	150	300	150	300^^	2500

minimum required values

maximum allowable values

All values are subject to variation by local regulatory authorities, although ecoAID Pty Ltd. is not responsible for any alterations by others to ecoAID's standard details where values lie outside the ranges specified above.

^ EC-1000 chambers have been assessed with factored W80 (AS 5100.2) wheel loads and typical service vehicle loadings with a minimum of 450mm cover soil, however adoption of the AS/NZS 2566.1:1998 Buried Flexible Pipelines - Part 1: Structural Design recommendations (Table 3.1, p14) ensure situations where rutting or consolidation occur over the service life of any road structure are considered.

^^ Consideration must be given to the root zone depth of any trees/ vegetation over the chamber system.

This Spec-Guide accompanies the EC-1000 written System Specification.

Check the ecoAID website for currency of this document

Abbreviations:

h_c - chamber material cover thickness
h_f - chamber material foundation thickness
w_p - trench perimeter width
s_p - chamber spacing
H - total cover height over chambers

All dimensions herein are nominal, and given in millimeters, unless specified otherwise.

STORMWATER MANAGEMENT
www.ecoaid.com.au

ECOLOGICAL ENGINEERING
e: technical@ecoaid.com.au

ecoAID SPEC-GUIDE

EC-1000 Subgrade, Bedding, Embedment and Cover Requirements

Date: 06/03/2012

Drawing No: TNC_001