

**SHIRE OF RAVENSTHORPE**  
**LOCAL PLANNING SCHEME No. 6**

**LOCAL STRUCTURE PLAN**

**SPECIAL USE - SU7**  
**RURAL RESIDENTIAL – RR5**  
**LOT 8 HOPETOUN - RAVENSTHORPE ROAD, HOPETOUN**


**Endorsement**

This structure plan is prepared under the provisions of the Shire of Ravensthorpe  
Local Planning Scheme No. 6.

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

\_\_\_ 10 July 2018 \_\_\_ Date

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

\_\_\_ 11 July 2018 \_\_\_ Date

\_\_\_ 10 July 2028 \_\_\_ Date of Expiry

**Amendments:**

Amendment No.	Summary of Amendment	Amendment Type	Date Approved (WAPC)

## EXECUTIVE SUMMARY

This Local Structure Plan has been prepared to replace the original Subdivision Guide Plan for Lot 8 on the corner of Hopetoun-Ravensthorpe Road and Steerdale Road, Hopetoun.

The purpose of the plan is to provide lots for 'Rural Living and Associated Enterprises' and also for 'Composite Rural Living/Rural Enterprise' Lots with a minimum lot size of one hectare.

The subject land was rezoned from the 'General Agriculture' zone to Rural Conservation zone No. 9 and Special Use zone No. 16 by way of Amendment No. 25 to the Shire of Ravensthorpe's previous Town Planning Scheme No. 5. Final approval to this amendment was granted on 3<sup>rd</sup> February 2016, subject to the preparation of this Structure Plan.

The Shire of Ravensthorpe's Local Planning Scheme No. 6 was gazetted on 11 July 2017. Within Local Planning Scheme No. 6, the subject land is zoned 'Rural Residential (RR5)', 'Special Use (SU7)' and 'Rural'.

Key elements of the plan include:

- Creation of approximately 31 composite rural living/rural enterprise lots of around one hectare in area.
- Creation of approximately 13 rural living and associated enterprise lots ranging in size from 1.0ha to 1.7 ha in area.
- Retention of 'Rural' zoning within which sand mining activities are located.

Table One below summarises the key statistics of the Local Structure Plan.

**Table 1: Local Structure Plan Summary Table:**

Item	Date		Section Number referenced within the Local Structure Plan Report
<b>Total Area of Local Structure Plan</b>	<b>81.085 ha</b>		Part 2 Section 1.1
<b>Land use Proposed</b>	<b>Area</b>	<b>Lot Yield</b>	
Rural Residential RR5	14.7712	13	Part 2 Section 1.1
Special Use SU7	33.8946	31	Part 2 Section 1.1
Rural	27.1242	1	Part 2 Section 1.1
<b>TOTAL</b>	<b>75.79</b>	<b>44</b>	
Estimated Dwellings		44	Part 2 Section 1.1
Estimated Additional Population	110		Part 2 Section 1.1

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BUSHFIRE MANAGEMENT PLAN – BIO DIVERSE SOLUTIONS – MAY 2018

LAND CAPABILITY - GEOTECHNICAL ASSESSMENT – LANDFORM RESEARCH - JUNE 2013

FLORA & VEGETATION ASSESSMENT – LANDFORM RESEARCH - MAY 2013

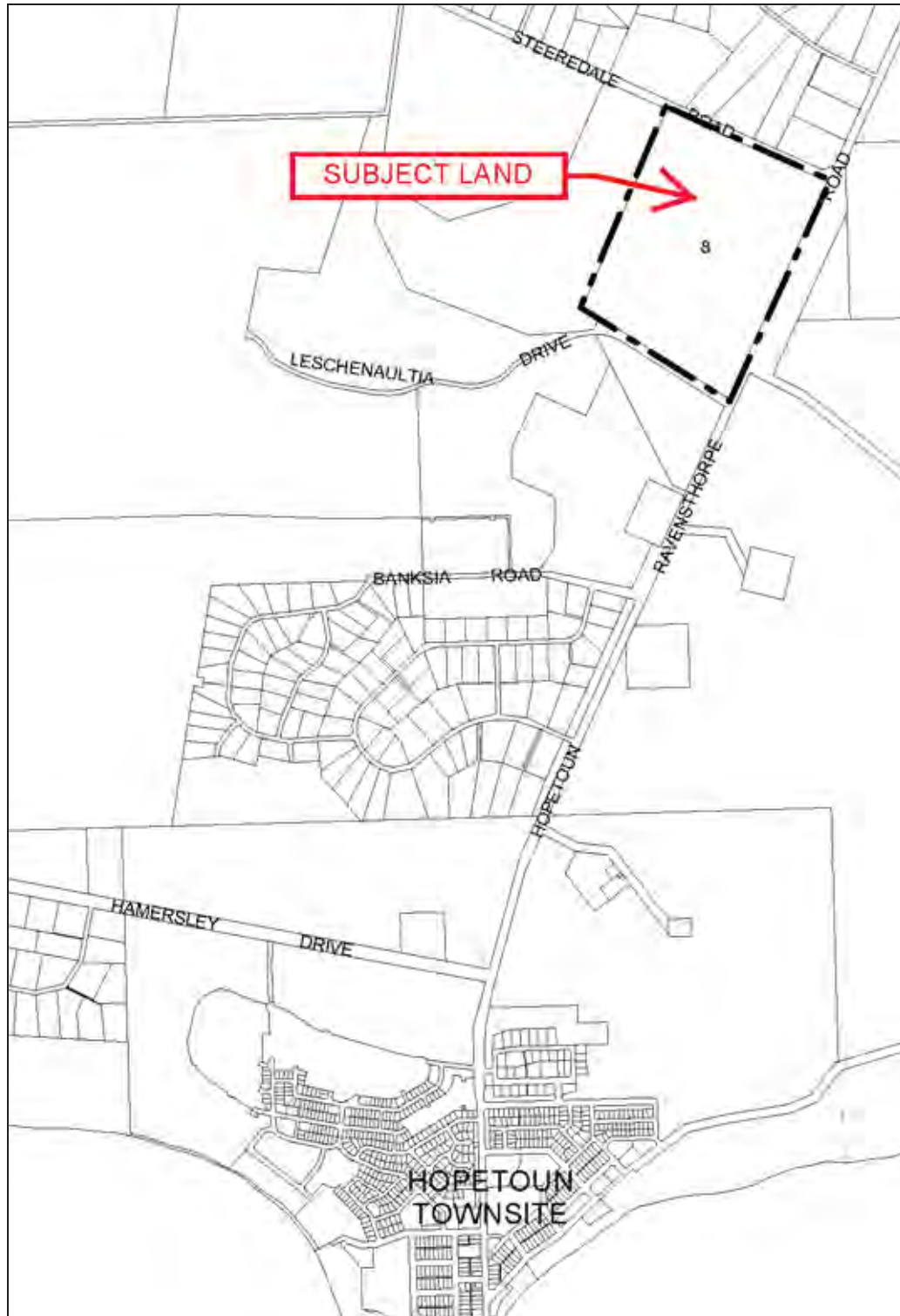
LOCAL WATER MANAGEMENT STRATEGY – LANDFORM RESEARCH - SEPTEMBER 2015

LATE WINTER SOIL TESTING

## PART 1. – STATUTORY

### 1.0 Structure Plan Area

The Structure Plan covers Lot 8 which is located on the south west corner of Steerdale Road and Hopetoun - Ravensthorpe Road, Hopetoun as shown below.



The property is 81.085ha in area and is zoned 'Rural Residential (RR5)', 'Special Use (SU7)' and 'Rural'.

## **2.0 Content of Local Structure Plan**

The Local Structure Plan comprises two parts being:

1. Statutory; Containing the Local Structure Plan Map (Following Page).
2. Explanatory; referring to background information, issues and proposed outcomes.

## **3.0 Relationship to Local Planning Scheme No. 6**

The requirements of the LSP apply as if they were part of the Scheme.

In any conflict between scheme clauses or provisions and the LSP, the provisions or clauses of the scheme shall prevail.

Words and expressions used in the LPS have the same meaning as given in Local Planning Scheme No. 6. Pursuant to clause 27 Schedule 2 Part 4 of the Planning and Development (Local Planning Schemes) Regulations 2015, due regard is to be given to the requirements of the Local Structure Plan in any subdivision and development applications.
















## **4.0 Operation**

The LSP will come into effect following certification by the WA Planning Commission.

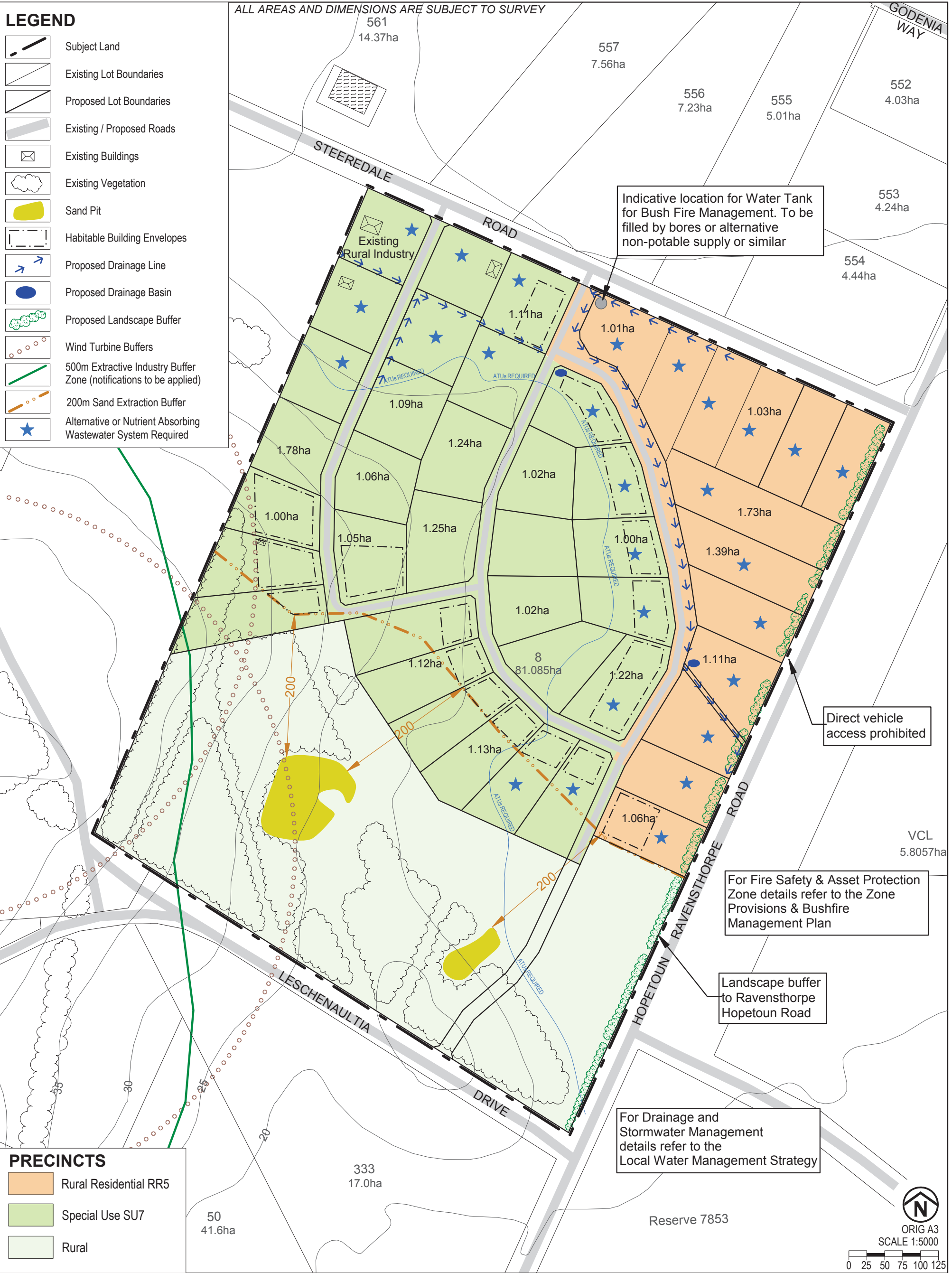
## **5.0 Subdivision and Development Conditions**

In addition to the general clauses of the Scheme and the Special Provisions of Schedule 1 relating to Special Use zone No. 7 and provisions of Schedule 3 relating to Rural Residential zone No. 5, subdivision is to follow that shown on the LSP Map. Minor variations may be approved by the WA Planning Commission.




**LEGEND**

-  Subject Land
-  Existing Lot Boundaries
-  Proposed Lot Boundaries
-  Existing / Proposed Roads
-  Existing Buildings
-  Existing Vegetation
-  Sand Pit
-  Habitable Building Envelopes
-  Proposed Drainage Line
-  Proposed Drainage Basin
-  Proposed Landscape Buffer
-  Wind Turbine Buffers
-  500m Extractive Industry Buffer Zone (notifications to be applied)
-  200m Sand Extraction Buffer
-  Alternative or Nutrient Absorbing Wastewater System Required

ALL AREAS AND DIMENSIONS ARE SUBJECT TO SURVEY



**PRECINCTS**

-  Rural Residential RR5
-  Special Use SU7
-  Rural

**LOCAL STRUCTURE PLAN**  
 Lot 8 Hopetoun Ravensthorpe Road  
 (cnr Steeredale Road) Hopetoun  
 Shire of Ravensthorpe

16-20-L-SP(a)



## **PART 2 – EXPLANATORY**

### **1.0 Planning Background**

#### **1.1 Introduction and Purpose**

This Local Structure Plan has been prepared to replace the original Subdivision Guide Plan for Lot 8 on the corner of Hopetoun-Ravensthorpe Road and Steerdale Road, Hopetoun.

The purpose of the plan is to provide lots for 'Rural Living and Associated Enterprises' and also for 'Composite Rural Living/Rural Enterprise' Lots with a minimum lot size of one hectare.

Thirteen (13) lots with a minimum lot size of one hectare are proposed within the 'Rural Residential (RR5)' zone. Low key business enterprises will be encouraged in order to facilitate employment generation.

Some thirty one (31) lots are proposed in the 'Special Use (SU7)' zone wherein selected Service, Light and Rural Industry, together with an associated Caretakers' dwelling may be considered.

The balance of the property, which contains sand mining activities, is retained in the Rural zone.

The area abuts the Water Corporation's Waste Water Treatment Plant buffer and approval has previously been granted to three rural industries in the north west corner. It is intended that the 'Special Use' zone will act as a buffer to the 'Rural Residential' zone.

The Local Structure Plan outlines the future lot layout, access arrangements, building envelopes, buffers, drainage, landscape buffers, sand extraction areas and effluent disposal requirements. The development has the potential to accommodate up to 44 dwellings and based on 2.5 persons per dwelling, a population of 110 people.

#### **1.2 Land Description**

##### **1.2.1 Location**

The subject land is located approximately 4.5km north of the Hopetoun town centre and is 81.085ha in area and bounded to the north by Steerdale Road, to the south by Leschenaultia Drive and to the east by Hopetoun-Ravensthorpe Road. Access to the property is restricted to Steerdale Road and Leschenaultia Drive.

##### **1.2.2 Site description**

Lot 8 is approximately rectangular in shape. The north east section of the site is relatively flat rising from approximately 18 metres ahd in the north east to 20m at the base of the ridge. The highest point is in the south west of the site and is approximately 45m. A ridge of sand dunes and limestone crosses the south west corner of the site, generally rising to 25 - 40m ahd.

Water from adjoining properties and the road network to the north enters the site and discharges via culverts under the main road towards Dunns Swamp which is 3.5km to the south east. A drainage channel has been constructed within the site to manage peak flows and stormwater runoff from Steeredale Road and the catchment area to the north.

The subject land has been used for the extraction of a number of basic raw materials. A former gravel pit operated in the north west of the site. The area was leased to Readymix and has since been re-contoured and rehabilitated. A small scale sand and soft-rock limestone pit is currently operating from portion of the property. The pit/s are being progressively re-contoured and stabilised in accordance with Licence requirements.

The north west section of the site has been developed as a low key 'Expansive' or 'Dry' rural industrial area. Lease sites have been established and selected businesses have re-located from the smaller sized lots in the Industrial area in town.

Lot 8 in the vicinity of the Water Corporation's WWTP and is adjacent to, but outside the odour buffer. The noise buffers for the wind turbines on the adjoining lot encroach the south west corner of the subject land. The Notification Buffer Zone for the Basic Raw Materials (limestone) extraction pit on Lot 48 also affects a small portion of the south west corner of the subject land.

### **1.2.3 Area and land use**

The adjacent property (former Lot 6832) is zoned Rural Conservation Area 7; it was the subject of Amendment 12 to Town Planning Scheme No.5. Lot 333 to the south of Leschenaultia Drive has subsequently been subdivided into predominantly 1ha Lots. Further to the south is the existing parkland cleared Krystal Park Estate which is zoned Rural Conservation Areas 2 and 5 which have been subdivided and developed for 1- 2ha rural lifestyle lots. The recently endorsed Subdivision Guide Plan for Lot 52 to the west, provides for 1-4ha lots. Culham Inlet is approximately 4km west of the subject land and beyond that to the west is the Fitzgerald National Park.

Pt Location 638 to the south is zoned Special Use zone Area 11 – Caravan Park. Former Lots 2 and 7 to the north are zoned Rural Small Holding 3 and 4 respectively and were the subject of recent Scheme Amendments. The properties are currently used for a range of rural living and broadacre rural purposes.

Lots 10, 11 and 48 to the west and south are zoned General Agriculture. Lot 10 is the site of the Water Corporation's WWTP. Lot 11 contains the recently constructed wind turbines and diesel power generator. Lot 48 contains sand and limestone quarries, associated buildings and a Manager's Residence.

On the opposite side of the Ravensthorpe-Hopetoun Road are various reserves and Unallocated Crown Land which are shown on the Scheme map as Aerial Landing Ground and Recreation. It should be noted that a new, larger air field has been developed approximately 20km to the north to service the mines. The reserves contain areas of remnant vegetation. Lot 61 to the north to the original airstrip is zoned Rural Conservation Area 8.

## **1.3 Planning framework**

### **1.3.1 Zoning and reservations**

The subject land is zoned 'Rural Residential (RR5)', 'Special Use (SU7)' and 'Rural'.

Scheme provisions which have been incorporated into Local Planning Scheme No. 6 include measures regarding:

- Minimum lots sizes and layout.
- Permissible uses.
- Building design, materials and setbacks.
- Service arrangements.
- Bushfire management controls.
- Vegetation protection.

### **1.3.2 Local Planning Strategy**

The Local Planning Strategy (LPS) identifies the subject land as a Rural Living Development Area within the confines of groundwater protection, capability and servicing considerations.

The LPS identifies Lot 8 as a 'Composite Zone' whereby consideration should be given to the establishment of a composite residential/light industrial zone to allow for home business operation, which will complement recent approvals in the precinct.

## 2.0 Site Conditions and Constraints

### 2.1 Biodiversity and natural area assets

### 2.2 Landform and soils

A comprehensive land capability and environmental assessment was conducted in February 2007 by Landform Research. Site investigations, including soil testing and a vegetation study were carried out. The geology, hydrology and salinity were mapped. The Land Capability – Geotechnical Assessment, dated June 2013, describes the existing environmental and general characteristics of the site and is attached. A Local Water Management Strategy for Lot 8 and a Flora and Vegetation Assessment are also attached. The main findings and recommendations contained in these documents have been used to inform the preparation of the Structure Plan.

Key findings are as follows:

- The soils across the western two thirds of the site are deep yellow sand over earthly yellow sand. Under the highest portion of the site the sands overlay limestone and limestone pinnacles, and on the central northern edge of the site, the sand overlies laterite gravel on top of the junction with underlying silts, loams and loam clays.
- On the low elevations adjacent to the Hopetoun-Ravensthorpe Road in the east, the sands overlies alluvial silts, sands, loams and loam clays.
- The soils have high phosphate retention and nutrient management capability. Conventional leach drains are acceptable in most locations. Any deficiencies in local nutrient management can be overcome by use of nutrient absorbing waste water disposal systems.
- The water table in the area is several metres below the lowest land elevation and presents no significant issue for waste water disposal.
- Large storm flows from land to the north of the subject land affect Lot 8 and are accommodated by a drain which directs them in a south easterly direction across the property and under the Hopetoun Ravensthorpe Road and ultimately to Dunn's Swamp to the south east.
- The Local Water Management Strategy addresses the issue of storm water management in more detail.
- The deep sands have high levels of foundation stability and construction capability and are clarified as High C Site Class A with potentially some locations at S, AS 2870.
- The foundation stability of the sand over Sandy Clay depends on the thickness of the overlying sand sheet. On locations where the sand sheet is in excess of 1 to 2 metres, the foundation stability is classified as generally High (Site Class S-M, AS 2870).
- Where the depth of sand is thin, such areas may have a Moderate foundation stability (Site Class M with some areas potentially H, AS 2870).
- The property is highly suitable for the construction of roads.
- There is no evidence of actual or potential Acid Sulfate.
- The subdivision had been designed in sympathy with the soil and land capability, landform, remnant vegetation and drainage regime.

### 2.3 Stormwater/Drainage

Stormwater runoff will be retained and disposed of onsite wherever possible in accordance with water sensitive design principles.

A Local Water Management Strategy (LWMS) has been prepared by Landform Research and is attached.

Key elements of the Strategy include:

- Stormwater Management for dwellings: It is proposed that rainwater tanks and soak wells will be used to retain stormwater from the one hour 1 in 1 year event. Excess water from rainfall events greater than this will flow onto the ground for broad area infiltration. The large lot sizes (minimum 1ha) and the permeable deep sand soils or sand over sandy clay duplex soils provide sufficient area and depth for infiltration.
- Road drainage: 1 in 1 year one hour stormwater events will be retained within swale drains along all roads which will be capable of retaining up to 1 in 5 one hour events.
- Stormwater in excess of the 1 hour 1 year return event will be directed to infiltration basins and the central drain across Lot 8. With large lots (minimum 1ha) there is ample room for infiltration basins.
- The size of the swale drains and detention basins will be refined during the detailed engineering design phase at the subdivision stage of development.

#### **2.4 Bushfire hazard**

A Bushfire Management Plan is attached which addresses the Western Australian Planning Commission's State Planning Policy 3.7: *Planning in Bushfire Prone Areas (SPP 3.7)* and *Guidelines for Planning in Bushfire Prone Areas*.

The requirements set out in the Shire of Ravensthorpe Annual Fire Regulation Notice address Firebreaks and Building Protection Zone around residential buildings. The combination of these requirements, supplemented by special provisions applicable within the zone, afford the necessary fire safety and risk mitigation measures.

#### **2.5 Vegetation**

A vegetation assessment of Lot 8 has been carried out by Landform Research and is attached.

Key Findings from the report include:

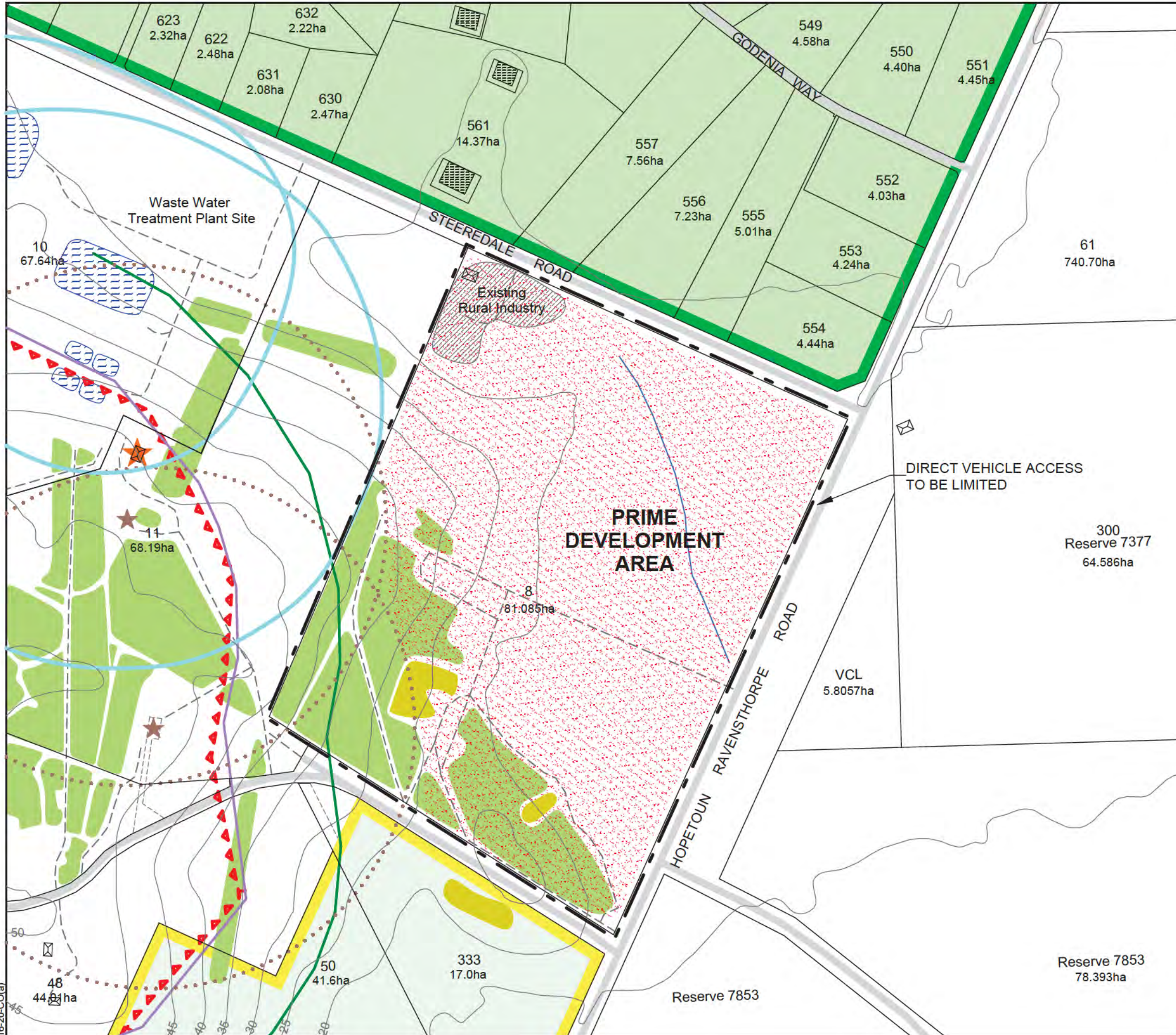
- Approximately 20% of Lot 8 is covered in vegetation which is in Good or better condition. The balance of the property consists of pasture or degraded remnant vegetation.
- No threatened (Declared Rare), Priority species or Significant flora, or Threatened or Priority Communities/Complexes were recorded from the proposed excavation area.
- The vegetation is well represents and being coastal is generally not under significant threat apart from clearing at development nodes such as Hopetoun.
- Suggested management actions include:
  - Retain remnant vegetation in as large an area as possible, with larger lots allocated to those areas.
  - Locate roads and buildings envelopes in already cleared or disturbed where possible. Use bollards/poles to mark Lot boundaries in vegetated areas in order to minimise clearing.
  - Avoid locating fire breaks through vegetation where possible.
  - Use weed and dieback management techniques where vegetation has to be cleared and/or during construction.

#### **2.6 Context and other land use constraints and opportunities**

The site characteristics are reflected on the Constraints and Opportunities Plan overleaf.

# CONSTRAINTS AND OPPORTUNITIES

## Lot 8 Hopetoun Ravensthorpe Road (cnr Steeredale Road) Hopetoun, Shire of Ravensthorpe



**LEGEND**

- Subject Land
- Easements
- Existing Buildings
- Dam
- Existing Drainage Line
- Existing Roads
- Tracks
- Vegetation
- Sand Pit
- Rural Small Holding Zone
- Rural Conservation Zone
- Existing Rural/Dry Industry Leases
- Prime Development Site
- SCA-Basic Raw Material Protection Area
- Extractive Industry Buffer Proposed Special Control Area 500m Buffer zone (notifications to be applied)
- Diesel Power Generator Plant
- Wind Turbine
- Wind Turbine Buffers
- Wastewater Treatment Plant & Buffer
- Wastewater Treatment Plant Pond

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 SCALE 1:7500  
 0 50 100 150 200 250

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**Lot 8 Steeredale Road,  
Hopetoun WA 6348**

# Bushfire Management Plan



28/5/2018

Kathryn Kinnear

Bio Diverse Solutions

## DOCUMENT CONTROL

### TITLE

Title: Bushfire Management Plan – Lot 8 Steeredale Rd, Hopetoun WA 6348

Author (s): Kathryn Kinnear

Reviewer (s): Nick Ayton/Bert Quayle

Job No.: AB 006

Client: Morray King

### REVISION RECORD

Revision	Summary	Revised By	Date
Draft Id 28/08/2017	Internal QA Review	Chiquita Burgess	28/08/2017
Draft Id 28/08/2017	Issued to client for review	K.Kinnear	28/08/2017
Final Id 30/08/2017	Updates as per client review. Submitted to client as final	K. Kinnear	30/08/2017
Final Id 14/12/2017	Updated as per DFES comments	K.Kinnear	14/12/2017
Final Id 28/5/2018	Updated as per WAPC Schedule of modifications	K.Kinnear	28/5/2018

*The recommendations and measures contained in this assessment report are based on the requirements of the Australian Standards 3959 – Building in Bushfire Prone Areas, WAPC SPP3.7, Guidelines for Planning in Bushfire Prone Areas (WAPC, 2017) and CSIRO’s research into Bushfire behaviour. These are considered the minimum standards required to balance the protection of the proposed dwelling and occupants with the aesthetic and environmental conditions required by local, state and federal government authorities. They DO NOT guarantee that a building will not be destroyed or damaged by a bushfire. All surveys and forecasts, projections and recommendations made in this assessment report and associated with this proposed dwelling are made in good faith on the basis of the information available to the fire protection consultant at the time of assessment. The achievement of the level of implementation of fire precautions will depend amongst other things on actions of the landowner or occupiers of the land, over which the fire protection consultant has no control. Notwithstanding anything contained within, the fire consultant/s or local government authority will not, except as the law may require, be liable for any loss or other consequences (whether or not due to negligence of the fire consultant/s and the local government authority, their servants or agents) arising out of the services rendered by the fire consultant/s or local government authority.*



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Figure 7: Access Plan

## **APPENDICES**

Appendix A: Local Structure Plan (Aytou Baesjou)

## 1. Executive Summary

Murray King (Client) commissioned Bio Diverse Solutions (Bushfire Consultants) to conduct a bushfire hazard assessment and prepare a Bushfire Management Plan to guide all future bushfire management for a Structure Plan and subsequent proposed subdivision of Lot 8 Steeredale Road, Hopetoun WA.

The proposed Local Structure Plan for the Subject Site consists of 13 Rural Conservation (Rural Living and Associated Enterprise) lots ranging in size from 1.0ha to 1.4ha and 31 Special Use 16 (Composite Rural Living and Rural Enterprise) lots ranging in size from 1.0ha to 1.8ha. A road network connecting the lots to Steeredale Road is also proposed as part of subdivision works. The south-western portion of the site will not be developed and will remain as a sand mine surrounded by remnant vegetation.

The subject site was assessed as having internal areas of Grassland Type G consistent with rural farmland and Shrubland Type C and Scrub Type D consistent with remnant vegetation and coastal heath in the area. BAL contouring across the Subject Site has allocated BAL 29 or less shall apply to any proposed buildings on the lots. BAL 12.5 can be achieved on any internal grassland/shrubland areas through a minimum of a 20-22m APZ area around individual buildings. All future buildings can achieve an APZ area associated with a BAL allocation of BAL 29 or less meeting Acceptable Solutions.

The Local Structure Plan shows two exit/entry points via public roads onto Steeredale Road to the north and Leschenaultia Drive to the south. This provides two alternative access points to alternative directions as required by the guidelines. All other public roads conform to the minimum standards as required by the Acceptable Solutions.

Strategic water will be supplied with a Shire vested supply (tank) in the north of the subdivision as demonstrated in the Structure Plan. An existing bore is located on the balance of land to the south (the property within the area being mined for sand). The land owner confirms there is a good supply of water available and the environmental assessment done by Landform Research also confirmed there is an underground water supply.

An assessment to the WAPC Guidelines for Planning in Bushfire Prone Areas (vers 1.1, 2017) Acceptable Solutions of the 4 bushfire protection criteria is summarised over the page in Table 1.

**Table 1: Bushfire protection criteria applicable to the site**

Element	Acceptable Solution	Applicable or not Yes/No	Meets Acceptable Solution
Element 1 – Location	A1.1 Development Location	Yes	Compliant BAL 29 or less applied to lots
Element 2 – Siting and Design	A2.1 Asset Protection Zone	Yes	Compliant, APZ in BAL 29 or less
Element 3 – Vehicular Access	A3.1 Two Access Routes	Yes	Compliant two access points to 2 destinations
	A3.2 Public Road	Yes	Compliant
	A3.3 Cul-de-sacs	No	N/A
	A3.4 Battle axes	No	N/A
	A3.5 Private driveways	Yes	Compliant
	A3.6 Emergency Access Ways	No	N/A, public road network used
	A3.7 Fire Service Access Ways	No	N/A, public road network used
	A3.8 Firebreaks	Yes	Compliant on parent lot, applicable to future lots
Element 4 – Water	A4.1 Reticulated areas	N/A	N/A
	A4.2 Non-reticulated areas	Yes	Compliant
	A4.3 Individual lots in non-reticulated areas	N/A	N/A

## 2. Introduction

Murray King (Client) commissioned Bio Diverse Solutions (Bushfire Consultants) to prepare a Bushfire Management Plan (BMP) to guide all future bushfire management for a Local Structure Plan and subsequent proposed subdivision of Lot 8 Steeredale Road, Hopetoun WA.

This BMP has been prepared to assess the subject site to the current and endorsed Guidelines for Planning in Bushfire Prone Areas Vers 1.2 (WAPC, 2017) and State Planning Policy 3.7 (WAPC, 2015).

Such planning takes into consideration standards and requirements specified in various documents such as Australian Standard (AS3959-2009), Western Australian Planning Commission (WAPC) Guidelines for Planning in Bushfire Prone Areas Vers 1.2 (WAPC, 2017) and State Planning Policy 3.7 (WAPC, 2015). These policies, plans and guidelines have been developed by WAPC to ensure uniformity to planning in designated “Bushfire Prone Areas” and consideration of the relevant bushfire hazards when identifying or investigating land for future development.

### 2.1. Location

Lot 8 Steeredale Road, Hopetoun WA (herein referred to as the Subject Site) is 81.1ha and located approximately 4km north of the Hopetoun township. The Subject Site is bound by Steeredale Road to the north, Hopetoun Ravenshorpe Road to the east, Leschenaultia Drive to the south and a private rural property to the west. The location of the Subject Site is shown on Figure 1.



Figure 1: Location Plan

## 2.2. Development Proposal

The proposed Structure Plan (SP) for the Subject Site consists of 13 Rural Conservation (Rural Living and Associated Enterprise) lots ranging in size from 1.0ha to 1.4ha and 31 Special Use 16 (Composite Rural Living and Rural Enterprise) lots ranging in size from 1.0ha to 1.8ha. A road network connecting the lots to Steeredale Road is also proposed as part of subdivision works. The south-western portion of the site will not be developed and will remain as a sand mind surrounded by remnant vegetation. The SP (Ayton Baesjou) has been included as Appendix A.

## 2.3. Statutory Framework

This document and the recommendations contained within are aligned to the following policy and guidelines:

- *Planning and Development Act 2005;*
- *Planning and Development Regulations 2009;*
- *Planning and Development (Local Planning Scheme) Regulations 2015;*
- State Planning Policy 3.7 Planning in Bushfire Prone Areas;
- Guidelines for Planning in Bushfire Prone Areas;
- *Building Act 2011;*
- *Building Regulations 2012;*
- Building code of Australia (National Construction Code);
- *Fire and Emergency Services Act 1998.*
- AS 3959-2009 "Construction of Buildings in Bushfire Prone Areas" current and endorsed standards;
- *Bushfires Act 1954;* and
- Shire of Ravensthorpe Annual Fire Regulation Notice.

The publicly released Bushfire Prone Area Mapping (DFES, 2017) shows that approximately half of the Subject Site is located within a Bushfire Prone Area (situated within 100m of >1 ha of bushfire prone vegetation). Bushfire Prone Area Mapping is shown on Figure 2.



**Figure 2: Bushfire Prone Area Mapping**

## **2.4. Suitably Qualified Bushfire Consultant**

This BMP has been prepared by Kathryn Kinnear (nee White), who has 10 years operational fire experience with the (formerly) DEC (1995-2005) and has the following accreditation in bushfire management:

- Incident Control Systems;
- Operations Officer;
- Prescribed Burning Operations;
- Fire and Incident Operations;
- Wildfire Suppression 1, 2 & 3;
- Structural Modules – Hydrants and hoses, Introduction to Structural Fires, and Fire extinguishers; and
- Ground Controller.

Kathryn Kinnear currently has the following tertiary Qualifications:

- BAS Technology Studies & Environmental Management;
- Diploma Business Studies; and
- Graduate Diploma in Environmental Management.

Kathryn Kinnear is an accredited Level 2 Bushfire Practitioner (Accreditation No: BPAD30794). Bio Diverse Solutions are Silver Corporate Members of the Fire Protection Australia Association and Kathryn is a suitably qualified Bushfire Practitioner to prepare this Bushfire Management Plan.

### 3. Objectives

The objectives of this BMP are to assess the bushfire risks associated with the existing site and the proposed SP to reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property and the environment. It also aims to guide the SP design by assessing the proposed subdivision according to the Bushfire Protection Criteria Acceptable Solutions as outlined in the Guidelines for Planning in Bushfire Prone Areas Vers 1.1 (WAPC, 2017).

The BMP aims to:

- Achieve consistency with objectives and policy measures of SPP 3.7 (WAPC, 2015);
- Assess any building requirements to AS3959-2009 (current and endorsed standards) and BAL Construction;
- Assess the SP proposal against the Bushfire Protection Criteria Acceptable Solutions as outlined in the Guidelines for Planning in Bushfire Prone Areas (WAPC, 2017);
- Understand and document the extent of the bushfire risk to the Subject Site;
- Prepare bushfire risk management measures for bushfire management of all land within the Subject Site with due regard to people, property, infrastructure and the environment;
- Nominate individuals and organisations responsible for fire management and associated works within the Subject Site; and
- Ensure alignment to the recommended assessment procedure which evaluates the effectiveness and impact of proposed, as well as existing, bushfire risk management measures and strategies.

## 4. Spatial consideration of bushfire threat

A site inspection was conducted on the 13<sup>th</sup> May 2016 by Kathryn Kinnear to assess the current land use, topography/slope, vegetation and conditions of the site and its surroundings. Photographs of the Subject Site and surrounding areas were taken and have been presented in this report.

### 4.1. Land use

The Subject Site consists predominately of cleared rural land in the north-eastern portion of the Subject Site used for cropping and livestock and remnant vegetation (predominantly shrubland and scrub) in the south-western portion of the site. There is an old sand mine in the southern-central portion of the site which is not currently in operation and instead utilised as a used car and scrap metal dumping ground, there is also an area further north of the mine used to dump old farm machinery and store a sea container. There are two sheds in the north of the site adjacent to Steeredale Road used for light industrial activities. Land use on the Subject Site is shown on Photographs 1 to 4.



**Photograph 1** – View from the west looking northeast into Subject Site



**Photograph 2** – View from the east looking west into Subject Site



**Photograph 3** – View of shed within Subject Site used for light industry. View to the southwest from Steeredale Road.



**Photograph 4** – View of old farm machinery and a sea container in the centre of the Subject Site.



## 4.2. Surrounding land uses

The Subject Site is surrounded by cleared rural land to the north and south and remnant vegetation (predominantly shrubland and scrub) to the east and west. The surrounding areas are shown on Photographs 5 to 8.



**Photograph 5** – View to the east of Steeredale Road.



**Photograph 6** – View of private property to the north of Steeredale Road.



**Photograph 7** – View of remnant vegetation to the east of Subject Site.



**Photograph 8** – View of cleared rural land to the north.

## 4.3. Topography

The Subject Site generally slopes gradually from south-west to north-east, from a high point of 45m AHD at the south-western corner of the site to a low point of 20m AHD at the north-eastern corner of the site. Topographic contours (5 metre contours) are shown on Figure 2.

The effective slopes (measured as per AS3959-2009) for the Subject Site are relatively low across the site ranging from flat to 2 degrees. Topography is significantly steeper on the western portion of the site with the eastern portion being relatively flat and low lying.

#### 4.4. Bushfire fuels – Vegetation




The subject site lies within the Esperance Plains IBRA bioregion. Hearn et al (2002) describes the bioregion as; *'myrtaceous and proteaceous scrub and Mallee heaths on sandplain overlying Eocene sediments; rich in endemics. Herbfields and heaths (rich in endemics) on abrupt granite tors and quartzite ranges that rise from the plain. Eucalypt woodlands occur in gullies and alluvial foot-slopes.'*




The vegetation has been mapped on a broad scale by J.S. Beard (Shepherd et al 2002) in the 1970's, where a system was devised for state-wide mapping and vegetation classification based on geographic, geological, soil, climate structure, life form and vegetation characteristics (Sandiford and Barrett 2010). A GIS search of J.S. Beards (DEC, 2005) vegetation classification places the Subject Site within one System and Vegetation Association (DEC Pre-European Vegetation GIS dataset, 2005):



- **System Association Name:** Esperance
- **Vegetation Association Number:** 47
- **Vegetation Description:** Shrublands; Tallerack Mallee Heath

The vegetation across the Subject Site and surrounding areas is consistent with rural farmland in the area, with the eastern and northern portion of the site and surrounds comprising of grazed pasture dominated by pasture grass species. The western and southern portion of the site comprises of remnant vegetation consistent with the area; low coastal heath and shrubland/scrub comprising of acacias, banksias and occasional Mallee trees.

All vegetation within 100m of the Subject Site was classified in accordance with Clause 2.3 and Exclusions as per Clause 2.2.3.2 of AS 3959-2009. Field inspection was carried out prior to the Guidelines for Planning in Bushfire Prone Areas update to Version 1.2 (August 2017) whereby the guideline change states vegetation should be assessed to 150m of the Subject Site. Each distinguishable vegetation plot with the potential to determine the Bushfire Attack Level is identified over the page. Each plot is representative of the Vegetation Classification to AS3959-2009 Table 2.3 and shown on the Vegetation Classification Mapping (Figure 3).

Plot	1	Classification or Exclusion Clause	Shrubland Type C
	<p><b>Location:</b> Internal to site in the north-western portion of Subject Site.</p> <p><b>Separation distance:</b> 0m. Internal to site.</p> <p><b>Dominant species &amp; description:</b> Continuous vegetative structure consisting of <i>Acacias</i> and native shrubs with the occasional <i>Banksia</i> and Christmas tree &gt;3m. Low coastal heath.</p> <p><b>Average vegetation height:</b> 2m.</p> <p><b>Vegetation Coverage:</b> &gt;30 %.</p> <p><b>Available fuel loading:</b> 15t/ha.</p> <p><b>Effective slope:</b> Downslope &gt;0 to 5 degrees.</p>		
<p>Photo Id 1: View looking north-east across Shrubland Type C in Plot 1.</p>			
Plot	2	Classification or Exclusion Clause	Scrub Type D
	<p><b>Location.</b> Internal to site in the south-western corner of site extending to adjacent private property to the south-west.</p> <p><b>Separation distance:</b> 0m. Internal to site.</p> <p><b>Dominant species &amp; description:</b> Closed scrub consisting of <i>Banksia</i>, <i>Acacia</i> and occasional <i>Mallee</i>.</p> <p><b>Average vegetation height:</b> 2-4m.</p> <p><b>Vegetation Coverage:</b> &gt;30 %.</p> <p><b>Available fuel loading:</b> 15 – 25t/ha.</p> <p><b>Effective slope:</b> Upslope.</p>		
<p>Photo Id 2: View looking south-west from Subject Site towards wind turbine.</p>			
Plot	3	Classification or Exclusion Clause	Shrubland Type C
	<p><b>Location:</b> Located between lot boundary and western extent of assessment zone in adjacent private property.</p> <p><b>Separation distance:</b> 0m.</p> <p><b>Dominant species &amp; description:</b> Continuous vegetative structure consisting of <i>Acacias</i> and native shrubs with the occasional <i>Banksia</i> and <i>Melaleuca</i> (&lt;2m). Occasional Christmas tree (approx. 3m).</p> <p><b>Average vegetation height:</b> 2m.</p> <p><b>Vegetation Coverage:</b> &gt;30%.</p> <p><b>Available fuel loading:</b> 15t/ha.</p> <p><b>Effective slope:</b> Upslope.</p>		
<p>Photo Id 3: View looking east from western boundary of assessment zone down slope to Subject Site.</p>			

Plot		Classification or Exclusion Clause	
4			<b>Grasslands Type G</b>
		<p><b>Location:</b> Situated between the southern extent of the assessment zone and Leschenaultia Drive.</p> <p><b>Separation distance:</b> 30m.</p> <p><b>Dominant species &amp; description:</b> Patchy pasture grasses, occasional <i>Banksia</i> and W.A. Christmas tree.</p> <p><b>Average vegetation height:</b> 100-300mm.</p> <p><b>Vegetation Coverage:</b> 90%.</p> <p><b>Available fuel loading:</b> 4.5t/ha.</p> <p><b>Effective slope:</b> Downslope &gt;0 to 5 degrees.</p>	
<p>Photo Id 4: View looking southeast along Leschenaultia Drive.</p>			
5			<b>Shrubland Type C</b>
		<p><b>Location:</b> Internal to Subject Site in the southern corner.</p> <p><b>Separation distance:</b> 0m.</p> <p><b>Dominant species &amp; description:</b> Predominately <i>Banksia</i> scrub with the occasional <i>Eucalypt</i>.</p> <p><b>Average vegetation height:</b> 2m.</p> <p><b>Vegetation Coverage:</b> 30%.</p> <p><b>Available fuel loading:</b> 15t/ha.</p> <p><b>Effective slope:</b> Upslope.</p>	
<p>Photo Id 5: View looking north east across to the Hopetoun / Ravensthorpe Road</p>			
6			<b>Grasslands Type G</b>
		<p><b>Location:</b> Internal to the site in the northern and eastern portion, as well as to the north of the Subject Site adjacent to Steeredale Road.</p> <p><b>Separation distance:</b> 0m. Adjacent and internal to site.</p> <p><b>Dominant species &amp; description:</b> Numerous pasture grasses.</p> <p><b>Average vegetation height:</b> 0.75m.</p> <p><b>Vegetation Coverage:</b> 100%.</p> <p><b>Available fuel loading:</b> 4.5t/ha.</p> <p><b>Effective slope:</b> Downslope&lt;0 to 5 degrees.</p>	
<p>Photo Id 6: Photo 6 view looking west across to Plot 2 from within eastern boundary of lot.</p>			

Plot	7	Classification or Exclusion Clause	Shrubland Type C
			<p><b>Location:</b> Situated between the Hopetoun-Ravensthorpe Road and the eastern boundary of the assessment zone.</p> <p><b>Separation distance:</b> 25m.</p> <p><b>Dominant species &amp; description:</b> <i>Grevillea</i>, <i>Acacias</i> and low shrubs (1.2m) under occasional <i>Mallee</i> and <i>Banksia</i>.</p> <p><b>Average vegetation height:</b> 1.2 – 2m.</p> <p><b>Vegetation Coverage:</b> &lt;30%.</p> <p><b>Available fuel loading:</b> 15t/ha.</p> <p><b>Effective slope:</b> Downslope &lt;0 to 5 degrees.</p>
<p><i>Photo 1d 7: View looking east across shrubland from Hopetoun-Ravensthorpe Road.</i></p>			
Plot	8	Classification or Exclusion Clause	Low fuel or non-vegetated areas 2.2.3.2 (e)
			<p><b>Location:</b> Located in the northern corner of the Subject Site and three small areas in the south-western portion of the site.</p> <p>Includes the light industry commercial buildings and hardstands in the north.</p> <p>Includes the sand mine activities in the south-west.</p> <p>Includes Ravensthorpe-Hopetoun Road, Leschenaultia Drive, wind farm access and Steeredale Road.</p> <p><b>Separation distance:</b> 0m.</p>
<p><i>Photo 1d 8: View of light industry sheds on northern boundary of lot along Steeredale Road.</i></p>			

Comments on Vegetation Classification:

- Distances from vegetation were made based on surface fuels to edge of lot (subject site) boundary;
- Effective slopes were measured in the field using a Nikon Forestry Pro and represented on the respective plots;
- Method 1 (AS3959-2009) Simplified procedure was used for vegetation classification;
- All vegetation was classified within the subject site and within 100m of the subject site lot boundaries to AS3959 Table 2.3; and
- The perimeter of the vegetation noted in the field was measured using field GPS and notations on field GIS maps.

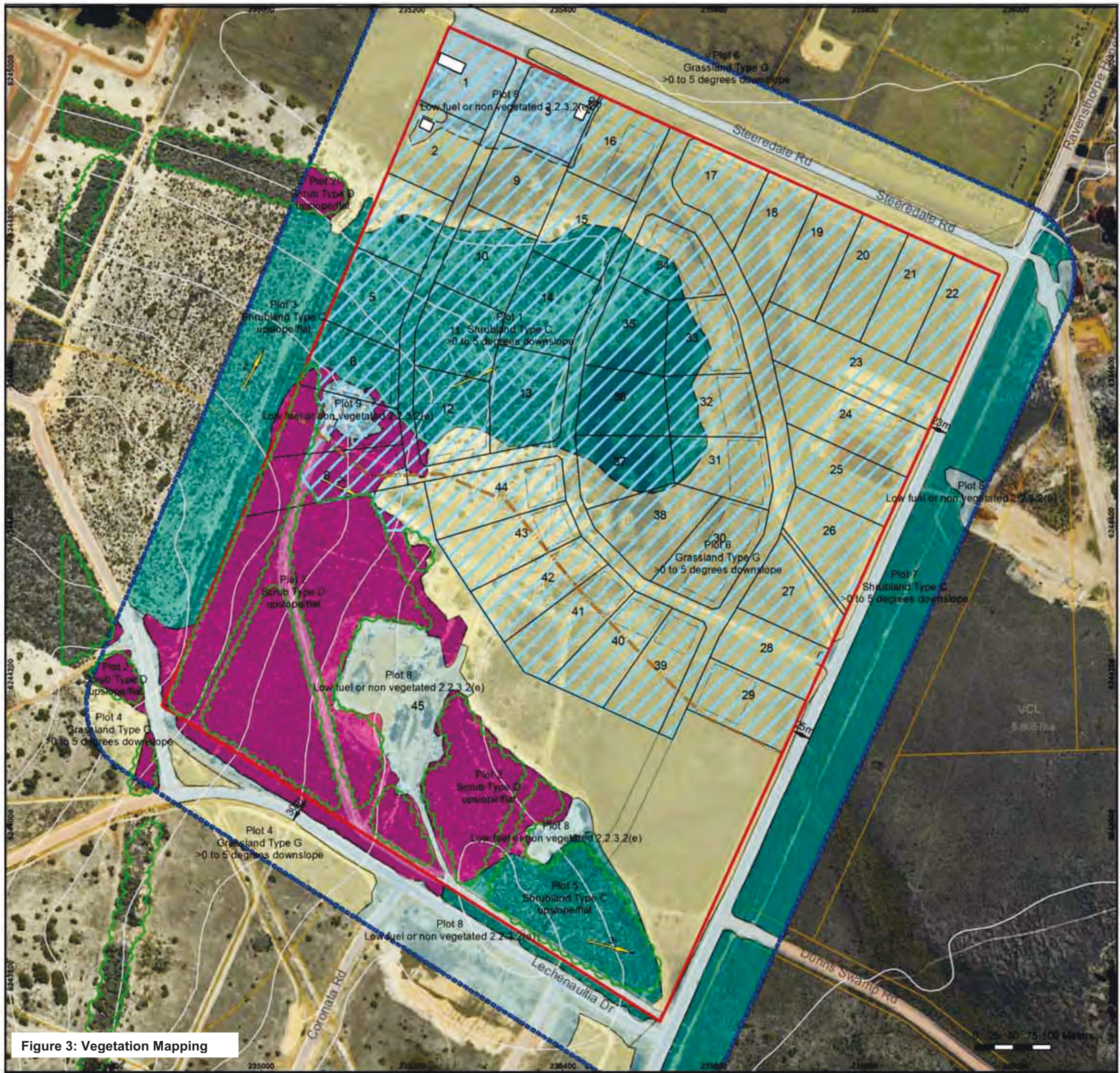


Figure 3: Vegetation Mapping

This BAL Plan was prepared by:  
 Kathryn Kinnear, Bio Diverse Solutions  
 Accreditation No: BPAD30794  
 Jurisdiction: Level 2 - WA

**BPAD**  
 Bushfire  
 Planning & Design  
 Accredited Practitioner  
 Level 2

**BIO DIVERSE SOLUTIONS**

29 Hercules Crescent  
 Albany, WA 6330  
 Australia  
 Tel: 08 9842 1575  
 Fax: 08 9842 1575

Overview Map Scale 1:150,000

**Legend**

- Subject Site
- 100m Assessment Boundary
- Cadastral
- Existing house
- 5m Contours
- Slope Degrees
- Separation Distance
- Vegetation retained
- Area to be modified to low threat state

**Vegetation**

- Woodland Type B
- Shrubland Type C
- Scrub Type D
- Grassland Type G
- Low fuel or non vegetated 2.2.3.2

Scale  
 1:5,000 @ A3  
 GDA MGA 94 Zone 50

**Data Sources**  
 Aerial Imagery: SLIP Virtual Mosaic WMS Service, Landgate 2017  
 Cadastral, Relief Contours and Roads: Landgate 2017  
 IRIS Road Network: Main Roads Western Australia 2017  
 Overview Map: World Topographic map service, ESRI 2012

**CLIENT**  
 Ayton Baesjou Planning  
 Lot 8 Steeredale Road  
 Hope town, WA 6348

**Vegetation Classes**

BAL Assessor	QA Check	Drawn by
SW	KK	SA
STATUS	FILE	DATE
FINAL	AB006	28/05/2018

## 5. Bushfire Attack Levels (BAL)

Bushfire Attack Level (BAL) is the process in AS3959-2009 for measuring the severity of a building's potential exposure to ember attack, radiant heat and direct flame contact. The threat or risk of bushfire attack is assessed by an accredited BAL Assessor. BAL rating determinations are of 6 levels BAL-LOW, BAL-12.5, BAL-19, BAL-29, BAL-40, BAL-FZ. Building is generally not recommended in BAL-40 or BAL-FZ areas. The BAL rating is determined by the distance of the building to vegetation, slope and vegetation type adjacent to the dwelling. Refer to Figure 4.



**Figure 4: Building to BAL**

Bushfire Attack Level (BAL) has been calculated using the Method 1 procedure as outlined in AS3959-2009. This incorporates the following factors:

- WA adopted Fire Danger Index (FDI);
- Vegetation Classes;
- Slope under classified vegetation; and
- Distance between proposed development site and classified vegetation.

The outcomes of the above inputs then allocate a specified BAL construction/setback for proposed buildings.

### 5.1. Fire Danger Index

The Western Australian adopted FDI is 80 as outlined in AS3959-2009 and endorsed by Australasian Fire and emergency Services Authorities Council. The FDI input for this project is also therefore 80.

### 5.2. Vegetation Classes

All vegetation within 100m of the Subject Site was classified to AS3959. The vegetation classes (as described in Section 4.4) are shown on Figure 3 and listed below.

- Shrubland Type C;
- Scrub Type D;
- Grassland Type G; and
- Exclusions 2.2.3.2 (e)

### 5.3. Slope Under Classified Vegetation

Slope under classifiable vegetation (Effective Slope) was assessed in accordance with Section 2.2.5 of AS3959-2009. Table 2 below summarises the slopes assigned to each plot of classifiable vegetation for the BAL calculation.

**Table 2: Effective slope allocation to classified vegetation**

Plot Number	Vegetation Classification	Effective Slope
1	Shrubland Type C	Downslope >0 to 5 degrees
2	Scrub Type D	Upslope/Flat
3	Shrubland Type C	Upslope/Flat
4	Grassland Type G	Downslope >0 to 5 degrees
5	Shrubland Type C	Upslope/Flat
6	Grassland Type G	Downslope >0 to 5 degrees
7	Shrubland Type C	Downslope >0 to 5 degrees
8	Low Fuel and Non-vegetated areas (e)	N/A

Plots 8 is allocated exclusion Clauses 2.2.3.2 and therefore do not have an effective slope allocation.

### 5.4. Method 1 BAL Calculation

A Method 1 BAL calculation (in the form of BAL contours) has been completed for the proposed development in accordance with AS 3959-2009 methodology. The BAL rating gives an indication of the level of bushfire attack (i.e. the radiant heat flux) that may be received by proposed buildings and subsequently informs the standard of building construction required to increase building tolerance to potentially withstand such impacts in line with the assessed BAL.

BAL ratings for the Subject Site are presented in Table 3 with BAL Contours for the Subject Site (post development) shown on Figure 6. Internal areas of Grassland Type G (Plot 6) and Shrubland Type C (Plot 1) **have not been mapped on the BAL Contour Plan** with BAL-FZ applicable to the whole of site. A 20m APZ area will apply in Grassland Type G and 22m in Shrubland Type C to ensure that all proposed building will be subject to a BAL rating of BAL-12.5. Refer to Section 6 for more detail.



**Table 3: BAL Allocation**

Lot number	Vegetation Type	Distance to Vegetation (m)	Effective Slope	Highest BAL Contour	Modified BAL Contour
1 -3	Grassland Type G (Plot 6)	0m	Downslope >0 to 5 degrees	BAL FZ	BAL 29, BAL 19 & BAL 12.5 can apply.
4 - 5	Shrubland Type C (Plot 3)	0m	Upslope/flat	BAL FZ	BAL 12.5 (22m APZ applied)
6	Shrubland Type C (Plot 3)	0m	Upslope/flat	BAL FZ	BAL 29, BAL 19 & BAL 12.5 (APZ demonstrated)
	Scrub Type D (Plot 2)	0m	Upslope/flat	BAL FZ	BAL 29, BAL 19 & BAL 12.5 (APZ area demonstrated)
7 - 8	Scrub Type D (Plot 2)	0m	Upslope/flat	BAL FZ	BAL 29, BAL 19 & BAL 12.5 (APZ area demonstrated)
10- 15, 31-33, 34-37	Shrubland Type C (Plot 1)	0m	Downslope >0 to 5 degrees	BAL FZ	BAL 12.5 (22m APZ applied)
9, 16 – 29, 30, 38, 39 - 44	Grassland Type G (Plot 6)	0m	Downslope >0 to 5 degrees	BAL FZ	BAL 12.5 (20m APZ applied)

Lot 6 has two BAL contours applicable, the highest BAL is to apply depending on final placement of the dwelling. The proposed new buildings are to be placed in BAL 29, BAL 19 or BAL 12.5 zones. Remaining areas within the lots are to be maintained to Asset Protection Zone (APZ) standards within the lot boundary at all times. A minimum of 20m APZ is required in Grassland Type G and a minimum of 22m APZ is required in Shrubland Type C.

Assumptions made in BAL Contour Mapping:

- The Subject Site will be developed according to the SP layout shown in Appendix A.
- Low fuel areas associated with Asset Protection Zones (APZ) are recommended as a minimum of 22m in Shrubland and 20m in Grassland areas to maintain BAL 12.5. See Section 6.2 for more detail.
- Vegetation clearing can occur internally on the lots to meet APZ requirements.
- Remnant vegetation to remain in perpetuity is shown on the SP and BAL Contour Plan (green outline).
- The owner of the balance of land will maintain grasslands internal to the site at all times in a low fuel state (Asset Protection Zone Standards) for a minimum distance of 100m from any dwellings or construction areas.

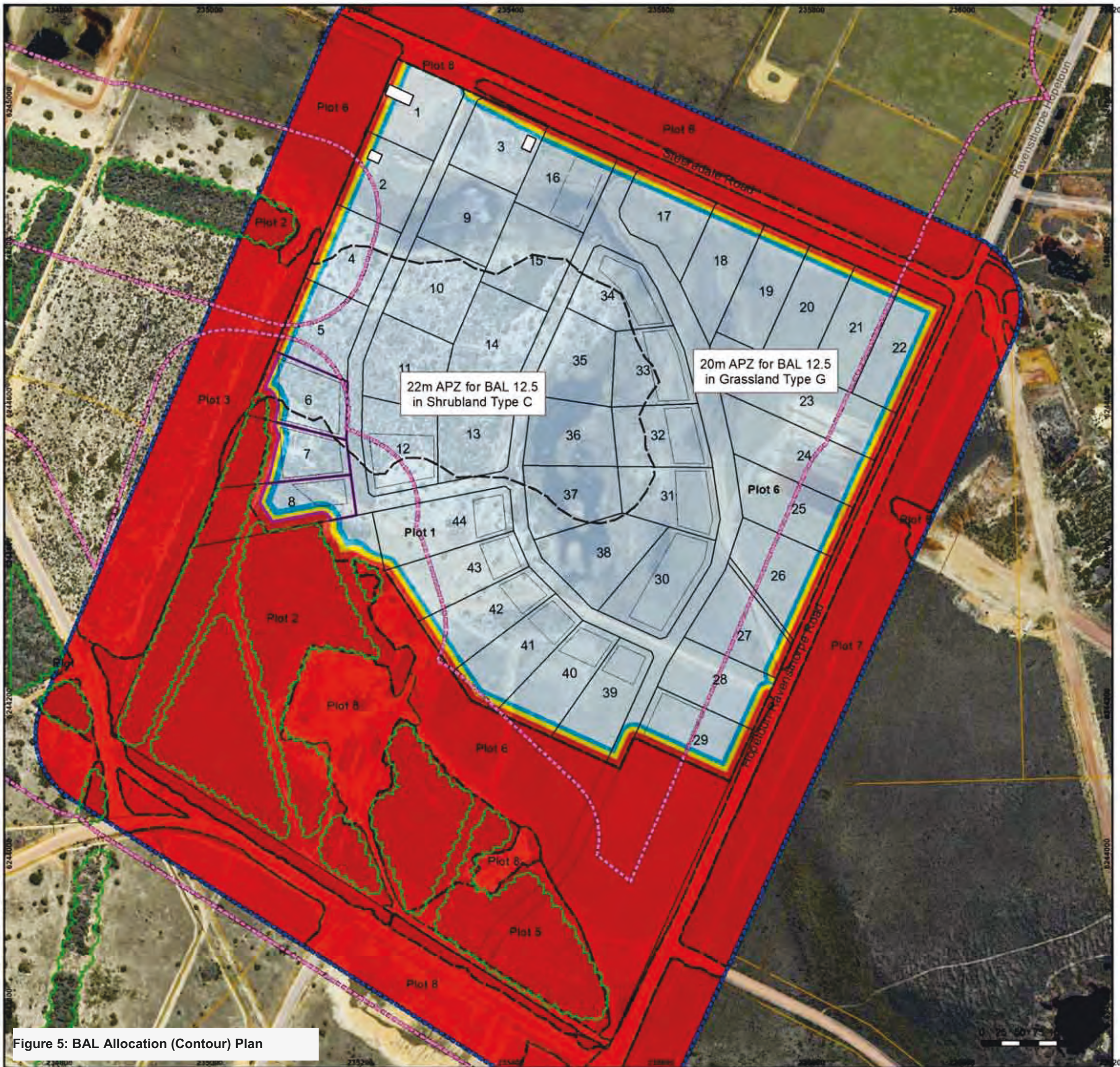


Figure 5: BAL Allocation (Contour) Plan

This BAL Plan was prepared by Kathryn Kinnear, Bio Diverse Solutions  
 Accreditation No: BPAD30794  
 Jurisdiction: Level 2 - WA

**BPAD** Bushfire Planning & Design Accredited Practitioner Level 2

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 Australia  
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Overview Map Scale 1:150,000

**Legend**

- 100m Assessment Boundary
- Local Structure Plan
- Cadastre
- Existing Shed
- APZ
- Vegetation retained
- OBRM Bush Fire Prone Areas 2017

**BAL Contours**

- BAL-FZ
- BAL-40
- BAL-29
- BAL-19
- BAL-12.5

Scale  
 1:5,000 @ A3  
 GDA MGA 94 Zone 50

**Data Sources**  
 Aerial Imagery: SLIP Virtual Mosaic WMS Service, Landgate 2017  
 Cadastre, Relief Contours and Roads, Landgate 2017  
 IRIS Road Network: Main Roads Western Australia 2017  
 Overview Map: World Topographic map service, ESRI 2012

**CLIENT**  
 Ayton Baesjou Planning  
 Lot 8 Steerdale Road  
 Hopetoun, WA 6348

**BAL Contour Plan**

BAL Assessor	QA Check	Drawn by
KK	BT	SA
STATUS	FILE	DATE
FINAL	AB006	28/05/2018

## 6. Assessment to the bushfire protection criteria

The Guidelines for Planning in Bushfire Prone Areas Version 1.2 (WAPC, 2017) outlines bushfire protection criteria which subdivision and development proposals are assessed for compliance. The bushfire protection criteria (Appendix 4, WAPC, 2017) are a performance based criteria utilised to assess bushfire risk management measures and they outline four elements, being:

- Element 1: Location
- Element 2: Siting and Design of Development;
- Element 3: Vehicle Access; and
- Element 4: Water.

(WAPC, 2017)

The Local Structure Plan (SP) is required to meet the “Acceptable Solutions” of each Element of the bushfire mitigation measures (WAPC, 2017). The SP and subsequent subdivision proposal will be assessed against the bushfire protection criteria Acceptable Solutions for Elements A1, A2, A3 and A4. A summary of the assessment is provided below in Table 4. The following sections of this report outlines how the proposal complies with the bushfire protection criteria Acceptable Solutions as per the Guidelines for Planning in Bushfire Prone Areas (WAPC, 2017). Please refer to the summary table below and the detailed assessment in Sections 6.1-6.4.

**Table 4: Bushfire protection criteria applicable to the site**

Element	Acceptable Solution	Applicable or not Yes/No	Meets Acceptable Solution
Element 1 – Location	A1.1 Development Location	Yes	Compliant BAL 29 or less applied to lots
Element 2 – Siting and Design	A2.1 Asset Protection Zone	Yes	Compliant, APZ in BAL 29 or less
Element 3 – Vehicular Access	A3.1 Two Access Routes	Yes	Compliant two access points to 2 destinations
	A3.2 Public Road	Yes	Compliant
	A3.3 Cul-de-sacs	No	N/A
	A3.4 Battle axes	No	N/A
	A3.5 Private driveways	Yes	Compliant
	A3.6 Emergency Access Ways	No	N/A, public road network used
Element 4 – Water	A4.1 Reticulated areas	N/A	N/A
	A4.2 Non-reticulated areas	Yes	Compliant
	A4.3 Individual lots in non-reticulated areas	N/A	N/A

## 6.1. Element 1: Location

**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.**

### Acceptable Solutions

**A1.1 Development Location:** *The strategic planning proposal, subdivision and development application is located in an area that is or will, on completion, be subject to either a moderate or low Bushfire hazard level or BAL-29 or below (WAPC, 2017).*

### Assessment to Acceptable Solutions

**A1.1 Development Location:** The publicly released Bushfire Prone Mapping (DFES 2017) indicates this area as partially bushfire prone. The BAL Contour Plan (Figure 5) and BAL Allocation Table (Table 3) demonstrates the BAL Contours upon completed construction of the Structure Plan, demonstrating the dwellings could be subject to BAL 29 or less and can apply to the proposed Building Envelopes (BE's) and lots. BAL 12.5 can be achieved on any internal lots through a minimum of a 20m (Grasslands) and 22m (Shrublands) APZ area. Refer to Section 6.2 for more detail. Setback distances associated with BAL 29 or less can be achieved within the lot/subject site.

Vegetation to be retained in the subject site is shown on the Structure Plan (Appendix A) and the BAL Contour Plan (green line). The other internal Shrubland/Grasslands areas are assumed to be cleared to low fuel (APZ) standards and BAL setback requirements.

Staged development will occur with lots 1, 2 and 3 subdivided in Stage 1. The development of the balance of lots in subsequent stages is presently unknown. The developer/parent lot owner is to ensure they maintain vegetation in accordance with the BAL Contour Plan and APZ standards (See Section 6.2).

It is noted that only dwellings located within the Bushfire Prone area mapping are legally required to build to BAL and AS3959.

The development is considered to meet A1 Acceptable Solution.

### Recommendations

The recommendations arising from the assessment of the SP to Element 1: Location:

- Development is deemed compliant to A1.1 due to no higher BAL allocation than BAL 29 will apply to buildings and/or building envelopes upon completion of the subdivision;
- The developer will be responsible for the implementation of a notification on title pursuant to Section 70A of the Transfer of Land Act 1893 for all lots affected by an increase in construction standards consistent with a BAL rating/AS3959-2009 allocation to the lot, and alerting the prospective owner(s) of the lots and successors in title of the Bushfire Management Plan;
- BAL can only legally be applied to dwellings within the Bushfire Prone Area Mapping (SLIP, 2017); and
- Individual BAL assessments may be considered on the lots by the new owners when dwelling design/placement is known and can be undertaken at building approval stages with the engagement of an Accredited Level 1 BAL Assessor.

## 6.2. Element 2: Siting and Design

**Intent: To ensure that the siting and design of development minimises the level of bushfire impact.**

### Acceptable Solutions

**A2.1 Asset Protection Zone (APZ):** Every habitable building is surrounded by, and every proposed lot can achieve, an APZ depicted on submitted plans, which meets the following requirements:

- **Width:** Measured from any external wall or supporting post or column of the proposed building, and of sufficient size to ensure the potential radiant heat impact of a bushfire does not exceed 29kW/m<sup>2</sup> (BAL-29) in all circumstances.
- **Location:** The APZ should be contained solely within the boundaries of the lot on which the building is situated, except in instances where the neighbouring lot or lots will be managed in a low-fuel state on an ongoing basis, in perpetuity (see explanatory notes).
- **Management:** The APZ is managed in accordance with the requirements of 'Standards for Asset Protection Zones'.

(WAPC, 2017)

An Asset Protection Zone (APZ) is an area surrounding a building that is managed to reduce the bushfire hazard to an acceptable level (WAPC, 2017). This is also defined as a “defendable zone”. Any buildings will have an APZ utilising low threat or non-vegetated areas as classified by AS3959-2009 Section 2.2.3.2. Any replanting, revegetation and landscaping across the lots is to be to an APZ standard as per WAPC Guidelines V 1.1 (WAPC, 2017) as outlined below.

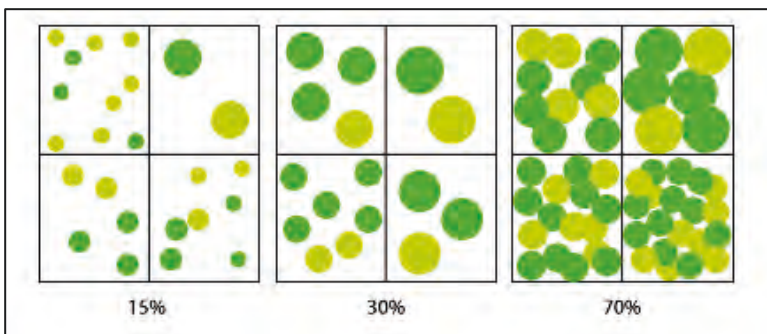
### WAPC Guidelines for an APZ (WAPC, 2017)

**Fences:** Within the APZ are constructed from non-combustible materials (e.g. iron, brick, limestone, metal post and wire). It is recommended that solid or slatted non-combustible perimeter fences are used.

**Objects:** Within 10 metres of a building, combustible objects must not be located close to the vulnerable parts of the building i.e. windows and doors.

**Fine Fuel load:** Combustible dead vegetation matter less than 6 millimetres in thickness reduced to and maintained at an average of two tonnes per hectare.

**Trees (> 5 metres in height):** Trunks at maturity should be a minimum distance of 6 metres from all elevations of the building, branches at maturity should not touch or overhang the building, lower branches should be removed to a height of 2 metres above the ground and or surface vegetation, canopy cover should be less than 15% with tree canopies at maturity well spread to at least 5 metres apart as to not form a continuous canopy. See Figure 6 (WAPC Figure 16, Appendix 4) below.



**Figure 6: Tree Canopy Coverage – ranging from 15 to 70% at maturity (WAPC, 2017)**

**Shrubs (0.5 metres to 5 metres in height):** Should not be located under trees or within 3 metres of buildings, should not be planted in clumps greater than 5m<sup>2</sup> in area, clumps of shrubs should be separated from each

other and any exposed window or door by at least 10 metres. Shrubs greater than 5 metres in height are to be treated as trees.

**Ground covers (<0.5 metres in height):** Can be planted under trees but must be properly maintained to remove dead plant material and any parts within 2 metres of a structure, but 3 metres from windows or doors if greater than 100 millimetres in height. Ground covers greater than 0.5 metres in height are to be treated as shrubs.

**Grass:** Should be managed to maintain a height of 100 millimetres or less.

(WAPC, 2017).

### **Assessment to Acceptable Solutions**

**A2.1 Asset Protection Zone (APZ):** All future buildings can achieve an APZ area associated with a BAL allocation of BAL 29, BAL 19 or BAL 12.5. A minimum 20m APZ area is recommended on all internal lots adjacent to Grassland Type G to ensure adequate setbacks are maintained. A minimum 22m APZ area is recommended for all internal lots on or adjacent to Shrubland Type C to ensure adequate setbacks are maintained. APZ setbacks associated with BAL allocation is to apply to individual buildings and is dependent on final placement of the dwelling on the lot. Additional distance (i.e. >20m) can apply to the APZ area depending on final placement of the dwelling, distance to classifiable vegetation and can be at the discretion of the lot owner. Minimum APZ areas apply as demonstrated on the BAL Contour Plan.

Staged development of the subject site is to incorporate maintenance of the balance of land internal grassland areas to APZ requirements to 100m from any dwellings or construction areas. The developer will be responsible for maintenance of the site until ownership is relinquished to new lot owners.

Any future plantings, revegetation and landscaping areas internal to the site are to be to an APZ standard as outlined in this report. New lot owners are to conform to any planting on their lot for revegetation, screening or windbreaks to APZ standards.

The Structure Plan is deemed to be compliant with A2.1.

### **Recommendations**

The recommendations arising from assessment of the Structure Plan to Element 2: Siting and design:

- A minimum APZ area of 20-22m to apply to the lots or as demonstrated on the BAL Contour Plan.
- Staged construction is to ensure that the balance of land (i.e. internal grassland and shrubland areas) are maintained as per APZ areas to a minimum of 100m from any future dwellings or dwelling construction sites; and
- Any future internal landscaping, revegetation or replanting is to conform to APZ standards.

### 6.3. Element 3: Vehicle Access

**Intent: To ensure that the vehicular access serving a subdivision/development is available and safe during a bushfire event.**

#### Acceptable Solutions

**Table 5: Vehicular Access Technical Requirements (WAPC, 2017)**

Technical requirements	Public Road	Private Driveways
Minimum trafficable surface (m)	*6	4
Horizontal clearance (m)	6	6
Vertical clearance (m)	4.5	4.5
Maximum grades	1 in 10	1 in 10
Minimum weight capacity (t)	15	15
Maximum crossfall	1 in 33	1 in 33
Curves minimum inner radius (m)	8.5	8.5
Maximum Length	N/A	50m

\*Denotes the width can include a 4m wide paving with one metre wide constructed road shoulders

#### Assessment to Acceptable Solutions

**A3.1 Two access routes:** The Local Structure Plan shows two exit/entry points via public roads onto Steeredale Road to the north and Leschenaultia Drive to the south. This provides two alternative access points to alternative directions as required by the guidelines. The balance of Lot 8 which has frontage to Leschenaultia Drive is zoned General Agriculture and is currently being used to mine sand. It is anticipated that once the sand resource has been removed, application will be made under the provisions of Local Planning Scheme No 6 to rezone the land to create additional lots within cleared areas and the public road providing access to Lot 29 will be extended to Leschenaultia Drive. See Figure 7. Subject site deemed compliant with A3.1



**Figure 7: Access Plan**

**A3.2 Public roads:** All internal public roads shall be constructed with a minimum of 16-20m road reserves measured, meeting the minimum construction requirements. The Vehicular Access Standards (Refer to Table 5 – Column 1) and relevant technical information shall be detailed in civil engineering designs and approved by the Shire of Ravensthorpe at subdivision stage. The SP is deemed compliant to Acceptable Solution A3.2.

**A3.3 Cul-de-sac:** Cul-de-sacs are not recommended in Bushfire Prone Areas, there are no cul-de-sacs proposed for this development. Subject site not assessed to Acceptable Solution A3.3.

**A3.4 Battle-axe:** Battle axes are to be avoided in bushfire prone areas. The SP does not indicate any battle axe and therefore the SP is not assessed to Acceptable Solution A3.4.



**A3.5 Private driveways:** Private driveways will conform to the minimum technical standards as outlined in Table 5 – Column 2. Where driveways exceed 50m a turnaround area will be required at the house to accommodate heavy duty vehicles, driveway's will not exceed 200m from the public road and therefore passing bays will not be required. The SP is deemed compliant to Acceptable Solution A3.5.

**A3.6 Emergency Access Ways:** An Emergency Access Way (EAW) will not be applied at this development. Any emergency access will be along the established internal and external public roads, with a separate dedicated EAW not required. The SP is not assessed to this Acceptable Solution.A3.6.

**A3.7 Fire Service Access Routes:** Fire Service Access (FSA) Routes will not be applied at this development. Any emergency access will be along the established internal and external public roads, with a separate dedicated FSA not required. The SP is not assessed to this Acceptable Solution A3.7.

**A3.8 Firebreaks:** Firebreaks are currently in existence along the property boundary of the parent block. Firebreaks to 3m will be required along the perimeter of new lots to be maintained by the developer until the lots are relinquished to new lot owners. The Shire of Ravensthorpe Fire Regulation Notice (annually updated) is to be referred to and can be obtained from their office or from:

[www.ravensthorpe.wa.gov.au](http://www.ravensthorpe.wa.gov.au)

Perimeter firebreaks are to be maintained by the owner until the land is relinquished to new lot owners. New lot owners are to maintain firebreaks as per the Shire of Ravensthorpe Fire Break Order (annually updated).

Structure Plan meets Acceptable Solution

The SP and subsequent subdivision proposal will meet Acceptable Solution A3 (1-8).

### **Recommendations**

The recommendations from assessment of the SP to Element 3: Vehicular Access:

- Is deemed compliant with Element 3 as it meets the Acceptable Solutions as outlined A3.1 to A3.8;
- The developer implements the vehicular construction standards as outlined in Table 4;
- Engineering construction details on the road network particularly to meet maximum allowable grades is provided to the Shire prior to construction of each development stages; and
- Fire breaks as per the requirements in the Shire of Ravensthorpe Fire Regulation Notice (annually updated) maintained by the owner until the land is relinquished to new lot owners. New lot owners to maintained firebreaks as per the Shire of Ravensthorpe Fire Break Order (annually updated).

## 6.4. Element 4: Water

**Intent: To ensure that water is available to the subdivision, development or land use to enable people, property and infrastructure to be defended from bushfire.**

### Acceptable Solutions

**A4.1 Reticulated areas:** *The subdivision, development or land use is provided with a reticulated water supply in accordance with the specifications of the relevant water supply authority and Department of Fire and Emergency Services.*

**A4.2 Non-reticulated areas:** *Water tanks for firefighting purposes with a hydrant or standpipe are provided and meet the following requirements: Volume: minimum 50,000 litres per tank; Ratio of tanks to lots: minimum one tank per 25 lots (or part thereof); Tank location: no more than two kilometres to the further most house site within the residential development to allow a 2.4 fire appliance to achieve a 20 minute turnaround time at legal road speeds; Hardstand and turn-around areas suitable for a type 3.4 fire appliance (i.e. kerb to kerb 17.5 metres) are provided within three metres of each water tank; and Water tanks and associated facilities are vested in the relevant local government.*

**A4.3 Individual lots within non-reticulated areas (Only for use if creating 1 additional lot and cannot be applied cumulatively):** *Single lots above 500 square metres need a dedicated static water supply on the lot that has the effective capacity of 10,000 litres.*

### Assessment to Acceptable Solutions

**A4.1 Reticulated areas:** Reticulated water cannot be provided to the development and therefore is not assessed to this Acceptable Solution.

**A4.2 Non-reticulated areas:** A 50,000L strategic water tank and bore supply of water is proposed in the north of the development. Refer to Figure 7 and shown in the subject site on the Structure Plan (refer to Appendix A). The tank is to be located in public land to be vested to the Shire of Ravensthorpe. As The 50,000L tank is located along a public road and is not more than 2km from the furthest dwelling as demonstrated in the Structure Plan (Appendix A). A 20-minute turnaround time at legal road speed can be achieved to all dwellings. A hardstand and turnaround area suitable for a 3.4 appliance vehicle is to be provided at the tank for access from fire appliances.

The Strategic water will be supplied via bore source. An existing bore is located on the balance of land to the south (the property within the area being mined for sand). The land owner confirms there is a good supply of water available and the environmental assessment done by Landform Research (Landform Research, 2015) has also confirmed there is an underground water supply.

Prior to clearance of titles, a procedure of filling and maintaining the tanks capacity (from the proposed bore source) is to be agreed to by the Shire of Ravensthorpe.

**A4.3 Individual lots within non-reticulated areas:** The Structure Plan is not assessed to A4.3.

### Recommendations

The recommendations from assessment of the Structure Plan to Element 4: Water:

- A 50,000L tank and bore water source is installed by the developer;
- A procedure of filling and maintaining the tanks capacity (from the proposed bore source) is to be agreed to by the Shire of Ravensthorpe and the developer.

## 7. Other Fire Mitigation Measures

### 7.1. Evaporative air conditioners

Evaporative air conditioning units can catch fire as a result of embers from bushfires entering the unit. These embers can then spread quickly through the home causing rapid destruction. It can be difficult for fire-fighters to put out a fire in the roof spaces of homes.

It is also recommended that the developer:

- Ensure that suitable external ember screens are placed on roof top mounted evaporative air conditioners compliant with AS3959-2009 (current and endorsed standards) and that the screens are checked annually; and
- Maintain evaporative air conditioners regularly as per DFES recommendations, refer to the DFES website for further details:  
<http://www.dfes.wa.gov.au>

### 7.2. Barrier Fencing

In November 2010, the Australian Bushfire CRC issued a "Fire Note" (Bushfire CRC, 2010) which outlined the potential for residential fencing systems to act as a barrier against radiant heat, burning debris and flame impingement during bushfire. The research aimed to observe, record, measure and compare the performance of commercial fencing of Colourbond steel and timber (treated softwood and hardwood).

The findings of the research found that:

*".. Colourbond steel fencing panels do not ignite and contribute significant heat release during cone calorimeter exposure" (exposure to heat)*

*..." Colourbond steel (fencing) had the best performance as a non-combustible material. It maintained structural integrity as a heat barrier under all experimental exposure conditions, and it did not spread flame laterally and contribute to fire intensity during exposure"*

It is also noted that non-combustible fences are recommended by WAPC (APZ standards: Fences and sheds within the APZ are constructed using non-combustible materials e.g. colourbond iron, brick, limestone, metal post and wire). The developer will be encouraged to build Colourbond or non-combustible fences where applicable.

## 8. Implementation

### 8.1. Overall fire threat

Murray King (Client) commissioned Bio Diverse Solutions (Bushfire Consultants) to conduct a bushfire hazard assessment and prepare a Bushfire Management Plan to guide all future bushfire management for a Structure Plan and subsequent proposed subdivision of Lot 8 Steeredale Road, Hopetoun WA.

This BMP report provides details of the fire management strategies proposed to be implemented across the site as it is developed to ensure adequate protection of life, property and biodiversity assets. To ensure the mitigation measures are implemented, responsibilities are outlined in the following sections for the future lot owners and the developer.

### 8.2. Future Lot owner's Responsibility

It is recommended the future property owners shall be responsible for the following:

Lot owner– Ongoing management			
No	Implementation Action	Annual	All times
1	Individual BAL assessments may be considered on the lots by the new owners when dwelling design/placement is known and can be undertaken at building approval stages with the engagement of an Accredited Level 1 BAL Assessor.	<input type="checkbox"/>	<input type="checkbox"/>
2	APZ areas to apply as specified in the BAL Contour Plan at all times.	<input type="checkbox"/>	<input checked="" type="checkbox"/>
3	Firebreaks to be maintained as per SoR fire break notice.	<input checked="" type="checkbox"/>	

### 8.3. Developer's responsibility

Prior to development being given final approval by the Shire of Ravensthorpe, the developer shall be required to carry out works that include the following but in respect to individual stages of development. Subsequent to the issue of final approval, the Developer shall have no further responsibilities to the provision of firefighting facilities and fire management on individual lots that pass from their ownership.

It is recommended the developer be responsible for the following:

Developer – Prior to issue of titles		
No	Implementation Action	Subdivision Clearance
1	Notification on title 70A of the Transfer of Land Act 1893 to alert prospective owners that the lots are located in a bushfire prone area and may be subject to increased construction standards to AS3959.	<input checked="" type="checkbox"/>
2	Maintain balance of land in ownership in a low fuel state (APZ standards) at all times.	<input checked="" type="checkbox"/>
3	Ensure Vehicle Access constructed to Table 5 standards. Staged access to incorporate alternative access to separate destinations.	<input checked="" type="checkbox"/>
4	Perimeter 3m fire breaks as per the requirements in the SoR maintained by the developer until lots are relinquished to new owners.	<input checked="" type="checkbox"/>
5	Ensure Vehicle Access constructed to Table 5 standards.	<input checked="" type="checkbox"/>
6	Strategic water to be supplied for the subdivision. A procedure of filling and maintaining the tanks capacity (from the proposed bore source) is to be agreed to by the Shire of Ravensthorpe and the developer.	<input checked="" type="checkbox"/>

#### 8.4. Shire of Ravensthorpe Responsibility

LGA– Clearance of conditions		
No	Implementation Action	Subdivision Clearance
1	Designation of the approved BMP through their annual fire break order to ensure provisions as outlined in this BMP report prevail over the lots.	<input type="checkbox"/>
2	Ensure Vehicle Access constructed to Table 5 standards.	<input type="checkbox"/>
3	A procedure of filling and maintaining the tanks capacity (from the proposed bore source) is to be agreed to by the Shire of Ravensthorpe and the developer.	<input type="checkbox"/>

## 9. References

AS 3959-2009 Australian Standard, *Construction of buildings in bushfire-prone areas*, Building Code of Australia, Primary Referenced Standard, Australian Building Codes Board and Standards Australia.

Bushfire CRC (2010) *Managing Forest in South West Western Australia*, Research project undertaken by Dr Lachlan McCaw and Dr Roy Wittkuhn, retrieved from: <http://www.bushfirecrc.com/projects/b11/managing-forest-fires-south-western-australia>

Landform Research (2015) Local Water Management Strategy Lot 8 Hopetoun – Ravensthorpe Road Hopetoun. Unpublished report.

Shire of Ravensthorpe Fire Regulation Notice, yearly advise brochure, accessed July 2017 from: [http://www.ravensthorpe.wa.gov.au/Profiles/ravensthorpe/Assets/ClientData/Documents/Content/Fire\\_Break\\_Notice/Firebreak\\_Notice\\_2016\\_-\\_2017.pdf](http://www.ravensthorpe.wa.gov.au/Profiles/ravensthorpe/Assets/ClientData/Documents/Content/Fire_Break_Notice/Firebreak_Notice_2016_-_2017.pdf)

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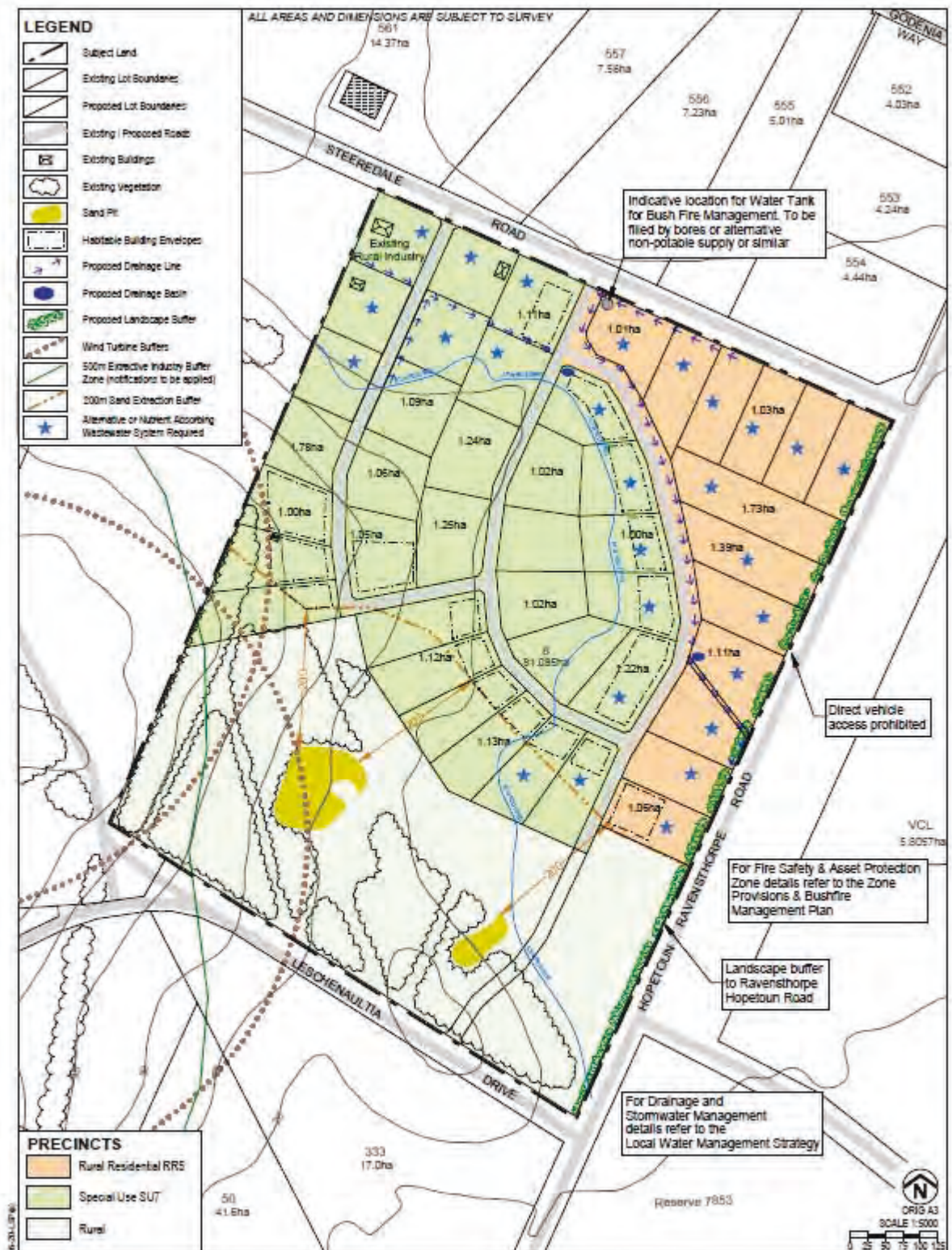
Western Australian Planning Commission (WAPC) (2017) Guidelines for Planning in Bushfire Prone Areas. Western Australian Planning Commission and Department of Planning WA, Government of Western Australia.

Western Australian Planning Commission (WAPC, 2015) State Planning Policy 3.2 Planning in Bushfire Prone Areas. Department of Planning WA and Western Australian Planning Commission.

State Land Information Portal (SLIP) (2015 & 2016) Map of Bushfire Prone Areas. Office of Bushfire Risk Management (OBRM) data retrieved from: <https://maps.slip.wa.gov.au/landgate/bushfireprone/>

## **Appendices**

### **Appendix A – Local Structure Plan**







LAND CAPABILITY - GEOTECHNICAL  
ASSESSMENT

LOT 8 HOPETOUN – RAVENSTHORPE  
ROAD, HOPETOUN

SHIRE OF RAVENSTHORPE

June 2013



## **SUMMARY OF LAND CAPABILITY AND GEOTECHNICS**

A land study of Lot 8 Hopetoun – Ravensthorpe Road was conducted by Lindsay Stephens of Landform Research on 8 February 2007. The surrounding area and site has previously been investigated on a number of occasions. That is, the land to the north of Steerdale Road, the adjoining land to the west and south, an assessment for waste water disposal for an accommodation facility on the nearby Lot 6881 and land to the east.

During the study a series of 19 backhoe test holes was excavated to assess the soils on Lot 8. Other soil data was obtained during extensive site mapping from the examination of soils exposed in numerous small excavations, and soil disturbance generally, carried out as a result of sand and gravel excavations, drains and farm activities. The geology, hydrology and salinity were mapped by completing numerous traverses over each site together with interpretations from aerial photography.

Lot 8 from the Hopetoun – Ravensthorpe Road up a ridge in the west with a hill to the south west. In recent years the site has been used for grazing and sand excavation.

A shed is located in the north western corner adjacent to Steerdale Road.

The site adjoins land to the north that has been subdivided to rural living. The land to the west and south has also been assessed for rural living.

Two wind turbines are located west of the land and the buffers just intrude the south western corner of Lot 8.

The types of developments are likely to be dwellings on rural living properties with a lot size in excess of 1 hectare, and some potential for small scale commercial or industrial uses in the north west. Sand excavation is to continue in the south.

Lot sizes have been designed in sympathy with the soil and land capability, landform and remnant vegetation condition.

The soils are deep yellow sand over earthy yellow sand across the western two thirds of the site. Under the highest portion of the site the sands overly limestone and limestone pinnacles, whereas on the central northern edge of the site, the sand overlies laterite gravel developed on the top of the junction with underlying silts, loams and loam clays.

On the low elevations, adjacent to the Hopetoun Ravensthorpe Road in the east, the sands overly alluvial silts sands, loams and loam clays.

The soils have high phosphate retention and nutrient management capability. Conventional leach drains are acceptable in most locations. Any deficiencies in local nutrient management can be overcome by the use of nutrient adsorbing waste water disposal systems.

The Hopetoun Drinking Water Reserve lies outside the southern boundary of Lot 8. The Hopetoun Groundwater Area is used for drinking purposes.

Hirschberg 1980 recorded the elevation of the water table as being 9 metres AHD south of the southern boundary of Lot 8. By interpretation that would equate to an elevation of 10 metres AHD at the southern boundary, seven metres below the lowest land elevation in that corner, rising towards the north eastern corner where a separation of several metres occurs.

Lot 8 is therefore sufficiently above the water table for there to be no significant issue for waste water disposal.

Lot 8 currently accepts large storm flows from the land north of Steerdale Road and directs it along a drain that constrains the natural flows. Drainage is to Dunn's Swamp to the south

east. The storm flows can be significant and have been provided for within the proposed subdivision.

The drain currently has a cross sectional flow area of 3.0 m<sup>2</sup>. During the last decade the storm flows have had a cross sectional area of 1.8 m<sup>2</sup>.

It is uncertain what effects the drainage on the subdivision to the north will have on the potential flood flows from the land to the north. Therefore in the absence of new calculations of the runoff from the catchment the maintenance of a drain and culverts with a 3.0 m<sup>2</sup> surface area flow capacity is recommended

Stormwater from roads can be retained on site by draining to swale drains, as occurs on most rural roads, with the potential to use swale drains and detention basins on sloping ground. Soakwells will be capable of dealing with stormwater from roofs.

The deep sands are well known for their high levels of foundation stability and construction capability and are classified as High (Site Class A with potentially some locations at S, AS 2870).

The foundation stability of the Sand over Sandy Clay depends on the thickness of the overlying sand sheet. On locations where the sheet is in excess of 1 – 2 metres the foundation stability is classified as generally High (Site Class S – M, AS 2870).

There are some locations where the depth of sand is thin and those areas may have Moderate foundation stability (Site Class M with some areas of potentially H, AS 2870).

With continued drainage and fill the natural foundation stability as noted above will be raised.

Lot 8 is highly suitable for the construction of roads.

No specific actions are required for dwellings on sloping soils apart from normal construction techniques.

Water Management is considered in the attached Local Water Management Plan.

A separate Flora and Vegetation Survey is attached.

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## 1.0 INTRODUCTION

### **Site Assessment - Methodology**

A land study of Lot 8 Hopetoun – Ravensthorpe Road was conducted by Lindsay Stephens of Landform Research on 8 February 2007. The surrounding area and site has previously been investigated on a number of occasions. That is, the land to the north of Steerdale Road, the adjoining land to the west and south, an assessment for waste water disposal for an accommodation facility on the nearby Lot 6881 and land to the east.

During the study a series of 19 backhoe test holes was excavated to assess the soils on Lot 8. Other soil data was obtained from extensive walking traverses and the examination of soils exposed in numerous small excavations, and soil disturbance generally, carried out as a result of sand and gravel excavations, drains and farm activities. The geology, hydrology and salinity were mapped by completing numerous traverses over each site together with interpretations from aerial photography.

Vegetation was examined at the community and species level to further add data to the soil information, based on species composition and distribution. It was also compared to vegetation studies of the adjoining vegetation to the west and south. The vegetation condition was mapped, and the species recorded during the site inspections listed.

A study of the geology can provide valuable background material on the nature of the site and the way that various land uses may impact on the developments. This was completed during the field work.

### **Site Description**

The whole site rises from the Hopetoun – Ravensthorpe Road up a ridge in the west with a hill to the south west. In recent years the site has been used for grazing and sand excavation.

A shed is located in the north western corner adjacent to Steerdale Road.

The site adjoins land to the north that has been subdivided to rural living. The land to the west and south has also been assessed for rural living.

Two wind turbines are located west of the land and the buffers intrude slightly onto the south western corner of Lot 8.

The Hopetoun Drinking Water Reserve lies outside the southern boundary of Lot 8.

The Hopetoun Waste Water Treatment Plant lies to the west of Lot 8 with the buffer extending to the western boundary of Lot 8.

An extractive Industry with associated Special Control Area lies to the south west with a related 500 metre notification buffer to the Special Control Area extending slightly onto the south western corner of Lot 8.

### **Proposed Developments**

The types of developments are likely to be dwellings on rural living properties with a lot size in excess of 1 hectare, and some potential for small scale commercial or industrial uses in the north west. Sand excavation is to continue in the south.

Lot sizes have been designed in sympathy with the soil and land capability, landform and remnant vegetation condition.

## **2.0 WEATHER CONDITIONS**

Long term weather records for Hopetoun are not available, however detailed records have been kept at Munglinup which is to the east and slightly inland and therefore will have some differences in temperatures and perhaps in rainfall.

The climate of Hopetoun consists of moist cool winters followed by warm to hot summers. Temperatures (at Munglinup) range from winter maxima of about 16.1 degrees C to summer maxima of 27.8 degrees C.

Average annual rainfall is 512 mm with monthly rainfall varying from 28.2 mm in summer months to 60 mm in the winter months. Rainfall is now recorded at Hopetoun North as having an average of 499 mm per year, but being near a hill the earlier 512 mm is used in this documentation.

Long term evaporation is recorded at Munglinup. This could be expected to be slightly higher than on the coast at Hopetoun which is subject to more humid sea breezes. Evaporation ranges from 2.5 mm per day in July to 8.3 mm per day in January. On this basis evaporation at Munglinup exceeds rainfall in every month.

Long term wind data is only available for Esperance, although the data has some applicability to Hopetoun data based on local comment. At Esperance the predominant winds on this section of coast are strong south east to southerly sea breezes on summer afternoons. For example at 3.00 pm in January wind blows from the south east on 46% of the time and from the south for 32%. Morning winds at 9.00 am are lighter and spread widely, with 22% from the south east. Wind roses are shown in Appendix 4.

Winter winds are more variable at Esperance with 36% from the north west and 25% from the north in July at 9.00 am. In winter the winds blow from the north west to south west on 57% of the afternoons at 3.00 pm. Winter storms are generally from the south west.

Humidity ranges between 57% – 81% at 9.00 am to 46% – 62% at 3.00 pm.



### **3.0 REGOLITH AND SOIL ASSESSMENT**

#### **3.1 Geology and Geomorphology**

A study of the geology can provide valuable background material on the nature of the site, the hydrogeology and the way the proposed land uses may impact on the site.

The site straddles the eastern slopes of a ridge north of Hopetoun. The land drops from the south western corner at 45 metres AHD down to 12 metres AHD in the north western and north eastern corners. The south eastern corner lies at 17 metres AHD.

The geology of the site has been investigated in several studies with the most recent being contained on the 1 : 250 000 Hydrological Map Series. Other information is contained in several Geological Survey of WA reports such as Hirschberg 1980. Additional information was obtained during the site investigations when all the soils and surface geology was mapped.

The site is underlain at depth by undulating Archaean gneiss and migmatite at depths of near sea level (1 : 250 000 Hydrological Map Series). Hirschberg 1980, states that the basement is undulating and forms a high north east of the site and a smaller high to the south west. These form a trough in which the Hopetoun water resource lies.

Overlying this is the Tertiary Plantagenet Group which fills the base of the basement troughs. The 1 : 250 000 Hydrological Map Series lists the Werillup Formation as locally occurring, consisting of coarse grained siltstone, carbonaceous clay and limestone. Overlying this from about sea level is the Quaternary “alluvium, colluvium and sandsheet – mostly sand, gravel, minor clay and silt, mainly overlying Plantagenet Group of sediments”. Above this is listed Coastal aeolian and marine sediments, sand clay and limestone.

Data from the 1 : 250 000 Hydrological Map Series provides information on the base materials below about sea level, but little site specific information, which is provided from field mapping and Hirschberg 1980.

The top of the hill to the south west and along the western boundary is sheeted by yellow sand of aeolian origin. Underlying this is a horizontal bed of limestone with a thickness of 9 to 14 metres. This limestone is not typical of the coastal Tamala Limestone but is more calcified, contains large rounded pisolitic structures, brecciated and re-cemented structures indicative of lithified soil materials, contained and overlying laterite gravels and a high calcium carbonate content. The colour is light pink brown with variations due to iron oxide content.

All these features indicate that the limestone is older than the typical Tamala Limestone. The limestone is more akin to limestone in the Cape Range area which are Early to Mid Tertiary in age and prior to widespread laterisation. This would fit with the limestone observed on site.

There is no evidence of karst features or conditions that would have formed karst conditions in the past or currently. The levels of oxidation and iron oxide in the limestone suggest that it has always been above sea level and the water table.

The limestone extends down to an elevation of at least 25 metres AHD along the western boundary where the sand overlies pinnacle limestone.

Underlying the limestone are clayey and silty sediments that are alluvial and possibly lacustrine sediments that are exposed along the eastern and northern boundaries and under the surface sands subsoils in that area, and in the gravel pits near the northern boundary. The elevation of these beds is about 20 metres AHD and they appear to extend to depth. The sediments are the “Quaternary alluvium” in the 1 : 250 000 Hydrological Map Series. They can be identified by their silt and clay lenses and lenses

of alluvial materials containing rounded pebbles of alluvial origin. The development of gravel on these sediments and their relationship to the limestone suggest that they are likely to be older than Quaternary.

It is difficult to see whether these sediments extend up to the base of the limestone because of the overlying sheet covering of sand, however gravelly silts that are similar in nature occur at elevations of up to 20 metres on the northern edge of the site.

Hirschberg 1980 showed by drilling that a lens of sandy sediments of the Werillup Formation opens up to the south of Lot 8 and forms the main aquifer of the Hopetoun Water Source Area. The Werillup Formation pinches out at the southern edge of Lot 8.

Minor traces of laterite gravels are developed on the older soils such as the limestone ridge and the silts on the western and northern edge of the site.

There has been minor leaching of the surface sands in places particularly in the west and south west.

### **Basic Raw Materials**

An existing sand excavation is present in the south western corner. The sand ridge itself is a significant sand resource that is less common locally. The sand is medium grained yellow silica with a small amount of clay in the earthy yellow sand of the subsoils.

The sand is used locally for fill and has been sent to Kalgoorlie in the past. The sand resource extends outside Lot 8 to the west and south where it has also been extracted in combination with limestone.

Limestone is present under the ridge of Lot 8 but is its pinnacle formation poking up into the surface sands rather than the higher grade recalcified calcrete duricrust (caprock). That limestone is extracted on land to the south west where a Special Control Area has been applied. A 500 metre notification buffer to the Special Control Area extends onto the south western corner of Lot 8 close to the existing sand excavation.

### **3.2 Regolith and Soils**

The soils were mapped during the site inspections.

The soils are deep yellow sand over earthy yellow sand on the western two thirds of the site. Under the highest portion of the site the sands overly limestone and limestone pinnacles, whereas on the central northern edge of the site, the sand overlies laterite gravel developed on the top of the junction with underlying silts, loams and loam clays.

On the low elevations, adjacent to the Hopetoun Ravensthorpe Road in the east, the sands overly alluvial silts sands, loams and loam clays.

The upper horizons of the soils have been leached to white sands grading into paler yellow sands. The potential for wind erosion of the site is moderate to high on these leached and pale surface soils particularly when the protecting vegetation is removed.

There are areas where the grey and lighter surface sands have been removed by wind following clearing, leaving the more resistant earthy yellow sands. This has led to removal of the topsoil which will now have to reform, as pasture and native plant growth continues.

2.2 Soils

**Table 1 Descriptions of the soil types**

KEY	SOIL GROUP	DESCRIPTION
YS	<b>Yellow Sand</b>	<ul style="list-style-type: none"> <li>• Yellow silica sands over dark yellow earthy sands at depths of 100 to 500 mm occurring along the western boundary and south west.</li> <li>• These also overly the alluvial silts in the east and in the north below approximately the 20 metre AHD elevation.</li> <li>• Yellow sands also overly limestone and limestone pinnacles on the ridge.</li> <li>• The earthy yellow sands contain clay in variable proportions but generally in the 1 – 5 % range.</li> <li>• The small amounts of clay and sesqui-oxides provide moderate phosphate retention (PRI), that increases with depth. PRI values of 3.1 – 4.4 are typical.</li> <li>• The underlying limestone has very high PRI with values of 29.</li> <li>• These sands tend to be neutral to alkaline particularly near limestone.</li> </ul>
W/YS	Leached Yellow Sands	<ul style="list-style-type: none"> <li>• These mainly occur in the central south west and west and are the same sands as other locations except that there has been vertical displacement of sesquioxides and clay downwards. The earthy sands do not occur within 1000 mm of the surface, but occur at depth in these locations.</li> <li>• The surface yellow sand typically have PRI of 0.9 to 2.0. The more earthy subsoils have PRI of near 5.0</li> <li>• These sands tend to be neutral to alkaline particularly near limestone.</li> </ul>
S/C	Sand over Sandy Clay	<ul style="list-style-type: none"> <li>• Brown sands to depths of 500 mm overly yellow sandy and loam clay. There is some indication of historical elevated salinity to the sand over clay soils that appears to have been at least partially mitigated by better drainage.</li> <li>• Gravel occurs in the west and north eastern corner. The gravel has previously been excavated and the pit now bottoms on sandy clay.</li> <li>• In the east and north the underlying silty clays and loams have high PRI of 64 to 120.</li> <li>• At depths of 650 - 850 mm the sandy clay becomes lighter to light yellow.</li> <li>• Below a variable depth of 850 - 1050 the sandy clay becomes grey and mottled with brown to yellow mottles, indicating seasonal wetting and drying conditions.</li> </ul>

**Table 2 Soil Properties**

PROPERTY	DESCRIPTION	SOIL SUSCEPTIBILITY	SOILS POTENTIALLY REQUIRING MANAGEMENT
WATER REPELLENCE	Water repellence is the uneven or non wetting characteristic of a soil. This commonly occurs in dry situations and more commonly affects soils that contain less clay such as sands. It may lead to greater surface runoff in summer, resulting in lower soil moisture and reduced crop growth in winter.	Some of the pale yellow sand and leached sand in the central west has some susceptibility to water repellence.	Minor and localised
SOIL COMPACTION	Soil compaction results from tractor and machinery movements compacting soils and reducing aggregates. It leads to reduced root penetration and reduced water infiltration. Compaction hard pans commonly form. Loamy sands are the most susceptible.	The more earthy sand can be susceptible to machinery traffic compaction. This is most likely to occur in the subsoils of the Yellow Sands and therefore has little potential impact.	Subsoils of the Yellow Sands
DISPERSIBLE SOILS	Soils containing sodium in the clay content can disperse when wet, leading to soil erosion and subsoil tunnel formation.	No obvious evidence of soil dispersion. There is minor evidence of past elevated salinity in some lower areas of the sand over Sandy Clay Soils and this could increase the potential for dispersibility.	Managed by drainage and the use of sand fill.
WIND EROSION	Wind erosion can impact on sands and loose soil when inadequate soil cover is retained. Duplex and sandy soils are at high risk. The worst times are prior to the winter rains.	The soils are susceptible to wind erosion. The paler and more leached soils are more susceptible.	This affects the Leached Yellow Sands
WATER EROSION	Water erosion can occur in susceptible soils which have inadequate soil cover, steeper slopes, higher sand content and dispersibility.	Slopes are gentle to moderate. Most water erosion risk will be from movement during storms and along roads. Some sand is susceptible when crusted and non wetting.	Minor potential on the steeper slopes.
SOIL ACIDITY	Soil acidity depends on a number of factors such as the amount of calcareous material within the soil, the crops grown, fertiliser usage and the proportion of clay. Soils that are too acidic can allow elements such as metals, including aluminium, to dissolve and become toxic.	The soils are neutral to acidic as is typical for such natural soils. There has been little agricultural activity that would lead to an increase in soil acidity.	No Issues for rural living land use or ancillary industrial use.
SALINITY	Salinity is the proportion of salt in a soil. Often mildly saline soil moisture is concentrated on the surface through evaporation, leading to an inability to support crops and plant growth. Normally worse	There is no evidence of salinity on the ridges and elevated ground. There is some evidence of soil salinity in previously poorly drained Sand over Sandy Clay	No issues although the potentially saline affected soils should remain drained and can be filled.

	where ancient soils and laterite profiles are present.	soils in the central north. These appear to be historical and have been improved by drainage.	
ROOTING DEPTH	The depth roots can penetrate depends on texture changes in the soil such as duplex soils, the proximity of bedrock, stone in the soil, hard clay layers and soil compaction.	The soils are deep apart from where shallow limestone occurs, or where compacted silt and clay underlies gravel.	Areas of limestone at shallow depth and compacted clay under gravel.
SOIL MOISTURE STORAGE	The ability of a soil to retain water determines the potential for crop growth and the amount of rainfall and irrigation required.	The more earthy the soils the better the soil moisture retention. The degree of leaching reduces soil moisture holding capability.	Leached yellow sands
WATER LOGGING	Water can lay on the surface, clogging the pores in the soil. This reduces soil oxygen leading to loss of nitrogen and reduced crop growth	Not susceptible and well drained on the elevated ground. There is evidence of previous waterlogging but this has been reduced by drainage.	Only near Steerdale Road
SOIL WORKABILITY	Workability is the ease that the soil can be cultivated. Waterlogging, the presence of stone and slope can all impact on the ease of cultivation.	The soils are workable except where limestone touches the surface	Only where limestone touches the surface.

### Soil Testing

A total of 19 soil test holes were sunk by backhoe, combined with field soil mapping by numerous traverses.

The location of the soil test holes is shown on the attached Soil Map.

Samples from adjoining land were collected and analysed for phosphate retention previously by the Chemistry Centre. See 5.2 Nutrient Management – Phosphorus.

The same soils occur on this site and the data remains useful.

### Hydrogeology

See the attached Local Water Management Strategy and Section 6.0 Hydrogeological Assessment for a summary.

#### 4.0 SITE FOUNDATION GEOTECHNICAL ASSESSMENT

The Geotechnical Assessment was conducted by Lindsay Stephens to identify issues listed under *State Planning Policy 3.4, Natural Hazards*. The work was conducted to various standards that are listed throughout the report, but particularly to *AS 1726 Geotechnical Site Investigations, AS 2870 Residential Slabs and Footings – Construction* and *AS 3798, Guidelines on Earthworks for Commercial and Residential Developments* in addition to Guidelines produced by the *Australian Geomechanics Society*.

A summary of the geotechnical issues is included in the table below.

**Table 3 Summary of geotechnical properties for development**

PROPERTY	DESCRIPTION	SOIL SUSCEPTIBILITY	SOILS POTENTIALLY REQUIRING MANAGEMENT
FOUNDATION STABILITY	Foundation stability is related to the ability of a soil to compact and remain stable. Silica sands are best for this. Sloping clay soils, soils loaded with water, or expanding clay, will all lower the stability. Sometimes it is not always obvious what can happen under exceptional conditions.	Good foundation conditions occur on the sandy ridge and elevated soils  The Sand over Sandy Clay soils have a lower foundation stability but this can be managed through continued drainage and the use of fill.	Normal requirements for Sand over Sandy Clay soils
LANDSLIP RISK	Steep soils that are loaded with water and have the slopes changed or vegetation removed are all at greater risk of soil creep and landslip. Assessed to Australian Geomechanics Journal March 2000 ( <i>Landslide Risk Management</i> ).	Gently sloping sandy hill with no landslip risk. Other areas are flat or nearly so.	No special requirements apart from those normally required for footings for dwellings in similar soils.
EASE OF EXCAVATION	The presence of basement rock, shallow groundwater, steep slopes or hard clay can all restrict excavation.	High apart from minor areas where a limestone pinnacle is encountered in the west.	High
COMPACTION ABILITY	Some soils such as quartz sands are easier to compact when using cut and fill. Others such as calcareous sands and hard clays can be difficult to compact.	Sandy soils have high compaction capability. The Sand over Sandy Clay Soils will be filled with sand and not compacted or used for fill.	No special requirements.
EXPANSIVE SOILS	Some clays such as smectites are expansive and can swell when wet and shrink when dry, therefore impacting on developments.	No expansive soils were noticed but some expansive characteristics of the Sand over Sandy Clays cannot be ruled out and it is likely that the subsoils of those soils are partially expansive.	No special requirements. Handled by drainage, fill and appropriate foundation design and construction.
WATER LOGGING - INUNDATION	Soils that become waterlogged can impact on dwellings through capillary action.	There has been some historical water logging but the drainage of the site has mitigated most of this apart from a small area in the central north.	Confined to a small area in the central north that can be managed through fill and drainage.

FLOOD RISK	Soils that are subject to flooding from storm events and watercourses are at risk. Sometimes it is not always obvious what can happen under exceptional conditions.	There are no obvious natural watercourses.  The land to the north sheds large volumes of water in storms and this flows into the central north of the site draining to the central east. There is a drain collecting and confining this water, but the volumes can be relatively large and management of the flood flows is required.	Drainage line from central north to central east and adjoining land.
DEPTH TO IMPERMEABLE CLAY	A minimum of 1.2 metres of free draining soil under the base of waste water disposal areas	The elevated soils are deep sands over limestone and sandy clay. They are well drained.  The Sand over Sandy Clay are well drained in the south east with sand over the clay. Parts of the north east and central north have reduced sand over clay but even the underlying sandy clay is slowly permeable.	Managed by normal development actions.
DEPTH TO THE WATER TABLE	The depth to the water table must be a minimum of > 1.8 metres for conventional septic systems and >0.5 metres for alternative waste water units.	The water table is below the level that might impact on developments or wastewater disposal.	Managed by normal actions for waste water disposal and development.
PHOSPHATE RETENTION	Phosphate is retained on sesqui-oxides, clays and calcareous particles. Soils such as white sands that do not retain water or clays, do not allow water to penetrate and will not adsorb phosphate.	Phosphate retention levels are high in the yellow sands which have soils with friable clay subsoils. PRI values of 3.1 – 4.4 are typical for the yellow sands but these are deep and the depth combined with the phosphate retention provides high retention. The underlying limestone has very high PRI with values of 29. In the east and north the underlying silty clays and loams have high PRI of 64 to 120.	Not a significant issue.
REMOVAL OF NITROGEN	Moist and wet soils with reduced oxygen levels can lead to nitrogen losses through denitrification. Soils such as white sands that do not retain water, or clays that do not allow water to penetrate, may not allow sufficient time for denitrification.	All soils have sufficient capability for denitrification to occur.	Not a significant issue.
MICROBIAL PURIFICATION	Soil microbes require a minimum of 5 metres of	All ridge soils have high capability.	Managed through the appropriate selection

	sandy soil or less (down to 1 metre) for soils of lower permeability such as loams. The longer a soil retains waste water the better the microbial purification. Clays may not be permeable enough for waste water to penetrate the soils.	The Sand over Sandy Clay have generally good management and any deficiencies will be managed through the selection and construction of appropriate waste water disposal systems	of waste water systems.
PERMEABILITY	Soil permeability affects the ability to accept waste water or the ability to retain waste water long enough for adequate treatment. Soils that are too permeable, such as white sands, or clays that are impermeable, are at risk.	The sands are highly permeable. Underlying Sand over Sandy Loam Soils in the east and north are slowly permeable.	Managed through the appropriate selection of waste water systems and drainage

#### 4.1 Foundation Stability

**Foundation Stability** relates to the suitability of the soils to accept dwellings or other structures. The assessment of Foundation Stability is conducted using the geotechnical methods outlined in AS 1726, and to the standards outlined in AS 2870, for single storey dwellings.

*Foundation stability is related to the ability of a soil to compact and remain stable. Silica sands are best for this. Sloping clay soils, soils loaded with water, or expanding clay, will all lower the stability.*

*AS 2870 considers foundation stability to a depth of three metres and a 50 year consideration period. The foundation stability rating can be improved by the use of compacted sand fill, pile foundations and heavier footings.*

*Field assessment is an important part of this assessment to determine what soils factors may impact on soil stability. The type and composition of the soils, the underlying geology, the presence of expansive clays or compressible materials, slope stability, summer and winter soil moisture and vegetation can all influence soil conditions. The interpretation provides background on what soil modifications are appropriate and what changes or improvements might result. Normally on Site Class M soils, a compacted sand pad of 900 – 1200 mm thickness is used to improve the Site Class to Class S.*

*A number of drainage steps and good construction techniques are normally also used to improve foundation stability*

This assessment describes the soils under natural conditions, without any drainage or fill which will improve the land capability and foundation stability.

The soils on the ridge are well drained deep sands over limestone, with sand over Sandy Clay in the east.

The deep sands are well known for their high levels of foundation stability and construction capability and are classified as High (Site Class A with potentially some locations at S, AS 2870).

The foundation stability of the Sand over Sandy Clay depends on the thickness of the overlying sand sheet. On locations where the sheet is in excess of 1 – 2 metres the foundation stability is classified as generally High (Site Class S – M, AS 2870).

There are some locations where the depth of sand is thin and those areas may have Moderate foundation stability (Site Class M with some areas of potentially H, AS 2870).



With continued drainage and fill the natural foundation stability as noted above will be raised. For example those areas of thin overlying sand will have sand fill placed on them raising the foundation stability to the same as those with thick overlying sand; that is Site Class M or S.

### **Ease of Excavation**

*The presence of basement rock, shallow groundwater, steep slopes or hard clay can all restrict excavation and increase costs of developments.*

All soils are easily excavated for developments. There are some limited areas of limestone pinnacle in the central north west, but the pinnacles are easily removed and are not limiting.

### **Compaction Ability**

*Some soils such as quartz sands are easier to compact when using cut and fill. Others such as calcareous sands and hard clays can be more difficult to compact under certain conditions such as when dry or non wetting. Under such situations wetting agents, water and efficient compaction in lifts can be used to ensure compaction for developments.*

The subsoils of the ridge are sands that are readily able to be effectively compacted. The Sand over Sandy Clay will not be used for fill and is not recommended for that purpose. Therefore the compaction capability of those soils is unlikely to be required.

### **Expansive Soils**

*Some clays such as smectites can be expansive and can swell when wet and shrink when dry. This occurs more commonly in poorly drained, seasonally wet and saline conditions in Western Australia. However in the Eastern States expansive clays are relatively common and occupy 30% of the soils in Australia. To maintain stable foundations under expansive clay conditions the footings may need to be heavier or sand pads thicker in addition to maintaining stable soil moisture.*

The soils of the ridge are sand based, with no risk of expansive soil conditions.

The sandy clay subsoils in the east and north east may have subsoils that demonstrate some expansion capability but this will be mitigated by drainage and filling with sand. Even so no obviously expansive clays were observed.

The previously wet soils in the central north, which exhibit some evidence of past saline conditions, are likely to have a slightly higher potential for expansion issues, but still at a level that is readily managed by fill and drainage.

### **Karst**

*Karst is cavity and cave development in limestone, or dolomite that occurs under conditions where groundwater has or had strong flows in the past or where groundwater had contact with acidic organic enhanced conditions such as at the edge of wetlands or where limestone overlies impervious basement such as clay or granite. In such situations the limestone may have cavities developed in it which can reduce foundation stability.*

Even though the ridge has a core of limestone there is no significant limestone outcrops and no signs of karst features.

The surface water flows from the north are to the east away from the ridge.

There are no water flows along the base of the limestone at the clay interface under the sand and limestone ridge. Subsurface water flows along a clay interface are geomorphological situations where solution features can develop, but these are not present on site and there is no evidence of those flows in the geological historic past.

**Capillary Action**

*Capillary action in a soil is the drawing up of water from subsoils or wet areas. Normal design of footings, the thickness of sand pads and the use of impermeable membranes are all used to negate any risk.*

*As good practise the use of cutoff drains and sand pads on potentially wet areas on slopes is recommended.*

The subject land is generally well elevated and well drained. There are minor areas in the central north that were susceptible to winter wet conditions in the past, but these have been mitigated by drainage. Only minor areas now exist where water may lay on the surface for limited times. These occur in the north east and north west and are avoided by subdivision design and the allocation of building envelopes in addition to improving the existing drainage and by the use of sand fill.

It is normal good practise to have the sand fill a minimum of 600 mm above the natural soil grading back around the perimeters to that natural soil.

The road swale drainage will provide cut-off for water flowing down the gentle slopes.

**Road Construction**

Road construction conditions are high, with gentle sandy slopes where road construction costs are minimised.

The road layout reduces the amount of road on the sandy clay soils in the north east and combines the road reserve with drainage and flood functions.

<b>Foundation Stability Risks Identified and Recommended Management</b>	
Dwellings	<ul style="list-style-type: none"> <li>• Foundation stability is generally classified as high Site Class A – S, AS 2870 for the sandy elevated areas.</li> <li>• The Sand over Sandy Clay in the south east has Site Class S – M, AS 2870 and the north eastern areas Site Class M with potentially some H, AS 2870. These soils are recommended to have heavier footings even if deep fill is used.</li> <li>• The classifications above are for natural soils with no drainage or fill improvements, which will lift the stability to better classes.</li> <li>• Development conditions are therefore high for dwellings, because any limitations can be mitigated during development</li> </ul>
Roads	<ul style="list-style-type: none"> <li>• Development conditions are high for road construction.</li> </ul>
Recommendations	<ul style="list-style-type: none"> <li>• <i>Site specific soil testing is required for each dwelling at the design stage in line with normal practice where an engineering certification is provided with the submissions of the drawings.</i></li> </ul>

**4.2 Landslip Risk**

**Landslip Risk** is assessed using the methods developed by the Australian Geomechanics Society (*Journal Australian Geomechanics, Volume 35, No 1, March*

2000). *The risk of Landslip or ground movement depends on the geology, soil types, hydrology, landforms and vegetation.*

*Steep soils that are loaded with water and have the slopes changed or vegetation removed are all at greater risk of soil creep and Landslip.*

Slopes on the ridge are sand with a limestone core with no landslip risk.

Other areas are flat with no risk of movement.

The only risk of movement will normally be from inappropriately constructed or compacted fill on slopes cut into the natural soils.

<b>Landslip Risk Identified and Recommended Management</b>	
Landslip	<ul style="list-style-type: none"> <li>Landslip Risk is rated as Very Low and managed through normal foundation design and construction as described in Section 4.2 above.</li> </ul>
Recommendations	<ul style="list-style-type: none"> <li>Normal construction practise matched to the soils.</li> </ul>

#### 4.3 Stability of Dams

**Stability of Dams** depends on their location with respect to the underlying geology, the hydrology and the soil types. *The proportion of clay, whether the clay is dispersible, slopes and gradients, the water table, rainfall pattern, design and construction of the dam and spillway, and geology, can all impact on the potential stability of a dam.*

*The salinity of the dam can also impact on the structure of the clays making the clay more dispersible and therefore more susceptible to tunnel and other failure.*

There are no dams on site because the underlying sandy clay subsoils are too porous and do not hold water.

It is unlikely that dams will be able to be constructed.

<b>Risk Identified with Dams and Recommended Management</b>	
Dams	<ul style="list-style-type: none"> <li>No risk.</li> </ul>
Recommendations	<ul style="list-style-type: none"> <li>Nil</li> </ul>

#### 4.4 Earthquake Risk

**Earthquake Risk** is dependant on the proximity to the active earthquake areas, mainly in the Wheatbelt, the soil types and the types of construction. *Wet unconsolidated sediments carry the highest risk when liquefaction can sand or mud subsoil movements can occur. The most at risk soils are the Estuarine Silts that could liquefy under shaking stress.*

*The risk has been defined by Geoscience Australia and is based on AS 1170.3:1993.*

The ridge soils are well drained, located on a sloping land surface, with no greater risk than any other development in Hopetoun.

The Sand over Sandy Clay soils in the north eastern and northern portion of the site carry a slightly higher risk if earthquake activity occurred when the soils were wet and saturated.

Risk is mitigated by the design and construction of foundations combined with normal practices of using cutoff drains and sand fill and heavier footings as necessary, and is covered under Foundation Stability.

<b>Earthquake Risk Identified and Recommended Management</b>	
Earthquake	<ul style="list-style-type: none"> <li>• Similar to other developments in the Hopetoun area for the elevated soils.</li> <li>• The sandy clay soils of the north east are recommended to have heavier footings even if deep fill is used.</li> </ul>
Recommendations	<ul style="list-style-type: none"> <li>• Use normal testing, design and construction for soils.</li> </ul>

#### 4.5 Acid Sulfate Risk

**Acid Sulfate Soils** can potentially form under reducing conditions when there is a source of carbon and a source of sulfur (normally from sea or saline water). Micro-organisms are thought to play an important role in reducing the sulfates within the sediments to form the iron sulfide. It is a natural phenomena, that can be exacerbated by disturbance.

Potential acid sulfate conditions most commonly form under current or past estuarine conditions, peaty conditions, and may also result from weathering of some geological formations and situations which contain sulfides.

Overall, at risk areas are geologically a minor occurrence, but in some situations can be important, and lead to acidic polluting conditions developing.

Acid conditions can form if soils containing pyrite are exposed to the air, allowing sulfuric acid to be formed. The soils most at risk are normally saline/estuarine soils, gley soils, peat and some organoferricretes.

Planning Bulletin Number 64, Department of Environment Guidelines, the Acid Sulfate Soil Management Advisory Committee NSW, 1998, Acid Sulfate Manual provides the most information on recognition and mitigation of potential acid sulfate conditions.

Potential acid sulfate soils are tested under conditions which speed up the natural oxidation of the soils on exposure to the atmosphere. Natural oxidation can occur within hours and days of exposure and is normally complete for small samples within a month. Laboratory testing speeds up this process with the use of H<sub>2</sub>O<sub>2</sub> or other oxidising agent and then tries to quantify the amount of oxidation and acid development. One of the best methods of preliminary assessment is to collect samples and leave them exposed to the atmosphere for one month. The pH of the sample is to be tested immediately on exposure and at the end of one month for changes to pH.

WAPC mapping does not extend this far. The soils are elevated free draining, and well oxygenated.

The yellow sand indicates high oxygen levels. The limestone that underlies the ridge is calcium carbonate which neutralises acidic conditions.

The only areas for consideration are the sandy clay based soils in the north and north east. These are not estuarine in origin, but rather alluvial. The salinities are generally low and there is no evidence of organic matter accumulating or permanently reducing conditions which would all be necessary for acid sulphate conditions to develop.

The sandy clay subsoils are permeable and dry out in summer when oxidising conditions develop and negate any acid sulphate risk.

<b>Acid Sulfate Risk Identified and Recommended Management</b>	
<b>Acid Sulfate</b>	<ul style="list-style-type: none"><li>• No risk identified or likely to occur on any part of the site.</li></ul>
<i>Recommendations</i>	<ul style="list-style-type: none"><li>• <i>Nil for development area.</i></li></ul>

## **5.0 WASTE WATER – CAPABILITY AND NUTRIENT ASSESSMENT**

### **5.1 Geotechnical Capability for Waste Water Disposal**

*The **Capability of a Site for Waste Water Disposal** depends on a number of geotechnical factors. These include the soil type, depth and permeability of the soil, depth to impermeable layer, depth of perched or other water tables and potential for flooding or waterlogging. Assessment should be made from field investigations because the whole soil profile and local geology can determine the likely path of the waste water.*

*Interpreted information of water tables from soil profile and geomorphological examination is an important part of the assessment process because conditions vary from year to year and tests conducted in some well below average years may not reflect potential impacts in excessively wet years. The assessment should also take into consideration the potential for soils conditions to be changed through water loading and earthworks as a result of developments.*

*The mineralogy of the soil profiles can be determined by visual and field examination, with the species and form of iron oxide being particularly useful at providing data on soil moisture conditions through the seasons. Natural site vegetation species are also useful as indicators of historical seasonal soil moisture conditions.*

*The Government Sewerage Policy, 1996, Government Draft Country Sewerage Policy, 2002, Department of Health Guidelines for the Reuse of Greywater in Western Australia, Department of Health Specification for Aerobic Treatment Units 1992, Health (Treatment of Sewerage and Disposal of Effluent and Liquid Waste) Regulations 1974, AS/NZS1547:2000, all provide input into the acceptable site characteristics. The Health Act Regulations require 1 200 mm of free draining soil beneath waste water disposal areas.*

*The types of waste water systems all have different installation requirements and potential impacts, and can be selected to alleviate adverse site conditions. Whether a conventional septic system or nutrient or composting waste water system is used will depend on the site conditions.*

#### **Soil Type**

The soils on most of Lot 8 are elevated across the western and southern parts with deep sands.

The remainder of the site is sand over sandy clay.

The Government Sewerage Policy permits waste water disposal from lots as small as 0.2 hectares in leached white sand with little phosphate retention capability. All lots are in excess of 10 000 m<sup>2</sup> or 1 hectare on soils with greater soil capability than sand. Even the Sand over Sandy Clay soils in the east, north east and north generally have 500 mm of sand with slowly permeable sandy clay subsoils that permit water infiltration. The clay content provides for greater soil moisture retention and a slowing of infiltration, and ,combined with the clay and sesquioxides, provides good nutrient management that is significantly better than leached white sands.

See 3.2 Regolith and Soils and the attached maps and photographs for details of soils.

## **Waterlogging**

The subject land is well drained across most of the site. There is an historical area of winter wet soils in the central north that has been improved by the construction of a drain directing water from the central north to the central east.

The drain enables water entering from the north to be moved more rapidly across Lot 8 and not pool on site and add to potential for waterlogging.

The continued maintenance and enhancement of the drainage is proposed for the subdivision. The drain combined with the use of fill will enable satisfactory waste water disposal in the east and north of Lot 8 where shallow sand over sandy clay may occur.

The critical issues are that the waste water should be disposed of into dry conditions and the waste water should infiltrate into the natural soils and not be able to move laterally and short circuit the disposal area.

The eastern and northern portions of Lot 8 may require nutrient adsorbing waste water treatment systems. For those locations the use of fill and drainage is more likely to enable the use of alternative waste water systems. On the other hand in such locations conventional septic systems with inverted or semi-inverted leach drains may be acceptable.

The Shire of Ravensthorpe is responsible for approving waste water systems. They will normally require either a conventional septic system, or an alternative waste water system and specify and approve the installation.

## **Water Table**

The site investigations were conducted by Landform Research on 8 February 2007.

The water table was not intersected in any soil test hole. Observations on site at other times has shown that the main water loading on site is from storm events that can occur at any time of the year and contribute water from north of Steerdale Road.

Winter rainfall is higher but reaches 60 mm per month and in many months is not sufficient to saturate the soils.

Normally when the soils are saturated it is a surface situation with water temporarily perched on the land with the water table at depth. This is borne out by the work of Hirschberg 1980 whose drilling and water table depth assessment does not extend onto Lot 8. Hirschberg recorded the elevation of the water table as being 9 metres AHD south of the southern boundary of Lot 8. By interpretation that would equate to an elevation of 10 metres AHD at the southern boundary, seven metres below the lowest land elevation in that corner.

The water table would rise towards the north eastern corner but, by interpretation of the geology and Hirschberg 1980, slow enough for a separation of several metres at the north eastern corner.

Lot 8 is therefore sufficiently above the water table for there to be no issue.

## **Setbacks from Water bodies**

The Government Sewerage Policy provides guidelines on the setbacks required from water bodies, with which this proposal complies for alternative waste water systems. This is 50 metres for alternative or nutrient adsorbing waste water systems, for creeks.

However the *Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974*, provide for a 30 metre buffer under all situations and this will prevail.

There are no dams and no water courses. There is the constructed drain from the central north to the central east. A 30 metre buffer is recommended for conventional septic systems and leach drains. It is possible that a reduced setback could be sustainable if nutrient adsorbing waste water systems are used.

The Health Department Code of practice for ATU's suggests a 10 metre separation to drains, but the Regulations only require 6 metres which would also prevail.

**Infiltration results**

Infiltration tests were not conducted because the overlying sand sheets and deep sands are well known for their ability to provide high infiltration rates.

The soils mapped were all assessed as being permeable and capable of meeting the Government Guidelines.

For conventional septic systems, according to *Schedule 8 of the Health Act 1911*, a loading of 20 litres/m<sup>2</sup>/day is applicable for leach drains in loam soils with alternating leach drains, and 10 litres/m<sup>2</sup>/day for non alternating systems on sites such as this. It is standard practice to use dual leach drains with waste water disposal being able to be directed alternately to each leach drain.

Alternative/nutrient adsorbing (aerobic, Filtrex or Ecomax) effluent disposal systems are also acceptable and require a waste water loading not exceeding 10 litres/m<sup>2</sup>/day.

Australian Standard 1726 for Geotechnical Investigations permits interpreted assessments. Interpreted assessments are an essential part of site evaluation because it is crucial to know how representative the test hole is and what conditions are indicated by the colour, nature, texture and mode of formation of the soil profile. These observations suggest acceptable infiltration ability.

The use of greywater recovery systems, which treat the black water separately and use the greywater for subsurface irrigation of plants, are effective and water saving.

<b>Geotechnical Assessment for Waste Water Disposal and Recommended Management</b>	
<b>Waste Water Disposal</b>	<ul style="list-style-type: none"> <li>The whole site has a high capability for waste water disposal from conventional septic systems and alternative or nutrient adsorbing waste water systems.</li> </ul>
<i>Recommendations</i>	<ul style="list-style-type: none"> <li><i>Waste water disposal systems should be installed according to the;</i> <ul style="list-style-type: none"> <li><i>Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974 – Health Act 1911,</i></li> <li><i>Department of Health, 2001, Code of Practice for the Design, Manufacture, and Operation of Aerobic Treatment Units Servicing Single Dwellings</i></li> <li><i>Government Sewerage Policy.</i></li> </ul> </li> <li><i>Grey water disposal systems are acceptable with the greywater systems installed to the Department of Health Greywater Guidelines.</i></li> </ul>

**5.2 Nutrient Management**

*A change in land use may alter the Nutrient Input and Management patterns and loadings. Changed agricultural regimes and more intense development may lead to*



*increased nutrient loading. The pattern of this loading and the ability of the soils to accept the loading depend on many factors, such as the type of land use, lot size, type of waste water system, type of crop, nutrient application rates, soils, depth to groundwater, flow paths of surface and groundwater, permeability of the soils and underlying geology.*

*The various Government policies and regulations are designed to ensure minimisation of the risk of nutrient export so in many cases compliance with these guiding documents is all that is required. The guidelines take into consideration the soil characteristics as well as setbacks from wetlands and water bodies.*

*The following documents provide input into the acceptable site characteristics and the acceptable Subdivision or development; Government Sewerage Policy, 1996, Government Draft Country Sewerage Policy, 2002, Department of Health Guidelines for the Reuse of Greywater in Western Australia, Department of Health Specification for Aerobic Treatment Units 1992, Health (Treatment of Sewerage and Disposal of Effluent and Liquid Waste) Regulations 1974, AS/NZS1547:2001.*

*The type of waste water system and its installation can be used to ameliorate potential problems.*

*A site specific consideration of the in ground behaviour of phosphorus, nitrogen and microbial inputs is desirable.*

## **Nutrient Loadings and Stocking Rates**

***Nutrient Management** encompasses the management from waste water disposal and land uses. Nutrient management may need to change in order to sustain a new land use. There may also be opportunities to improve the management of nutrients from current land uses.*

*The management of nutrients is normally linked to other environmental and management issues such as revegetation and the treatment of stormwater.*

- **Current Loading**

Current potential nutrient export comes from the existing land uses.

Lot 8 has in recent years been used for sand excavation and limited grazing. A small rural industry has been undertaken in the north western corner.

Therefore there has limited nutrient input apart from the grazing by stock.

Nutrients from stock normally occur from the washing of fertiliser, soil particles and manure along drainage lines and from minor vertical infiltration through the natural soils. Vertical infiltration is very limited on a site such as this because of the very large dilution factors.

The worst time for nutrient export in agricultural areas is during summer storms, during the first autumn flush, but this is less applicable on this site because of the sand over clay soils. This applies to the washing of dung from the stocked land to the north of Steerdale Road during storm events when flows can be large.

Any waste water disposal sites will need to be selected based on individual site inspection. The location of any leach drains should be assessed on a site by site basis, and may have to be semi-inverted. Any leach drains installed in these soils are recommended to be bunded by natural soil to prevent waste water short-circuiting the soils.

Therefore the best means of comparison of nutrient loading is from the loading that would apply from grazing on Lot 8 compared to the proposed subdivision.

Stocking rates for sandy soils of the site are estimated to be 5 DSE or 1 adult cow per 2 hectares. (1 breeding cow equates to 8 – 16 sheep depending on whether N or P are compared).

This equates to 5 DSE (dry sheep equivalents) for dry pasture and where limited supplemental feed is supplied. This equates to a loading of 50.3 kg/N/ha/year and 6.35 kg/P/ha/year (Van Gool et al 2002). No crops have been grown on Lot 8 in recent years but could be planted on the eastern parts of the site.

- **Proposed Loading**

Lot sizes are proposed to be 1.0 hectares connected to scheme water.

To place that into perspective, the Government Sewerage Policy permits conventional septic waste water disposal systems on lots as small as 0.2 hectares. With minimum lot sizes of 1.0 hectares the proposed developments are low intensity with respect to waste water management.

Data on nutrient inputs is taken from Van Gool D, K Angell and L Stephens, 2000, *Stocking Rate Guidelines for Rural Small Holdings Swan Coastal Plain and Darling Scarp*, Department of Agriculture, Miscellaneous Publication 02/2000, Legislative Assembly, 1994, *Select Committee on Metropolitan Development and Groundwater Supplies, Western Australia*, Dames and Moore, undated, *Draft nitrate management in Jandakot UWPCA*, Water Authority of Western Australia.

From the above references a typical lot with a conventional septic system, small garden and lawn, dog and cat plus some chickens has a nutrient loading of 31 kg/N/year and 9.6 kg/P/year. This will be added to the soil on the building envelope. A conventional septic system releases 18 kg N and 5.5 kg P per year as a point source. The other nutrients are spread more broadly across the soil surface.

For a nutrient adsorbing waste water system (ATU) a significant proportion of the phosphorus and nitrogen is removed within the waste water disposal area and is not directly added to the soil, reducing the overall soil input to 19 kg/N/year and 4.6 kg/P/year per lot.

A horse has a typical loading of 11 kgP/year and 60 kgN/year. Horses and other stock will require management of wastes. Best management of manure is outlined in Van Gool D, K Angell and L Stephens, 2000, *Stocking Rate Guidelines for Rural Small Holdings Swan Coastal Plain and Darling Scarp*, Department of Agriculture. On lot sizes of 1.0 hectares not every lot will have a horse and an average of one per lot is applicable.

**Typical nutrient loadings of some land uses**

Possible lot size and activity	Nitrogen loading per hectare	Phosphorus loading per hectare	Likely nutrient scenario
Estimated average current stocking at 5 DSE per hectare, without pasture improvement or irrigation.	50.3 kg/N/ha/year	6.35 kg/P/ha/year	Unlikely to be nutrient export based on deep yellow and earthy sands and sand over slowly permeable sandy clay with minor on gravel. Possible nutrient export from flood storm events.
Likely nutrient input after subdivision to 1.0 hectare lots. Conventional septic system. Small garden, small fertilised lawn, dog, cat, 6 fowl or additional garden. Average one horse per lot.	91.0 kg/N/ha/year	20.6 kg/P/ha/year	Higher nutrient loading with the greatest contribution from the horse. Provided the manure is spread across the lot and is not a point source or located in the storm flood path there is minimal risk of nutrient export. See the calculations on the high phosphate retention capability of the soils.
Likely nutrient input after subdivision to 1.0 hectare lots. Conventional septic system. Small garden, small fertilised lawn, dog, cat, 6 fowl or additional garden. No stock.	31.0 kg/N/ha/year	9.6 kg/P/ha/year	Similar nutrient loading with minimal to no nutrient export risk.
Likely nutrient input after subdivision to 1.0 hectare lots. Nutrient adsorbing waste water system (ATU). Small garden, small fertilised lawn, dog, cat, 6 fowl or additional garden. No stock.	19.0 kg/N/ha/year	4.6 kg/P/ha/year	Lower nutrient loading with minimal to no nutrient export risk.

- A variety of average lot sizes and stocking rates are used to provide an indication of nutrient inputs prior to and following subdivision. Horses are used as a likely example.
- The calculations above are made on the basis of the total area averaged across cleared land and remnant vegetation.
- A variety of average lot sizes and stocking rates are used to provide an indication of nutrient inputs prior to and following subdivision. Horses are used as a likely example.
- One horse is equivalent to six sheep in terms of nutrient output.

**Fate of Nutrients**

*Nutrient Management encompasses the management from waste water disposal and land uses.*

*The ability of soils to adsorb phosphorus, reduce nitrogen and inactivate microorganisms is important.*

The main issue with effluent disposal from dwellings, is nitrogenous and phosphate compounds together with organic matter or BOD. This could be released by animals, contained in waste water or introduced in biological matter.

- **Phosphorus**

*Phosphorus is the main nutrient implicated in algal blooms in waterways and therefore it is important to limit its loss from the site. Phosphorus is capable of being stored in the basal muddy sediments of water bodies. From there the phosphates are released over time and provide nutrient to fuel algal blooms. In this case phosphorus addition to the soils is the issue.*

*Phosphorus is readily adsorbed onto clay and sesquioxides of the subsoils, gravels and yellow sands. Calcareous soils and calcretes retain phosphorus as apatite. The soils on site, with their loam nature and increased clay content in the subsoils, have inherently high phosphate retention capability.*

*Phosphorus adsorbing amended soils would be used for the waste water disposal area of alternative waste water systems on the lower elevations where the sands have low phosphate retention. These systems are nutrient adsorbing, and are designed to adsorb all or almost all the phosphorus released in waste water.*

*Phosphate Retention (PRI) can be a useful indicator, but the nature of the analysis can understate or overstate the field behaviour. Some soils theoretically can have good phosphate retention characteristics, but the behaviour of the waste water in the field may negate these characteristics. For example particles larger than 2 mm are sieved out prior to analysis and a gravelly sand may therefore have a lower PRI than the field reality. On the other hand clay may have a very high PRI but may not be sufficiently permeable for the waste water to penetrate.*

The deep yellow and earthy sands are well known for their aggressive adsorption of phosphate. The soils are highly suitable for conventional septic systems provided lot sizes of > 0.2 hectares are used, and comply with the Government Sewerage Policy.

The phosphate retention (PRI) of the soil profiles are high when considering the whole soil profile (compared to the database of type soils held by Landform Research for PRI and with Chemistry Centre data).

The same soil types were assessed for the adjoining land to the west and south for PRI.

- The earthy yellow sands contain clay in variable proportions but generally in the 1 – 5 % range.
- The small amounts of clay and sesqui-oxides provide moderate phosphate retention (PRI), that increases with depth. PRI values of 3.1 – 4.4 are typical.
- The limestone underlying the sand ridge has very high PRI with values of 29.
- The basal sand clay subsoils have PRI of 64 to 120.

This data compares with the data from Allen and Jeffrey 1990 and Landform Research database.

At PRI 20, each 1 m<sup>3</sup> soil is capable of adsorbing 30 kg P, the equivalent of 5 years' phosphorus released in annual domestic waste water discharge. At PRI 10 the adsorbing capacity is 20 kg/m<sup>3</sup> which is sufficient for 3.6 years of domestic waste water disposal.

Even at PRI 2 which is lower than the yellow sands on site the phosphate retention is 3.0 kg/m<sup>3</sup>. With the depth of these soils that means that every 50 metres depth of these soils the phosphate retention is 15 kg/m<sup>3</sup> per lateral square metre of land area. However the situation is even better than that in that the yellow sands become earthy with depth and overly limestone on the ridge, both of which have much greater phosphate retention.

This illustrates the high capability of the soils for waste water disposal. The key is to retain the soils on the Sand over Sandy Clay soils in the north east. This is illustrated in State Planning Policy 2.1, The Peel – Harvey Coastal Plain Catchment where intensive land uses such as intensive agriculture are only recommended to be located on deep yellow Spearwood Soils that are essentially the same as the deep yellow sands.

Similar conclusions are made in Van Gool D, K Angell and L Stephens, 2000, and Gerritse et al 1990. Gerritse et al 1990 found that phosphorus export was not an issue for urban areas even under Bassendean Sands although there is likely to reach a time when the soils become saturated to phosphorus in those leached sands. Poinke et al (undated) found that even with continuous irrigated horticulture the phosphorus loading of over 100 kg per hectare per year results in no phosphorus export.

The potential for phosphorus management on the Sand over Sandy Clay soils is indicated by Gerritse R G and J A Adeney, 1992 who found that phosphorus input for urbanised and cultivated areas with loadings of 20 – 80 kg/ha resulted in exports of 0.007 – 0.04 mg/L in streams at Mundaring and Paterson Road. Phosphorus in streams at Stoneville were between 0.007 to 0.46 mg/L. Their conclusions were that “concentrations of phosphorus in streams on the Darling Scarp are low and barely affected by land use. Average concentrations were in the order of a few ug/L and are only marginally higher in streams in subcatchments dominated by orchards.”

The hills studies are based on significant gravel with loams and some sand over loams in the valleys. The Sand over Sandy Clay does have surface gravel in places and the sands are brown indicating increased sesquioxide presence. Sesquioxide in ferricrete within subsoils was found to be highly phosphate retaining for soils of the Swan Coastal Plain, by Lantzke 1997.

Further studies on the likely fate of nutrients, phosphorus export from orchards and other land uses in catchments in the Perth Hills, on gravel and loam/clay soils that have similar permeability that have an inherently higher capability for phosphate retention and with a higher rainfall, was found to be low and barely affected by land use. Gerritse et al, 1995 again found in their studies the phosphorus levels in streams were so low, in the order of a few ug/L, as to be negligible.

Gerritse et al, 1995B, found that all phosphate was adsorbed within 2 metres from a 7 year old leach drain in Yarrigal loam soils that have some similarity for phosphate retention with the loam soils. The critical point is retention times within the soils.

Conventional septic systems are acceptable using standard leach drains provided the subsoils are suitable. In addition alternative/nutrient adsorbing waste water systems are also acceptable but on this site will not provide any greater nutrient management than conventional septic systems. See Land Capability Mapping.

Alternative/nutrient adsorbing waste water systems can result in lower levels of nutrients being added to the natural soils. Some indication of the quality of the waste water leaving the waste water disposal area of a nutrient adsorbing system can be shown from contacts with Ecomax and Filtrex. Ecomax reveal that their unit provides for 95% phosphate adsorption to enter the natural soils. Research by Filtrex has found that phosphate reduced to less than 1 mg/L at the edge of the waste water disposal area, where it tipped into natural soil (pers com Filtrex).

*Phosphorus loading from onsite conventional septic systems or alternative waste water systems is therefore not regarded as a significant environmental issue for subdivision. The deep yellow sands and limestone are highly capable of aggressively adsorbing phosphorus when the depth to the water table is considered. The sand over sandy clay soils also have high capability, but in some locations and alternative waste water systems may be required to overcome shallow overlying sand and potential lateral leakage at the clay interface.*

*The lot size, down to 1.0 hectares is much greater than the waste water disposal loading permitted by the Government Sewerage Policy.*

- **Nitrogen**

*Nitrogen is a prominent part of living matter and is constantly recycled through the organic matter and the atmosphere.*

*Nitrogen is also held within the soil organic matter and some ions are attached to clay particles. When organic matter breaks down or fertiliser is applied and not taken up by plants, nitrogen is converted to ammonia or rapidly converts to nitrite and then nitrate under the influence of oxygen.*

*The nitrogenous products are taken up by vegetation, denitrified by bacteria under wet and anoxic soil conditions or lost through volatilisation of ammonia or the conversion of ammonia to soluble nitrogenous ions.*

*Nitrifying bacteria are widely present in soil and obtain their carbon from CO<sub>2</sub> and energy from the oxidation of NH<sub>4</sub> or NO<sub>2</sub> to NO<sub>3</sub>. Denitrifying bacteria on the other hand reduce NO<sub>2</sub> and NO<sub>3</sub> to gaseous N<sub>2</sub>O and N<sub>2</sub> which is lost to the atmosphere.*

*Soil microbes rapidly colonise the interface where waste water contacts the soil, with small amounts of organic matter at the interface providing the energy to sustain the microflora. Nitrates are normally removed by soil micro flora under anoxic conditions in the soils including leached white sands. The microflora remove the oxygen to leave nitrogen gas which is lost to the atmosphere. Inorganic nitrogen can also attach to clay particles.*

*Nitrogen is not generally responsible for algal blooms in freshwater environments, but high levels of nitrogen can affect the health of saline water bodies.*

*Nitrogen loss relates to retention times within the soil and microbial activity.*

In a conventional septic system the nitrogen in waste water is changed to nitrate on exit from the tank and entry to the soil. The waste nitrate is then stripped of oxygen by microflora, in reducing conditions and particles in the soil, in the presence of organic matter. This converts the nitrate to nitrogen gas which is lost to the atmosphere. This occurs in all soil types and is independent of the soil type, and depends on soil oxygen levels and to a lesser extent the nature of the soil particles.

The same process occurs in Alternative waste water systems which use amended soil beds, such as Ecomax and Filtrex systems, and in the soils of the waste water disposal area of all systems. Filtrex found that 75% of the nitrogen was lost in the waste water disposal area by the time the waste water had reached the edge of the system. Alternative waste water systems are unlikely to be used although they may be preferred by some landholders to recover the waste water for irrigation of gardens.

The behaviour of nitrogen in soils depends on the oxygen, moisture and organic matter in the soils rather than the soil type.

Many studies, for example Dawes and Goonetilleke, 2001, have found that nitrogen is readily stripped from waste water released from moist soils and drainage trenches. For example on a sloping sandy loam site in Brisbane the water entering the trenches had a concentration of 171 - 190 mg/L N but within 1 metre of the last trench the nitrogen concentration had dropped to 1.7 to 3.7 mg/L

Gerritse et al, 1995, recorded a total of 140 mg/L nitrogen (NH<sub>4</sub> - 100 mg/L and NO<sub>2</sub> - 40 mg/L), exiting a leach drain. After a travel distance through shallow soils of 1 metre this

had dropped to between 20 and 100 mg/L, and by 3 metres the total nitrogen had dropped to 0.03 to 0.2 mg/L. When loaded with nitrogenous compounds the microflora of soils quickly adjusts to the loading, by increases in the number and type of bacteria. For example, under anaerobic conditions with nitrogen loading, the denitrifying bacteria increase significantly. This can be expected to occur in soil aggregates within the top 2.5 metres of soil, which is regarded as the active bed and root zone for the waste water disposal areas.

Lantzke 1997, also found high levels of denitrification in moist leached sands on the Swan Coastal Plain indicating that even leached sands can provide good denitrification.

As noted above nitrogen levels are significantly reduced in a very short distance if the water is able to be retained within the soils with microbial activity. The issue is that the waste water is slowed or prevented from quickly dropping vertically downwards below the level of microbial activity. Nutrient adsorbing waste water systems are designed to provide greatly increased retention times and conditions for microbial activity either within the system itself or by having an impermeable retaining membrane. Nitrogen loss relates to retention times within the soil, and microbial activity and redox conditions, rather than soil type.

This occurs in both conventional septic systems and alternative waste water systems.

Considering that, Gerritse 1995 found that with almost total loss of nitrogen within 3 metres of disposal the potential for nitrogen to significantly add to the groundwater is minimal to nil.

*Nitrogen loading from onsite conventional septic systems or alternative waste water systems is therefore not regarded as a significant environmental issue for subdivision.*

*The lot size down to 1.0 hectares is much greater than the waste water disposal loading permitted by the Government Sewerage Policy.*

- **Microbial Purification**

*Microbial material from stock or waste water systems can present a health hazard unless the material is deactivated by normal soil microbial organisms. Microbes could consist of thermotolerant bacteria, viruses and other organisms. For deactivation to occur sufficient dilution and retention time in the soils or other media are required.*

*Microbial purification is an important part of effluent disposal to ensure that all fine organic matter and micro-organisms are broken down.*

*Soil microbes require a minimum of 5 metres of sandy soil or less (down to 1 metre) for soils of lower permeability such as loams. (Wells and King, 1989). ). The longer a soil retains waste water the better the microbial purification. Organic matter builds up in the soil and supports microbial activity which deactivates and destroys thermotolerant and other organisms.*

Soil microbes require a minimum of 5 metres of sandy soil or less (down to 1 metre) for soils of lower permeability such as loams (Wells and King 1989). The longer a soil retains waste water the better the microbial purification. Therefore it is important that the leach drains are correctly constructed. On this site the deep sand soils are capable of retaining waste water for adequate microbial purification.

The soils comply with all Government Guidelines and are highly capable of dealing with microbial material.

Alternative/nutrient adsorbing waste water systems require that 90% of samples have less than 20 mg/L organic matter, with no sample greater than 30 mg/L. Faecal coliforms are required to not exceed 10 per 100 mL of waste water.

The Government Sewerage Policy provides guidelines on the setbacks required from water bodies, with which this proposal complies. The lot size down to 1.0 hectares is much greater than the waste water disposal loading permitted by the Government Sewerage Policy.

Microbial loading from onsite conventional septic systems or alternative waste water systems is therefore not regarded as a significant environmental issue for subdivision.

The *Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974 – Health Act 1911* require the Local Authority to approve the construction or installation of approved systems in Part 2 of the Regulations, which provides for some control.

<b>Analysis of Nutrient Loading and Recommended Management</b>	
Waste Water Loading	<ul style="list-style-type: none"> <li>Conventional septic systems and Alternative (nutrient adsorbing) waste water systems are acceptable and comply with the Government Country Sewerage Policy on lots down to 0.2 hectares.</li> <li>Lot sizes are over 1.0 hectares.</li> </ul>
Nutrient Export	<ul style="list-style-type: none"> <li>The soils on site are highly capable of accepting the nutrient loading on the lot sizes proposed, bearing in mind the type and depth of soils and distance of lateral flows, without adversely impacting on the Hopetoun Drinking Water Reserve to the south which has a Priority 2 Protection Classification.</li> </ul>
<i>Recommendations</i>	<ul style="list-style-type: none"> <li><i>Installation should be in compliance with Guidelines and Regulations for waste water systems. See previous section on Geotechnical Assessment for waste water disposal above.</i></li> <li><i>Nutrient adsorbing waste water systems or semi-inverted/inverted leach drains may be required in the east and north of Lot 8.</i></li> <li><i>Individual site assessment combined with the use of fill or drainage may be required in parts of the north and east of Lot 8. See attached Figures.</i></li> <li><i>The Local Authority is responsible for approving the type and installation of any waste water system.</i></li> <li><i>A setback of 30 metres is recommend for waste water disposal to the drain. Nutrient adsorbing waste water systems may be able to justify smaller setbacks.</i></li> </ul>



## **6.0 HYDROGEOLOGICAL ASSESSMENT**

### **6.1 Surface Water**

*The impact of the proposal on Rivers, Wetlands and Streams relates to whether the proposal will lead to any adverse effects on the waterbodies. The issues involve setbacks, flows of surface and groundwater, and buffers, and their management.*

Surface water is discussed in detail in the accompanying Local Water Management Strategy.

There is no surface water on the elevated land of the west and south of Lot 8.

There is evidence of past waterlogging of an area of the Sand over Sandy Clay Soils in the central north that has been largely mitigated by drainage.

The natural lie of the land is that of a broad and extensive gently sloping plain extending north from Steerdale Road. That land has been investigated previously by Lindsay Stephens of Landform Research and found to be sandy over clay duplex soils that drain south to Steerdale Road.

During heavy storm events a substantial volume of water flows from north of Steerdale Road across Steerdale Road entering the central north of Lot 8 and exiting in the central east, including running along the roadside drain for a small distance and then crossing the Hopetoun – Ravensthorpe Road to travel south east to Dunn's Swamp and the coast.

A drain has been constructed across Lot 8 from the central north to the central east to direct and confine the stormwater and provide drainage of the central north of Lot 8. The drain is 6 metres wide and 500 mm deep. The drain has extensions along the southern side of Steerdale Road to pick up any flows coming across Steerdale Road.

During the floods of 2004? the storm flows exceeded the culverts on Steerdale Road and the water flowed across the surface scouring the foundations of the road.

During the storm events in the past 10 years the landowner has noted that the drain across Lot 8 has coped with the flows and has filled to a maximum depth of about 300 mm. That would indicate a flow surface area of  $6 \text{ m} \times 0.30 \text{ m} = 1.8 \text{ m}^2$ .

Details on the flood regimes and flows are located in the accompanying Local Water Management Plan.

### **Soil Moisture**

The soils are well drained deep sands with low water retention capability. The Sand over Sandy Loam soils have good moisture retention in the subsoils but reduced retention in the overlying sands.

### **Drainage**

*Drainage relates to the water levels in summer and winter, the elevation of perched or regional water tables, the type of soils, underlying geology and hydrology, natural and potential drainage of a site.*

*Poor drainage can result in waterlogged soils and may impact on foundation stability. Soil moisture can also result in capillary action which can impact on structures.*

The site is gently sloping and elevated in the south east where the soils are very permeable and well drained.

There is a small area in the central north where there has been historical reduced drainage, but this has been largely mitigated in recent years by the constructed drain.

### **Rivers, Wetlands and Streams**

There are no defined natural watercourses, rivers or creeks. There is a previously undefined overland flow of stormwater that crosses Lot 8 from the central north to the central east following storm events. This has now been defined by a drain.

The drain constrains the natural storm flows from the land north of Steerdale Road and take it more directly to the central east where the water crosses under the Hopetoun – Ravensthorpe Road and travels to Dunn’s Swamp and the coast.

### **Waterlogging**

Water logging is discussed under drainage above.

### **Flood Risk**

***Flooding** relates to the potential of a watercourse to flood a particular area. An area susceptible to flooding can be subject to the flood flow or may lie in a flood fringe. Construction should not impede a flood flow and normally structures are not to be placed in the floodway.*

*The flood fringe is not subject to the same erosive forces as the floodway and structures may be located in the flood fringe provided they do not increase the elevation of the flood. Normally a 500 mm separation is required between the 1 : 100 year flood level and any floor elevation.*

There is defined natural watercourses apart from the drain. The drain collects significant storm flows from the land north of Steerdale Road where they are concentrated, to cross Steerdale Road north of Lot 8, and are directed and confined to the constructed drain as storm flood flows.

The constructed drain is 6 metres wide and 500 mm deep. It has a surface area capacity of 3.0 m<sup>2</sup>.

Within the past 10 years the drain has coped with some significant rainfall events and those events have filled it to about 300 mm, which gives the flood path a surface area of 1.8 m<sup>2</sup>.

Discussion of the flood flows is contained within the accompanying Local Water Management Strategy where the potential flood flows are considered within the subdivision design.

## Wetlands

There are no wetlands on site. The area of previously winter wet soils in the central north is really wet pasture rather than a wetland. The drain is partially being colonised by wet site species.

An area of previously moist land in the central north has *Isolepis nodosa* growing in it. This is not a wetland species but grows on coastal dunes in addition to lower moist areas.

## Dams

There are no dams on site and none are likely to be constructed because of the slow permeability of the underlying sandy clay subsoils.

## Salinity

*Salinity depends on the landform, underlying geology and hydrology, as well as the regolith profile. Some regolith has more salt stored in it when compared to other areas.*

*A consideration of the land use changes and water management is normally required to minimise the risk of additional salinity loading and impact. Vegetation plays a part in the assessment and can be used to mitigate salinity issues.*

The soils are well elevated and well drained with no evidence of salinity over almost all the site.

The only area where there is evidence of minor surface salinity is a previously poorly drained area in the central north, which has been improved by the current drain.

Surface Water and Recommended Management	
Surface water	<ul style="list-style-type: none"><li>• There are no limitations from surface water.</li></ul>
Recommendations	<ul style="list-style-type: none"><li>• Nil</li></ul>

## 6.2 Groundwater

The site investigations were conducted by Landform Research on 8 February 2007 and on other earlier occasions on the adjoining land to the north, south and east on a number of occasions and seasons.

The Hopetoun Groundwater Area to the south of Lot 8 is used for drinking purposes. It is possible that there is some subsurface flow to the catchment.

Hirschberg 1980 shows the site is underlain by a trough in the undulating Archaean gneiss and migmatite at depths of near sea level that extends from the southern edge of Lot 8 to the coast.

Groundwater flow is therefore from north east to south west including potential flows from the southern edge of Lot 8.

Hirschberg 1980 assumed recharge of 3% to 10% for the water resource which occurs under the deep sand ridge. On the remainder of Lot 8 recharge to the groundwater source aquifer is interpreted to be minimal to nil with water draining mainly by surface flows to Dunn's Swamp to the south east.

Hirschberg recorded the elevation of the water table as being 9 metres AHD south of the southern boundary of Lot 8. By interpretation that would equate to an elevation of 10 metres AHD at the southern boundary, seven metres below the lowest land elevation in that corner, rising towards the north eastern corner where a separation of several metres occurs.

Lot 8 is therefore sufficiently above the water table for there to be no significant issue.

Additional information on Groundwater is discussed in the accompanying Local Water management Strategy.

<b>Ground Water and Recommended Management</b>	
Groundwater	<ul style="list-style-type: none"><li>• There are no limitations or risk to groundwater from normal rural living subdivision.</li></ul>
<i>Recommendations</i>	<ul style="list-style-type: none"><li>• <i>No specific site recommendations are required.</i></li></ul>

## **7.0 BIODIVERSITY ASSESSMENT and MANAGEMENT**

### **7.1 Flora and Fauna**

*This relates to whether the proposal will have significant impacts on the existing **Flora and Fauna** of the area under assessment.*

The flora and vegetation was studied by Lindsay Stephens of Landform Research on the 8th of October 2007. A vegetation study was undertaken for the adjoining vegetation to the west and south by Woodman Environmental Consulting Pty Ltd in January 2006 (fieldwork October 2005)

Additional information is contained within the accompanying Flora and Vegetation survey.

#### **Remnant Vegetation**

The south western corner of Lot 8 has remnant vegetation. The vegetation in Good or better condition represents about 20% of Lot 8 or approximately 17 hectares.

Adjoining that vegetation to the north and east is cleared land with scattered shrub remnants over pasture.

#### **Species and Vegetation Complexes**

The types of developments are 1.0 hectare rural living lots.

The vegetation is located within the Eyre Vegetation District (Esperance Plains Region) of the South West Province. The Esperance System is characterised by 4 vegetation types. The Scrub Heath classification best fits the vegetation on Lot 8.

The remnant vegetation on Lot 8 consists of one community, Open Scrubland of *Banksia species* and *Banksia coccinea* over *Melaleuca striata* and *Beaufortia empetrifolia* over a herb layer dominated by sedges on yellow sand.

The same description is used as in the Woodman Report because it is the same vegetation community and to enable correlation between the two studies.

There is a small area in the central north adjacent to the drain where moist soils contain *Isolepis nodosa* and minor rushes.

Data from National Resource Mapping database through the Department of Agriculture and Food database is shown in the table below.

Vegetation Association	47.1	Shrublands Tallerack Mallee Heath
Vegetation Type	1154	Shrublands Tallerack Mallee Heath
Type Description	1	
Description		Esperance
NVIS Lv2 Structural Formation		Open Mallee Shrubland
NVIS Lv3		Eucalypts Open Mallee Shrubland

A total of 84 taxa were recorded. This compares to 118 taxa identified by Woodman Consulting, but their study covered a larger area and four vegetation Communities.

Some exotic, weed and pasture species were also noted but generally not within the remnant vegetation and were therefore not recorded as they were not impacting on the remnant vegetation in better condition at the time of the site inspection.

A total of 14 additional taxa were identified that were not recorded on the adjoining land. 83% of the species were common with the adjoining vegetation study.

### **Vegetation Condition**

There are 17 hectares in Good or better condition with the remainder either Degraded or Completely Degraded. See the attached Flora and Vegetation Report.

### **Controls**

Smaller lots have generally been placed in already cleared areas with larger lots allocated to the remnant vegetation in better condition and the sand excavation areas.

Where possible fences and roads have been located in previously cleared areas, fire breaks or tracks.

A number of principles are proposed for consideration to assist in the protection of the better remnant vegetation.

How much of the better remnant vegetation remains will depend on the approvals for sand excavation. The excavated sand areas will be returned to native vegetation through respreading of the recovered topsoil during clearing.

### **Vegetation – Habitat Recommendations**

1. Remnant vegetation should be retained in as large an area as possible with larger lots allocated to those areas.
2. Roads and building envelopes have been located in already cleared or disturbed areas, fire breaks or tracks.
3. Lot boundaries through remnant vegetation in better condition can be marked by poles or fenced with stranded wire in which the bottom wire is left off to enable small fauna to move through.
4. Vegetation to be disturbed such as along fence lines or roads is recommended to be checked at an appropriate time and the subdivision adjusted as necessary at the subdivision stage.
5. Clearing of lot boundaries through remnant vegetation is not recommended. Surveying and the construction of fences can be undertaken without significant clearing, leaving sufficient remnant vegetation to enable maintenance, but not to significantly compromise biodiversity or visual issues.
6. If possible boundary fire breaks are not recommended through remnant vegetation that is to be retained. Strategic fire breaks, combined with the building envelopes located on cleared land may be able to be used and will depend on the recommendations of a Bushfire Hazard Report.
7. When clearing native vegetation, and during construction, provide weed and dieback managed construction techniques.

- All vehicles and equipment to be used during land clearing or land reinstatement should be clean or cleaned prior to being brought on site from an outside infected area. They should be brushed or washed down prior to arriving on site, using the procedures in DEC Guidelines for Dieback Management.
- Access to vegetated areas should be discouraged and minimised during the subdivision construction processes.
- Runoff from roads is recommended to be directed to swale drains, draining to basins located outside remnant vegetation.
- Any materials to be used in rehabilitation should be dieback free.
- Earthworks and construction machinery should push material from remnant vegetation towards previously cleared areas to minimise the spread of weed species and plant diseases.
- Earthworks should be carried out to comply with DEC Best Practice Guidelines for the Management of *Phytophthora cinamomi*, draft 2004, and Dieback Working Group 2005, Management of *Phytophthora* Dieback Guidelines for Local Government.

### **Wetlands**

There are no wetlands on site. An area of previously moist land in the central north has *Isolepis nodosa* growing in it. This is not a wetland species but grows on coastal dunes in addition to lower moist areas.

### **Fauna**

A fauna study was completed by Ninnox Wildlife Consulting in April 2006 for the adjoining remnant vegetation to the south and west.

They recorded Carnaby's Cockatoo feeding locally but did not record any other significant species. They did note that the importance of the *Banksia* Shrublands is not well known for wildlife habitat and listed a number of management actions that could be used to reduce habitat impact.

The protection of fauna becomes a protection of habitat issue. In other areas fauna still make good use of areas such as this with similar or much smaller lot sizes. For example Black Cockatoos are regular visitors to the urban areas of the Perth Hills.

The remnant vegetation in better condition is, as noted above, dependent on the approvals provided for the extraction of sand. These approvals are independent of the subdivision process.

The remnant vegetation needs to be accessible by fauna and the nature of the fencing could be selected to enable this, as noted above under flora.

With the removal of grazing from some vegetation remnants the understory will recover slowly and add habitat that will compensate for any areas to be cleared.

There are currently a significant number of kangaroos on site that access adjoining lots. These animals will be advantaged if they can continue to move freely across the site, and into the remnant vegetation.

Apart from the use of Conservation Covenants which are not applicable on lot sizes of 1 hectare fauna can be provided with a level of protection by the following;

- Land for Wildlife where private land owners are encouraged to manage habitat for wildlife. (This is probably better introduced through an awareness program by the Local Authority).
- Management of domestic pets; particularly cats, but fencing dogs to the building envelopes or reduced areas. (Recommended to form part of an awareness program through the Local Authority).
- Fencing should be constructed to enable the movement of kangaroos either by gates or the selection of the wire. (Could be conditioned on the subdivision).
- Weed management. (Recommended to form part of an awareness program through the Local Authority).
- Fire Management. (Managed through the Local Authority).
- Rural Pursuits in remnant vegetation such as exclusion of stock and trail bikes. (Stock could be conditioned and the subject of an awareness program conducted by the Shire of Ravensthorpe).

<b>Analysis of Biodiversity and Recommended Management</b>	
Remnant Vegetation	<ul style="list-style-type: none"> <li>• The remnant vegetation in Good Condition has high species diversity. Other vegetation is Degraded to Completely Degraded.</li> <li>• The key to flora and fauna protection is the retention of habitat.</li> </ul>
<i>Recommendations</i>	<ul style="list-style-type: none"> <li>• <i>The best vegetation will be managed through the approval processes for sand excavation which is independent of subdivision.</i></li> <li>• <i>The style of fences cutting the remnant vegetation should enable the exchange of flora and fauna.</i></li> <li>• <i>Where possible firebreaks are not recommended to cut remnant vegetation in Good Condition.</i></li> </ul>



## **8.0 CAPABILITY FOR CHANGED LANDUSES**

The following items are identified as the most likely to impact on the environment. These items can be managed by the implementation of the management recommendations. Other items are unlikely to impact or the impact is regarded as small.

### **Current Land Uses**

The site has been used for limited cropping and grazing and other rural purposes such as horse agistment in recent years. Portions of the site remain covered by remnant vegetation.

### **The opportunities of the site are;**

- The sloping nature of the land surfaces.
- Potential for a mixture of land uses.
- The views that can be obtained from most parts of the site.
- Proximity to Hopetoun townsite.
- Setback from existing roads.
- The amount of remnant vegetation remaining on site.
- Soils with good phosphate retention.
- The high nutrient holding capability of the soils.

### **The constraints of the site are;**

- The buffer to the wind turbines.
- The staging of sand excavation.
- The existing drain and storm flood path.
- Restricted ground water for more intensive cropping and horticulture or other uses.
- The Priority 3 Water Source Protection Area that occupies the southern portion of Lot 8.

### **Potential land uses**

The sandy soils have high capability for dwellings and onsite wastewater disposal. Other areas are also highly capable when filled and the existing drainage is maintained.

The most likely potential land uses are therefore rural living combined with ancillary uses as proposed.

## **8.1 Alternative Landuse and Land Capability**

### **Alternative Landuses**

The land is likely to be used for rural living.

It is unlikely that there will be sufficient water for other than part time or hobby plantings of perennial horticulture. The site therefore has capability for continued grazing only, with some hay production or pasture on the lower flat areas.

The site is currently used for sand excavation. The excavation is a separate approval process that requires Planning Consent and Extractive Industries Licence from the Shire of Ravensthorpe and, if native vegetation is to be cleared, a Clearing Permit from the Department of Environment and Conservation.

It is anticipated that sand excavation will continue on the larger lots to the south and south west. Excavated land will be returned to local native vegetation through the re-use of topsoil recovered during land clearing.

### Lot Sizes

The size of lots is 1.0 hectares which complies with the Priority 3 Water Source Protection Area nomination.

Change of landuse	
Potential Impact	<ul style="list-style-type: none"> <li>The adjoining lots are already rural living and this subdivision will match those landuses.</li> <li>The proposed lot sizes and land uses are no different to other parts of the local area.</li> </ul>
Recommendations	<ul style="list-style-type: none"> <li>No specific recommendations required.</li> </ul>

### 8.2 Aesthetics

*Aesthetics is the visual impact that the proposal may have on the local area.*

The main consideration with the aesthetics is landscape protection which can be controlled by the location of the developments and the location of the building envelopes.

It is likely that dwellings will be visible from the Hopetoun – Ravensthorpe Road and Steerdale Road.

Adverse visual impacts are likely to be assisted but not completely mitigated by the planting of clumps or belts of trees as shown by the extensive planting along the access roads on the site, the use of sympathetic construction materials and existing vegetation.

The number of trees that are normally planted on such rural living lots, will assist with visual protection of the views from the main roads.

Some general recommendations are

- The siting and appearance of buildings and works be sympathetic with the area.
- "Landscape sympathetic materials" could be used for the construction of dwellings.
- Minimise clearing of the remnant vegetation where possible.
- Strategic planting of clumps of trees or tree belts along road reserves will minimise visual impact.
- In cleared areas trees can be planted lower in the landscape along contour, and along the boundaries adjoining Hopetoun – Ravesthorpe and Steerdale Roads.
- The colour and style of dwellings and other structures should be visually compatible with the area and to this end developments should be coloured, painted or colour bond sheeting used where applicable. The use of grey galvanised or zinc/alum sheeting should be avoided unless as an integral part of a development such as a roof on a "country style" home or shielded from key sight lines.

<b>Analysis of Visual Impact and Recommended Management</b>		
Potential Visual Impact	Visual	<ul style="list-style-type: none"> <li>The amount of visual impact will be assisted by the subdivision layout, road verge tree planting and the normal planting of individual lot owners combined with the use of sympathetic building materials.</li> <li>Larger lots of 1.0 hectares will provide sufficient buffers and visual separation.</li> </ul>
Recommendations		<ul style="list-style-type: none"> <li><i>Restrictions could be placed on the use of visually non compatible materials.</i></li> <li><i>The colour and style of dwellings and other structures should be visually compatible with the area and to this end developments should be coloured, painted or colour bond sheeting used where applicable.</i></li> </ul>

### 8.3 Preservation of Agricultural Land

*The Preservation of Agricultural land is a comment on the quality of the land for agricultural purposes. The quality of the land depends on a number of things such as the soils, water availability and surrounding land uses. The comments relate to effects the proposal may potentially have on sterilising, fragmenting or removing high quality land from production.*

The soils are deep sands and lower sand over sandy clay. Little agricultural production has taken place on this land.

Whilst the use of rural living or smaller rural lots may take some land out of production, the quality of the land is not sufficiently high, and, considering the proximity to Hopetoun, the loss of low quality agricultural soils will be a consequence of town site expansion that fills a community need.

<b>Analysis of Agricultural Significance and Recommended Management</b>		
Agricultural Significance		<ul style="list-style-type: none"> <li>There is a need for this type of lot size and the proposal represents a balanced compromise between the loss of agricultural land, the need for rural living lots and better preservation of the remnant vegetation.</li> </ul>
Recommendations		<ul style="list-style-type: none"> <li><i>Nil</i></li> </ul>

### 8.4 Land Use Buffers

*Land Use Buffers relate to the potential for land use conflicts between the proposed and existing land uses and dwellings. The buffers could relate to noise, dust, odour, spray drift or other potential conflicts.*

*Buffers to significant environmental features such as watercourses, wetlands, and heritage areas are also important and are considered separately.*

No changes in land use are proposed with all land continuing as grazing and cropping with some rural living. Therefore no specific buffers are required.

With larger lot sizes, buffers are not likely to be a significant issue.

The adjoining land to the south, north and west has already been subdivided to rural living.

The main buffers to be considered are those to the wind turbines. These buffers impinge on the south western corner of Lot 8.

The Hopetoun Waste Water Treatment Plant lies to the west of Lot 8 with the buffer extending to the western boundary of Lot 8.

An extractive Industry for limestone and gravel which has a Special Control Area, lies to the south west with a related 500 metre notification buffer to the Special Control Area extending slightly onto the south western corner of Lot 8.

Some buffers will be required for continued sand excavation on Lot 8. Considering the low volumes of sand excavated and the use of one loader, a 100 metre buffer is considered sufficient when excavation generally takes place behind the active face.

<b>Land Use Buffers and Recommended Management</b>	
Buffers	<ul style="list-style-type: none"> <li>• There are no adjoining land uses existing or proposed that will require large or significant buffers.</li> <li>• Lot sizes are sufficiently large to manage any buffers through setbacks and screening tree belts.</li> </ul>
Recommendations	<ul style="list-style-type: none"> <li>• <i>No significant buffers required.</i></li> </ul>

### 8.5 Fire Control

*Fire Management is a normal summer practice on all properties. The risk can be reduced through a range of activities such as the provision of fire breaks, providing fuel reduction zones, grazing or slashing and the provision of emergency facilities, procedures and exits.*

*Fire risk is best described in FESA, 2001, Planning for Fire, Fire and Emergency Services Authority of Western Australia.*

*Dwellings can be designed to comply with Australian Standard 3959 to assist in protection.*

In recent years some fire impacts have affected the rural living fringe. Effective management by individual landholders is required to minimise the risks.

A Fire Management Plan will normally be required and the recommendations then incorporated into the subdivision design.

<b>Fire and Recommended Management</b>	
Fire Management	<ul style="list-style-type: none"> <li>• The change to fire risk is best addressed through a Fire Management Plan.</li> </ul>
Recommendations	<ul style="list-style-type: none"> <li>• <i>Compliance with Bush Fires Control Act 1954 (as amended) and the Shire of Ravensthorpe bylaws.</i></li> <li>• <i>Compliance with the Fire Risk Assessment and Fire Management Plan is recommended.</i></li> </ul>

## 9.0 LOCAL WATER MANAGEMENT

A Water Management Strategy has been prepared as a separate document by Landform Research.

Much of the information required in a Water Management Strategy is the same as that required for land capability and geotechnical reporting. However DOW requires a separate report from the Land Capability and Geotechnical reporting.

<b>Analysis of Stormwater and Recommended Management</b>	
Individual lots	<ul style="list-style-type: none"> <li>The soils on site are deep sands and sand over sandy clay.</li> <li>The initial calculations reveal that soakwells will be able to accept and retain on site the ARI 1 hour 1 year rainfall events. Stormwater from heavier rainfall events will distribute onto the land surface.</li> </ul>
Road drainage	<ul style="list-style-type: none"> <li>The initial calculations reveal that swale drains will be able to accept and retain on site the ARI 1 hour 1 - 5 year rainfall events.</li> <li>For 1 in 10 – 1 in 100 year 1 hour events the excess water will be directed to detention basins and an existing drainage system.</li> <li>Provided contingencies are used in water management for kerbing, there are no limitations to development, or any limitations identified can be controlled by good water management.</li> </ul>
Storm and Flood Management	<ul style="list-style-type: none"> <li>An existing drain collects significant storm flows from the land north of Steerdale Road, where they are concentrated, to cross Steerdale Road north of Lot 8 and are directed and confined to the constructed drain as storm flood flows.</li> <li>The constructed drain is 6 metres wide and 500 mm deep. It has a surface area capacity of 3.0 m<sup>2</sup>.</li> <li>Within the past 10 years the drain has coped with some significant rainfall events and those events have filled it to about 300 mm, which gives the flood path a surface area of 1.8 m<sup>2</sup>.</li> <li>It is uncertain what effects the drainage on the subdivision to the north will have on the potential flood flows from the land to the north. Therefore in the absence of new calculations of the runoff from the catchment the maintenance of a drain and culverts with a 3.0 m<sup>2</sup> surface area flow capacity is recommended</li> <li>Discussion of the flood flows is contained within the accompanying Local Water Management Strategy where the potential flood flows are considered within the subdivision design.</li> </ul>
Water Management	<ul style="list-style-type: none"> <li>There are no limitations imposed by the site on water management that would result from subdivision or development provided the existing drain is maintained and the flood path protected.</li> </ul>
<i>Recommendations</i>	<ul style="list-style-type: none"> <li>The installation of rainwater tanks with a minimum of 5000 litres can be considered but will not impact on water management. Grey water reuse is encouraged to minimise scheme water use.</li> <li>Detention basins and sumps for the acceptance of excess surface water from roads, if kerbed, will be required.</li> <li>For a 1 – 5 year return event a drain on either side of the road 1.5 metre wide and 300 mm deep in the centre, combined with riprap on slopes to retain and slow the water. (<i>A Manual for Managing Urban Stormwater Quality in Western Australia</i> grassed swales BMP 14) See the attached Local Water Management Strategy.</li> <li>Detention basins are recommended for the subdivision internal roads (<i>A Manual for Managing Urban Stormwater Quality in Western Australia</i> infiltration basins BMP 110 and Wet Basins</li> </ul>

	<p>BMP 18).</p> <ul style="list-style-type: none"><li>• Stormwater volumes will need to be revisited during the engineering design stage when the final subdivision design has been determined.</li><li>• A drain and culverts capable of accepting a storm flow of 3 m<sup>2</sup> should be provided along the proposed road network in the north east. The volume of the flood flow may be modified on the basis of detailed engineering calculations.</li><li>• Swale drains and table drains are recommended for road drainage to encourage infiltration and cutoff functions. See DOW (Water and Rivers Commission), 1998, 3.17 (BMP14).</li><li>• Easements are recommended for the main drain and minor drains, detention basins, servicing or pipes across lots and private land.</li></ul>
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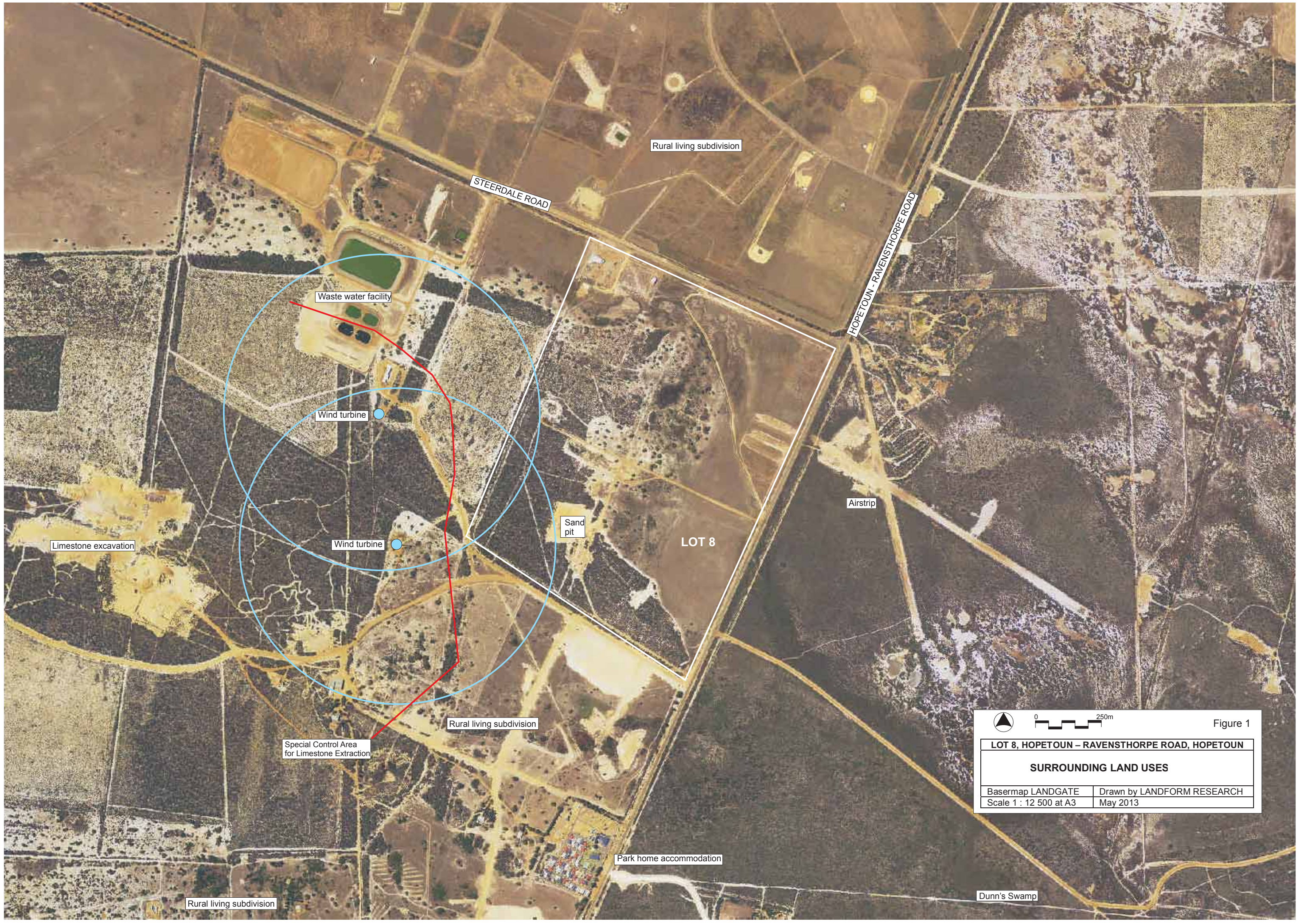


Figure 1

**LOT 8, HOPETOUN - RAVENSTHORPE ROAD, HOPETOUN**

**SURROUNDING LAND USES**

Basemap LANDGATE	Drawn by LANDFORM RESEARCH
Scale 1 : 12 500 at A3	May 2013



KEY		SOIL	DESCRIPTION
S/C	S/C	Sand over clay	Brown sand to depths to 500 mm over yellow sandy and loam clay. At depths of 650 – 850 the clay becomes lighter.
	SG/C	Sand/gravel over clay	Sand over clay as above but with gravel developed at the clay interface and generally thinner sand sheet.
	LS/C	Lower sand over clay	Brown sand over yellow sandy clay with a thinner sand layer. Subject to winter wet conditions.
YS	YS	Yellow sand	Deep pale yellow sand grading to darker earthy yellow sand at depths of 100 – 500 mm.
	YSP	Yellow sand over limestone	As above but with limestone pinnacles at 1 – 3 metres on limestone.
WYS	WYS	White sand grading to yellow sand	Same as the Yellow Sand but with a deeper leached surface horizon and white to pale yellow sand extending to depths of 1 plus metre.
	LWYS	Low white sand grading to yellow sand	Same as the leached white sand over yellow sand but at a lower elevation where the vegetation changes slightly.

⑥ Soil test hole



Figure 2

LOT 8, HOPETOUN – RAVENSTHORPE ROAD, HOPETOUN	
<b>SOIL DISTRIBUTION</b>	
Basemap LANDGATE	Drawn by LANDFORM RESEARCH
Scale 1 : 5 000 at A3	May 2013

## MANAGEMENT of IDENTIFIED CONSTRAINTS for LAND USE AND DEVELOPMENT

KEY	CONSTRAINTS IDENTIFIED	GEOTECHNICAL and ENVIRONMENTAL MANAGEMENT
a	Soil permeability limitations	<ul style="list-style-type: none"> <li>• Provide appropriate waste water disposal systems.</li> </ul>
b	Foundation soundness	<ul style="list-style-type: none"> <li>• Requires fill pads of sufficient depth to counteract potential clay or expanding sub-soils.</li> <li>• Organic subsoils may need to be removed if present.</li> </ul>
c	Potential slope instability	<ul style="list-style-type: none"> <li>• AS 2870 Site Class P generally applies to cut and fill.</li> <li>• Provide appropriate foundation design.</li> <li>• Upslope cutoff drains recommended.</li> <li>• Upslope water loading to be avoided.</li> <li>• Trees to be retained/planted. Pasture cover to be maintained</li> </ul>
d	Steep slopes that require significant management	<ul style="list-style-type: none"> <li>• Steep slopes that will require significant management to develop.</li> <li>• The slopes are often associated with a landscape feature.</li> <li>• Pier-pole foundations may be more appropriate than cut and fill.</li> <li>• Larger lot sizes recommended; &gt; 1000 m<sup>2</sup>.</li> </ul>
e	Water erosion risk	<ul style="list-style-type: none"> <li>• Maintain soil cover of crops, pasture, trees or shrubs</li> <li>• Use contour drains and agricultural practices.</li> <li>• Stormwater to be controlled.</li> </ul>
f	Potential flooding	<ul style="list-style-type: none"> <li>• Requires sand pad to be set sufficiently (0.5m) above highest known water level to minimise capillary effects.</li> <li>• Locate developments outside areas of flooding.</li> </ul>
i	Subject to winter wet conditions or water logging risk in wet years.	<ul style="list-style-type: none"> <li>• Alternative waste water treatment systems likely to be required.</li> <li>• Cut off drains and other drainage likely to be required.</li> <li>• Raise and or terrace waste water disposal areas.</li> <li>• Fill may be required for developments.</li> <li>• Floor elevations to have clearance above water risk levels.</li> <li>• Reduce stock in winter.</li> <li>• Road drainage and cut off drains will intersect and divert surface water from upslope, drying areas lower down slope.</li> </ul>
k	Soil workability	<ul style="list-style-type: none"> <li>• Remove or avoid rock, clay subsoils or other restrictions.</li> </ul>
m	Low moisture availability of soil	<ul style="list-style-type: none"> <li>• Manage or reduce stock to ensure pasture cover through summer.</li> <li>• Restrict clearing to building envelopes.</li> </ul>
n	Low nutrient retention ability	<ul style="list-style-type: none"> <li>• Alternative waste water treatment systems may be required.</li> <li>• Leach drains may need to be inverted or semi-inverted, banded by natural soil or impermeable membrane on downslope side.</li> <li>• Setback developments appropriate distances from water bodies/wetlands.</li> <li>• Use reticulated sewerage.</li> <li>• Feed stormwater through detention basins and swale drains.</li> <li>• Manage nutrient and fertiliser applications and stock</li> <li>• Restrict clearing to building envelopes.</li> <li>• Restrict the density of development.</li> </ul>
o	Water pollution risk by overland flow	<ul style="list-style-type: none"> <li>• Retain surface water in basins, use swale and grass filters.</li> <li>• Manage stock and potentially polluting land uses.</li> </ul>
p	Potentially low microbial purification	<ul style="list-style-type: none"> <li>• Alternative waste water treatment systems required.</li> <li>• Correctly install waste water systems.</li> <li>• Bund waste water disposal areas sufficiently.</li> </ul>
q	Water table <0.5 metres depth	<ul style="list-style-type: none"> <li>• Soils can be modified using fill, cutoff drains to comply with the Government Country Sewerage Policy.</li> <li>• Use Filtrex or Ecomax, which can be installed where the water table is at 0.25 and 0.0 m below the surface.</li> </ul>
r	Restricted rooting conditions	<ul style="list-style-type: none"> <li>• Avoid rock, hardpan or other restrictions.</li> </ul>
s	Water pollution risk by subsurface flow	<ul style="list-style-type: none"> <li>• See (n) above.</li> </ul>
t	Low topsoil nutrient retention	<ul style="list-style-type: none"> <li>• See (n) above.</li> </ul>
v	Remnant vegetation	<ul style="list-style-type: none"> <li>• Restrict clearing to building envelopes. Maintain linkages.</li> </ul>
w	Wind erosion risk	<ul style="list-style-type: none"> <li>• Manage or reduce stock, irrigate and improve pasture.</li> <li>• Maintain vegetation/stubble cover through summer.</li> <li>• Restrict clearing to building envelopes.</li> </ul>
x	Reduced ease of excavation	<ul style="list-style-type: none"> <li>• Remove rock or avoid constrained areas.</li> </ul>
y	Salinity risk	<ul style="list-style-type: none"> <li>• Provide drainage and reduce ponding.</li> <li>• Plant deep rooted species including deep rooted crops.</li> </ul>
z	Wetland conservation	<ul style="list-style-type: none"> <li>• Exclude building envelopes and developments.</li> <li>• Provide appropriate buffer distances.</li> <li>• Place conservation covenants on wetlands and/or vegetation.</li> </ul>
&	Potential for acid sulfate conditions	<ul style="list-style-type: none"> <li>• Minimise deep excavations or bulk earthworks; use fill.</li> <li>• Neutralise removed affected soils.</li> <li>• Minimise or exclude dewatering and lowering of groundwater.</li> </ul>
\$	Restricted water availability	<ul style="list-style-type: none"> <li>• Water may be restricted for some horticulture land uses</li> </ul>
#	Semi-inverted leach drains	<ul style="list-style-type: none"> <li>• Leach drains should be semi-inverted, banded by natural soil or impermeable membrane on the downslope side.</li> </ul>
@	Alternative waste water treatment system required	<ul style="list-style-type: none"> <li>• Unsuitable for conventional septic systems. All lots will be required to use alternative waste water treatment systems to comply with Regulations, Policy and Department Guidelines.</li> </ul>



**LAND CAPABILITY FOR DWELLINGS and DEVELOPMENTS**

KEY	CAPABILITY FOR SELECTED LAND USE
I	<ul style="list-style-type: none"> <li>Very high capability with few physical limitations.</li> </ul>
II	<ul style="list-style-type: none"> <li>High capability with minor physical limitations that can be overcome by planning and minor site modifications.</li> </ul>
III	<ul style="list-style-type: none"> <li>Fair capability with moderate physical limitations. The cost of development can be managed by the design of subdivision layout, lot size foundations.</li> <li>Consideration during planning will be required.</li> <li>Some site modification may be required.</li> </ul>
IV	<ul style="list-style-type: none"> <li>Lower capability with a number of smaller management actions required or there is one significant factor that will require management.</li> <li>Subdivision or development design can be used to contain additional costs.</li> <li>Additional site works may be required; retaining walls, drainage, increased rock removal, heavier foundations, cut and fill, general fill, flood mitigation, increased costs or the presence of significant saline soil - acid sulfate.</li> </ul>
V	<ul style="list-style-type: none"> <li>Reduced physical capability or with significant limitations.</li> <li>A number of management actions or a significant level of management will be required for one or more factors.</li> <li>Limiting site factors might include drainage, heavier foundations, significant basement rock, significant cut and fill, slope stability, high construction costs, general fill, soil instability, saline soil, acid sulfate or flood mitigation.</li> </ul>
X	<ul style="list-style-type: none"> <li>Development not acceptable because of significant environmental or geotechnical issues, or Government Policy. (Includes Conservation Category or EPP Wetlands and significant remnant vegetation, high risk geotechnical issues).</li> </ul>

See Key and map for specific limitations.



Figure 3

<b>LOT 8, HOPETOUN - RAVENSTHORPE ROAD, HOPETOUN</b>	
<b>LAND CAPABILITY FOR DWELLINGS</b>	
Basemap LANDGATE	Drawn by LANDFORM RESEARCH
Scale 1 : 5 000 at A3	May 2013



# FLORA AND VEGETATION ASSESSMENT

LOT 8  
HOPETOUN – RAVENSTHORPE ROAD  
RAVENSTHORPE

SHIRE OF RAVENSTHORPE

MAY 2013

# FLORA AND VEGETATION ASSESSMENT

LOT 8  
HOPETOUN – RAVENSTHORPE ROAD  
RAVENSTHORPE

SHIRE OF RAVENSTHORPE



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## **SUMMARY and CONCLUSIONS**

A subdivision of 1 hectare lots is proposed for Lot 8 Hopetoun – Ravensthorpe Road, Hopetoun.

Sand extraction occurs within the southern portion of the remnant vegetation, but that is controlled through separate Planning Consent and an Extractive Industries Licence from the Shire of Ravensthorpe.

Lot 8 drops from a sand ridge hill in the south western corner to low sand over clay soils in the north east and east. The site adjoins land that has already been subdivided to rural living to the west, south and north.

Part of the site has remnant vegetation and this study aims to quantify the significance of the vegetation. The vegetation in Good or better condition represents about 20% of Lot 8 or approximately 17 hectares. Other parts of the site are covered by Degraded remnant vegetation and pasture.

A level 1 flora and vegetation study was completed by Lindsay Stephens of Landform Research by way of field inspections on 8 February 2007 and previously on the adjoining land. The adjoining land to the south and west has been assessed for fauna and flora by independent consultants in 2006 and those reports provide additional data.

The only remnant vegetation is Proteaceae Shrubland.

A total of 84 taxa were identified.

No Threatened (Declared Rare), Priority species or Significant flora, or Threatened or Priority Communities/Complexes were recorded from the proposed excavation area.

The remnant vegetation is ascribed to Vegetation Association – 47.1 Shrublands Tallerack Mallee Heath of which 455 429 hectares of the original 1 272 406 hectares remains. This represents 35.8% of the original extent.

Of the remaining vegetation 54% is located within IUCN Class I – IV Reserves, 0.0% is located within other Reserves and 0.0% is located within pastoral leases managed by DEC.

The vegetation is therefore well represented and being coastal is generally not under significant threat apart from clearing at development nodes such as Hopetoun.

Some management actions suggested to assist in the management of retained vegetation are listed below.

### **Habitat Recommendations**

1. Remnant vegetation should be retained in as large an area as possible with larger lots allocated to those areas.
2. Roads and building envelopes have been located in already cleared or disturbed areas, fire breaks or tracks.
3. Lot boundaries through remnant vegetation in better condition can be marked by poles or fenced with stranded wire in which the bottom wire is left off to enable small fauna to move through.
4. Vegetation to be disturbed such as along fence lines or roads is recommended to be checked at an appropriate time and the subdivision adjusted as necessary at the subdivision stage.



5. Clearing of lot boundaries through remnant vegetation is not recommended. Surveying and the construction of fences can be undertaken without significant clearing, leaving sufficient remnant vegetation to enable maintenance, but not to significantly compromise biodiversity or visual issues.
6. If possible boundary fire breaks are not recommended through remnant vegetation that is to be retained. Strategic fire breaks, combined with the building envelopes located on cleared land may be able to be used and will depend on the recommendations of a Bushfire Hazard Report.
7. When clearing native vegetation, and during construction, provide weed and dieback managed construction techniques.
  - All vehicles and equipment to be used during land clearing or land reinstatement should be clean or cleaned prior to being brought on site from an outside infected area. They should be brushed or washed down prior to arriving on site, using the procedures in DEC Guidelines for Dieback Management.
  - Access to vegetated areas should be discouraged and minimised during the subdivision construction processes.
  - Runoff from roads is recommended to be directed to swale drains, draining to basins located outside remnant vegetation.
  - Any materials to be used in rehabilitation should be dieback free.
  - Earthworks and construction machinery should push material from remnant vegetation towards previously cleared areas to minimise the spread of weed species and plant diseases.
  - Earthworks should be carried out to comply with DEC Best Practice Guidelines for the Management of *Phytophthora cinamomi*, draft 2004, and Dieback Working Group 2005, Management of *Phytophthora* Dieback Guidelines for Local Government.

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## Flora and Vegetation Assessment

### Lot 8 Hopetoun – Ravensthorpe Road, Hopetoun

#### **1.0 BACKGROUND**

A subdivision of 1 hectare lots is proposed for Lot 8 Hopetoun – Ravensthorpe Road, Hopetoun.

Part of Lot 8 has remnant vegetation and this study aims to quantify the significance of the vegetation.

In recent years Lot 8 has been used for grazing, a small amount of sand excavation and minor gravel extraction.

#### **2.0 METHODOLOGY**

##### **2.1 Aims of the Survey**

The study was conducted to a Level 1 survey, and used the methodology outlined in the Environmental Protection Authority (2004) Guidance Statement, *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*, No 51 June 2004.

The aims of the survey are to determine the significance of the vegetation and to determine whether there are any Declared Rare, Priority or Significant taxa present in the vegetation to be affected by the proposed clearing.

In addition, the vegetation on likely building envelopes and remnant vegetation, which might be impacted on by development and fire protection actions, was searched more intensively.

The aim was also to determine the best vegetation and determine that which should be protected.

##### **2.2 Methods of Survey**

The flora and vegetation was studied by Lindsay Stephens of Landform Research on the 8th of February 2007. A vegetation study was undertaken for the adjoining vegetation to the west and south by Woodman Environmental Consulting Pty Ltd in January 2006 (fieldwork October 2005)

The vegetation directly impacted on by the proposed developments was searched thoroughly. Other areas were walked by numerous traverses to determine the environmental values.

During the surveys the vegetation on site was walked, photographs taken, transects completed, the species identified, the soils noted and the vegetation structure recorded.

The databases listed under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* were also searched. These are attached.

The results of the other studies are included in the Land Capability and Geotechnical Assessment Report for the precinct.

Determinations and inferences on the Vegetation Complexes and Floristic Community Types were made in a number of ways, relating to comparisons to published floristics and geomorphic and regolith matching.

- Interrogation of the National Resource Mapping database through the Department of Agriculture and Food database.
- Comparisons were made to the Woodman Consulting Survey (2006).
- Comparisons to Beard JS, 1979, *Vegetation Survey of Western Australia, RAVENSTHORPE 1 : 250 000 map sheet*, University of Western Australia.
- The Commonwealth EPBC databases were searched.
- Soil and regolith mapping and assessment of the geomorphology by Lindsay Stephens at the time of the site inspections.

The vegetation assessment was conducted to Environmental Protection Authority (2004) Guidance Statement, *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*, No 51 June 2004 and “*Bushland Plant Survey*” *Wildflower Society of WA (Inc)*.

The study was conducted to a Level 1 with all taxa observed being recorded.

### **Limitations**

The main limitation was the survey being conducted in February and on only one occasion.

Some of this is mitigated by the availability of the Woodman Consulting Report which covers vegetation to the adjoining boundary along the west and east of Lot 8. The vegetation community identified by Woodman was found on Lot 8 and good comparisons could therefore be made. Lindsay Stephens also observed the soils and vegetation on the adjoining land over which the Woodman Report was conducted in spring 2005.

The comparisons were therefore felt to be highly relevant and useful for Lot 8.

## **3.0 PHYSICAL ENVIRONMENT**

### **3.1 Site Description**

The site straddles the eastern slopes of a ridge north of Hopetoun. The land drops from the south western corner at 45 metres AHD down to 12 metres AHD in the north western and north eastern corners. The south eastern corner lies at 17 metres AHD.

The geology of the site has been investigated in several studies with the most recent being contained on the 1 : 250 000 Hydrological Map Series. Other information is contained in several Geological Survey of WA reports such as Hirschberg 1980. Additional information was obtained during the site investigations when all the soils and surface geology were mapped.

The site is underlain at depth by undulating Archaean gneiss and migmatite at depths of near sea level (1 : 250 000 Hydrological Map Series). Hirschberg 1980, states that the basement is undulating and forms a high north east of the site and a smaller high to the south west. These form a trough in which the Hopetoun water resource lies.

Overlying this is the Tertiary Plantagenet Group which fills the base of the basement troughs. The 1 : 250 000 Hydrological Map Series lists the Werillup Formation as locally occurring, consisting of coarse grained siltstone, carbonaceous clay and limestone.

The top of the hill to the south west and along the western boundary is sheeted by yellow sand of aeolian origin. Underlying this is a horizontal bed of limestone with a thickness of 9 to 14 metres.

### 3.2 Regolith and Soils

The vegetated soils are yellow sand over earthy yellow sand as a sheet across the western two thirds of the site. Under the highest portion of the site the sands overly limestone and limestone pinnacles, whereas on the central northern edge of the site, the sand overlies laterite gravel developed on the top of the junction with underlying silts, loams and loam clays. Minor laterite gravel caps the limestone ridge where it forms a resistant cap on the surface and has been used for gravel extraction.

The upper horizons of the soils have been leached to white sands grading into paler yellow sands. The potential for wind erosion of the site is moderate to high on these leached and pale surface soils particularly when the protecting vegetation is removed.

The soils on which the remnant vegetation occurs are;

KEY	SOIL GROUP	DESCRIPTION
YS	Yellow Sand	<ul style="list-style-type: none"> <li>Yellow silica sands over dark yellow earthy sands at depths of 100 to 500 mm occurring along the western boundary and south west.</li> <li>These also overly the alluvial silts in the east and in the north below approximately the 20 metre AHD elevation.</li> <li>Yellow sands also overly limestone and limestone pinnacles on the ridge.</li> <li>The earthy yellow sands contain clay in variable proportions but generally in the 1 – 5 % range.</li> <li>These sands tend to be neutral to alkaline particularly near limestone.</li> </ul>
W/YS	Leached Yellow Sands	<ul style="list-style-type: none"> <li>These mainly occur in the central south west and west and are the same sands as other locations except that there has been vertical displacement of sesquioxides and clay downwards. The earthy sands do not occur within 1000 mm of the surface, but occur at depth in these locations.</li> <li>The surface yellow sands typically have PRI of 0.9 to 2.0. The more earthy subsoils have PRI of near 5.0</li> <li>These sands tend to be neutral to alkaline particularly near limestone.</li> </ul>

### 3.3 Climate

Long term weather records for Hopetoun are not available, however detailed records have been kept at Munglinup which is to the east and slightly inland and therefore will have some differences in temperatures and perhaps in rainfall.

The climate of Hopetoun consists of moist cool winters followed by warm to hot summers. Temperatures (at Munglinup) range from winter maxima of about 16.1 degrees C to summer maxima of 27.8 degrees C. Average annual rainfall is 512 mm with monthly rainfall varying from 28.2 mm in summer months to 60 mm in the winter months.

Long term evaporation is recorded at Munglinup. This could be expected to be slightly higher than on the coast at Hopetoun which is subject to more humid sea breezes. Evaporation

ranges from 2.5 mm per day in July to 8.3 mm per day in January. On this basis evaporation at Munglinup exceeds rainfall in every month.

Long term wind data is only available for Esperance, although the data has some applicability to Hopetoun data based on local comment. At Esperance the predominant winds on this section of coast are strong south east to southerly sea breezes on summer afternoons. For example at 3.00 pm in January wind blows from the south east on 46% of the time and from the south for 32%. Morning winds at 9.00 am are lighter and spread widely, with 22% from the south east. Wind roses are shown in Appendix 4.

Winter winds are more variable at Esperance with 36% from the north west and 25% from the north in July at 9.00 am. In winter the winds blow from the north west to south west on 57% of the afternoons at 3.00 pm. Winter storms are generally from the south west.

Humidity ranges between 57% – 81% at 9.00 am to 46% – 62% at 3.00 pm.

### **3.4 Hydrology**

There are no watercourses as the ridge with the remnant vegetation is located on deep sands overlying limestone.

The lower elevation soils of the north east are sand over clay and are pasture with several wet site species associated with a drain.

### **3.5 Existing and Proposed Landuse**

Lot 8 rises from the Hopetoun – Ravensthorpe Road up a ridge in the west with a hill to the south west. In recent years the site has been used for grazing and sand excavation.

A shed and small rural industry is located in the north western corner adjacent to Steerdale Road.

The site adjoins land to the north that has been subdivided to rural living. The land to the west and south has also been assessed for rural living.

A wind turbine is located west of the land and a buffer falls over the south western corner of Lot 8.

The Hopetoun Drinking Water Reserve lies just inside the southern boundary of Lot 8.

The remnant vegetation is located across the south western portion of Lot 8, with degraded and cleared remnant vegetation extending into central parts.

### **3.6 Proposed Developments**

The types of developments proposed are 1.0 hectare rural living lots.

## **4.0 VEGETATION ASSESSMENT**

### **4.1 Community Types**

The vegetation is located within the Eyre Vegetation District (Esperance Plains Region) of the South West Province. The Esperance System is characterised by 4 vegetation types. The Scrub Heath classification best fits the vegetation on Lot 8.

The remnant vegetation on Lot 8 consists of one community, Open Scrubland of *Banksia species* and *Banksia coccinea* over *Melaleuca striata* and *Beaufortia empetrifolia* over a herb layer dominated by sedges on yellow sand.

The same description is used as in the Woodman Report because it is the same vegetation community and to enable correlation between the two studies.

There is a small area in the central north adjacent to the drain where moist soils contain *Isolepis nodosa* and minor rushes.

Data from National Resource Mapping database, through the Department of Agriculture and Food database, is shown in the table below.

Vegetation Association	47.1	Shrublands Tallerack Mallee Heath
Vegetation Type	1154	Shrublands Tallerack Mallee Heath
Type Description	1	
Description		Esperance
NVIS Lv2 Structural Formation		Open Mallee Shrubland
NVIS Lv3		Eucalypts Open Mallee Shrubland

## 4.2 Vegetation on Site

### • Species List

A total of 84 taxa were recorded. This compares to 118 taxa identified by Woodman Consulting, but their study covered a larger area and four vegetation Communities.

Some exotic, weed and pasture species were also noted but generally not within the remnant vegetation and were therefore not recorded as they were not impacting on the remnant vegetation in better condition at the time of the site inspection.

A total of 14 additional taxa were identified that were not recorded on the adjoining land. 83% of the species were common with the adjoining vegetation study.

### Native species recorded during the site inspections

FAMILY	GENUS - SPECIES	Taxa Recorded
Anthericaceae	<i>Laxmannia brachyphylla</i>	x
	<i>Ticoryne elatior</i>	x
	<i>Thysanotus sparteus</i>	x
Casuarinaceae	<i>Allocasuarina humilis</i>	x
	<i>Allocasuarina thuyoides</i>	x
Chenopodiaceae	<i>Enchylaena tomentosa</i>	x
	<i>Halosarcia indica</i>	x
Cyperaceae	<i>Baumeae juncea</i>	x
	<i>Caustis dioica</i>	x
	<i>Ficinia nodosa</i>	x
	<i>Lepidosperma sp</i>	x
	<i>Mesomelaena graciliceps</i>	x
	<i>Mesomelaena tetragona</i>	x
	<i>Schoenus curvifolius</i>	x
	<i>Schoenus pleiostemoneus</i>	x
	<i>Tricostularia neesii</i>	x
Dasyopogonaceae	<i>Lomandra hastilis</i>	x

Dilleniaceae	<i>Hibbertia gracilipes</i>	x
	<i>Hibbertia hypericoides</i> var <i>meridionalis</i>	x
Epacridaceae	<i>Andersonia macranthera</i>	x
	<i>Andersonia sprengelioides</i>	x
	<i>Leucopogon crassifolius</i>	x
	<i>Leucopogon gibbosus</i>	x
	<i>Lysinema cilitatum</i>	x
	<i>Oligarrhena micrantha</i>	x
Euphorbiaceae	<i>Stachysemon polyandrus</i>	x
Goodeniaceae	<i>Dampiera fasciculata</i>	x
	<i>Dampiera linearis</i> ?	x
	<i>Lechenaultia heteromera</i>	x
Haemodoraceae	<i>Anigozanthos rufus</i>	x
	<i>Conostylis vaginata</i>	x
	<i>Haemodorum spicatus</i>	x
Iridaceae	<i>Patersonia lanata</i>	x
	<i>Patersonia occidentalis</i>	x
Loranthaceae	<i>Nuytsia floribunda</i>	x
lauraceae	<i>Cassytha filiformis</i>	x
Mimosaceae	<i>Acacia cyclops</i>	x
Myrtaceae	<i>Beaufortia empetrifolia</i>	x
	<i>Calothamnus gbbosus</i>	x
	<i>Calytrix decandra</i>	x
	<i>Calytrix depressa</i>	x
	<i>Calytrix tenuiramea</i>	x
	<i>Chamelaucium megalopetalum</i>	x
	<i>Conothamnus aureus</i>	x
	<i>Eucalyptus decurva</i>	x
	<i>Leptospermum sericeum</i>	x
	<i>Leptospermum spinescens</i>	x
	<i>Melaleuca striata</i>	x
	<i>Melaleuca thymoides</i>	x
	<i>Melaleuca tuberculata</i> var <i>tuberculata</i>	x
	<i>Taxandria spathulata</i>	x
	<i>Verticordia sieberi</i>	x
Papilionaceae	<i>Daviesia benthamii</i> subsp <i>acanthoclona</i>	x
	<i>Daviesia major</i>	x
	<i>Gompholobium tomentoseum</i>	x
Proteaceae	<i>Adenanthos cuneatus</i>	x
	<i>Banksia baxteri</i>	x
	<i>Banksia coccinea</i>	x
	<i>Banksia pulchella</i>	x
	<i>Banksia speciosa</i>	x
	<i>Banksia violaceae</i>	x
	<i>Conospermum distichum</i>	x
	<i>Conospermum teretifolium</i>	x
	<i>Franklandia fucifolia</i>	x
	<i>Hakea corymbosa</i>	x
	<i>Isopogon polycephalus</i>	x
	<i>Isopogon trilobus</i>	x
	<i>Lambertia inermis</i> var <i>drummondii</i>	x
	<i>Lambertia inermis</i> var <i>inermis</i>	x
	<i>Petrophile teretifolia</i>	x
	<i>Stirlingia anethifolia</i>	x
Restionaceae	<i>Anarthria scabra</i>	x
	<i>Chordiflex crispatus</i>	x
	<i>Chordiflex sphacelatus</i>	x
	<i>Desmocladius fasciculatus</i>	x
	<i>Desmocladius flexuosus</i>	x
	<i>Hypolaena exsulca</i>	x
	<i>Hypolaena humilis</i>	x



	<i>Lepidochaetocephalus</i>	<b>x</b>
	<i>Lyginia inbergis</i>	<b>x</b>
Rutaceae	<i>Boronia ramosa subsp amethifolia</i>	<b>x</b>
Stylidiaceae	<i>Stylidium schoenoides</i>	<b>x</b>
Xanthorrhoeaceae	<i>Xanthorrhoea platyphylla</i>	<b>x</b>
<b>TOTAL NATIVE SPECIES</b>		<b>84</b>

### Note

The use of *Dryandra* is continued because the incorporation of *Dryandra* into the Genus *Banksia* is not recognised by all botanists or in the literature (eg Collins et al 2008, and Cavanagh and Pieroni, 2006). Moreover, the proposed name change removes the classification of a group of closely related plants and results in a loss of botanical knowledge and understanding for most of the community.

### • Plant Density

The plant density of the overstorey is largely intact in the best vegetation, but where grazing has occurred the density of the understorey is proportionally reduced dependant on the amount of grazing the vegetation has been subjected to.

Even in the vegetation in excellent condition the vegetation is relatively open and not generally dense apart from regrowth *Dryandra (Banksia)* thicket.

### • Vegetation Structure

The vegetation is shrubland.

The best vegetation is in the south western corner

VEGETATION STRUCTURE	HEIGHT	CONDITION	COMMENTS
Overstorey	> 4 m		Not part of the original community
Tall Shrub layer	2 – 4 m	Good	Dominated by <i>Banksia</i> spp and other Proteaceae
Lower Shrub Layer	0.5 – 2 m	Good	Dominated by Proteaceae and Myrtaceae shrubs
Ground Cover	< 0.5 m	Good	Dominated by sedges

Cleared and grazed vegetation in the centre west and centre south

VEGETATION STRUCTURE	HEIGHT	CONDITION	COMMENTS
Overstorey	> 4 m		Not part of the original community
Tall Shrub layer	2 – 4 m	Degraded to Completely Degraded	Scattered <i>Banksia</i> spp and other Proteaceae
Lower Shrub Layer	0.5 – 2 m	Degraded to Completely Degraded	Scattered Proteaceae and Myrtaceae shrubs
Ground Cover	< 0.5 m	Completely Degraded	Isolated to scattered sedges and pasture.

## 5.0 SIGNIFICANT VEGETATION

### 5.1 Declared Threatened, Priority or Significant Taxa

Databases held under State Legislation and the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* were searched. No plant communities or taxa are listed as a Threatened Ecological Community or taxa under *the Commonwealth Environment Protection and Biodiversity Conservation Act 1999*.

According to NatureMap there are a number of Priority Flora that have been recorded within a 10 km radius on 23 May 2013.

<i>Acacia empelioclada</i>	P4
<i>Anthocercis fasciculata</i>	P4
<i>Calochilus pruinus</i>	Threatened
<i>Dampiera sericantha</i>	P3
<i>Dodonea hexandra</i>	P1
<i>Jacksonia compressa</i>	P4
<i>Mitreola minima</i>	P3
<i>Spyridium montanum</i>	P2
<i>Spyridium oligocephalum</i>	P3
<i>Thysanotus brachiatus</i>	P2
<i>Verticordia pityrhops</i>	Threatened

No Declared Rare, Priority Species or Significant flora were recorded during the site examinations. None were recorded in the adjoining Woodman 2006 survey.

No Taxa or plant communities that occur on site are listed under Commonwealth Legislation.

### 5.2 Threatened or Priority Ecological Communities

The vegetation is not listed as either Endangered or a Priority Community under State databases and Legislation.

### 5.3 EPBC Legislation

Databases held under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* were searched.

No vegetation or taxa listed under Commonwealth legislation were observed during the site investigations. In addition no unusual or unidentified species were recorded.

## 6.0 VEGETATION CONDITION

The Vegetation Condition Score used in this study is that used in Bush Forever 2000. Generally the remnant vegetation is in Good condition in the uncleared portions in the south western corner.

The vegetation in Good or better condition represents about 20% of Lot 8 or approximately 17 hectares.

Towards the north and east where the remnant vegetation has been cleared the vegetation condition is Completely Degraded to Degraded with the groundcover replaced by pasture.

Using the vegetation condition score developed by Kaesehagen 1995 the vegetation is generally classified as Poor to Good.

## **7.0 REPRESENTATION OF THE FLORA - VEGETATION**

### **7.1 Significant Flora**

No Declared Threatened, Priority Species, Significant flora or Threatened or significant ecological communities were identified during the vegetation assessment.

No plant communities or taxa are listed as a Threatened Ecological Community or taxa under *the Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. The species present are common species.

Vegetation on site will be providing habitats for birds and other small fauna.

A fauna study was completed by Ninox Wildlife Consulting in April 2006 for the adjoining remnant vegetation to the south and west.

They recorded Carnaby's Cockatoo feeding locally but did not record any other significant species. They did note that the importance of the banksia Shrublands is not well known for wildlife habitat and listed a number of management actions that could be used to reduce habitat impact.

These were

- Conservation Covenants. (not considered easy to apply on 1 hectare lots)
- Land for Wildlife where private land owners are encouraged to manage habitat for wildlife. (This is probably better introduced through an awareness program by the Local Authority).
- Management of domestic pets; particularly cats, but fencing dogs to the building envelopes or reduced areas. (Recommended to form part of an awareness program through the Local Authority).
- Fencing should be constructed to enable the movement of kangaroos either by gates or the selection of the wire. (Could be conditioned on the subdivision).
- Weed management. (Recommended to form part of an awareness program through the Local Authority).
- Fire Management. (Managed through the Local Authority).
- Rural Pursuits in remnant vegetation such as exclusion of stock and trail bikes. (Stock could be conditioned and the subject of an awareness program conducted by the Shire of Ravensthorpe).

### **7.2 Vegetation Representation**

EPA Position Statement No 2, December 2000, *Environmental Protection of Native Vegetation in Western Australia*, specifically targets the retention of native vegetation in the Agricultural Areas in 4.1, *Clearing in the agricultural areas for agricultural purposes*. In 4.3, *Clearing in other areas of Western Australia*, it is unclear what "other areas" refers to, but may refer to retention of a 30% threshold in non agricultural areas.

Section 4.3 *Clearing in other areas of Western Australia*, (EPA Position Statement No 2, December 2000) expects that clearing will not take vegetation types below the 30% of the pre-clearing vegetation as recommended by ANZECC, 1999, *National Framework for the Management and Monitoring of Australia's Native Vegetation*. The National Objectives and Targets for Biodiversity Conservation 2001 - 2005 (Commonwealth of Australia 2001) also recognise 30% as the trigger value.

NRM mapping shows the site as;

Vegetation Association – 47.1 Shrublands Tallerack Mallee Heath

Shepherd et al 2002, *Native Vegetation in Western Australia Extent, Type and Status*, Department of Agriculture and Food Resource Management Technical Report 249 lists Vegetation Association 47.1 as having;

**Vegetation Association –**

Pre-European extent of Vegetation Association – 47.1 is 1 272 406 hectares of which 455 429 hectares remains. This represents 35.8% of the original extent.

Of the remaining vegetation 54% is located within IUCN Class I – IV Reserves, 0.0% is located within other Reserves and 0.0% is located within pastoral leases managed by DEC.

Although not meeting the 30% requirement in reserves the vegetation is well represented and is not generally under threat along coastal parts of Western Australia. The amount of clearing will be limited to the building envelopes and roads with most of the best vegetation being retained. Sand excavation is currently occurring, but that is separate to subdivision and will be subject to other approvals and a requirement for a Clearing Permit.

**8.0 CLEARING ASSESSMENT**

Clearing is controlled under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. These regulations provide for a number of principles against which clearing is assessed. (See attached notes for explanations).

Clearing will be restricted to the building envelopes.

Therefore no assessment under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* is required.

• **Discussion**

Clearing is controlled under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. These regulations provide for a number of principles against which clearing is assessed.

	<b>CLEARING PRINCIPLE</b> <i>(Schedule 5 Environmental Protection Amendment Act, 1986)</i>
1a	<i>High Level of diversity</i>
1b	<i>Significant fauna habitat</i>
1c	<i>Necessary to existence of Rare flora</i>
1d	<i>Threatened Ecological Community</i>

1e	<i>Significant area of vegetation in an area that has been extensively cleared</i>
1f	<i>Wetland or watercourse</i>
1g	<i>Land degradation</i>
1h	<i>Impact on adjacent or nearby conservation areas</i>
1i	<i>Deterioration of underground water</i>
1j	<i>Increase flooding</i>

The *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* provide for planning and other policy issues to be taken into account when determining clearing applications.

Section 51O of the *Environmental Protection Act 1986* allows the CEO to take planning matters into account when making clearing decisions, such as a State Planning Policy.

The proposal therefore has been assessed under the Clearing Principles of the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*, and the additional considerations below, to provide an assessment of the likely impacts of the proposal.

Whilst a Clearing Permit will not be required for subdivision, a consideration under the Clearing Principles is included.

### Assessment against the Clearing Principles

	<b>CLEARING PRINCIPLE</b> <i>(Schedule 5 Environmental Protection Amendment Act, 1986).</i>	<b>COMMENT</b>
1a	High Level of diversity	<ul style="list-style-type: none"> <li>The site has been assessed to have a high level of diversity within the remnant vegetation classified as Good or better (approximately 20% of Lot 8).</li> <li>The vegetated areas will have larger lots of 1 hectares.</li> <li>The largest lots are placed in an area of sand extraction which is subject to separate approval through the Shire of Ravensthorpe and Clearing Permits if required through the Department of Environment and Conservation.</li> </ul> <p><i>The proposed clearing is predominantly not at variance with this principle although 20% is at variance.</i></p>
1b	Significant fauna habitat	<ul style="list-style-type: none"> <li>All vegetation provides good fauna habitat and any clearing may impact on fauna.</li> <li>The protection of habitat is the best way to protect fauna.</li> <li>The vegetated areas are generally not proposed to be cleared or have larger lots and building envelopes allocated to them.</li> <li>The potential impacts can be reduced if measures are used to maintain or establish wildlife corridors and provide fauna friendly fencing.</li> <li>Kangaroos are present but normally feed on pasture and are happy to co-exist with development on larger lots.</li> <li>Normally owners of small rural lots plant significant numbers of native shrubs and trees which will compensate for any loss and help increase habitat for birds.</li> <li>A number of management actions are proposed for the subdivision which will assist in maintaining linked vegetation and fauna habitats.</li> </ul> <p><i>The proposed clearing is partially at variance with this principle.</i></p>
1c	Necessary to existence of Rare flora	<ul style="list-style-type: none"> <li>No Threatened (Declared Rare) or Priority Flora was found.</li> </ul> <p><i>The proposed clearing is not at variance with this principle.</i></p>
1d	Threatened Ecological Community	<ul style="list-style-type: none"> <li>No Priority or Threatened Ecological Community occurs on site.</li> </ul> <p><i>The proposed clearing is not at variance with this principle.</i></p>
1e	Significant area of vegetation in an area that has been extensively cleared	<ul style="list-style-type: none"> <li>The vegetation remaining is Proteaceous Shrubland which is assigned to Vegetation Association 47.1 Shrublands Mallee Heath.</li> <li>Shepherd et al 2002, Native Vegetation in Western Australia Extent, Type and Status, Department of Agriculture and Food Resource Management Technical Report 249 lists Vegetation Association 47.1 as having; <ul style="list-style-type: none"> <li>Pre-European extent of Vegetation Association – 47.1 is 1 272 406 hectares of which 455 429 hectares remains. This represents 35.8% of the original extent.</li> <li>Of the remaining vegetation 54% is located within IUCN Class I – IV Reserves, 0.0% is located within other Reserves and 0.0% is located within pastoral leases managed by DEC.</li> </ul> </li> <li>The vegetation already meets the 30% retention criteria but not the 30% located within secure reserves.</li> <li>A significant portion of the remnant vegetation will be retained.</li> <li>Normally owners of small rural lots plant significant numbers of native shrubs and trees which will compensate for any loss.</li> </ul>

		<i>The proposed clearing is partially at variance with this principle.</i>
1f	Wetland or watercourse	<ul style="list-style-type: none"> <li>There are no defined wetlands apart from the drain.</li> </ul> <p><i>The proposed clearing is unlikely to be at variance with this principle.</i></p>
1g	Land degradation	<ul style="list-style-type: none"> <li>Normally owners of small rural lots plant significant numbers of native shrubs and trees which will compensate for any loss and will assist in returning the cleared land to having a greater number of deep rooted species and therefore assist in salinity management.</li> <li>No other land degradation issues are attributed to land clearing. Any potential issues relate to construction and development and these are handled through the land capability and geotechnical assessment.</li> </ul> <p><i>The proposed clearing is not at variance with this principle.</i></p>
1h	Impact on adjacent or nearby conservation areas	<ul style="list-style-type: none"> <li>There is no proposal to clear the remnant vegetation and it is proposed to be subdivided to small rural lots. Therefore there is little likelihood of offsite impacts.</li> </ul> <p><i>The proposed clearing is not at variance with this principle.</i></p>
1i	Deterioration of underground water	<ul style="list-style-type: none"> <li>See land degradation above.</li> <li>The southern edge of Lot 8 lies on a Priority 3 Groundwater Protection Area.</li> <li>There is unlikely to be any significant changes to recharge and therefore no changes to salinity.</li> <li>The proposed subdivision complies with the Department of Water Guidelines for Priority 3 Groundwater Protection Areas.</li> </ul> <p><i>The proposed clearing is not at variance with this principle.</i></p>
1j	Increase flooding	<ul style="list-style-type: none"> <li>There will be minor additional hard surfaces, but with large lots there are large areas for detention basins and, combined with additional tree planting, these features can be used to slow and retain water on site.</li> <li>The water management features can be designed to maintain the pre-development flows, which will have increased with initial land clearing.</li> <li>Therefore there is an opportunity to better manage surface water.</li> <li>The issue of flooding relates to other geomorphological issues that are addressed by the Local Water Management Strategy.</li> </ul> <p><i>The proposed clearing is not at variance with this principle.</i></p>

## REFERENCES

- ANZECC, 1999, *National Framework for the Management and Monitoring of Australia's Native Vegetation*.
- Beard JS, 1979, *Vegetation Survey of Western Australia, RAVENSTHORPE 1 : 250 000 map sheet*, University of Western Australia
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- Chamber of Commerce and Industry, 1995 and 1996, *Managing the Basic Raw Materials of Perth and the Outer Metropolitan Region*, Parts 1 and 2.
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- Commonwealth of Australia, 2001, *National Objectives and Targets for Biodiversity Conservation 2001 – 2005*.
- Department of Environment and Conservation, 2006, *Declared Rare and Priority Flora List*.
- Environmental Protection Authority (2004) Guidance Statement, *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*, No 5,1 June 2004.
- Environmental Protection Authority, Guidance 10, *Level of assessment for proposals affecting natural areas within the System 6 region and Swan Coastal Plain portion of the System 1 Region*.
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- Woodman Environmental Consulting Pty Ltd, 2006, *Krystal Park Estate Pty Ltd, Lot 6382 Steerdale Road, Flora and Vegetation Assessment*.



## THREATENED, SIGNIFICANT FLORA AND VEGETATION NOTES

### 1.0 THREATENED AND SIGNIFICANT FLORA AND VEGETATION

**Flora can be significant on the basis of features of the taxa, its distribution and rarity. Flora as a vegetation community or complex can also be significant based on similar principles. The most commonly used determinants of significance are listed below.**

*A number of flora are regarded as significant even though they may not be listed as Declared Rare or Priority species. “Significant flora” and “Significant vegetation” are defined in Environmental Protection Authority (2004) Guidance Statement, Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia, No 51, June 2004.*

*Species, subspecies, varieties, hybrids and ecotypes may be significant for a range of reasons, other than as Declared Rare Flora or Priority flora, and may include the following:*

- *a keystone role in a particular habitat for threatened species, or supporting large populations representing a significant proportion of the local regional population of a species;*
- *relic status;*
- *anomalous features that indicate a potential new discovery;*
- *being representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);*
- *the presence of restricted subspecies, varieties, or naturally occurring hybrids;*
- *local endemism/a restricted distribution;*
- *being poorly reserved.*

### 1.1 DECLARED THREATENED FLORA

*Species specially protected under the Wildlife Conservation Act 1950, as identified in the current listing. Normally listed within a Wildlife Conservation (Rare Flora) Notice; Schedule 1 Extant taxa.*

**T: Declared Threatened Flora – Extant Taxa**

*Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such.*

**X: Declared Rare Flora – Presumed Extinct Taxa**

*Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.*

### 1.2 PRIORITY FLORA

Lists of plant taxa, maintained by the Department of Conservation and Land Management that are either under consideration as threatened flora but are in need of further survey to adequately determine their status, or are adequately known but require monitoring to ensure their security does not decline.

**1: Priority One – Poorly known taxa**

*Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, eg road verges, urban areas, farmland, active mineral leases, etc, or the plants are under threat, eg from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declarations as “rare flora”, but are in urgent need of further survey.*

**2: Priority two – Poorly known taxa**

*Taxa which are known from one or a few (generally <5) populations, at which some at least are not believed to be under immediate threat (ie currently not endangered). Such taxa are under consideration for declarations as “rare flora”, but are in urgent need of further survey.*

**3: Priority Three – Poorly known taxa**

*Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (ie not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declarations as “rare flora”, but are in urgent need of further survey.*

**4: Priority Four – Poorly known taxa**

*Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5 – 10 years.*

**Significant Vegetation**

*Vegetation may be significant for a range of reasons, other than a statutory listing as Threatened Ecological Communities or because the extent is below a threshold level, and may include the following reasons:*

- *scarcity;*
- *unusual species;*
- *novel combination of species;*
- *a role as a refuge;*
- *a role as a key habitat for threatened species or large populations representing a significant proportion of the local to regional total population of a species;*
- *being representative of the range of a unit (particularly, a good local and/or regional example of a unit in “prime” habitat, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);*
- *a restricted distribution.*

### 1.3 THREATENED ECOLOGICAL COMMUNITY

*Ecological communities that have been assessed through a procedure (coordinated by CALM) and assigned to one of the following categories related to the status of the threat to the community. (EPA Guidance Statement No 51 2004).*

#### **Presumed Totally Destroyed**

#### **Critically Endangered**

*<10% of the pre-European extent remains in an intact condition in the bioregion.*

#### **Endangered**

*10 – 30% of pre-European extent remains*

#### **Vulnerable**

*Declining and/or has declined in distribution and/or condition, and whose ultimate security is not yet assured (it could move into a category of higher threat in the near future if threatening processes continue)*

### 1.4 PRIORITY ECOLOGICAL COMMUNITY

*Ecological communities that have been assessed through the procedures for Threatened Ecological Communities, but do not meet the criteria although still potentially at risk are assigned to one of the following categories related to the status of the threat to the community. (Definitions and Criteria for Priority Ecological Communities, DEC and CALM Policy Statement No 9).*

#### **Priority One**

*Poorly known ecological communities that are very restricted and not actively managed for conservation.*

#### **Priority Two**

*Poorly known ecological communities that are restricted and mostly actively managed for conservation*

#### **Priority Three**

*Poorly known ecological communities that are of more widespread occurrence, which may not be well reserved or subject to disturbance pressures or significant communities that are not under threat.*

#### **Priority Four**

*Communities that are adequately known, but rare and not threatened, or are near the status of Threatened. They are divided into Rare, Near Threatened or communities removed from the Threatened List.*

#### **Priority Five**

*Communities that are not threatened, but are dependent on conservation for their survival.*

## 1.5 COMMONWEALTH LEGISLATION

*Some vegetation communities or plant taxa that are very rare or of National importance are listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.*

*Databases held under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 can be searched.*

## 1.6 REPRESENTATION OF VEGETATION COMMUNITIES

*The significance of the flora depends on a number of issues.*

- *Rare, Priority or Significant species may be present.*
- *A Threatened Ecological Community may be present.*
- *The development may take the area of the particularly vegetation community or complex below desirable levels or guidelines.*
- *There may be an aspect of the flora that may be listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.*

*EPA Position Statement No 2, December 2000, Environmental Protection of Native Vegetation in Western Australia, specifically targets the retention of native vegetation in the Agricultural Areas in 4.1, Clearing in the agricultural areas for agricultural purposes. In 4.3, Clearing in other areas of Western Australia, it is unclear what "other areas" refers to, but may refer to retention of a 30% threshold in non agricultural areas.*

*Section 4.3 Clearing in other areas of Western Australia, (EPA Position Statement No 2, December 2000) expects that clearing will not take vegetation types below the 30% of the pre-clearing vegetation as recommended by ANZECC, 1999, National Framework for the Management and Monitoring of Australia's Native Vegetation. The National Objectives and Targets for Biodiversity Conservation 2001 - 2005 (Commonwealth of Australia 2001) also recognise 30% as the trigger value.*

*For the Perth Metropolitan Area and the Greater Bunbury Area the minimum retention figure is 10%.*

## VEGETATION CONDITION NOTES

The vegetation condition mapping used is that used by the Department of Environment and Conservation and is taken from *Bush Forever 2000*.

**Vegetation Condition Scale reproduced from page 48 (*Bush Forever 2000*).**

<b>Condition Score</b>	<b>Vegetation Condition</b>	<b>Vegetation Descriptors</b>
<b>1</b>	<b>Pristine</b>	<i>Pristine or nearly so, no obvious signs of disturbance</i>
<b>2</b>	<b>Excellent</b>	<i>Vegetation structure intact, disturbance affecting individual species, and weeds are non aggressive species.</i>
<b>3</b>	<b>Very Good</b>	<i>Vegetation structure altered, obvious signs of disturbance. For example disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.</i>
<b>4</b>	<b>Good</b>	<i>Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.</i>
<b>5</b>	<b>Degraded</b>	<i>Basic structure of the vegetation severely impacted on by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.</i>
<b>6</b>	<b>Completely Degraded</b>	<i>The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as "parkland cleared" with the flora comprising weed or crop species with isolated native trees or shrubs.</i>

*This condition scale uses a scale that can distort the public perception of middle vegetation condition when compared to previous vegetation studies. In previous studies the word "Good" would have been a lower classification such as "Poor" as shown in *Bush Forever 2000*, page 48. The scale Good also does not seem to match the vegetation description provided on page 48. The *Bush Forever 2000* Condition Score is possibly better related to the potential for regeneration of remnant vegetation rather than being a descriptor of its current condition. See Attachment 2.*

Another approach is to use the number of remaining species as an indicator of vegetation condition. This provides for a less subjective assessment of the vegetation condition. Kaesehagen, 1995, *Bushland Condition Mapping*, IN *Invasive Weeds and Regenerating Ecosystems in Western Australia*, Proceedings of Conference held at Murdoch University, July 1994, Institute for Science and Technology Policy, Murdoch University, 1995, A copy of the Kaesehagen 1995 vegetation condition table is shown below.

<b>Descriptor</b>	<b>Percentage of species remaining</b>	<b>Comments</b>
<b>Very Good - Excellent</b>	<b>80 – 100%</b>	<ul style="list-style-type: none"> <li>• <i>Vegetation structure intact or nearly so.</i></li> <li>• <i>Cover / abundance of weeds less than 5%.</i></li> <li>• <i>No or minimal signs of disturbance.</i></li> </ul>
<b>Fair - Good</b>	<b>50 – 80%</b>	<ul style="list-style-type: none"> <li>• <i>Vegetation structure modified.</i></li> <li>• <i>Cover / abundance of weed 5 – 20%, any number of individuals.</i></li> <li>• <i>Minor signs of disturbance</i></li> </ul>
<b>Poor</b>	<b>20 – 50%</b>	<ul style="list-style-type: none"> <li>• <i>Vegetation structure completely modified.</i></li> <li>• <i>Cover / abundance of weeds 20 – 60% any number of individuals.</i></li> <li>• <i>Disturbance incidence high</i></li> </ul>
<b>Very Poor</b>	<b>0 – 20%</b>	<ul style="list-style-type: none"> <li>• <i>Vegetation structure disappeared.</i></li> <li>• <i>Cover / abundance of weeds 60 – 100% cover, any number of individuals.</i></li> <li>• <i>Disturbance incidence very high.</i></li> </ul>

## CLEARING PRINCIPLES

Clearing is controlled under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. These regulations provide for a number of principles against which clearing is assessed.

	<b>CLEARING PRINCIPLE</b> <i>(Schedule 5 Environmental Protection Amendment Act, 1986)</i>
1a	<i>High Level of diversity</i>
1b	<i>Significant fauna habitat</i>
1c	<i>Necessary to existence of Rare flora</i>
1d	<i>Threatened Ecological Community</i>
1e	<i>Significant area of vegetation in an area that has been extensively cleared</i>
1f	<i>Wetland or watercourse</i>
1g	<i>Land degradation</i>
1h	<i>Impact on adjacent or nearby conservation areas</i>
1i	<i>Deterioration of underground water</i>
1j	<i>Increase flooding</i>

The *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* also provide for planning and other policies and issues to be taken into account when determining clearing applications.

Section 51O of the *Environmental Protection Act 1986* allows the CEO to take planning matters into account when making clearing decisions, such as a State Planning Policy. There is an agreement between DEC and DMP permitting DMP to issue Clearing Permits.

As well as considering Biodiversity and other conservation issues the Clearing Principles that have to be satisfied are apparently designed for rural regions and do not adequately address the issues of resource needs. Therefore some additional principles need to be added when considering the need for essential Raw Materials. In an attempt to provide a better balance to the clearing principles those principles have been expanded as listed in the tables below.

	<b>ADDITIONAL CLEARING PRINCIPLES – EXTRACTIVE INDUSTRIES</b>
<b>Environmental Protection Act 1984 Section 51O</b>	
<b>Planning Matters</b>	
1	<i>Planning Matters</i>
<b>Environmental Protection Act 1984 Section 51O</b>	
<b>Relevant Matters</b>	
2a	<i>Need for the resource</i>
2b	<i>Classification of the resource and existing approvals</i>
2c	<i>Availability of alternative resources and the impact of their use</i>
2d	<i>Proposed final land use</i>
2e	<i>Offsite Environmental impacts if the resource is not used</i>
2f	<i>Sound environmental management and rehabilitation</i>

## Search Results

Method='By Circle'; Centre=120°12' 00" E,33°55' 00" S; Buffer=10km; Current Names Only=Yes; Core Datasets Only=Yes; Data Source=WA Herbarium Specimen Database;

	Species	Records
TOTAL	490	1053

## Species List

[Acacia aemula](#) subsp. [aemula](#)  
[Acacia chrysocephala](#)  
[Acacia cochlearis](#) [Rigid Wattle](#)  
[Acacia crassiuscula](#)  
[Acacia curvata](#)  
[Acacia cyclops](#) [Coastal Wattle](#)  
[Acacia delphina](#)  
[Acacia durabilis](#)  
[Acacia empelioclada](#) **P4**  
[Acacia glaucoptera](#) [Flat Wattle](#)  
[Acacia gonophylla](#)  
[Acacia lasiocalyx](#) [Silver Wattle](#), [Wilyurwur](#)  
[Acacia moirii](#) subsp. [dasycarpa](#)  
[Acacia myrtifolia](#)  
[Acacia ophiolithica](#)  
[Acacia phlebopetala](#) var. [phlebopetala](#)  
[Acacia pravifolia](#)  
[Acacia pulchella](#) var. [goadbyi](#)  
[Acacia rostellifera](#) [Summer-scented Wattle](#)  
[Acacia saligna](#) subsp. [lindleyi](#)  
[Acacia subcaerulea](#)  
[Acacia unifissilis](#)  
[Acacia varia](#) var. [parviflora](#)  
[Acrotriche cordata](#) [Coast Ground Berry](#)  
[Adenanthos cuneatus](#) [Coastal Jugflower](#)  
[Adenanthos flavidiflorus](#)  
[Agonis baxteri](#)  
[Agrostocrinum scabrum](#) subsp. [scabrum](#)  
[Allocauarina humilis](#) [Dwarf Sheoak](#)  
[Allocauarina thuyoides](#) [Horned Sheoak](#)  
[Alyogyne wrayae](#)  
[Amphipogon avenaceus](#)  
[Amphipogon turbinatus](#)  
[Anarthria gracilis](#)  
[Anarthria humilis](#)  
[Anarthria laevis](#)  
[Anarthria scabra](#)  
[Andersonia caerulea](#) [Foxtails](#)  
[Andersonia macranthera](#)  
[Andersonia parvifolia](#)  
[Anigozanthos humilis](#) [Catspaw](#)  
[Anigozanthos humilis](#) subsp. [humilis](#)  
[Anthocercis fasciculata](#) **P4**  
[Anthocercis littorea](#) [Yellow Tailflower](#)  
[Anthotium humile](#) [Dwarf Anthotium](#)  
[Aotus](#) sp. [Esperance](#) (P.G. Wilson 7904)  
[Aotus](#) sp. [Southern Wheatbelt](#) (C.A. Gardner & W.E. Blackall 1412)  
 \*[Arctotheca populifolia](#) [Dune Arctotheca](#)  
[Astartea](#) sp. [Jerdacuttup](#) (A. Strid 21898)  
[Asteridea asteroides](#)  
[Astroloma epacridis](#)  
[Astroloma prostratum](#) [Cranberry Heath](#)  
[Astroloma serratifolium](#) [Kondrung](#)  
[Astroloma tectum](#)  
[Atriplex cinerea](#) [Grey Saltbush](#)  
[Austrostipa acrociliata](#)  
[Austrostipa flavescens](#)  
[Banksia baxteri](#) [Baxter's Banksia](#)  
[Banksia coccinea](#) [Scarlet Banksia](#)  
[Banksia nivea](#) [Honeypot Dryandra](#), [Pudjarn](#)  
[Banksia obovata](#) [Wedge-leaved Dryandra](#)



[Banksia obtusa](#) Shining Honeypot  
[Banksia pulchella](#) Teasel Banksia  
[Banksia repens](#) Creeping Banksia  
[Banksia speciosa](#) Showy Banksia  
[Banksia tenuis](#) var. [tenuis](#)  
[Battarrea stevenii](#)  
[Beaufortia empetrifolia](#)  
[Beaufortia micrantha](#) Little Bottlebrush  
[Beaufortia schaueri](#) Pink Bottlebrush  
[Billardiera coriacea](#)  
[Billardiera fusiformis](#) Australian Bluebell  
[Billardiera venusta](#)  
[Boronia albiflora](#)  
[Boronia spathulata](#) Boronia  
[Boronia tetrandra](#) Yellow Boronia  
[Bossiaea preissii](#)  
[Brachyscome bellidioides](#)  
[Brachyscome iberidifolia](#)  
[Brachyscome pusilla](#)  
 \* [Cakile maritima](#) Sea Rocket  
[Caladenia cairnsiana](#) Zebra Orchid  
[Caladenia decora](#)  
[Caladenia discoidea](#) Dancing Orchid  
[Caladenia graminifolia](#)  
[Caladenia longicauda](#) subsp. [crassa](#)  
[Caladenia x ericksoniae](#)  
[Calandrinia brevipedata](#) Short-stalked Purslane  
[Calandrinia](#) sp. Kenwick (G.J. Keighery 10905)  
[Calectasia gracilis](#)  
[Calectasia grandiflora](#) subsp. [Wheatbelt](#) (A.M. Coates 4315)  
[Callistachys](#) sp. south-coast variant (M. Carter 180)  
[Callitris drummondii](#) Drummond's Cypress Pine  
[Calochilus pruinus](#) **T**  
[Calothamnus gracilis](#)  
[Calothamnus pinifolius](#) Dense Clawflower  
[Calothamnus quadrifidus](#) subsp. [quadrifidus](#)  
[Calotis erinacea](#) Tangled Burr-daisy  
[Calytrix decandra](#) Pink Starflower  
[Calytrix depressa](#)  
[Calytrix leschenaultii](#)  
[Cassytha glabella](#) forma [glabella](#)  
[Caustis dioica](#)  
 \* [Centaurea melitensis](#) Maltese Cockspur  
[Chamaescilla spiralis](#)  
[Chamelaucium axillare](#) Esperance Waxflower  
[Chamelaucium ciliatum](#)  
 \* [Chenopodium murale](#) Nettle-leaf Goosefoot  
[Chordifex crispatus](#)  
[Chordifex laxus](#)  
[Chordifex sphacelatus](#)  
[Chorizandra enodis](#) Black Bristlerush  
[Chorizema cytisoides](#)  
[Chorizema glycinifolium](#)  
[Clematis pubescens](#) Common Clematis  
[Coleanthera myrtoides](#)  
[Comesperma acerosum](#)  
[Comesperma polygaloides](#) Small Milkwort  
[Conospermum distichum](#)  
[Conospermum leianthum](#)  
[Conospermum leianthum](#) subsp. [leianthum](#)  
[Conospermum teretifolium](#) Spider Smokebush  
[Conostephium drummondii](#)  
[Conostylis breviscapa](#)  
[Conostylis petrophiloides](#)  
[Conostylis seorsiflora](#) subsp. [seorsiflora](#)  
[Conostylis serrulata](#)  
[Conostylis vaginata](#) Sheath Conostylis  
[Conothamnus aureus](#)  
[Cooperhooikia polygalacea](#)  
[Corybas despectans](#)  
[Corybas limpidus](#) **P4**  
[Cryptandra craigiae](#) **P1**

[Cryptandra pungens](#)  
[Cyanicula gemmata](#)  
[Cyathochaeta equitans](#)  
[Cypselocarpus haloragoides](#)  
[Dampiera fasciculata](#) Bundled-leaf Dampiera  
[Dampiera juncea](#) Rush-like Dampiera  
[Dampiera linearis](#) Common Dampiera  
[Dampiera sericantha](#) **P3**  
[Darwinia diosmoides](#)  
[Darwinia sp. Ravensthorpe](#) (G.J. Keighery 8030)  
[Darwinia vestita](#) Pom-pom Darwinia  
[Dasya extensa](#)  
[Daucus glochidiatus](#) Australian Carrot  
[Daviesia incrassata](#)  
[Daviesia incrassata subsp. reversifolia](#)  
[Daviesia retrorsa](#)  
[Daviesia teretifolia](#)  
[Desmocladius flexuosus](#)  
[Dillwynia laxiflora](#)  
[Dillwynia uncinata](#) Silky Parrot Pea  
[Diploptaxis muralis](#) Wall Rocket  
[Disphyma crassifolium subsp. clavellatum](#)  
[Diuris concinna](#)  
[Diuris corymbosa](#)  
[Diuris pulchella](#)  
[Diuris setacea](#) Bristly Donkey Orchid  
[Dodonaea caespitosa](#)  
[Dodonaea ceratocarpa](#)  
[Dodonaea hexandra](#) **P1**  
[Dodonaea pinifolia](#)  
[Drosera glanduligera](#) Pimpernel Sundew  
[Drosera menziesii subsp. penicillaris](#)  
[Drosera occidentalis subsp. australis](#)  
[Drosera paleacea subsp. trichocaulis](#)  
[Drosera scorpioides](#) Shaggy Sundew  
[Enchylaena tomentosa var. tomentosa](#) Barrier Saltbush  
[Eremophila densifolia subsp. densifolia](#)  
[Eremophila dichroantha](#) Bale-hook Eremophila  
[Eriochilus scaber subsp. scaber](#)  
[Eucalyptus angulosa](#) Ridge-fruited Mallee, Kwarari  
[Eucalyptus conglobata](#) Port Lincoln Mallee  
[Eucalyptus decurva](#) Slender Mallee  
[Eucalyptus densa subsp. improcera](#) Dwarf Blue Mallee  
[Eucalyptus dissimulata subsp. dissimulata](#)  
[Eucalyptus ecostata](#)  
[Eucalyptus falcata](#) Silver Mallet, Dulyurnuk  
[Eucalyptus incrassata](#) Lerp Mallee  
[Eucalyptus kessellii subsp. eugnosta](#)  
[Eucalyptus lehmannii subsp. parallela](#)  
[Eucalyptus leptocalyx](#) Hopetoun Mallee  
[Eucalyptus leptocalyx subsp. leptocalyx](#)  
[Eucalyptus micranthera](#) Alexander River Mallee  
[Eucalyptus oleosa subsp. corvina](#)  
[Eucalyptus phaenophylla subsp. phaenophylla](#)  
[Eucalyptus pleurocarpa](#)  
[Eucalyptus redunca](#) Black Marlock  
[Eucalyptus scyphocalyx](#) Goblet Mallee  
[Eucalyptus sporadica](#)  
[Eucalyptus suggrandis subsp. suggrandis](#)  
[Eucalyptus tetraptera](#) Four-winged Mallee  
[Eucalyptus tumida](#)  
[Eucalyptus uncinata](#) Hook-leaved Mallee  
[Eucalyptus utilis](#)  
[Eucalyptus x stoataptera](#)  
[Euphorbia paralias](#) Sea Spurge  
[Eutaxia cuneata](#)  
[Eutaxia empetrifolia](#)  
[Eutaxia inuncta](#)  
[Eutaxia major](#)  
[Exocarpos sparteus](#) Broom Ballart, Djuk  
[Ficinia nodosa](#) Knotted Club Rush  
[Franklandia fucifolia](#) Lanoline Bush

\**Fumaria muralis* subsp. *muralis*  
*Gahnia ancistrophylla* Hooked-leaf Saw Sedge  
*Gahnia* sp. Headland (G.J. Keighery 8501)  
*Gahnia trifida* Coast Saw-sedge  
*Gastrolobium congestum*  
*Gastrolobium musaceum*  
*Gastrolobium spinosum* Prickly Poison  
*Glischrocaryon flavescens*  
*Gnephosis drummondii*  
*Gompholobium baxteri*  
*Gompholobium confertum*  
*Gompholobium scabrum*  
*Gompholobium tomentosum* Hairy Yellow Pea  
*Goodenia concinna* Elegant Goodenia  
*Goodenia pterigosperma*  
*Goodenia scapigera* White Goodenia  
*Goodenia scapigera* subsp. *scapigera*  
*Goodenia viscida* Viscid Goodenia  
*Gratiola pubescens*  
*Grevillea anethifolia*  
*Grevillea coccinea* subsp. *coccinea*  
*Grevillea nudiflora*  
*Grevillea tripartita* subsp. *macrostylis*  
*Guichenotia ledifolia*  
*Guichenotia micrantha* Small Flowered Guichenotia  
*Gyrostemon sheathii*  
*Haemodorum brevisepalum*  
*Haemodorum spicatum* Mardja  
*Hakea cinerea* Ashy Hakea  
*Hakea denticulata*  
*Hakea ferruginea*  
*Hakea nitida* Frog Hakea  
*Hakea obliqua* subsp. *obliqua*  
*Hakea smilacifolia*  
*Hakea sulcata* Furrowed Hakea  
*Hakea varia* Variable-leaved Hakea  
*Hakea verrucosa*  
*Hakea victoria* Royal Hakea, Dalyongurd  
*Halgania andromedifolia*  
*Halgania cyanea* var. *cyanea*  
*Harperia lateriflora*  
 \**Hedynois rhagadioloides* subsp. *cretica*  
*Heterocladia caudata*  
*Hibbertia acerosa* Needle Leaved Guinea Flower  
*Hibbertia commutata*  
*Hibbertia gracilipes*  
*Hibbertia mucronata* Prickly Hibbertia  
*Hibbertia racemosa* Stalked Guinea Flower  
*Hibbertia rupicola*  
*Hormosira banksii*  
*Hovea acanthoclada* Thorny Hovea  
*Hovea pungens* Devil's Pins, Puyenak  
*Hybanthus floribundus* subsp. *adpressus*  
*Hypocalymma asperum*  
*Hypolaena humilis*  
*Isopogon polycephalus* Clustered Coneflower  
*Isopogon teretifolius* subsp. *teretifolius* Nodding Coneflower  
*Isopogon trilobus* Barrel Coneflower  
*Isotoma hypocrateriformis* Woodbridge Poison  
*Isotoma scapigera* Long-scaped Isotome  
*Isotropis cuneifolia* Granny Bonnets  
*Isotropis drummondii* Lamb Poison  
*Jacksonia capitata*  
*Jacksonia compressa* P4  
*Jacksonia elongata*  
*Jacksonia furcellata* Grey Stinkwood  
*Jacksonia spinosa*  
*Johnsonia acaulis*  
*Juncus radula*  
*Kennedia nigricans* Black Kennedia  
*Keraudrenia hermannifolia*  
*Keraudrenia integrifolia* Common Firebush

Kunzea jucunda  
 Kunzea preissiana  
 Labichea lanceolata Tall Labichea  
 Labichea lanceolata subsp. brevifolia  
 Lambertia inermis Chittick, Djidiok  
 Lambertia inermis var. drummondii  
 Lambertia inermis var. inermis  
 Lasiopetalum discolor  
 Lasiopetalum quinquenervium  
 Lasiopetalum rosmarinifolium  
 Laxmannia brachyphylla Stilted Paper-lily  
 Laxmannia sessiliflora Nodding Lily  
 Lechenaultia biloba Blue Leschenaultia  
 Lechenaultia formosa Red Leschenaultia  
 Lechenaultia heteromera Claw Leschenaultia  
 Lechenaultia tubiflora Heath Leschenaultia  
 Lepidosperma squamatum  
 Leptocarpus laxus  
 Leptoceras menziesii  
 Leptomeria lehmannii  
 Leptospermum spinescens  
 Leucopogon conchifolius  
 Leucopogon crassifolius  
 Leucopogon flavescens var. brevifolius  
 Leucopogon gibbosus  
 Leucopogon obovatus subsp. obovatus  
 Leucopogon obtusatus  
 Leucopogon sp. Coujinup (M.A. Burgman 1085)  
 Leucopogon woodsii Nodding Beard-heath  
 Levenhookia pauciflora Deceptive Stylewort  
 Lobelia anceps Angled Lobelia  
 Lobelia heterophylla Wing-seeded Lobelia  
 Logania buxifolia  
 Logania campanulata Bell-flowered Logania  
 Logania fasciculata  
 Logania micrantha  
 Logania serpyllifolia subsp. angustifolia  
 Logania serpyllifolia subsp. serpyllifolia  
 Logania stenophylla  
 Lomandra mucronata  
 Lomandra nigricans  
 Lomandra rupestris  
 Lycogala epidendrum  
 Lyginia imberbis  
 Lysinema ciliatum Curry Flower  
 Lysinema pentapetalum  
 \*Malva arborea Tree Mallow  
 \*Medicago truncatula Barrel Medic  
 Meeboldina crebriculmis  
 Melaleuca apodocephala  
 Melaleuca brevifolia  
 Melaleuca brophyi  
 Melaleuca carrii  
 Melaleuca cuticularis Saltwater Paperbark  
 Melaleuca hamata  
 Melaleuca lanceolata Rottnest Teatree, Moonah  
 Melaleuca nesophila Mindiyed  
 Melaleuca pentagona var. pentagona  
 Melaleuca pulchella Claw Flower  
 Melaleuca raphiophylla Swamp Paperbark  
 Melaleuca rigidifolia  
 Melaleuca scabra Rough Honey-myrtle, Wurru Bush  
 Melaleuca striata  
 Melaleuca suberosa Corky Honey-myrtle  
 Melaleuca subtrigona  
 Melaleuca thymoides  
 Melaleuca thyoides  
 \*Mesembryanthemum aitonis Angled Iceplant  
 Mesomelaena stygia subsp. stygia  
 Microcorys barbata  
 Microcorys subcanescens  
 Microtis alba White Mignonette Orchid

Microtis alboboviridis  
 Mitreola minima **P3**  
 Muehlenbeckia adpressa Climbing Lignum  
 Myoporum insulare Blueberry Tree, boobialla  
 Myoporum platycarpum Sugarwood  
 Myoporum tetrandrum Boobialla  
 Needhamiella pumilio  
 Nematolepis phebalioides  
 Nitraria billardierei Nitre Bush  
 Nuytsia floribunda Christmas Tree, Mudja  
 Olax phyllanthi  
 Olearia axillaris Coastal Daisybush  
 Oligarrhena micrantha  
 Opercularia vaginata Dog Weed  
 Ornduffia parnassifolia  
 \*Oxalis pes-caprae Soursob  
 Patersonia lanata forma calvata  
 Patersonia lanata forma lanata  
 Patersonia occidentalis Purple Flag, Koma  
 Persoonia dillwynioides Fitzgerald Persoonia  
 Persoonia teretifolia  
 Petrophile prostrata  
 Petrophile squamata  
 Petrophile squamata subsp. Ravensthorpe (E.M. Bennett 2597)  
 Petrophile teretifolia  
 Phebalium tuberculosum  
 Phymatocarpus maxwellii  
 Pimelea angustifolia Narrow-leaved Pimelea  
 Pimelea cracens  
 Pimelea drummondii  
 Pimelea erecta  
 Pimelea ferruginea  
 Podotheca angustifolia Sticky Longheads  
 \*Polypogon monspeliensis Annual Beardgrass  
 Pomaderris myrtilloides  
 Pterostylis concava  
 Pterostylis leptochila  
 Pterostylis mutica Midget Greenhood  
 Pterostylis recurva Jug Orchid  
 Pterostylis sanguinea  
 Pterostylis sp. short sepals (W. Jackson BJ259)  
 Pterostylis sp. small stature (W. Jackson BJ303)  
 Pterostylis vittata Banded Greenhood  
 Puccinellia stricta Marsh Grass  
 Pultenaea barbata  
 Pultenaea empetrifolia  
 Pultenaea heterochila  
 Pultenaea indira subsp. indira  
 Pyrrochis nigricans Red beaks, Elephants ears  
 Rhagodia baccata subsp. baccata  
 Rhagodia crassifolia Fleshy Saltbush  
 Rhodanthe citrina  
 Scaevola crassifolia Thick-leaved Fan-flower  
 Scaevola cuneiformis Wedge-leaved Scaevola  
 Scaevola pulvinaris Cushion Fanflower  
 Scaevola thesioides subsp. filifolia  
 Scaevola thesioides subsp. thesioides  
 Schoenus curvifolius  
 Schoenus grandiflorus Large Flowered Bogrush  
 Schoenus lanatus Woolly Bog-rush  
 Schoenus obtusifolius  
 Schoenus pleiostemoneus  
 Schoenus subbarbatus Bearded Bog-rush  
 Schoenus subfascicularis  
 Schoenus subflavus subsp. long leaves (K.L. Wilson 2865)  
 Senecio pinnatifolius var. maritimus Coastal Groundsel  
 \*Silene nocturna Mediterranean Catchfly  
 Siloxerus humifusus Procumbent Siloxerus  
 \*Sisymbrium orientale Indian Hedge Mustard  
 \*Solanum americanum Glossy Nightshade  
 Solanum symonii  
 \*Solanum triflorum Threeflower Nightshade

[Sonchus hydrophilus](#) Native Sowthistle  
 \*[Sonchus oleraceus](#) Common Sowthistle  
[Sphaerolobium daviesioides](#) Prickly Globe-pea  
[Sphaerolobium drummondii](#)  
[Spinifex hirsutus](#) Hairy Spinifex  
[Sporobolus virginicus](#) Marine Couch  
[Spyridium globulosum](#) Basket Bush  
[Spyridium majoranifolium](#)  
[Spyridium montanum](#) P2  
[Spyridium oligocephalum](#) P3  
[Stachystemon polyandrus](#)  
[Stirlingia anethifolia](#)  
[Stylidium albomontis](#)  
[Stylidium breviscapum](#) Boomerang Triggerplant  
[Stylidium camosum](#) Fleshy-leaved Triggerplant  
[Stylidium corymbosum](#) Whitecaps  
[Stylidium corymbosum](#) var. *corymbosum*  
[Stylidium insensitivum](#) Insensitive Trigger Plant  
[Stylidium pilosum](#) Silky Triggerplant  
[Stylidium repens](#) Matted Triggerplant  
[Stylidium rupestre](#) Rock Triggerplant  
[Stylidium schoenoides](#) Cow Kicks  
[Stylidium turleyae](#)  
[Styandra glauca](#) Blind Grass  
[Styphelia exserta](#)  
[Styphelia melaleuroides](#) var. *melaleuroides*  
[Synaphea divaricata](#)  
[Synaphea oligantha](#)  
[Taxandria spathulata](#)  
[Templetonia neglecta](#)  
[Templetonia retusa](#) Cockies Tongues  
[Tetragonia implexicoma](#) Bower Spinach  
[Tetrapora verrucosa](#)  
[Thelymitra benthamiana](#) Leopard Orchid  
[Thomasia angustifolia](#) Narrow Leaved Thomasia  
[Thomasia microphylla](#)  
[Threlkeldia diffusa](#) Coast Bonefruit  
[Thryptomene australis](#) subsp. *australis*  
[Thysanotus brachiatus](#) P2  
[Thysanotus patersonii](#)  
[Thysanotus sparteus](#)  
[Thysanotus triandrus](#)  
[Trachymene cyanopetala](#)  
[Trachymene pilosa](#) Native Parsnip  
[Tribonanthes violacea](#)  
[Tricoryne tenella](#)  
[Tricostularia neesii](#) var. *neesii*  
 \*[Typha orientalis](#) Bulrush, Cumbung  
[Utricularia menziesii](#) Redcoats  
[Velleia trinervis](#)  
 \*[Vellereophyton dealbatum](#) White Cudweed  
[Verticordia chrysantha](#)  
[Verticordia densiflora](#) var. *cespitosa*  
[Verticordia humilis](#)  
[Verticordia inclusa](#)  
[Verticordia minutiflora](#)  
[Verticordia pityrhops](#) T  
[Verticordia plumosa](#) var. *grandiflora*  
[Verticordia sieberi](#) var. *lomata*  
[Verticordia vicinella](#)  
[Vittadinia australasica](#) var. *australasica*  
[Westringia dampieri](#)  
[Westringia rigida](#) Stiff Westringia  
[Wilsonaea dictyroides](#)  
[Wilsonia backhousei](#) Narrow-leaf Wilsonia  
[Wilsonia rotundifolia](#) Round-leaf Wilsonia  
[Wurmbea cernua](#)  
[Xanthorrhoea platyphylla](#)  
[Zygophyllum billardierei](#) Coast Twinleaf

#### Conservation Status

T - Rare or likely to become extinct  
 X - Presumed extinct

IA -Protected under international agreement  
S - Other specially protected fauna  
1 - Priority 1  
2 - Priority 2  
3 - Priority 3  
4 - Priority 4  
5 - Priority 5



## EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information about the EPBC Act including significance guidelines, forms and application process details can be found at <http://www.environment.gov.au/epbc/assessmentsapprovals/index.html>

LGA RAVENSTHORPE, WA

Report created: 23/05/13 17:39:20

[Summary](#)

[Details](#)

[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)



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## Summary

### Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see <http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html>

<a href="#">World Heritage Properties:</a>	None
<a href="#">National Heritage Places:</a>	2
<a href="#">Wetlands of International</a>	None
<a href="#">Great Barrier Reef Marine Park:</a>	None
<a href="#">Commonwealth Marine Areas:</a>	None
<a href="#">Threatened Ecological Communities:</a>	None
<a href="#">Threatened Species:</a>	66
<a href="#">Migratory Species:</a>	29



## Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage/index.html>

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at <http://www.environment.gov>.

<u>Commonwealth Lands:</u>	1
<u>Commonwealth Heritage Places:</u>	None
<u>Listed Marine Species:</u>	49
<u>Whales and Other Cetaceans:</u>	11
<u>Critical Habitats:</u>	None
<u>Commonwealth Reserves:</u>	None

## Extra Information

This part of the report provides information that may also be relevant to the area you have

<u>Place on the RNE:</u>	10
<u>State and Territory Reserves:</u>	15
<u>Regional Forest Agreements:</u>	None
<u>Invasive Species:</u>	17
<u>Nationally Important Wetlands:</u>	2

## Details

### Matters of National Environmental Significance

National Heritage Properties		<a href="#">[ Resource Information ]</a>
Name	State	Status
<b>Natural</b>		
<a href="#">Fitzgerald River Ravensthorpe Range Area</a>	WA	Nominated place
<a href="#">Great Western Woodlands of Western Australia</a>	WA	Nominated place
Threatened Species		<a href="#">[ Resource Information ]</a>
Name	Status	Type of Presence
<b>BIRDS</b>		

Name	Status	Type of Presence
<a href="#">Acanthiza iredalei iredalei</a> Slender-billed Thornbill (western) [25967]	Vulnerable	Species or species habitat may occur within area
<a href="#">Botaurus poiciloptilus</a> Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area
<a href="#">Calyptrorhynchus latirostris</a> Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Breeding likely to occur within area
<a href="#">Cereopsis novaehollandiae grisea</a> Cape Barren Goose (south-western), Recherche Cape Barren Goose [25978]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Dasyornis longirostris</a> Western Bristlebird [515]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Diomedea exulans antipodensis</a> Antipodean Albatross [82269]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Diomedea exulans exulans</a> Tristan Albatross [82337]	Endangered	Species or species habitat may occur within area
<a href="#">Diomedea exulans (sensu lato)</a> Wandering Albatross [1073]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Leipoa ocellata</a> Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Macronectes giganteus</a> Southern Giant-Petrel [1060]	Endangered	Species or species habitat may occur within area
<a href="#">Macronectes halli</a> Northern Giant-Petrel [1061]	Vulnerable	Species or species habitat may occur within area
<a href="#">Pezoporus flaviventris</a> Western Ground Parrot [84650]	Endangered	Species or species habitat known to occur within area
<a href="#">Thalassarche cauta cauta</a> Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Species or species habitat may occur within area
<b>MAMMALS</b>		
<a href="#">Dasyurus geoffroi</a> Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Eubalaena australis</a> Southern Right Whale [40]	Endangered	Breeding known to occur within area
<a href="#">Megaptera novaeangliae</a> Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Neophoca cinerea</a> Australian Sea-lion [22]	Vulnerable	Breeding known to occur within area
<a href="#">Parantechinus apicalis</a> Dibbler [313]	Endangered	Species or species habitat likely to occur within area
<a href="#">Phascogale calura</a> Red-tailed Phascogale [316]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
<a href="#"><i>Pseudomys shortridgei</i></a> Dayang, Heath Rat [77]	Vulnerable	Species or species habitat likely to occur within area
<b>PLANTS</b>		
<a href="#"><i>Acacia lanuginophylla</i></a> Woolly Wattle [55575]	Endangered	Species or species habitat may occur within area
<a href="#"><i>Acacia rhamphophylla</i></a> Kundip Wattle [64659]	Endangered	Species or species habitat known to occur within area
<a href="#"><i>Adenanthos dobagii</i></a> Fitzgerald Woollybush [21253]	Endangered	Species or species habitat likely to occur within area
<a href="#"><i>Adenanthos ellipticus</i></a> Oval-leaf Adenanthos [4570]	Vulnerable	Species or species habitat likely to occur within area
<a href="#"><i>Adenanthos pungens subsp. effusus</i></a> Sprawling Spiky Adenanthos [10742]	Endangered	Species or species habitat likely to occur within area
<a href="#"><i>Anigozanthos bicolor subsp. minor</i></a> Little Kangaroo Paw, Two-coloured Kangaroo Paw, Small Two-colour Kangaroo Paw [21241]	Endangered	Species or species habitat known to occur within area
<a href="#"><i>Banksia anatona</i></a> Cactus Dryandra [82758]	Endangered	Species or species habitat may occur within area
<a href="#"><i>Banksia pseudoplumosa</i></a> False Plumed-Banksia [82760]	Endangered	Species or species habitat likely to occur within area
<a href="#"><i>Boronia clavata</i></a> Bremer Boronia [5538]	Endangered	Species or species habitat may occur within area
<a href="#"><i>Caladenia hoffmanii</i></a> Hoffman's Spider-orchid [56719]	Endangered	Species or species habitat may occur within area
<a href="#"><i>Centrolepis caespitosa</i></a> [6393]	Endangered	Species or species habitat likely to occur within area
<a href="#"><i>Chordifex abortivus</i></a> Manypeaks Rush [64868]	Endangered	Species or species habitat may occur within area
<a href="#"><i>Conostylis lepidospermoides</i></a> Sedge Conostylis [9254]	Endangered	Species or species habitat likely to occur within area
<a href="#"><i>Cooperhooikia georgei</i></a> Maue Cooperhooikia [21218]	Endangered	Species or species habitat likely to occur within area
<a href="#"><i>Darwinia oxylepis</i></a> Gillham's Bell [13188]	Endangered	Species or species habitat may occur within area
<a href="#"><i>Darwinia wittwerorum</i></a> Wittwer's Mountain Bell [15626]	Endangered	Species or species habitat may occur within area
<a href="#"><i>Daviesia megacalyx</i></a> Long-sepalled Daviesia [56785]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
<a href="#"><u>Daviesia obovata</u></a> Paddle-leaf Daviesia [17311]	Endangered	Species or species habitat known to occur within area
<a href="#"><u>Eremophila denticulata subsp. denticulata</u></a> Fitzgerald Eremophila [64569]	Vulnerable	Species or species habitat likely to occur within area
<a href="#"><u>Eremophila lactea</u></a> Milky Emu Bush [2416]	Endangered	Species or species habitat may occur within area
<a href="#"><u>Eremophila subteretifolia</u></a> Lake King Eremophila [56702]	Endangered	Species or species habitat known to occur within area
<a href="#"><u>Eremophila verticillata</u></a> Whorled Eremophila [7032]	Endangered	Species or species habitat likely to occur within area
<a href="#"><u>Eucalyptus burdettiana</u></a> Burdett Gum [13505]	Endangered	Species or species habitat likely to occur within area
<a href="#"><u>Eucalyptus coronata</u></a> Crowned Mallee [2308]	Vulnerable	Species or species habitat likely to occur within area
<a href="#"><u>Eucalyptus merrickiae</u></a> Goblet Mallee [13119]	Vulnerable	Species or species habitat likely to occur within area
<a href="#"><u>Grevillea infundibularis</u></a> Fan-leaf Grevillea [5772]	Endangered	Species or species habitat likely to occur within area
<a href="#"><u>Grevillea involucrata</u></a> Lake Varley Grevillea [4631]	Endangered	Species or species habitat likely to occur within area
<a href="#"><u>Isopogon uncinatus</u></a> Hook-leaf Isopogon [20871]	Endangered	Species or species habitat may occur within area
<a href="#"><u>Kennedia glabrata</u></a> Northcliffe Kennedia [16452]	Vulnerable	Species or species habitat likely to occur within area
<a href="#"><u>Marianthus mollis</u></a> Hairy-fruited Billardiera [82825]	Endangered	Species or species habitat likely to occur within area
<a href="#"><u>Muehlenbeckia horrida subsp. abdita</u></a> Remote Thorny Lignum [65937]	Critically Endangered	Species or species habitat may occur within area
<a href="#"><u>Rhizanthella gardneri</u></a> Underground Orchid, Western Australian Underground Orchid [20109]	Endangered	Species or species habitat likely to occur within area
<a href="#"><u>Ricinocarpos trichophorus</u></a> Barrens Wedding Bush [19931]	Endangered	Species or species habitat likely to occur within area
<a href="#"><u>Roycea pycnophylloides</u></a> Saltmat [21161]	Endangered	Species or species habitat likely to occur within area
<a href="#"><u>Sphenotoma drummondii</u></a> [21160]	Endangered	Species or species habitat may occur within area
<a href="#"><u>Stylidium galioides</u></a> Yellow Mountain Triggerplant [4666]	Vulnerable	Species or species

Name	Status	Type of Presence
<a href="#">Thelymitra psammophila</a> Sandplain Sun-orchid [4908]	Vulnerable	habitat likely to occur within area Species or species habitat likely to occur within area
<a href="#">Verticordia crebra</a> [55678]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Verticordia helichrysantha</a> Coast Featherflower [8204]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Verticordia pityrhopis</a> [55798]	Endangered	Species or species habitat likely to occur within area

## REPTILES

<a href="#">Caretta caretta</a> Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
<a href="#">Chelonia mydas</a> Green Turtle [1765]	Vulnerable	Breeding likely to occur within area
<a href="#">Dermochelys coriacea</a> Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area

## SHARKS

<a href="#">Carcharias taurus (west coast population)</a> Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat may occur within area
<a href="#">Carcharodon carcharias</a> Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Rhincodon typus</a> Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

## Migratory Species

## [Resource Information](#)

\* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
<b>Migratory Marine Birds</b>		
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<a href="#">Diomedea antipodensis</a> Antipodean Albatross [64458]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Diomedea dabbenena</a> Tristan Albatross [66471]	Endangered*	Species or species habitat may occur within area
<a href="#">Diomedea exulans (sensu lato)</a> Wandering Albatross [1073]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Macronectes giganteus</a> Southern Giant-Petrel [1060]	Endangered	Species or species habitat may occur within area
<a href="#">Macronectes halli</a> Northern Giant-Petrel [1061]	Vulnerable	Species or species habitat may occur within area
<a href="#">Puffinus carneipes</a> Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely

Name	Threatened	Type of Presence
<u><i>Sterna anaethetus</i></u> Bridled Tern [814]		to occur within area  Foraging, feeding or related behaviour likely to occur within area
<u><i>Sterna caspia</i></u> Caspian Tern [59467]		Foraging, feeding or related behaviour known to occur within area
<u><i>Thalassarche cauta (sensu stricto)</i></u> Shy Albatross, Tasmanian Shy Albatross [64697]	Vulnerable*	Species or species habitat may occur within area
<b>Migratory Marine Species</b>		
<u><i>Balaenoptera edeni</i></u> Bryde's Whale [35]		Species or species habitat may occur within area
<u><i>Caperea marginata</i></u> Pygmy Right Whale [39]		Species or species habitat may occur within area
<u><i>Carcharodon carcharias</i></u> Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
<u><i>Caretta caretta</i></u> Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
<u><i>Chelonia mydas</i></u> Green Turtle [1765]	Vulnerable	Breeding likely to occur within area
<u><i>Dermochelys coriacea</i></u> Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
<u><i>Eubalaena australis</i></u> Southern Right Whale [40]	Endangered	Breeding known to occur within area
<u><i>Lagenorhynchus obscurus</i></u> Dusky Dolphin [43]		Species or species habitat may occur within area
<u><i>Lamna nasus</i></u> Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
<u><i>Megaptera novaeangliae</i></u> Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
<u><i>Orcinus orca</i></u> Killer Whale, Orca [46]		Species or species habitat may occur within area
<u><i>Rhincodon typus</i></u> Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
<b>Migratory Terrestrial Species</b>		
<u><i>Haliaeetus leucogaster</i></u> White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
<u><i>Leipoa ocellata</i></u> Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
<u><i>Merops ornatus</i></u> Rainbow Bee-eater [670]		Species or species habitat may occur within area
<u><i>Pezoporus wallicus flaviventris</i></u> Western Ground Parrot [26024]	Endangered*	Species or species

Name	Threatened	Type of Presence
<b>Migratory Wetlands Species</b>		
<u><a href="#">Ardea alba</a></u>		
Great Egret, White Egret [59541]		Species or species habitat known to occur within area
<u><a href="#">Ardea ibis</a></u>		
Cattle Egret [59542]		Species or species habitat likely to occur within area
<u><a href="#">Calidris ruficollis</a></u>		
Red-necked Stint [860]		Species or species habitat known to occur within area

## Other Matters Protected by the EPBC Act

### Commonwealth Lands [\[ Resource Information \]](#)

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

#### Name

Commonwealth Land -

### Listed Marine Species [\[ Resource Information \]](#)

\* Species is listed under a different scientific name on the EPBC Act - Threatened Species list

Name	Threatened	Type of Presence
<b>Birds</b>		
<u><a href="#">Apus pacificus</a></u>		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<u><a href="#">Ardea alba</a></u>		
Great Egret, White Egret [59541]		Species or species habitat known to occur within area
<u><a href="#">Ardea ibis</a></u>		
Cattle Egret [59542]		Species or species habitat likely to occur within area
<u><a href="#">Calidris ruficollis</a></u>		
Red-necked Stint [860]		Species or species habitat known to occur within area
<u><a href="#">Cereopsis novaehollandiae grisea</a></u>		
Cape Barren Goose (south-western), Recherche Cape Barren Goose [25978]	Vulnerable	Species or species habitat known to occur within area
<u><a href="#">Charadrius ruficapillus</a></u>		
Red-capped Plover [881]		Species or species habitat known to occur within area
<u><a href="#">Diomedea antipodensis</a></u>		
Antipodean Albatross [64458]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
<u><a href="#">Diomedea dabbenena</a></u>		
Tristan Albatross [66471]	Endangered*	Species or species habitat may occur within area
<u><a href="#">Diomedea exulans (sensu lato)</a></u>		
Wandering Albatross [1073]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<u><a href="#">Haliaeetus leucogaster</a></u>		
White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
<a href="#">Larus pacificus</a> Pacific Gull [811]		Foraging, feeding or related behaviour known to occur within area
<a href="#">Macronectes giganteus</a> Southern Giant-Petrel [1060]	Endangered	Species or species habitat may occur within area
<a href="#">Macronectes halli</a> Northern Giant-Petrel [1061]	Vulnerable	Species or species habitat may occur within area
<a href="#">Merops ornatus</a> Rainbow Bee-eater [670]		Species or species habitat may occur within area
<a href="#">Pandion haliaetus</a> Osprey [952]		Breeding known to occur within area
<a href="#">Phalacrocorax fuscescens</a> Black-faced Cormorant [59660]		Foraging, feeding or related behaviour likely to occur within area
<a href="#">Puffinus assimilis</a> Little Shearwater [59363]		Foraging, feeding or related behaviour known to occur within area
<a href="#">Puffinus carneipes</a> Flesh-footed Shearwater, Fleishy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
<a href="#">Recurvirostra novaehollandiae</a> Red-necked Avocet [871]		Species or species habitat known to occur within area
<a href="#">Sterna anaethetus</a> Bridled Tern [814]		Foraging, feeding or related behaviour likely to occur within area
<a href="#">Sterna caspia</a> Caspian Tern [59467]		Foraging, feeding or related behaviour known to occur within area
<a href="#">Thalassarche cauta (sensu stricto)</a> Shy Albatross, Tasmanian Shy Albatross [64697]	Vulnerable*	Species or species habitat may occur within area
<a href="#">Thinornis rubricollis</a> Hooded Plover [59510]		Species or species habitat known to occur within area
<b>Fish</b>		
<a href="#">Acentronura australe</a> Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
<a href="#">Campichthys galei</a> Gale's Pipefish [66191]		Species or species habitat may occur within area
<a href="#">Heraldia nocturna</a> Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
<a href="#">Hippocampus breviceps</a> Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
<a href="#">Histiogamphelus cristatus</a> Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
<a href="#">Leptoichthys fistularius</a> Brushtail Pipefish [66248]		Species or species



Name	Threatened	Type of Presence
<a href="#"><u>Lissocampus caudalis</u></a> Australian Smooth Pipefish, Smooth Pipefish [66249]		habitat may occur within area  Species or species habitat may occur within area
<a href="#"><u>Lissocampus runa</u></a> Javelin Pipefish [66251]		Species or species habitat may occur within area
<a href="#"><u>Maroubra perserrata</u></a> Sawtooth Pipefish [66252]		Species or species habitat may occur within area
<a href="#"><u>Nannocampus subosseus</u></a> Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
<a href="#"><u>Notiocampus ruber</u></a> Red Pipefish [66265]		Species or species habitat may occur within area
<a href="#"><u>Phycodurus eques</u></a> Leafy Seadragon [66267]		Species or species habitat may occur within area
<a href="#"><u>Phyllopteryx taeniolatus</u></a> Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
<a href="#"><u>Pugnaso curtirostris</u></a> Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
<a href="#"><u>Solegnathus lettiensis</u></a> Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
<a href="#"><u>Stigmatopora argus</u></a> Spotted Pipefish, Gulf Pipefish [66276]		Species or species habitat may occur within area
<a href="#"><u>Stigmatopora nigra</u></a> Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
<a href="#"><u>Urocampus carinirostris</u></a> Hairy Pipefish [66282]		Species or species habitat may occur within area
<a href="#"><u>Vanacampus margaritifer</u></a> Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
<a href="#"><u>Vanacampus phillipi</u></a> Port Phillip Pipefish [66284]		Species or species habitat may occur within area
<a href="#"><u>Vanacampus poecilolaemus</u></a> Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
<b>Mammals</b>		
<a href="#"><u>Arctocephalus forsteri</u></a> New Zealand Fur-seal [20]		Species or species habitat likely to occur within area
<a href="#"><u>Neophoca cinerea</u></a> Australian Sea-lion [22]	Vulnerable	Breeding known to occur within area
<b>Reptiles</b>		
<a href="#"><u>Caretta caretta</u></a> Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known

Name	Threatened	Type of Presence
<a href="#">Chelonia mydas</a> Green Turtle [1765]	Vulnerable	to occur within area Breeding likely to occur within area
<a href="#">Dermochelys coriacea</a> Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area

### Whales and other Cetaceans [ Resource Information ]

Name	Status	Type of Presence
<b>Mammals</b>		
<a href="#">Balaenoptera acutorostrata</a> Minke Whale [33]		Species or species habitat may occur within area
<a href="#">Balaenoptera edeni</a> Bryde's Whale [35]		Species or species habitat may occur within area
<a href="#">Caperea marginata</a> Pygmy Right Whale [39]		Species or species habitat may occur within area
<a href="#">Delphinus delphis</a> Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
<a href="#">Eubalaena australis</a> Southern Right Whale [40]	Endangered	Breeding known to occur within area
<a href="#">Grampus griseus</a> Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
<a href="#">Lagenorhynchus obscurus</a> Dusky Dolphin [43]		Species or species habitat may occur within area
<a href="#">Megaptera novaeangliae</a> Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Orcinus orca</a> Killer Whale, Orca [46]		Species or species habitat may occur within area
<a href="#">Tursiops aduncus</a> Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
<a href="#">Tursiops truncatus s. str.</a> Bottlenose Dolphin [68417]		Species or species habitat may occur within area

### Extra Information

#### Places on the RNE [ Resource Information ]

Note that not all Indigenous sites may be listed.

Name	State	Status
<b>Natural</b>		
<a href="#">North Fitzgerald Area</a>	WA	Indicative Place
<a href="#">The South Coast Reserves</a>	WA	Indicative Place
<a href="#">Cocanarup Reserve</a>	WA	Registered
<a href="#">Fitzgerald River National Park (1980 boundary)</a>	WA	Registered
<a href="#">Fitzgerald River National Park (1989 Boundary)</a>	WA	Registered
<a href="#">Jerdacuttup River Komatiites</a>	WA	Registered
<a href="#">Ravensthorpe Range Area</a>	WA	Registered

Name	State	Status
<b>Historic</b>		
<a href="#">Mine Managers House (former)</a>	WA	Indicative Place
<a href="#">Cocanarup Homestead, Outbuildings and Grave of John Dunn</a>	WA	Registered
<a href="#">Palace Hotel</a>	WA	Registered

### State and Territory Reserves [\[ Resource Information \]](#)

Name	State
Cheadanup	WA
East Naernup	WA
Fitzgerald River	WA
Frank Hann	WA
Hayes	WA
Jerdacuttup Lakes	WA
Koornong	WA
Kundip	WA
Lake Shaster	WA
Long Creek	WA
Overshot Hill	WA
Unnamed WA26662	WA
Unnamed WA27177	WA
Unnamed WA31424	WA
Unnamed WA43060	WA

### Invasive Species [\[ Resource Information \]](#)

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit,

Name	Status	Type of Presence
------	--------	------------------

#### Birds

##### [Anas platyrhynchos](#)

Mallard [974] Species or species habitat likely to occur within area

##### [Columba livia](#)

Rock Pigeon, Rock Dove, Domestic Pigeon [803] Species or species habitat likely to occur within area

##### [Streptopelia senegalensis](#)

Laughing Turtle-dove, Laughing Dove [781] Species or species habitat likely to occur within area

##### [Sturnus vulgaris](#)

Common Starling [389] Species or species habitat likely to occur within area

#### Mammals

##### [Canis lupus familiaris](#)

Domestic Dog [82654] Species or species habitat likely to occur within area

##### [Capra hircus](#)

Goat [2] Species or species habitat likely to occur within area

##### [Felis catus](#)

Cat, House Cat, Domestic Cat [19] Species or species habitat likely to occur within area

##### [Mus musculus](#)

House Mouse [120] Species or species habitat likely to occur within area

##### [Oryctolagus cuniculus](#)

Rabbit, European Rabbit [128] Species or species habitat likely to occur within area

##### [Rattus rattus](#)

Black Rat, Ship Rat [84] Species or species

Name	Status	Type of Presence
<u><i>Sus scrofa</i></u> Pig [6]		habitat likely to occur within area  Species or species habitat likely to occur within area
<u><i>Vulpes vulpes</i></u> Red Fox, Fox [18]		Species or species habitat likely to occur within area
<b>Plants</b>		
<u><i>Asparagus asparagoides</i></u> Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
<u><i>Carrichtera annua</i></u> Ward's Weed [9511]		Species or species habitat may occur within area
<u><i>Lycium ferocissimum</i></u> African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
<u><i>Rubus fruticosus aggregate</i></u> Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
<u><i>Tamarix aphylla</i></u> Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
<b>Nationally Important Wetlands</b>		<b>[ Resource Information ]</b>
Name		State
<u>Culham Inlet System</u>		WA
<u>Fitzgerald Inlet System</u>		WA

## Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

## Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

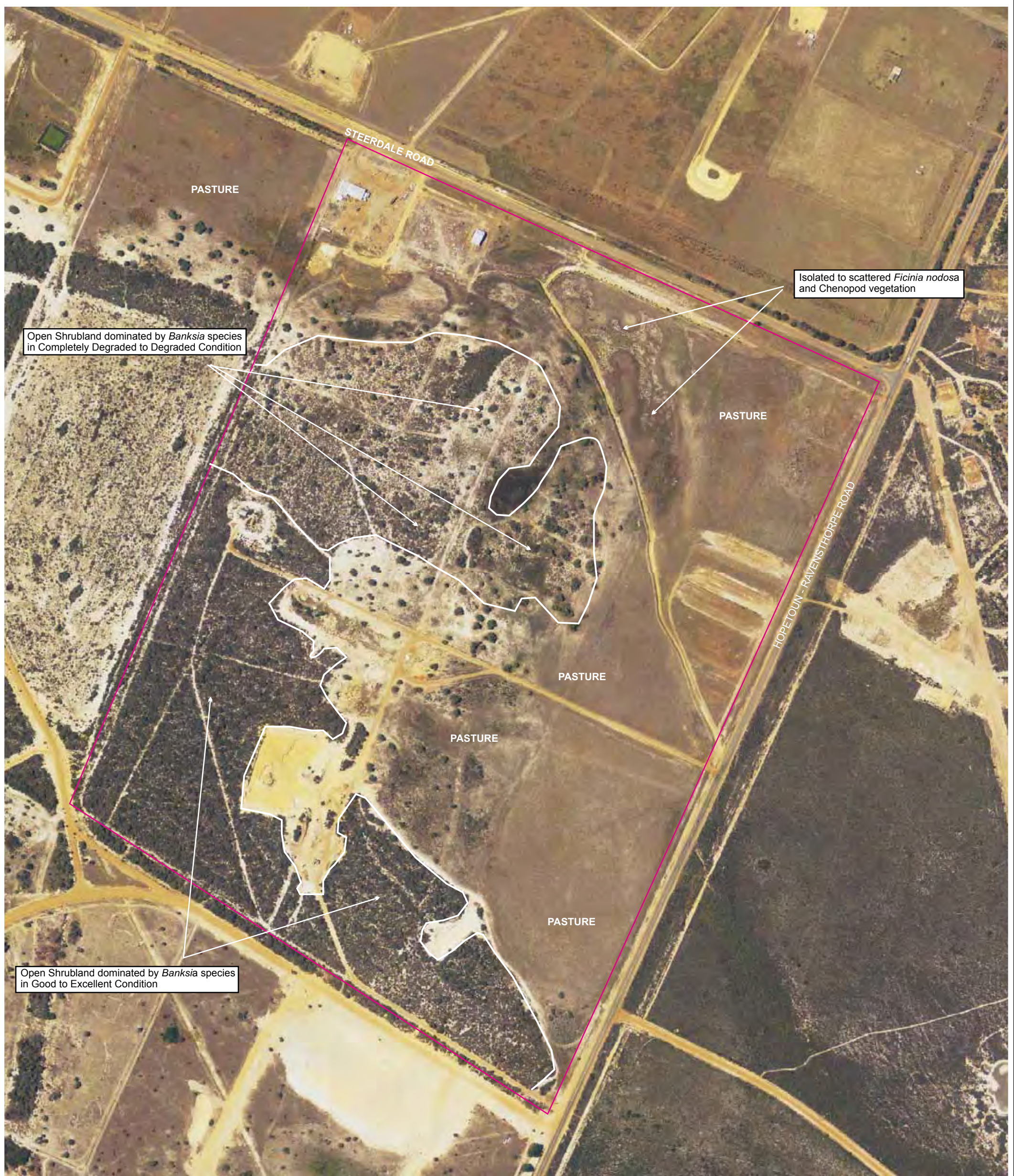
- [Department of Environment, Climate Change and Water, New South Wales](#)
- [Department of Sustainability and Environment, Victoria](#)
- [Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [Department of Environment and Natural Resources, South Australia](#)
- [Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts](#)
- [Environmental and Resource Management, Queensland](#)
- [Department of Environment and Conservation, Western Australia](#)
- [Department of the Environment, Climate Change, Energy and Water](#)
- [Birds Australia](#)
- [Australian Bird and Bat Banding Scheme](#)
- [Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [Museum Victoria](#)
- [Australian Museum](#)
- [SA Museum](#)
- [Queensland Museum](#)
- [Online Zoological Collections of Australian Museums](#)
- [Queensland Herbarium](#)
- [National Herbarium of NSW](#)
- [Royal Botanic Gardens and National Herbarium of Victoria](#)
- [Tasmanian Herbarium](#)
- [State Herbarium of South Australia](#)
- [Northern Territory Herbarium](#)
- [Western Australian Herbarium](#)
- [Australian National Herbarium, Atherton and Canberra](#)
- [University of New England](#)
- [Ocean Biogeographic Information System](#)
- [Australian Government, Department of Defence](#)
- [State Forests of NSW](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

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[Please feel free to provide feedback via the Contact Us page.](#)

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Open Shrubland dominated by *Banksia* species  
in Completely Degraded to Degraded Condition

Isolated to scattered *Ficinia nodosa*  
and *Chenopod* vegetation

Open Shrubland dominated by *Banksia* species  
in Good to Excellent Condition



LOT 8, HOPETOUN – RAVENSTHORPE ROAD, HOPETOUN	
<b>VEGETATION</b>	
Basemap LANDGATE	Drawn by LANDFORM RESEARCH
Scale 1 : 5 000 at A3	May 2013

# LOCAL WATER MANAGEMENT STRATEGY

## LOT 8 HOPETOUN – RAVENSTHORPE ROAD HOPETOUN

### SHIRE OF RAVENSTHORPE

September 2015 - Figures 4A, 4B and 4C updated



## **SUMMARY and CONCLUSIONS**

### **Background**

Information required by Department of Water (DOW) in a Water Management Strategy repeats, in many areas, the material included in the land capability and geotechnical reporting.

As DOW requires a Local Water Management Strategy Report that is separate from the Land Capability and Geotechnical reporting a significant proportion of the same information has to be repeated in both reports.

Where relevant, data and information is taken from the land capability reporting and summarised or modified as required for this report. References are also made in each document to the relevant sections.

### **Site**

Lot 8 Hopetoun – Ravensthorpe Road, Hopetoun lies near the northern edge of Hopetoun. It consists of a high sandy ridge taking up much of the south western part of Lot 8 with a low alluvial plain covering the eastern and northern portion of the site.

It adjoins rural living subdivisions to the north and south.

### **Subdivision**

It is proposed to subdivide Lot 8, Hopetoun – Ravensthorpe Road to 1 hectare lots with rural living and associated enterprises. Approximately 60 lots are proposed with all being connected to scheme water.

The proposed road network has connections to both Steerdale and Hopetoun – Ravensthorpe Roads with approximately 3.3 km of roads proposed.

### **Stormwater Management for Dwellings**

For dwellings it is proposed that stormwater from the one hour 1 in 1 year return event will be retained within rainwater tanks and soakwells on site.

Excess water from rainfall events greater than this will flow onto the ground for broad area infiltration. The large lot sizes, with a minimum of 1 hectare, and the permeable deep sand soils or sand over sandy clay duplex soils provide sufficient area and depth for infiltration.

### **Road Drainage**

The road design may need minor refinement during the detailed engineering design stage.

It is proposed to retain the 1 in 1 year one hour event within swale drains along all roads. The drains will be capable of retaining up to 1 in 5 year one hour events.

In order to maintain the environmental flows stormwater in excess of the 1 hour 1 year return event excess water will be directed to infiltration basins and the central drain across Lot 8. With large 1 hectare lots there is ample room for infiltration basins.

The size of the swale drains and detention basins will be refined during the detailed engineering design phase of the subdivision.



All drains and detention basins should be located either within road reserves or protected by an easement to enable future maintenance by the Local Authority.

### **Surface Water Drainage and Flood Risk**

There are no defined watercourses on Lot 8.

Lot 8 currently accepts large storm flows from the land north of Steerdale Road and directs it along the natural flow lines to Dunn's Swamp to the south east. The storm flows can be significant and are currently constrained by a drain.

The drain on Lot 8 currently has a cross sectional flow area of 3.0 m<sup>2</sup>. During the last decade the storm flows have had a cross sectional area of 1.8 m<sup>2</sup>.

Therefore, in the absence of new calculations of the runoff from the catchment to the north, the maintenance of a drain and culverts with a 3.0 m<sup>2</sup> surface area flow capacity is recommended.

It is recommended that Steerdale Road drainage be further investigated to ensure that the culvert or floodway in that location does not lead to damming of the flows or scouring of the road.

### **Groundwater**

The Hopetoun Water Source Protection Groundwater Area, which is used for drinking purposes, lies south of Lot 8.

Groundwater in the groundwater aquifer flows from north east to south west including potential flows from the southern edge of Lot 8 towards the Drinking Water Source Area.

Hirschberg 1980, recorded the elevation of the water table as being 9 metres AHD south of the southern boundary of Lot 8. By interpretation that would equate to an elevation of 10 metres AHD at the southern boundary, seven metres below the lowest land elevation in that corner, rising towards the north eastern corner where a separation to groundwater of several metres occurs.

Lot 8 is therefore sufficiently above the water table for there to be no significant issue.

### **Water Quality**

There is no evidence of salinity of soils across almost all of Lot 8 although there is a small area of historical salinity in the central north. No change to salinity is anticipated as a result of subdivision.

There is no evidence of acid sulfate conditions, and unlikely to be, based on geological and regolith considerations. No deep excavations are expected to be required that are likely to introduce at risk conditions.

A 30 metre setback to the drain is recommended for waste water disposal systems, although in situations where alternative waste water systems are used smaller setbacks may be acceptable.

### **Nutrient Impacts**

The site complies with the Draft Country Sewerage Policy (22 September 2002, SOCWM meeting) which permits waste water disposal on any soil type on lots in excess of 0.2 hectare, and allows for some site modification. AS/NZS1547:2000 is very flexible in the methods that can be used for waste water disposal. This proposed subdivision complies with AS/NZS1547:2000.

The soils are capable of accepting and retaining all waste water, from either a conventional septic system over most of Lot 8 with Alternative/Nutrient adsorbing waste water system in other locations.

See the Land Capability and Geotechnical Assessment dated May 2013.

### **CONCLUSIONS**

The proposed subdivision of Lot 8 to 1 hectare rural living lots is compatible with all Government policies and can be developed in a manner that manages and does not significantly impact on surface and groundwater.

**LOCAL WATER MANAGEMENT PLAN SUMMARY**

<b>SECTION</b>	<b>ITEM</b>	<b>REFERENCE</b>	<b>COMMENTS</b>
Executive Summary			
Introduction	Context	1.0 page 1	
Proposed Development	Site Context	2.0 page 2	
	Proposal Plan	Figure 4 2.0 page 2	
	Landscape Plan	Figures 1 and 2	
Design Criteria	Design Criteria	3.0 page 3 Figures 2 and 4	
Pre-Development Environment	Site Assessments	4.0 page 3	See the Land Capability and Geotechnical Assessment dated May 2013.
	Site Condition	4.0 page 3 - 13 Figures 1 - 2	See the Land Capability and Geotechnical Assessment dated May 2013.
	Geotechnical Conditions	4.0 pages 3 – 13 Figures 1 - 2	See the Land Capability and Geotechnical Assessment dated May 2013.
	Environmental Issues	Pages 11 –13 Figure 1 - 2	No wetlands, one watercourse.
	Existing Surface Water Flows	4.5 pages 9 - 11 Figures 1 and 2	
	Groundwater	4.6.6 page 11 - 13	
Water Use Sustainability Initiatives	Water efficiency	5.0 page 13 - 15	
	Water Supply	2.0 page 2	Scheme
	Wastewater Management	4.3.4 page 6 - 8	See the Land Capability and Geotechnical Assessment dated May 2013.
Stormwater Management Strategy	Flood Parameters	4.5.3 page 9 – 11 Figure 1 - 2	No watercourses on development area. Located in POS.
	100 Year Event	Pages 15 - 25	
	10 Year Event	above	
	1 Year Event	above	
	Groundwater Management Acid Sulfate	7.0 page 26 4.3.5 page 8	No groundwater impact No acid sulfate
Future Water Management		Page 26	Detailed designs will be required after approvals are gained
Implementation	Developer		This document is to support application for subdivision.
	Roles - Funding		
	Review		

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Concept Swales and Basins

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- Figure 2 Aerial photograph
- Figure 3 Bureau of Meteorology Storm Event Data
- Figure 4A Storm Event Flows 1 – 5 year events
- Figure 4B Storm Event Flows 1- - 100 year events
- Figure 4C Recommended Design and Constructed Water Management

For additional information see

“Land Capability and Geotechnical Assessment dated May 2013, prepared by Landform Research”

## LOCAL WATER MANAGEMENT

### 1.0 Introduction

#### 1.1 Background to a Water Management

In recent years Urban Water Management has received greater attention during the design phase to ensure that water resources are maximised and that environmental flows are maintained. The considerations and design are also directed towards minimising impact during storm events.

The Department of Water, 2008, *Better Urban Water Management* documents the issues.

This is also considered in Department of Planning, *Planning Bulletin 92, Urban Water Management* and *DOW 2004 – 2007) Stormwater Management Manual for WA*.

The focus of this local urban water planning is to provide for surface and groundwater management at all stages of the Planning and Development process to ensure that the management of water works at a Regional and Local level and that as land is progressively developed, a situation does not arise where a satisfactory solution or management cannot be found in the later stages of development.

In other words drainage and water management is to be considered up front in the broad scale and from there considered in progressively more detail until the final design at the local level is achieved.

With consideration of water issues up front there is more potential to design better management of water. The main trends of the *Better Urban Water Management* are summarised below.

- to increase the potential for sustainability,
- maintain environmental flows,
- maintain and enhance water quality
- minimise the potential impact on the surface and groundwater hydrology both onsite and offsite,
- maintain biodiversity
- provide nutrient retention and management,
- minimise flood risk
- encourage water conservation

The key design objectives are to

- maintain the one year one hour average recurrence interval (ARI) event on site, so that the peak post development flow rates are similar to the pre-development conditions.
- manage the catchment runoff from post development in excess of the 1 year one hour events (up to the 1 in 100 year ARI event) at volumes similar to the pre-development conditions.

- Minimise water use within the proposed subdivision to 100 kL per person/year including not more than 40 – 60 kL per person per year of scheme water.

The water planning outlined in *Better Urban Water Management, 2008* is;

**1. Regional or subregional land and water planning**

Water planning at a whole of catchment level.

**2. District water planning document**

Water planning at the local catchment level or within a planning precinct

**3. Local water planning**

Water planning within part of a catchment or at a subdivision level and at the primary design stage or rezoning stage of land. This is normally conducted using a **Local Water Management Strategy**.

For large subdivisions, or in urban catchments, more detailed water management is considered in an **Urban Water Management Plan**. This is completed once the subdivision design is refined and design volumes and management of the created and existing catchments are defined and the flow rates calculated.

**4. Detailed engineering design with technical calculations**

This is to accompany the site specific design for the subdivision and follows subdivision approval. This stage involves the detailed calculations and engineering designs.

At each stage of the water planning, the water balance, design and considerations integrate both upwards and downwards. In other words the regional or district planning should not preclude development at a local level and in turn development at a local level should not place unacceptable impacts on district or regional water attributes.

In *Better Urban Water Management* the Local Water Management Strategy is submitted as part of the subdivision application process. It is not a detailed design document with complex calculations and pipe widths and the like, but rather a consideration that sufficient land and management is available to manage the post development water.

**Local Water Management Strategy**

In the case of the proposed rezoning, a Local Water Management Strategy is required by the Shire of Ravensthorpe and Department of Water, even though the subdivision is not urban and the lots are over 1.0 hectare. This document is a Local Water Management Strategy.

An **Urban Water Management Plan** and detailed engineering design will be prepared once the development catchments are known and the flow rates calculated.

**2.0 Proposed Development - Subdivision**

The types of developments are likely to be dwellings on rural living properties with a lot size of 1 hectare. There are approximately 60 lots with 3.3 km of roads. Access is from both Steerdale and Hopetoun – Ravensthorpe Roads.

There is some potential for small scale ancillary commercial or industrial uses.

Sand excavation is to continue in the south.

Lot sizes have been designed in sympathy with the soil and land capability, landform and remnant vegetation condition.

### **3.0 Design Criteria**

A Local Water Management Strategy, through a stormwater drainage system, is used to provide information on the potential impact of road and other drainage on the local creek network. Guidance for this is provided by DOW 2009, *Decision process for stormwater management in WA*.

The water management will consider potential changes to recharge on individual lots and overall.

Department of Water seek to retain on site rainfall from a 1 in 1 year ARI 1 hour event on site with the excess from higher rainfall events being directed to the natural watercourses to maintain environmental flows.

### **4.0 Pre-development Environment**

#### **4.1 Existing Information**

##### **Site Assessment - Methodology**

A land study of Lot 8 Hopetoun – Ravensthorpe Road was conducted by Lindsay Stephens of Landform Research on 8 February 2007. The surrounding area and site has previously been investigated on a number of occasions. That is the land to the north of Steerdale Road, the adjoining land to the west and south, an assessment for waste water disposal from an accommodation facility on the nearby Lot 6881, and land to the east.

During the study a series of 19 backhoe test holes was excavated to assess the soils on Lot 8. Other soil data was obtained from the examination of soils exposed in numerous small excavations, and soil disturbance generally, carried out as a result of sand and gravel excavations, drains and farm activities. The geology, hydrology and salinity were mapped by completing numerous traverses over each site together with interpretations from aerial photography.



## 4.2 Site Description

Lot 8 rises from the Hopetoun – Ravensthorpe Road up a ridge in the west with a hill to the south west. In recent years the site has been used for grazing and sand excavation.

A shed and small rural industry is located in the north western corner adjacent to Steerdale Road.

The site adjoins land to the north that has been subdivided to rural living. The land to the west and south has also been assessed for rural living.

Two wind turbines are located west of the land and a buffers fall over the south western corner of Lot 8.

The Hopetoun Drinking Water Reserve lies to the south of Lot 8.

The Hopetoun waste water treatment plant lies to the west of Lot 8 with the buffer touching the western boundary.

Limestone and gravel extraction occurs to the south west. The extraction has a Special Control Area associated with it and a 500 metre notification buffer that extends onto the south western corner of Lot 8 near the existing sand excavations.

## 4.3 Geotechnical Attributes

### 4.3.1 Geology and Regolith

The site straddles the eastern slopes of a ridge north of Hopetoun. The land drops from the south western corner at 45 metres AHD down to 12 metres AHD in the north western and north eastern corners. The south eastern corner lies at 17 metres AHD.

The geology of the site has been investigated in several studies with the most recent being contained on the 1 : 250 000 Hydrological Map Series. Other information is contained in several Geological Survey of WA reports such as Hirschberg 1980. Additional information was obtained during the site investigations when all the soils and surface geology was mapped.

The site is underlain at depth by undulating Archaean gneiss and migmatite at depths of near sea level (1 : 250 000 Hydrological Map Series. Hirschberg 1980, states that the basement is undulating and forms a high north east of the site and a smaller high to the south west. These form a trough in which the Hopetoun water resource lies.

Overlying this is the Tertiary Plantagenet Group which fills the base of the basement troughs. The 1 : 250 000 Hydrological Map Series lists the Werillup Formation as locally occurring, consisting of coarse grained siltstone, carbonaceous clay and limestone. Overlying this from about sea level is the Quaternary “alluvium, colluvium and sandsheet – mostly sand, gravel, minor clay and silt, mainly overlying Plantagenet Group of sediments”. Above this is listed coastal aeolian and marine sediments, sand clay and limestone.

The top of the hill to the south west and along the western boundary is sheeted by yellow sand of aeolian origin. Underlying this is a horizontal bed of limestone with a thickness of 9 to 14 metres. This limestone is not typical of the coastal Tamala Limestone but is more calcified, contains large rounded pisolitic structures, brecciated and re-cemented structures indicative of lithified soil materials, contained and overlying laterite gravels and a high calcium carbonate content. The colour is light pink brown with variations due to iron oxide content.

The limestone extends down to an elevation of at least 25 metres AHD along the western boundary where the sand overlies pinnacle limestone.

Underlying the limestone are clayey and silty sediments that are alluvial and possibly lacustrine sediments that are exposed along the eastern and northern boundaries and under the surface sands subsoils in that area, and in the gravel pits near the northern boundary. The elevation of these beds is about 20 metres AHD and appear to extend to depth. The sediments are the “Quaternary alluvium” in the 1 : 250 000 Hydrological Map Series. They can be identified by their silt and clay lenses and lenses of alluvial materials containing rounded pebbles of alluvial origin. The development of gravel on these sediment and their relationship to the limestone, suggest that they are likely to be older than Quaternary.

It is difficult to see whether these sediments extend up to the base of the limestone because of the overlying sheet covering of sand, however gravelly silts that are similar in nature occur at elevations of up to 20 metres on the northern edge of the site.

Hirschberg 1980 showed by drilling that a lens of sandy sediments of the Werillup Formation opens up to the south of Lot 8 and forms the main aquifer of the Hopetoun Water Source Area. The Werillup Formation pinches out at the southern edge of Lot 8.

#### 4.3.2 Soils

The soils were mapped during the site inspections.

The soils are yellow sand over earthy yellow sand as a sheet across the western two thirds of the site. Under the highest portion of the site the sands overly limestone and limestone pinnacles, whereas on the central northern edge of the site, the sand overlies laterite gravel developed on the top of the junction with underlying silts, loams and loam clays. Minor laterite gravel caps the limestone ridge where it forms a resistant cap on the surface and has been used for gravel extraction.

On the low elevations, adjacent to the Hopetoun Ravensthorpe Road in the east, the sands overly alluvial silts sands, loams and loam clays.

The upper horizons of the soils have been leached to white sands grading into paler yellow sands. The potential for wind erosion of the site is moderate to high on these leached and pale surface soils particularly when the protecting vegetation is removed.

There are areas where the grey and lighter surface sands have been removed by wind following clearing leaving the more resistant earthy yellow sands. This has lead to removal of the topsoil which will now have to reform, as pasture and native plant growth continues.

KEY	SOIL GROUP	DESCRIPTION
YS	Yellow Sand	<ul style="list-style-type: none"> <li>Yellow silica sands over dark yellow earthy sands at depths of 100 to 500 mm occurring along the western boundary and south west.</li> <li>These also overly the alluvial silts in the east and in the north below approximately the 20 metre AHD elevation.</li> <li>Yellow sands also overly limestone and limestone pinnacles on the ridge.</li> <li>The earthy yellow sands contain clay in variable proportions but generally in the 1 – 5 % range.</li> <li>The small amounts of clay and sesqui-oxides provide moderate phosphate retention (PRI), that increases with depth. PRI values of 3.1 – 4.4 are typical.</li> <li>The underlying limestone has very high PRI with</li> </ul>

		<p>values of 29.</p> <ul style="list-style-type: none"> <li>• The basal clay subsoils have PRI of 64 to 120.</li> <li>• These sands tend to be neutral to alkaline particularly near limestone.</li> </ul>
<b>W/YS</b>	Leached Yellow Sands	<ul style="list-style-type: none"> <li>• These mainly occur in the central south west and west and are the same sands as other locations except that there has been vertical displacement of sesquioxides and clay downwards. The earthy sands do not occur within 1000 mm of the surface, but occur at depth in these locations.</li> <li>• The surface yellow sands typically have PRI of 0.9 to 2.0. The more earthy subsoils have PRI of near 5.0</li> <li>• These sands tend to be neutral to alkaline particularly near limestone.</li> </ul>
<b>S/SC</b>	Sand over Sandy Clay	<ul style="list-style-type: none"> <li>• Brown sands to depths of 500 mm overly yellow sandy and loam clay. There is some indication of historical elevated salinity to the sand over clay soils that appears to have been at least partially mitigated by better drainage.</li> <li>• Gravel occurs in the west and north eastern corner. The gravel has previously been excavated and the pit now bottoms on sandy clay.</li> <li>• In the east and north the underlying silty clays and loams have high PRI of 64 to 120.</li> <li>• At depths of 650 - 850 mm the sandy clay becomes lighter to light yellow.</li> <li>• Below a variable depth of 850 - 1050 the sandy clay becomes grey and mottled with brown to yellow mottles, indicating seasonal wetting and drying conditions.</li> </ul>

#### 4.3.3 Soil Permeability

Infiltration tests were not conducted because the overlying sand sheets and deep sands are well known for their ability to provide high infiltration rates.

The soils mapped were all assessed as being permeable and capable of meeting the Government Guidelines.

Australian Standard 1726 for Geotechnical Investigations permits interpreted assessments. Interpreted assessments are an essential part of site evaluation because it is crucial to know how representative the test hole is and what conditions are indicated by the colour, nature, texture and mode of formation of the soil profile. These observations suggest acceptable infiltration ability.

The use of greywater recovery systems, which treat the black water separately and use the greywater for subsurface irrigation of plants, are effective and water saving.

For conventional septic systems, according to *Schedule 8 of the Health Act 1911*, a loading of 20 litres/m<sup>2</sup>/day is applicable for leach drains in loam soils with alternating leach drains and 10 litres/m<sup>2</sup>/day for non alternating systems on sites such as this. It is standard practice to use dual leach drains with waste water disposal being able to be directed alternately to each leach drain.

Alternative/nutrient adsorbing (aerobic, Filtrex or Ecomax) effluent disposal systems are also acceptable and require a waste water loading not exceeding 10 litres/m<sup>2</sup>/day.

#### 4.3.4 Nutrient Retention Capability

The soils on site are capable of accepting and retaining all waste water in areas nominated for dwellings. However as this is at the structure planning stage additional on site testing is recommended at the subdivision stage, and as a matter of course every dwelling site will need to be tested at the time of the design of the footings to ensure that the design matches the soil conditions at the location chosen for the dwelling. The comments here are of a general nature.

During the site investigations the nutrient management impacts were reviewed.

The deep yellow and earthy sands are well known for their aggressive adsorption of phosphate. The soils are highly suitable for conventional septic systems provided lot sizes of > 0.2 hectares are used, and comply with the Government Sewerage Policy.

The phosphate retention (PRI) of the soil profiles are high when considering the whole soil profile (compared to the database of type soils held by Landform Research for PRI and with Chemistry Centre data).

The same soil types were assessed for the adjoining land to the west and south for PRI.

- The earthy yellow sands contain clay in variable proportions but generally in the 1 – 5 % range.
- The small amounts of clay and sesqui-oxides provide moderate phosphate retention (PRI), that increases with depth. PRI values of 3.1 – 4.4 are typical.
- The limestone underlying the sand ridge has very high PRI with values of 29.
- The basal sand clay subsoils have PRI of 64 to 120.

This data compares with the data from Allen and Jeffrey 1990 and Landform Research database.

At PRI 20, each 1 m<sup>3</sup> soil is capable of adsorbing 30 kg P, the equivalent of 5 years' phosphorus released in annual domestic waste water discharge. At PRI 10 the adsorbing capacity is 20 kg/m<sup>3</sup> which is sufficient for 3.6 years of domestic waste water disposal.

Even at PRI 2 which is lower than the yellow sands on site the phosphate retention is 3.0 kg/m<sup>3</sup>. With the depth of these soils that means that every 5.0 metres depth of these soils the phosphate retention is 15 kg/m<sup>3</sup> per lateral square metre of land area. However the situation is even better than that, in that the yellow sands become earthy with depth and overly limestone on the ridge, both of which have much greater phosphate retention.

This illustrates the high capability of the soils for waste water disposal. The key is to retain the soils on the Sand over Sandy Clay soils in the north east. This is illustrated in State Planning Policy 2.1, The Peel – Harvey Coastal Plain Catchment where intensive land uses such as Intensive agriculture are only recommended to be located on deep yellow Spearwood soils that are essentially the same as the deep yellow sands.

The potential for phosphorous management on the Sand over Sandy Clay soils is indicated by Gerritse R G and J A Adeney, 1992 who found that phosphorus input for urbanised and cultivated areas with loadings of 20 – 80 kg/ha resulted in exports of 0.007 – 0.04 mg/L in streams at Mundaring and Paterson Road.

The clay subsoils have very high phosphorous retention (PRI 64 – 120).

In a conventional septic system the nitrogen in waste water is changed to nitrate on exit from the tank and entry to the soil. The waste nitrate is then stripped of oxygen by microflora, in reducing conditions and particles in the soil, in the presence of organic matter. This converts the nitrate to nitrogen gas which is lost to the atmosphere. This occurs in all soil types and is independent of the soil type, and depends on soil oxygen levels and to a lesser extent the nature of the soil particles.

The same process occurs in alternative waste water systems which use amended soil beds, such as Ecomax and Filtrex systems, and in the soils of the waste water disposal area of all systems. Filtrex found that 75% of the nitrogen was lost in the waste water disposal area by the time the waste water had reached the edge of the system. Alternative waste water systems are unlikely to be used although they may be preferred by some landholders to recover the waste water for irrigation of gardens.

The behaviour of nitrogen in soils depends on the oxygen, moisture and organic matter in the soils rather than the soil type. Laterite gravels are well known for their efficient treatment of nitrogen from waste water.

Soil microbes require a minimum of 5 metres of sandy soil or less (down to 1 metre) for soils of lower permeability such as loams (Wells and King 1989). The longer a soil retains waste water the better the microbial purification. Therefore it is important that the leach drains are correctly constructed. On this site the deep sand soils are capable of retaining waste water for adequate microbial purification.

The soils comply with all Government Guidelines and are highly capable of dealing with microbial material.

Alternative/nutrient adsorbing waste water systems require that 90% of samples have less than 20 mg/L organic matter, with no sample greater than 30 mg/L. Faecal coliforms are required to not exceed 10 per 100 mL of waste water.

The Government Sewerage Policy provides guidelines on the setbacks required from water bodies, with which this proposal complies. The lot size down to 1.0 hectares is much greater than the waste water disposal loading permitted by the Government Sewerage Policy.

AS/NZS1547:2000 is very flexible in the methods that can be used for waste water disposal. This proposed subdivision complies with AS/NZS1547:2000 and the Government Country Sewerage Policy.

The proposed waste water loading complies with the Department of Water Guidelines for Priority 2 water Source Protection Areas.

#### **4.3.5 Acid Sulfate Soils**

WAPC mapping does not extend this far. Acid sulfate conditions normally only develop where saturated soil conditions occur in estuarine or peaty environments, in the presence of organic matter, sources of sulfur and under reducing conditions.

All soils observed on site are high in the landscape, well drained and oxidised, with the iron minerals being oxides. No reducing conditions were observed at the surface or at depth in the test holes. Any reducing conditions will be temporary due to waterlogging.

No organic pyritic, peat, gley or highly saline conditions were evident in any test hole. The site lies well above estuarine or saline conditions.

The majority of Lot 8 is elevated well oxygenated yellow sands over limestone. The yellow goethite indicates high oxygen levels.

The soils are elevated free draining and well oxygenated.

The yellow sand indicates high oxygen levels. The limestone that underlies the ridge is calcium carbonate which neutralises acid conditions.

The only area for consideration are the sandy clay based soils in the north and north east. These are not estuarine in origin, but rather alluvial. The salinities are generally low

and there is no evidence of organic matter accumulating or permanent reducing conditions which would all be necessary for acid sulphate conditions to develop.

The sandy clay subsoils are permeable and dry out in summer when oxidising conditions develop and negate any acid sulphate risk.

#### **4.4 Climate**

Long-term weather records for Hopetoun are not available, however detailed records have been kept at Munglinup which is to the east and slightly inland and therefore will have some differences in temperatures and perhaps in rainfall.

The climate of Hopetoun consists of moist cool winters followed by warm to hot summers. Temperatures (at Munglinup) range from winter maxima of about 16.1 degrees C to summer maxima of 27.8 degrees C.

Average annual rainfall is 512 mm with monthly rainfall varying from 28.2 mm in summer months to 60 mm in the winter months. Weather data is now collected at Hopetoun North where the average annual rainfall is 499 mm. For the basis of calculations 512 mm is used because the site is close to Hopetoun townsite and is related to a significant ridge

Long term evaporation is recorded at Munglinup. This could be expected to be slightly higher than on the coast at Hopetoun which is subject to more humid sea breezes. Evaporation ranges from 2.5 mm per day in July to 8.3 mm per day in January. On this basis evaporation at Munglinup exceeds rainfall in every month.

Long term wind data is only available for Esperance, although the data has some applicability to Hopetoun data based on local comment. At Esperance the predominant winds on this section of coast are strong south east to southerly sea breezes on summer afternoons. For example at 3.00 pm in January wind blows from the south east on 46% of the time and from the south for 32%. Morning winds at 9.00 am are lighter and spread widely, with 22% from the south east. Wind roses are shown in Appendix 4.

Winter winds are more variable at Esperance with 36% from the north west and 25% from the north in July at 9.00 am. In winter the winds blow from the north west to south west on 57% of the afternoons at 3.00 pm. Winter storms are generally from the south west.

Humidity ranges between 57% – 81% at 9.00 am to 46% – 62% at 3.00 pm.

#### **4.5 Hydrogeology**

##### **4.5.1 Soil Moisture**

Soils are generally moist through winter, drying in summer in the upper soil horizons.

Being elevated and sandy, the soils drain well and there is no evidence of saturated soils or seepages on the ridge.

The eastern and northern parts are occupied by Sand over Sandy Clay soils that are also well drained apart from a small area in the central north where there are indications of past reduced drainage.

A drain has been cut in that area and in recent years has enabled water to exit Lot 8 more readily and in turn has reduced the potential for water to lay on the surface.

#### 4.5.2 Surface Water

There is no surface water on the elevated land to the west and south of Lot 8.

There is evidence of past waterlogging of an area of the Sand over Sandy Clay Soils in the central north that has been largely mitigated by drainage.

The natural lie of the land is that a broad and extensive gently sloping plain extends north from Steerdale Road. That land has been investigated previously by Lindsay Stephens of Landform Research and found to be sandy over clay duplex soils that drain south to Steerdale Road.

During heavy storm events a substantial volume of water flows from north of Steerdale Road across Steerdale Road entering the central north of Lot 8 and exiting in the central east, including running along the roadside drain for a small distance and then crossing the Hopetoun – Ravensthorpe Road to travel south east to Dunn's Swamp and the coast.

A drain has been constructed across Lot 8 from the central north to the central east to direct and confine the stormwater and provide drainage of the central north of Lot 8. The drain is 6 metres wide and 500 mm deep. The drain has extensions along the southern side of Steerdale Road to pick up any flows coming across Steerdale Road.

The construction of Steerdale Road and the subdivision to the north of Steerdale Road did not take sufficient consideration of the flood flows and did not provide sufficient culverts to Steerdale Road. The constructions also form a small rise on the northern side of Steerdale Road which dammed the stormwater and made the impact of the storm worse. Steerdale Road was provided with 2 pipes of 560 mm diameter.

During a floods in 2004? the storm flows exceeded the culverts on Steerdale Road and the water flowed across the surface scouring the foundations of the road. It is understood that the Shire of Ravensthorpe has inspected the culverts in recent years and has made some modifications to assist the drainage past Steerdale Road.

However this does not change the flow volumes across Lot 8. During the storm events in the past 10 years the landowner has noted that the drain across Lot 8 has coped with the flows and has filled to a maximum depth of about 350 mm. That would indicate a flow surface area of  $6 \text{ m} \times 0.30 \text{ m} = 1.8 \text{ m}^2$ .

The two pipes across Steerdale Road provide a capacity of  $0.49 \text{ m}^2$  (that was exceeded), and explains why the water flowed across Steerdale Road.

It is understood that the crossing of the Hopetoun – Steerdale Road has a box culvert with a capacity of  $1.24 \text{ m} \times 0.6 \text{ m}$ , allowing for sediment, combined with a floodway 10 metres wide to a maximum depth of 500 mm. The culvert provides a capacity of  $0.744 \text{ m}^2$  which is less than half the estimated storm flow across Lot 8. It is not known whether the culvert has been exceeded but it is assumed that this will occur during some storm events.

That measurement can be used in the design of the subdivision, but the volume may not be quite a 1 : 100 year event so an additional allowance should be built into the flow rates.

#### 4.5.3 Flood Risk

The flood risk is discussed 4.5.2 Surface Water. The risk is high but is located along the flow path of the drain across Lot 8 and is confined to the current drain.

As a minimum the design surface area is recommended to be  $3.0 \text{ m}^2$  to cover a 1 : 100 year flood event unless the runoff from the catchment to the north is recalculated. This

could be incorporated by way of surface drain with provision for some overtopping, confined to a swale drain.

The drain needs to be able to be maintained, and will need to be located preferably within a road reserve or have access protected by easements. The location of the drain should be similar to the existing location and that will determine the location of the road network of the subdivision.

The drain will need to be incorporated into a crossing on the access road.

It is recommended that Steerdale Road drainage be further investigated to ensure that the culvert or floodway in that location does not lead to damming of the flows or scouring of the road. Currently it is uncertain what the impact of the drainage within the subdivision to the north has on the flood flows.

See the attached Figures.

#### **4.5.4 Wetlands**

There are no wetlands on site. An area of previously moist land in the central north has *Isolepis nodosa* growing in it. This is not a wetland species but grows on coastal dunes in addition to lower moist areas.

#### **4.5.5 Salinity**

The soils are well elevated and well drained with no evidence of salinity over almost all the site.

The only area where there is evidence of minor surface salinity is a previously poorly drained area in the central north, which has been improved by the current drain.

### **4.6 Groundwater**

The groundwater of the local area, with particular reference to the drinking water aquifer to the south that is based on the Werillup Formation, has been investigated in several studies with the most recent being contained on the 1 : 250 000 Hydrological Map Series. Other information is contained in several Geological Survey of WA reports such as Hirschberg 1980. The other studies relate to potential and current water supplies to the north and east of the townsite.

The most authoritative is Hirschberg 1980.

Hirschberg 1980 shows the site is underlain by undulating Archaean gneiss and migmatite at depths of near sea level (1 : 250 000 Hydrological Map Series. Hirschberg states that drilling shows an undulating basement that forms a high north east of the site and a smaller high to the south west. These form a trough in which the Hopetoun water resource lies.

All water production bores lie within the north west trending bedrock low between the two ridges.

The depth of the trough reaches a maximum of –10 metres AHD, rising to 0 metres AHD in the south west and 9 metres AHD in the north east of the trough near the southern boundary of Lot 8. The water table prior to utilisation ranged from 9 metres AHD in the north east near the southern boundary of Lot 8, down to 1 metre AHD in the south west.

The water resource is underlain by a saline water body below sea level or several metres below sea level that is located well to the south west of Lot 8.



Water flow is therefore from north east to south west including potential flows from the southern edge of Lot 8.

Salinity of the drinking water source to the south varies from 780 mg/L to 1100 mg/L in the pump tests, but it appears as if the salinity was higher in some exploratory bores, ranging up to 2090 mg/L and 2000 mg/L in the north east near the Hopetoun – Ravensthorpe Road close to Lot 8.

Salinity increases to the north and east are probably in response to lower recharge in those areas where the separations to the water table increase significantly and the separating sediments are alluvial silts and clays. That means that on Lot 8 most of the surface water drains to the east, off the landholding, and does not infiltrate down to the water table. It is possible that some precipitation falling on the sand ridge drains south to the drinking water source area.

The water table separation is approximately 8 metres at the south eastern corner of Lot 8.

Hirschberg 1980 assumed recharge of 3% to 10% for the water resource under the deep sand ridge with a mean annual rainfall of 504 mm. If overpumping occurs the saline underlying waterbody will be up coned or flow in from the sides leading to deterioration of water quality.

### **Depth to groundwater**

The site investigations were conducted by Landform Research on 8 February 2007.

The water table was not intersected in any soil test hole. Observations on site at other times show that the main water loading on site is from storm events that can occur at any time of the year and contribute water from north of Steerdale Road.

Winter rainfall is higher but reaches 60 mm per month and in many months is not sufficient to saturate the soils.

Normally when the soils are saturated it is a surface situation with water temporarily perched on the land with the water table at depth. This is borne out by the work of Hirschberg 1980 who shows that the water table depth does not extend onto Lot 8. Hirschberg recorded the elevation of the water table as being 9 metres AHD south of the southern boundary of Lot 8. By interpretation that would equate to an elevation of 10 metres AHD at the southern boundary, seven metres below the lowest land elevation in that corner.

The water table would rise towards the north eastern corner but by interpretation of the geology and Hirschberg 1980, slowly enough for a separation of several metres at the north eastern corner.

Lot 8 is therefore sufficiently above the water table for there to be no significant issue.

### **Town Wellfield**

The Town Wellfield is proclaimed as a Priority wellfield with P1, P2 and P3 zones under *Country Areas Water Supply Act 1947*.

The groundwater of the local area was originally investigated by Hirschberg 1980 with further documentation of the drinking water resources by Water Corporation 2004. It was most recently addressed in *Department of Water Report 106, Hopetoun water reserves drinking water source protection plan, Hopetoun Town Water Supply*.

The Town Wellfield lies to the south of Lot 8 with the land to the west and south providing most of the recharge for the resource.

Water Corporation 2004 lists the sustainable yield of the Town Wellfield as 40 ML/year. They noted that the hardness and iron levels were higher in the Town Wellfield which can be expected with limestone in the catchment and iron oxides being mobilised by water flowing from the surface. Salinity has also varied and has “often been above” the Australian Drinking Water Guidelines, depending on the recharge. A summary of the parameters is

	<b>Town Wellfield</b>	<b>Aust Drink Water Guidelines 2004</b>
Salinity	989 – 1000 mg/L	1000 mg/L
Hardness CaCO <sub>3</sub>	320 mg/L	200 mg/L
pH	7.22 – 7.68	6.5 – 8.5
Colour	Nil – 2	15 TCU
Iron	0.014 – 5 mg/L (0.85 mg/L)	0.3 mg/L
Manganese	Nil – 0.85 mg/L (0.028 mg/L)	0.1 mg/L (aesthetic) 0.5 mg/L (health)
Aluminium	Nil – 0.34 mg/L (Nil)	0.2 mg/L 0.1 mg/L (preferable level)

Averages are shown in brackets

As can be seen from the above data the water quality is at the upper limits for several parameters.

Water Corporation 2004 has considered the risks and protection. They identified the risks as follows.

- Regenerating bush is considered low risk by Water Corporation 2004
- Crown Land with regenerating bush is considered low risk by Water Corporation 2004.
- Broad acre farming – grazing and cropping. These are considered low risk by Water Corporation 2004.
- Special Rural Lots. The existing Krystal Park Estate south of Lot 6382 is 2 – 3.5 hectares in lot size.
- Uncontrolled activities on small lots is considered a higher risk.
- Pumping of the water resource from domestic bores is considered a high risk and is not permitted in the Priority areas.
- Hopetoun-Ravensthorpe Road has a high risk from fuel or chemical spills, but Water Corporation 2004 considers this manageable through emergency response plans.
- Caravan Park on Lot 6381 is considered a high risk by Water Corporation 2004 who suggest that the zoning be changed to prevent such development. The facility has been constructed.

Water Corporation 2004 discusses the risk from lots smaller than 1 hectare. They note that the risks should be minimised by placing restrictions on the keeping of animals, storage and collection of fuels, chemicals and pesticides.

Water Corporation did not identify Lot 8 as presenting a risk to water quality presumably because it lies largely north of the water source aquifer, and surface water drains east and not to the aquifer.

The issues raised have been considered in the design of the subdivision as the Priority 3 classification runs along inside the southern boundary of Lot 8 and affects the southern most lots. The subdivision design and the proposed continuation of the sand extraction complies with the Priority 3 Protection Classification.

## 5.0 Water Use and Sustainability Initiatives

The main water use initiatives rely on the individual landholders. The best way is not to mandate the water saving devices but rather to encourage the public on the best water saving management.

*Department of Health Draft, 2002, Guidelines for the Reuse of Greywater in Western Australia* provides the following water use.

Garden watering	47%	103.4 kL
Swimming Pool	2%	4.4 kL
Leaks	2%	4.4 kL
Taps	8%	17.6 kL
Shower	16%	35.2 kL
Washing machine	13%	28.6 kL
Toilet	10%	22.0 kL
		215.6 kL /year

The education of the purchasers is achieved in literature attached to Water Corporation accounts, Department of Water and Shire of Ravensthorpe awareness information.

The main water use initiatives for each lot are potentially;

- Potential use of rainwater tanks with a minimum of 5000 kL capacity. Saving 15.6 kL per year or 7% of usage.
- Recovery and reuse of water from nutrient adsorbing waste water systems. Saving 103.4 kL/year – (Note only one of nutrient adsorbing or grey water systems is possible).
- The recommended use of grey water recovery and use on gardens. Savings 81.4 kL/year – (Note only one of nutrient adsorbing or grey water systems is possible).
- The use of native or low water requiring street trees. Savings relate to soil moisture and in this area the savings could amount to a significant amount if summer irrigation of garden plants and trees is minimised.
- The encouragement for the use of low water requirement gardens. Savings estimated to be 10 – 20 kL per year.
- Encouragement for use of water saving four star and dual flush toilets. These are assumed to be used and therefore no additional savings are likely.
- Encouragement for the use of water saving shower heads and appliances. These are assumed to be used. Therefore no additional savings are likely apart from education of the public to take shorter showers and use water saving habits in the home.

It has been suggested by Water Corporation that savings of 60 – 80 kL per person are to be sought. These types of savings may have been possible for urban areas prior to the gradual introduction of water saving devices and extensive education programs.

Also in a location such as Hopetoun where rainfall is moderate water use tends to be less.

The target water savings are therefore to facilitate the use of water efficient facilities in the design of the subdivision and development of dwellings, coupled to continued education programs.

To achieve the maximum water savings the use of water wise gardening and plants, combined with rainwater tanks, combined with the use of water recovery and recycling through either a nutrient adsorbing waste water system or a dedicated greywater system will be required and/or changed or aware water use habits will be required.

From the available technologies listed above savings of up to 130 kL per year may be available per household, depending on the type of dwelling, facilities at the dwelling and dedication of the family to water savings.

With the level of public information now available it is likely that some initiatives will be taken up by new landholders. The Water Corporation has ongoing water savings advertising, education and community awareness initiatives.

If half the dwellings installed the water saving initiatives then savings of 26 kL per person may be available.

For water savings to be made, when compared to an older subdivision, such as the mandating of rainwater tanks, such conditions will need to be placed on the subdivision approval.

## **6.0 Stormwater Management Strategy**

### **6.1 Post Subdivision Water Input**

The proposed subdivision, has lots of 1.0 hectare.

All lots will be connected to scheme water.

The amount of scheme water used per dwelling will depend on the number of persons, the amount of water added to gardens and whether there is a swimming pool. The volume is normally in the range 200 – 300 kL per year for a family.

For a 1 ha lot in a medium rainfall area a 300 kL per hectare additional water loading, is assumed. The scheme water will be spread generally over the whole subdivision. The actual water use should be less, if the water savings initiatives listed previously are utilised, and depending on the number of persons per dwelling. For this exercise the maximum loading is assumed.

The other loading is from rainfall, at near 512 mm per year, of which most falls from April to October inclusive. This will not change.

There is potential for rainwater tanks on all lots. On lots connected to scheme water, a small tank for gardens will effectively attenuate rainfall for summer but not in winter when the tank will be full. On the other hand a small tank used for potable water will help attenuate rainfall throughout the year, but will still depend on the amount of water used daily.

The mandating of a 5 000 L rainwater tank and the use of water from that tank could account for a use of 15.6 plus kL per year per house depending on use patterns, that would reduce the input from scheme water. As the data is generalised, relatively small, and it is uncertain whether rainwater tanks will be used, this use of rainwater is ignored in the calculations. See 6.33 Rainwater Tanks.

Greywater disposal on site will potentially offset some scheme water use by replacing the need for scheme water for gardens.

For these calculations and considerations, the potential for some rainwater use by lots connected to scheme water, and greywater reuse, cannot be guaranteed, so the volumes of such use are not considered in the calculations. (See treatment of Stormwater below).

## 6.2 Changes to Soil Moisture as a Result of Subdivision

In order to determine the effects of development, and what should be designed for and considered, an assessment of the likely recharge now and after development is considered.

This provides an indication of what effect the construction of hard surfaces on the proposed lots and road drainage will have in drying or draining the soils. The changes can be summarised by the following.

*Scheme water + increased recharge from roofs to soakwells + increased loading from roads and driveways – drainage from roads removed offsite (this includes the recharge from the roads and driveways plus the water running off the sloping land that is collected by the roads) – any water substituted for scheme water use from greywater recovery or rainwater tanks – increased evapotranspiration due to additional trees and landscaping.*

In order to determine the effects of development, and what should be designed for and considered, an assessment of the likely recharge now and after development is undertaken.

This provides an indication of what effect the road drainage and hard surfaces will have in drying or draining the soils.

To gain some idea of the changes to recharge, the lot layout is 60 lots and 3.3 km roads which equates to lot sizes of minimum 1.0 hectare combined with say 55 metres of road per lot.

Engineers Australia 2007 rainfall design criteria is normally used to provide the ARI hourly one year design flow volume. At that criteria 93% of all water will be retained on site. (Department of Water Information). This is the design volume that Department of Water seeks to retain on site, with the excess being directed to stormwater runoff.

With development the amount of hard surface will increase, with dwellings, driveways and roads on the site.

Currently rainfall which falls on the subject land either soaks into the soils or runs from the site.

Apart from scheme water, loading from rainwater that is collected from roofs and not used in rainwater tanks, will be directed to soakwells.

### **Building envelopes**

For a dwelling a hard surface area of 350 m<sup>2</sup> is assumed, including the dwelling, driveways, sheds and garages.

To this is added 150 m<sup>2</sup> of driveway, to make an assumed area of hard surface per lot of 500 m<sup>2</sup>.

The recharge from soils rises because the runoff from the roofs increases and there is no pasture or other vegetation on that footprint to lead to evapotranspiration of the water.

Normal recharge for pasture is assumed to be 40% for high rainfall areas, but in this location a lower figure of 15% is used as an average across the whole site from the deep sands to the Sand over Sandy Clay soils in the east. Hirschberg 1980 used a figure of 3% – 10% recharge for the Hopetoun Wellfield.

The recharge from roofs and roads is rated at 90%. That is there will be an additional recharge of 75% for the area of hard surfaces on lots connected to scheme water, as a result of subdivision, because the evapotranspiration of pasture and vegetation is replaced by hard surface.

If rainfall from roofs is retained on lots, either through soakwells or rainwater tanks and on site waste water disposal, there will be little change to the water loading from development apart from the addition of scheme water.

There may be a small change as a result of reduced evapotranspiration from hard surface areas or increased evapotranspiration as a result of additional tree planting.

With the permeable sand and sand over clay soils all stormwater will be able to be retained on individual lots. Evapotranspiration from pasture is likely to be in the order of 90% with only 15% entering, recharging the ground. For hard surfaces a 90% runoff is assumed.

If the additional water collected and not soaking into the ground is directed to soils through soakwells, rainwater and waste water the difference in loading caused by reduced evapotranspiration from pasture is  $90\% - 15\% = 75\%$ .

The difference in water loading is;

For each lot at 500 m<sup>2</sup> per lot hard surface;

$500 \text{ m}^2 \times 0.512 \text{ m rainfall} \times 75\% \text{ change to evapotranspiration} = 192 \text{ m}^3$  or kL (increase) spread over a lot of 1 hectare or 10 000 m<sup>2</sup> which is equivalent to an additional 19 mm rainfall.

To this must be added the 300 kL scheme water per hectare which is equivalent to 30 mm rainfall.

### **Roads**

If all the water from the roads is contained within swale drains and infiltration basins then there will be no overall change in recharge on site from hard surfaces.

As roads collect water from upslope there will need to be some overflow from each basin in the event of sustained rainfall on already wet soils and to maintain environmental flows.

As noted above there is approximately 55 metres of road per lot, or in the order of 55 metres per hectare at 8 metres wide.

$440 \text{ m}^2 \times 0.512 \text{ m rainfall} \times 75\% \text{ change to evapotranspiration} = 169 \text{ m}^3$  or kL per 1 ha lot from roads or equivalent to 17 mm rainfall.

### **Recharge**

The recharge is equivalent to;

19 mm rainfall from hard surfaces associated with dwellings  
30 mm rainfall from scheme water  
17 mm rainfall from road surface

The total recharge is therefore equivalent to 66 mm rainfall over the whole site for the one hectare lot subdivision. This represents an increase of 13% rainfall over the small area of subdivision.

In this location of medium rainfall close to the coast with water flowing to Dunn's Swamp there will be no impact of the additional recharge and it in fact may benefit the swamp in a situation of reducing rainfall.

The only potential reduction in recharge is from additional planting of trees. This is likely as owners of rural living properties normally plant additional trees. There is also a reduction of grazing on remnant vegetation and the potential for some regrowth of understorey.

If the planting of deep rooted trees and shrubs across the site changed the recharge by 10%, by converting pasture to parkland pasture, this would be equivalent to a reduction in recharge of 512 mm x 10 % or 51 mm rainfall.

This is significantly just under the increased recharge. A 10% reduction is quite normal on rural living subdivisions of 1 hectare, based on the additional trees that are planted.

Therefore as a result of subdivision there is not anticipated to be any significant change to recharge of the soils.

With the proposed lot sizes the best way to maintain recharge at the pre development level is to retain some water on site and allow the storm events to behave in a manner similar to the pre development conditions. That is the water will be retained in detention basins and allowed to infiltrate the soils.

It should be noted that even though there will be a slight increase in recharge if dense tree planting was used then the recharge to groundwater could actually decrease.

It is further noted that recharge on the deep sands of the ridge will not change because the land is vegetated or partially vegetated and infiltration is rapid. On the lower Sand over Sandy Clay soils the most significant water loading is from storm flood events and this will not change. There may be some small changes in soil moisture due to the planting of additional trees and shrubs on individual lots.

Clearing of the remnant vegetation for sand excavation will result in perhaps 10% increase in recharge based on the depth of sand, for the opened area but this will return to the pre-excavation recharge with revegetation. Changes related to sand excavation are considered minor.

In the calculations the use of rainwater tanks is ignored because the potential savings are 7% when compared to individual water use by landholders. The mandating of rainwater tanks, if the water is substituted for scheme water, is considered in 6.3.3 Rainwater Tanks.

### **Storm Floods**

During the storm events in the past 10 years the landowner has noted that the drain across Lot 8 has coped with the flows and has filled to a maximum depth of about 350 mm.

That would indicate a flow surface area of 6 m x 0.30 m = 1.8 m<sup>2</sup>. In the absence of additional calculations of water flows from the catchment to the north, a surface area of flood flow at 3 m<sup>2</sup> through culverts/pipes and provision of excess floodway volume is recommended.

## 6.3 Stormwater Design

### 6.3.1 Design Criteria - Volumes

Department of Water seek to retain on site rainfall from a 1 in 1 year ARI 1 hour event with the excess directed to stormwater, which represents 93% of the rainfall events being retained on site. This provides for a maintenance of the pre-development environmental flows.

Higher volume rainfall events will be directed along the natural drainage line to Dunn's Swamp.

The methods of retention on site are consist of management taken at each dwelling, and secondarily management of the road drainage.

Management at dwellings will consist of soakwells to take roof drainage. This can be supplemented by rainwater tanks including the mandating of 5000 litre rainwater tanks. With large lots, runoff from other hard surfaces such as driveways and paving will normally flow onto the adjoining soils and soak into the ground.

Waste water will be directed to onsite waste water disposal.

Road drainage will use a number of features, but predominantly grassed swale drains which on the more gentle slopes will enable infiltration of the smaller rainfall events. On greater slopes, rip rap and other restraining devices will be used. Without some anti erosion features, there will be scouring of the drains on the sandy slopes.

Detention and infiltration basins will then collect the excess water from the swale drains. Water from the detention basins will be provided with a storm overflow to existing drain.

The existing drain to take the flood storm events must be maintained.

For estimating the design volumes that following storm events are used;

#### DESIGN RAINFALL

Storm Event	Rainfall (Bureau of Meteorology)
One hour one year return event	12 mm
One hour 5 year return event	20 mm
One hour 10 year return event	23 mm
One hour 100 year return event	40 mm

This data is used to provide sizes of the various water management features.

Drainage features such as swale drains will be located within road reserves. However detention basins, infiltration basins and overland flow paths can be either located within public open space or if on private land should be installed in locations where;

- access is readily available to the local authority to maintain the drainage feature, by proximity and time,
- the drainage feature cannot readily be blocked by landuse actions of the landholder,
- the drainage feature is constructed from a safety perspective and installed with relevant protection such as fences.



### 6.3.2 Roof Drainage and the Size of Soakwells

A rainfall design criteria of 16 mm is normally used to provide the ARI hourly one year design flow volume. At that criteria 93% of all water will be retained on site. (Department of Water Information).

For a dwelling on a subdivision a hard surface area of 500 m<sup>2</sup> is assumed, of which water from 300 m<sup>2</sup> is likely to be directed to soakwells.

The site has permeable sand soils over the elevated locations and sand over clay in the remainder. Soakage into the surface sands is rapid.

Soakwells will be located in the surface sands which will allow rapid lateral flows from them. With a lot size of 1.0 ha, even if water was fed to the pasture, that water would readily soak into the ground before it ran off as significant surface water.

In greater rainfall events such as a 100 year 1 hour event the excess stormwater will either still be taken up by the soakwells, overflow from soakwells, or, if no soakwells are used, simply flow onto the ground.

Based on the proposed subdivision, the soils and the slopes, and the calculations above, all stormwater will be able to be retained on site.

The requirement for soakwells is therefore not generally considered necessary.

As the surface area directed to soakwells is assumed to be 300 m<sup>2</sup>, and the rainfall criteria is 12 mm ARI event, with a 0.9 runoff coefficient from hard surfaces, then a volume of up to

$$300 \text{ m}^2 \times 0.9 \times 12/1000 \text{ mm} = 3.24 \text{ m}^3$$

With two such soakwells a total storage volume will be 3.18 m<sup>3</sup> or 98% of the 300 m<sup>2</sup> roof area used. Therefore, to round the figure off, a roof area of 300 m<sup>2</sup> will require three 1300 x 1200 mm soakwells with a degree of excess capacity, with a larger roof area potentially requiring correspondingly more soakwells to achieve a 1 in 1 hour ARI rainfall event.

Excess water from rainfall events greater than this will flow onto the ground for broad area infiltration. The large lot sizes with a minimum of 1 hectare provide sufficient area for excess infiltration.

The volume of water directed to soak wells can be reduced correspondingly for dwellings with rainwater tanks in excess of say 5 000 litres.

### 6.3.3 Rainwater Tanks

If a minimum 5 000 litre rainwater tank is recommended for lots with scheme water, provided it is plumbed into a system that is used all year round, such as potable water, washing, toilet use or a combination, for toilet use alone, at say a volume of 2.5 L per average flush with 6 flushes per person, the daily use will be 2.5 x 6 = 15 L per person per day.

For an average 2.5 person family over a month this amounts to 1 300 L per month or 1.3 m<sup>3</sup> kL per month. Even piping rainwater for toilet use represents a water saving, but is not sufficient alone in any month to effectively attenuate a storm event. The use of the rainwater tank to attenuate stormwater flows is therefore not included in the calculations because at this stage the actions of individual owners cannot be anticipated.

The total savings are in the order of 15.6 kL per year for a 2.5 person average family. With an estimated average use of water of 220 kL per year per dwelling this represents a saving of 7% if the water is substituted for scheme water.

For a 300 kL annual water usage by a family the water savings from a rainwater tank may be higher if plumbed in and used through the year. For example 7% equates to a saving of 21 kL per year.

### **6.3.4 Waste Water Management**

Nutrient retention is high on this site. This is discussed in the Land Capability and Geotechnical Assessment dated May 2013 prepared by Landform Research.

Land Capability mapping was discussed in Section 5.0 Waste Water Capability and Nutrient Assessment. The information was included on the Land Capability mapping of that document. The Land Capability mapping included a constraints table that considered the areas where ATU or alternative waste water systems are recommended.

From that mapping there were no areas identified as constrained, apart from normal setbacks from the constructed drain. Fill and continued drainage will be able to provide good on site conditions for waste water disposal. The drain is nominated as having a 30 metre setback, as an interpreted good compromise, although in situations where alternative waste water systems are used smaller setbacks may be acceptable.

The site, with 1.0 hectare lots, complies with the Draft Country Sewerage Policy (22 September 2002, SOCWM meeting) which permits waste water disposal on any soil type on lots in excess of 2 000 m<sup>2</sup> and allows for some site modification. See also 4.3.4 Nutrient Retention Capability.

The soils on all parts of the developable areas are capable of accepting and retaining all waste water.

Any fertiliser applied to gardens will similarly be strongly adsorbed onto the soil particles.

The critical issues are that the waste water should be disposed of into dry conditions and the waste water should infiltrate into the natural soils and not be able to move laterally and short circuit the disposal area.

The eastern and northern portions of Lot 8 may require nutrient adsorbing waste water treatment systems. For those locations the use of fill and drainage is more likely to enable the use of alternative waste water systems. On the other hand in such locations conventional septic systems with inverted or semi-inverted leach drains may be acceptable.

Waste water disposal volumes may also be reduced through the use of dedicated greywater systems.

The Shire of Ravensthorpe is responsible for approving waste water systems. They will normally require either a conventional septic system, or an alternative waste water system and specify and approve the installation.

### **6.3.5 Size of Road Drainage**

At this stage in the design it is not appropriate and not possible to make all the detailed calculations because the subdivision has not been designed other than to concept.

However it is possible to provide approximate data to ensure that the management of water has been adequately considered and that the subdivision guide plan reflects those volumes and provides sufficient space for any water management features.

In previous discussions with the Department of Water, in such situations, it is appropriate to ensure that there is sufficient ground available within the subdivision to enable the correct sized detention basins to be constructed.

As the land is essentially similar across the precinct the catchments will be determined on a per km basis for road drainage and volumes allocated for the length of roads within each catchment.

### **1 year 1 hour rainfall event**

It is proposed that the 1 year 1 hour rainfall events will be retained on site, through the use of soakwells on individual lots.

For roads the best solution for the 1 in 1 year one hour storm event is to allow the stormwater to drain from the road to the adjoining land. This is similar to the existing situation on the local roads and best matches the pre development with the post development situation.

In addition the swale drains either need to accept higher volumes or there needs to be a bypass system to enable environmental flows from higher rainfall events to be directed to the offsite water courses.

On roads, swale drains that permit infiltration from the 1 year one hour event and detention/infiltration basins are proposed. Higher rainfall events will be directed through the swale drainage to detention basins to the natural water courses and drainage areas.

A rainfall design criteria of 12 mm is used to provide the ARI hourly one year design flow volume.

The runoff from roads that are 8 metres wide for a 1 year 1 hour event is;

$$8 \times 1 \times 0.012 \text{ m}^3 \text{ per linear metre} = 0.096 \text{ kL or m}^3 \text{ per linear metre of road.}$$

To retain a 5 year event within the swale drains would require a capacity of;

$$8 \times 1 \times 0.020 \text{ m}^3 \text{ per linear metre} = 0.16 \text{ kL or m}^3 \text{ per linear metre of road.}$$

### **Swale Drains**

Being free draining sand and sand over clay soils the swale drains will permit adequate infiltration of the one year one hour return storm volumes.

With two swale drains this amount is easily retained in the swale drains.

Swale drains are typically larger in cross sectional area, and it is not uncommon for them to be 1.5 metres wide and 300 mm deep in the centre which provides for retention of 0.225 kL or m<sup>3</sup> per linear metre of road. Two such drains will provide for double the capacity and would retain the 1 : 100 year event.

However on elevated ground drains are sloping and unless the water is retained by rip rap or similar devices the amount of infiltration capacity will be reduced by the nature of the soils and the slope of the swale drains. Normally provision of rip rap at regular intervals is sufficient to prevent erosion and provide the required infiltration capacity.

The other factor is that the design volume of 12 mm per hour is spread over an hour and, with seepage into the sand soils, the actual required volumes will be less.

Examples are attached from the Department of Water, *A Manual for Managing Urban Stormwater Quality in Western Australia* grass swales BMP14.

On this basis there should be no need to utilise detention basins to contain the 1 year 1 hour rainfall event.

Kerbing or other stormwater constraining devices may be used.

In such cases, considerations may need to be given to the impact of the larger storm events and the amount of water to be retained on site. The detention basins are located in situations where they can be enlarged to provide for greater infiltration capacity if kerbing is used. At this stage kerbing is not proposed on such large lots, but could be considered at the engineering design and calculation stage.

### **1, 5, 10 and 100 year rainfall design volumes and management**

For larger storm events it is normal for surface water to flow across the ground and congregate in swales and lower elevations. For this situation to continue the runoff should also be unconstrained by kerbing or swale drains.

As the one year one hour return event will be retained on site and excess fed to the natural drainage lines the swale drains will be directed to small detention basins from which overflows are provided to the natural watercourses at the edge of the precinct.

A difficulty is dealing with different permeabilities of the soils within the catchments and swale drains.

With greater amounts of rainfall the more sloping swale drains will flow and this is shown on the Water Management flow in the attached Figures. Even with the 1 : 100 year event most sections of road in which the swale drains are used will retain water because of minimal slopes and highly permeable soils.

With large areas it must be assumed that the standard swale drain is constructed and that the proportion of excess stormwater that flows along the drain after construction will be proportional to the permeability of the soil.

This will provide for an inherent correlation between the pre and post construction flows from the soils.

Swale drains are recommended to be constructed on both sides of the road, but on steeper slopes may be installed on one side only.

## DESIGN VOLUMES PER LINEAR METRE OF ROAD

Storm Event	Volume handled by road
One hour one year return event	0.096 m <sup>3</sup> or 96 litres per linear metre
One hour 5 year return event	0.160 m <sup>3</sup> or 160 litres per linear metre
One hour 10 year return event	0.184 m <sup>3</sup> or 184 litres per linear metre
One hour 100 year return event	0.320 m <sup>3</sup> or 320 litres per linear metre

The other issue to be considered is the collection by the roads of upslope drainage. This drainage will normally flow pre development to the swales and then leave site. When the roads are collecting the upslope drainage the water will be concentrated and directed with the normal road drainage, and the additional volumes needs to be considered within the sizing of the detention basins.

This is likely to be minimal on the elevated sand ridges unless the rainfall is particularly heavy or the soils non wetting. There is sufficient capacity in these initial calculations for these flows to be dealt with by the swale drains.

The peak runoff flow rates for these surfaces varies with the intensity of rainfall. From Engineers Australia for sandy soils with pasture and forest the runoff does not normally occur until 32 – 45 mm rainfall per hour is exceeded. That is a near 1 : 100 year storm event. However non wetting characteristics of the soils can make the runoff occur at a smaller rainfall and it is likely that some non wetting will occur in some locations such as the more leached sands.

On this basis the non wetting soils are likely to result in patchy and intermittent runoff in the one year one hour event of 12 mm per hour and above.

### Infiltration Basins

As water up to the 1 in 1 hour 1 year and 5 year return events will be able to retained on site in the swale drains, all other volumes will be directed to the natural drainage. The detention basins will form the function of sediment trapping and flow management basins.

In reality with infiltration during the hour, provided the swale drains are contained it is likely that all rainfall events will be able to be retained within the swale drains. A contingency of drainage basis is however provided.

To retain higher volumes on site will change the pre-subdivision hydrology of the offsite watercourses.

The volume of the basins is therefore not critical but should be sufficiently large to be able to function appropriately. For all basins adequate sediment trapping can be completed in a 10 m<sup>3</sup> sized basin and these are proposed. These sizes will be refined during the detailed engineering considerations.

Detention and infiltration basins will require a piped or level sill outlet to prevent overflow and provide attenuated flow to the drain to prevent scouring. The basins are recommended to have shallow slopes and banks to increase safety and provide habitat and reed establishment

The design of any basin, its final volume and the area of the outlet will be prepared by the engineer as part of the Urban Water Management Plan. The dedicated drainage footprints need to be sufficiently large to enable flexibility during the engineering design stage and post construction.

The infiltration basins will be dry during summer and most of winter except in a larger storm event when some water will flow to them and slowly infiltrate into the soils.

The infiltration basins will be located either in public open space or on private land with an easement to enable future management control over their function. This will help protect the drainage network from changes by the landowner.

The basins are recommended to be located close to the road network or in the corner of a lot for access and management. Sufficient area is to be provided to enable changes in the size of any basin to be made during the engineering design phase when the subdivision is known.

Examples are attached from the Department of Water, *A Manual for Managing Urban Stormwater Quality in Western Australia* infiltration basins BMP 110 and Wet Basins BMP 18.

On this site, any detention basin or sump is recommended to be naturalised, with more gently sloping edges to the basins, to enable access for maintenance, and vegetated as a naturalised wetland or, for overflow storm volume, formed as a grassy swale.

The following documents provide information on potential designs see the attached notes/illustrations.

- *Stormwater Management Manual for Western Australia*, Department of Environment WA, 2004.
- *Guidelines for Groundwater Protection in Australia*, ARMCANZ, ANZECC, September 1995.
- Department of Water, 2008, *Better Urban Water Management*
- Environmental Protection Authority Victoria/ Melbourne Water, undated, *Urban Stormwater, Best Practice Environmental Management Guidelines*
- Water and Rivers Commission, 1998, *Manual for Managing Urban Stormwater Quality in Western Australia*.

### **Culvert and Drain Design**

The current drain has a capacity of 6 metres wide by 500 mm deep or 3m<sup>2</sup> cross sectional area.

During the storm events in the past 10 years the landowner has noted that the drain across Lot 8 has coped with the flows and has filled to a maximum depth of about 350 mm. That would indicate a flow surface area of 6 m x 0.30 m = 1.8 m<sup>2</sup>.

In the absence of additional calculations of the stormwater runoff from the catchment to the north, a surface area of flood flow of 3 m<sup>2</sup> through drains culverts/pipes and provision of excess floodway volume, is recommended.

That is the culvert and crossing at Steerdale Road are recommended to be re-investigated by the Shire of Ravensthorpe to ensure that the culvert and/or floodway can cope with the anticipated storm flow volumes.

The drain and excess capacity across Lot 8 are to be maintained at a cross sectional area of 3 m<sup>2</sup>. This can be through a smaller cut drain with excess swale capacity or one larger drain.

A similar capacity is recommended for the access road and along the edge of the Hopetoun – Ravensthorpe Road to the existing culvert.

A drain is also recommended to be maintained along the southern side of Part of Steerdale Road and from the north western corner along the lot boundaries as shown on the attached figures.

## **7.0 Groundwater Management Strategy**

The water recharge is not anticipated to change, therefore no changes are anticipated to groundwater regimes.

## **8.0 Future Design Considerations**

An additional stage of detailed engineering design, to accompany the site specific design for the subdivision, follows subdivision approval. In this case, with a relatively small number of large lots, the detailed design will be related to road design, swale drainage design and the design of the stormwater detention basins.

An Urban Water Management Plan will be prepared as part of the next stage of the progress of the subdivision, after approval of the subdivision and prior to construction. The Urban Water Management Plan will be prepared by the engineers who will incorporate any conditions and changed circumstances into the subdivision design and provide the detailed design drawings of the road network and drainage. At that time detailed calculations will be made to confirm and refine the drainage system.

The engineers will provide revised catchment calculations based on any changes to the catchments as a result of development. Flow rates and attenuation will also be considered, when designing pipework.

## **9.0 Monitoring**

Monitoring of water quality is not seen as necessary because there are no defined watercourses on the precinct and there are other issues that are listed below.

The only measureable water flows that will flow across Lot 8 will be from storm flows that will come from the land to the north of Steerdale Road and not from Lot 8, or with such insignificant contribution from Lot 8 that the water quality contribution from Lot 8 will be insignificant.

- It is proposed that all surface water up to and including the 1 hour 5 year return event will be retained on site within the swale drains. It is likely that water from most rainfall events will also be retained within the swale drains.
- Excess water will be directed to relatively small detention basins from which it will flow into the main drain. Water within the detention basins will quickly evaporate, be lost through transpiration and infiltration into the soils.
- Sampling is very much influenced by the land uses up catchment, the yearly weather regime and rainfall in dry years and this can make comparisons difficult. For example in a dry year salinity and often nitrates will normally be high due to evaporation and reduced dilution factors.
- Sampling the potential impact of subdivision is unlikely to be possible. The only samples will be storm samples and will measure the whole catchment and not Lot 8.

Sampling will have to be undertaken during storm flows.

The sampling is suggested for the following parameters, TSS, TP, TN, EC DO and pH is collected.

## **10.0 Implementation**

Implementation will only occur at the construction stage following the full engineering calculations for the roads and stormwater management.

At this stage, the Local Water Management Strategy is enough to provide sufficient assessment to ensure that there is provision within the subdivision guide plan to enable the required detention basins and drainage systems to be provided for.



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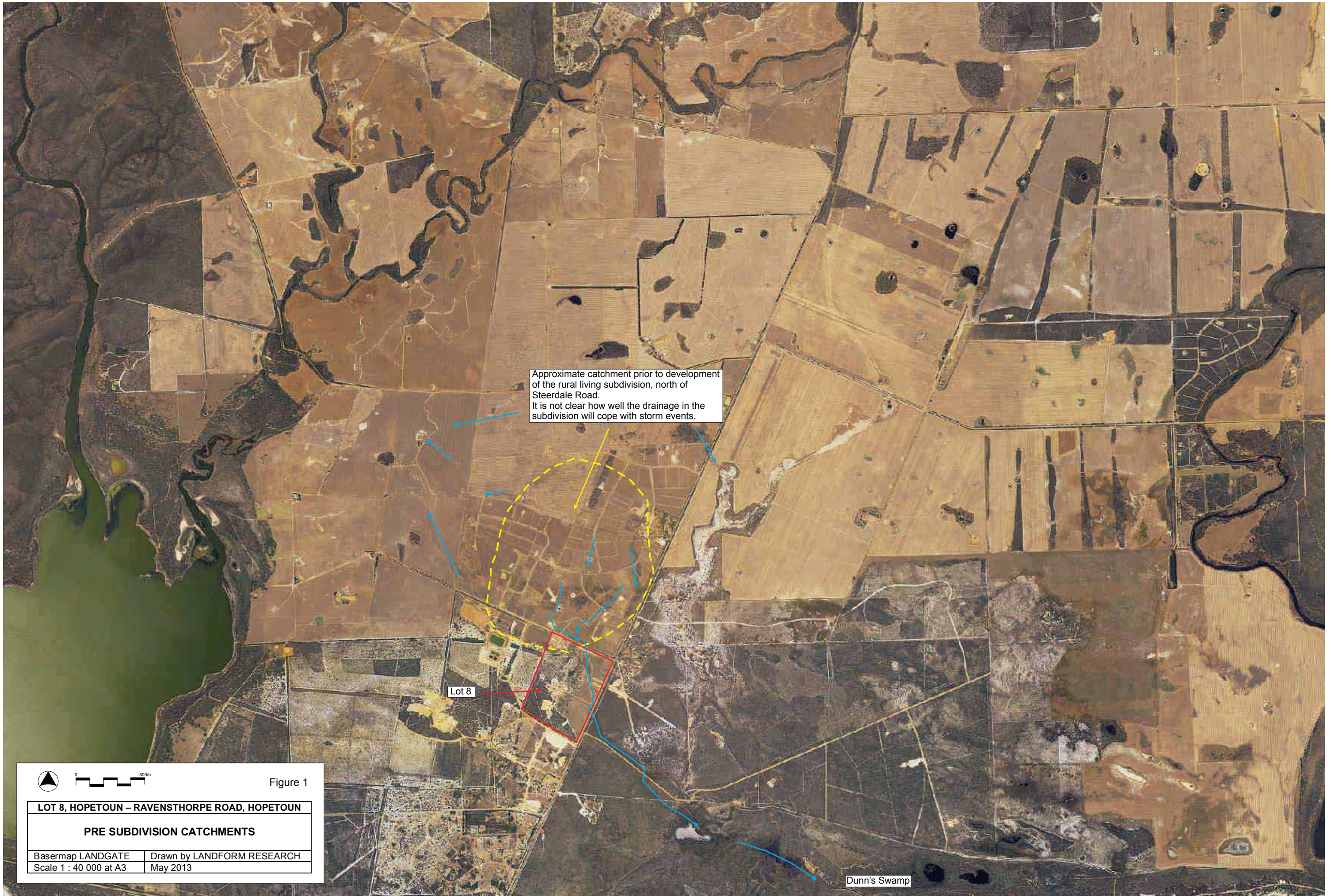
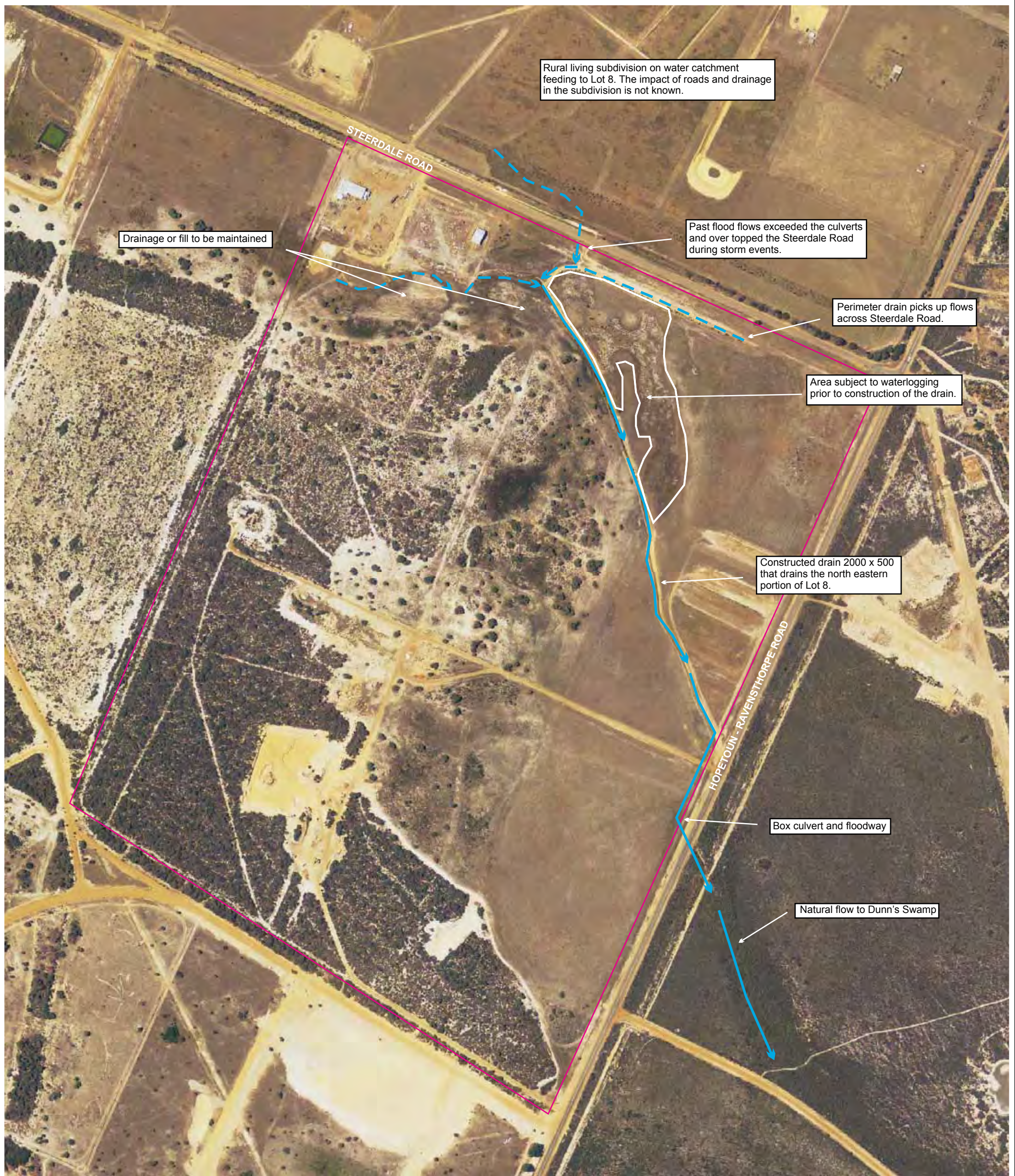


Figure 1

LOT 8, HOPETOUN – RAVENSTHORPE ROAD, HOPETOUN

**PRE SUBDIVISION CATCHMENTS**

Basemap LANDGATE	Drawn by LANDFORM RESEARCH
Scale 1 : 40 000 at A3	May 2013



Rural living subdivision on water catchment feeding to Lot 8. The impact of roads and drainage in the subdivision is not known.

Drainage or fill to be maintained

Past flood flows exceeded the culverts and over topped the Steerdale Road during storm events.

Perimeter drain picks up flows across Steerdale Road.

Area subject to waterlogging prior to construction of the drain.

Constructed drain 2000 x 500 that drains the north eastern portion of Lot 8.

Box culvert and floodway

Natural flow to Dunn's Swamp

→ Drainage and natural water flow direction



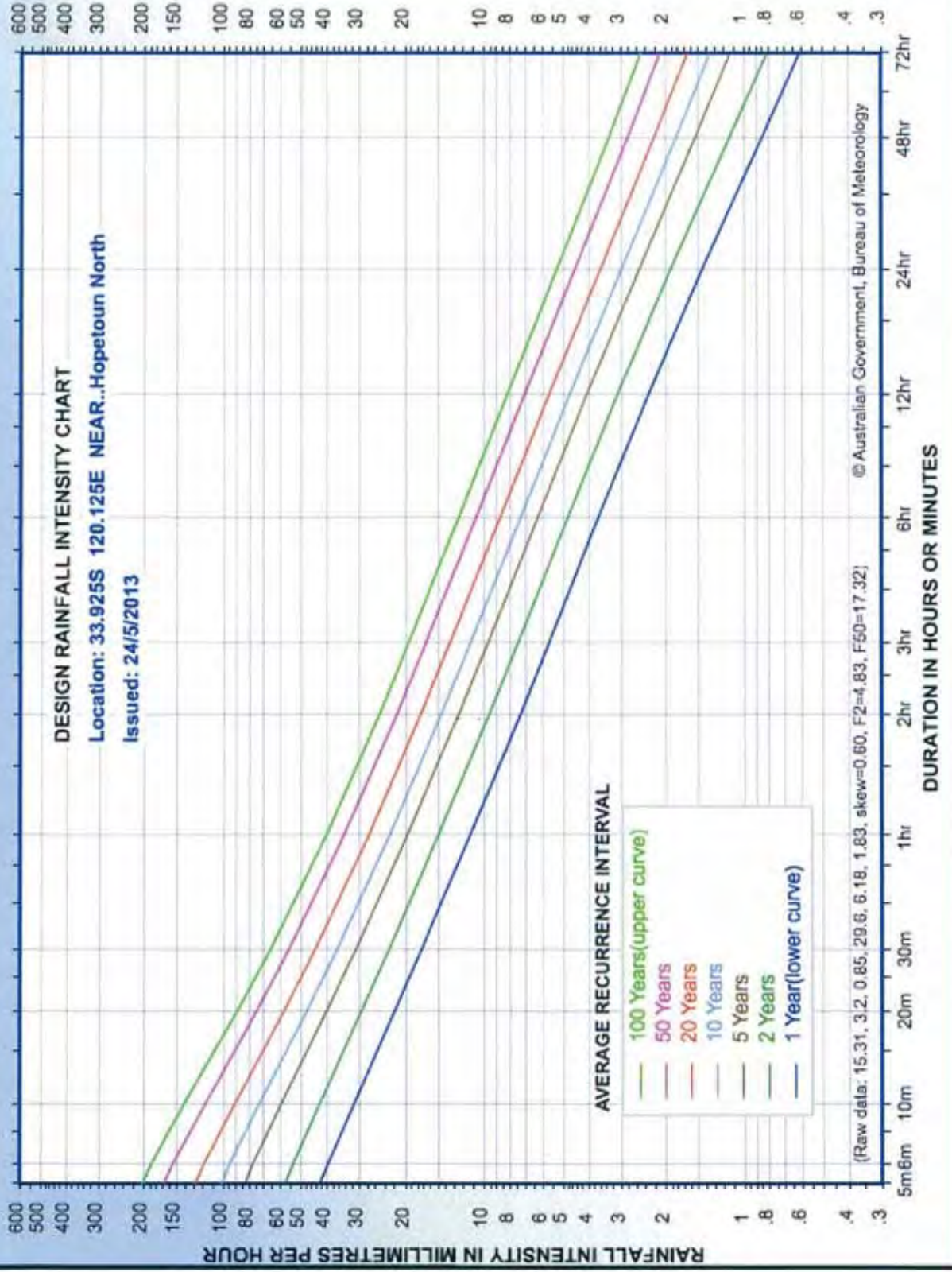
Figure 2

LOT 8, HOPETOUN - RAVENSTHORPE ROAD, HOPETOUN	
<b>NATURAL WATER FLOWS</b>	
Basemap LANDGATE	Drawn by LANDFORM RESEARCH
Scale 1 : 5 000 at A3	May 2013


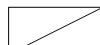






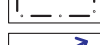




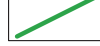




Home IFD Table IFD Chart Coefficients ARI Print IFD chart Help IFD chart

**DESIGN RAINFALL INTENSITY CHART**  
Location: 33.925S 120.125E NEAR..Hopetoun North  
Issued: 24/5/2013



**LEGEND**

-  Subject Land
-  Existing Lot Boundaries
-  Proposed Lot Boundaries
-  Existing / Proposed Roads
-  Existing Buildings
-  Existing Vegetation
-  Sand Pit
-  Habitable Building Envelopes
-  Proposed Drainage Line
-  Proposed Drainage Basin
-  Proposed Landscape Buffer
-  Wind Turbine Buffers
-  500m Extractive Industry Buffer Zone (notifications to be applied)
-  200m Sand Extraction Buffer
-  Fire Management Track
-  Alternative or Nutrient Absorbing Wastewater System Required

ALL AREAS AND DIMENSIONS ARE SUBJECT TO SURVEY

Drain required to cope with natural flows from the north west or that flow needs to be directed along Steerdale Road drainage.  
Note that drainage along Steerdale Road is currently restricted, forcing water into Lot 8.

Contribution of water from north of Steerdale Road is unclear as a result of subdivision and the construction of detention basins in that area.. Previous flows were recorded as a cross sectional area of 1.8m<sup>2</sup>. In the absence of new calculations this figure with a contingency is recommended to be used.

ADOPTED BY RESOLUTION OF THE COUNCIL OF THE \_\_\_\_\_ OF \_\_\_\_\_  
AT THE \_\_\_\_\_ COUNCIL MEETING  
ON THE \_\_\_\_\_ DAY OF \_\_\_\_\_  
CHIEF EXECUTIVE OFFICER \_\_\_\_\_

GODENIA WAY

552  
4.03ha

553  
4.24ha

554

In the absence of new revised calculations of storm flows from north of Steerdale Road the existing drain capacity of 3.0m<sup>2</sup> surface area of flow is recommended. This is significantly larger than storm flows in recent years that were though to represent 1 : 100 year events.

Indicative location for Water Tank for Bush Fire Management. To be filled by bores or alternative non-potable supply or similar

Direct vehicle access prohibited

Floodway with capacity of 3.0m<sup>2</sup> flow area to be provided. See above.

VCL  
5.8057ha

Natural flow to Dunn's Swamp

Landscape buffer to Ravensthorpe Hopetoun Road

Existing box culvert of 1.24m x 0.6m plus floodway to be maintained






For Drainage and Stormwater Management details refer to the Local Water Management Strategy

Reserve 7853





ORIG A3  
SCALE 1:5000

0 25 50 75 100 125

-  Overland water flows
-  Road swale drain
-  Main drain with surface area flow capacity of 3.0 m<sup>2</sup>, located in road reserve.
-  Smaller surface drain in road reserve or easement to pick up natural drainage and any potential overtopping of Steerdale Road.
-  Detention basin of 10m<sup>3</sup> capacity in absence of additional calculations, protected by lined outlet to main drain.

**PRECINCTS**

-  Rural Conservation (Rural Living and Associated Enterprises)
-  Special Use 16 (Composite Rural Living / Rural Enterprise)

06-35-SGP(n)

**AYTON BAESJOU**  
PLANNING  
11 Duke Street  
Albany WA 6330  
Ph 9842 2304 Fax 9842 8494

**STORM FLOW PATHS  
1 - 5 YEAR ONE HOUR STORM**


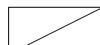






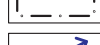




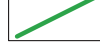


Water flows by

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Landform Research  
25 Heather Road  
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**SUBDIVISION GUIDE PLAN**  
Lot 8 Hopetoun Ravensthorpe Road  
(cnr Steerdale Road) Hopetoun  
Shire of Ravensthorpe

Figure 4A

**LEGEND**

-  Subject Land
-  Existing Lot Boundaries
-  Proposed Lot Boundaries
-  Existing / Proposed Roads
-  Existing Buildings
-  Existing Vegetation
-  Sand Pit
-  Habitable Building Envelopes
-  Proposed Drainage Line
-  Proposed Drainage Basin
-  Proposed Landscape Buffer
-  Wind Turbine Buffers
-  500m Extractive Industry Buffer Zone (notifications to be applied)
-  200m Sand Extraction Buffer
-  Fire Management Track
-  Alternative or Nutrient Absorbing Wastewater System Required

ALL AREAS AND DIMENSIONS ARE SUBJECT TO SURVEY

Drain required to cope with natural flows from the north west or that flow needs to be directed along Steerdale Road drainage.  
Note that drainage along Steerdale Road is currently restricted, forcing water into Lot 8.

Contribution of water from north of Steerdale Road is unclear as a result of subdivision and the construction of detention basins in that area.. Previous flows were recorded as a cross sectional area of 1.8m2. In the absence of new calculations this figure with a contingency is recommended to be used.

ADOPTED BY RESOLUTION OF THE COUNCIL OF THE \_\_\_\_\_ OF \_\_\_\_\_  
AT THE \_\_\_\_\_ COUNCIL MEETING  
ON THE \_\_\_\_\_ DAY OF \_\_\_\_\_  
CHIEF EXECUTIVE OFFICER \_\_\_\_\_

Indicative location for Water Tank for Bush Fire Management. To be filled by bores or alternative non-potable supply or similar

In the absence of new revised calculations of storm flows from north of Steerdale Road the existing drain capacity of 3.0m2 surface area of flow is recommended. This is significantly larger than storm flows in recent years that were though to represent 1 : 100 year events.

Direct vehicle access prohibited






Floodway with capacity of 3.0m2 flow area to be provided. See above.

Natural flow to Dunn's Swamp



Landscape buffer to Ravensthorpe Hopetoun Road

Existing box culvert of 1.24m x 0.6m plus floodway to be maintained

For Drainage and Stormwater Management details refer to the Local Water Management Strategy

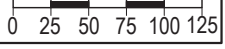
-  Overland water flows
-  Road swale drain
-  Main drain with surface area flow capacity of 3.0 m2, located in road reserve.
-  Smaller surface drain in road reserve or easement to pick up natural drainage and any potential overtopping of Steerdale Road.
-  Detention basin of 10m3 capacity in absence of additional calculations, protected by lined outlet to main drain.

**PRECINCTS**

-  Rural Conservation (Rural Living and Associated Enterprises)
-  Special Use 16 (Composite Rural Living / Rural Enterprise)

Reserve 7853

ORIG A3  
SCALE 1:5000



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**STORM FLOW PATHS**  
10 - 100 YEAR ONE HOUR STORM

Water flows by

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**Figure 4B**

**SUBDIVISION GUIDE PLAN**  
Lot 8 Hopetoun Ravensthorpe Road  
(cnr Steerdale Road) Hopetoun  
Shire of Ravensthorpe

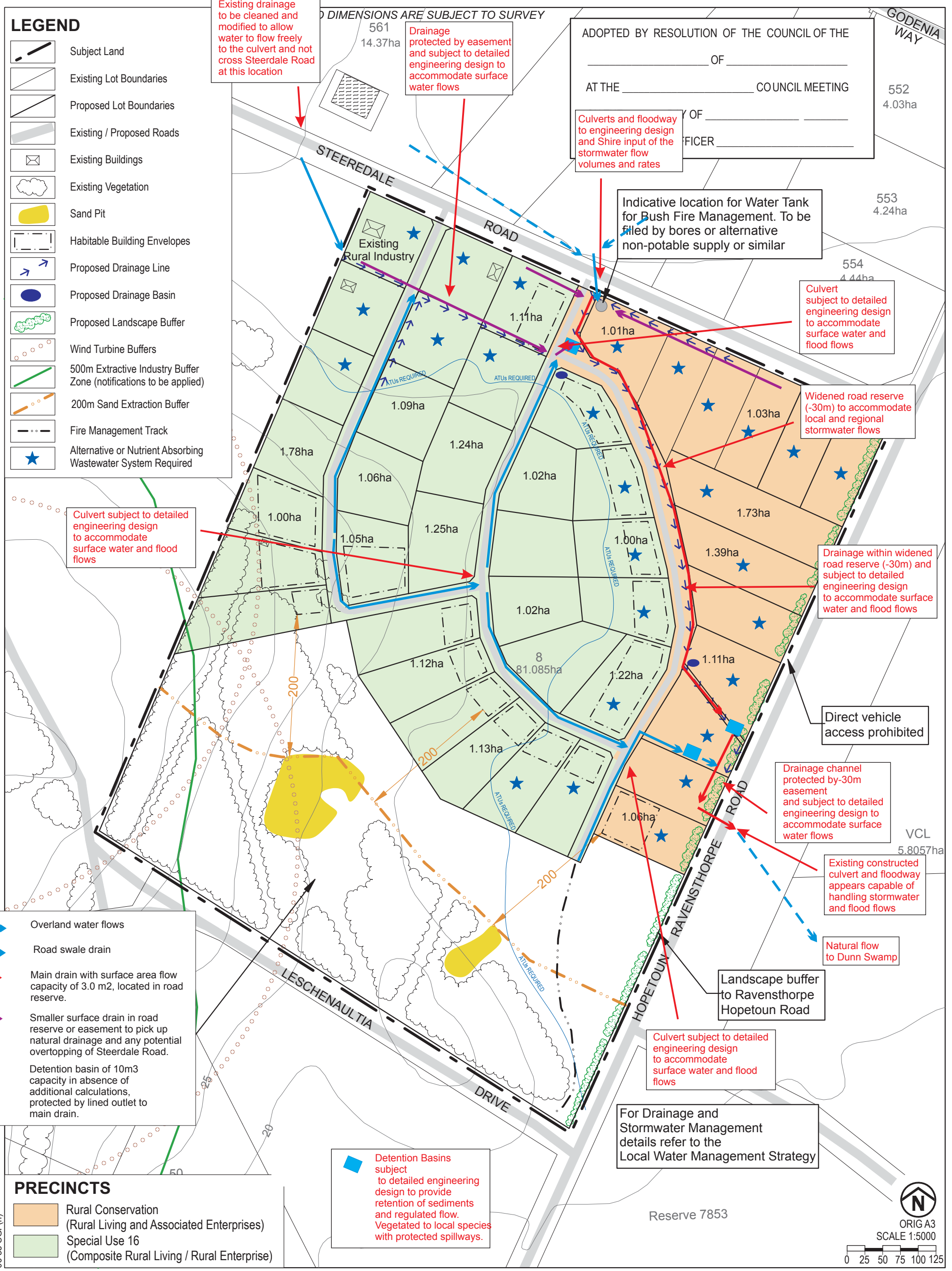


Figure 4C

# SUBDIVISION GUIDE PLAN

## Lot 8 Hopetoun Ravensthorpe Road (cnr Steeredale Road) Hopetoun Shire of Ravensthorpe



12 November 2015

## LATE WINTER SOIL TESTING

LOT 8, RAVENSTHORPE – HOPETOUN ROAD,  
HOPETOUN

## **Background**

Lot 8 was investigated by field work in February 2007.

That data was used to produce the mapping, geotechnical assessment, land capability and assessment for waste water disposal which was reported on in *“Land Capability – Geotechnical Assessment, Lot 8 Hopetoun – Ravensthorpe Road, Hopetoun, dated June 2013.*

The original soil testing and assessment consisted of 19 backhoe holes across the site. The soils were assessed using soil properties to determine the depth of winter water and soil moisture that might compromise waste water disposal.

## **Findings**

The testing identified the south western half as being formed from deep sand with limestone at depth in the west and the north eastern half of being lower elevation, but generally well drained land suitable for dwellings and waste water disposal.

There were several locations in the north east where the soils were lower lying and susceptible to water laying on the surface in winter.

As a result of the testing, 1.0 hectare lot sizes were proposed and a subdivision guide plan developed. The use of one hectare lots provided sufficient area to allow for a building envelope on all lots including the north east.

It was also identified that the fill used in the north western corner had partially dammed the soils in that location creating a winter wet area. See the attached aerial photograph.

In addition, water from north of Steerdale Road was being directed across to the north western corner of Lot 8 in addition to the main crossing in the north. This added to the water in the north western corner.

Drainage of the north western corner and fixing the swale drains along Steerdale Road to better manage the water were proposed as part of the subdivision.

## **Soil Testing October 2015**

To confirm the winter soil moisture, an additional 19 soil test holes were excavated across the low lying land on 5 October 2015. The location of these holes is shown on the attached aerial photograph as a yellow spot. The 2007 soil test hole are shown as a white spot.

The elevated south western half is obviously capable of high levels of waste water disposal through either conventional septic tank or nutrient adsorbing waste water systems and was not re-tested.

As the north eastern half is at a lower elevation, nutrient adsorbing waste water systems are proposed. Such systems allow for separations to the highest known water table of 500 mm. Therefore the soil test holes generally were excavated to between 1 000 to 1 700 metres, allowing a conservative approach of over 500 mm (between 500 – 1000 mm) incase 2015 was drier than normal or the 5 of October was later in the winter.

The rainfall in 2015 was near average and normally in south coastal localities the highest winter maximum water tables are late, in October.

There were therefore no limitations on the soil testing conducted on 5 October 2015.

## **Results of the soil testing**

The soil test hole logs are attached. Their location is overlain on the attached aerial photograph and site photographs of most of the test holes are also attached.

The soil testing simply confirmed the previous mapping. No soil boundaries, land capability or geotechnical mapping had to be changed as a result of the 2015 test holes, demonstrating the ability to determine winter soil moisture from soil horizons, composition and mineral content of the soils.

Only one hole (Hole 11) intersected the water table and that was at 600 mm depth located in the north west near where the stormwater has been allowed to enter from north of Steerdale Road. Soil test Hole 11 was deliberately located as close as possible to the soils on which water from north of Steerdale Road ponded in 2015 to provide a worst case scenario and a limit for waste water disposal.

Even so, Hole 11 complies with the installation requirements for nutrient adsorbing or ATU waste disposal units. The lot sizes in that location of 1 hectare enable the waste water and building envelope to be located further south, up slope away from the currently wetter soils.

The only other issue concerned the patches of lower lying soils near Hole 16. There are low sand ridges in those locations on which building envelopes can be located. This applies to Holes 15, 16, 17 and 18. The soils on the ridge are fine and meet the criteria for waste water disposal. See Holes 15 to 19, which are included as photographs and logs.

The north eastern corner has been used for gravel extraction and overburden and topsoil returned. The excavated gravel areas were tested by Holes 14 and 19. Both readily complied with the requirements for waste water disposal from nutrient adsorbing – alternative waste water systems.

## **Conclusions**

All lots on the subdivision guide plan are capable for development and are suitable for water disposal through approved waste water systems and meet the required criteria. The lots on lower elevations in the north eastern half are recommended to be installed with nutrient adsorbing or alternative waste water systems as shown in the mapping included in the *“Land Capability – Geotechnical Assessment, Lot 8 Hopetoun – Ravensthorpe Road, Hopetoun, dated June 2013* and repeated here as the attached Land Capability Map.

Lindsay Stephens

# Regolith and Hydrological Logs

Lindsay Stephens BSc (Geology) MSc (Botany) FIQA, EIANZ  
 25 Heather Road Roleystone 6111  
 Phone 9397 5145 Fax 9397 5350

Project	King	Site Assessed by	L Stephens
Location	Lot 8 Ravensthorpe - Hopetoun Road Hopetoun	Date of Inspections	5 October 2015

Test Hole Number	1	Natural Surface	
Location	East	Base of Hole	
Test Hole Type	Backhoe	Depth	
Diameter		Depth of static water level	
Depth	Description	Comments	
0 – 150 mm	Grey sandy topsoil		
150 – 550 mm	Brown gravelly sand		
550 – 1 050 mm	Permeable clay sand to loam		
Groundwater	Not intersected		
Comment			

Test Hole Number	2	Natural Surface	
Location	East	Base of Hole	
Test Hole Type	Backhoe	Depth	
Diameter		Depth of static water level	
Depth	Description	Comments	
0 - 140 mm	Grey sand - topsoil		
140 - 600 mm	Brown gravelly sand		
600 – 1 100 mm	Light yellowish brown mottled loam to sandy clay	Free draining	
Groundwater	Water table not intersected		
Comment			

Test Hole Number	3	Natural Surface	
Location	South east	Base of Hole	
Test Hole Type	Backhoe	Depth	
Diameter		Depth of static water level	
Depth	Description	Comments	
0 - 170 mm	Grey sand - topsoil		
170 - 650 mm	Light brown coarse gravelly sand		
650 – 900 mm	Light yellow sand		
900 – 1 200 mm	Grey loamy coarse sand		
Groundwater	Water table not intersected		
Comment			

Test Hole Number	4	Natural Surface	
Location	South east	Base of Hole	
Test Hole Type	Backhoe	Depth	
Diameter		Depth of static water level	
Depth	Description	Comments	
0 - 110 mm	Grey sand and topsoil		
110 - 530 mm	Light brown gravelly sand		
530 – 1 200 mm	Light brown clay sand - loam		
Groundwater	Water table not intersected		
Comment			

# Regolith and Hydrological Logs

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Project	King	Site Assessed by	L Stephens
Location	Lot 8 Ravensthorpe - Hopetoun Road Hopetoun	Date of Inspections	5 October 2015

Test Hole Number	5	Natural Surface	
Location	South east	Base of Hole	
Test Hole Type	Backhoe	Depth	
Diameter		Depth of static water level	
Depth	Description	Comments	
0 - 130 mm	Grey sand - topsoil		
130 - 720 mm	Brown gravelly sand		
720 - 1090 mm	Brown clay sand	damp	
Groundwater	Water table not intersected		
Comment			

Test Hole Number	6	Natural Surface	
Location	North	Base of Hole	
Test Hole Type	Backhoe	Depth	
Diameter		Depth of static water level	
Depth	Description	Comments	
0 - 210 mm	Grey sand - topsoil		
210 - 490 mm	Light brown ferricreted sandy gravel with 300 x 300 mm particles		
490 - 1000 mm	Light brown clay sand - loam		
Groundwater	Water table not intersected		
Comment			

Test Hole Number	7	Natural Surface	
Location	Central south	Base of Hole	
Test Hole Type	Backhoe	Depth	
Diameter		Depth of static water level	
Depth	Description	Comments	
0 - 80 mm	Light grey sand - topsoil		
80 - 850 mm	Light cream sand		
850 - 1 400 mm	Light yellow brown mottled clay sand		
Groundwater	Water table not intersected		
Comment			

Test Hole Number	8	Natural Surface	
Location	Central east	Base of Hole	
Test Hole Type	Backhoe	Depth	
Diameter		Depth of static water level	
Depth	Description	Comments	
0 - 130 mm	Yellowish grey sand		
130 - 480 mm	Dark yellow sand, minor gravel		
420 - 1 250 mm	Light mottled yellow to grey clay sand		
Groundwater	Water table not intersected		
Comment			

# Regolith and Hydrological Logs

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Project	King	Site Assessed by	L Stephens
Location	Lot 8 Ravensthorpe - Hopetoun Road Hopetoun	Date of Inspections	5 October 2015

Test Hole Number	9	Natural Surface	
Location	Central east	Base of Hole	
Test Hole Type	Backhoe	Depth	
Diameter		Depth of static water level	
Depth	Description	Comments	
0 - 100 mm	Yellow grey sand		
130 - 520 mm	Pale grey - yellow sand		
520 - 1 250 mm	Light brown sandy loam		
Groundwater	Water table not intersected		
Comment			

Test Hole Number	10	Natural Surface	
Location	Central north	Base of Hole	
Test Hole Type	Backhoe	Depth	
Diameter		Depth of static water level	
Depth	Description	Comments	
0 - 110 mm	Light grey sand		
110 - 490 mm	Variable coloured yellow sand		
490 - 1 450 mm	Yellow grey clay sand	Moist	
Groundwater	Water table not intersected		
Comment			

Test Hole Number	11	Natural Surface	
Location	North	Base of Hole	
Test Hole Type	Backhoe	Depth	
Diameter		Depth of static water level	
Depth	Description	Comments	
0 - 140 mm	Cream to white sand		
140 - 1 300 mm	Light brown fine to medium sand		
1 300 - 1 500 mm	Light mottled clay sand		
Groundwater	Water table 600 mm		
Comment			

Test Hole Number	12	Natural Surface	
Location	North west	Base of Hole	
Test Hole Type	Backhoe	Depth	
Diameter		Depth of static water level	
Depth	Description	Comments	
0 - 100 mm	Light grey sand		
100 - 500 mm	Dark orange brown clay sand with minor gravel		
500 - 1 300 mm	Pale yellow sand		
1 300 - 1 700 mm	Yellow sand		
Groundwater	Water table not intersected		
Comment			

# Regolith and Hydrological Logs

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Project	King	Site Assessed by	L Stephens
Location	Lot 8 Ravensthorpe - Hopetoun Road Hopetoun	Date of Inspections	5 October 2015

Test Hole Number	13	Natural Surface	
Location	North west corner	Base of Hole	
Test Hole Type	Backhoe	Depth	
Diameter		Depth of static water level	
Depth	Description	Comments	
0 - 200 mm	Pale grey sand		
200 - 1 300 mm	Pale yellow sand		
1 300 - 1 700 mm	Yellow sand		
Groundwater	Water table not intersected		
Comment			

Test Hole Number	14	Natural Surface	
Location	South east	Base of Hole	
Test Hole Type	Backhoe	Depth	
Diameter		Depth of static water level	
Depth	Description	Comments	
0 - 600 mm	Dark grey black sand	Old gravel pit. Rehabilitated by spreading topsoil.	
600 - 1100 mm	Light grey yellow mottled clay sand	Moist	
Groundwater	Water table not intersected		
Comment			

Test Hole Number	15	Natural Surface	
Location	North east	Base of Hole	
Backhoe	Backhoe	Depth	
Diameter		Depth of static water level	
Depth	Description	Comments	
0 - 190 mm	Dark grey sand		
190 - 340 mm	Brown gravelly sand		
340 - 900 mm	Yellow brown and white sandy clay		
900 - 1 200	Light mottled clay sand		
Groundwater	Water table not intersected.		
Comment			

Test Hole Number	16	Natural Surface	
Location	Central north	Base of Hole	
Test Hole Type	Backhoe	Depth	
Diameter		Depth of static water level	
Depth	Description	Comments	
0 - 120 mm	Light grey sand	Located on a low elevated ridge 500 mm high. Has <i>Ficinia nodosa</i> on elevated soils.	
120 - 670 mm	Pale yellowish brown sand		
670 - 1 280 mm	Light coloured mottled yellow and grey clay sand		
Groundwater	Water table not intersected		
Comment			

## Regolith and Hydrological Logs

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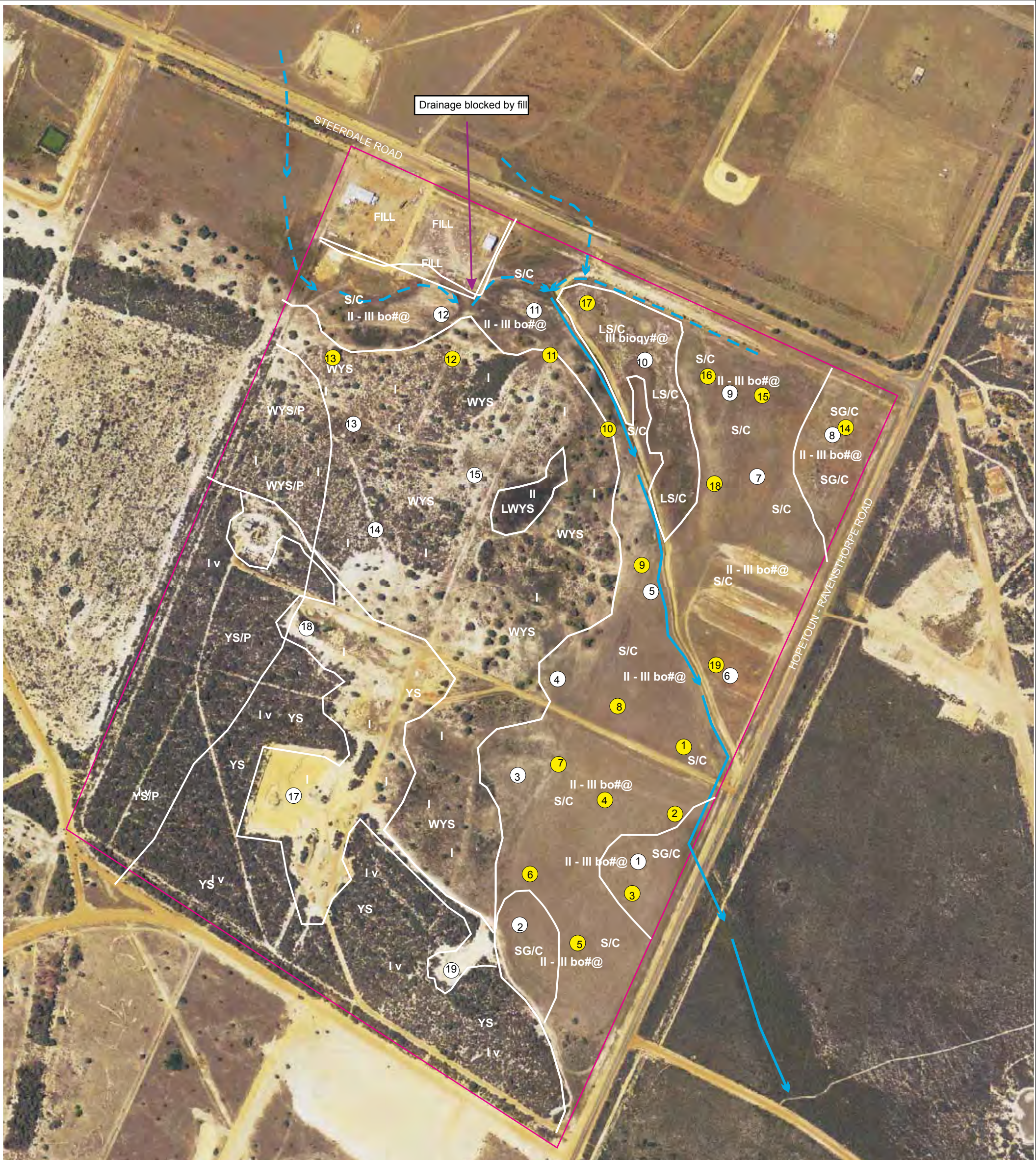
Project	King	Site Assessed by	L Stephens
Location	Lot 8 Ravensthorpe - Hopetoun Road Hopetoun	Date of Inspections	5 October 2015

Test Hole Number	17	Natural Surface		
Location	Central north	Base of Hole		
Test Hole Type	Backhoe	Depth		
Diameter		Depth of static water level		
Depth	Description	Comments		
0 – 120 mm	Grey brownish sand	Located on a low elevated ridge 500 mm high. Has <i>Ficinia nodosa</i> on elevated soils.		
120 - 650 mm	Pale yellow brown sand			
650 – 1300 mm	Yellow grey mottled clay sand			
Groundwater	Water table not intersected			
Comment				

Test Hole Number	18	Natural Surface		
Location	Central north east	Base of Hole		
Test Hole Type	Backhoe	Depth		
Diameter		Depth of static water level		
Depth	Description	Comments		
0 – 120 mm	Grey brown sand			
120 - 480 mm	Grey brown sand			
480 – 1 290 mm	White to pale yellow clay sandy loam			
Groundwater	Water table not intersected			
Comment				

Test Hole Number	19	Natural Surface		
Location	Central east	Base of Hole		
Test Hole Type	Backhoe	Depth		
Diameter		Depth of static water level		
Depth	Description	Comments		
0 – 430 mm	Dark grey sand	Located on old gravel pit.		
430 - 640 mm	Dark yellow sand			
640 – 1310 mm	Yellow mottled clay sand, fine and silty	Damp		
Groundwater	Water table not intersected.			
Comment				





**LAND CAPABILITY FOR DWELLINGS and DEVELOPMENTS**

KEY	CAPABILITY FOR SELECTED LAND USE
I	<ul style="list-style-type: none"> <li>Very high capability with few physical limitations.</li> </ul>
II	<ul style="list-style-type: none"> <li>High capability with minor physical limitations that can be overcome by planning and minor site modifications.</li> </ul>
III	<ul style="list-style-type: none"> <li>Fair capability with moderate physical limitations. The cost of development can be managed by the design of subdivision layout, lot size foundations.</li> <li>Consideration during planning will be required.</li> <li>Some site modification may be required.</li> </ul>
IV	<ul style="list-style-type: none"> <li>Lower capability with a number of smaller management actions required or there is one significant factor that will require management.</li> <li>Subdivision or development design can be used to contain additional costs.</li> <li>Additional site works may be required; retaining walls, drainage, increased rock removal, heavier foundations, cut and fill, general fill, flood mitigation, increased costs or the presence of significant saline soil - acid sulfate.</li> </ul>
V	<ul style="list-style-type: none"> <li>Reduced physical capability or with significant limitations.</li> <li>A number of management actions or a significant level of management will be required for one or more factors.</li> <li>Limiting site factors might include drainage, heavier foundations, significant basement rock, significant cut and fill, slope stability, high construction costs, general fill, soil instability, saline soil, acid sulfate or flood mitigation.</li> </ul>
X	<ul style="list-style-type: none"> <li>Development not acceptable because of significant environmental or geotechnical issues, or Government Policy. (Includes Conservation Category or EPP Wetlands and significant remnant vegetation, high risk geotechnical issues).</li> </ul>

See Key and map for specific limitations.

→ Drainage and natural water flow direction

- ⑲ Soil test hole February 2007 conducted for general soil mapping and geotechnical investigations for dwellings and waste water disposal.
- ⑤ Soil test Hole 5 October 2015 to check soil moisture in late winter



<b>LOT 8, HOPETOUN - RAVENSTHORPE ROAD, HOPETOUN</b>	
<b>LAND CAPABILITY FOR DWELLINGS</b>	
Basemap LANDGATE	Drawn by LANDFORM RESEARCH
Scale 1 : 5 000 at A3	October 2015

## MANAGEMENT of IDENTIFIED CONSTRAINTS for LAND USE AND DEVELOPMENT

KEY	CONSTRAINTS IDENTIFIED	GEOTECHNICAL and ENVIRONMENTAL MANAGEMENT
<b>a</b>	Soil permeability limitations	<ul style="list-style-type: none"> <li>Provide appropriate waste water disposal systems.</li> </ul>
<b>b</b>	Foundation soundness	<ul style="list-style-type: none"> <li>Requires fill pads of sufficient depth to counteract potential clay or expanding sub-soils.</li> <li>Organic subsoils may need to be removed if present.</li> </ul>
<b>c</b>	Potential slope instability	<ul style="list-style-type: none"> <li>AS 2870 Site Class P generally applies to cut and fill.</li> <li>Provide appropriate foundation design.</li> <li>Upslope cutoff drains recommended.</li> <li>Upslope water loading to be avoided.</li> <li>Trees to be retained/planted. Pasture cover to be maintained</li> </ul>
<b>d</b>	Steep slopes that require significant management	<ul style="list-style-type: none"> <li>Steep slopes that will require significant management to develop.</li> <li>The slopes are often associated with a landscape feature.</li> <li>Pier-pole foundations may be more appropriate than cut and fill.</li> <li>Larger lot sizes recommended; &gt; 1000 m<sup>2</sup>.</li> </ul>
<b>e</b>	Water erosion risk	<ul style="list-style-type: none"> <li>Maintain soil cover of crops, pasture, trees or shrubs</li> <li>Use contour drains and agricultural practices.</li> <li>Stormwater to be controlled.</li> </ul>
<b>f</b>	Potential flooding	<ul style="list-style-type: none"> <li>Requires sand pad to be set sufficiently (0.5m) above highest known water level to minimise capillary effects.</li> <li>Locate developments outside areas of flooding.</li> </ul>
<b>i</b>	Subject to winter wet conditions or water logging risk in wet years.	<ul style="list-style-type: none"> <li>Alternative waste water treatment systems likely to be required.</li> <li>Cut off drains and other drainage likely to be required.</li> <li>Raise and or terrace waste water disposal areas.</li> <li>Fill may be required for developments.</li> <li>Floor elevations to have clearance above water risk levels.</li> <li>Reduce stock in winter.</li> <li>Road drainage and cut off drains will intersect and divert surface water from upslope, drying areas lower down slope.</li> </ul>
<b>k</b>	Soil workability	<ul style="list-style-type: none"> <li>Remove or avoid rock, clay subsoils or other restrictions.</li> </ul>
<b>m</b>	Low moisture availability of soil	<ul style="list-style-type: none"> <li>Manage or reduce stock to ensure pasture cover through summer.</li> <li>Restrict clearing to building envelopes.</li> </ul>
<b>n</b>	Low nutrient retention ability	<ul style="list-style-type: none"> <li>Alternative waste water treatment systems may be required.</li> <li>Leach drains may need to be inverted or semi-inverted, banded by natural soil or impermeable membrane on downslope side.</li> <li>Setback developments appropriate distances from water bodies/wetlands.</li> <li>Use reticulated sewerage.</li> <li>Feed stormwater through detention basins and swale drains.</li> <li>Manage nutrient and fertiliser applications and stock</li> <li>Restrict clearing to building envelopes.</li> <li>Restrict the density of development.</li> </ul>
<b>o</b>	Water pollution risk by overland flow	<ul style="list-style-type: none"> <li>Retain surface water in basins, use swale and grass filters.</li> <li>Manage stock and potentially polluting land uses.</li> </ul>
<b>p</b>	Potentially low microbial purification	<ul style="list-style-type: none"> <li>Alternative waste water treatment systems required.</li> <li>Correctly install waste water systems.</li> <li>Bund waste water disposal areas sufficiently.</li> </ul>
<b>q</b>	Water table <0.5 metres depth	<ul style="list-style-type: none"> <li>Soils can be modified using fill, cutoff drains to comply with the Government Country Sewerage Policy.</li> <li>Use Filtrex or Ecomax, which can be installed where the water table is at 0.25 and 0.0 m below the surface.</li> </ul>
<b>r</b>	Restricted rooting conditions	<ul style="list-style-type: none"> <li>Avoid rock, hardpan or other restrictions.</li> </ul>
<b>s</b>	Water pollution risk by subsurface flow	<ul style="list-style-type: none"> <li>See (n) above.</li> </ul>
<b>t</b>	Low topsoil nutrient retention	<ul style="list-style-type: none"> <li>See (n) above.</li> </ul>
<b>v</b>	Remnant vegetation	<ul style="list-style-type: none"> <li>Restrict clearing to building envelopes. Maintain linkages.</li> </ul>
<b>w</b>	Wind erosion risk	<ul style="list-style-type: none"> <li>Manage or reduce stock, irrigate and improve pasture.</li> <li>Maintain vegetation/stubble cover through summer.</li> <li>Restrict clearing to building envelopes.</li> </ul>
<b>x</b>	Reduced ease of excavation	<ul style="list-style-type: none"> <li>Remove rock or avoid constrained areas.</li> </ul>
<b>y</b>	Salinity risk	<ul style="list-style-type: none"> <li>Provide drainage and reduce ponding.</li> <li>Plant deep rooted species including deep rooted crops.</li> </ul>
<b>z</b>	Wetland conservation	<ul style="list-style-type: none"> <li>Exclude building envelopes and developments.</li> <li>Provide appropriate buffer distances.</li> <li>Place conservation covenants on wetlands and/or vegetation.</li> </ul>
<b>&amp;</b>	Potential for acid sulfate conditions	<ul style="list-style-type: none"> <li>Minimise deep excavations or bulk earthworks; use fill.</li> <li>Neutralise removed affected soils.</li> <li>Minimise or exclude dewatering and lowering of groundwater.</li> </ul>
<b>\$</b>	Restricted water availability	<ul style="list-style-type: none"> <li>Water may be restricted for some horticulture land uses</li> </ul>
<b>#</b>	Semi-inverted leach drains	<ul style="list-style-type: none"> <li>Leach drains should be semi-inverted, banded by natural soil or impermeable membrane on the downslope side.</li> </ul>
<b>@</b>	Alternative waste water treatment system required	<ul style="list-style-type: none"> <li>Unsuitable for conventional septic systems. All lots will be required to use alternative waste water treatment systems to comply with Regulations, Policy and Department Guidelines.</li> </ul>



General view from east to west, showing the higher sand ridge in the west



General view in the location of Hole 9