GRAY&LEWIS
LAND USE PLANNERS

STRUCTURE PLAN

LOT 791 WALKER ROAD, SERPENTINE

SERP/2015/-1

WAPC REF: SPN/2140

December 2017

Suite 5, 2 Hardy Street South Perth WA 6151 T [08] 9474 1722 F [08] 9474 1172 perth@graylewis.com.au
Member of the Australian Association of Planning Consultants Registered Town Planning Consultant
ABN 11 363 195 855

Prepared for: Gary and Jacqueline Squire

Prepared by: Gray & Lewis Landuse Planners
Suite 5 / 2 Hardy Street, South Perth

Telephone: (08) 9474 1722
Facsimile: (08) 9474 1172
Email: geoff@graylewis.com.au

Job Reference: 100889

Shire Reference: SERP/2015/-1

WAPC Reference: SPN/2140

DOCUMENT CONTROL

Version	Report file name	Authorised	Date
1	V1 Structure Plan Report December 2015	Liz Bushby / Geoff Lewis	December 2015
2	V2 Structure Plan Report November 2017	Geoff Lewis	November 2017
3	V3 Structure Plan Report 1 December 2017	Geoff Lewis	1 December 2017

ENDORSEMENT PAGE

This Structure Plan is prepared under the provisions of the Shire of Serpentine Jarrahdale Town Planning Scheme No 2.

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

4 December 2017 .....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

4 December 2017 .....Date

4 December 2027 .....Date of Expiry

TABLE OF AMENDMENTS

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

EXECUTIVE SUMMARY

Item	Data	Structure Plan Ref (section no.)
Total area covered by the Structure Plan	18.507ha	1.2.2 & Plan 1
Area of each landuse proposed: • Rural Living	 16.78ha (excluding roads & drainage)	3.1
Total estimated lot yield	34	3.1
Estimated number of dwellings	34	3.1
Estimated residential site density	1.89 dwellings per site /hectare	N/A
Estimated population	87	3.1
Estimated area and percentage of public open space	10% public open space to be provided in the form of cash-in-lieu	3.2
Estimated percentage of natural area	Individual trees to be retained where possible. A landscape and vegetation management plan to be provided at subdivision stage.	2.1

CONTENTS

List of Figures & APPENDIXs

PART 1 - IMPLEMENTATION

1. STRUCTURE PLAN AREA

The Structure Plan for Lot 791 Walker Road, Serpentine applies to the land contained within the inner edge of the red line denoting the Structure Plan boundary on the Structure Plan map (Plan 1 – Structure Plan).

2. OPERATION

This Structure Plan will come into effect on the date that the Structure Plan is approved by the Western Australian Planning Commission.

3. STAGING

This Structure Plan is proposed to be completed as one stage of subdivision.

4. SUBDIVISION AND DEVELOPMENT REQUIREMENTS

	GENERAL DEVELOPMENT REQUIREMENTS
4a	Lot 791 Walker Road, Serpentine is zoned 'Rural Living A' under the Shire of Serpentine Jarrahdale Town Planning Scheme No 2. Development shall be in accordance with Clause 5.12, and the special provisions for 'RLA 28' listed in 'Appendix 4A – Rural Living Zone' under the Shire of Serpentine Jarrahdale Town Planning Scheme No 2.
4b	Development will generally occur within the building envelopes shown on the Structure Plan. A building envelope with an area not exceeding 1,000m² has been provided on each lot, with the building envelope being no closer than 20 metres to the primary street boundary and no closer than 10 metres to any other lot boundary.
	GENERAL SUBDIVISION REQUIREMENTS
4c	Subdivision shall generally be designed to include road connections to the 'Rural Living B' zone to the south and 'Rural Living A' zone to the north.

	SITE SPECIFIC SUBDIVISION AND DEVELOPMENT REQUIREMENTS
4.1	A Site and Soil Evaluation report is to be undertaken in accordance with AS/NZS 1547:2012 On-site domestic wastewater management, during winter conditions, to the satisfaction of the Shire and submitted with the application for subdivision.
4.2	A landscape and vegetation management plan is to be submitted at subdivision. The plan should reflect existing vegetation to be retained, street tree planting, landscaping of drainage reserve and revegetation of all lots. The plan should include species list and methodology of application.
4.3	Building envelopes should be positioned with regard to geotechnical investigations, retention of vegetation and bushfire management.
4.4	Subdivision of the site is subject to a minimum of 10% contribution towards public open space.

SUBDIVISION GUIDE PLAN ADOPTED BY COUNCIL AT THEIR ORDINARY MEETING HELD ON THE ..... DAY OF ..... 2016 IN ACCORDANCE WITH CLAUSE 5.12.9 OF THE SCHEME

CHIEF EXECUTIVE OFFICER

ALL PROPOSED BUILDING ENVELOPES GENERALLY IN ACCORDANCE WITH SHIRE OF SERPENTINE-JARRAHDALE BUILDING SETBACK REQUIREMENTS;

- MINIMUM 20m SETBACK FROM PRIMARY STREET
- MINIMUM 10m SETBACK TO ANY OTHER BOUNDARY

THE LOCATION OF THE BUILDING ENVELOPES ARE INDICATIVE ONLY. BUILDING ENVELOPES AND EFFLUENT DISPOSAL ENVELOPES WILL BE REQUIRED TO ENSURE ADEQUATE SEPARATION DISTANCE TO GROUNDWATER IS ACHIEVED. THE EXACT LOCATION OF THESE ENVELOPES WILL BE DETERMINED AT BUILDING LICENCE STAGE BASED ON SITE ASSESSMENTS OF INDIVIDUAL LOTS.

STRUCTURE PLAN

LOT 791 (No. 84) WALKER ROAD SERPENTINE

LEGEND

- SUBJECT LAND
- OPEN DRAINAGE (Table drain in Road Reserve)
- BUILDING ENVELOPES
- D DRAINAGE / POS
- 6m FIRE SERVICE ACCESS ROUTE
- 4m GATES
- DENOTES TREES TO BE REMOVED
- INDICATIVE LOCATION OF FIRE HYDRANT

N

0 50m

SCALE 1:2000 @ A3

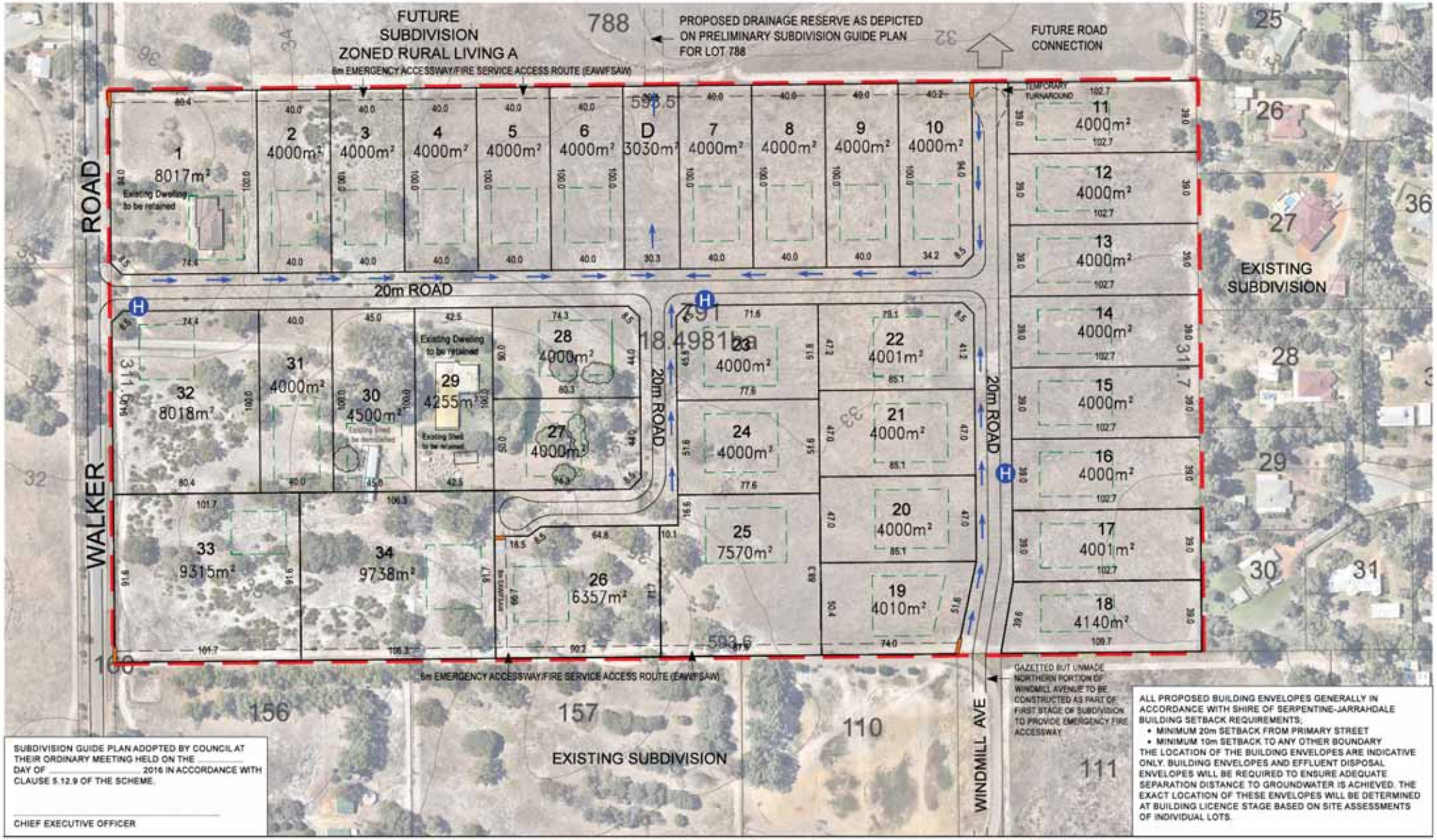
NOTE: Areas and dimensions subject to survey.

Plan 1

GRAY & LEWIS
LAND USE PLANNERS

Suite 5, 2 Hardy Street
South Perth, WA 6151
T (08) 9474 1722
F (08) 9474 1172
perth@graylewis.com.au

JOB REFERENCE: 100869 DATE: 30th NOVEMBER 2017



SUBDIVISION GUIDE PLAN ADOPTED BY COUNCIL AT THEIR ORDINARY MEETING HELD ON THE ..... DAY OF ..... 2016 IN ACCORDANCE WITH CLAUSE 5.12.9 OF THE SCHEME.

.....
CHIEF EXECUTIVE OFFICER

ALL PROPOSED BUILDING ENVELOPES GENERALLY IN ACCORDANCE WITH SHIRE OF SERPENTINE-JARRAHDALE BUILDING SETBACK REQUIREMENTS;

- MINIMUM 20m SETBACK FROM PRIMARY STREET
- MINIMUM 10m SETBACK TO ANY OTHER BOUNDARY

THE LOCATION OF THE BUILDING ENVELOPES ARE INDICATIVE ONLY. BUILDING ENVELOPES AND EFFLUENT DISPOSAL ENVELOPES WILL BE REQUIRED TO ENSURE ADEQUATE SEPARATION DISTANCE TO GROUNDWATER IS ACHIEVED. THE EXACT LOCATION OF THESE ENVELOPES WILL BE DETERMINED AT BUILDING LICENCE STAGE BASED ON SITE ASSESSMENTS OF INDIVIDUAL LOTS.

STRUCTURE PLAN

LOT 791 (No. 84) WALKER ROAD SERPENTINE

LEGEND

- SUBJECT LAND
- OPEN DRAINAGE (Table drain in Road Reserve)
- BUILDING ENVELOPES
- D DRAINAGE / POS
- 6m FIRE SERVICE ACCESS ROUTE
- 4m GATES
- DENOTES TREES TO BE REMOVED
- INDICATIVE LOCATION OF FIRE HYDRANT

N

0 50m

SCALE 1:2000 @ A3

NOTE:
Areas and dimensions subject to survey.

Plan 1

GRAY & LEWIS
LAND USE PLANNERS

Suite 5, 2 Hardy Street
South Perth, WA 6151
T (08) 9474 1722
F (08) 9474 1172
perth@graylewis.com.au

JOB REFERENCE: 100689 DATE: 30th NOVEMBER 2017

PART 2 – EXPLANATORY REPORT

1. PLANNING BACKGROUND

1.1 Introduction and Purpose

This Structure Plan has been prepared on behalf of Gary and Jacqueline Squire who are the registered owners of Lot 791 Walker Road, Serpentine.

The purpose of this Structure Plan is to provide refined planning for future subdivision of Lot 791 Walker Road, Serpentine to comply with Clause 5.12.8 of the Shire of Serpentine Jarrahdale Town Planning Scheme No 2, and Part 4 of the *Planning and Development (Local Planning Schemes) Regulations 2015*.

The lots proximity to the existing townsite and surrounding Rural Living subdivisions make it ideal to cater for low density lifestyle lots as an extension of the existing subdivision pattern established to the east.

The lot was identified as 'Rural Living' under the Shire of Serpentine Jarrahdale Rural Land Strategy, and was subsequently re-zoned from 'Rural' to 'Rural Living A' under Amendment 186 to the Shire of Serpentine Jarrahdale Town Planning Scheme No 2.

Amendment 186 was approved by the Minister for Planning on the 3 December 2014, and gazetted on the 9 January 2015.

This report examines the surrounding zoning, surrounding subdivision pattern, site characteristics, and provides justification for the Structure Plan design.

The Structure Plan has been developed having regard for the physical features of the land, surrounding road network, existing development and recommendations of the Land Capability Report. There has also been discussion with the Shire of Serpentine Jarrahdale in regards to lot sizes.

1.2 Land Description

1.2.1 Location

Serpentine townsite is located approximately 55 kilometres south-south east of Perth, and 7 kilometres south of Mundijong.

Lot 791 Walker Road is located approximately two kilometres south-west from the centre of the Serpentine townsite.

The lot therefore has excellent access to local services, shops and the nearby Serpentine primary school, golf course and sporting grounds.

Walker Road extends between Karnup Road to the north and Wattle Road to the south. A Location plan is included as Figure 1.

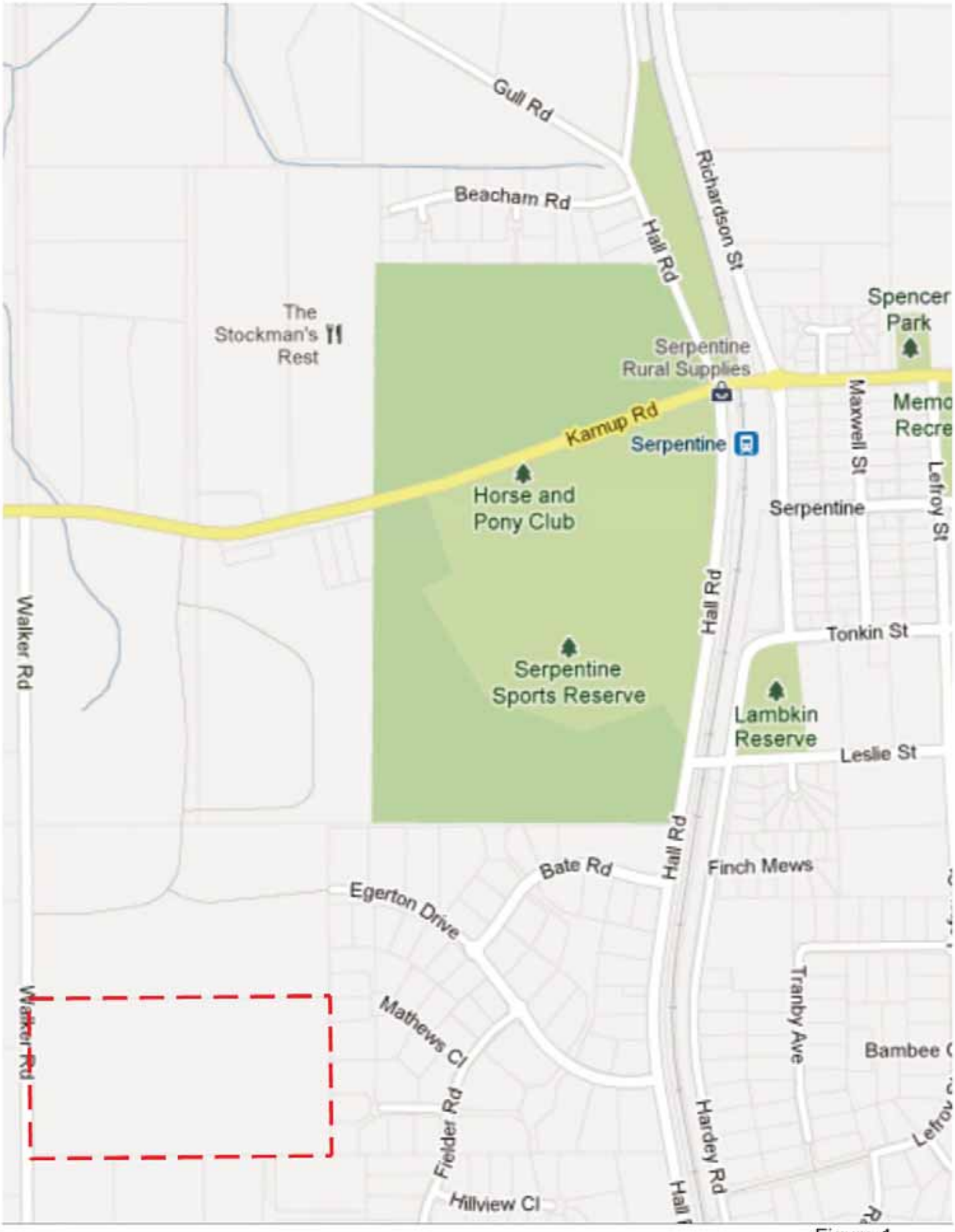


Figure 1

LOCATION PLAN

LOT 791 (No. 84) WALKER ROAD
SERPENTINE

LEGEND
SUBJECT LAND

N
0 250m
SCALE 1:10 000 @ A4

GRAY & LEWIS
LAND USE PLANNERS
Suite 5, 2 Hardy Street
South Perth, WA 6151
T (08) 9474 1722
F (08) 9474 1172
perth@graylewis.com.au

JOB REFERENCE: 100689 DATE: 23rd MAY 2013

1.2.2 Area and landuse

The subject land has an area of 18.507 hectares, and is currently used for Rural Residential / lifestyle living and contains two dwellings. One dwelling is located in the north western portion of the lot and the second dwelling is setback further from Walker Road and located in the central portion of the lot.

The land has historically been used for some ancillary hobby farm uses such as horse agistment and some cattle grazing. It is too small to be viable for agricultural use.

The majority of the land has been cleared and there are scattered trees dispersed throughout the south west portion of the lot.

View to north east

1.2.3 Legal Description and Ownership

The subject land is described as Lot 791 on Deposited Plan 202447 on Certificate of Title Volume 1529 and Folio 239 - APPENDIX 1.

The registered proprietors are Gary Everson Squire and Jacqueline Ruth Squire.

1.3 Planning Framework

1.3.1 Zoning and Reservations

Lot 791 is zoned 'Rural' under the Metropolitan Region Scheme - refer Figure 2.

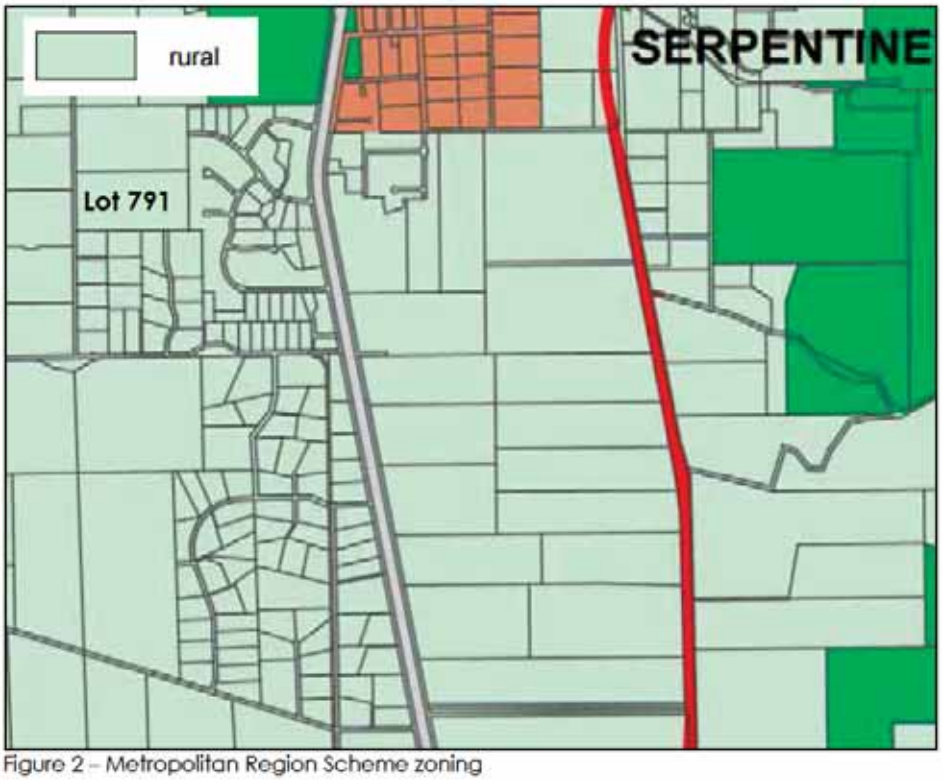


Figure 2 – Metropolitan Region Scheme zoning

Under the Shire of Serpentine Jarrahdale Town Planning Scheme No 2, the lot is zoned 'Rural Living A' - refer Figure 3.

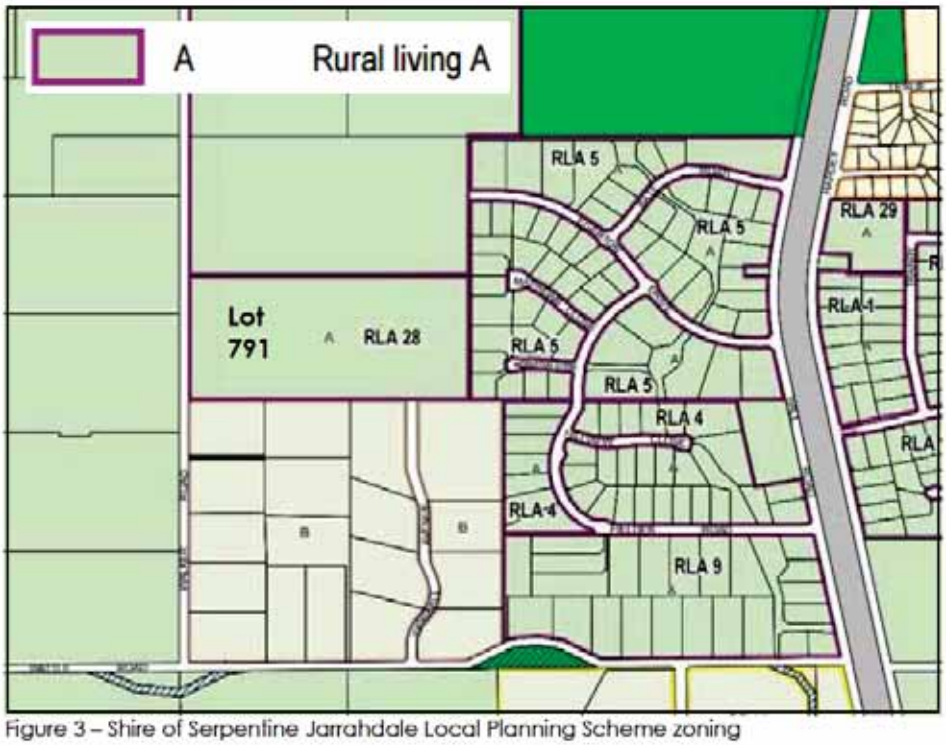


Figure 3 – Shire of Serpentine Jarrahdale Local Planning Scheme zoning

1.3.2 Regional and Sub Regional structure plan

There are no specific regional and sub-regional structure plans applicable to the locality, however there is a regional planning framework relevant to the local government area.

Following on from Directions 2031, the Western Australian Planning Commission has developed the Draft Perth and Peel@3.5 million documents to examine population growth, infill density targets and utilisation of existing infrastructure.

The Draft Plan is supported by four frameworks including the Outer Metropolitan Perth and Peel Sub Regional framework covering the Shire of Serpentine – Jarrahdale local authority area - refer Figure 4.

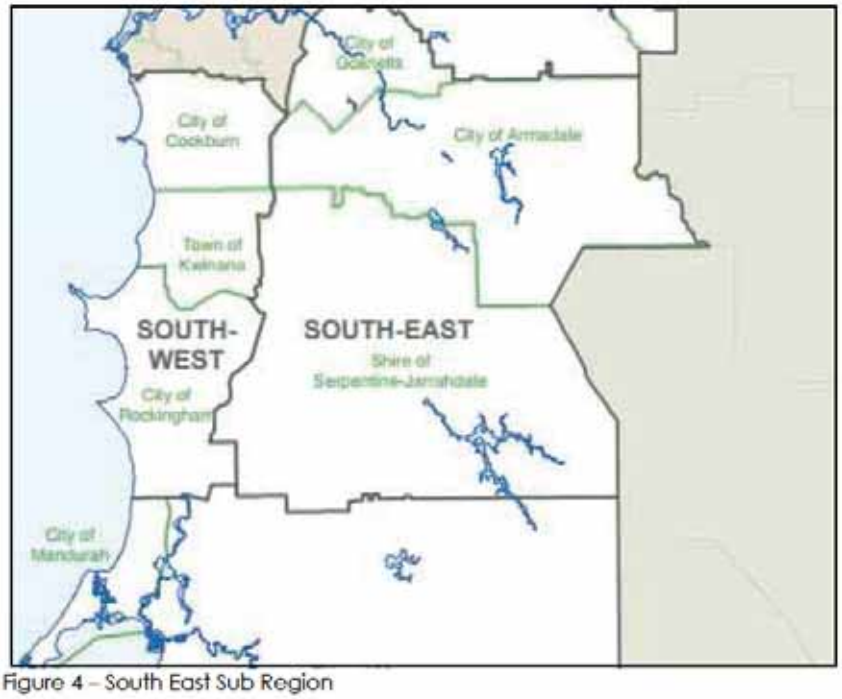


Figure 4 – South East Sub Region

The Shire of Serpentine Jarrahdale is part of the south-east sub region. The sub regional plan recognises that the Shire is largely rural with mainly low-density residential urban development spread throughout the area.

The estimated dwelling yield for Serpentine is 800 under the 'business as usual' and City scenario.

1.3.3 Planning Strategies

The Shire of Serpentine Jarrahdale Rural Land Strategy has been the basis of rural land use planning and environmental management in the Shire of Serpentine-Jarrahdale since 1994.

There have been two reviews since the adoption of the Strategy by the Commission in 1996 and 2003 and a further review is currently underway.

In the 1996 Rural Strategy Review Council confirmed its commitment to reverse the *'trend towards a proliferation of 2 hectare allotments'*.

The 2003 review recognised a need to distinguish those parts of the Shire dominated by horse related activities from conventional rural residential subdivisions within the Rural Living A and B zones.

Under the 1994 Strategy, Lot 791 is identified within the Rural Living A and B Policy Area, indicating that lot sizes may range from 0.4 ha to 4 ha. This recognises mixed land capability and the desire for smaller lots to be developed close to Serpentine where the land is capable.

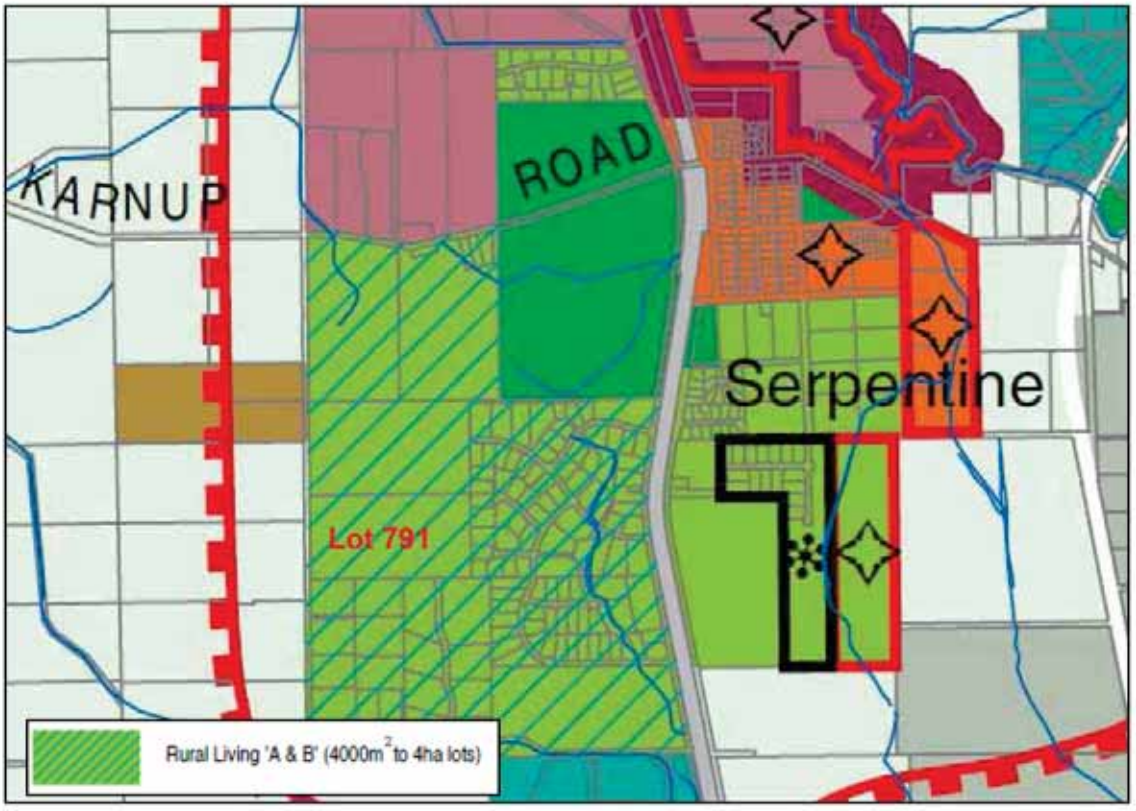


Figure 5 – Extract existing Local Rural Strategy (March 2002)

The objective of the Rural Living Policy Area is to provide opportunities for a 'rural living' lifestyle, with a greater sense of space and privacy. The minimum lot size for the Rural Living A Policy Area is 0.4 ha.

An analysis of lot sizes which forms part of the current Rural Strategy Review demonstrates that the predominant lot sizes west of Lot 791 are in the 4000m² to 1 hectare range.

The lot size pattern in this area has already been well established.

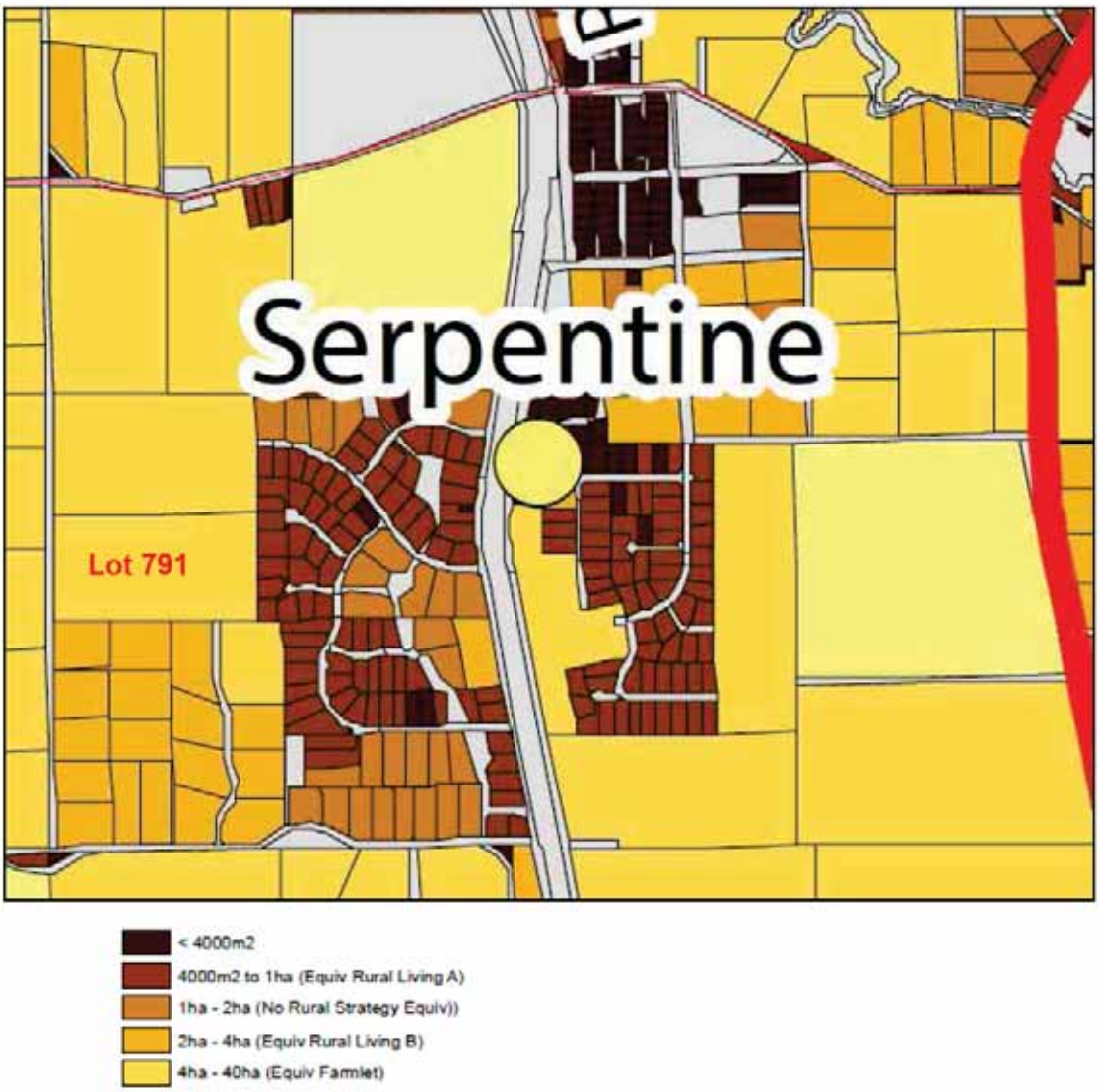


Figure 6 – Extract reviewed 2012 Local Rural Strategy

This Structure Plan is consistent with the 1994 and 2003 Rural Strategy Review.

1.3.4 Planning Policies

There are no specific Local Planning Policies relating to Structure Plans. It is worth noting the following Local Planning Policies:

- Local Planning Policy No. 33 – Construction of Dams: The Shire does not generally support dams on Rural living lots that have an area less than 2 hectares.
- Local Planning Policy No. 38 – Road Naming: Formalises a standard process for road naming, in recognition that the naming of roads is a key component of the creation of new subdivisions.

1.3.5 Other approvals and decisions

Lot 791 has been re-zoned from 'Rural' to 'Rural Living A' under Amendment 186 to the Shire of Serpentine Jarrahdale Town Planning Scheme No 2. The amendment was approved by the Minister for Planning and gazetted on the 9 January 2015.

1.3.6 Pre-lodgement consultation

When considering final adoption of Scheme Amendment No. 186, the Shire of Serpentine Jarrahdale sought some variation in lot sizes to provide transition to adjacent Rural Living subdivisions.

Gray & Lewis undertook a site visit with Shire Officers in February 2015, and it was generally agreed that:

- The land along Walker Road has the highest and best land capability for 4000m² lots.
- Larger lots could be accommodated along the southern boundary where the Structure Plan ties into Windmill Avenue.
- The Shire seeks some variety in lot size provision.

2.0 SITE CONDITIONS AND CONSTRAINTS

Site conditions and constraints have been ascertained through a site specific Land Capability Assessment.

Land Capability is the recognition of the suitability of a site for a proposed landuse. An integral part of this process is the identification of issues and the way they can be managed to ensure that the proposed landuse is sustainable and does not lead to significant environmental impacts.

The detailed land capability report conducted by Landform Research includes comprehensive information on the physical environment, hydrology, flora/fauna, current and potential landuses, geotechnical factors and environmental factors – APPENDIX 2.

The land capability report concluded that the rezoning and subdivision of existing Lot 791 will not have any significant environmental impacts and will essentially be similar to landuses on adjoining properties.

The following is a summary of the main environmental characteristics.

2.1 Biodiversity and natural area assets

Biodiversity is defined as '*the variety of life forms, the different plants, animals and micro-organisms, the genes they contain, and the ecosystems they form. It is usually considered at three levels: genetic diversity; species diversity; and ecosystem diversity*'. (Commonwealth of Australia 1996).

The measurement of biodiversity is a difficult undertaking considering the complexity of natural systems. Its measure can best be expressed as the extent and condition of

ORTHOPHOTO

LOT 791 (No. 84) WALKER ROAD
SERPENTINE

NOTE:
Areas and dimensions subject to survey.

LEGEND
SUBJECT LAND

N
0 100m
SCALE 1:4000 @ A3

Figure 7

GRAY & LEWIS
LAND USE PLANNERS

Suite 5, 2 Hardy Street
South Perth, WA 6151
T (08) 9474 1722
F (08) 9474 1172
perth@graylewis.com.au

JOB REFERENCE: 100689 DATE: 4th JULY 2013

the natural environment remaining in a given area. Biodiversity value decreases where the understorey of bushland has been cleared or degraded.

Lot 791 has been significantly cleared, with the only remnant vegetation being Jarrah trees on the deeper western sand ridge, with scattered Marri and occasional Sheok, a few Woody Pear and scattered Grass Trees.

No understory or groundcover species were recorded (as part of the land capability assessment), with the groundcover being pasture. Pale Rush occurs in the lower elevation of the south western corner.

The vegetation in the central east is listed as "Geomorphic Wetland" as shown on Shire mapping, although it is more correctly described as a low lying floodway.

The vegetation in the east is Completely Degraded as it is parkland pasture. In some isolated pockets in the central east, the proximity of the trees raises the condition to Degraded (Bush Forever Scale 2000).

Several Jarrah and Marri trees are large and mature on the higher elevation sand ridge in the central west, and will be retained where possible, subject to safety issues from falling branches and the need to provide building envelopes with sufficient clearance to address bushfire management issues.

The Shire's Scheme requires a Landscape and Vegetation Management Plan at subdivision stage. It is clear that landscaping can be managed with 4000m² lots as demonstrated by vegetation established in adjacent 'Serpentine Greens'.

2.2 Landform and Soils

The site is gently sloping, falling from the sand ridge in the west to a swale in the central east before rising again at the eastern boundary – refer to Figure 7.

The soils consist of alluvial loams and clays which are exposed on the surface in the areas of lower elevation, in depressions and weak flow line. The alluvial soils are nominated as the Pinjarra System.

Generally, the soils are regarded as duplex type soils with a sheet of sand over a loam clay base. The variation being the thickness of the overlying sand sheet. Overlying these alluvial soils is grey brown sand over brown and yellow earthy sand of the Bassendean Sands.

The soils on site are much better than those within the adjoining subdivisions to the east. The sand ridge in the west is much higher, and the lower elevation swales are more elevated and sandy than those on nearby land that has already been developed.

The covering sand sheet has a minimum of 1,000mm thickness across almost the whole site over sandy clay. One small area has a thickness of 850mm.

Across much of the site, the thickness of the surface sand increased to over 3 metres, which makes the soils highly capable and much better than adjacent land.

2.3 Ground water and Surface water

Landform Research undertook late winter testing on the lot in 2012. Water was only intersected in two soil test holes; one at 1200 mm and the other at 850 mm.

The wettest soil test hole was in the central north, and was due to there being locally perched water on the sand clay subsoil which was at 910 mm depth at that site.

The soils and land capability are similar or better than those on the already subdivided lots on which dwellings have been constructed.

The depths to the highest known water tables, prior to any subdivision or drainage can be different as shown by the well drained nature of the adjoining subdivisions that have been constructed on similar soils but improved by drainage and fill.

With the constructed road drainage the water table elevations will reduce to be lower and the separations greater.

2.4 Bushfire Management

The Structure Plan complies with WAPC Planning for Bushfire Protection Guidelines as demonstrated by a Bushfire Management Plan.

A Bushfire Management Plan was generally supported by the Department of Fire and Emergency Services (DFES) on the 16 March 2017 - APPENDIX 3. In order to address subsequent comments by the Department of Planning, Heritage and Lands the Bushfire Management Plan has been revised – APPENDIX 4.

The proposed subdivision shows the provision of two different vehicular access routes, both of which connect to the public road network; 20m wide road reserve widths; and a cul-de-sac less than the 200 metre maximum length.

Potential bushfire impact analysis was undertaken in accordance with Australian Standard 3959 Methodology 1 to determine the potential worst case scenario radiant heat impact on the boundaries for proposed lots.

In accordance with State Planning Policy 3.7, a Bushfire Attack Level (BAL) Contour Map has been prepared as part of the Bushfire Management Plan to illustrate the potential radiant heat impacts and associated BAL ratings for the Structure Plan after subdivision is completed.

The BAL contour map identifies that building envelopes within proposed Lots 1, 11, 12, 17 to 19, 26 and 32 to 34 are subject to a radiant heat impact not exceeding BAL-29 equivalent. The remaining 24 lots have proposed building envelopes located within a BAL-LOW area - Figure 8.

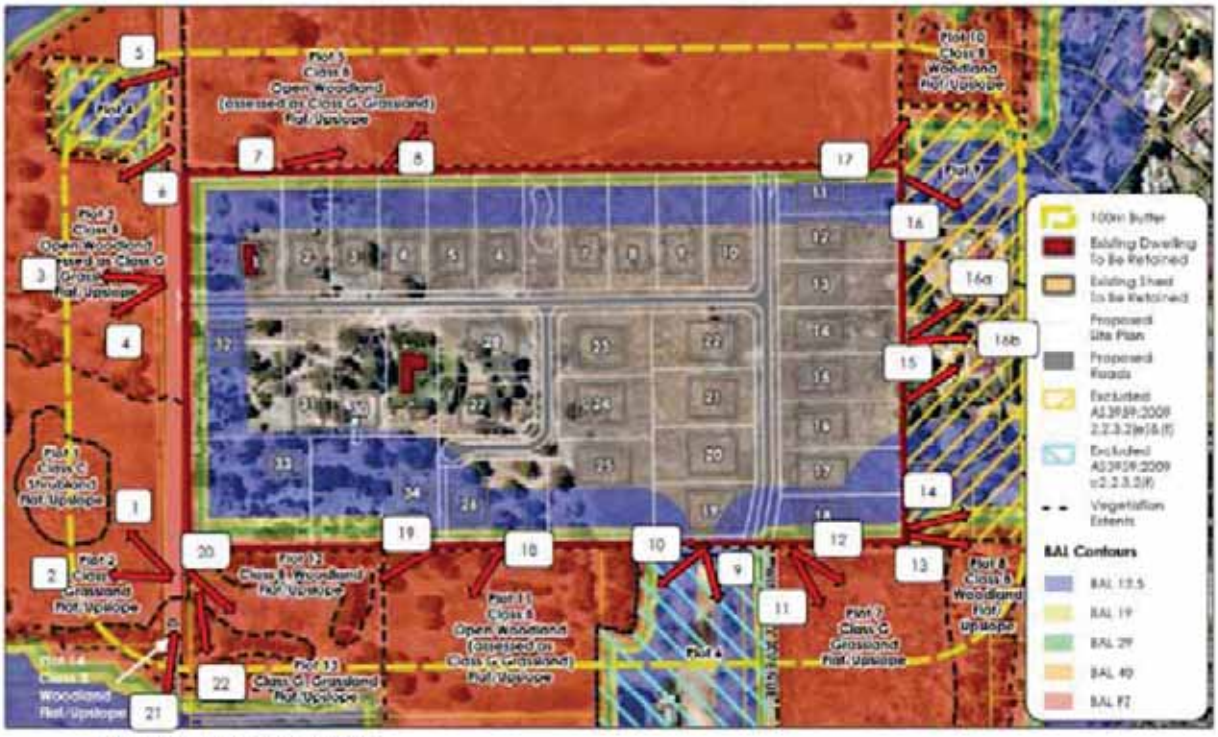


Figure 8 – BAL Contour Map

2.5 Heritage

No known European or Aboriginal heritage exists within the subject area.

2.6 Context and other landuse constraints and opportunities

A Context and Site analysis can be effectively illustrated on one plan as a number of elements associated with the proposed Structure Plan design have been predetermined (such as the need to utilise the Windmill Avenue road connection from the south). This approach is consistent with Appendix 1 of Liveable Neighbourhoods which states *'Context and site mapping may be undertaken together or separately'*.

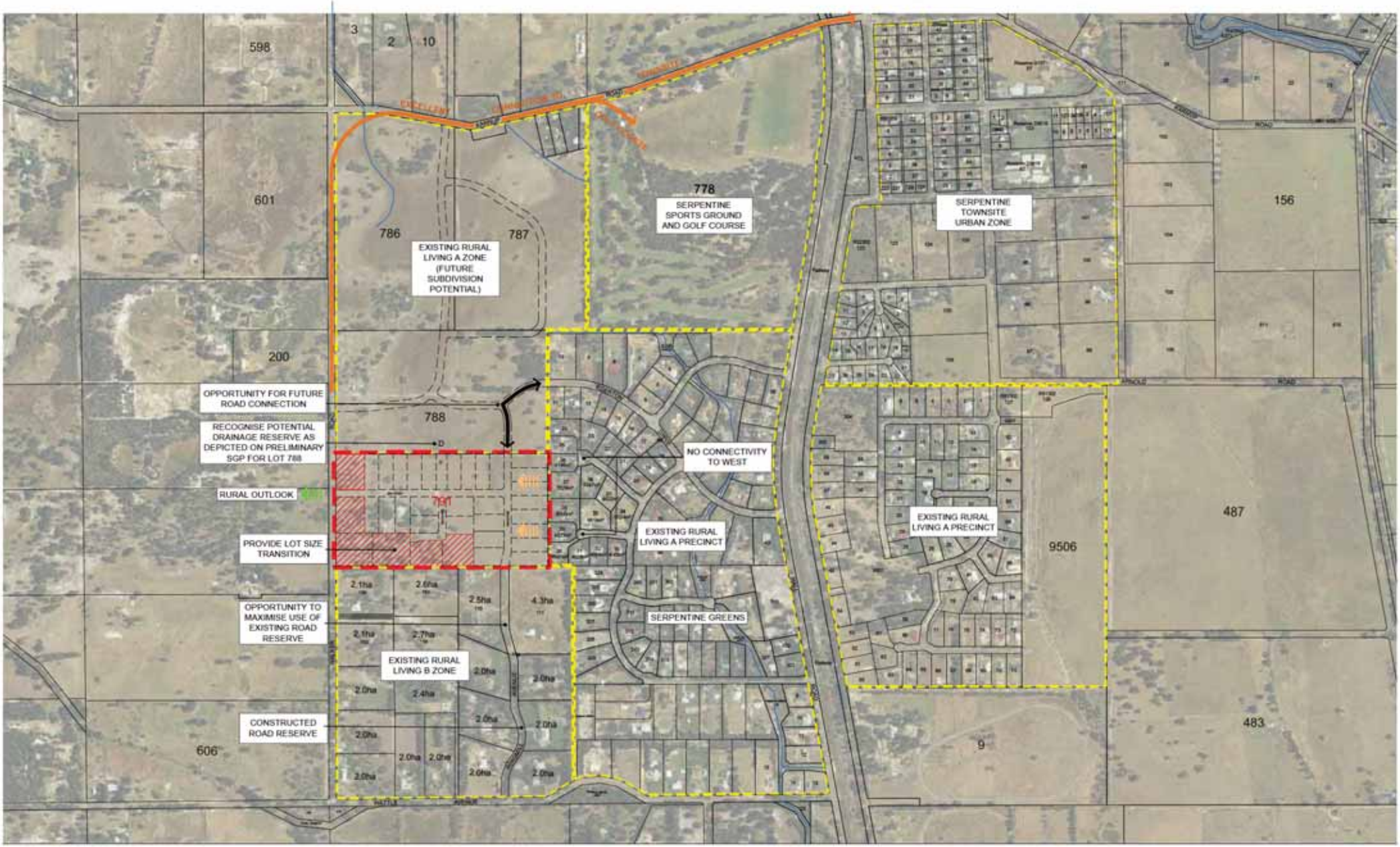
The purpose of context analysis is to connect and integrate the Structure Plan for Lot 791 with surrounding developed areas, and to facilitate appropriate road connections to adjoining un-subdivided land.

A Context and Site analysis plan has been prepared to identify surrounding land uses to recognise existing and potential road links, and to provide road connections to the north - Figure 9.

2.6.1 Surrounding Zoning and Landuses

The land to the immediate north of Lot 791 is zoned 'Rural Living A' under the Shire of Serpentine-Jarrahdale Town Planning Scheme No. 2 ('the Scheme).

The 'Rural Living A' area to the north has future subdivision potential, although it is understood the current owners have no immediate intention to subdivide.



CONTEXT AND SITE ANALYSIS - STRUCTURE PLAN

LOT 791 (No. 84) WALKER ROAD
SERPENTINE

LEGEND
SUBJECT LAND

SCALE 1:10 000 @ A3

Figure 9

GRAY & LEWIS
LAND USE PLANNERS

Suite 5, 2 Hardy Street
South Perth, WA 6151
T (08) 9474 1722
F (08) 9474 1172
perth@graylewis.com.au

JOB REFERENCE: 100689 DATE: 23rd OCTOBER 2017 2017

Land to the immediate east is zoned 'Rural Living A', has been subdivided and is known as 'Serpentine Green'.

The majority of lots within Serpentine Green are within the 4000m² – 5000m² range, with some larger lots strategically located at the end of cul-de-sacs or adjacent to creek lines.

The lots abutting the eastern boundary of Lot 174 are within the 4000m² range with two larger lots at the end of existing cul-de-sacs (being 6000m² and 7021m²).

Existing subdivision to the east – Serpentine Green

There has been extensive tree planting and land rehabilitation within the smaller lots in Serpentine Green and it is clear that valuable vegetation corridors can still be established within the 4000m² lot sizes.

The smaller lots are more manageable, easier to maintain, require less watering, and maximise use of available infrastructure and services.

Existing house on approximately 4000m2 lot – Serpentine Green

Land to the south is zoned 'Rural Living B' under the Scheme and the majority has been subdivided into 2 hectare lots.

One 2.5 hectare lot and one 4.3 hectare lot is located at the end of the constructed portion of Windmill Avenue.

Larger one hectare lot in Serpentine Green estate

Larger 4.3 hectare lot in Windmill Avenue

3.0 LANDUSE AND SUBDIVISION REQUIREMENTS

3.1 Landuse and Lot Sizes

The Structure Plan will facilitate creation of 34 lots ranging between 4000m² and 9315m² for rural living / lifestyle lots in accordance with the zoning of the land.

Whilst Gray & Lewis is of the view that continuing the 4000m² lot size pattern to Lot 791 is compatible with existing development in the immediate area, larger lots have been incorporated along the western and southern boundary to act as a transition to the adjacent 'Rural Living B' zone and to allow for retention of mature trees.

Incorporation of larger transitional lots and increased opportunity for tree retention on larger lots has been supported by the Western Australian Planning Commission through the Structure Plan process.

3.2 Public Open Space

The lot sizes are sufficiently large that they are commensurate of a Special Residential subdivision, for which public open space is not required in accordance with WAPC Development Control Policy 2.5. Nevertheless the Council and Commission have determined that a 10% contribution towards public open space should be provided, and it is therefore proposed that this be provided in part by a cash in lieu payment.

The Policy Objectives include provision for lots between 2,000 square metres and one hectare in suitable locations. The proposed lot sizes fit comfortably within this range.

3.3 Residential

The Structure Plan will facilitate increased residential housing choice creating a larger lifestyle lot product commensurate and compatible with surrounding subdivision.

3.3.1 Building Envelopes

Building envelopes have been located having regard for existing vegetation (to minimise tree removal); soil types and depths of sand to provide optimal sites for on site effluent disposal; and the Bushfire Management Plan.

Where possible the envelopes have been positioned to maximise separation distances to vegetation to achieve the lowest BAL rating. All building envelopes achieve compliance with acceptable BAL ratings. The majority of future dwellings will be in BAL-LOW and the remainder are capable of achieving BAL 12.5.

3.4 Movement Networks

There is an existing road connection from the south being Windmill Avenue. The constructed road pavement ceases approximately 1000 metres to the south and will need to be extended to the southern boundary of Lot 791.

The two east west cul-de-sacs in adjacent 'Serpentine Greens', being Middleton and Mathews Close, means road linkages can only occur to the north, west and south.

There is opportunity to provide a road connection to the north so that when Lot 788 is developed in the future it maximises road connectivity with the ability to ultimately connect to existing Egerton Drive.

All roads are proposed with 20 metre widths as shown on the Structure Plan. At subdivision stage, detailed engineering drawings will be required and all roads will be constructed to meet the specifications of the Shire of Serpentine Jarrahdale.

3.5 Water Management

A Local Water Management Strategy has also been prepared for Lot 791 by Landform Research - APPENDIX 5.

The Local Water Management Strategy includes the following recommendations that relate to subdivision design;

- Swale drains are recommended to be installed along road reserves that connect to easements on private land to enable maintenance as required in the future.

- The surface water input from the adjoining land to the south needs to be taken into account during the design of the stormwater network.

The proposed 20m road reserve width is sufficient to accommodate a 6m wide road pavement (unkerbed) with open table drains on each side. All roads will be designed and drained to the satisfaction of the Shire of Serpentine Jarrahdale.

The Local Water Management Strategy is supported by a detailed engineering design by Groundwork Consulting Engineers - Figure 10.

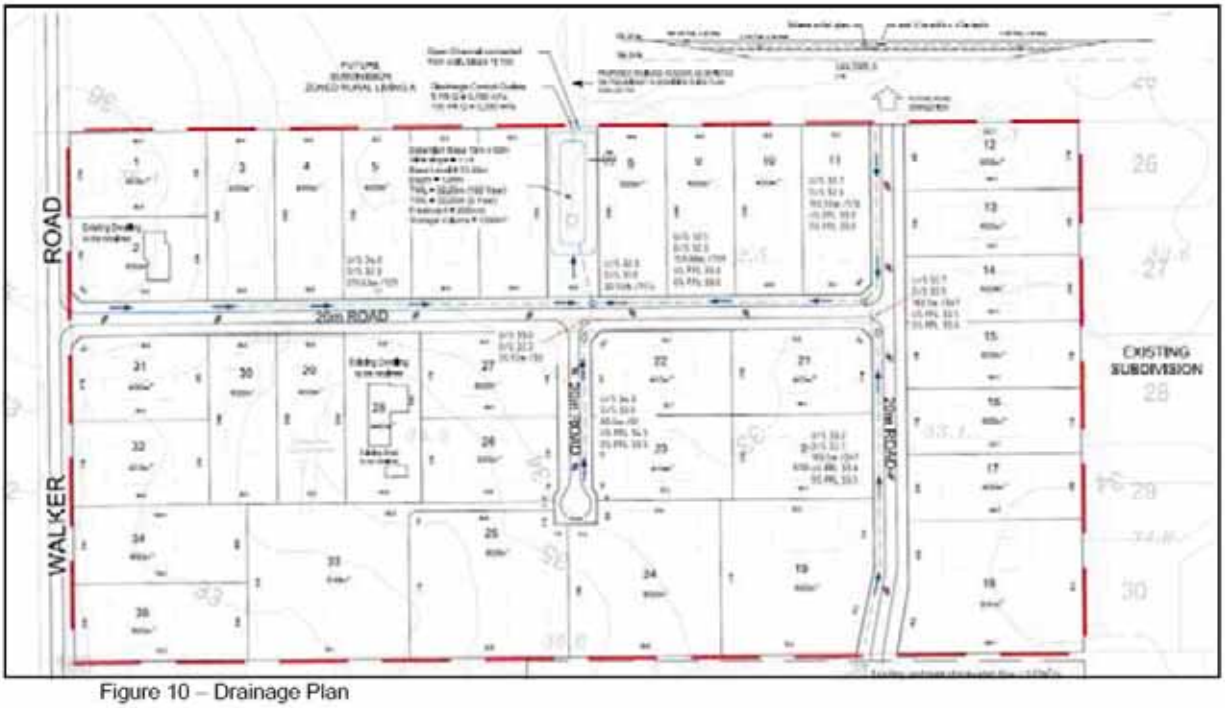


Figure 10 – Drainage Plan

A basin with a storage capacity of approximately 1350m² is proposed as part of the drainage strategy, which can be revegetated and landscaped to the requirements of the Shire.

Open table drains in the road reserves can direct water flow to the proposed drainage reserve, which will then ultimately drain to the north.

The Local Water Management Strategy has been supported by the Department of Water - APPENDIX 6.

3.6 Infrastructure co-ordination, servicing and staging

3.6.1 Effluent Disposal

The existing dwellings on site are serviced by conventional septic systems with full inverted leach drains that show no sign of leakage, or seepage.

The Land Capability report concludes that the proposed lots have high capability for wastewater disposal, and conventional septic systems are acceptable on the elevated Spearwood type yellow sands which occur on the western third of the property illustrating the high capability of the land.

All effluent disposal systems will require separate approval by the Shire of Serpentine Jarrahdale at development stage.

3.6.2 Water

A potable water supply will be required to service each new lot and be taken over and operated by the Water Corporation. All water reticulation is at the expense of the developer.

3.6.3 Power

There is existing power infrastructure in the immediate vicinity therefore it is reasonable to assume these services can be extended to service the proposed subdivision.

Any upgrades required to the network for the proposed subdivision can be ascertained during the formal design process.

3.6.4 Telecommunications

It is expected that logical extensions and upgrades from nearby the site will service the subdivision. There are existing telecommunications services available in Walker Road.

4. TECHNICAL STUDIES APPENDIX INDEX

APPENDIX NO	DOCUMENT TITLE	NATURE OF DOCUMENT	ASSESSING AGENCY	APPROVAL STATUS
1.	Certificate of Title	Supporting	Not Applicable	N/A
2.	Land Capability Report	Supporting	Shire of Serpentine Jarrahdale/WAPC	Assessed as part of the Structure Plan
3.	Letter from Department of Fire and Emergency Services	Supporting	Not Applicable	N/A
4.	Bushfire Management Plan	Supporting	Shire of Serpentine Jarrahdale/Department of Fire and Emergency Services/ Western Australian Planning Commission	Assessed as part of the Structure Plan. Supported by Department of Fire and Emergency Services.
5.	Local Water Management Strategy	Supporting	Shire of Serpentine Jarrahdale/Department of Water	Assessed as part of the Structure Plan. Supported by Department of Water.
6.	Letter from Department of Water	Supporting	Not Applicable	N/A

5. CONCLUSION

The Structure Plan will facilitate future subdivision of Lot 791 Walker Road, Serpentine consistent with the intention of the 'Rural Living' zone.

The Structure Plan will ensure subdivision design is compatible with the existing established subdivision pattern to the immediate east, Rural Living A zone to the north and Rural Living B zone to the south.

It will provide for Rural Living with maintainable lot sizes in a rural setting. Due to the close proximity to the Serpentine townsite, Lot 791 has excellent access to a wide range of existing services and infrastructure.

Future subdivision will result in an improved and more efficient use of the land with clear benefits including a logical 'rounding off' of the 'Rural Living' zone boundary.

The Land Capability Assessment justifies the suitability and supports the subdivision of the land.

There is a rapidly growing demand for smaller lot sizes in proximity to the Serpentine townsite. Purchasers are moving out of the city and looking for larger lots with some space but still seek lot sizes that are more readily maintainable.

Lot 791 provides a location where residents can still be close to a townsite with associated community facilities. Future subdivision will provide Rural Living lots with good aspect and outlook towards the hills, on higher ground without any fill requirement and some will contain scattered mature trees.

APPENDIX 1

Certificate of Title

WESTERN AUSTRALIA

REGISTER NUMBER	
791/DP202447	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
2	20/6/2005

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

VOLUME 1529 FOLIO 239

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

REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 791 ON DEPOSITED PLAN 202447

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

GARY EVERSON SQUIRE
JACQUELINE RUTH SQUIRE
BOTH OF 32 WATTLE ROAD, SERPENTINE
AS JOINT TENANTS

(T J310277) REGISTERED 3 JUNE 2005

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

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

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

STATEMENTS:

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

SKETCH OF LAND:	1529-239 (791/DP202447).
PREVIOUS TITLE:	1448-554.
PROPERTY STREET ADDRESS:	84 WALKER RD, SERPENTINE.
LOCAL GOVERNMENT AREA:	SHIRE OF SERPENTINE-JARRAHDALE.

APPENDIX 2

Land Capability Report
Landform Research

LAND CAPABILITY - GEOTECHNICAL ASSESSMENT

LOT 791, WALKER ROAD, SERPENTINE

SHIRE OF SERPENTINE - JARRAHDALE

OCTOBER 2015

LAND CAPABILITY - GEOTECHNICAL ASSESSMENT

LOT 791, WALKER ROAD, SERPENTINE

SHIRE OF SERPENTINE - JARRAHDALE

Landform Research
Land Systems · Quarries · Environment

SUMMARY OF LAND CAPABILITY AND GEOTECHNICS

Lot 791 Walker Road, Serpentine was assessed to determine the potential for subdivision to rural living lots, from a geotechnical consideration down to 4 000 m^2.

The site was assessed by hand auger on 21 September 2012 by Lindsay Stephens of Landform Research. At the time of inspection the site was relatively wet being spring, even though there had been less than average winter rainfall.

The subject land, like all the surrounding area, lies in part of the Peel Harvey Catchment, covered by Environmental Protection Policy (Peel Inlet - Harvey Estuary). It also falls under Statement of Planning Policy 2.1, The Peel Harvey Coastal Plain Catchment.

Current Land Use

The land has two dwellings on it, one on the south and one in the north west.

In recent times the land has predominantly been used for horse agistment and some cattle grazing.

Proposed Land Use

Lot 791 is proposed for subdivision to rural living lots down to 4 000 m^2 with a range up to 9 144 m^2.

Capability

The soils on site are much better than those within the adjoining subdivisions to the east. The sand ridge in the west is much higher and the lower elevation swales more elevated and sandy than those on nearby land that has already been developed.

The western half is defined as a ridge with deep sand soils that are highly capable for dwellings, waste water disposal and water management,

The eastern half has a covering sand sheet has a minimum of 1000 mm thickness across almost the whole site over sandy clay. One small area has a thickness of 850 mm. Across much of the site the thickness of the surface sand increases to over 3 metres. Those attributes make the soils highly capable and much better than adjoining areas. They are suitable for road and dwelling construction provided normal development measures and methods are undertaken and can provide high capability for waste water disposal through the use of nutrient adsorbing or ATU waste water disposal systems.

The water table was only intersected in 2 of the 20 soil test holes at depths of 850 mm and 1200 mm. There may be some excess sand from the sand ridge that can be used to provide some fill for the lower elevations.

It is important to note that the soil assessments are made on the natural existing land as it was at the time of the site inspections. Like all local developments the soils will be improved by drainage and the addition of fill, which will upgrade the land capability to a much higher more capable surface. The drainage and fill requirements will be made during the detailed design for the subdivision.

There are no significant limitations that cannot be mitigated during the design and construction processes.

The minimum lot size of 0.4 hectares is significantly greater than the 0.2 hectare minimum recommendation contained within the Government Sewerage Policy.

Foundation stability is rated as AS2870 Site Class A on the deep sand across most of the western half of the site with Site Class A – S and possibly M in areas with less surface sand cover on the ridge to the east dropping to S - M off the ridges and M over the lower central swales. There is potential (but unlikely) for Site Class H to occur in minor wet and dry areas.

Detailed individual testing of building envelopes will be required to determine the site specific soil conditions at the time of construction. The depth of fill sand will also determine the Site Class. For example adding 1 metre of fill is likely to reduce the Site Class by one category.

Water Management Strategy

In 2015 additional action was undertaken with respect to water planning. Groundwork Consulting Engineers undertook design work with respect to the water management, flows into and out of the site and the potential for flood flows.

The updated information determined that an up date to the water planning documentation was required and that was removed from the land capability mapping to a separate document.

The summary from the updated Local Water Management Strategy is set out below.

Analysis of Stormwater and Recommended Management	
Individual lots	• The soils on site are coloured sands over loam/clay and deep yellow sands. • The site investigations and engineering design calculations made by Groundwork Consulting Engineers show that the soils 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.
Road drainage	• The site investigations and engineering design calculations made by Groundwork Consulting Engineers demonstrate that the swale drains will be able to manage surface water. • For events in excess of the 1 in 1 year 1 hour, the excess water is directed to a detention basin in the central north. • Based on the calculations for water management, there are no limitations to development, or any limitations identified can be controlled by good water management. • The swale drains are designed to encourage infiltration and cutoff functions. See DOW (Water and Rivers Commission), 1998, 3.17 (BMP14). • Swale drains are located in the road reserves for maintenance.
Water Management	• There are no limitations imposed by the site on water management that would result from subdivision or development. • The flow into the site from upstream is determined by Groundwork Consulting Engineers to be 0.07 m^3/s. This flow has been incorporated into the water management design, Figure 6. • The detention basins and swales will be able to deal with storm and flood events without compromising the potential for flooding the developable land. • The swale drains associated with the road network will reduce the potential for water to lay on the surface in winter, drying the soils.
Detention basin	• The detention basin is designed to be installed above the highest known groundwater and will be able to deal with storm

	and flood events without compromising the potential for flooding the developable land. • The detention basin is recommended to retain the 1 in 1 year 1 hour events (*A Manual for Managing Urban Stormwater Quality in Western Australia* infiltration basins BMP 110 and Wet Basins BMP 18). • The detention basin is provided with its own lot for greater ability to manage. • The detention basin is to be revegetated with local native trees and shrubs combined with fringing reeds and rushes.
Recommendations	• The installation of rainwater tanks with a minimum of 5000 litres can be considered but will not impact on water management. • Greywater reuse is encouraged to minimise scheme water use. • Stormwater volumes will need to be revisited during the engineering design stage when the final subdivision design has been determined.

Conclusions

The site is also highly suitable for the construction of roads and dwellings.

The thickness of the sand sheet on the lower ground to the east is a significant difference to other developed local areas which have sandy clay close to the surface. The additional sand provides for better site Foundation Stability, drainage and depth to perched winter water tables

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

A Water Management Strategy is attached and demonstrates with calculations that the water inputs and outputs of the subdivision are readily managed with an outlet detention basin and swale drains.

CONTENTS

See the separate document that should be read in conjunction with the land capability documentation.

The Local Water Management Strategy updated in October 2015 contains the engineering design and calculations for on site stormwater management.

ATTACHMENTS

REGOLITH AND HYDROLOGICAL LOGS

PRELIMINARY ACID SULFATE ASSESSMENT

FIGURES

1.0 INTRODUCTION

Site Assessment - Methodology

Lot 791 Walker Road was assessed to determine the potential for subdivision to rural living lots, from a geotechnical consideration down to 4 000 m^2.

The site was assessed by hand auger on 21 September 2012 by Lindsay Stephens of Landform Research. At the time of inspection the site was relatively wet being spring, even though there had been less than average winter rainfall. The soil test holes the soil properties and pasture species provided good indications of the soil structure and hydrogeology.

The broader scale Geotechnical Assessment was conducted to identify issues listed under *Statement of 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*.

The best time of year to complete soil testing is in late winter and this was done even allowing for below average winter rainfall.

During the study 20 soil test holes were sunk across the whole site, covering a wider area.

The locations of these soil test holes are shown in Figure 1. The soil test holes, soil characteristics, pasture species and other features have been used to provide a good indication of the highest known perched water table. See Appendix 2 for the Soil Test Hole Logs.

All mapping was thorough; the soil data from that report was compared to aerial photography and local land capability to assess the suitability of the subject land for dwellings on rural living lots. Any vegetation was also recorded at the time of the site inspections. The salinity of water bodies was noted and water bodies mapped.

A study of the geology and regolith can provide valuable background material on the nature of the site and the way that various land uses may impact on the developments.

Groundwork Consulting Engineers assessed the water balances and loading in 2015 and made calculations from which they developed designs for water management. The designs and calculations are provided in the Local Water Management Strategy that should be read in conjunction with this documentation.

Site Description

The sites is gently sloping, dropping from the sand ridge in the west to a swale in the central east before rising again at the eastern boundary.

It lies in Serpentine, immediately west of similar land that has been subdivided centered on Egerton Drive. The townsite of Serpentine lies 1.3 km to the north east. See Figure 1.

The subject land, like all the surrounding area, lies in part of the Peel Harvey Catchment, covered by Environmental Protection Policy (Peel Inlet - Harvey Estuary). It also falls under Statement of Planning Policy 2.1, The Peel Harvey Coastal Plain Catchment.

Current Land Use

The land has two dwellings on it, one on the south and one in the north west.

In recent times the land has predominantly been used for horse agistment and some cattle grazing.

Proposed Developments

Lot 791 was assessed to determine the potential for subdivision to rural living lots, from a geotechnical consideration, down to 4 000 m^2.

2.0 WEATHER CONDITIONS

The climate of the area is classified as Mediterranean, with hot summers and cool winters.

Precipitation is near 950 mm of which over 80% falls in the winter months, April to October inclusive. Evaporation exceeds rainfall in the six summer months.

Temperatures range from average summer maxima of near 30 degrees C down to average winter minima of below 9 degrees C.

Prevailing winds are generally easterly in the morning and south westerly in the afternoon in summer months. Summer easterly morning breezes can be quite strong because of katabatic effects of the Darling Scarp. During winter winds are more variable due to the presence of winter lows and reduced diurnal heating.

Weather Conditions

The study was conducted on 21 September 2012 following a below average winter at a time of average spring rainfall.

3.0 REGOLITH AND SOIL ASSESSMENT

3.1 Geology and Geomorphology

The subject land lies on a portion of the Pinjarra Plain, which is an alluvial plain formed by the meandering of rivers and streams draining from the Darling Scarp.

It is undulating but drains from 35 - 36 metres AHD in the central north west down to 25 metres AHD in the central north. And 32 metres AHD in the south western corner.

In this area the there is no defined watercourses, although drains have been cut in the land to the north to drain surface water from low elevations to the north and ultimately west via drains to the Serpentine River.

The underlying geology are sediments of the Perth Basin at depth, overlain by alluvial sediments deposited by the older watercourses. The sediments are predominantly interbedded loams and clays with sandy lenses that vary both vertically and horizontally. These sediments are ascribed to the Guildford (Pinjarra Plain) and Bassendean Land Systems.

Superimposed across the alluvial plain are thin sheets of sand that have added to the topsoils and formed low sand ridges and drainage channel infill of aeolian silica sand and minor alluvial deposits.

Drill data from the Armadale Environmental Geology 1 : 50 000 Geological Map, Geological Survey of Western Australia, 1981 shows the site as being underlain by deeper sediments of the Perth Basin at a depth of > 5 metres.

3.2 Regolith and Soils

The soils consist of alluvial loams and clays as basal soil units. These are exposed on the surface in the areas of lower elevation, in depressions and weak flow lines. The alluvial soils are nominated as the Pinjarra System.

Generally the soils are regarded as duplex type soils with a sheet of sand over a loam clay base. The variation being the thickness of the overlying sand sheet.

Soils are developed on the alluvial clays and loams, such as Soil Type P1b. (Department of Agriculture and Food mapping 1983, *Land Resources in the Northern Section of the Peel – Harvey Catchment, Swan Coastal Plain, Western Australia*). It should be noted that the Department of Agriculture and Food mapping was broad scale and based on aerial photography with road observations and limited soil test holes.

Overlying these alluvial soils are grey brown sand over brown and yellow earthy sand of the Bassendean Sands. The sand is 1000 mm >3 000 mm thick. The Department of Agriculture and Food show this as B1.

The mapping, and that completed by Landform Research, relates to the pre-subdivision ground conditions.

See Figures 1 and 4. Figure 5 shows a cross section of the soils with the slope of the land shown. Drainage of the land is possible to prevent water building up in the surface sands during winter.

See the attached soil test logs and Figure 1.

TABLE 1 Soil Descriptions

KEY	DESCRIPTION		DEP. AGRIC/FOOD SOIL UNITS (Note that the units allocated to the soils do not match the DAF mapping)
RS	**Ridge Sand**	Elevated well drained sand ridge with over 3000 mm cream to yellow earthy sand becoming darker and more earthy with depth. Small amount of iron induration and gravel at depth.	B1
S/C	**Sand over Clay**	Lower sand plain that has between 500 mm and 1200 mm white, pale yellow and pale brown sand grading earthy sand over sandy clay. Can have an organo ferricrete layer and at the loam clay interface. Can be subject to winter wet soils in parts prior to site drainage.	P1b
HS/C	**Well Drained Sand over Clay**	Slightly higher elevations with between 500 - 1200 mm cream, brown and gravelly sand over loam clay. Well drained and not subject to winter wet conditions.	P1b

Table 2 Observed Agricultural 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.	Minor to significant in the deeper sands and soils with sandy topsoils. May occur when the topsoils are dry.	No issues for development
TRAFFIC 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.	Most soils on site have low potential for traffic compaction. The more brown sands have some potential for traffic compaction. Winter wet clays are less trafficable but are unlikely to be present.	No issues for development
DISPERSIBLE SOILS	Soils containing sodium in the clay content can disperse when wet, leading to soil erosion and subsoil tunnel formation.	No evidence of soil dispersion with the soils being deeper sands over the sandy clay.	Unlikely to occur. Sand fill and adequate foundations will be used to correct any shortcomings.
WIND EROSION	Wind erosion can impact on sands and loose soil when inadequate soil cover is retained. Duplex and sandy	The drier sandy soil horizons could be more susceptible but are yellow and earthy which	No issues for development apart from short term disturbance

	soils are at high risk. The worst times are prior to the winter rains.	provides protection.	during construction.
WATER EROSION	Water erosion can occur in susceptible soils which have inadequate soil cover, steeper slopes, higher sand content and dispersibility.	Slopes are gentle. No evidence of water courses from storm events on the subject land.	No issues for development
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 moderately acidic. Surface sands were measured at pH 5.5 - 6.	No issues for development
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 where ancient soils and laterite profiles are present.	There no evidence of salinity in winter wet areas in the central north, the most likely place for it to occur.	The use of sand fill will help negate this on lower areas. Reduced by drainage as part of subdivision.
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 sands with little restriction to sandy clay subsoils and winter wet subsoils. Most soils have 500 - >1000 mm sand over loam soils.	No issues for development.
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 sand soils have less moisture retention for crops.	No issues for development
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	Winter waterlogging occurs in the lower elevations where lateral drainage is reduced. Most of the subdivision is located on elevated sand ridges.	Reduced by drainage as part of subdivision and fill as required.
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 highly workable on the more sandy soils.	Minor issues for development

Regolith and Soils and Recommended Management	
Regolith and Soils	• Soils have high capability for development with subdivision design being used to overcome any limitations. • Any adverse conditions can be avoided by subdivision design.
Recommendations	• *Normal practice of soil and development management on sloping loam soils is recommended.*

4.0 SITE FOUNDATION GEOTECHNICAL ASSESSMENT

Geotechnical Assessment was conducted by Lindsay Stephens to identify issues listed under *Statement of 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.	Foundation conditions are sand over loam clay with 500 mm - > 1 000 mm sand and deep yellow sands. They are no different to those on the already developed lots in nearby subdivisions. Foundation stability is higher on the deeper sands in the west.	High stability with the central swale being able to be filled. There is a good opportunity to move some sand from the west by creating a more undulating surface and providing fill in the central swale. Can be managed. *See 5.1 Foundation Stability*
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 (*Landslide Risk Management*).	Soils are flat or gently sloping sand that carry no risk.	No special requirements
EASE OF EXCAVATION	The presence of basement rock, shallow groundwater, steep slopes or hard clay can all restrict excavation.	High over all the site.	Managed by fill and site construction techniques if required. *See 5.1 Foundation Stability*
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.	Soils are sand over clay and deep yellow sand with minimum of 800 mm - > 1 200 mm sand.	Managed by normal fill and site construction techniques. *See 5.1 Foundation Stability*
EXPANSIVE SOILS	Some clays such as smectites are expansive and can swell when wet and shrink when dry, therefore impacting on developments.	Soils are sand over clay and deep sand with minimum of 500 mm sand. The overlying sand has no expansive capability and any tendencies in the sandy clay subsoils will be negated by fill.	Managed by fill and site construction techniques and drainage. Some sandy basal clays may exhibit expansive qualities. *See 5.1 Foundation Stability*

WATER LOGGING - INUNDATION	Soils that become waterlogged can impact on dwellings through capillary action.	Winter waterlogging can occur on lower elevations in winter when precipitation exceeds infiltration and drainage rates. Occurs in the central swale. The land receives winter surface	Managed by fill, drainage and site construction. *See 5.3 Drainage and Flood Risk*
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.	Minor flood potential in storm events in the central swale associated with drains and water entering from the south. The surface water is readily contained by the drains.	Engineered drainage will be required to mitigate these areas or the lines of drainage retained on the subdivision.
DEPTH TO IMPERMEABLE CLAY	A minimum of 1.2 metres of free draining soil under the base of waste water disposal areas	Soils are sand over sandy clay with a minimum of 500 mm plus sand. The sandy clay is slow permeable and not impermeable.	Managed by fill and site construction and drainage techniques. *See 4.1 Foundation Stability*
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.	Water table depth in bores the bore on site is 7 metres to the water table at its highest elevation. That is an elevation of 26 metres AHD. Rainfall in winter forms temporary perched surface water in the central swale that is drained to the north and accepts water from the south. The site is much better drained than constructed dwelling sites in the adjoining subdivisions which have the same soil formations.	Managed by fill, and the use of alternative and nutrient adsorbing waste water systems. *See 5.1 Geotechnical Suitability for Waste Water Disposal and 5.2 Nutrient Management*
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 and brown sands and minor ferricrete. Reduced permeability sandy clays can have less phosphate retention because water infiltrates slowly rather than penetrating the soils.	Managed by selection of building envelopes and the use of alternative and nutrient adsorbing waste water systems. *See 5.1 Geotechnical Suitability for Waste Water Disposal and 5.2 Nutrient Management*
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 because of their denitrification potential from reducing conditions particularly in winter wet conditions.	No special requirements *See 5.1 Geotechnical Suitability for Waste Water Disposal and 5.2 Nutrient Management*
MICROBIAL PURIFICATION	Soil microbes require a minimum of 5 metres of sandy	Sandy soils have moderate microbial	Managed by requirement of

	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.	purification under natural conditions with 800 mm - > 1000 mm sand over sandy clay. Winter wet soils and shallow surface sand soils have low microbial purification in winter.	alternative and nutrient adsorbing waste water systems, in addition to yellow sand fill. *See 5.1 Geotechnical Suitability for Waste Water Disposal and 5.2 Nutrient Management*
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 sandy soils horizons and deep sands are permeable. The underlying sandy clay subsoils have reduced permeability that can be less than winter precipitation when surface water may build up.	Managed by selection of building envelopes, fill, and the use of alternative and nutrient adsorbing waste water systems. *See 5.1 Geotechnical Suitability for Waste Water Disposal and 5.2 Nutrient Management*
ACID SULFATE	Acid conditions can be formed when 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.	No observed risk. No organo ferricrete or peat soils were observed. Deep excavations are not required or proposed for dwellings but some drains will need to be constructed. Lower risk than many surrounding land areas that have been developed.	No risk from construction of dwellings. *See 4.5 Acid Sulfate Risk*

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

Foundation stability is assessed to AS2870 classification, from detailed site mapping at the subdivision stage, and in particular the design of the footings, taking into account the type of dwelling to be constructed.

The land is underlain by alluvial loams and clays with minor alluvial sands. Sheeted across this are moderate ridges of Bassendean Sand in the west with a lower ridge in the east.

The classifications change across the soil units as the land surface rises and falls. Changes occur both laterally and vertically from sands through to clays. In general the higher, better drained more sandy soils are recommended to be selected for preferential location of the building envelopes.

The thickness of sand over the clay subsoils is used to reduce any potential soil movements in the underlying clays. Potential soil movements are therefore managed by strategic location of building envelopes, introduced sand fill and the design and construction of footings.

Depending on the type of dwelling and site, additional sand fill may be recommended by the engineer at the time of design and construction of a dwelling. On the other hand the engineer may choose to specify heavier footings.

Foundation stability is rated as AS2870 Site Class A on the deep sand across most of the western half of the site with Site Class A – S and possibly M in areas with less surface sand cover on the ridge to the east dropping to S - M off the ridges and M over the lower central swales. There is potential (but unlikely) for Site Class H to occur in minor wet and dry areas.

Detailed individual testing of building envelopes will be required to determine the site specific soil conditions at the time of construction. At this stage the exact location of any dwelling and knowledge of the type of construction is not known. The individual site testing will be incorporated into the engineered site plans and designs for any dwelling.

The depth of fill sand will also determine the Site Class. For example adding 1 metre of fill is likely to reduce the Site Class by one category.

This level of testing cannot be completed now because the site will be drained and/or filled which will potentially change the Foundation Stability Site Class.

The advantage of Lot 791 is that some of the sand from the western ridge may be able to be used for fill in the central swale to form a more undulating ridge. The other advantage is that whilst there is s central swale the depth of sand is about 1000 mm thick over the sandy clay subsoils. This provides much greater pre-development soil stability when compared to many areas in the Serpentine locality where clay is often at or near the surface

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.

The main constraining feature is the depth to underlying sandy clay.

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 are sand over sandy clay with the upper layers able to be readily and effectively compacted. The clay subsoils are less readily compacted and will generally require fill to raise their compaction. As noted above in Foundation Stability, the sand sheet is variable at 500 mm to several metres and mostly in excess of 1000 in almost all locations making construction easier.

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 are sand over sandy clay based.

The subsoils are sand over sandy clay with the upper layers able to be readily and effectively compacted. The clay subsoils are less readily compacted and will generally require fill to raise their compaction. As noted above in Foundation Stability, the sand sheet is at 1000 in most locations making construction easier.

Generally there is nil risk in the sand but some expansion-contraction can occur in the underlying clay subsoils. Any winter wet soils should be considered as potentially moderately expanding, and the footings assessed and designed accordingly.

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.

No limestone is present and therefore no karst occurs.

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 well elevated and well drained. There are some small areas of valley floors that are susceptible to minor winter wet conditions, but these are avoided by subdivision design and the allocation of building envelopes.

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 slopes where road construction costs are minimised.

The relatively thick sand sheet on site are excellent for road construction and it is likely that road making materials could be taken from on site as required.

Foundation Stability Risks Identified and Recommended Management	
Dwellings	• Foundation stability is generally classified as high (Site Class A-S and M on lower elevations. (AS 2870). • Development conditions are high for dwellings.
Roads	• Development conditions are high for road construction.
Recommendations	• *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.*

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 development area are gentle with minimal soil creep or landslip risk.

The only risk of movement will normally be from inappropriately constructed or compacted fill on slopes cut into the natural soils that become overloaded with water. On this site situations such as this are unlikely and would be related to road construction only.

Landslip risk was assessed using the methods outlined in Australian Geomechanics, Volume 35 No 1, March 2000 and is rated as Very Low and covered by providing suitable foundations.

Landslip Risk Identified and Recommended Management	
Landslip	• Landslip Risk is rated as Very Low and managed through normal foundation design and construction as described in Section 4.2 above.
Recommendations	• *Normal construction practise matched to the soils.*

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.

It is possible that a deep dam could be constructed in the low elevations but unlikely on 4 000 m^2 lots.

Risk Identified with Dams and Recommended Management	
Dams	• No risk in general. No observed risk for the dam in the south west which is installed with overflow channels.
Recommendations	• *Nil*

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.*

The risk has been defined by Geoscience Australia and is based on AS 1170.3:1993. See also *Sinadinovski, 2005, Earthquake Risk IN Natural Hazard Risk In Perth Western Australia, Australian Government.*

The soils are lower lying and can at times provide more surface movement and vibration when saturated than well drained sands and rock based soils on the Darling Scarp.

The site risk factors are normal with no very soft or unconsolidated sands or clays and do not add any site specific risk factors.

The site is better than some other locations in the Serpentine area as the soils are better drained with only the central swale as being winter wet. The depth of sand sheet is also greater than other locations. Risk is reduced by good design of foundations to match the local soil conditions as part of foundation stability.

Risk is therefore mitigated by the design and construction of foundations, and is covered under Foundation Stability.

Earthquake Risk Identified and Recommended Management	
Earthquake	• Covered by the considerations in 4.1 Foundation Stability and the recommendations for the developable area. • The soils and land capability are similar to those on the already subdivided nearby lots on which dwellings have been constructed.
Recommendations	• *Use normal testing, design and construction for soils.*

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_2O_2 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 Planning Bulletin Number 64, identifies the whole area as yellow, Moderate to Low risk (yellow) of acid sulfate conditions (AASS and PASS) occurring below 3 metres depth. This is the same as all the existing lots that have been developed in the Byford, Cardup and Serpentine areas.

WAPC Planning Bulletin Number 64, identifies the whole area as yellow, Moderate to Low risk (yellow) of acid sulfate conditions (AASS and PASS) occurring below 3 metres depth.

A small area is shown as red on the central southern boundary in WAPC Planning Bulletin 64; "High Risk of actual acid sulphate soil AASS and PASS occurring generally at depths of <3m." These nominations are copied into the Shire of Serpentine Jarrahdale database and mapping, however the information is largely has little meaning or field application because it is broad scale and

The yellow classification is the same as all the existing lots that have been developed in the Byford, Cardup and Serpentine areas which are flatter and less well drained. The high sand ridge is the same classification as the low winter wet areas, and the red high risk area to the west of Lot 791 is shown as partially across wet areas and the sand ridge.

The winter wet areas mostly dry out in summer which enables any reducing conditions and minerals to oxidise. The wet areas in this location slope and have through flow soil moisture and do not allow the accumulation of organic matter which would indicate and be necessary for acid sulphate conditions to develop.

The winter wet areas are most likely to be filled if developed and not be subject to deep excavations.

No at risk areas or "suspect" minerals or conditions have been identified during the site investigations or soil auger holes. Surface sands were measured at pH 5.5 - 6. The most acid condition was pH 4.5 in one sample from the sandy clay subsoil at 1000 mm depth.

All soils observed on site are oxidised, with the iron minerals being oxides.

No reducing conditions were observed in the soil test holes. No peat or organoferricrete or other "at risk" materials were observed.

If any conditions did occur they would only be an issue if deep excavations are undertaken.

Deep drains or excavations are not required and were not required on the existing subdivisions.

See attached Acid Sulfate Assessment.

Acid Sulfate Risk Identified and Recommended Management	
Acid Sulfate	• WAPC Planning Bulletin Number 64, identifies the whole area as yellow Moderate to Low risk (yellow) of acid sulfate conditions (AASS and PASS) occurring below 3 metres depth over most of the area. In the field the red area is not identified as any higher risk than any other part of the central swale • The soils and land capability are similar to those on the already subdivided lots on which dwellings have been constructed. See Figures 1 and 2. • No obvious risk areas have been identified. • No deep excavation or additional drainage is required. See attached Preliminary Acid Sulfate Assessment Sheet.
Recommendations	• *Nil for development area.*

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 watertables 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, to *Department of Health, 2001, Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units (ATUs); Serving Single Dwellings*, 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.

The capability for waste water disposal is independent of lot size. It is no different geotechnically for a waste water system on a 2 000 m^2 or 2.0 hectare lot in terms of performance. There is a difference in the nutrient loading per hectare.

Soil Type

The Government Draft Country Sewerage Policy, 2002, permits waste water disposal from lots as small as 0.2 hectares in leached white sand with little phosphate retention capability.

The sandy upper surface horizons have low to moderate phosphate retention depending on the level of iron sesquioxides and clay, but the subsoils are silty loams and clay loam/silt with the clay content and presence of minor ferricrete providing good phosphorus retention.

Conventional septic systems are not acceptable in the local area because of the potential for elevated water tables and policies to protect the Peel Harvey Estuary such as SPP 2.1, The Peel – Harvey Coastal Plain Catchment. However they are acceptable on elevated Spearwood type deep yellows sands which occurs on the western third of the property illustrating the high capability of the land.

Effluent disposal areas for most nutrient adsorbing waste water systems need to be 500 mm above temporarily water logged areas to comply with Health Department requirements, and 1 200 mm above any impermeable clay layer.

It should be noted that Filtrex are approved by the Health Department to be installed where a separation of 250 mm to the water table applies.

A suitable system will be selected and must be approved by the Shire of Serpentine - Jarrahdale. These include the type of waste water system to be installed and the provision of sand fill and amended soils to form an acceptable waste water disposal area.

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.

Waterlogging

Some low lying areas are subject to winter waterlogging in the central swale because the precipitation exceeds the current drainage or infiltration capacity of the soils in winter. That area is drained and the water does not lie there for any significant time.

Water has been directed into the site from the subdivision to the south and this increases the amount of water adding to the site in winter.

The addition of increased drainage during the construction of the subdivision will reduce the waterlogging potential of the soils.

Therefore the pre-development assessments are better regarded as being used to assist the planning and initial engineering actions. Detailed assessments may be required at the time of the design of the drainage systems.

Water Table

Late winter testing was completed. It was undertaken on 21 September 2012. Water was only intersected in two soil test holes. One at 1200 mm and the other at 850 mm.

The wettest soil test hole was in the central north, and was due to there being locally perched water on the sand clay subsoil which was at 910 mm depth at that site.

All other locations had thicker surface sand sheets and did not experience water perched so close to the surface.

All soils comply with the 500 mm separation required for nutrient/alternative waste water systems. The sand ridges have separations of > 2000 mm to the perched temporary water table.

The soils and land capability are similar or better than those on the already subdivided lots on which dwellings have been constructed.

The depths to the highest known water tables, prior to any subdivision or drainage can be different as shown by the well drained nature of the adjoining subdivisions that have been constructed on similar soils but improved by drainage and fill.

With the constructed road drainage the water table elevations will reduce to be lower and the separations greater.

With the constructed road drainage the amount of surface water present on site has been reduced, with drainage assisted by the 1930's drains that drain to the west and Serpentine River. The type of waste water system can be selected to match each site.

It should be noted that the elevation of the water table is independent of lot size. It is no different geotechnically to construct a dwelling on a 2 000 m^2 or 4 000m^2 lot.

See Figures 1, 5 and 4.

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 watercourses, with the central drain being swale drainage through pasture with no defined bed. 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. The subdivision complies with the setback to drains.

Infiltration results

No infiltration tests were conducted on site. Any surface sands are permeable and the underlying loam clays slowly permeable.

The least permeable sites have a minimum of 1000 mm sand over the sand – clay with the majority including the sand ridges having much more separation and infiltration rates.

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.

Alternative/Nutrient adsorbing waste water systems spread the waste water loading over a larger area and are designed to overcome any localised lower infiltration rates and provide safeguards with the quality of waste water in terms of microbial and nutrient content to ensure that health and environmental impacts are negated or minimised.

Alternative/nutrient adsorbing (aerobic, adsorbing) effluent disposal systems are recommended and require a waste water loading not exceeding 10 litres/m^2/day.

For conventional septic systems, according to *Schedule 8 of the Health Act 1911*, a loading of 20 litres/m^2/day is applicable for leach drains in loam soils with alternating leach drains, and 10 litres/m^2/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.

Waste water should be disposed of into a well designed waste water disposal area to enable the waste water to infiltrate into the natural soils and not be able to move laterally and short circuit the disposal area. When this is undertaken good nutrient retention can be achieved. The Local authority is required under the Health Act 1911 to oversee and approve waste water disposal; in this case to the Health Department Guidelines 2001 for ATU's.

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.

Geotechnical Assessment for Waste Water Disposal and Recommended Management	
Waste Water Disposal	• The whole site has a high capability for waste water disposal from alternative or nutrient adsorbing waste water systems. • The western third of Lot 791 is suitable for conventional septic systems even though they will not be used. • It has much better capability than most of the nearby land that has been developed, such as to the east.

Recommendations	• *Waste water disposal systems should be installed according to the;*
	  • *Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974 – Health Act 1911,*
	  • *Department of Health, 2001, Code of Practice for the Design, Manufacture, and Operation of Aerobic Treatment Units Servicing Single Dwellings*
	  • *Government Sewerage Policy.*
	• *Grey water disposal systems are acceptable with the greywater systems installed to the Department of Health Greywater Guidelines.*

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, to *Department of Health, 2001, Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units (ATUs); Serving Single Dwellings*, Health (Treatment of Sewerage and Disposal of Effluent and Liquid Waste) Regulations 1974, AS/NZS1547:200l.

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.

Background

Phosphorus is the main nutrient implicated in algal blooms in waterways. Nitrates are normally taken up by vegetation, denitrified by bacteria under anoxic soil conditions or lost through volatilisation of ammonia.

Surface water from the site drains to ultimately end up in the Peel Harvey Estuary.

This site drains to the north and is part of the Peel Harvey Catchment, covered by Environmental Protection Policy (Peel Inlet - Harvey Estuary) and SPP 2.1 The Peel Harvey Coastal Plain Catchment Policy.

The nutrient management issues relate to waste water disposal and gardens and are not dependant on lot size.

The Government Sewerage Policy permits lots down to 2 000 m^2 size.

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 washing of fertiliser, soil particles and manure along drainage lines. 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 loam-clay soils.

In recent times the land has predominantly been used for horse agistment and some cattle grazing.

Stocking rates on soils such as the soils of the site are estimated to be 10 DSE or 1 adult cow per hectare. (1 breeding cow equates to 8 – 16 sheep depending on whether N or P are compared).

This equates to 10 DSE (dry sheep equivalents) for dry pasture and where limited supplemental feed is supplied. This equates to a loading of 60 - 80 kg/N/ha/year and 18 – 27 kg/P/ha/year (Van Gool et al 2002) using averages and the cattle on site being large. One large cow releases 70 kg/N/year and 22.5 kg/P/year.

The amount of nutrients used on broad acre crops is not dissimilar to other land uses, but will vary depending on the existing nutrient status of the soils and the type of crop grown; for example if a legume or green manure crop had been used in rotation and if stubble is retained.

- **Proposed Loading**

The proposed lot size is 0.4 hectare or 4 000 m^2 lots. The calculations of nutrient loadings for a 0.4 ha lot are the same as for a 0.5 ha lot, because no allowance for road reserve is allowed for the 0.5 ha lot in the table below.

When this is added to a 0.4 ha lot the loading is effectively the same because a road network to service 0.4 ha lots amounts to approximately 0.1 ha per lot.

It should be noted that the Government Draft Country Sewerage Policy, 2002, permits waste water disposal from lots as small as 0.2 hectares in leached white sand with little phosphate retention capability. This subdivision is double the minimum recommendation and is located on much better soils than the minimum.

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 has a nutrient loading of 28.5 kg/N/year and 8.64 kg/P/year. This will be added to the soil on the building envelope. A conventional septic system alone releases 18 kg N and 5.5 kg P per year as a point source, not a lot different to a horse except the nutrients from a horse are normally spread more broadly. Conventional septic systems are not recommended because the site lies within the Peel Harvey Catchment.

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 16.5 kg/N/year and 3.64 kg/P/year per lot for the with the same loading of a garden, lawn, dog, cat and some chicken. This demonstrates the reduced phosphorus from these systems when compared to conventional septic systems.

All lots in the subdivisions are required to use ATU's or nutrient adsorbing waste water systems. Alternative waste water systems are to be installed to *Department of Health, 2001, Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units (ATUs); Serving Single Dwellings.*

A horse has a typical loading of 11 kgP/year and 60 kg/N/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.

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 10 DSE per hectare, or large cattle at 1 per hectare.	70.0 kg/N/ha/year	22.5 kg/P/ha/year	Nutrient export could occur when the soils are saturated in winter so that additional rainfall on the lower wetter areas runs off. It could also occur with the autumn flush of water. Probable nutrient export from winter wet soils.
Likely nutrient input after subdivision of 4 000 m^2 - 5 000m^2 lots. Nutrient adsorbing or alternative waste water system. Small garden, small fertilised lawn, dog, cat. No stock.	33.0 kg/N/ha/year	7.5 kg/P/ha/year	Lower nutrient loading. Significantly reduced nutrient export risk. The actual loading is likely to be less because not all lots will have a cat and dog. *NOTE* *This loading per hectare is effectively the same for 0.4 ha lot because the road network effectively contributes 0.1 ha per lot.*

- 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.

Phosphorus is the main nutrient responsible for agal blooms in the Peel Harvey Estuary. In more recent times that increased awareness and reduced phosphorus inputs and construction of the Dawesville Cut has significantly reduced the agal blooms in the estuary

The soils are suitable for nutrient adsorbing waste water systems and unsuitable for conventional septic systems, because lot sizes of > 0.2 hectares are used.

The soils comply with the Government Draft Country Sewerage Policy, 2002.

The sandy upper soil horizons soils result in more rapid infiltration into the subsoils. Nutrients will infiltrate vertically through surface sands. From there the nutrients can potentially move laterally through the soil within the sand sheet where the sand is at its thinnest and spread out on top of the underlying loam subsoils.

The deep yellow and brown sandy upper soil horizons have moderate and in the deeper areas good phosphate retention capability. Even so, phosphorus adsorbing amended soils are used for the waste water disposal area of alternative waste water systems. These systems are nutrient adsorbing, and designed to adsorb all or almost all the phosphorus released in waste water.

Ferricrete layers that may occur at the sand/underlying yellow silt clay interface typically have very high capability for phosphorus retention as shown by Lantzke 1997, *Phosphorus and nitrate loss from horticulture on the Swan Coastal Plain*, Department of Agriculture Miscellaneous Publication 16/97. Some of these layers are occasionally present.

Nutrient adsorbing or alternative waste water systems spread the waste water over large areas through irrigation or by the use of amended soils that have high phosphate retention capability. Phosphorus adsorbing amended soils (PRI>20) are required to be used for the waste water disposal area of alternative waste water systems. These systems are nutrient adsorbing, and designed to adsorb all or almost all the phosphorus released in waste water.

Some indication of the improvements to the quality of the waste water leaving the waste water disposal area of nutrient adsorbing waste water systems can be shown from contacts with Ecomax and Filtrex. Ecomax reveal that their unit provides for 95% phosphate adsorption typically present exiting the system to enter the natural soils. Research by Filtrex has found that phosphate can reduce to less than 1 mg/L at the edge of the waste water disposal area, for at least ten years (Filtrex 2009).

The risk from phosphorus is therefore not regarded as a significant issue from domestic waste water systems.

The phosphorus loading will reduce under the proposed subdivision.

As lots are 0.4 hectares stock will not be permitted.

In both cases the estimated phosphorus loading would reduce from 22.5 kgP/ha/year down to 7.3 kgP/ha/year.

In addition the ATU waste water disposal systems required are designed to mitigate any adverse nutrient retention issues by specifying amended soil disposal areas with minimum phosphate retention. Soils must be capable of >PRI 20.

The reduction in phosphate export risk is in line with Government 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 $C0_2$ and energy from the oxidation of NH_4 or $N0_2$ to $N0_3$. Denitrifying bacteria on the other hand reduce $N0_2$ and $N0_3$ to gaseous N_20 and N_2 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.

The removal of nitrogen is related to the oxygen conditions of the soils in addition to the microbial material present. The ammonium compounds that exit the two tanks of the waste water system are normally high in ammonia and nitrite and lower in nitrate. With exposure to oxygen the ammonia and nitrite are converted to nitrate under the influence of nitrifying bacteria. The 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.

Many studies, for example Dawes and Goonetilleke, 2001, have found that nitrogen is readily stripped from waste water released from a septic system to 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_4 - 100 mg/L and $N0_2$ - 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.

The increased effectiveness of nutrient adsorbing waste water systems is shown by research by Filtrex which has found that nitrogen is reduced by 75% at the edge of the waste water disposal area, (Filtrex, March 2009) and then further reduced by the soils.

Lantzke 1997, 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. The earthy subsoils and loam soils will provide increased subsoil capability for the management of nitrogen.

The critical factor is retaining water in the soil or on site for as long as possible. With the proposed lots and loam soils, waste water and nitrogen is likely to be retained on site.

Nitrogen loading is therefore not regarded as a significant issue from waste water disposal.

The issues relating to nitrogen removal from waste water are the same and are irrespective of lot size provided it is above the minimum of 2 000 m^2 which the approved lots area. Within the waste water disposal bed soil bacteria convert nitrate to nitrogen gas which is lost to the atmosphere.

Stock will not be permitted and nitrogen loading will reduce. The estimated nitrogen loading would reduce from 70.0 kgN/ha/year down to 33.0 kgN/ha/year.

- **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 or nutrient adsorbing waste water systems are correctly constructed.

Nutrient adsorbing waste water systems are designed to provide for waste water leaving the systems as "of a standard suitable for irrigation" (Health Department 2002), which indicates the low level of microbial and organic matter entering natural soils after leaving the waste water disposal areas. This means that nutrient adsorbing waste water systems can be used to overcome potential deficiencies in the soils. Systems disposing to the ground surface require chlorination of the treated waste water which reduces the microbial risk of that type of water disposal.

In comparison to conventional septic systems, the Health Department, *Specification for Aerobic Treatment Units (ATU'S) Serving Single Households* (Health Department 2002), shows that the average BOD released from a nutrient adsorbing system should be <20 mg/litre, prior to on ground disposal. The systems used on this site may not be aerobic in nature.

The health risks will be the same for each waste water system irrespective of lot size and depend on the capability of the soil and the installation of units rather than the lot size. For example if the soils are suitable and the waste water treatment units are installed correctly the health risks from failure will be similar irrespective of lot size. The only variation will be that on smaller lots there are more units to be maintained and there is a greater chance of one not being maintained to standard. This risk is minimised by the requirements for service contracts that apply to nutrient adsorbing waste water systems.

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.

The risk from microbial purification depends on the installation and maintenance of the waste water systems rather than lot size. All lots are more than double the minimum suggested by the Government Sewerage Policy, in better soils, therefore there are not considered to be any inherent microbial risks associated with the soils on site.

The microbial purification capacity is dependant on the waste water system used, not the lot size. It either works and is no issue or it does not. For the same reasons that apply to nitrogen and phosphorus loading the microbial loading will reduce.

Nutrient adsorbing systems are designed to reduce the thermotolerant coliform bacterial down to an average of <10 organisms /100 litres and BOD(organic matter to < 20 mg/L on average.

NOTE

It is important to note that the soil assessments are made on the natural existing land as it was at the time of the site inspections. Like all local developments the soils will be improved by drainage and the addition of fill, which will upgrade the land capability to a much higher more capable surface. The drainage and fill requirements will be made during the detailed design for the subdivision

Analysis of Nutrient Loading and Recommended Management	
Waste Water Loading	• The soils and land capability are similar to those on the already subdivided lots on which dwellings have been constructed locally. • Nutrient loading will reduce. • Waste water disposal can comply with all Government Guidelines and Policy • *Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974 – Health Act 1911.* • *Government Draft Country Sewerage Policy, 2002* (revised September 2003 • *Specification for Aerobic Treatment Units (ATU's) Serving Single Households*, Health Department of Western Australia 1992 or superseding document. • *Draft Guidelines for the Reuse of Greywater in Western Australia*, Health Department of Western Australia 2002, or superseding document. • The use of nutrient adsorbing systems is recommended.
Nutrient Export	• 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. • As nutrient loading is reduced there is reduced risk of export.
Recommendations	• *Installation should be in compliance with Guidelines and Regulations for waste water systems. See previous section on Geotechnical Assessment for waste water disposal above.* • *It is recommended that stock not be permitted on 0.4 ha lots or according to the Shire of Serpentine – Jarrahdale Guidelines based on policies and local planning strategies which may change over time.*

6.0 BIODIVERSITY ASSESSMENT and MANAGEMENT

6.1 Flora and Fauna

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

Remnant Vegetation

The only remnant vegetation is Jarrah (*Eucalyptus marginata*) remnant trees on the deeper western sand ridge with scattered Marri *Eucalyptus (Corymbia) calophylla* occasional Sheoak *Allocasuarina fraseriana*, a couple of Woody Pear *Xylomelum occidentale* and scattered *Xanthorrhoea preissii*.

No understory or groundcover species were recorded with the groundcover being pasture.

Juncus pallidus occurs in the lower elevation of the south western corner.

The vegetation in the central east is listed as a "Geomorphic Wetland" is shown on Shire and DEC mapping. That nomination is wrong and covers high elevation sand ridge that has no wetland attributes or vegetation and must have been identified from mistaken aerial photography interpretation. It is noted that the same nomination covers all the developed land to the east.

Vegetation Condition

Generally the site is cleared. The vegetation in the east is Completely Degraded as it is parkland pasture. In some isolated pockets in the central east the proximity of the trees raises the condition to Degraded. (Bush Forever Scale 2000).

Several Jarrah trees are large and mature and are worthy of retention where possible and subject to safety issues from falling branches. See Figure 1.

Controls

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

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 will not be an issue on this site because the trunks are sufficiently spread that fencing should not be impeded.

4. Strategic fire breaks, combined with the building envelopes located on cleared areas where possible, may be able to be used and will depend on the recommendations of the Bushfire Hazard Report.

5. Large habitat trees may be able to be protected with the use of larger lots and by locating roads and developments at a sufficient buffer. Figure 1.

6. When clearing native vegetation, and during construction, provide weed and dieback managed construction techniques. This is not likely to be an issue on this site, but as a matter of due diligence the same principles should be applied for mobile plant brought to site.

   - 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.

   - 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. See above under Remnant Vegetation. See Figures 2 and 3 and the attached Water Management Strategy for the design of surface water drainage and the proposed naturalised detention basin.

Fauna

Fauna is advantaged by the presence of habitat. The more native vegetation and trees retained and planted the better the habitat for fauna. Habitat protection is the key to fauna management.

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

The vegetation may be used by a variety of fauna, some of which may be significant such as the Black Cockatoos which are listed under State and Commonwealth Legislation.

All three species of Black Cockatoo *Calyptorhynchus baudinii, C. banksii* and *C. latirostris* are listed under State Legislation, and *C. baudinii* and *C. latirostris* under Commonwealth Legislation, and are likely to utilise the site occasionally for access to the Jarrah and Marri seeds. This might occur for brief times (around half an hour) at a time several times annually. Experience with lots even down to 0.2 hectares shows that black coackatoos will readily use tress on small lots. It is unlikely that the subdivision will prevent continues of the trees for food.

Any trees required to be cleared for roads or building envelopes can be offset by providing additional revegetation.

Analysis of Biodiversity and Recommended Management	
Remnant Vegetation	• The site is completely cleared with a small area of "Completely Degraded" vegetation.

Recommendations	• *The larger vegetation remnants are recommended to be retained in conservation areas which has been done.* • *The style of fences cutting the remnant vegetation should enable the exchange of flora and fauna.* • *Where possible firebreaks are not recommended to cut remnant vegetation.*

7.0 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 and cattle agistment in recent years. Little remnant vegetation remains. Tree belts have been planted in the north. See Figures 1 and 3.

The opportunities of the site are;

- The gently undulating nature of the land surfaces.
- The local views that can be obtained from the western sand ridge.
- Proximity to Serpentine townsite.
- Setback from existing roads.
- Proximity to existing service centre.
- Ability to have horses on larger lots.
- Adjoin existing subdivided land.
- Elevation of most of the land negating the need for sand fill.
- Availability of some sand that can be used to distribute across lower elevations.
- The thick sand sheet across the site that is almost totally >1000 mm thick.
- The existing drainage to the north.
- The compliance of the whole site for >500 separation to the winter perched water table.
- The presence of existing native trees.

The constraints of the site are;

- The sandy surface soil horizons that have reduced nutrient capability in some parts of the site.
- Minor winter surface water that lies on some parts prior to effective drainage being implemented.
- Surface water being directed onto site from the south.

Potential land uses

The soils have a similar capability for dwellings and onsite wastewater disposal to the adjoining subdivisions to the east.

The most likely potential land uses are therefore rural living in some form.

7.1 Alternative Landuse and Land Capability

Alternative Landuses

The land is likely to be used for rural living to complement other such land in the local area.

Lot Sizes

The size of lots on the cleared land will be mainly related to planning issues. Environmental issues are not limiting. Lot sizes are more related to planning and servicing and drainage.

It is important to note that the soil assessments are made on the natural existing land as it was at the time of the site inspections. Like all local developments the soils will be improved by drainage and the addition of fill, which will upgrade the land capability to a much higher more capable surface. The drainage and fill requirements will be made during the detailed design for the subdivision.

Lot sizes have been set at a minimum of 0.4 hectares rising to 9 144 m^2.

Alternative land uses

It is unlikely that there will be sufficient water for other than part time or hobby plantings or continued grazing and horse agistment.

Change of landuse	
Potential Impact	• The surrounding lots are already rural living and this subdivision will match those landuses. • The proposed lot sizes and land uses are no different to many other parts of the local area.
Recommendations	• *No specific recommendations required.*

7.2 Aesthetics

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

The site lies outside the Shire of Serpentine – Jarrahdale Landscape plan for the Darling Scarp.

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.

Any adverse visual impacts can be solved by the planting of clumps or belts of trees along fencelines.

Existing trees should be protected where possible and a small but ongoing tree replacement program could be considered.

The number of trees that are normally planted on rural living lots will provide adequate protection of the views from outside the site.

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.
- Strategic planting of clumps of trees or tree belts and the retention of the existing trees will minimise or mitigate visual impact.

- 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.

Analysis of Visual Impact and Recommended Management	
Potential Visual Impact	• The amount of visual impact is readily controlled and will occur as new landholders plant gardens. This will visually protect the site from adjoining lots. This will occur naturally as it does on many other similar subdivisions. • The land is no different from the surrounding land that has already been developed.
Recommendations	• *Restrictions could be placed on the use of visually non compatible materials.* • *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.*

7.3 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.

As noted earlier the soils of the site are sand over sandy clay or deep sand which on this site are quite productive for pasture and grazing holding pasture into summer. The elevation of the sand ridge makes less water available for pasture and the grass is not held into summer. Pasture is held for longer in the central swale.

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 the planning precinct of Serpentine, the loss of agricultural soils will be a consequence of town site expansion that fills a community need.

Analysis of Agricultural Significance and Recommended Management	
Agricultural Significance	• 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.
Recommendations	• *Nil*

7.4 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.

Buffers to Broad acre Cropping and Grazing

The land to the east is already subdivided. The buffers between that land and rural land will be no different from this land, when subdivided, to the adjoining rural land to the west.

On these types of developments the greatest land use conflict risks are from spray drift issues between lots or from adjoining cropping land.

The land surrounding land is not cropped but used for grazing, horse agistment and hay production, none of which require broad scale spraying.

The most comprehensive study in recent times has been by Department of Natural Resources, and Department of Local Government and Planning, Queensland, 1997, *Planning Guidelines Separating Agricultural and Residential Land Uses*. Studies in Emerald and further research showed that in open ground there is negligible spray drift at 300 metres. However a single belt of trees captures 80% of the spray drift and where a satisfactory vegetated buffer element is planted and maintained the buffer distance can be reduced to 40 metres. (pages 9 - 11 of the Queensland Guideline).

A buffer of 300 metres is therefore often applied to non hooded sprays on broad acre open flat ground. Primary Industries Standing Committee 2002, *Spray Drift Management*, SCARM, Report 82, provides guidance on the type of vegetated buffer on page 27. The buffer should consist of trees and shrubs and be up to 20 metres wide.

The Draft Environmental Code of Practice for Vineyards, jointly prepared by Agriculture WA, Department of Environment, Grape Growers Association and the Wine Industry of WA, recognises that buffers are related to aspects of the site conditions and land uses.

The Draft Environmental Management Guidelines for Vineyards (February 2001) discusses best practise with respect to spraying and land management techniques which are useful for all forms of horticulture but does not list buffer distances.

The Cessnock Development Control Plan No 28,1999, recommends a 100 metre separation between a commercial vineyard and a dwelling. Cessnock Development Control Plan No 28, 1999 (Appendix 2) also notes that research has shown that 30 metre wide tree buffers can provide effective barriers to chemical drift.

These studies have been incorporated it to the *Department of Health 2012, Guidelines for Separation of Agricultural and Residential Land Uses*. That guidelines uses the same data and recommendations as the above policies and studies.

The buffer distances are available, using building envelopes to locate dwellings away from side boundaries adjoining rural land. In recent years there have been major advances and research into spray technology which have helped to reduce spray drift and increase efficiency. Spraying normally takes place 4 - 6 times per year when growing crops. Using a boom spray a 5 hectare slice of land can normally be sprayed in 30 minutes, which means that the adjoining broad acre land within 300 metres of a new or existing dwelling will be sprayed for about 3 hours (30 minutes x 6) per year. Prior to such times notification of the adjoining land holder can be undertaken.

However with "Best Practise", hooded sprays applied close to the ground increase efficiency, reduce waste of spray and improve safety. The use of hooded spraying equipment and "Best Practise" can therefore permit reductions in buffers.

Some of the technological factors that have been found to be important in reducing spray drift are listed below. (Farming Ahead No 102, June 2000). All of these would apply to ground spraying but would only apply to adjoining rural landholders through their duty of care.

- Lowering the elevation of the boom from 500 to 350 mm will reduce the potential for drift by 40%.

- Spraying when wind speeds are steady and less than 20 kph.
- Spraying when wind is blowing away from sensitive areas.
- Spraying when the temperature is between 15 and 25°C which reduces vaporisation.
- Using larger nozzles to increase droplet size.
- Modifying air movement around the sprays with hoods, screens, curtains and the like.
- Reducing spray speeds to 12 to 15 kph.
- The use of polymeric anti-drift products which reduce drift by changing the surface tension of the droplets.
- Avoidance of temperature inversions.
- The use of wind breaks or the screening of remnant vegetation.
- Loss of spray through drift is wasteful and avoided wherever possible. (spray is expensive).

Common law rights would apply to landholders. It is also good practice to notify adjoining land holders when spraying.

The potential land uses, on site conditions, location and distance to other properties, do not require any particular buffers. The land uses are the same as proposed, rural living and increasingly smaller lots.

Land Use Buffers and Recommended Management	
Buffers	• There are no adjoining land uses existing or proposed that will require large or significant buffers. • Lot sizes are sufficiently large to manage any buffers through setbacks and screening tree belts.
Recommendations	• *No significant buffers required.*

7.5 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 be required and the recommendations can be incorporated into the subdivision design. The risk factors will however be no different to the existing subdivisions.

Fire and Recommended Management	
Fire Management	• The change to fire risk is best addressed through a Fire Management Plan.
Recommendations	• *Compliance with Bush Fires Control Act 1954 (as amended) and the Shire of Serpentine - Jarrahdale bylaws.* • *Compliance with the Fire Risk Assessment and Fire Management Plan is recommended.*

REFERENCES

Allen D G and R C Jeffery, 1990, *Methods for Analysis of Phosphorus in Western Australian Soils,* Chemistry Centre Report on Investigation No 37.

ANZECC, 1992, *Australian Water Quality Guidelines for Fresh and Marine Waters.*

Appleyard S J 1993, *Explanatory Notes for the Groundwater Vulnerability to Contamination Maps of the Perth Basin*, Geological Survey of Western Australia, Record 1993/6.

Australian Health and Medical Research Council, 1996, *Australian Drinking Water Guidelines.*

Berkman D A, 1995, *Field Geologists Manual*, The Australian Institute of Mining and Metallurgy.

Bureau of Meteorology, 2013, *Rainfall Intensity Chart.*

Coles and Moore, 1998, *Runoff and Water Erosion*, IN Soil Guide, WA Department of Agriculture, Bulletin 4343.

Dames and Moore, undated, *Nitrate Management* in the Jandakot UWPCA.

Data from Select Committee on Metropolitan Development and Groundwater Supplies, Legislative Assembly 1994.

Dawes L and A Goonetilleke, 2001, *The importance of site assessment in designing effluent disposal areas*, Proceedings of the 2nd Australia and New Zealand Conference on Environmental Geotechnics - Geoenvironment, University of Newcastle New South Wales.

Department of Environment WA, 2004, *Stormwater Management Manual for Western Australia*.

Department of Health, 2001, *Code of Practice for the Design, Manufacture, and Operation of Aeorobic Treatment Units Servicing Single Dwellings*

Department of Natural Resources, and Department of Local Government and Planning, Queensland, 1997, *Planning Guidelines Separating Agricultural and Residential Land Uses*.

Department of Water, September 2006, *Wastewater treatment – on site domestic systems*, Water Quality protection Note.

Department of Water. 2008, *Better Urban Water Management.*

Dixon R N M, 1996, *Trees on farms to reduce salinity in the Clearing Control Catchments Volume 4, Helena Catchment*, Water and Rivers Commission, Rep. No. WRT8.

Dixon R N M, G W Mauger and A Rogers, 1998, *Trees on Farms to reduce Salinity in the Clearing of Control Catchments*, Water and Rivers Commission, WRT 20.

Engineers Australia 2003, *Australian Runoff Quality*, National Committee on Water Engineering.

Environment Australia, 2002, *Introduction to Urban Stormwater Management in Australia.*

Environmental Protection Authority Victoria/ Melbourne Water, undated, *Urban Stormwater, Best Practice Environmental Management Guidelines*

EPA Bulletin 711, 199, *Western Australian Water Quality Guidelines for Fresh and Marine Waters.*

FESA, 2001, *Planning for Fire*, Fire and Emergency Services Authority of Western Australia.

Geological Survey of WA, 1986, *Perth Environmental Geology 1 : 50 000 sheet.*

Gerritse et al, 1995, *Retention of Nitrate and Phosphate in Soils of the Darling Plateau in Western Australia*: Implications for Domestic Septic Tank Systems, Aust. J. Soil Res. 33, 36367.).

Gerritse R G and J A Adeney, *Nutrient export from various land uses on the Darling Plateau in Western Australia* , CSIRO Report 92141.

Gerritse R G, C Barber and J A Adeney, 1990, *The Impact of Residential Urban Areas on Groundwater Quality: Swan Coastal Plain, Western Australia*, CSIRO Water Resources Series No 3.

Gerritse R, 1993, *The influence of landuse and soil type on nutrient losses*, IN Swan River - The Future, Swan River Trust Report No 8.

Government of Western Australia, 2003, *Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974, Health Act 1911.*

Guidelines for Groundwater Protection in Australia, ARMCANZ, ANZECC, September 1995.

Jones T, M Middletone and N Corby, 2005, *Natural hazard risk in Perth, Western Australia*, Australian Government, Geoscience Australia.

King P D and M R Wells, 1990, *Darling Range Rural Land Capability Study*, Department of Agriculture and Food Land Resources Series No 3

Poinke H B, M L Sharma and J K Hosking, *Effect of Irrigated Horticultural Cropping on Groundwater Quality: Swan Coastal Plain, Western Australia*, CSIRO Water Research Series No 2.

Van Gool D, K Angell and Lindsay Stephens, 2000, *Stocking Rate Guidelines for Rural Small Holdings, Swan Coastal Plain and Darling Scarp, Western Australia*, Department of Agriculture, Miscellaneous Publication 02/2000.

Water and Rivers Commission, 1998, *Manual for Managing Urban Stormwater Quality in Western Australia.*

Water and Rivers Commission, 1998, *Stabling and Agistment of Horses*, Water Quality Protection Note.

Wells M R and P D King, 1989, *Land Capability Assessment Methodology*, Western Australian Department of Agriculture.

Whitehead J H and P M Geary, 2005, *Geotechnical Challenges for Onsite Wastewater Management in the Hunter Region,* Australian Geomechanics Vol 40, No 2, June 2005.

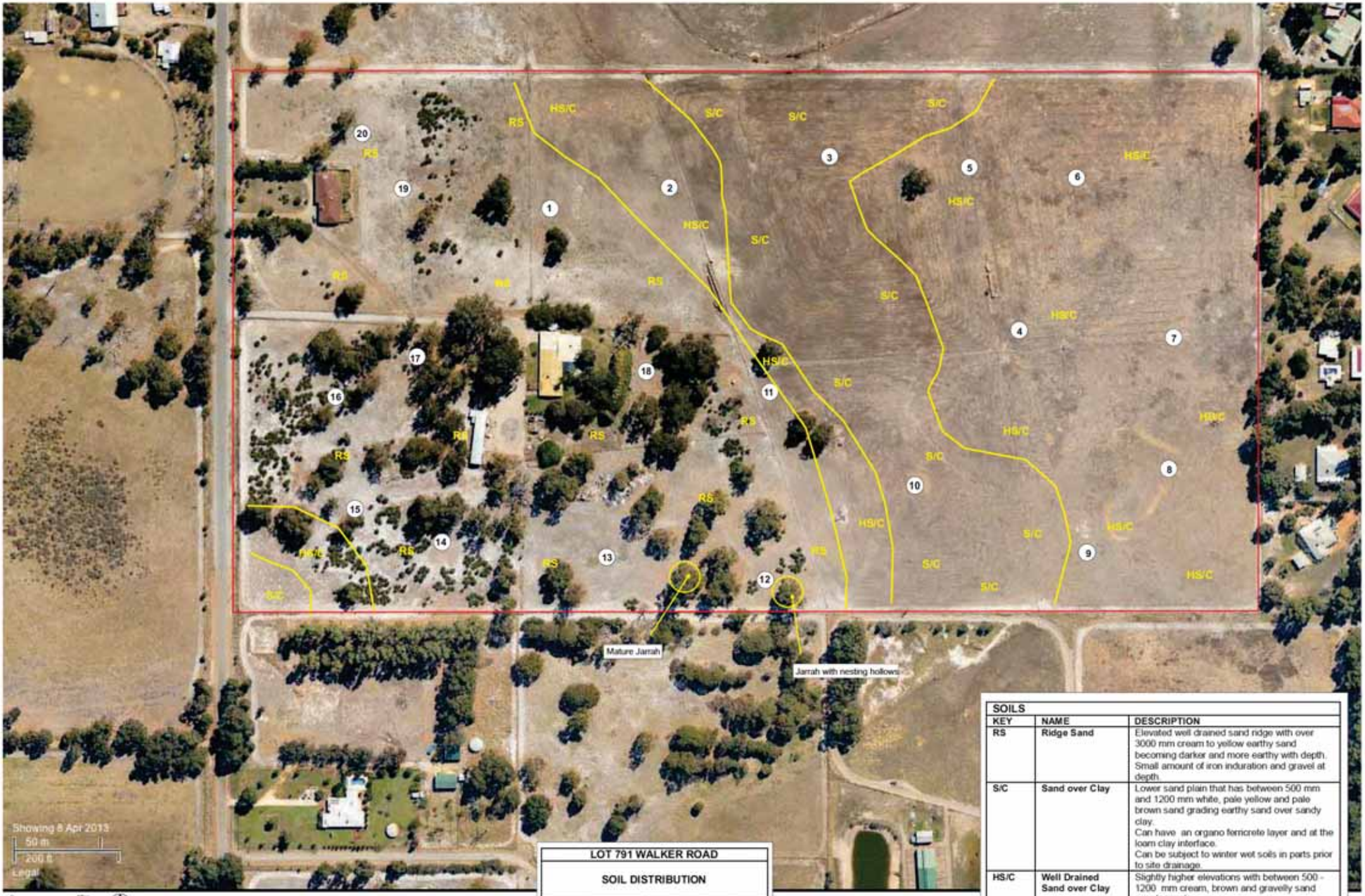
Wilde S A and G H Low, 1978, 1 : *250 000 Perth Geological Series*, Geological Survey of Western Australia.

LOCAL WATER MANAGEMENT STRATEGY

See the separate document that should be read in conjunction with the land capability documentation.

The Local Water Management Strategy updated in October 2015 contains the engineering design and calculations for on site stormwater management.

FIGURES



LOT 791 WALKER ROAD	
SOIL DISTRIBUTION	
Basemap NEARMAP	Landform Research
Scale 1 : 2000	May 2013

Figure 1

SOILS		
KEY	NAME	DESCRIPTION
RS	Ridge Sand	Elevated well drained sand ridge with over 3000 mm cream to yellow earthy sand becoming darker and more earthy with depth. Small amount of iron induration and gravel at depth.
S/C	Sand over Clay	Lower sand plain that has between 500 mm and 1200 mm white, pale yellow and pale brown sand grading earthy sand over sandy clay. Can have an organo ferricrete layer and at the loam clay interface. Can be subject to winter wet soils in parts prior to site drainage.
HS/C	Well Drained Sand over Clay	Slightly higher elevations with between 500 - 1200 mm cream, brown and gravelly sand over loam clay. Well drained and not subject to winter wet conditions.

LAND CAPABILITY FOR DWELLINGS and DEVELOPMENTS

KEY	CAPABILITY FOR SELECTED LAND USE
I	• Very high capability with few physical limitations.
II	• High capability with minor physical limitations that can be overcome by
IV	• Lower capability with a number of smaller management actions required or there is one significant factor that will require management. • Subdivision or development design can be used to contain additional costs. • 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.

MANAGEMENT of IDENTIFIED CONSTRAINTS for LAND USE AND DEVELOPMENT

KEY	CONSTRAINTS IDENTIFIED	GEOTECHNICAL and ENVIRONMENTAL MANAGEMENT
a	Soil permeability limitations	• Provide appropriate waste water disposal systems.
b	Foundation soundness	• Requires fill pads of sufficient depth to counteract potential clay or expanding sub-soils. • Organic subsoils may need to be removed if present.
c	Potential slope instability	• AS 2870 Site Class P generally applies to cut and fill. • Provide appropriate foundation design. • Upslope cutoff drains recommended. • Upslope water loading to be avoided. • Trees to be retained/planted. Pasture cover to be maintained
d	Steep slopes that require significant management	• Steep slopes that will require significant management to develop. • The slopes are often associated with a landscape feature. • Pier-pole foundations may be more appropriate than cut and fill. • Larger lot sizes recommended; > 1000 m^2.
e	Water erosion risk	• Maintain soil cover of crops, pasture, trees or shrubs • Use contour drains and agricultural practices. • Stormwater to be controlled.
f	Potential flooding	• Requires sand pad to be set sufficiently (0.5m) above highest known water level to minimise capillary effects. • Locate developments outside areas of flooding.
i	Subject to winter wet conditions or water logging risk in wet years.	• Alternative waste water treatment systems likely to be required. • Cut off drains and other drainage likely to be required. • Raise and or terrace waste water disposal areas. • Fill may be required for developments. • Floor elevations to have clearance above water risk levels. • Reduce stock in winter. • Road drainage and cut off drains will intersect and divert surface water from upslope, drying areas lower down slope.
k	Soil workability	• Remove or avoid rock, clay subsoils or other restrictions.
m	Low moisture availability of soil	• Manage or reduce stock to ensure pasture cover through summer. • Restrict clearing to building envelopes.
n	Low nutrient retention ability	• Alternative waste water treatment systems may be required. • Leach drains may need to be inverted or semi-inverted, bunded by natural soil or impermeable membrane on downslope side. • Setback developments appropriate distances from water bodies/wetlands. • Use reticulated sewerage. • Feed stormwater through detention basins and swale drains. • Manage nutrient and fertiliser applications and stock • Restrict clearing to building envelopes. • Restrict the density of development.
o	Water pollution risk by overland flow	• Retain surface water in basins, use swale and grass filters. • Manage stock and potentially polluting land uses.
p	Potentially low microbial purification	• Alternative waste water treatment systems required. • Correctly install waste water systems. • Bund waste water disposal areas sufficiently.
q	Water table <0.5 metres depth	• Soils can be modified using fill, cutoff drains to comply with the Government Country Sewerage Policy. • Use Filtrex or Ecomax, which can be installed where the water table is at 0.25 and 0.0 m below the surface.
r	Restricted rooting conditions	• Avoid rock, hardpan or other restrictions.
s	Water pollution risk by subsurface flow	• See (n) above.
t	Low topsoil nutrient retention	• See (n) above.
v	Remnant vegetation	• Restrict clearing to building envelopes. Maintain linkages.
w	Wind erosion risk	• Manage or reduce stock, irrigate and improve pasture. • Maintain vegetation/stubble cover through summer. • Restrict clearing to building envelopes.
x	Reduced ease of excavation	• Remove rock or avoid constrained areas.
y	Salinity risk	• Provide drainage and reduce ponding. • Plant deep rooted species including deep rooted crops.
z	Wetland conservation	• Exclude building envelopes and developments. • Provide appropriate buffer distances. • Place conservation covenants on wetlands and/or vegetation.
&	Potential for acid sulfate conditions	• Minimise deep excavations or bulk earthworks; use fill. • Neutralise removed affected soils. • Minimise or exclude dewatering and lowering of groundwater.
$	Restricted water availability	• Water may be restricted for some horticulture land uses
#	Semi-inverted leach drains	• Leach drains should be semi-inverted, bunded by natural soil or impermeable membrane on the downslope side.
@	Alternative waste water treatment system required	• 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.

Deep yellow sand soil

Earthy yellow sands

Pale yellow-brown sand (right) over earthy yellow sand (left)

Typical pasture and elevated ridge land

View east along the northern boundary

View north through the centre of the site

View east along the southern boundary showing mature Jarrah tree

Scattered Marri with cattle in the central south.

View west across the pasture

Figure 3

ALL PROPOSED BUILDING ENVELOPES GENERALLY IN ACCORDANCE WITH SHIRE OF SERPENTINE-JARRAHDALE BUILDING SETBACK REQUIREMENTS;

- MINIMUM 20m SETBACK FROM PRIMARY STREET
- MINIMUM 10m SIDE AND REAR SETBACKS
- MAXIMUM AREA OF 1000m²

THE LOCATION OF THE BUILDING ENVELOPES ARE INDICATIVE ONLY. BUILDING ENVELOPES AND EFFLUENT DISPOSAL ENVELOPES WILL BE REQUIRED TO ENSURE ADEQUATE SEPARATION DISTANCE TO GROUNDWATER IS ACHIEVED. THE EXACT LOCATION OF THESE ENVELOPES WILL BE DETERMINED


1 hour 1 year return events to be retained on site in detention basin.
All flows of excess water from the 5 - 100 year events will be directed along the existing drainage
SEE SUBDIVISION GUIDE PLAN FOR DETAILS OF THE CONCEPT DRAINAGE STRATEGY
Existing surface water flows
Proposed surface water flow in the subdivision, linked to the existing flow paths.
See Subdivision Guide Plan for details

APPENDIX 3

Letter by Department of Fire & Emergency Services

Government of Western Australia
Department of Fire & Emergency Services

DFES
Department of Fire & Emergency Services

Our Ref: D00560
Your Ref: SJ1927

Helen Maruta
Shire of Serpentine Jarrahdale
info@sjshire.wa.gov.au

Dear Helen,

LOT 791 NO 84 WALKER ROAD SERPENTINE – LOCAL STRUCTURE PLAN – RESUBMISSION BMP V1.2

I refer to an email from Darrel Krammer of RUIC Fire Pty. Ltd. dated 16 February 2017 regarding the submission of a "Bushfire Management Plan" Version 1.2 submitted for the above structure plan.

The Department of Fire and Emergency Services (DFES) provide the following comments with regard to *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (SPP 3.7) and the *Guidelines for Planning in Bushfire Prone Areas* (Guidelines):

Emergency Access Ways (EAW) provide access to emergency vehicles and fire appliance traffic in addition to allowing two-wheeled drive vehicles for domestic access/egress. In order for DFES to provide a successful service to the community, we require access to properties in an efficient manner and have sufficient room to manoeuvre and operate appliances and emergency vehicles within the proximity of the emergency. The BMP currently shows gates on individual property lines and doesn't confirm if these portions of land will be ceded which defeats the purpose of requiring an EAW along the northern and southern boundaries of the structure plan. Whilst it is acknowledged that these procedural and operational details can be confirmed at subsequent stages of the planning process (subdivision and development) we request that the depiction of gates be removed from the relevant figures within the BMP.

Notwithstanding the above, DFES advises that the proponent has adequately identified issues arising from the bushfire hazard level assessment and considered how compliance with the bushfire protection criteria can be achieved within the submitted Bushfire Management Plan.

Should you require further information, please contact me on telephone number 9482 1761.

Yours sincerely

Sandeep Shankar
LAND USE PLANNING OFFICER

16 March 2017

DFES Advisory Services | 20 Southport Street, West Leederville WA 6007
Tel (08) 9482 1764 | Fax (08) 9395 9384 | advice@dfes.wa.gov.au | www.dfes.wa.gov.au
ABN 39 563 851 304

APPENDIX 4

Bushfire Management Plan
Version 1.4

Bushfire management plan/Statement addressing the Bushfire Protection Criteria coversheet

Site address: Lot 791 Walker Rd, Serpentine

Site visit: Yes ☑ No ☐

Date of site visit (if applicable): Day 28th Month April Year 2017

Report author: Darrel Krammer (Grad Cert Bushfire Protection) / Erika Dawson (Grad Dip Bushfire Protection)

WA BPAD accreditation level (please circle):

Not accredited ☐ Level 1 BAL assessor ☐ Level 2 practitioner ☐ Level 3 practitioner ☑

If accredited please provide the following.

BPAD accreditation number: 36371 Accreditation expiry: Month August Year 2018

Bushfire management plan version number: 1.4

Bushfire management plan date: Day 02nd Month November Year 2017

Client/business name: GE & JR Squire

	Yes	No
Has the BAL been calculated by a method other than method 1 as outlined in AS3959 (tick no if AS3959 method 1 has been used to calculate the BAL)?		✓
Have any of the bushfire protection criteria elements been addressed through the use of a performance principle (tick no if only acceptable solutions have been used to address all of the bushfire protection criteria elements)?	✓	

Is the proposal any of the following (see SPP 3.7 for definitions)?	Yes	No
Unavoidable development (in BAL-40 or BAL-FZ)		✓
Strategic planning proposal (including rezoning applications)	✓	
Minor development (in BAL-40 or BAL-FZ)		✓
High risk land-use		✓
Vulnerable land-use		✓

None of the above ☐

Note: Only if one (or more) of the above answers in the tables is yes should the decision maker (e.g. local government or the WAPC) refer the proposal to DFES for comment.

Why has it been given one of the above listed classifications (E.g. Considered vulnerable land-use as the development is for accommodation of the elderly, etc.)?

Report has been updated to include comments from DPLH. No bushfire modelling, performance solutions or other bushfire protection strategies have been modified since DFES referral. Building envelopes have been repositioned to minimize vegetation removal, this action has not increased the BAL rating on any lot to >BAL-29.

The information provided within this bushfire management plan to the best of my knowledge is true and correct:

Signature of report author  Date 02/11/2017

BAL ASSESSMENTS | BUSHFIRE MANAGEMENT PLANS | CONSULTANCY

RUIC FIRE

BUSHFIRE MANAGEMENT PLAN

Subdivision Application

Lot 791 Walker Rd, Serpentine

Version: 1.4 Reference: 5273 November 2017

Project Number:	5273
Project Name:	Lot 791 Walker Rd, Serpentine
Author:	Darrel Krammer, Grad Cert Bushfire Protection, BPAD33412, Level 2
Approved by:	Erika Dawson, Grad Dip Bushfire Protection, BPAD37361, Level 3
Version:	1.4
Date of issue:	02nd November 2017

Author:
Date: 02/11/2017

Approved by:
Date: 02/11/2017

In the signing the above, the author declares that this Bushfire Management Plan meets the requirements of State Planning Policy 3.7. This report supersedes all previous Bushfire Management Plans for the site.

DISCLAIMER AND LIMITATION

This report is prepared solely for **GE & JR Squire** (the 'proponent') and any future landowners of the subject lot(s)and is not for the benefit of any other person and may not be relied upon by any other person.

The mitigation strategies contained in this Bushfire Management Plan are considered to be prudent minimum standards only, based on the writer's experience as well as standards prescribed by relevant authorities. It is expressly stated that RUIC Fire and the writer do not guarantee that if such standards are complied with or if a property owner exercises prudence, that a building or property will not be damaged or that lives will not be lost in a bush fire.

Fire is an extremely unpredictable force of nature. Changing climatic factors (whether predictable or otherwise) either before or at the time of a fire can also significantly affect the nature of a fire and in a bushfire prone area it is not possible to completely guard against bushfire.

Further, the growth, planting or removal of vegetation; poor maintenance of any fire prevention measures; addition of structures not included in this report; or other activity can and will change the bushfire threat to all properties detailed in the report. Further, the achievement of the level of implementation of fire precautions will depend on the actions of the landowner or occupiers of the land, over which RUIC Fire has no control. If the proponent becomes concerned about changing factors then a new Fire Risk Management Plan should be requested.

To the maximum extent permitted by the law, RUIC Fire, its employees, officers, agents and the writer ("RUIC Fire") excludes all liability whatsoever for:

1. claim, damage, loss or injury to any property and any person caused by fire or as a result of fire or indeed howsoever caused;
2. errors or omissions in this report except where grossly negligent; and

the proponent expressly acknowledges that they have been made aware of this exclusion and that such exclusion of liability is reasonable in all the circumstances.

If despite the provisions of the above disclaimer RUIC Fire is found liable then RUIC Fire limits its liability to the lesser of the maximum extent permitted by the law and the proceeds paid out by RUIC Fire's professional or public liability insurance following the making of a successful claim against such insurer.

RUIC Fire accepts no liability or responsibility whatsoever for or in respect of any use or reliance upon this report and its supporting material by any third party.

This report is valid for a period of three years only from the date of its issue. All BAL ratings identified in this report are indicative and are required to be verified at the time of construction of individual buildings to ensure appropriate setbacks identified in the proposed development have been achieved.

RUIC Fire is a trading name of

Rural Fire Risk Consultancy Pty Ltd

ABN: 48 151 451 713

Contents Page

1.0 Introduction

1.1 Subject Site

The site the subject of this Bushfire Management Plan (BMP) is Lot 791 Walker Rd, Serpentine. The site is located within the municipality of the Shire of Serpentine Jarrahdale. Figure 1A illustrates the subject site and its immediate surrounds.

The site is identified as being Bushfire Prone on the State Bushfire Prone Maps.

The proponent has not identified any relevant environmental considerations (wetlands, foreshores, Bush Forever sites, remnant vegetation, threatened species, ecological communities, nature reserves or coastal reserves) within the site or being affected by the development.

1.2 Development Description

The development involves the subdivision of Lot 791 into 34 residential lots and one drainage lot (the development), with residential lots ranging in size from 4,000msq to 9,315msq as shown in Figure 1B.

The existing dwelling and shed will be retained within proposed lot 29, the existing dwelling within Lot 1 will be retained, and the existing shed within proposed Lot 30 will be demolished for the subdivision of the lot.

Access to the development will be from Walker Road and Windmill Ave until future development within lots north of the development provide further access arrangements. The broader area context of the subdivision is illustrated in Figure 1C.

1.3 Previous Bushfire Assessments

A previous Bushfire Management Plan (RUIC Fire, V1.3, March 2017) was endorsed by DFES for the proposed structure plan application. This BMP has been updated to address comments from the Department of Planning, Lands and Heritage (DPLH) dated 04th October 2017.

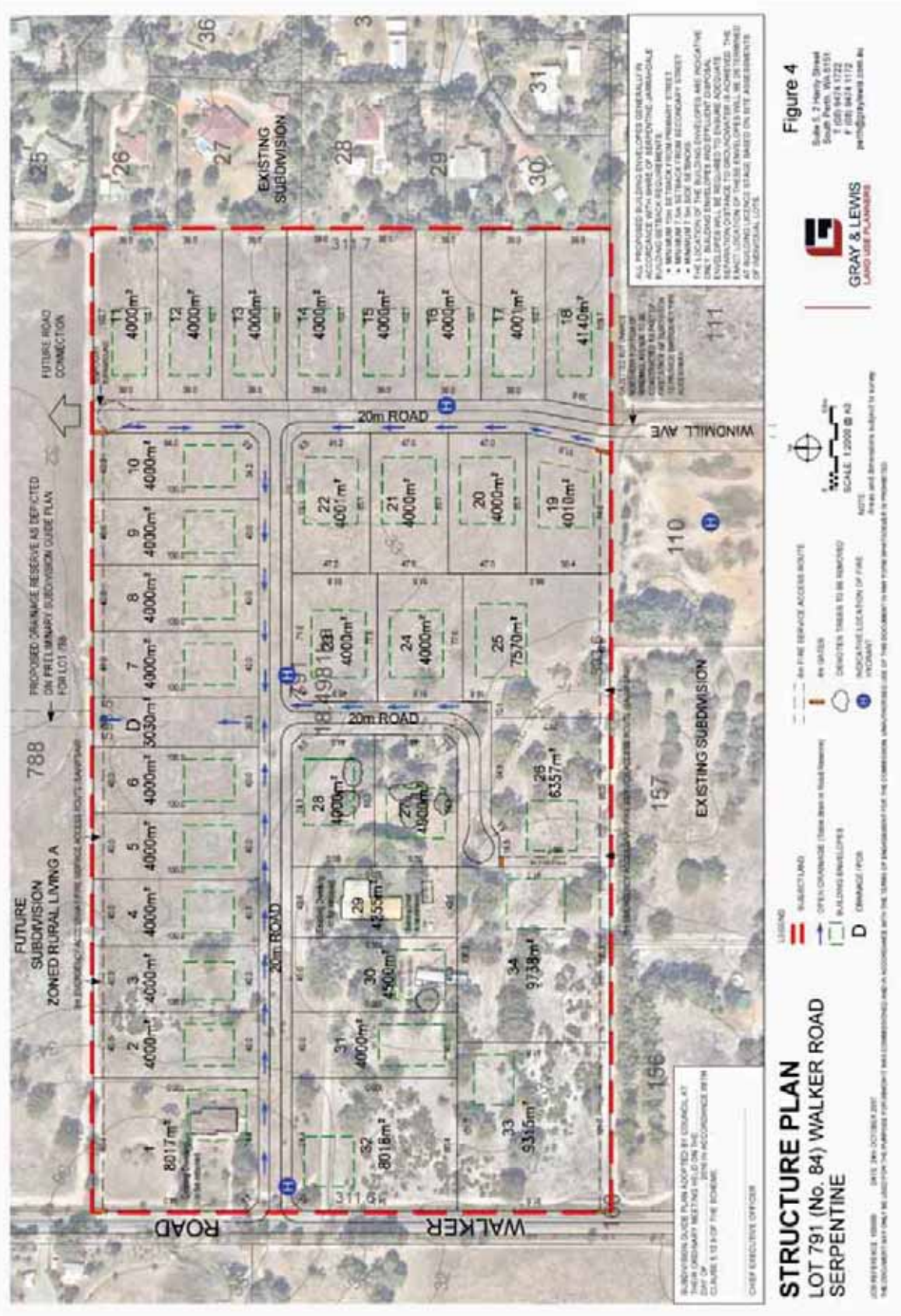


Figure 1A: Site Overview

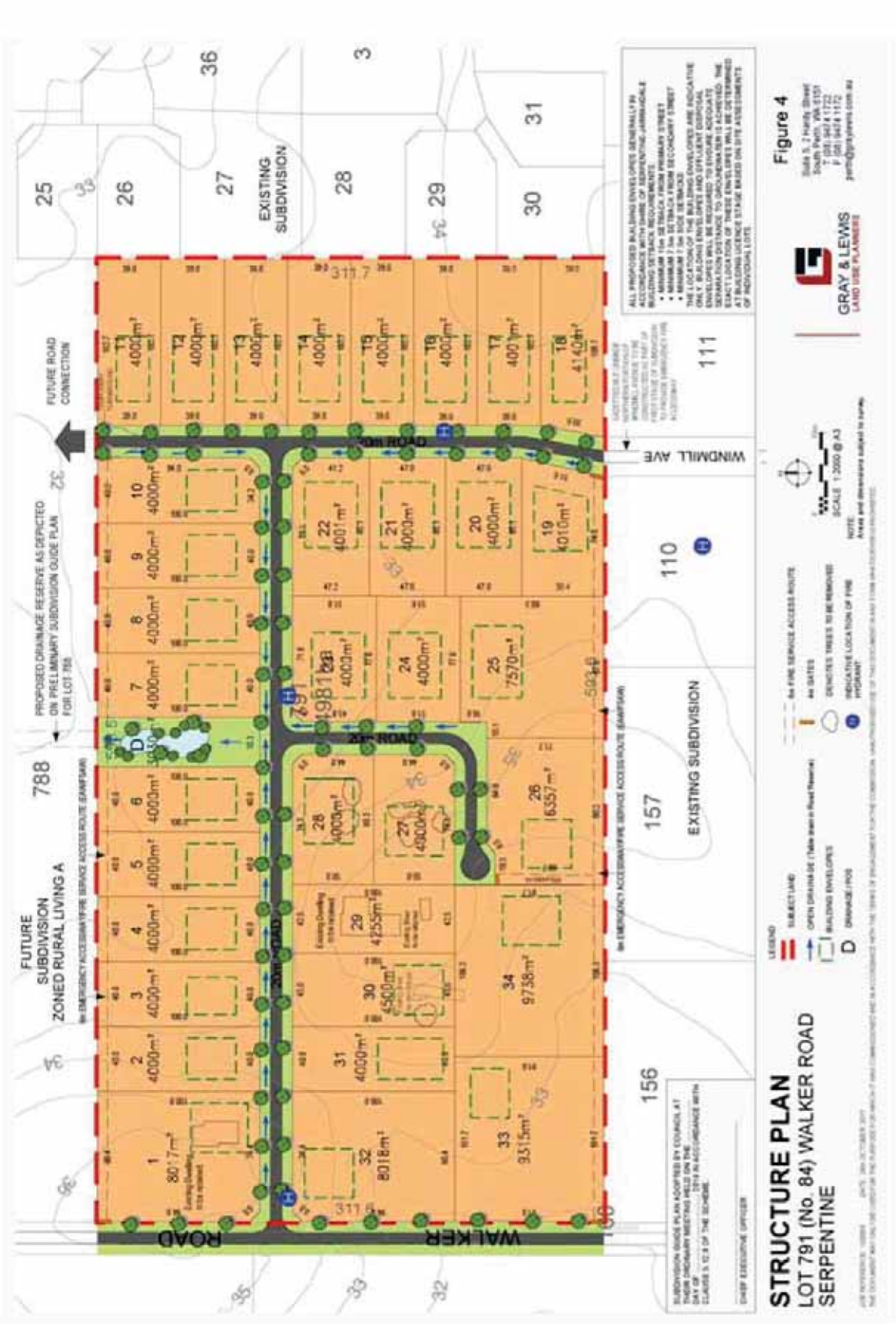


Figure 1B: Proposed Subdivision Plan

Figure 1C: Broader Area Context

2.0 Spatial consideration of bushfire threat

2.1 Bushfire Fuels and Potential Bushfire Impact

The location and extent of AS 3959 vegetation structures, including clause 2.2.3.2 low threat exclusions, within 100m of the site are mapped in Figures 2A – 2E, and illustrated in the associated Photos. Bushfire fuel loads are identified as consistent with AS 3959 Table B2 for radiant heat flux modelling purposes. All bushfire structures and fuel loads are assessed in their mature states (including revegetation and rehabilitation areas) unless otherwise identified.

Photo location and direction information is shown on Figure 2A.

Photo 1: Plot 1 Class C Shrub (background)

Photo 2: Plot 2 Class G Grassland

Photo 3: Plot 3 Class G Grassland (Open Woodland)

Photo 4: Plot 3 Class G Grassland (Open Woodland)

Photo 5: Plot 4 Low Threat Exclusions 2.2.3.2 (e)&(f)

Photo 6: Plot 4 Low Threat Exclusions 2.2.3.2 (e)&(f)

Photo 7: Plot 5 Class G Grassland (Open Woodland)

Photo 8: Plot 5 Class G Grassland (Open Woodland)

Photo 9: Plot 6 Low Threat Exclusions 2.2.3.2 (e)&(f)

Photo 10: Plot 6 Low Threat Exclusions 2.2.3.2 (e)&(f)

Photo 11: Plot 7 Class G Grassland

Photo 12: Plot 7 Class G Grassland

Photo 13: Plot 8 Class B Woodland (right side)

Photo 14: Plot 9 Low Threat Exclusions 2.2.3.2 (e)&(f)

Photo 15: Plot 9 Low Threat Exclusions 2.2.3.2 (e)&(f)

Photo 16: Plot 9 Low Threat Exclusions 2.2.3.2 (e)&(f)

Photo 16a: Plot 9 Low Threat Exclusions 2.2.3.2 (e)&(f)

Photo 16b: Plot 9 Low Threat Exclusions 2.2.3.2 (e)&(f)

Photo 17: Plot 10 Class B Woodland

Photo 18: Plot 11 Class G Grassland (Open Woodland)

Photo 19: Plot 12 Class B Woodland

Photo 20: Plot 13 Class G Grassland

Photo 21: Plot 14 Class B Woodland

Photo 22: Plot 14 Class B Woodland

The following table outlines the worst case BAL for each of the Plots based separation distance to the external site development boundary.

Table 2A: Maximum Existing BAL rating that applies to the site

Plot	Vegetation Classification	Effective Slope	Separation (m)	BAL Rating
1	Class C Shrubland	Flat/Upslope	65m	BAL-12.5
2	Class G Grassland	Flat/Upslope	0m	BAL-FZ
3	Open Woodland (assessed as Class G Grassland)	Flat/Upslope	0m	BAL-FZ
4	Excluded AS3959-2009 2.2.3.2 (e) & (f)	N/A	N/A	N/A
5	Open Woodland (assessed as Class G Grassland)	Flat/Upslope	3m	BAL-FZ
6	Excluded AS3959-2009 2.2.3.2 (e) & (f)	N/A	N/A	N/A
7	Class G Grassland	Flat/Upslope	3m	BAL-FZ
8	Class B Woodland	Flat/Upslope	55m	BAL-12.5
9	Excluded AS3959-2009 2.2.3.2 (e) & (f)	N/A	N/A	N/A
10	Class B Woodland	Flat/Upslope	50m	BAL-12.5
11	Open Woodland (assessed as Class G Grassland)	Flat/Upslope	3m	BAL-FZ
12	Class B Woodland	Flat/Upslope	3m	BAL-FZ
13	Class G Grassland	Flat/Upslope	3m	BAL-FZ
14	Class B Woodland	Flat/Upslope	42m	BAL-12.5

Potential bushfire impact analysis was undertaken in accordance with AS 3959 Methodology 1 to determine the potential worst case scenario radiant heat impact on the proposed lot boundaries for each of the lots in the proposed subdivision. In accordance with SPP 3.7, a BAL Contour Map has been prepared to illustrate the potential radiant heat impacts and associated BAL ratings for the assessment area after the development is completed (see Figure 2A).

In accordance with the Shire of Serpentine Jarrahdales' 2017/18 Firebreak Notice and Fuel Load Reduction Notice (October 2017), Appendix A, each lot is to meet the following requirements of Sections 1, 2 or 7:

1. *All areas of land 4047m2 (one acre) or less*

Requirement (a)

- *All grasses and flammable materials are to be maintained below 25mm in height by mowing or slashing or other means.*
- *All trees, bushes, shrubs are to be trimmed back over driveways and access ways to all buildings to four (4) metres wide with a clear vertical axis of not less than five (5) metres over it to afford access for emergency services to all structures and points of the property or provide firebreaks as per category 2.*

Fuel Hazard Reduction (b)

- *Remove fuels as per 1(a).*
- *Manage and maintain hazard separation zones*

Dwellings, Out Buildings (c)

- *Maintain 20m asset protection zones adjacent to all buildings and outbuildings.*
- *Trim back all overhanging trees from buildings.*

Duration: Compliance required on or before 30th November and maintained up to and including the 31st May each and every year.

2. *All areas of land greater than 4047m2 (one acre)*

Requirement (a)

- *Install trafficable, bare mineral earth firebreaks clear of all flammable material to a minimum of three (3) metres wide immediately inside all external boundaries and immediately surrounding all agricultural buildings, sheds or groups of buildings situated on the land.*
- *All overhanging branches, trees and limbs are to be trimmed back four (4) metres wide with a clear vertical axis of not less than five (5) metres over the firebreak area. This includes driveways and access to all buildings on the land.*
- *The maximum permissible width of a firebreak is five (5) metres unless otherwise approved in writing by Council or its duly authorised officer.*

- *Any development is to be sited not less than four (4) installation and maintenance of the firebreak area unless otherwise approved in writing by Council.*

Fuel Hazard Reduction (b)

- *Keep grasses short.*
- *Manage and maintain hazard separation zones*

Dwellings, Out Buildings (c)

- *Maintain 20m Asset Protection zones adjacent to all buildings and outbuildings or in accordance with land category 7.*
- *Trim back all overhanging trees from buildings.*

Duration: Compliance required on or before 30th November and maintained up to and including the 31st May each and every year.

7. Does your property have a Bushfire or Emergency Management Plan?

Requirement (a)

- *All properties with a bushfire management, emergency management plan or an approved Bushfire Attack Level (BAL) assessment approved as part of a Town Planning Scheme, subdivision approval, development approval or building permit for an individual or group of properties shall comply with the plan in its entirety.*
- *A bushfire management plan's requirements are in addition to the requirements of this notice.*

PENALTY: $5000.

Fuel Hazard Reduction (b)

- *In accordance with your Bushfire Management/Emergency Management Plan and/or Bushfire Attack Level assessment and this Firebreak Notice.*

Dwellings, Out Buildings (c)

- *• In accordance with your Bushfire Management/Emergency Management Plan and/or Bushfire Attack Level assessment and this Firebreak Notice.*

Duration: Compliance is required throughout the year, each and every year.

Therefore, in accordance with Section 7 of the Firebreak Notice and Fuel Load Reduction Notice, this BMP requires that the entirety of each lot is to have grassland maintained at <25mm, to be considered low threat and excludable from BAL assessment in accordance with AS3959-2009 Clause 2.2.3.2 (f). In order to balance environmental and biodiversity protection, trees are to be retained as far as is practicable, whilst meeting the requirements of A2.1 Asset Protection Zones (APZ), whereby trees are to be retained to ensure a canopy separation at maturity >15% and at least 5m between the canopies.

Whilst the building envelopes have been located to minimise tree removal, prior to future development within Lots 27 to 34, the landowners shall obtain an arborist report to recognise trees for retention, and to guide the establishment of the APZ with consideration for the environmental values of the flora.

The proposed subdivision would ensure that the specific location and separation distance from the classified vegetation threat ensures that the radiant heat impact on the building envelope boundaries does not exceed 29kW/m², therefore being consistent with A2.1 of the *Guidelines for Planning in Bushfire Prone Areas* (Guidelines).

Figure 2A outlines the maximum BAL applicable to each lot boundary post development. The worst case BAL for any proposed building envelope is BAL-29. This achieves the requirement of A1.1 of the Guidelines.

2.2 Bushfire Hazard Issues

From the BAL Contour Map, the following bushfire hazard issues have been identified.

- The building envelopes located within the following lots are subject to a radiant heat impact not exceeding BAL-29 equivalent; Lots 1, 11, 12, 17 to 19, 26 and 32 to 34. The remainder of the lots have the building envelopes located within BAL-LOW area.
- The site boundaries have a radiant heat impact greater than 29 kW/m² (applicable to the external lot boundaries) because of bushfire threats located external to and within the site.
- Future habitable building development is to be in areas with BAL-29 or lower BAL ratings.
- Future residential Class 1, 2, 3 and associated Class 10a buildings will be required to comply with the construction requirements of AS 3959-2009 (where applicable) and will be subject to relevant bushfire related planning conditions.
- Non-habitable development such as roads, low threat gardens, parking etc. may be located within BAL-40 and BAL-FZ areas.
- The BAL Contour map within this BMP is considered to be indicative only. A future BAL Contour Map is to be produced at the completion of civil works and final BAL ratings are to be confirmed post subdivision works, being prior to the building permit for any construction of any habitable buildings. Alternatively, a BAL assessment may be carried out for each individual lot.
- Any future landscaping or revegetation works proposed within the lots is to be designed so as not to increase the bushfire threat above BAL-29.
- As a condition for future Development Approval within individual Lots 26 to 34, landowners are required to obtain an arborist report to recognise trees for retention, and to guide the establishment of the APZ with consideration for the environmental values of the flora. Full landscape clearing of existing native vegetation is not permitted within lots with a total area >2047m².
- A Landscape and Vegetation Management Plan is required as a condition of subdivision to recognise existing vegetation to be retained, street tree planting, landscaping of drainage reserve and revegetation of all lots.
- A Revegetation Management Plan is required as a condition of subdivision to guide appropriate revegetation regarding bushfire risk management. This BMP will require updating at the subdivision stage of planning to account for landscaping and revegetation.

These issues are addressed in Section 4 of this report.

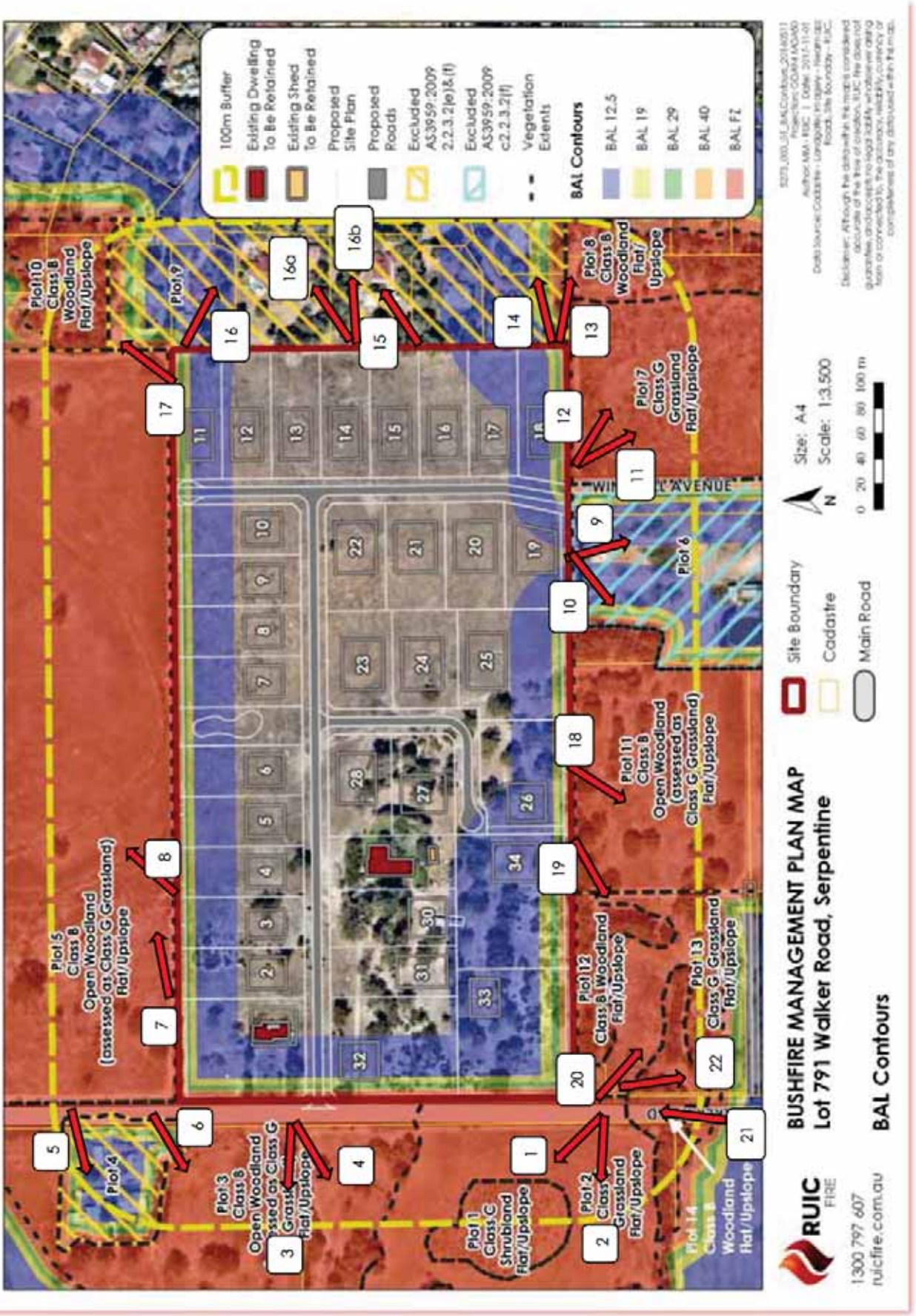


Figure 2A: BAL Contour Map

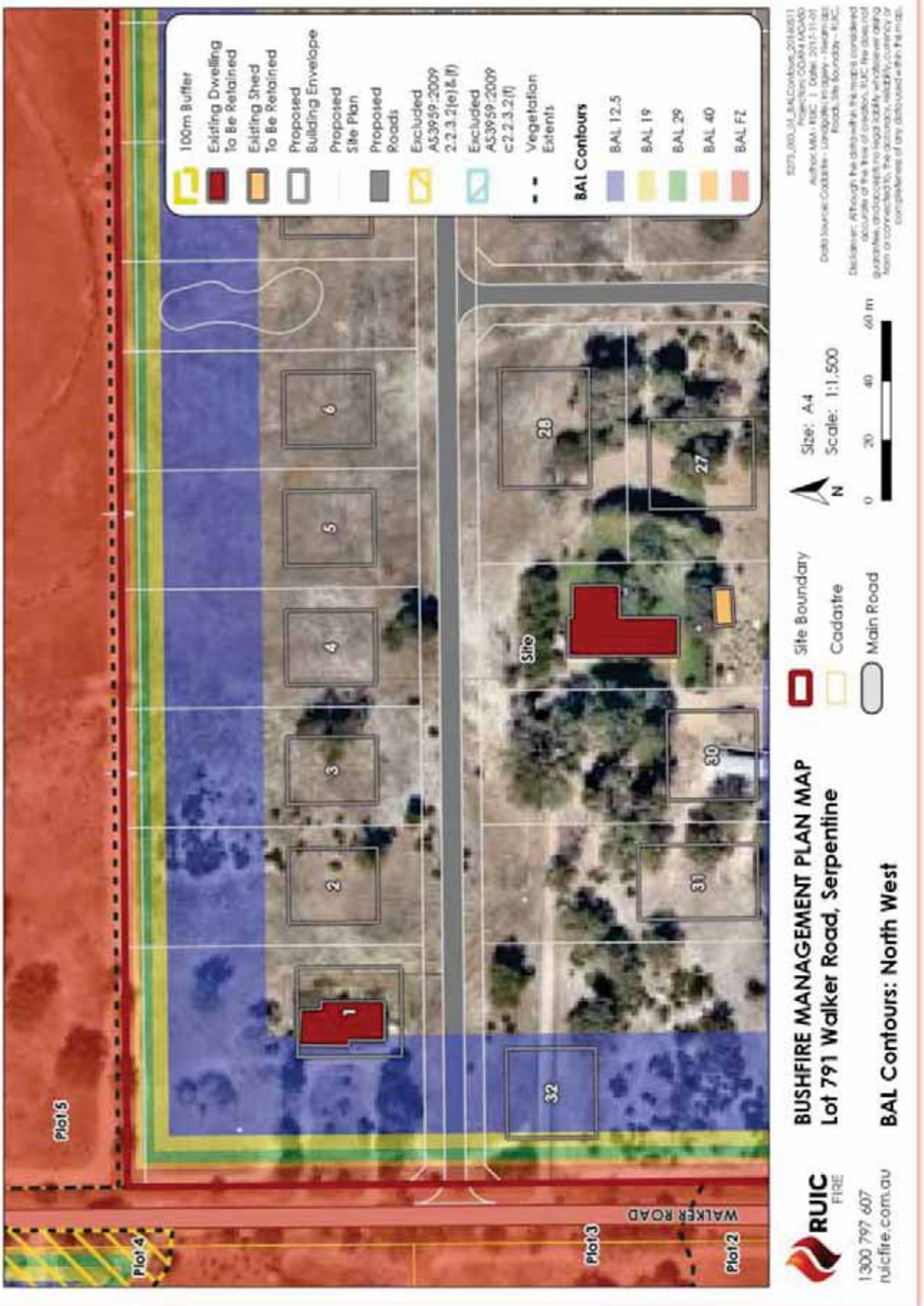


Figure 2B: BAL Contour Map (North West)

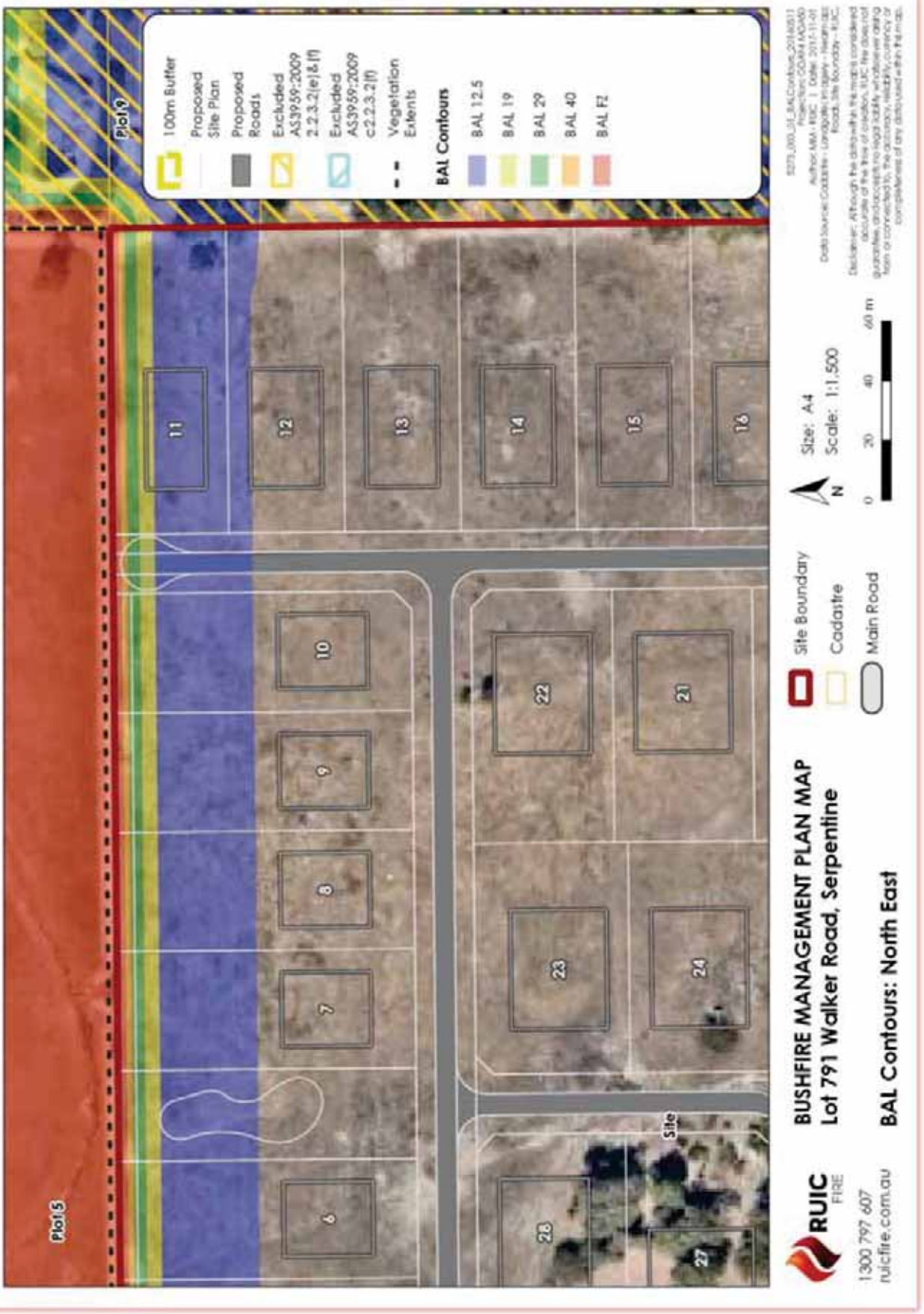


Figure 2C: BAL Contour Map (North East)

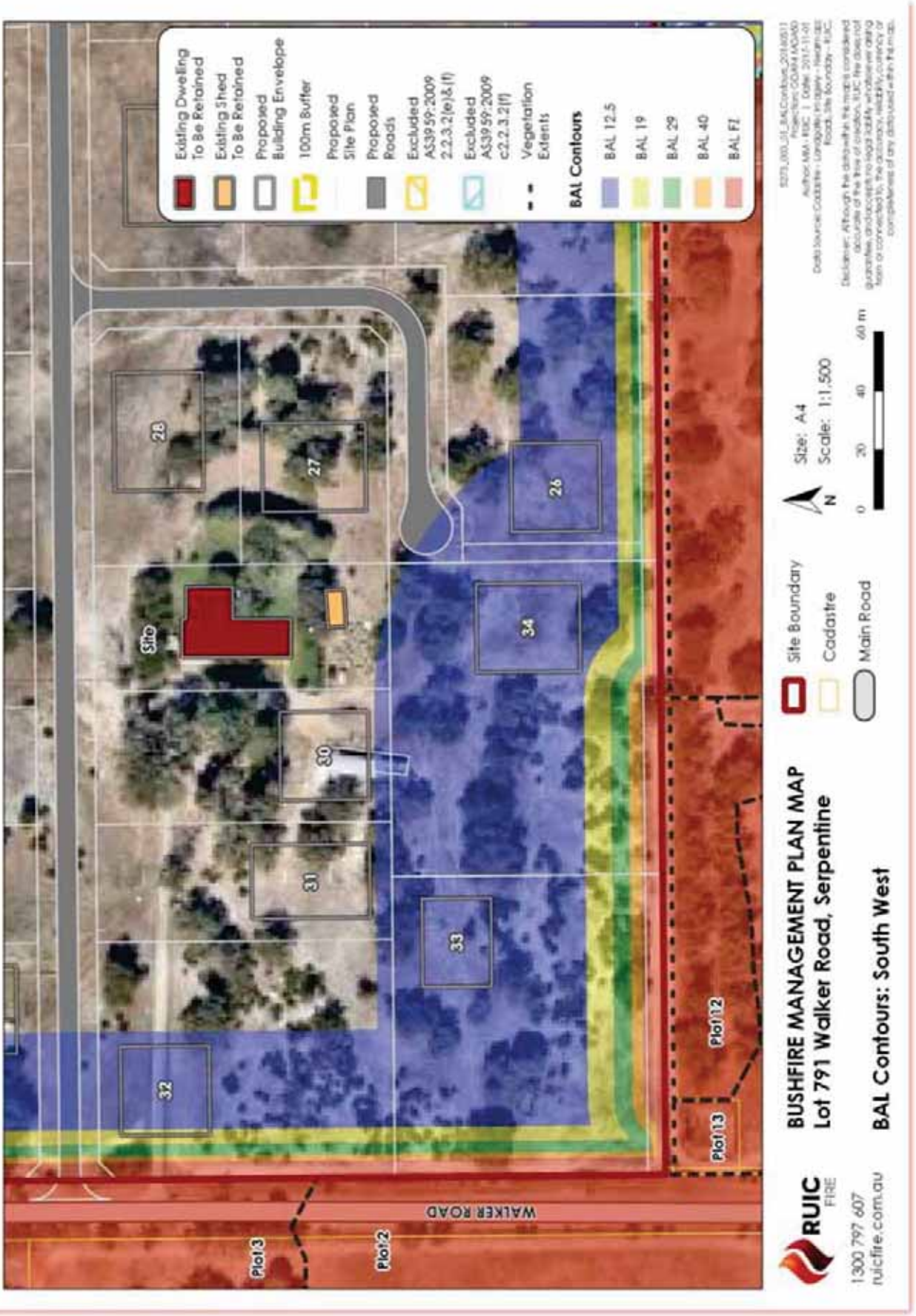


Figure 2D: BAL Contour Map (South West)

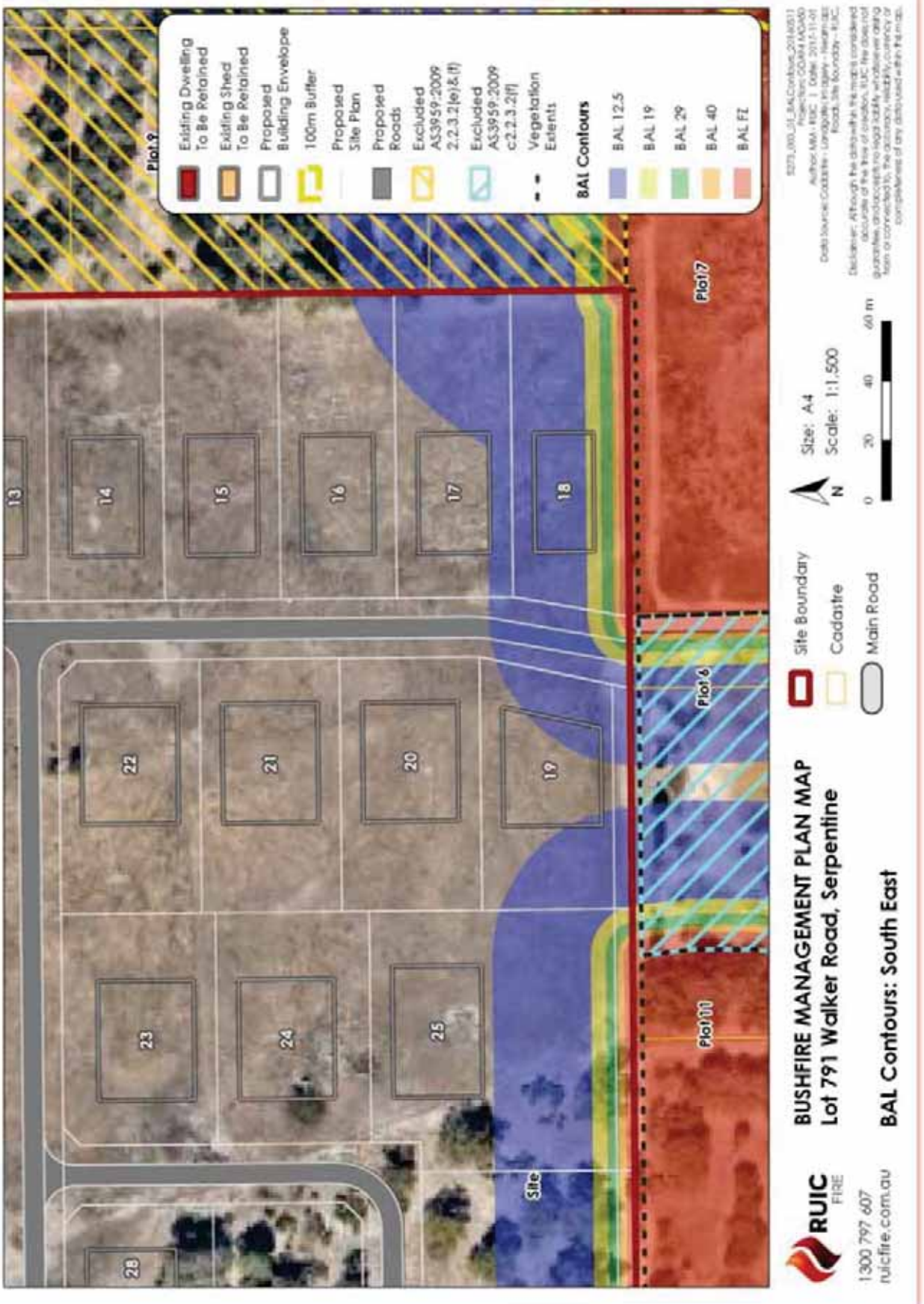


Figure 2E: BAL Contour Map (South East)

3.0 Proposal compliance and justification

3.1 State Planning Policy 3.7 – Planning in Bushfire Prone Areas (SPP 3.7)

SPP3.7 applies to all subdivision applications in designated bushfire prone areas.

3.1.1 Objectives

Policy Measure 5 contains the objectives of SPP3.7. The following demonstrates how the proposed development meets each of the objectives.

Objective 1: ***Avoid increasing the threat of bushfire to people, property, and infrastructure. The preservation of life and management of bushfire impact is paramount.***

Development Response

Objective 1 is satisfied through the compliance of the proposed development with all required Policy Principles as detailed below and all GPBPA Performance Principles as detailed in Section 4 of this report.

Objective 2: ***Reduce vulnerability to bushfire through the identification and consideration of bushfire risks in decision-making at all stages of the planning and development process.***

Development Response

Objective 2 is satisfied through the appropriate identification and assessment of all relevant bushfire hazards as detailed in Section 2 of this report, specifically the BAL Contour Mapping.

Objective 3: ***Ensure that higher order strategic planning documents, strategic planning proposals, subdivision and development applications take into account bushfire protection requirements and include specified bushfire protection measures.***

Development Response

Objective 3 is satisfied through the compliance of the proposed development with all required Policy Principles as detailed below and all GPBPA Performance Principles as detailed in Section 4 of this report.

Objective 4: ***Achieve an appropriate balance between bushfire risk management measures and, biodiversity conservation values, environmental protection and biodiversity management and landscape amenity, with consideration of the potential impacts of climate change.***

Development Response

Objective 4 is satisfied through the appropriate consideration of all biodiversity and environmental assets as detailed in Section 1 of this report in the development of bushfire related risk mitigation strategies detailed in Section 4 of this report.

3.1.2 Policy Measures

3.1.2.1 Subdivision Applications

Policy Measure 6.2 requires that subdivision applications within designated bushfire prone areas and that have a BAL above BAL-LOW are to comply with Policy Measure 6.4.

3.1.2.2 Information to Accompany Subdivision Applications

Policy Measure 6.4 applies to subdivision applications. It requires certain information to be provided with such applications. The following outlines where the required information has been provided.

Table 3A: Compliance of the proposed development with the Policy Measures of SPP 3.7.

Policy Measure	Description	Development Response
a	A BAL Contour Map to determine the indicative acceptable BAL ratings across the subject site, in accordance with the Guidelines. BAL Contour Maps should be prepared by an accredited Bushfire Planning Practitioner	Figures 2A-2F provide the BAL Contour Map.
b	The identification of any bushfire hazard issues arising from the BAL Contour Map;	Section 2.2 addresses the bushfire hazard issues.
c	An assessment against the bushfire protection criteria requirements contained within the Guidelines demonstrating compliance within the boundary of the subdivision site.	Section 4 provides an assessment of the development against the bushfire protection criteria.

3.1.2.3 Vulnerable or High Risk Land Uses

The proposed subdivision does not contain any vulnerable or high risk land uses.

3.1.2.4 Applications in BAL-40/BAL-FZ Areas

On completion of development, the developable building envelopes would not be subject to BAL-40 or BAL-FZ as outlined in Section 2.1.

3.1.2.5 Advice of State/Relevant Authority/s for Emergency Services to be Sought

The proposed subdivision:

- Complies with the SPP3.7 Policy measures;
- Does not propose any additional/alternative measures;
- Is a Strategic Planning Proposal; and
- Does not contain unavoidable development, vulnerable or high risk land uses.

Therefore, the advice of State/Relevant Authorities for Emergency Services **is required** to be sought for this application.

3.1.2.6 Advice of State/Relevant Agencies/Authorities for Environmental Protection to be Sought

The proposed subdivision:

- Is not known to propose clearing of vegetation within environmentally sensitive areas protected under State or Federal legislation;
- Is not known to propose clearing of locally significant native vegetation; and
- Does not abut vegetated land managed by that authority.

Therefore, the advice of State/Relevant Agencies/Authorities for Environmental Protection is not required to be sought for this application.

3.2 Guidelines for Planning in Bushfire Prone Areas V1.2 (Guidelines)

The Guidelines apply to subdivision applications located within designated bushfire prone areas. The Guidelines provide supporting information for implementation of SPP3.7. Specifically, they provide the Bushfire Protection Criteria to be address for all applications.

This report has also been developed in order to comply with the requirements of all referenced and applicable documents. No non-compliances have been identified.

4.0 Bushfire Risk Management Measures

The bush fire risk mitigation strategies detailed in this report are designed to comply with the Bushfire Protection Criteria detailed *in Guidelines for Planning in Bushfire Prone Areas Version 1.2* (the Guidelines) *Appendix 4* (WAPC, 2017b).

i. The notation (P3) refers to Performance Principle 3 of the Guidelines Appendix 4.

ii. The notation (A3.1) refers to Acceptable Solution 3.1 of the Guidelines Appendix 4.

iii. The notation (E3.1) refers to Explanatory Note 3.1 of the Guidelines Appendix 4.

iv. Where discrepancy occurs between State and Local bushfire planning provisions the higher standard of mitigation has been selected.

4.1 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.

Performance Principle (P1): The strategic planning proposal, subdivision and development application is located in an area where the bushfire hazard assessment is or will, on completion, be moderate or low, or a BAL–29 or below, and the risk can be managed. For unavoidable development in areas where BAL–40 or BAL–FZ applies, demonstrating that the risk can be managed to the satisfaction of the Department of Fire and Emergency Services and the decision-maker.

The following table outlines the Acceptable Solutions (AS) that are relevant to the proposal; identifies where a Performance Solution (PS) has been used instead of an AS; and states, where applicable, the reason why the AS is not relevant to the proposal.

Solution	AS	PS	N/A	Comment
A1.1 Development location	☒	☐	☐	

Acceptable Solution 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.

Development Response/Recommendations

As illustrated in Figures 2A-2E, the subdivision would ensure all future habitable buildings are, upon completion of development, able to be located in an area subject to BAL-29 or lower.

The entirety of each lot is to maintain grassland to <25mm and have treed areas comply with the requirements of A2.1 Asset Protection Zone.

4.2 Element 2 - Siting and design of Development

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

Performance Principle (P2): The siting and design of the strategic planning proposal, subdivision or development application, including roads, paths and landscaping, is appropriate

to the level of bushfire threat that applies to the site. That it minimises the bushfire risk to people, property and infrastructure, including compliance with AS 3959 if appropriate.

The following table outlines the Acceptable Solutions (AS) that are relevant to the proposal; identifies where a Performance Solution (PS) has been used instead of an AS; and states, where applicable, the reason why the AS is not relevant to the proposal.

Solution	AS	PS	N/A	Comment
A2.1 Asset Protection Zone	☒	☐	☐	

Acceptable Solution A2.1 Asset Protection Zone (APZ)

Every building is surrounded by an Asset Protection Zone (APZ), depicted on submitted plans, which meets the following requirements:

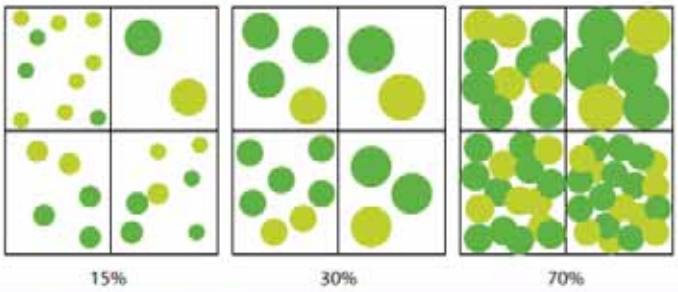
a. **Width**: Measured from any external wall or supporting post or column of the proposed building, and of sufficient size to ensure the potential radiant heat impact of a fire does not exceed 29kW/m² (BAL-29) in all circumstances.

b. **Location**: the APZ should be contained solely within the boundaries of the lot on which a 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).

c. **Management**: the APZ is managed in accordance with the requirements of *'Standards for Asset Protection Zones' (below):*

- **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.

Figure 16: Tree canopy cover – ranging from 15 to 70 per cent at maturity



Source: *The Guidelines (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 5m² 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.

Explanatory Notes:
An APZ is an area surrounding a building that is managed to reduce the bushfire hazard to an acceptable level. The width of the required APZ varies with slope and vegetation. The APZ should at a minimum be of sufficient size to ensure the potential radiant heat impact of a fire does not exceed 29kW/m² (BAL-29). It should be lot specific. Hazard separation in the form of using subdivision design elements (refer to E2) or excluded and low threat vegetation adjacent to the lot may be used to reduce the dimensions of the APZ within the lot.

The APZ includes a defendable space which is an area adjoining the asset within which firefighting operations can be undertaken to defend the structure. Vegetation within the defendable space should be kept at an absolute minimum and the area should be free from combustible items and obstructions. The width of the defendable space is dependent on the space which is available on the property, but as a minimum should be 3 metres.

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. The APZ may include public roads, waterways, footpaths, buildings, rocky outcrops, golf courses, maintained parkland as well as cultivated gardens in an urban context, but does not include grassland or vegetation on a neighbouring rural lot, farmland, wetland reserves and unmanaged public reserves.

Development Response/Recommendations

In accordance with Section 7 of the Firebreak Notice and Fuel Load Reduction Notice, this BMP requires that the entirety of each lot is to have grassland maintained at <25mm, to be considered low threat and excludable from BAL assessment in accordance with AS3959-2009 Clause 2.2.3.2 (f).

In order to balance environmental and biodiversity protection, trees are to be retained as far as is practicable, whilst meeting the requirements of A2.1 Asset Protection Zones (APZ), whereby trees are to be retained to ensure a canopy separation at maturity >15% and at least 5m between the canopies.

Figures 2A – 2E outline the maximum BAL rating applicable to each building envelope boundary post development. The worst case BAL for the development is BAL-19. Therefore, it can be seen that each of the proposed building envelopes are subject to less than the maximum radiant heat impact of 29kW/m², consistent with A2.1 of the Guidelines.

Implementation

i. APZs to be implemented as a condition of subdivision, in accordance with Figure 4A.

ii. It is the responsibility of the developer to ensure the APZ standard is established.

iii. It is the responsibility of the individual property owner to ensure the APZ standard continues to be achieved post completion of the construction.

Figure 4B: Bushfire Management Strategies

4.3 Element 3 - Vehicular Access

Intent: To ensure that the vehicular access serving a subdivision/ development is safe in the event of a bush fire occurring.

Performance Principle (P3): The internal layout, design and construction of public and private vehicular access in the subdivision/development allows emergency and other vehicles to move through it easily and safely at all times.

The following outlines the Acceptable Solutions that are relevant to the proposal, identifies where a Performance Solution has been utilised instead of an Acceptable Solution, and where the Acceptable Solution is not relevant to the proposal and why.

Solution	AS	PS	N/A	Comment
A3.1 Two Access Routes	☒	☐	☐	
A3.2 Public Road	☒	☐	☐	
A3.3 Cul-de-sacs (including dead-end road)	☐	☒	☐	Temporary and permanent cul-de-sacs proposed
A3.4 Battle-axe	☐	☐	☒	
A3.5 Private Driveway longer than 50 metres	☒	☐	☐	
A3.6 Emergency Access Way	☒	☐	☐	
A3.7 Fire Service Access Routes	☒	☐	☒	Dual purpose EAW/FSARs proposed
A3.8 Firebreak width	☒	☐	☐	

Acceptable Solution A3.1 Two access routes

Two different vehicular access routes are provided, both of which connect to the public road network, provide safe access and egress to two different destinations and are available to all residents/the public at all times and under all weather conditions.

Development Response/Recommendations

The site connects directly to Walker Rd to the west and Windmill Ave to the south of the site, both connecting to the wider public road network (Figure 4C). The greater public road network provides access to at least two directions, able to be used by all vehicles in all weather conditions. Once the surrounding lots to the north of the site are developed, the proposed subdivision will have additional road connections.

The site is constrained in that it is the first area to be developed as part of the LSP which connects directly to Walker Rd and Windmill Ave. No access to the east, from this development, is possible due to the existing urban/rural living development, or north due to undeveloped lots. Every lot is able to access Walker Rd and Windmill Ave via the main internal road network or via the temporary dual purpose emergency access ways (EAW)/fire service access routes (FSAR) along the north and south boundary's of the development.

As depicted on the Context Plan (Figure 1C), the land to the south has already been subdivided into Rural Living B lots. Windmill Ave to the south is a public gazetted road reserve right up to the southern boundary of Lot 791, and the road connection will be made as part of the proposed subdivision.

A temporary EAW will be provided parallel to the northern, and a permanent EAW along the southern, lot boundary's, providing access from Walker Rd to the temporary turnaround adjacent to Lots 11 and 12, and connecting to the proposed cul-de-sac within the centre of the development through Lot 27. Therefore the development meets the requirements of A3.1.

Figure 4C: Site Access

Acceptable Solution A3.2 Public roads

A public road is to meet the requirements in Table 4A, Column 1.

Table 4A: Vehicular access technical requirements

Technical Requirement	1 Public road	2 Cul-de-sac	3 Private driveway	4 Emergency access way	5 Fire service access routes
Minimum trafficable surface (m)	6	6	4	6	6
Horizontal clearance (m)	6	6	6	6	6
Vertical clearance (m)	4	N/A	4.5	4.5	4.5
Maximum grade over <50m	1 in 10	1 in 10	1 in 10	1 in 10	1 in 10
Minimum weight capacity (t)	15	15	15	15	15
Maximum crossfall	1 in 33	1 in 33	1 in 33	1 in 33	1 in 33
Curves minimum inner radius (m)	8.5	8.5	8.5	8.5	8.5

Development Response/Recommendations

Public roads within the development will be constructed to meet the standards within Table 4A, column 1, thereby meeting the requirements of A3.2

Implementation

i. Public roads are to be constructed prior to subdivision clearance.

ii. It is the responsibility of the developer to ensure that public roads are constructed to the applicable standard.

iii. It is the responsibility of the local government to ensure public roads are maintained to the applicable standard after completion of the construction.

Acceptable Solution A3.3 Cul-de-sac (including a dead-end road)

A cul-de-sac and/or a dead end road should be avoided in bushfire prone areas. Where no alternative exists (i.e. the lot layout already exists and/or will need to be demonstrated by the proponent), the following requirements are to be achieved:

a. Requirements in Table 4A, Column 2;

b. Maximum length: 200 metres (if public emergency access is provided between cul-de-sac heads maximum length can be increased to 600 metres provided no more than eight lots are serviced and the emergency access way is no more than 600 metres); and

c. Turn-around area requirements, including a minimum 17.5 metre diameter head.

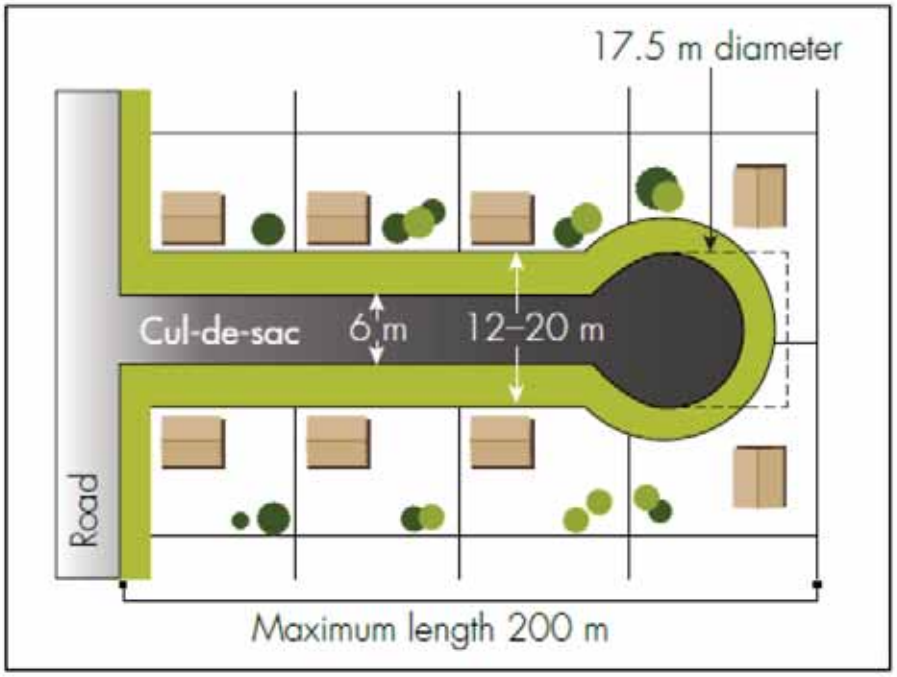


Figure 4D: Cul-de-sac standards

Development Response/Recommendations

One temporary cul-de-sac and one permanent cul-de-sac are proposed for the development.

The temporary cul-de-sac will be removed and the road network connected to proposed road connections through future development in the northern adjoining lots. The temporary cul-de-sac will be directly connected via a dual purpose EAW/FSAR along the northern boundary of all lots, through to Walker Rd (approx. 470m). The temporary cul-de-sac is approximately 90m and services two (2) lots.

Additionally, temporary signage shall be placed at the intersection of the roads to indicate that the northern public road portion is a no through road and for local traffic only.

The permanent cul-de-sac is approximately 175m long and services seven (7) lots. A portion of the proposed cul-de-sac is located within a BAL-12.5 area by only approximately 20m and the direction of travel of the cul-de-sac moves all vehicles to the north into BAL-LOW areas. All lots within the subdivision are to be maintained as low threat, therefore access is via areas of no bushfire threat. This is not considered to be prohibitive of development.

The permanent cul-de-sac is also connected by a dual purpose EAW/FSAR, via Lot 27 to both Walker Road (approx. 270m) and Windmill Avenue (approx. 315m).

In recognising that cul-de-sacs within bushfire prone areas are not preferred, a permanent EAW/FSAR is provided along the southern boundary, and a temporary EAW/FSAR along the north boundary, to provide alternate access until future development removes the need for temporary cul-de-sac.

All cul-de-sacs will meet the construction requirements of Table 4A, Column 2 and Figure 4D, therefore complying with A3.3.

Implementation

i. Cul-de-sacs are to be constructed prior to subdivision clearance.

ii. It is the responsibility of the developer to ensure that cul-de-sacs are constructed to the applicable standard.

iii. It is the responsibility of the local government owner to ensure cul-de-sacs are maintained to the applicable standard after completion of the construction.

Acceptable Solution A3.4 Battle-axe

Development Response/Recommendations

No battle-axe lots are proposed for the development

Acceptable Solution 3.5 Private Driveway longer than 50 metres

A private driveway is to meet all of the following requirements:

a. Requirements in Table 4A, Column 3;

b. Required where a house site is more than 50 metres from a public road;

c. Passing bays: every 200 metres with a minimum length of 20 metres and a minimum width of two metres (i.e. the combined width of the passing bay and constructed private driveway to be a minimum six metres);

d. Turn-around areas designed to accommodate type 3.4 fire appliances and to enable them to turn around safely every 500 metres (i.e. kerb to kerb 17.5 metres) and within 50 metres of a house; and

e. Any bridges or culverts are able to support a minimum weight capacity of 15 tonnes.

f. All-weather surface (i.e. compacted gravel, limestone or sealed).

Development Response/Recommendations

The development will have multiple house sites that are more than 50m from a public road. All private driveways will allow for two-way access and have a minimum width of 6m carriageway. Turn around areas will be designed to enable a 3.4 fire appliance to turn around safely within 50m of a house.

Implementation

i. To be constructed prior to the occupancy of any habitable dwellings on the subject lots.

ii. It is the responsibility of the individual land owner to ensure the private driveway meets the required standard.

iii. It is the responsibility of the individual land owner to ensure the private driveway continues to meet the required construction standard.

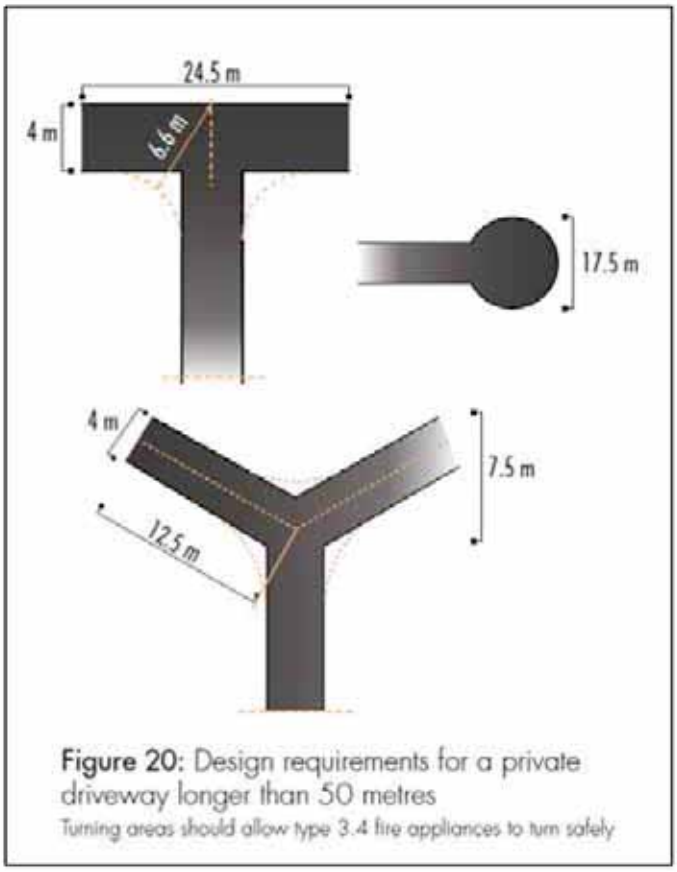


Figure 20: Design requirements for a private driveway longer than 50 metres
Turning areas should allow type 3.4 fire appliances to turn safely

Figure 4E: Private driveway turnaround area standards

Acceptable Solution 3.6 Emergency Access Way (EAW)

An access way that does not provide through access to a public road is to be avoided in bushfire prone areas. Where no alternative exists (this will need to be demonstrated by the proponent), an emergency access way is to be provided as an alternative link to a public road during emergencies. An emergency access way is to meet all of the following requirements:

a. Requirements in Table 4, Column 4;

b. No further than 600 metres from a public road;

c. Provided as right of way or public access easement in gross to ensure accessibility to the public and fire services during an emergency; and

d. Must be signposted.

Development Response/Recommendations

One temporary (north) and one permanent (south) EAW is to be installed in the locations shown on Figure 4B as part of the development and the north EAW is to remain in place at least until such a time as development occurs within the northern adjoining lots that provides for additional access routes.

The EAW's will also serve as a dual purpose FSAR.

Implementation

i. To be constructed prior to the clearance of the subdivision conditions.

ii. It is the responsibility of the developer to ensure the EAW meets the required standard.

iii. It is the responsibility of the individual landowners to ensure their portion of the EAW is maintained to the required standard.

Acceptable Solution 3.7 Fire Service Access Routes (Perimeter Roads)

Fire service access routes are to be established to provide access within and around the edge of the subdivision and related development to provide direct access to bushfire prone areas for fire fighters and link between public road networks for firefighting purposes. Fire service access routes are to meet the following requirements:

a. Requirements Table 4, Column 5;

b. Provided as right of ways or public access easements in gross to ensure accessibility to the public and fire services during an emergency;

c. Surface: all-weather (i.e. compacted gravel, limestone or sealed)

d. Dead end roads are not permitted;

e. Turn-around areas designed to accommodate type 3.4 appliances and to enable them to turn around safely every 500 metres (i.e. kerb to kerb 17.5 metres);

f. No further than 600 metres from a public road;

g. Allow for two-way traffic and;

h. Must be signposted.

Development Response/Recommendations

Dual purpose EAW/FSAR are proposed as part of the subdivision along the north and south boundaries, to provide fire service access to the bushfire threats located within adjoin lots.

FSAR are not considered necessary along the eastern boundary of the subdivision as the lots abut managed existing residential lots, compliant with the Shires Firebreak Notice and consistent with AS3959-2009 exclusion 2.2.3.2 (f).

Additionally a FSAR is not considered necessary along the north boundary of Lot 12, as access to the bushfire vegetation to the north can be gained from the public road or via the internal firebreaks to be established within the lot.

The northern FSAR is considered temporary, only until such a time that development within the abutting northern lots removes all bushfire prone vegetation.

Implementation

i. To be constructed prior to the clearance of the subdivision conditions.

ii. It is the responsibility of the developer to ensure the FSAR meets the required standard.

iii. It is the responsibility of the individual landowners to ensure their portion of the EAW is maintained to the required standard.

Acceptable Solution A3.8 Firebreak width

Lots greater than 0.5 hectares must have an internal perimeter firebreak of a minimum width of three metres or to the level as prescribed in the local firebreak notice issued by the local government.

Development Response/Recommendations

Firebreaks are to be installed in accordance with the annual Shire of Serpentine-Jarrahdale Firebreak Notice and Fuel Hazard Reduction Notice, as amended, and outlined for 2017/18, Section 2, for all land greater than 4047m² (one acre), as follows.

a) Standard:

i. Install trafficable, bare mineral earth firebreaks clear of all flammable material to a minimum of three (3) metres wide immediately inside all external boundaries and immediately surrounding all buildings, sheds or groups of buildings situated on the land.

ii. All overhanging branches, trees and limbs are to be trimmed back four (4) metres wide with a clear vertical axis of not less than five (5) metres over the firebreak area. This includes driveways and access to all buildings on the land.

iii. The maximum permissible width of a firebreak is five (5) metres unless otherwise approved in writing by Council or a duly authorised officer.

iv. Any development is to be sited not less than four (4) metres from the perimeter fencing of the lot to allow installation and maintenance of the firebreak area unless otherwise approved in writing by Council.

Implementation

i. To be constructed prior to the clearance of the subdivision conditions.

ii. It is the responsibility of the developer to ensure the firebreaks meets the required standard until sale of the individual lot.

iii. It is the responsibility of the individual landowners to ensure the firebreaks are maintained to the required standard.

4.4 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.

Performance Principle (P4): The subdivision, development or land use is provided with a permanent and secure water supply that is sufficient for firefighting purposes.

The following outlines the Acceptable Solutions that are relevant to the proposal, identifies where a Performance Solution has been utilised instead of an Acceptable Solution, and where the Acceptable Solution is not relevant to the proposal and why.

	Solution	AS	PBS	N/A	Comment
A4.1	Reticulated Areas	☒	☐	☐	
A3.2	Non-reticulated Areas	☐	☐	☒	Reticulated water supply available
A3.3	Individual lots within non-reticulated areas	☐	☐	☒	Reticulated water supply available

Acceptable Solution 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.

Development Response/Recommendations

The site is to be serviced by reticulated scheme water and firefighting hydrants, to DFES standards and Water Corporation DS63, satisfying Acceptable Solution A4.1.

Implementation

i. To be constructed prior to the clearance of the subdivision conditions.

ii. It is the responsibility of the developer to ensure the fire hydrants meet the required standard.

iii. It is the responsibility of the water corporation the fire hydrants are maintained to the required standard.

Acceptable Solution A4.2 Non-reticulated areas

Development Response/Recommendations

N/A – Reticulated water supply available.

Acceptable Solution A4.3 Individual lots within non-reticulated areas (Only for use if creating one additional lot and cannot be applied cumulatively)

Development Response/Recommendations

N/A – Reticulated water supply available.

5.0 Implementation and Enforcement

Table 5A summarises the responsible party for each mitigation strategy and the time frame in which it must be completed.

Table 5A: Developer Schedule of Works

Strategy	Implementation		Maintenance	
	Responsible	Time Frame	Responsible	Time Frame
Amendments to BMP	Any amendments to this BMP shall be approved by the relevant Jurisdiction Having Authority.			
Asset Protection Zone	Developer	Prior to subdivision clearance	Individual Land Owners	Ongoing
Construction to AS 3959	Individual Land Owners & Local Government	On construction of all new habitable buildings	Individual Land Owners	Ongoing
Cul-de-sacs	Developer	Prior to clearance of subdivision conditions	Local Government	Ongoing
Battle Axes	N/A	N/A	N/A	N/A
Private Driveways & Turnaround Areas	Individual Land Owners	Prior to occupation of all habitable buildings	Individual Land Owners	Ongoing
Emergency Access Ways	Developer	Prior to clearance of subdivision conditions	Individual Land Owners	Ongoing for southern, north until future development north of the site provides additional access
Fire Service Access Routes	Developer	Prior to clearance of subdivision conditions	Individual Land Owners	Ongoing for southern, north until future development north of the site removes bushfire prone vegetation
Firebreaks	Developer	Prior to clearance of subdivision conditions	Individual Land Owners	Ongoing
Firefighting Water (hydrants)	Developer	Prior to clearance of subdivision conditions	Water Corporation	Ongoing
Firefighting Water (private tanks)	N/A	N/A	N/A	N/A

Strategy	Implementation		Maintenance	
	Responsible	Time Frame	Responsible	Time Frame
Firefighting Services & Response	DFES and Local Government	Ongoing	DFES and Local Government	Ongoing
Fuel Load Reduction and Fire Break Notice	Local Government	Ongoing	Local Government	Ongoing
Inspection and Issue of Works Orders or Fines.	Local Government	Ongoing	Local Government	Ongoing

6.0 References

Shire of Serpentine-Jarrahdale (2017). Firebreak Notice and Fuel Hazard Reduction Notice.

Shire of Serpentine-Jarrahdale (2016). Town Planning Scheme No.2.

Standards Australia. (2009). AS 3959:2009 Construction of buildings in bushfire prone areas: SAI Global.

WAPC. (2006). State Planning Policy 3.4 Natural Hazards and Disasters. State Law Publisher.

WAPC. (2015a). State Planning Policy 3.7 Planning in Bushfire Prone Areas. Western Australian Planning Commission & Department of Planning.

WAPC. (2017a). Guidelines for Planning in Bushfire Prone Areas Version 1.2. Western Australian Planning Commission, Department of Planning & Department of Fire and Emergency Services.

WAPC. (2017b). Guidelines for Planning in Bushfire Prone Areas Appendices Version 1.2. Western Australian Planning Commission, Department of Planning & Department of Fire and Emergency Services.

WAPC. (2016). Planning Bulletin 111/2016 Planning in Bushfire Prone Areas. Western Australian Planning Commission.

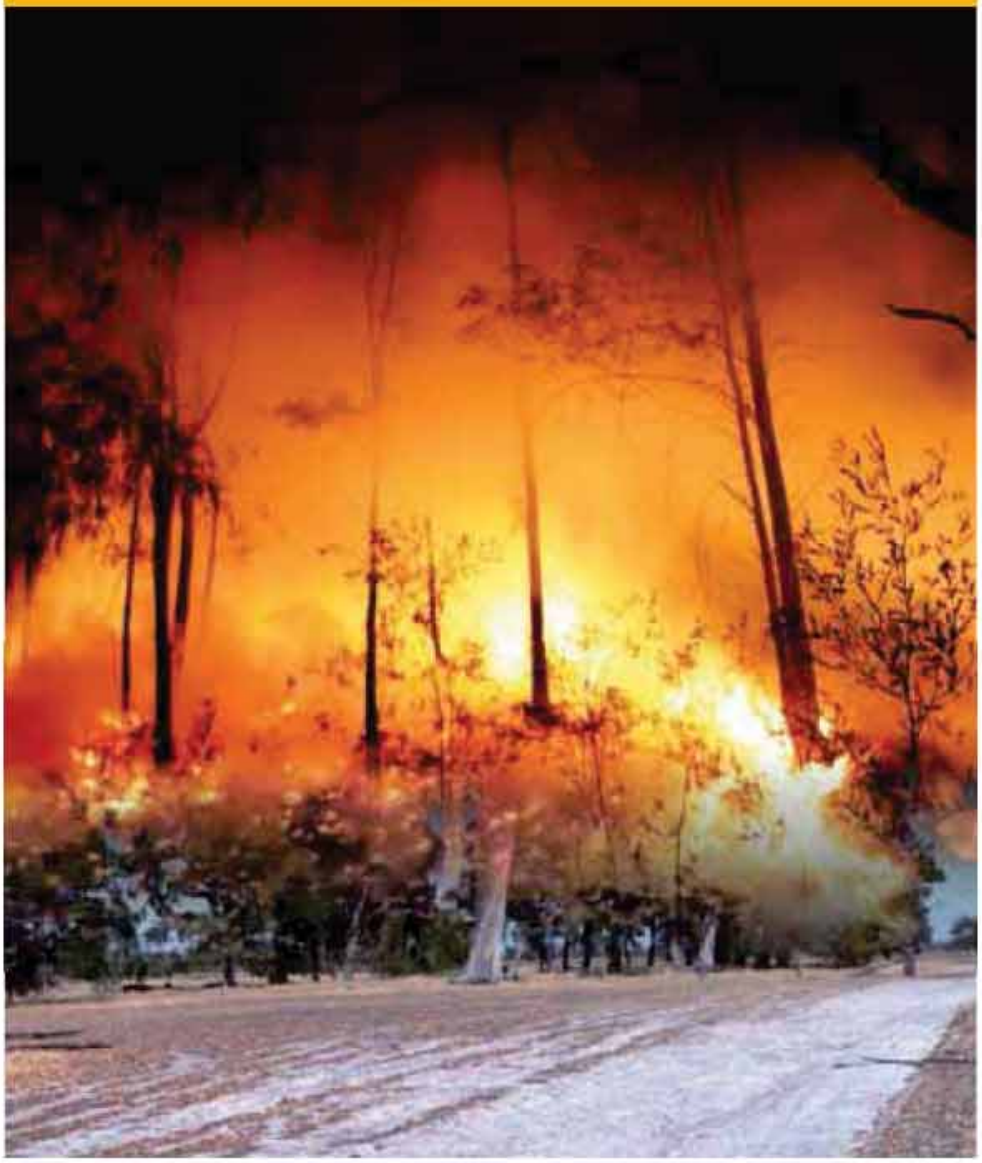
7.0 Appendix A – 2017/18 Firebreak Notice

Notice is hereby served to all residents and ratepayers of the Shire of Serpentine Jarrahdale

Firebreak Notice and Fuel Hazard Reduction Notice

Your legal responsibilities and fire safety information

Failure to install and maintain firebreaks in accordance with this notice may result in a $5,000 fine



This Notice and information has effect from 1 October 2017.
All previous Firebreak Notices are hereby cancelled.
By order of Council, KR Donohoe, Chief Executive Officer

Shire of Serpentine Jarrahdale

Contents

Important dates

Restricted Burning Period commences* ____ 1 October

Variation to Firebreak Notice completed by ____ 31 October

Variation to Firebreak Notice, as approved by council, to be complied with by ____ 15 November

Firebreak Installed by ____ 30 November

Prohibited Burning Period commences* ____ 1 December

Maintenance of Firebreaks ____ 1 December to 31 May

Prohibited burning period ends as Restricted Burning Period commences* ____ 1 April

Restricted Burning Period finishes* ____ 31 May

*Subject to seasonal changes - check with the Shire of Serpentine Jarrahdale

TO REPORT ANY FIRE: DIAL 000

Don't come home to this...

...or this

FIREBREAK NOTICE

Good firebreaks must be clear of everything - it may save a life.

BUSH FIRES ACT 1954
Shire of Serpentine Jarrahdale

PLEASE READ CAREFULLY

THESE ARE YOUR LEGAL REQUIREMENTS

Action is required by all property owners to comply with this notice.

Pursuant to the powers contained in Section 33 of the Bush Fires Act 1954 (as amended) all land owners/occupiers within the Shire of Serpentine Jarrahdale are hereby required in accordance with the following categories to maintain the land for such duration and in such positions/dimensions and specifications as required by this Notice or approved in writing by Council or its authorised officer.

Failure to comply may result in a $5,000 fine

Definitions

"Asset protection zone" means an area with a radius of twenty (20) metres measured from the external perimeter of the building or as stated in your approved BAL assessment, within the boundaries of the lot on which the building is situated. Fuel loads in this zone should be reduced and maintained to a fuel loading of two (2) tonnes per hectare."

"Firebreak" means a strip of land that has been cleared of all trees, bushes, grasses and any other object or thing or flammable vegetation material leaving clear bare mineral earth. This includes the trimming back of all overhanging trees, bushes, shrubs and any other object or thing over the fire break area.

"Flammable" means any bush, plant, tree, grass, vegetation, object, thing or material that may or is likely to catch fire and burn.

"Hazard separation zone" means an area with a radius of eighty (80) metres measured from the outer edge of the Asset Protection Zone, within the boundaries of the lot on which the building is situated. Fuel loads in this zone should be reduced and maintained to a fuel loading of eight (8) tonnes per hectare.

"Trafficable" means to be able travel from one point to another in a 4x4 fire vehicle on a firm and stable surface, unhindered without any obstruction that may endanger resources, no firebreak is to terminate without provision for egress to a safe place or a cleared turn around area of not less than a 21 meter radius (prior written approval from council is required).

"Vertical axis" means a continuous vertical uninterrupted line at a right angle to the horizontal line of the firebreak.

"Duration" means the period of time stipulated in categories 1-7 on the following pages.

YOUR LEGAL REQUIREMENTS

1. All areas of land 4047m2 (one acre) or less

Requirement (a)

- All grasses and flammable materials are to be maintained below 25mm in height by mowing or slashing or other means.
- All trees, bushes, shrubs are to be trimmed back over driveways and access ways to all buildings to four (4) metres wide with a clear vertical axis of not less than five (5) metres over it to afford access for emergency services to all structures and points of the property or provide firebreaks as per category 2.

Fuel Hazard Reduction (b)

- Remove fuels as per 1(a).
- Manage and maintain hazard separation zones

Dwellings, Out Buildings (c)

- Maintain 20m asset protection zones adjacent to all buildings and outbuildings.
- Trim back all overhanging trees from buildings.

More information pages 12-19.

Duration: Compliance required on or before 30th November and maintained up to and including the 31st May each and every year.

2. All areas of land greater than 4047m2 (one acre)

Requirement (a)

- Install trafficable, bare mineral earth firebreaks clear of all flammable material to a minimum of three (3) metres wide immediately inside all external boundaries and immediately surrounding all agricultural buildings, sheds or groups of buildings situated on the land.
- All overhanging branches, trees and limbs are to be trimmed back four (4) metres wide with a clear vertical axis of not less than five (5) metres over the firebreak area. This includes driveways and access to all buildings on the land.
- The maximum permissible width of a firebreak is five (5) metres unless otherwise approved in writing by Council or its duly authorised officer.
- Any development is to be sited not less than four (4) metres from the perimeter fencing of the lot to allow installation and maintenance of the firebreak area unless otherwise approved in writing by Council.

Fuel Hazard Reduction (b)

- Keep grasses short.
- Manage and maintain hazard separation zones

Dwellings, Out Buildings (c)

- Maintain 20m Asset Protection zones adjacent to all buildings and outbuildings or in accordance with land category 7.
- Trim back all overhanging trees from buildings.

More information pages 12-19.

Duration: Compliance required on or before 30th November and maintained up to and including the 31st May each and every year.

3. Application to vary firebreak

Requirement (a)

- If you consider you cannot clear firebreaks as required by this Notice, you may apply in writing to Council on or before 31st day of October in any given year requesting permission to provide firebreaks in an alternative position or take alternative action to comply with this Firebreak Notice. If Council or its authorised officer does not grant permission for your variation or your variation is cancelled, you shall comply with the requirements of this Notice in its entirety.
- Variations to the Firebreak Notice once approved will not be required to be applied for each subsequent year after granting. Variation to firebreak notice approvals are provided to the property owner, not the land.
- To apply for a Variation please call 9526 1111 and request a Variation to Firebreak Notice Kit.

Fuel Hazard Reduction (b)

- In accordance with your approved Variation to Firebreak Notice.

Dwellings, Out Buildings (c)

- In accordance with your approved Variation to Firebreak Notice.

More information pages 20-22.

Duration: Compliance required on or before 15th November and maintained up to and including the 31st May each and every year.

4. Plantations

Requirement (a)

- All plantations shall comply with Councils conditions of approval and/or the approved Bushfire Management Plan and this firebreak notice.
- Install bare mineral earth trafficable firebreaks clear of all flammable material to a minimum of twenty (20) metres wide immediately inside all external boundaries of the land with all overhanging branches, trees, limbs, etc to be trimmed back to a clear vertical axis over the firebreak area.
- Install bare mineral earth trafficable firebreaks to a minimum of twenty (20) metres wide immediately surrounding all buildings, sheds and haystacks or groups of buildings situated on the land.
- All overhanging branches, trees, limbs etc. to be trimmed back to a clear vertical axis over the firebreak area.
- If a new structure is applied for then AS3959 applies.

Fuel Hazard Reduction (b)

- Firebreaks to remain clear of all flammable material.

Dwellings, Out Buildings (c)

- Comply with AS3959.
- Comply with approved conditions of approval and/or Bushfire Management Plan.
- Maintain firebreaks clear to mineral earth as per 4(a).
- Maintain all vegetation away from power lines.

Duration: Compliance is required throughout the year, each and every year.

5. Fuel storage/hay stacks

Requirement (a)

- On all land where hydrocarbons (fuel) is stored or located or where fuel dumps, whether containing fuel or not, are stored, clear firebreaks a minimum of four (4) metres wide with a clear vertical axis of not less than five (5) metres around any pile, drum, ramp or stack of drums.
- The maximum permissible dimensions and firebreak size for storage of flammable materials (including hay mulch, vegetation, greenwaste, timber or any other flammable material), unless otherwise approved in writing by Council or its authorised officer are as follows (L x W x H):

  - Hay stacks: 25m x 10m x 5m – Bare, mineral earth firebreaks minimum 5m in width with a clear vertical axis of not less than five (5) metres installed directly adjacent to each stack or pile in all directions with an additional 5m low fuel area directly adjacent to the firebreak.

  - Any other flammable material (including mulch, vegetation or green waste): 20m x 10m x 3m – Bare, mineral earth firebreaks minimum 10m in width with a clear vertical axis of not less than five (5) metres installed directly adjacent to each stack or pile in all directions.

- The clearing of any standing vegetation (trees/ substantive shrubs) to achieve firebreaks required in this land category will require the requisite planning approval from Council
- Where possible, additional low fuel zones outside of the firebreak area around each individual pile of flammable material should be maintained. Grasses should be kept below 100mm in height within this low fuel zones.
- The maximum permissible width of a firebreak required under this land category is 20m unless otherwise approved in writing by Council or its authorized officer.

Fuel Hazard Reduction (b)

- As per 5(a).

Dwellings, Out Buildings (c)

- AS3959 applies to dwellings.

More information pages 12-19.

Duration: Compliance required on or before 30th November and maintained up to and including the 31st May each and every year.

6. Hazard reduction requirements

Requirement (a)

- In addition to the above firebreak requirements where Council or the Authorised Officer requires that additional fire prevention works be undertaken within the property to reduce the hazard, Council or the Authorised Officer may instruct in writing the owner and/or occupier to comply with the required works specified within the notice.

- This may include hazard reduction works identified as part of a bushfire risk treatment plan derived from Council's Bushfire Risk Management Plan.

Fuel Hazard Reduction (b)

- In accordance with 6(a).
- Manage and maintain hazard separation zones.

Dwellings, Out Buildings (c)

- Additional hazard reduction as required by Council/ authorised officer.

More information page 14.

Duration: Compliance is in accordance with the written notice throughout the year.

7. Does your property have a Bushfire or Emergency Management Plan?

Requirement (a)

- All properties with a bushfire management, emergency management plan or an approved Bushfire Attack Level (BAL) assessment approved as part of a Town Planning Scheme, subdivision approval, development approval or building permit for an individual or group of properties shall comply with the plan in its entirety.
- A bushfire management plan's requirements are in addition to the requirements of this notice.

PENALTY: $5000.

Fuel Hazard Reduction (b)

- In accordance with your Bushfire Management/ Emergency Management Plan and/or Bushfire Attack Level assessment and this Firebreak Notice.

Dwellings, Out Buildings (c)

- In accordance with your Bushfire Management/ Emergency Management Plan and/or Bushfire Attack Level assessment and this Firebreak Notice.

Duration: Compliance is required throughout the year, each and every year.

8. Exemptions

Requirement (a)

Council does not issue exemptions.

OTHER LEGAL REQUIREMENTS

9. Restrictions on the burning of garden refuse.

Legislation

Section 24G of the Bush Fires Act 1954.

Requirements

The following restrictions on the burning of garden refuse apply on all land within the Shire of Serpentine Jarrahdale apply:

- Maximum of two garden refuse burns per calendar month per property
- Maximum permissible size of a single pile of garden refuse is one cubic metre
- Only one pile may be alight at any one time
- Only dry garden refuse (vegetation) may be burnt
- 72 hours prior to the burn, adjoining residents must be notified
- Vegetation being burnt must be from the property on which the burn is occurring
- Burning may not be undertaken during the prohibited burning times
- Burning may not be undertaken on Sundays or Public Holidays Accelerants must not be used in the pile.

Duration: Compliance is required throughout the year, each and every year.

Failure to comply with these requirements carries a $3,000 penalty.

More information page 30.

FIREBREAK INSTALLATION GUIDE

The purpose of this guide is to give an understanding of the principle locations of firebreaks on properties. Council acknowledges that not all properties are the same and has introduced a variation to firebreak system. This allows property owners to apply for a variation to manage their properties responsibly within the environment they live in accordance with the Council firebreak notice. See ESINFO 03 Page 20.

Mowed firebreaks are not accepted as they are not considered mineral earth. Mowed firebreaks may endanger the lives of firefighters.

NON ACCEPTABLE FIREBREAK

Additional information

Trees - live standing trees: Council does not expect you to remove large trees from or adjacent to boundaries so as to install the firebreak. The firebreak can simply detour around the tree so as to afford safe access. This procedure does not require a Variation to Firebreak Notice as long as the normal dimensions of the firebreak exist. If there is a requirement to detour around multiple trees then a Variation to Firebreak Notice will be required.

Roads, verges, bridle paths, footpaths, dual use access ways and reserves: None of the above can be classified as a firebreak for your property. Firebreaks must be on your own property to conform to the Firebreak Notice. However, any additional fire prevention activities on verges etc. is encouraged as long as it does not present a liability issue to Council. Removal of indigenous and substantive trees/ vegetation requires council approval.

Emergency access ways: These are for Emergency Services vehicles only and are not to be considered as an escape route unless declared as such by the Incident Controller during an emergency.

Maintenance of firebreak, access and vegetation: Once your firebreaks, accesses and vegetation have been managed to meet your legal requirements of the Firebreak Notice, please ensure that these conditions are maintained all the way through until 31 May each year. It is fairly normal for regrowth to occur between December and May. Keep firebreaks and accesses mineral earth and free of obstructions such as fallen tree limbs, ensure vegetation is maintained to minimum levels.

Effective firebreaks: Firebreaks are there to provide safe access on your property to fire fighters. They need to be able to use the firebreak as a place of safety for themselves and their vehicles where the fire will not travel under their vehicles or underfoot. On days of strong winds or extreme conditions it is fully accepted that a three metre firebreak will be unlikely to stop a wildfire. The more fire prevention work you undertake, the greater the chance of your family and property surviving the ravages of fire.

NON ACCEPTABLE FIREBREAK

ACCEPTABLE FIREBREAK

The installation of firebreaks is only one element of the fire prevention picture. Firebreaks are required to be installed and

maintained from 30 November until 31 May each and every year. In some cases **firebreaks may have to be reinstalled several times in one year.**

It is the property owner, not the contractor or lessee that is responsible for the standard and quality of the firebreaks installed and maintained.

Ploughing and grading: these methods can produce effective firebreaks, however, the areas need constant maintenance. Loose soil may erode in steep areas, particularly where there is high rainfall and strong winds. Stepping and grading the firebreak into the incline reduces this effect.

The installation of firebreaks needs to be in harmony with total fire prevention activities of which some are highlighted below:

How to do hazard reduction

Reduction of fuel does not have to be as drastic as removing all vegetation. Environmentally this would be disastrous and often trees and plants can provide you with some bushfire protection from strong winds, intense heat and flying embers.

Methods of hazard reduction:

- hand clearing
- mechanical clearing
- chemical spraying (should be undertaken from June – September)
- hazard reduction burning

In many circumstances, hand and mechanical clearing methods should be considered the best way to protect assets. These methods can be safer than burning, and easier to organise and maintain.

Manual removal of fine fuels: remove debris such as fallen leaves, twigs, grasses and bark on a regular basis.

Mowing grass: keep grass short, green and well watered.

Slashing and mulching: this is an economical method of fuel reduction. To be effective, the cut material must be removed or allowed to rot before summer starts. Slashing and mowing may leave cut grass in rows, increasing fuel in some places. Mulching, or turbo mowing, also mulches the vegetation leaving it to rot away.

Hazard reduction program

Autumn to winter (May - August)

- Tree Pruning - remove lower branches from the ground up to 2 metres; check that power lines are clear. Use a professional contractor.
- Reduce fuel levels around the house - clear long grass, leaves, twigs and flammable shrubs.
- Ensure petrol and other flammables are safely stored away from the main dwelling.
- Make sure your fire fighting equipment is in good working order and serviced where required.
- Make sure all residents are aware of your emergency plan including evacuation routes.
- Chemical spraying of firebreaks and low fuel zones – first and second applications (June to September).

Spring (September - November)

- Move woodpiles and stacked timber at least 20 metres away from the main dwelling.
- Keep grass short.
- Clean gutters and roof debris.
- Install firebreaks in accordance with this Firebreak Notice, your Variation to Firebreak Notice and/or take action to comply with your Bushfire Management Plan or Bushfire Attack Level assessment.
- Chemical spraying of firebreaks and low fuel zones – final applications and maintenance.
- Review your family's bushfire survival plan. Further information on bushfire planning can be found on the Department of Fire and Emergency Services website.
- Make sure you consider your specific circumstances, including pets and livestock in your bushfire preparation.
- Implement identified bushfire risk management treatments.

Summer (November - May)

- Water lawns, trees and shrubs near the buildings to keep them green.
- Re-check fire fighting equipment, screens, water supplies and that gutters remain clear.
- Maintain firebreaks in accordance with this Firebreak Notice, your approved Variation to Firebreak Notice and/ or continue to take action to comply with your Bushfire

Management Plan or Bushfire Attack Level assessment.

- Maintain identified bushfire risk management treatments.

Long term precautions

- Ensure firebreaks are prepared in accordance with the latest Firebreak Notice or any Variation to Firebreak Notice or Bushfire Management Plan approved by council.
- Ensure that any planting of wind breaks or trees is in accordance with this Firebreak Notice and will not be detrimental to fire suppression requirements in years to come.
- Make sure that the buildings are safe - fit metal fly screens and shutters, fill gaps into roof/wall spaces, fit fire screens to evaporative air conditioners and have them operable to provide a water only supply.
- Give consideration to installing external building sprinkler systems and back up power for emergencies.
- Ensure emergency water supplies have the correct fittings and that access is unobstructed and trafficable.
- Get basic training in fire fighting from your local Bush Fire Brigade or even join your local Brigade.
- Join or start a local Bushfire Ready Action Group.

Development in bushfire prone areas

Bushfire Prone Areas

In December 2015 the State Government announced reform to help protect life and property in the event of a bush-fire. Areas within the State were mapped and declared "Bushfire Prone". Approximately 97% of our Shire has been designated bushfire prone as part of State Government reform. You can check your property online using the following: https://maps.slip.wa.gov.au/landgate/bushfireprone2016/

The bushfire prone area map is used as a trigger to determine if additional construction requirements are required prior to the construction of your building. These additional requirements may include a Bushfire Attack Level (BAL) assessment and/or a Bushfire Management Plan in accordance with State Planning Policy 3.7.

Bushfire Attack Levels (BALs)

Bushfire Attack Level Assessments (BALs) are used as a means of measuring the likely impact of a bushfire on a structure and, in accordance with Australian Standard 3959 are used as the basis for establishing the additional requirements for construction to improve survival of buildings from attack by bushfire.

There are six BAL levels, split between BAL Low and BAL Flame Zone. Although there are no specific construction requirements for BAL Low it does not mean that your building is not at risk! Due to the unpredictable behaviour of fire, there can be no guarantee that a building will survive a bushfire event on every occasion.

The Community Resource Centre have a list of contractors who can assist in firebreak and fuel hazard reduction works and the provision of bushfire attack level assessments and fire management planning. These contractors provide landowners with assessments relating to their development. Please refer to the link below for this information or phone the Resource Centre on 9525 9999: http://serpentinevalley.com.au/app/webroot/js/tiny_mce/plugins/filemanager/files/Firebreak_Contractors.jpg

Bushfire Management Plans

A Bushfire Management Plan will generally be required when a subdivider receives subdivision approval from the Western Australian Planning Commission.

Bushfire Management Plans may incorporate specific conditions or requirements for your lot, including strategic firebreaks, access, water supplies, hardstands, gates and BAL assessments, which are in addition to the requirements contained within this Firebreak Notice.

Lots which have had a Bushfire Management Plan prepared for them usually have a Section 70A notification on the certificate of title, and as a landowner you should be notified of this prior to purchasing the land. For further information or to find out if your lot is covered by a Bushfire Management Plan, contact the Shire of Serpentine Jarrahdale.

Asset Protection Zones

An asset protection zone is a low fuel area immediately surrounding a building and is designed to minimise the likelihood of flame contact with buildings and reduce the effect of radiant heat. Asset protection zones must be a minimum of 20 metres on flat land.

It is important to maintain asset protection zones by keeping fuel loads below 2 tonnes per hectare as per the Visual Fuel Loading Guide - Swan Coastal Plain and Darling Scarp available from the following link:

https://www.dfes.wa.gov.au/safetyinformation/fire/bushfire/VisualFuelLoadsPublications/Visual%20Fuel%20Load%20Guide%20Swan%20Coastal.pdf. This can be achieved through removal of long grasses and sedges, leaf litter, twigs and flammable shrubs.

Trees in the asset protection zone should be under pruned to 2 metres high and if there are large trees within 20 metres of the house, consider having them pruned by a professional contractor. Trees overhanging buildings or assets within the asset protection zone should be trimmed back to provide 2 metres clearance between the structure and the tree. Where an asset protection zone is required as part of an approved Bushfire Attack Level (BAL) assessment it must be maintained all year round as prescribed in the BAL report.

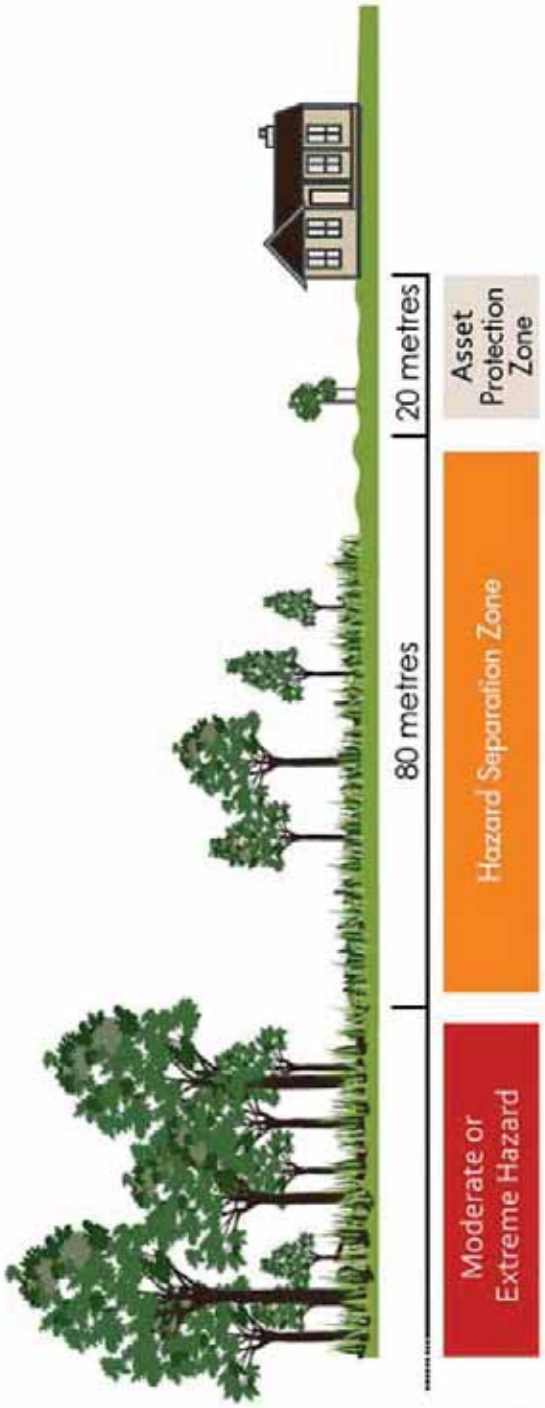
Hazard Separation Zone

A Hazard separation zone is needed to provide additional fire protection by reducing the amount of available fuel between the buildings and the surrounding vegetation to reduce the impact of bush fires. A Hazard Separation Zone (HSZ) should extend for 80 metres beyond the asset protection zone or where the 80 metres cannot be achieved then the HSZ is to be to the lot boundary.

As the occurrence of bush fires in this locality is inevitable and will burn in accordance with the prevailing weather and fuel conditions at the time, it is essential that property owners maintain HSZs on their land to have any degree of safety. The following items provide a guide to maintain a HSZ:

- Bush fire fuels within the HSZ should be kept below 4-6 tonnes per ha. as per the Visual Fuel Load Guide for the Swan Coastal Plain and Darling Scarp.
- All grasses within the HSZ must be a maximum of 100mm in height.
- All accumulated litter, twigs, bark of trees, fallen tree branches and logs should be removed from the area on a regular basis prior to and during to the bushfire season.

The hardest aspect of fire prevention is explaining to your family why you didn't undertake any



FIREBREAK VARIATION GUIDELINES

The following guidelines are acceptable categories for which a variation to firebreak may be applied for:

1. The topography/composition makes the normal placement or construction methods of a firebreak impractical or dangerous and alternative firebreak emergency access and fire prevention methods that meet the intention of the firebreak notice is provided and demonstrated.
2. An approved Bushfire Management Plan for the property is in place and being conformed to and meets the intention of the fire break order is provided and demonstrated.
3. The firebreak variation only applies to a portion of the property that is reticulated lawn that is kept green and it can be demonstrated that it is maintained regularly to less than 25mm from the 1st December through to the 31st May inclusive.
4. The firebreak variation only applies to a portion of the property that is reticulated feed paddocks that is kept green and it can be demonstrated that it is maintained regularly to less than 100mm from the 1st December through to the 31st May inclusive.
5. The variation only applies to the portion of the property that has reticulated garden beds, lawn, orchard or other accepted sustained cultivation, unless it is deemed by the Council or its Authorised Officer that the fuel type/ loadings are a hazard, however, there must be in all cases, cleared access provided to enable emergency vehicular access to buildings and outbuildings and all parts of the property in accordance with Councils firebreak notice.
6. Where permission was previously granted to plant trees, where the firebreak would normally be placed, and placement of the firebreak is in an approved alternative position that affords proper emergency vehicular access and hazard management and prevention principles in accordance with Councils firebreak notice.
7. Firebreaks are provided in approved alternative locations to negate natural obstructions.
8. Constructed driveways may where authorised, substitute for fire breaks as long as it remains trafficable for the firebreak as a whole and is maintained clear of all obstructions and flammable materials at all times in accordance with Councils firebreak notice.

All requests must be made by the property owner or person authorised to act upon the owners behalf. Individual requests are required for each property and must be submitted on the approved document/application form.

The authorising officer has the right to grant, refuse, alter or add any conditions to an application, where alterations or additions are applicable, failure to comply within the timescales provided by the authorised officer will result in the refusal of the application and prosecution as if a firebreak had not been installed in accordance with this Firebreak Notice.

Approved firebreak variations are perpetual to the owner unless there is:

- A change to any law or statute which has an effect on the variation
- Non-compliance with the variation
- A change in the ownership of the property

Where refusal of an application takes place the owner has fourteen (14) days in which to conform to the normal requirements of the Councils firebreak notice.

Please note: You must have your variation in place and operational by the 15th November in the year you wish it to commence. It is your responsibility to demonstrate that the variation will be maintained from the 15th November through to the 31st May each year. Failure to demonstrate compliance and the ability to maintain the alternative solutions approved within the variation will automatically require total compliance with the firebreak order in its entirety.

Example plan of alternate firebreak variations

BURNING INFORMATION

	What can I burn?		
	1m by 1m Garden Refuse 6pm to 11pm	Wood and Solid Fuel Barbecue	Grass, Paddock, Bonfire, Bush
Restricted Burning Period 1 October to 30 November**	**Allowed** in accordance with conditions listed on pages 26 to 31	**Allowed** in accordance with conditions listed on pages 26 to 31	**Permit Required** Contact your local Fire Control Officer
Prohibited Burning Period 1 December to 31 March**	**Prohibited**	**Allowed** in accordance with conditions listed on pages 26	**Prohibited**
Restricted Burning Period 1 April to 31 May**	**Allowed** in accordance with conditions listed on pages 26 to 31	**Allowed** in accordance with conditions listed on pages 26 to 31	**Permit Required** Contact your local Fire Control Officer

**N.B: Subject to seasonal changes. Please check with Council.

WHO TO CALL FOR A PERMIT

Volunteer Fire Control Officers

Frank Rankin 9525 1146
Areas: Byford, Darling Downs, Cardup and Karrakup

Paul Williamson 0439 994 803
Areas: Oakford and north of railway line in Oldbury

Darryl Ronan 0419 964 228
Areas: Mundijong, Whitby and south of railway line in Oldbury and north of the Serpentine River and Lowlands Road in Mardella

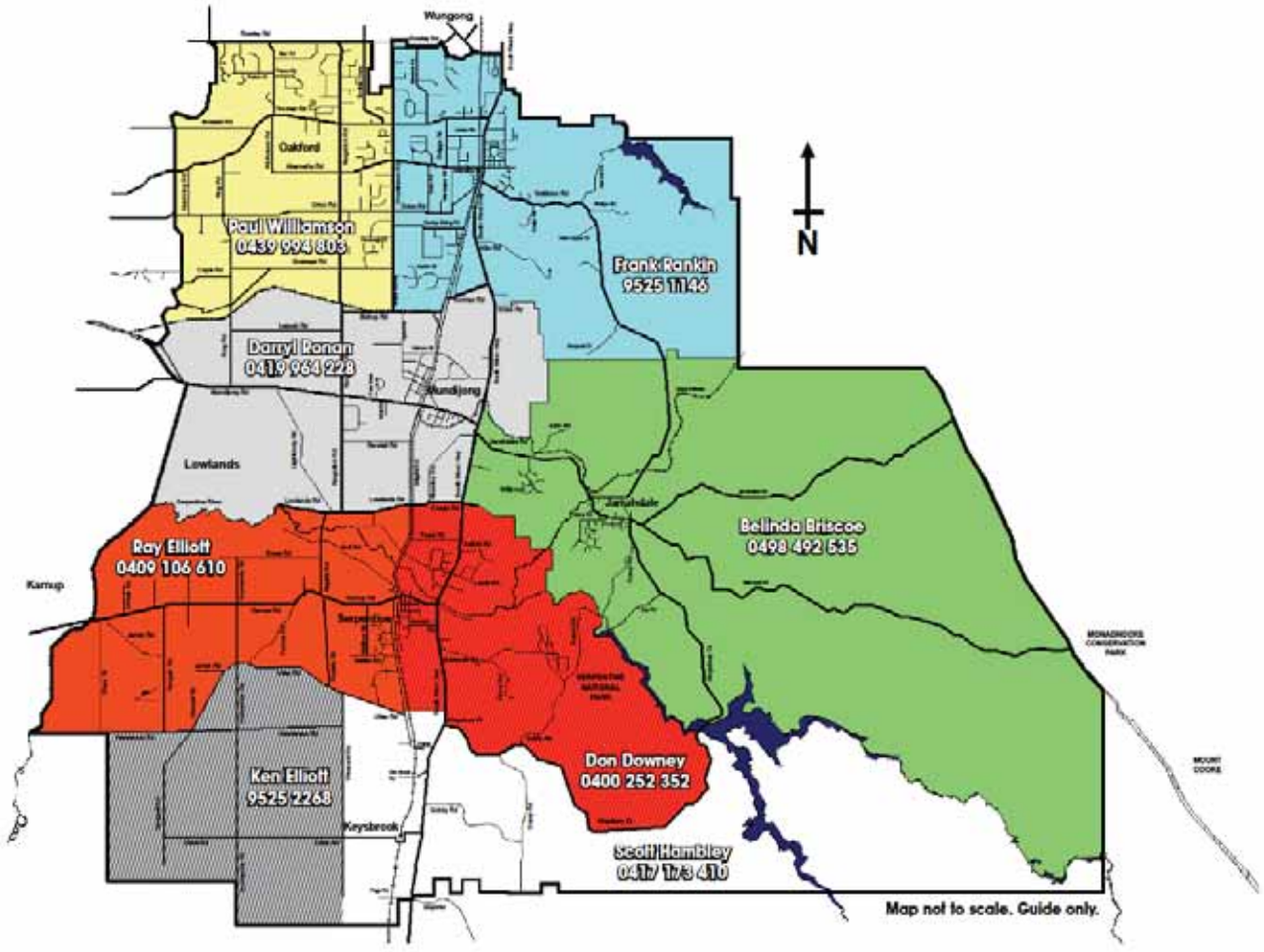
Belinda Briscoe 0498 492 535
Area: Jarrahdale

Ray Elliott 0409 106 610
Areas: Serpentine west of railway line, Hopeland and south of the Serpentine River and Lowlands Road in Mardella

Don Downey 0400 252 352
Area: Serpentine east of Railway Line

Ken Elliott 9525 2268
Area: Keysbrook west of Westcott Road

Scott Hambley 0417 173 410
Area: Keysbrook east of Westcott Road



The following conditions apply to all burning and fires in the Shire during the restricted and prohibited burning periods:

- on any day where the Fire Danger Rating is 'very high', 'severe', 'extreme' or 'catastrophic', permits are automatically cancelled. In addition, any solid fuel fire for the purpose of camping or cooking and/or garden refuse burning (including, but not limited to: wood, solid fuel barbecues, pizza ovens, spit roasts, hangis, incinerators or Webers) are NOT permitted to be used under any circumstance.
- Where the conditions allow camping or cooking fires, bush and inflammable material must be cleared for three (3) metres around any cooking or camping fire prior to ignition.
- Due to unseasonable weather conditions the Restricted and/or Prohibited Burning Periods may be extended or shortened. Check with the Shire Office or your local Fire Control Officer to confirm the burning period.

The Fire Danger Rating can be found by calling the weather information line 1196. If in doubt or you cannot find out - call Council on 9526 1111 for further information, or do not burn.

What will I be fined if I don't comply?

Failure to produce permit to burn	**$500**
Offences relating to lighting a fire in the open air	**$3,000**
Obstruction of an authorised officer	**$5,000**
Disposal of burning cigarettes etc.	**$5,000**
Failure of occupier to extinguish bush fire	**$10,000**
Setting fire to the bush during prohibited burning time and 14 years imprisonment	**$250,000**

If Council's volunteer bush fire brigades attend a fire at any time of the year that is in the opinion of the attending officer deemed to be

- Illegal or;
- not under control or;
- not adequately controlled;

the owner or occupier of the property where that fire is burning may be liable to penalties imposed under Council's Annual Schedule of Fees and Charges up to $10,000, in addition to any intringements or penalties imposed under the Bush Fires Act 1954 (as amended).

Fire permit application

All persons wishing to set fire to the bush during the Restricted Burning Times must first obtain a written permit from a Bush Fire Control Officer for their relevant area.

"Bush" is defined as: any vegetation, trees, bushes, plants, stubble, scrub and undergrowth of all kinds whatsoever whether alive or dead and whether standing or not standing and also a part of a tree, plant or undergrowth and whether severed there from or not so severed.

Before you call a Fire Control Officer ensure you have the following information:

- Who will be the three able bodied persons in attendance at all times whilst the fire is alight including contact phone number?
- What is the address of the property for which the permit applies?
- What fire fighting equipment and resources will you have at the fire front and is it in good working order?
- What is the size of burn to take place?
- Are there firebreaks installed and can a fire unit get access to the area?
- Is the material you are burning vegetation that is dry enough to burn without creating a nuisance?

Permits only apply to the burning of bush, so make sure any plastics, treated wood, tyres and other materials are removed from the burn area/pile. Burning these materials may be an offence under environmental legislation such as the Environmental Protection Act.

Validity of a permit

A permit is valid only for the day or days written on the permit. It is illegal for anyone who has been refused a permit or given a permit subject to special conditions to approach another Fire Control Officer for a permit concerning the same burn. Appeals can be lodged in writing to the Chief Bush Fire Control Officer of the Local Authority against the refusal of the permit or the conditions.

The Bush Fires Act and Regulations require that notification of the intention to set fire to the bush be given at least 4 days or not more than 28 days prior to burning to:

- The local bush fire control officer for the area.
- All neighbours.
- A Forest officer if the fire is to be lit within 3km of the State Forest.

- On the day of the burn, the Department of Fire and Emergency Services Communication Centre on 1800 198 140.

Notice can be verbal or written in such a way that the person to be notified is aware of the date and time that the burn will take place. In case where notice is given verbally, the period of notice may be determined by mutual agreement between all parties.

Please Note:
All hazard reduction burning over one acre in area which is being undertaken on behalf of a landowner for pecuniary gain has the following conditions:

- Written permission and a valid "permit to set fire to the bush" must be obtained from the Shire of Serpentine Jarrahdale at least one week prior to the burn
- A copy of the prescription, including a site plan, traffic and smoke management plan, written permission from the landowner and details of the burn must be submitted as part of the written application
- The Shire and its authorised officer/s reserve the right to either approve, refuse, amend or request additional information in relation to any request to burn on a landowners behalf.

Note:
- At least three (3) able bodied persons and adequate fire suppression equipment or appliances must be in attendance at the fire until it is safe.
- The requirements for a fire to be "safe" is defined as all burning or smouldering debris to be completely extinguished for a distance of 30 metres within the perimeter of the burn area.
- The Fire Control Officer or Local Authority may endorse the permit to vary any conditions on the reverse of the permit.
- A fire may not be lit when the daily fire danger forecast for the area, issued by the Bureau of Meteorology, is very high, severe, extreme or catastrophic.
- The fire must be monitored to make sure smoke is not impacting on neighbours or causing a traffic hazard; if this is found to be the case, all fire must be extinguished as soon as possible.
- Local Government bans the lighting of fires on Sundays or Public Holidays except for brigades or Department of Parks and Wildlife.

- In all cases, the conditions written on the permit must be rigidly observed.
- If, in the opinion of a Fire Control Officer, the fire is considered to be not adequately controlled or is uncontrolled, you may be required to extinguish the fire or Council's Bush Fire Brigade(s) will extinguish the fire and fees may be charged in accordance with Council's Schedule of Fees and Charges.
- Failure to comply with the directions of a Fire Control Officer or obstructing a Fire Control Officer are offences under the Bush Fires Act 1954 and carry penalties of $2,000 and $5,000 respectively.

Insurance before you burn

Please ensure you have appropriate insurance in place to cover you, your property and your public liability responsibilities before you begin to burn.

Environmental considerations

Does your property have specific environmental restrictions such as:

- threatened ecological communities
- environmentally sensitive areas
- noted as a bush forever site
- areas of native vegetation or specific areas of revegetation which may be prohibited from burning under legislation such as the Environmental Protection Act 1986
- previous development/subdivision approval conditions.

If the answer to any of these questions is yes, or you are not sure information is available by:

- accessing the Shire of Serpentine Jarrahdale's website
- contacting Councils office on 9526 1111

It is highly recommended that weed control be undertaken after burning, as weeds can actually increase the fuel loading after a burn. Contact SJ Landcare centre on 9526 0012 for further information.

Remember

It is the permit holder's responsibility to ensure that the fire remains under control. In the event of any fire escaping beyond the boundaries of the area, the holder of the permit shall dial "000" immediately. In accordance with Regulation

43 of the Bush Fires Regulations, notification must be made to the local government within seven (7) days reporting in full the circumstances causing the escape of the fire and any losses and equipment used to suppress the fire. Should a fire escape, the permit holder may be held responsible to damages caused to others.

Roadside (verge) burning: Please note it is an offence to set fire to Council road reserves/verges at any time of the year without an approved permit. Permits for this activity can only be obtained from the Council. Contact 9526 1111 to have the relevant paperwork sent to you for completion.

Penalties

The Bush Fires Act and Regulations specifies penalties for breaches of these conditions. If a brigade has to attend your burn for suppression activities you could be liable for fines and/or costs.

Advice
Further information can be obtained from your local Fire Control Officer or from the Shire Office on 9526 1111.

GARDEN REFUSE

Burning of garden refuse is permitted during the restricted burning period as long as residents comply with this firebreak notice. If in doubt, check with your local Fire Control Officer or the Shire of Serpentine Jarrahdale.

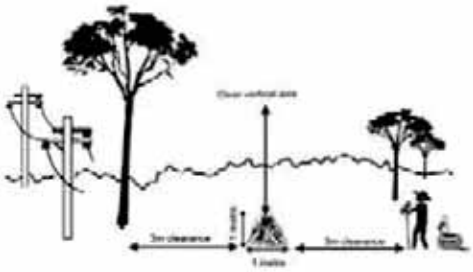
Burning on any day with a fire danger of 'Very High', 'Severe', 'Extreme', or 'Catastrophic' is not permitted, and holds a penalty of $3,000.

As a courtesy, you must notify all residents who adjoin the site of the garden burn at least 72 hours prior to the burn. Where practicable, other residents who might be inconvenienced by the pile burn should also be notified. This allows residents with respiratory conditions to make alternative arrangements prior to the burning of garden refuse. The following requirements apply to all garden refuse burning:

- The pile must not exceed one cubic metre in size.
- Only dry garden refuse (vegetation) may be burnt. This means no household or building materials, plastics, pallets or cardboard may be burnt.
- Garden refuse being burnt must be from the property on which the burn is occurring. You may not burn garden refuse from other properties.
- At least one person must be in attendance during the entire duration of the burn.

- Three (3) metres must be cleared from the edge of the pile in all directions .
- Only one pile may be burnt at a time. If you wish to burn more than one pile at a time you will need a permit from a your local Fire Control Officer.
- All adjoining residents must be notified at least 72 hours prior to the burn. Notice can be either verbal or written.
- The fire cannot be lit before 6pm at night, additional vegetation may be added to a maximum of 1m in width and height until 11pm and the fire must be fully extinguished by midnight on the same night.
- There is a maximum of two garden refuse burns per calendar month per property.
- Accelerants must not be used in the pile.
- Penalties of up to $3,000 apply for burning garden refuse contrary to any of these conditions.

RIGHT ☑



Pile is the correct size and clearance. Burn pile clear of trees, fences, buildings and power lines

WRONG ⊗

More than one pile being burnt, piles are too big and are being burnt under trees.

You would not want to come home to this!

Imagine returning from work to find all your possessions gone, all the valuables, jewellery, treasured momentos from children and family, all your tools, machinery and vehicles burnt beyond recognition.

Could your family cope with being homeless? What about your pets and livestock? What if your family was injured or worse?

Take action now

- Know your neighbours, share information and practice your fire plan! (pages 34 and 35)
- Follow the Hazard Reduction Program (page 14-16)
- Have a bushfire action plan
- Have an evacuation plan, contingency plan and know where you will go in an emergency

ARE YOU BUSHFIRE READY?

Bushfire ready information

There are a range of bushfire safety publications available from the following websites:

www.emergency.wa.gov.au

www.areyouready.wa.gov.au

www.redcross.org.au/prepare

These publications include:

- bushfire action plans and checklists
- information on preparing survival kits
- how to prepare pets and animals for emergencies
- understanding fire danger ratings and warnings

Alerts and warnings

During a bushfire, alerts and warnings may be provided by the Department of Fire and Emergency Services or Parks and Wildlife through the following sources:

www.emergency.wa.gov.au

www.twitter.com/dfes_wa

www.facebook.com/dfeswa

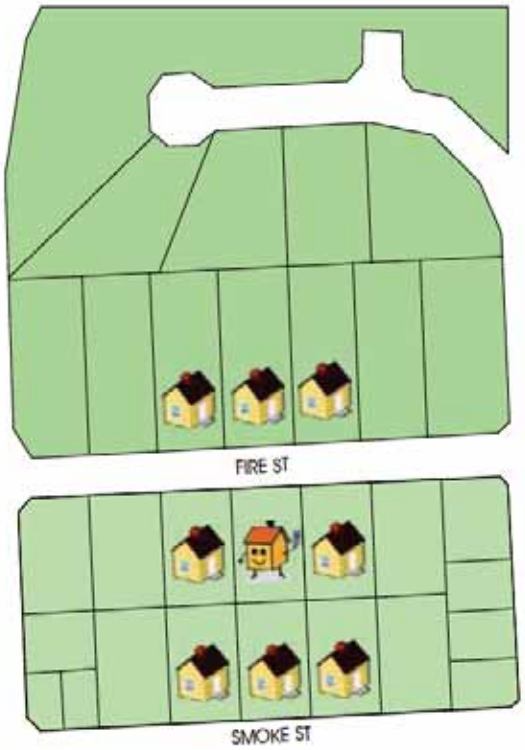
13 DFES (13 3337)

www.dpaw.wa.gov.au/

www.twitter.com/WAParksWildlife

Alerts, warnings and fire ban information is also broadcast on the local ABC radio station (720 AM).

"BE A MATE TO EIGHT"



Important Emergency Contacts	
Name/Organisation	**Contact Number**
Fire / Police / Ambulance	000
State Emergency Service	132 500
DFES Public Information	13 33 37
Main Roads WA	138 138
Western Power	13 13 51
ATCO Gas	13 13 52
Water Corporation	13 13 75
Telstra	13 22 03
RSPCA WA	9209 9300
Wildcare Helpline	9474 9055
Local GP/Doctors	
Hospital	
Insurance Company	

Neighbour contact details

	Name	Address	Home Phone	Work Phone	Mobile Phone
1					
2					
3					
4					
5					
6					
7					
8					

Remember, report all fires to

000

If firefighters can't get to you, have you done enough to survive?

Are you being a part of your community?

Join your local Volunteer Bushfire Brigade!
There are a lot of ways you can help, from active and physical roles to brigade support roles.

Make a difference!
Call 9526 1111

a 6 Paterson Street,Mundijong WA 6123
t 9526 1111
f 9525 5441
e info@sjshire.wa.gov.au
w sjshire.wa.gov.au
facebook.com/shireofsj
instagram.com/unearthsj

APPENDIX 5

Local Water Management Strategy
Landform Research

LOCAL WATER MANAGEMENT STRATEGY

LOT 791, WALKER ROAD, SERPENTINE

SHIRE OF SERPENTINE - JARRAHDALE

OCTOBER 2015

Landform Research

Land Systems - Quarries - Environment

SUMMARY OF LAND CAPABILITY AND GEOTECHNICS

This Local Water Management Strategy updates the Strategy included in the Land Capability – Geotechnical Assessment completed in June 2013.

The Strategy incorporates the engineering designs for water management that are now available and comments provided by the Department of Water dated 22 August 2014.

Figures are taken from the Land Capability – Geotechnical Assessment completed in June 2013.

Lot 791 Walker Road, Serpentine was assessed to determine the potential for subdivision to rural living lots, from a geotechnical consideration, down to 4 000 m^2.

The site was assessed by hand auger on 21 September 2012 by Lindsay Stephens of Landform Research. At the time of inspection the site was relatively wet being Spring, even though there had been less than average winter rainfall.

The subject land, like all the surrounding area, lies in part of the Peel Harvey Catchment, covered by Environmental Protection Policy (Peel Inlet - Harvey Estuary). It also falls under State Planning Policy 2.1, The Peel Harvey Coastal Plain Catchment.

Current Land Use

The land has two dwellings on it, one in the south and one in the north west.

In recent times the land has predominantly been used for horse agistment and some cattle grazing.

Proposed Land Use

Lot 791 is proposed for subdivision to rural living lots down to 4 000 m^2.

Capability

The soils on site are much better than those within the adjoining subdivisions to the east. The sand ridge in the west is much higher and the lower elevation swales more elevated and sandy than those on nearby land that has already been developed.

The covering sand sheet has a minimum of 1000 mm thickness across almost the whole site over sandy clay. One small area has a thickness of 850 mm. Across much of the site the thickness of the surface sand increases to over 3 metres. That makes the soils highly capable and much better than adjoining areas.

The water table was only intersected in 2 of the 20 soil test holes at depths of 850 mm and 1200 mm. There may be some excess sand from the sand ridge that can be used to provide some fill for the lower elevations.

It is important to note that the soil assessments are made on the natural existing land as it was at the time of the site inspections. Like all local developments the soils will be improved by drainage and the addition of fill, which will upgrade the land capability to a much higher more capable surface. The drainage requirements have been calculated by Groundwork Consulting Engineers and are attached.

There are no significant limitations that cannot be mitigated during the design and construction processes.

The lot size of 0.4 hectares is significantly greater than the 0.2 hectare minimum recommendation contained within the Government Sewerage Policy.

Foundation stability is rated as AS2870 Site Class A on the deep sand across most of the western half of the site with Site Class A – S and possibly M in areas with less surface sand cover on the ridge to the east dropping to S - M off the ridges and M over the lower central swales. There is potential (but unlikely) for Site Class H to occur in minor wet and dry areas.

Detailed individual testing of building envelopes will be required to determine the site specific soil conditions at the time of construction. The depth of fill sand will also determine the Site Class. For example adding 1 metre of fill is likely to reduce the Site Class by one category.

Conclusions

The site is also highly suitable for the construction of roads.

The thickness of the sand sheet is a significant difference to other developed local areas which have sandy clay close to the surface. The additional sand provides for better site Foundation Stability, drainage and depth to perched winter water tables.

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

A Water Management Strategy is attached and includes the following recommendations that relate to subdivision design. Other recommendations and design considerations are included in the Strategy.

- Swale drains are recommended to be installed along road reserves that connect to easements on private land to enable maintenance as required in the future.
- The surface water input from the adjoining land to the south needs to be taken into account during the design of the stormwater network.
- The subdivision may need tweaking to enable stormwater to be adequately addressed.

By retaining the 1 hour 1 year storm event on site, and releasing water from larger storm events. it has been calculated by Groundwater Consulting Engineers that the pre- development recharge will be similar to the post development recharge.

The surface water volumes and flows onto and offsite will be similar from pre-development to post development and the recharge to groundwater will be similar.

Analysis of Stormwater and Recommended Management	
Individual lots	• The soils on site are coloured sands over loam/clay and deep yellow sands. • The site investigations and engineering design calculations made by Groundwork Consulting Engineers show that the soils 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.
Road drainage	• The site investigations and engineering design calculations made by Groundwork Consulting Engineers demonstrate that

	the swale drains will be able to manage surface water. • For events in excess of the 1 in 1 year 1 hour, the excess water is directed to a detention basin in the central north. • Based on the calculations for water management, there are no limitations to development, or any limitations identified can be controlled by good water management. • The swale drains are designed to encourage infiltration and cutoff functions. See DOW (Water and Rivers Commission), 1998, 3.17 (BMP14). • Swale drains are located in the road reserves for maintenance.
Water Management	• There are no limitations imposed by the site on water management that would result from subdivision or development. • The flow into the site from upstream is determined by Groundwork Consulting Engineers to be 0.07 m^3/s. This flow has been incorporated into the water management design, Figure 6. • The detention basins and swales will be able to deal with storm and flood events without compromising the potential for flooding the developable land. • The swale drains associated with the road network will reduce the potential for water to lay on the surface in winter, drying the soils.
Detention basin	• The detention basin is designed to be installed above the highest known groundwater and will be able to deal with storm and flood events without compromising the potential for flooding the developable land. • The detention basin is recommended to retain the 1 in 1 year 1 hour events (*A Manual for Managing Urban Stormwater Quality in Western Australia* infiltration basins BMP 110 and Wet Basins BMP 18). • The detention basin is provided with its own lot for greater ability to manage. • The detention basin is to be revegetated with local native trees and shrubs combined with fringing reeds and rushes.
Recommendations	• The installation of rainwater tanks with a minimum of 5000 litres can be considered but will not impact on water management. • Greywater reuse is encouraged to minimise scheme water use. • Stormwater volumes will need to be revisited during the engineering design stage when the final subdivision design has been determined.

LOCAL WATER MANAGEMENT STRATEGY

CONTENTS

FIGURES

SECTION	ITEM	REFERENCE	COMMENTS
Executive Summary			
Introduction	Context	1.0 page 1	
Proposed Development	Site Context	2.0 page 1	
	Proposal Plan	2.0 page 2	
	Landscape Plan	Figures 1 and 2	
Design Criteria	Design Criteria	3.0 page 3	
Pre-Development Environment	Site Assessments	4.0 page 3 - 9	See the Land Capability and Geotechnical Assessment.
	Site Condition	4.2 page 3 - 7 Figures 1 - 2	See the Land Capability and Geotechnical Assessment.
	Geotechnical Conditions	4.0 pages 7 Figures 1 - 3	See the Land Capability and Geotechnical Assessment.
	Environmental Issues	Pages 3 - 7 Figures 1, 2, 3, 4	No wetlands, one watercourse.
	Existing Surface Water Flows	4.5 pages 7 Figure 1	
	Groundwater	4.6.page 9	
Water Use Sustainability Initiatives	Water efficiency	5.0 page10	
	Water Supply	5.0 page 10	Scheme
	Wastewater Management	4.3.3 page 16	See the Land Capability and Geotechnical Assessment.
Stormwater Management Strategy	Flood Parameters	4.5.3 page 8	No watercourses on development area. Located in road reserve and dedicated lot.
	100 Year Event	Pages 8	
	10 Year Event	above	
	1 Year Event	above	
	Groundwater Management	7.0 page 19	No groundwater impact
	Acid Sulfate	4.3.5 page 5	No acid sulphate. See Land Capability and Geotechnical Assessment.
Future Water Management		Page 20	Detailed designs will be required after approvals are gained
Implementation	Developer	Page 7	This document is to support application for subdivision.
	Roles - Funding		
	Review		

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.*
>
> Department of Water, *2008 Developing local water management strategy (interim)*
>
> Department of Water, *2009, Decision process for stormwater management in WA.*

The focus of 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.

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 one 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.

Local Water Management Strategy

In the case of the proposed rezoning, a Local Water Management Strategy is required by the Shire of Serpentine – Jarrahdale and Department of Water.

The project has progressed sufficiently for detailed engineering design works to be completed. These have been prepared by Groundwork Consulting Engineers and are attached as Figure 6.

2.0 Proposed Development - Subdivision

Lot 791 Walker Road Serpentine was assessed to determine the potential for subdivision to rural living lots from a geotechnical consideration down to 4 000 m^2, although the lot sizes that have been designed range from 4 000 m^2 to 9 144 m^2.

The subdivision consists of a road connecting to Walker Road in the west and to a road network north and south on the eastern side of Lot 791.

All lots will be connected to scheme water but none will be connected to sewerage.

Water from up catchment enters Lot 791 through the southern boundary and exists through the northern boundary. Road drainage is directed along swale drains to a detention basin in the central north at the release point of the existing water flows which will be managed by the proposed earthworks.

3.0 Design Criteria

Department of Water 2009, seeks to

- Identify and manage the potential for Acid Sulfate Conditions
- Retain rainfall from a 1 in 1 year ARI 1 hour event to be retained on site, with the excess from higher rainfall events being directed to the natural watercourses to maintain environmental flows.
- Protect Waterways and Wetlands
- Manage Groundwater levels
- Retain the onsite infiltration and maintain watercourse flows of an urban area in a manner similar to the pre-development flows. This is to maintain the local water dependant habitats and ensure that storms and flooding do not significantly adversely affect the developments of habitats or place the community at increased risks.

The water management design (Figure 6) also seeks to consider the water originating from up catchment and manage water travelling through the subdivision and that being released from site.

It also seeks to consider and manage stormwater from individual lots and roads.

4.0 Pre-development Environment

4.1 Existing Information

The site was assessed by hand auger on 21 September 2012 by Lindsay Stephens of Landform Research. At the time of inspection the site was late winter following drier than average winter rainfall, although the soil properties and pasture species provided good indications of the soil structure and hydrogeology.

During the study 20 soil test holes were sunk across the whole site, covering a wider area.

The locations of these soil test holes are shown in Figure 1. The soil test holes, soil characteristics, pasture species and other features have been used to provide a good indication of the highest known perched water table. See the attached Soil Test Hole Logs.

4.2 Site Description

The site consists of one parcel of land running east from Walker Road. See Figures.

The sites is gently sloping, dropping from the west to a swale in the central east before rising again at the eastern boundary.

It lies in Serpentine, immediately west of similar land that has been subdivided, centered on Egerton Drive. The townsite of Serpentine lies 1.3 km to the north east.

The land has two dwellings on it, one in central west and one in the north west.

In recent times the land has predominantly been used for horse agistment and some cattle grazing.

The subject land, like all the surrounding area, lies in part of the Peel Harvey Catchment, covered by Environmental Protection Policy (Peel Inlet - Harvey Estuary). It also falls under State Planning Policy 2.1, The Peel Harvey Coastal Plain Catchment.

4.3 Geotechnical Attributes

4.3.1 Geology and Regolith

The underlying geology are sediments of the Perth Basin at depth, overlain by alluvial sediments deposited by the older watercourses. The sediments are predominantly interbedded loams and clays with sandy lenses that vary both vertically and horizontally. These sediments are ascribed to the Guildford (Pinjarra Plain) and Bassendean Land Systems.

Superimposed across the alluvial plain are thin sheets of sand that have added to the topsoils and formed low sand ridges and drainage channel infill of aeolian silica sand and minor alluvial deposits.

Drill data from the Armadale Environmental Geology 1 : 50 000 Geological Map, Geological Survey of Western Australia, 1981 shows the site as being underlain by deeper sediments of the Perth Basin at depth of > 5 metres.

Lot 791 is undulating but drains from 35 - 36 metres AHD in the central north west down to 25 metres AHD in the central north, and 32 metres AHD in the south western corner.

4.3.2 Soils

The soils consist of alluvial loams and clays as basal soil units. These are exposed on the surface in the areas of lower elevation, in depressions and weak flow lines. The alluvial soils are nominated as the Pinjarra System.

Generally the soils are regarded as duplex type soils with a sheet of sand over a loam clay base. The variation being the thickness of the overlying sand sheet.

Soils are developed on the alluvial clays and loams, such as Soil Type P1b. (Department of Agriculture and Food mapping 1983, *Land Resources in the Northern Section of the Peel – Harvey Catchment, Swan Coastal Plain, Western Australia*). It should be noted that the Department of Agriculture and Food mapping was broad scale and based on aerial photography with road observations and limited soil test holes.

Overlying these alluvial soils are grey brown sand over brown and yellow earthy sand of the Bassendean Sands. The sand is 1000 mm - >3 000 mm thick. The Department of Agriculture and Food soil types shown are B1.

The mapping, and that completed by Landform Research, related to the pre-subdivision ground conditions.

Additional drainage of the land is possible to prevent water building up in the surface sands during winter.

The soil descriptions are based on pre-development conditions. That is they do not take into account drainage or other issues that will improve the soil quality. See Figures 1, 4 and 5. See the attached soil test logs and Figure 1.

KEY	DESCRIPTION		DEP. AGRIC/FOOD SOIL UNITS (Note that the units allocated to the soils do not match the DAF mapping)
RS	Ridge Sand	Elevated well drained sand ridge with over 3000 mm cream to yellow earthy sand becoming darker and more earthy with depth. Small amount of iron induration and gravel at depth.	B1
S/C	Sand over Clay	Lower sand plain that has between 500 mm and 1200 mm white, pale yellow and pale brown sand grading yo earthy sand over sandy clay. Can have an organo ferricrete layer and at the loam clay interface. Can be subject to winter wet soils in parts prior to site drainage.	P1b
HS/C	Well Drained Sand over Clay	Slightly higher elevations with between 500 - 1200 mm cream, brown and gravelly sand over loam clay. Well drained and not subject to winter wet conditions.	P1b

4.3.3 Soil Permeability

No infiltration tests were conducted on site. Any surface sands are permeable and the underlying loam clays slowly permeable.

The soils across the site mostly have a minimum of 500 mm sand over the loam – clay. The loam – clay is slowly permeable.

As alternative waste water systems are proposed the waste water disposal area can be located or formed to mitigate any unsuitable conditions.

Alternative/nutrient adsorbing effluent disposal systems are also acceptable and require a waste water loading not exceeding 10 litres/m^2/day (to *Department of Health, 2001, Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units (ATUs); Serving Single Dwellings).*

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.

Alternative/Nutrient adsorbing waste water systems spread the waste water loading over a larger area and are designed to overcome any localised lower infiltration rates and provide safeguards with the quality of waste water in terms of microbial and nutrient content to ensure that health and environmental impacts are negated or minimised.

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.

4.3.4 Nutrient Retention Capability

The soils are sand over clay and deep yellow sand. The overlying sand has low nutrient retention and the clay high nutrient retention when the waste water has access to the soils.

In order to mitigate any risk from the low nutrient capability of the soils, alternative (nutrient adsorbing) waste water systems are proposed.

These are designed to mitigate any adverse nutrient retention issues by specifying amended soil disposal areas with a minimum phosphate retention rate. Soils must be capable of >PRI 20.

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.

It is important to note that the soil assessments are made on the natural existing land as it was at the time of the site inspections. Like all local developments the soils will be improved by drainage and the addition of fill, which will upgrade the land capability to a much higher more capable surface. The drainage and fill requirements will be made during the detailed design for the subdivision.

> See Section 6.3.4 Waste Water Management and Land Capability mapping is discussed in *Landform Research 2013, Land Capability – Geotechnical Assessment, Lot 791 Walker Road, Serpentine*.

4.3.5 Acid Sulfate Soils

See the Acid Sulphate section in the land capability section of this report. WAPC Planning Bulletin Number 64, identifies the whole area as yellow, Moderate to Low risk (yellow) of acid sulfate conditions (AASS and PASS) occurring below 3 metres depth, which is the same as all the existing lots that have been developed in the Byford, Cardup and Serpentine areas.

All soils observed on site are oxidised, with the iron minerals being oxides.

No reducing conditions were observed in the soil test holes. No peat or organoferricrete or other "at risk" materials were observed. See attached Acid Sulfate Assessment.

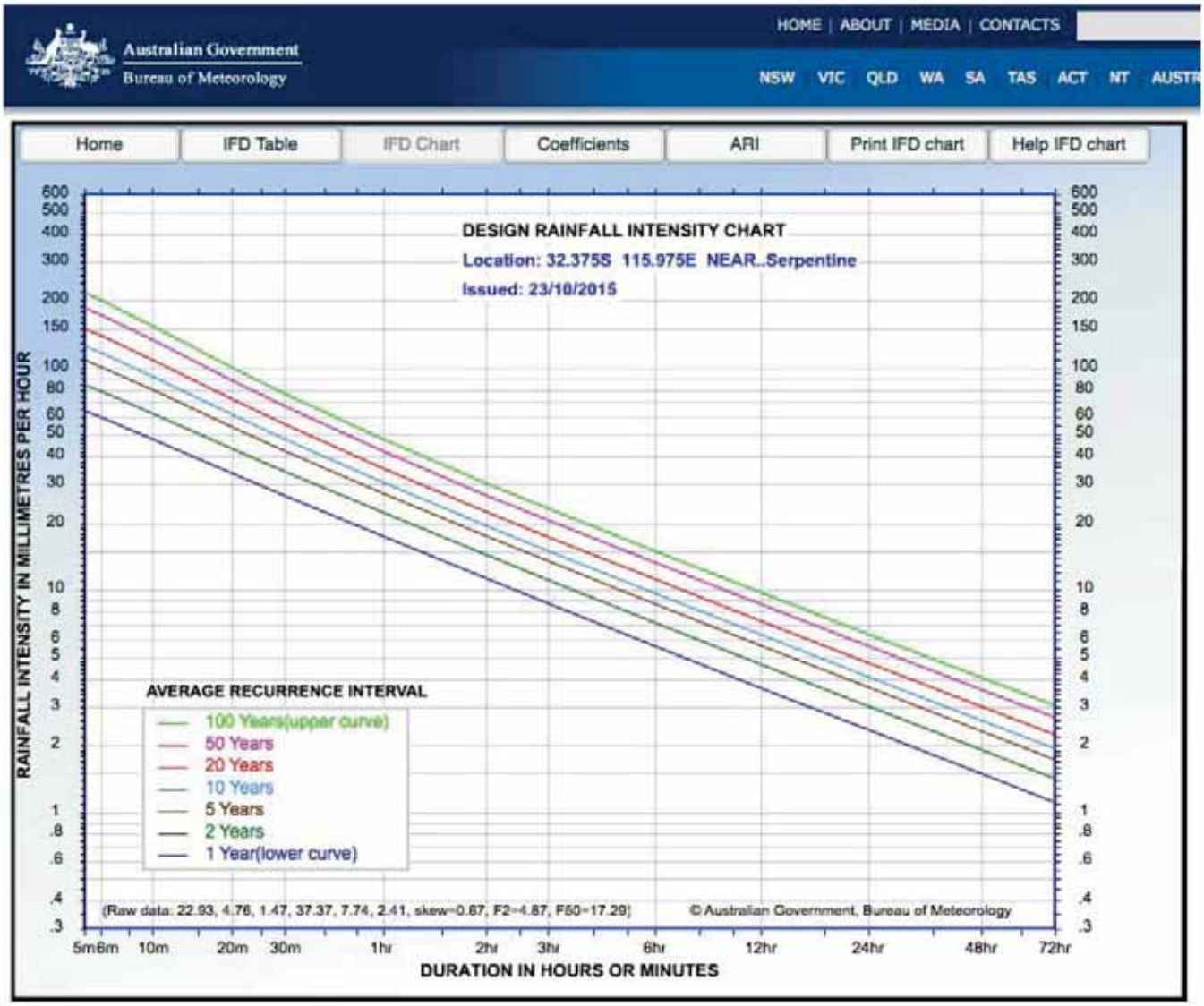
No soils, from the descriptions or the geomorphology, that have physical or compositional characteristics of acid sulfate conditions, were recorded in the soil test holes.

4.4 Climate

See the land capability section of the report. The climate of the area is classified as Mediterranean, with hot summers and cool winters. Precipitation is near 950 mm of which over 80% falls in the winter months, April to October inclusive. Evaporation exceeds rainfall in the six summer months.

Temperatures range from average summer maxima of near 30 degrees C down to average winter minima of below 9 degrees C.

Prevailing winds are generally easterly in the morning and south westerly in the afternoon in summer months.



4.5 Hydrology

4.5.1 Soil Moisture

Soils are generally moist throughout the autumn to spring times of the year.

In summer the soils become dry in the sandy upper horizons especially on the ridges in the east and west.

Some of the soils in the central swale are subject to winter wet conditions. The winter wet conditions occur when the rainfall temporarily exceeds the permeability of the underlying sand clay materials allowing the water to fill the upper sandy soil horizon, and if in excess to slow runoff across pasture.

Constructed drainage and better definition of the drainage will manage that water and reduce temporary surface water perching.

4.5.2 Surface Water

In this area there are no defined watercourses, although drains have been cut in the land to the north to drain surface water from low elevations to the north and ultimately west via drains to the Serpentine River.

On site there are no watercourses apart from the drains, with drainage being swale drainage through pasture with no defined bed. The soil moisture is discussed above.

Drill data from the Armadale Environmental Geology 1 : 50 000 Geological Map, Geological Survey of Western Australia, 1981 shows the site as being underlain by deeper sediments of the Perth Basin at a depth of > 5 metres.

There is a gentle depression in the central swale that receives surface water from the adjoining subdivision to the south. A surface drain has been cut from that wet area to the north of the property were it drains north from Lot 791 and eventually to end up at the Serpentine River. Figure 5.

Engineering calculations by Groundwork Consulting Engineers found the inflow from the south to be a flow rate of 0.07 m^3/s and this figure has been used in the design calculations. Figure 6.

With design and construction of the subdivision, the road network will disrupt the across pasture drainage. The drainage will be defined along swale drains within the road reserves as shown on the subdivision guide plan and engineering drainage plan.

The engineered drainage plan will collect surface water from roads and direct the drainage along swale drains to maintain natural environmental flows.

It should be recognised that the surface water will have increased in volume when the land was originally cleared so drains are required for the arable land but would not have been required when the site was vegetated with native vegetation.

In turn the planting of additional deep rooted species, particularly trees, will reduce surface water through increased evapotranspiration.

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.

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 prevail. The subdivision complies with the setbacks for drains.

Setbacks and buffers have been determined and are defined on the subdivision guide plan through the use of building envelopes and engineering drainage layout.

4.5.3 Flood Risk and Drainage

The only existing drainage is small constructed drains. In times of heavy storm events in winter these may flow more but will not constitute a flood risk because the water is contained within the drains or adjoining few metres of land. Figure 1.

The lots located on elevated land will ensure that there is sufficient separation from the drainage swales to eliminate any risk from flood flows. The risk from flood flows is designed and managed in the engineering design as shown on the attached plan Figure 6.

The low lying areas that are subject to winter waterlogging occur where precipitation exceeds the current drainage or infiltration capacity of the soils in winter.

These parameters were generally not exceeded in winter 2012 and little land experienced waterlogging.

The addition of increased drainage from the design and construction of the subdivision will reduce the waterlogging potential of the soils.

The engineering design has considered the stormwater runoff and drainage to 1 : 100 year events.

4.5.4 Wetlands

There are no wetlands on site. An area of winter wet soils occurs in the central swale as shown on the soil plans attached to this report.

It is noticed that a "Geomorphic Wetland" is shown on Shire and DOW mapping as covering Lot 791 including the high sand ridges, and this carries across all the subdivided and developed land adjoining to the east. That nomination is wrong and must have been identified from mistaken aerial photography interpretation.

4.5.5 Salinity

Whilst the soils are undulating and not significantly higher than the surrounding land, there is no evidence of obvious salinity. There are no salt scalds and no obvious signs of salt dependant pasture species. There are minor indicators of salt tolerant species in the wetter areas.

In winter these areas are flushed by precipitation and the water flows to the local road drainage system.

4.6 Groundwater

The soils and land capability are similar to those on the already subdivided lots on which dwellings have been constructed.

As noted above the winter water consists of rainfall filling the upper sandy layers in the lower areas and then temporarily perching on the less permeable underlying sandy clays.

The depth to groundwater is shown in the Perth Groundwater Atlas, being 30 to 31 metres, rising to the east. This concurs with the on ground observations which show the water table as not intersecting the land surface with the only water being temporary perched surface water which will be removed by constructed drainage. The detention basin is designed not to intersect the groundwater, being constructed just above the maximum elevation.

There is also a bore located on this site in the central west. The bore is sunk into the underlying sedimentary aquifers which contain a head of pressure that lifts the water in the bore.

The depth of the highest known water in that bore is 7 metres below the surface which equates to an elevation of 26 metres AHD, 6 metres below the elevation of the lowest land on Lot 791.

With the constructed road drainage the amount of surface water present on site has been reduced, with drainage assisted to the regional 1930's drains that drain to the west and to the Serpentine River. Figure 5.

The type of waste water system can be selected to match each site to minimise the risk of nutrient export to groundwater. Based on the pre-subdivision data Ecomax and Filtrex nutrient adsorbing waste water systems will comply with Department of Health criteria.

With the constructed road drainage the amount of temporary surface water will reduce to provide greater separations.

5.0 Water Use and Sustainability Initiatives

5.1 Water Supply

Water supply is to be scheme water.

5.2 Water Saving Initiatives

- ***Rainwater Tanks***

If a minimum 5 000 litre rainwater tank is recommended by Government 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 7 = 17.5 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^3 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 300 kL per year per dwelling this represents a saving of 3.3% if the water is substituted for scheme water.

- ***Education and Appliances***

The education of the purchasers is achieved in literature attached to Water Corporation accounts, Department of Water and Shire of Serpentine - Jarrahdale awareness information.

The Australian Bureau of Statistics in *Water Conservation inside the Dwelling (2007)* records the ways most likely to save water as being education and awareness activities, such as only using the washing machine or dishwasher with a full load, purchasing more efficient washing machine or dishwasher, reuse of greywater from the laundry, dual flush efficient toilets, taking shorter showers, checking for leaking pipes, using efficient shower heads.

The Water Corporation uses the same educational methods of saving water, such as programing sprinklers or watering on the allotted days, efficient use of hoses, water saving practices in the home, collecting and utilising stormwater for garden irrigation, using plants with low water requirements, using single lever mixer taps, insulating hot water pipes, use of soil improvements, using rain sensitive sprinklers and the efficient use of evaporative air conditioners.

The Waterwise Household Assessment Sheet produced by Water Corporation summarises the efficiency measures, all of which are educational or dependant on the type of appliances and fittings provided for the home. They are not efficiency measures that can be mandated apart from greywater reuse.

All new homes in Western Australia are required by the 5 Star Plus Building Code Amendment 2008 to fit water efficient appliances such as dual flush toilets and water efficient taps and showerheads. As the requirements are part of the Building Code of Australia the term "5 Star" is being phased out. The potentially mandated savings are all in place and are not available as additional savings.

Department of Water discusses water efficiencies, and notes that 50% of water goes on gardens. The type of garden developed on each lot and the water use within that garden can only be achieved through education and not mandated.

For lots using rainwater tanks it is in the householder's interest to be as water efficient as possible.

With the water captured and released to site there is little change to the water regime. Some water saving measures are listed below.

The main water use initiatives for each lot could potentially be;

- Potential use of rainwater tanks with a minimum of 5000 kL capacity.

  Saving 20 kL per year. This is a small amount, in the order of 3.3% of typical household usage, and only applies if the water is used throughout the year such as for flushing toilets.

- Dwellings could use ATU's and then use the recovered water on gardens. ATU's will be required for some lots due to < 2.0 metres to the water table.

  Savings 81.4 kL. Note; Greywater recovery systems are not available where ATU's are used as all water is recovered and can be directed to gardens.

  Greywater Recovery Systems are available on lots with conventional septic systems and can result in that water being diverted to gardens which will reduce the amount of water that may be required from a bore.

  The use of native or low water requiring exotic trees for landscaping. This is probably not significant in a location such as this with a high winter rainfall and loam based soils. 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. However it may be preferable to plant trees to reduce water loading on site.

- The encouragement for the use of low water requirement gardens.
  Savings estimated to be 10 – 20 kL per year.

- The use of water saving devices, water saving shower heads and dual flush toilets are already mandatory in Western Australia and are part of the Building Code.

  These can save up to 90 litres water per day according to Water Corporation and are assumed to be used in the estimated average of 220 kL per year and therefore no additional savings will be available to the rezoning.

- The estimated savings of 220 kL per year appear inflated when compared to the actual and projected water use for dwellings by Department of Planning of 155 to 170 kL per capita. Normally averaged dwellings use around 300 – 350 kL water per year for both inside and outside use.

- Encouragement for the use of water efficient 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.

- Utilising the road drainage for irrigating the road and community landscaping.

If the average dwelling holds 2.5 persons, and yearly water use is 300 kL per year, the average use per person is 120 kL per year, without any savings.

To achieve the target of 80 kL per person per year will be difficult and probably does not take into account the reductions in water use that have been made in recent years including the mandated provisions. With the mandated water saving features there is little that can be done to save additional water from a physical process with most of the savings coming from public education.

To achieve water savings the use of water wise gardening and plants, rainwater tanks, 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.

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.

6.0 Stormwater Management Strategy

6.1 Post Subdivision Water Input

The proposed subdivision, has lots down to 4 000 m^3 with the largest lot being 9 144 m^2.

All lots will be connected to scheme water but will have on site waste water disposal.

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 0.4 ha lot this equates to say 300 kL per lot additional water loading. The scheme water will be spread generally over the whole subdivision.

The other loading is from rainfall, at near 950 mm per year, most of which 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 20 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.

ATU with waste water directed to gardens 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 irrigation from ATUs, are considered in the calculations. (See treatment of Stormwater below).

6.2 Changes to Soil Moisture as a Result of Subdivision

- ***Inflows to site***

Groundwork Consulting Engineers calculate the inflow surface water volumes at 0.07m^3/sec. They have designed the drainage system to incorporate those input surface water flows from the south, Figure 6.

- ***Building envelopes***

For a dwelling a hard surface area of 350 m^2 is assumed, including the dwelling, driveways, sheds and garages.

To this is added 50 m^2 of driveway, to make an assumed area of hard surface per lot of 400 m^2.

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% and recharge from roofs and roads is rated at 90%. That is there will be an additional recharge of 50% 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 no change to the water loading from development.

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.

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% - 40% = 50%.

The difference in water loading is;

For each lot at 400 m^2 per lot hard surface;

400 m^2 x 0.950 m rainfall x 50% change to evapotranspiration = 190 m^3 or kL (increase) spread over a lot of 0.4 hectares or 4 000 m^2 which is equivalent to an additional 47.5 mm rainfall.

To this must be added the 300 kL scheme water per 0.4 ha lot which is equivalent to 75 mm rainfall.

These calculations have been made by Groundwork Consulting Engineers in order to arrive at the flow scenarios. See attached plan.

- ***Roads***

If all the additional water from the roads is contained within swale drains and the detention basin then there will be no overall change in recharge on site as a result of development.

The road drainage has been calculated by Groundwork Consulting Engineers to infiltrate into the soils through the swale drain and detention basin. Excess water in excess of the 1 in 1 year event is permitted to flow from the detention basin in line with Department of Water Guidelines.

- ***Recharge***

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.*

This provides an indication of what effect the road and swale drainage and hard surfaces will have in drying or draining the soils.

To gain some idea of the changes to recharge, the 35 lot subdivision is considered.

Currently rainfall which falls on the subject land either soaks into the soils or runs from the site.

With development the amount of hard surface will increase, with dwellings, driveways and roads on the site.

The runoff from the road network and hard surfaces is calculated by Groundwork Consulting Engineers and is included on their attached plan. That drainage is directed to a detention basin in the central north for infiltration and overflow during large storm events.

Apart from scheme water, loading from rainwater that is collected from roofs and not used in rainwater tanks, will be directed to on site soakwells.

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.

As noted above scheme water contributes water of around 75 mm rainfall equivalent.

The additional hardstand on each 4 000 m^2 lot increases soil moisture by around 47.5 mm rainfall equivalent as shown above.

These two values are equivalent to around 13% of rainfall as an increase.

If the planting of deep rooted trees and shrubs changed the recharge by 15%, by converting pasture to parkland pasture, this would be equivalent to a reduction in recharge of 950mm x 15% or 0.950 m rainfall. That is 15% of rainfall across the site or 142.5 mm rainfall.

As the additional recharge is equivalent to the loss of water from the additional tree planting by individual lot owners on their land the pre and post development water loading will be similar.

These calculations have been used by Groundwork Engineers in their calculations of the water loading and drainage requirements.

Therefore as a result of subdivision there is not anticipated to be any additional increase in recharge to soils.

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.

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.

These calculations have been used by Groundwork Engineers in their calculations of the water loading and drainage requirements. See attached design Figure 6.

Higher volume rainfall events will be directed along the designed drainage to link with the regional drainage, by accepting the stormwater from the south and releasing the stormwater along the natural flow path across the northern boundary. The detention basin is located at the point of the natural flows.

The methods of retention on site consist of management taken at each dwelling, and additionally management of the road drainage and detention basin.

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 to irrigate gardens and substitution for scheme water.

The design of the detention basin is sized appropriately with cross sections and elevations of water bodies provided by Groundwater Consulting Engineers. The figure produced shows the location of the detention basin, the volume, the volumes of the various storm events, the invert levels and the outlet volumes and location. Figure 6.

Drainage features such as swale drains are located within road reserves.

The detention basin is located on its own lot to ensure;

- 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 shallow slopes and as necessary fences.

The other issue that requires consideration is the landforms of most catchments pre-subdivision direct larger storm flows to the headwaters of the local regional drainage lines.

6.3.2 Roof Drainage and the Size of Soakwells

A rainfall design criteria of 16.5 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 450 m^2 is assumed, of which water from 300 m^2 is likely to be directed to soakwells.

The site has permeable deep sand and sand over loam soils that will enclose any soak wells and allow lateral flows from them. The soak wells will be located in sand. With a lot size of 0.4 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.

As the surface area directed to soakwells is assumed to be 300 m^2, and the rainfall criteria is 16.5 mm ARI event, with a 0.9 runoff coefficient from hard surfaces, then a volume of up to

$$300\ m^2 \times 0.9 \times 16.5/1000\ mm = 4.455\ m^3$$

Typical soakwells of 1300 mm diameter x 1200 mm depth hold a volume of 1.59 m^3. Therefore, three 1300 x 1200 mm soakwells will be required, with a larger roof area requiring correspondingly four or more soakwells to achieve a 1 in 1 hour ARI rainfall event.

With two such soakwells a total storage volume will be 3.18 m^3 or 71% of the 300 m^2 roof area used. Therefore, to round the figure off, a roof area of 300 m^2 will require three 1300 x 1200 mm soakwells with a larger roof area 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 7 = 17.5 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^3 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 300 kL per year per dwelling this represents a saving of 3.3% if the water is substituted for scheme water.

6.3.4 Waste Water Management

The critical issues are that the waste water should be disposed of into well a designed waste water disposal area to enable the waste water to infiltrate into the natural soils and not be able to move laterally and short circuit the disposal area. When this is undertaken good nutrient retention can be achieved. The Local authority is required, under the *Health Act 1911*, to oversee and approve waste water disposal; in this case to the Health Department Guidelines 2001 for ATU's.

Nutrient retention is high on this site when the use of ATUs is mandated. This is discussed in

> Land Capability mapping is discussed in *Landform Research 2013, Land Capability – Geotechnical Assessment, Lot 791 Walker Road, Serpentine*.

The use of nutrient adsorbing systems is recommended.

The Draft Country Sewerage Policy (22 September 2002, SOCWM meeting) permits waste water disposal on any soil type on lots in excess of 2 000 m^2 and allows for some site modification.

The soils on all parts of the developable areas are capable of accepting and retaining all waste water.

The deep yellow and brown sandy upper soil horizons have moderate phosphate retention capability and in the deeper areas in the west have good phosphate retention capability.

Phosphorus adsorbing amended soils are used for the waste water disposal area of alternative waste water systems in the lower elevations These systems are nutrient adsorbing, and designed to adsorb all or almost all the phosphorus released in waste water.

The increased effectiveness of nutrient adsorbing waste water systems for nitrogen removal is shown by research by Filtrex which has found that nitrogen is reduced by 75% at the edge of the waste water disposal area, (Filtrex, March 2009) and then further reduced by the soils.

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.

Waste water systems can readily be installed and comply with the waste water disposal guidelines for disposal and installation.

- *Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974 – Health Act 1911*.
- *Government Draft Country Sewerage Policy, 2002* (revised September 2003) and under revision.
- *Specification for Aerobic Treatment Units (ATU's) Serving Single Households*, Health Department of Western Australia 1992 or superseding document.
- *Draft Guidelines for the Reuse of Greywater in Western Australia*, Health Department of Western Australia 2002, or superseding document.

6.3.5 Size of Road Drainage

- ***Swale Drainage***

Being sand over clay soils the swale drains will permit adequate infiltration of the one year one hour return storm volumes. However in heavier events, when there will be some runoff, there will also be some seepage and drainage from the surface sands into the swale drains and constructed drains.

Road drainage will use a number of features, but predominantly grassed swale drains which will enable infiltration of the smaller rainfall events. 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 or designed drainage. The design and cross section of the swales is shown on Groundwork Consulting Engineers design, Figure 6.

Examples of swale drains are provided in Department of Water, *A Manual for Managing Urban Stormwater Quality in Western Australia* grass swales BMP14.

It is proposed that the 1 year 1 hour rainfall events will be retained on site, through the use of soakwells on individual lots. Data is obtained from the Bureau of Meteorology. Excess stormwater events permit runoff from the system to maintain environmental flows.

This is similar to the existing situation on the local roads and best matches the pre development with the post development situation.

The swale drains are also designed to accept the calculated flows of 0.07 ^{m3}/sec from the south.

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.

With such large areas the swale drain is constructed such that the proportion of excess stormwater that flows along the drain after construction will be proportional to the permeability of the soil.

- ***Detention Basin***

The surface water calculations have been made by Groundwork Consulting Engineers in their calculations of the water loading and drainage requirements. See attached design Figure 6.

Higher stormwater events (>1 hour 1 year event) will be directed along the designed drainage to link with the regional drainage, by accepting the stormwater from the south and releasing the stormwater along the natural flow path across the northern boundary. The detention basin is located at the point of the natural flows.

The methods of retention on site consist of management taken at each dwelling, and secondarily management of the road drainage and detention basin.

The design of the detention basin is sized appropriately with cross sections and elevations of water bodies provided by Groundwater Consulting Engineers. The figure produced shows the location of the detention basin, the volume, the volumes of the various storm events, the invert levels and the outlet volumes and location, Figure 6.

Drainage features such as swale drains are located within road reserves.

The detention basin is located on its own lot to ensure;

- 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 shallow slopes and as necessary fences.

The detention / infiltration basin will require a piped or level sill outlet to prevent overflow and provide attenuated flow to the headwaters of the catchments to prevent scouring. The basin is recommended to have shallow slopes and banks to increase safety and provide habitat and reed establishment. As shown by Groundwater Consulting Engineers.

On this site, the detention basin 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.*

It is proposed to plant local native trees and shrubs around the perimeter of the basin. The basin is likely to dry out in summer through evaporation and seepage through the underlying sandy clay subsoils, therefore reeds and rushes that can be used as perimeter planting will need to be able to withstand a period of dry conditions most years. The trees and shrubs will be planted at the rate of 1 plant per $3m^2$, with reeds and rushes planted at 3 plants per $1m^2$.

Suggested species include;

Trees and Shrubs

Banksia littoralis
Callistemon phoeniceus
Callitris preissii
Casuarina obesa
Eucalyptus rudis
Melaleuca cuticularis
Melaleuca laterifolia
Melaleuca preissiana
Melaleuca rhaphiophylla
Melaleuca teretifolia
Melaleuca viminea
Taxandria linearifolia
Viminaria juncea

Reeds and Rushes

Baumea juncea
Bolboschoenus caldwellii
Eleocharis acuta
Ficinia nodosa
Isolepis prolifera
Juncus articulates
Juncus microcephalus
Juncus pallidus

7.0 Groundwater Management Strategy

By retaining the 1 hour 1 year storm event on site and releasing water from larger storm events it has been calculated by Groundwater Consulting Engineers that the pre- development recharge will be similar to the post development recharge.

The surface water volumes and flows onto and offsite will be similar from pre-development to post development and the recharge to groundwater will be similar.

The water recharge is not anticipated to change, therefore no changes are anticipated to groundwater regimes.

8.0 Future Design Considerations

Additional detailed engineering design, to accompany the site specific design for the subdivision, may be required to adjust the water management if there are changes to the development, during construction of the development and if different soil conditions are encountered in localised areas during construction.

If that is the case 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 other issues that are listed below.

- It is proposed that all surface water up to and including the 1 hour 1 year return event will be retained on site within the swale drains. Excess water will be directed to relatively small detention basins from which it will flow to the external regional drainage system, outside the subdivision. Water within the detention basins will evaporate, be lost through transpiration and infiltrate into the soils in spring and summer.

  Unless taken immediately the only water available to sample will be the water in the dams or at the external drains.

- The subdivision may be developed in stages and not all stages will have water standing or running water available for sampling.

- Sampling is very much influenced by 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 only available after construction and the lots have been sold and developed, which limits potential sampling and modifications to the drainage system. Hence the need for sufficient area in the dedicated drainage footprints for flexibility.

On the precinct the only water readily available for sampling will be the created detention basin. Sampling is therefore proposed at the basin that will accept water from that catchment.

Samples from this basin will provide an indication of any impacts on water quality of the subdivision and will represent more than half the precinct.

The sampling will require at least one year, and preferably two, of sampling in spring and autumn to provide data on the quality of water in the existing drains on site if they flow in a particular winter.

Post development it is recommended that sampling occur in spring and autumn for two winters following any stage or final construction.

The sampling is suggested for the following parameters, TSS, TP, TN, EC DO and pH.

10.0 Implementation

Implementation will occur during construction.

If construction is staged the stormwater management will be developed to deal with the stormwater both during and at the end of construction

Analysis of Stormwater and Recommended Management	
Individual lots	• The soils on site are coloured sands over loam/clay and deep yellow sands. • The site investigations and engineering design calculations made by Groundwork Consulting Engineers show that the soils will be able to accept and retain on site the ARI 1 hour 1 year rainfall events. Figure 6. • Stormwater from heavier rainfall events will distribute onto the land surface.
Road drainage	• The site investigations and engineering design calculations made by Groundwork Consulting Engineers demonstrate that the swale drains will be able to manage surface water. • For events in excess of the 1 in 1 year 1 hour, the excess water is directed to a detention basin in the central north. • Based on the calculations for water management, there are no limitations to development, or any limitations identified can be controlled by good water management. • The swale drains are designed to encourage infiltration and cutoff functions. See DOW (Water and Rivers Commission), 1998, 3.17 (BMP14). • Swale drains are located in the road reserves for maintenance.
Water Management	• There are no limitations imposed by the site on water management that would result from subdivision or development. • The flow into the site from upstream is determined by Groundwork Consulting Engineers to be 0.07 m^3/s. This flow has been incorporated into the water management design. • The detention basins and swales will be able to deal with storm and flood events without compromising the potential for flooding the developable land. • The swale drains associated with the road network will reduce the potential for water to lay on the surface in winter, drying the soils.
Detention basin	• The detention basin is designed to be installed above the highest known groundwater and will be able to deal with storm and flood events without compromising the potential for flooding the developable land. • The detention basin is recommended to retain the 1 in year 1 hour events (*A Manual for Managing Urban Stormwater Quality in Western Australia* infiltration basins BMP 110 and Wet Basins BMP 18). • The detention basin is provided with its own lot for greater ability to manage. • The detention basin is to be revegetated with local native trees and shrubs combined with fringing reeds and rushes.
Recommendations	• The installation of rainwater tanks with a minimum of 5000 litres can be considered but will not impact on water management. • Greywater reuse is encouraged to minimise scheme water use. • Stormwater volumes will need to be revisited during the engineering design stage when the final subdivision design has been determined.

REFERENCES

Allen D G and R C Jeffery, 1990, *Methods for Analysis of Phosphorus in Western Australian Soils,* Chemistry Centre Report on Investigation No 37.

ANZECC, 1992, *Australian Water Quality Guidelines for Fresh and Marine Waters.*

Appleyard S J 1993, *Explanatory Notes for the Groundwater Vulnerability to Contamination Maps of the Perth Basin*, Geological Survey of Western Australia, Record 1993/6.

Australian Health and Medical Research Council, 1996, *Australian Drinking Water Guidelines.*

Berkman D A, 1995, *Field Geologists Manual*, The Australian Institute of Mining and Metallurgy.

Bureau of Meteorology, 2013, *Rainfall Intensity Chart.*

Coles and Moore, 1998, *Runoff and Water Erosion*, IN Soil Guide, WA Department of Agriculture, Bulletin 4343.

Dames and Moore, undated, *Nitrate Management* in the Jandakot UWPCA.

Data from Select Committee on Metropolitan Development and Groundwater Supplies, Legislative Assembly 1994.

Dawes L and A Goonetilleke, 2001, *The importance of site assessment in designing effluent disposal areas*, Proceedings of the 2nd Australia and New Zealand Conference on Environmental Geotechnics - Geoenvironment, University of Newcastle New South Wales.

Department of Environment WA, 2004, *Stormwater Management Manual for Western Australia.*

Department of Health, 2001, *Code of Practice for the Design, Manufacture, and Operation of Aeorobic Treatment Units Servicing Single Dwellings*

Department of Natural Resources, and Department of Local Government and Planning, Queensland, 1997, *Planning Guidelines Separating Agricultural and Residential Land Uses.*

Department of Water, September 2006, *Wastewater treatment – on site domestic systems*, Water Quality protection Note.

Department of Water. 2008, *Better Urban Water Management.*

Dixon R N M, 1996, *Trees on farms to reduce salinity in the Clearing Control Catchments Volume 4, Helena Catchment*, Water and Rivers Commission, Rep. No. WRT8.

Dixon R N M, G W Mauger and A Rogers, 1998, *Trees on Farms to reduce Salinity in the Clearing of Control Catchments*, Water and Rivers Commission, WRT 20.

Groundwater Consulting Engineers, 2015, *Design drawings for surface water management on Lot 791 Walker Road, Serpentine.*

Engineers Australia 2003, *Australian Runoff Quality*, National Committee on Water Engineering.

Environment Australia, 2002, *Introduction to Urban Stormwater Management in Australia.*

Environmental Protection Authority Victoria/ Melbourne Water, undated, *Urban Stormwater, Best Practice Environmental Management Guidelines*

EPA Bulletin 711, 199, *Western Australian Water Quality Guidelines for Fresh and Marine Waters.*

FESA, 2001, *Planning for Fire*, Fire and Emergency Services Authority of Western Australia.

Geological Survey of WA, 1986, *Perth Environmental Geology 1 : 50 000 sheet.*

Gerritse et al, 1995, *Retention of Nitrate and Phosphate in Soils of the Darling Plateau in Western Australia*: Implications for Domestic Septic Tank Systems, Aust. J. Soil Res. 33, 36367.).

Gerritse R G and J A Adeney, *Nutrient export from various land uses on the Darling Plateau in Western Australia* , CSIRO Report 92141.

Gerritse R G, C Barber and J A Adeney, 1990, *The Impact of Residential Urban Areas on Groundwater Quality: Swan Coastal Plain, Western Australia*, CSIRO Water Resources Series No 3.

Gerritse R, 1993, *The influence of landuse and soil type on nutrient losses*, IN Swan River - The Future, Swan River Trust Report No 8.

Government of Western Australia, 2003, *Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974, Health Act 1911.*

Guidelines for Groundwater Protection in Australia, ARMCANZ, ANZECC, September 1995.

Jones T, M Middletone and N Corby, 2005, *Natural hazard risk in Perth, Western Australia*, Australian Government, Geoscience Australia.

King P D and M R Wells, 1990, *Darling Range Rural Land Capability Study*, Department of Agriculture and Food Land Resources Series No 3

Landform Research, 2013, *Land Capability – Geotechnical Assessment, Lot 791, Walker Road, Serpentine.*

Poinke H B, M L Sharma and J K Hosking, *Effect of Irrigated Horticultural Cropping on Groundwater Quality: Swan Coastal Plain, Western Australia*, CSIRO Water Research Series No 2.

Van Gool D, K Angell and Lindsay Stephens, 2000, *Stocking Rate Guidelines for Rural Small Holdings, Swan Coastal Plain and Darling Scarp, Western Australia*, Department of Agriculture, Miscellaneous Publication 02/2000.

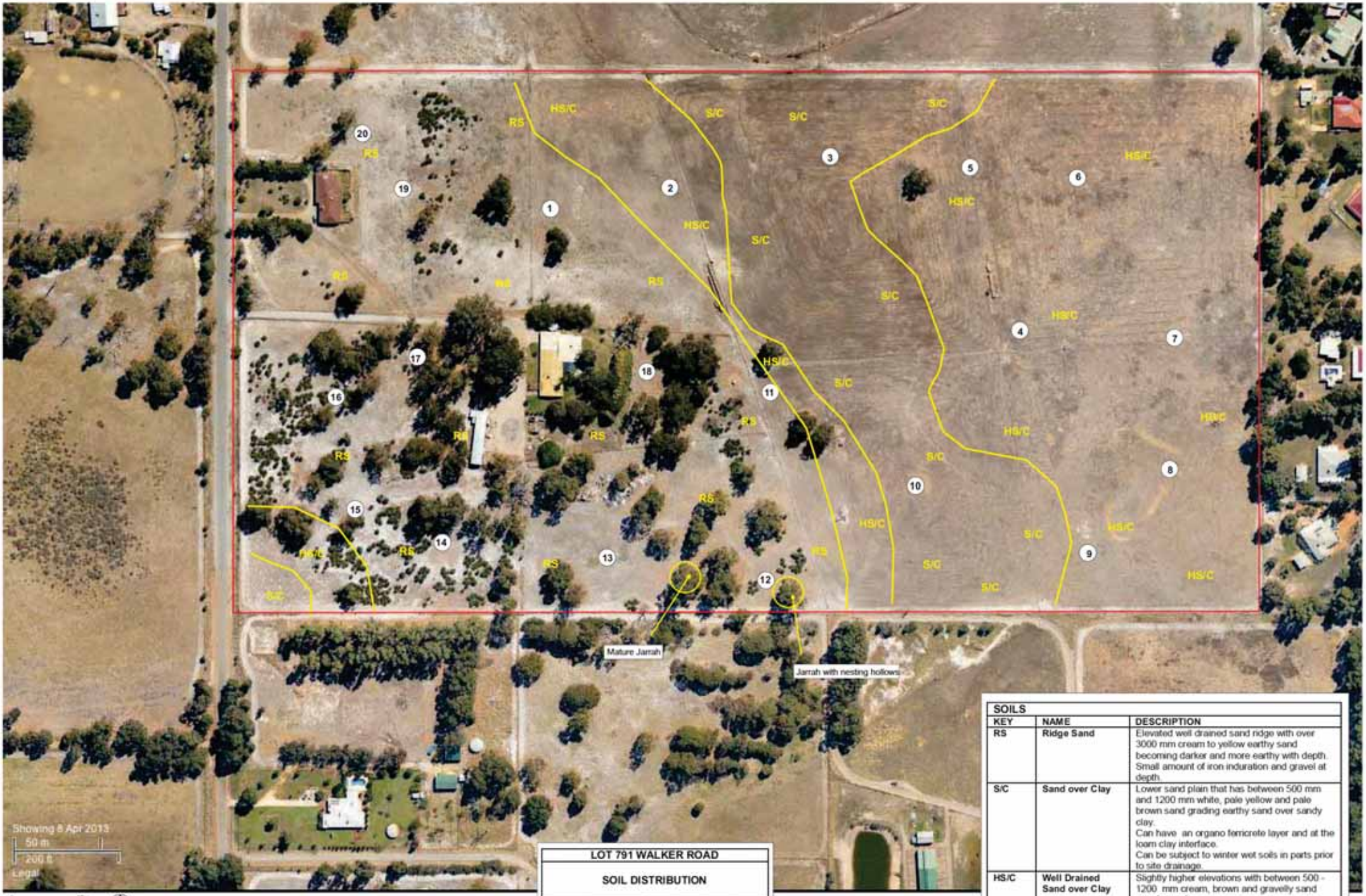
Water and Rivers Commission, 1998, *Manual for Managing Urban Stormwater Quality in Western Australia.*

Water and Rivers Commission, 1998, *Stabling and Agistment of Horses*, Water Quality Protection Note.

Wells M R and P D King, 1989, *Land Capability Assessment Methodology*, Western Australian Department of Agriculture.

Whitehead J H and P M Geary, 2005, *Geotechnical Challenges for Onsite Wastewater Management in the Hunter Region,* Australian Geomechanics Vol 40, No 2, June 2005.

Wilde S A and G H Low, 1978, 1 : *250 000 Perth Geological Series*, Geological Survey of Western Australia.



LOT 791 WALKER ROAD	
SOIL DISTRIBUTION	
Basemap NEARMAP	Landform Research
Scale 1 : 2000	May 2013

Figure 1

SOILS		
KEY	NAME	DESCRIPTION
RS	Ridge Sand	Elevated well drained sand ridge with over 3000 mm cream to yellow earthy sand becoming darker and more earthy with depth. Small amount of iron induration and gravel at depth.
S/C	Sand over Clay	Lower sand plain that has between 500 mm and 1200 mm white, pale yellow and pale brown sand grading earthy sand over sandy clay. Can have an organo ferricrete layer and at the loam clay interface. Can be subject to winter wet soils in parts prior to site drainage.
HS/C	Well Drained Sand over Clay	Slightly higher elevations with between 500 - 1200 mm cream, brown and gravelly sand over loam clay. Well drained and not subject to winter wet conditions.

LAND CAPABILITY FOR DWELLINGS and DEVELOPMENTS

KEY	CAPABILITY FOR SELECTED LAND USE
I	• Very high capability with few physical limitations.
II	• High capability with minor physical limitations that can be overcome by
IV	• Lower capability with a number of smaller management actions required or there is one significant factor that will require management. • Subdivision or development design can be used to contain additional costs. • 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.

MANAGEMENT of IDENTIFIED CONSTRAINTS for LAND USE AND DEVELOPMENT

KEY	CONSTRAINTS IDENTIFIED	GEOTECHNICAL and ENVIRONMENTAL MANAGEMENT
a	Soil permeability limitations	• Provide appropriate waste water disposal systems.
b	Foundation soundness	• Requires fill pads of sufficient depth to counteract potential clay or expanding sub-soils. • Organic subsoils may need to be removed if present.
c	Potential slope instability	• AS 2870 Site Class P generally applies to cut and fill. • Provide appropriate foundation design. • Upslope cutoff drains recommended. • Upslope water loading to be avoided. • Trees to be retained/planted. Pasture cover to be maintained
d	Steep slopes that require significant management	• Steep slopes that will require significant management to develop. • The slopes are often associated with a landscape feature. • Pier-pole foundations may be more appropriate than cut and fill. • Larger lot sizes recommended; > 1000 m^2.
e	Water erosion risk	• Maintain soil cover of crops, pasture, trees or shrubs • Use contour drains and agricultural practices. • Stormwater to be controlled.
f	Potential flooding	• Requires sand pad to be set sufficiently (0.5m) above highest known water level to minimise capillary effects. • Locate developments outside areas of flooding.
i	Subject to winter wet conditions or water logging risk in wet years.	• Alternative waste water treatment systems likely to be required. • Cut off drains and other drainage likely to be required. • Raise and or terrace waste water disposal areas. • Fill may be required for developments. • Floor elevations to have clearance above water risk levels. • Reduce stock in winter. • Road drainage and cut off drains will intersect and divert surface water from upslope, drying areas lower down slope.
k	Soil workability	• Remove or avoid rock, clay subsoils or other restrictions.
m	Low moisture availability of soil	• Manage or reduce stock to ensure pasture cover through summer. • Restrict clearing to building envelopes.
n	Low nutrient retention ability	• Alternative waste water treatment systems may be required. • Leach drains may need to be inverted or semi-inverted, bunded by natural soil or impermeable membrane on downslope side. • Setback developments appropriate distances from water bodies/wetlands. • Use reticulated sewerage. • Feed stormwater through detention basins and swale drains. • Manage nutrient and fertiliser applications and stock • Restrict clearing to building envelopes. • Restrict the density of development.
o	Water pollution risk by overland flow	• Retain surface water in basins, use swale and grass filters. • Manage stock and potentially polluting land uses.
p	Potentially low microbial purification	• Alternative waste water treatment systems required. • Correctly install waste water systems. • Bund waste water disposal areas sufficiently.
q	Water table <0.5 metres depth	• Soils can be modified using fill, cutoff drains to comply with the Government Country Sewerage Policy. • Use Filtrex or Ecomax, which can be installed where the water table is at 0.25 and 0.0 m below the surface.
r	Restricted rooting conditions	• Avoid rock, hardpan or other restrictions.
s	Water pollution risk by subsurface flow	• See (n) above.
t	Low topsoil nutrient retention	• See (n) above.
v	Remnant vegetation	• Restrict clearing to building envelopes. Maintain linkages.
w	Wind erosion risk	• Manage or reduce stock, irrigate and improve pasture. • Maintain vegetation/stubble cover through summer. • Restrict clearing to building envelopes.
x	Reduced ease of excavation	• Remove rock or avoid constrained areas.
y	Salinity risk	• Provide drainage and reduce ponding. • Plant deep rooted species including deep rooted crops.
z	Wetland conservation	• Exclude building envelopes and developments. • Provide appropriate buffer distances. • Place conservation covenants on wetlands and/or vegetation.
&	Potential for acid sulfate conditions	• Minimise deep excavations or bulk earthworks; use fill. • Neutralise removed affected soils. • Minimise or exclude dewatering and lowering of groundwater.
$	Restricted water availability	• Water may be restricted for some horticulture land uses
#	Semi-inverted leach drains	• Leach drains should be semi-inverted, bunded by natural soil or impermeable membrane on the downslope side.
@	Alternative waste water treatment system required	• 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.

Deep yellow sand soil

Earthy yellow sands

Pale yellow-brown sand (right) over earthy yellow sand (left)

Typical pasture and elevated ridge land

View east along the northern boundary

View north through the centre of the site

View east along the southern boundary showing mature Jarrah tree

Scattered Marri with cattle in the central south.

View west across the pasture

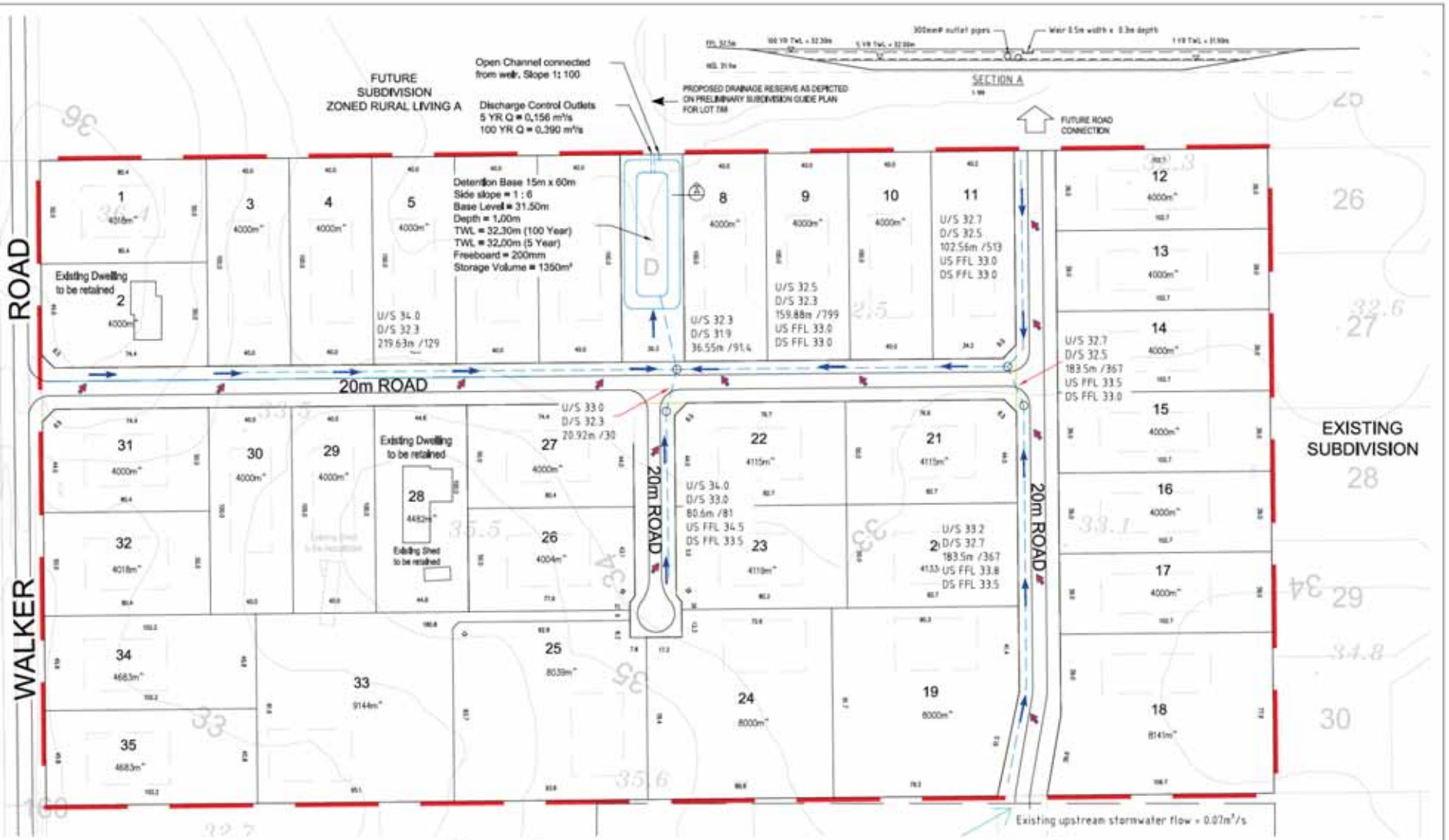
Figure 3

ALL PROPOSED BUILDING ENVELOPES GENERALLY IN ACCORDANCE WITH SHIRE OF SERPENTINE-JARRAHDALE BUILDING SETBACK REQUIREMENTS;

- MINIMUM 20m SETBACK FROM PRIMARY STREET
- MINIMUM 10m SIDE AND REAR SETBACKS
- MAXIMUM AREA OF 1000m²

THE LOCATION OF THE BUILDING ENVELOPES ARE INDICATIVE ONLY. BUILDING ENVELOPES AND EFFLUENT DISPOSAL ENVELOPES WILL BE REQUIRED TO ENSURE ADEQUATE SEPARATION DISTANCE TO GROUNDWATER IS ACHIEVED. THE EXACT LOCATION OF THESE ENVELOPES WILL BE DETERMINED

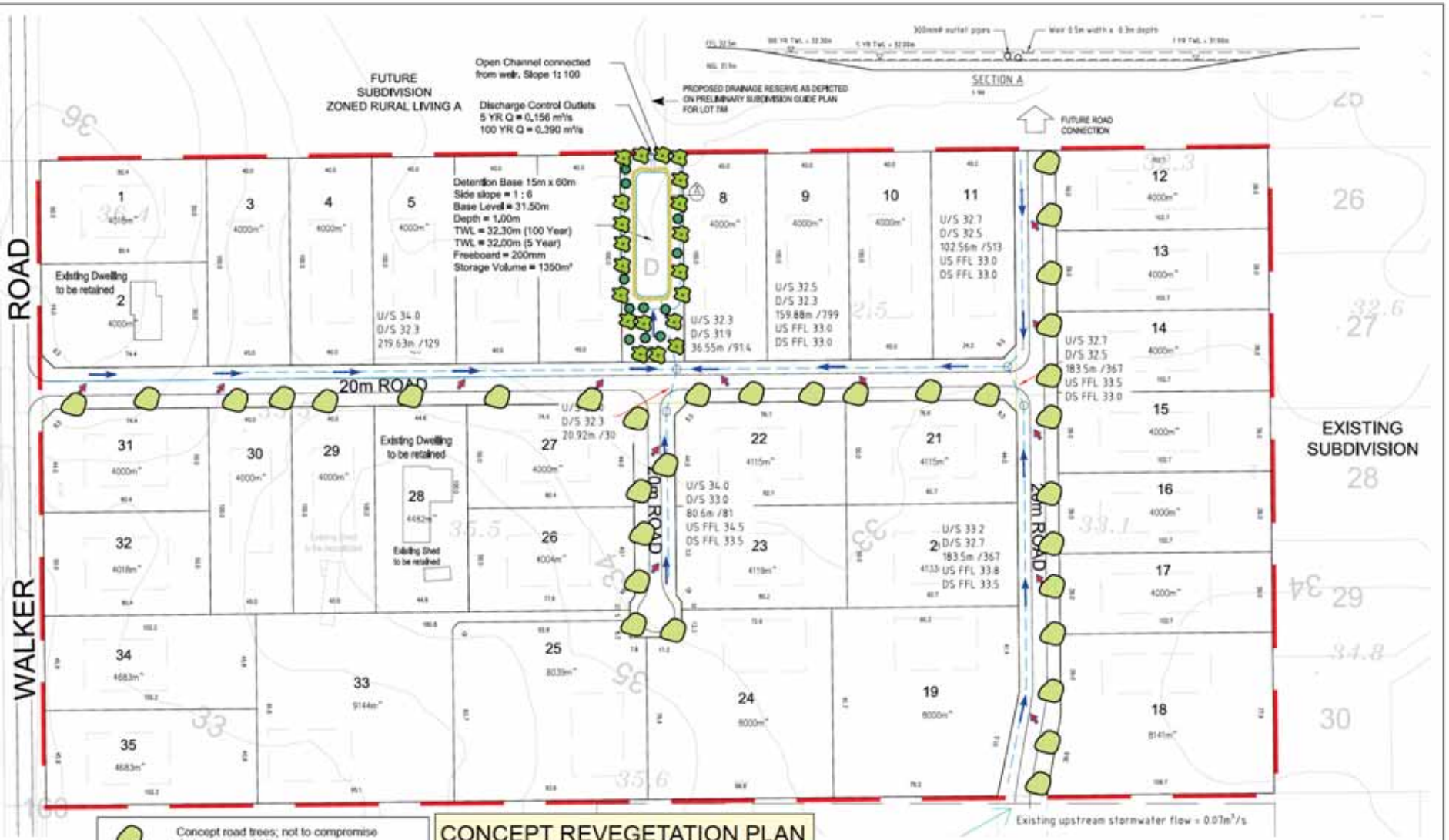

1 hour 1 year return events to be retained on site in detention basin.
All flows of excess water from the 5 - 100 year events will be directed along the existing drainage
SEE SUBDIVISION GUIDE PLAN FOR DETAILS OF THE CONCEPT DRAINAGE STRATEGY
Existing surface water flows
Proposed surface water flow in the subdivision, linked to the existing flow paths.
See Subdivision Guide Plan for details



AEP =		5						
td (mins)	I (mm/hr)	Impervious A (ha)	Qd (m3/s)	Post-Dev. Vol (m3)	Rainfall Vol (m3)	Qd (l/s)	PSD(l/s)	SSR(m3)
5	102.95	3.9249	1.12	1122.42	404.07	1322.69	212.62	411.50
10	81.41	3.9249	0.89	887.58	532.55	1686.62	212.62	426.65
20	56.17	3.9249	0.61	612.40	734.88	1345.64	212.62	538.25
30	44.07	3.9249	0.48	480.48	864.86	889.65	212.62	561.76
60	28.13	3.9249	0.31	306.69	1104.09	557.23	212.62	533.89

NOTE:
1. Minimum finished floor level for building envelop should be RL 32.5m.

Typical Roadside Swale Detail
Side slope = 1:4 maximum
Top width = 5.6m
Base width = Varies
Longitudinal slope = 1:100
Manning's Coefficient = 0.033
(short grass)



Concept road trees; not to compromise drainage or sight lines.

Native tall shrubs and small trees to assist in creating habitat.

Small native shrubs and wetland species.

Native reeds and rushes along water line.

CONCEPT REVEGETATION PLAN

td (mins)	I (mm/hr)	Impervious A (ha)	Qd (m3/s)	Post-Dev. Vol (m3)	Rainfall Qd (l/s)	PSD(l/s)	SSR(m3)
5	102.95	3.9249	1.12	1122.42	404.07	1322.69	212.62	411.50
10	81.41	3.9249	0.89	887.58	532.55	1686.62	212.62	426.65
20	56.17	3.9249	0.61	612.40	734.88	1345.64	212.62	538.25
30	44.07	3.9249	0.48	480.48	864.86	889.65	212.62	561.76
60	28.13	3.9249	0.31	306.69	1104.09	557.23	212.62	533.89

NOTE:
1. Minimum finished floor level for building envelop should be RL 32.5m.

Typical Roadside Swale Detail
Side slope = 1:4 maximum
Top width = 5.6m
Base width = Varies
Longitudinal slope = 1:100
Manning's Coefficient = 0.033 (short grass)

APPENDIX 6

Letter by Department of Water

APPENDIX 6

Government of Western Australia
Department of Water

Looking after all our water needs

RECEIVED
0 : APR 2016
BY:

Your ref: 100889
Our ref: RF9832-03
PA4885
Enquiries: Jane Sturgess (9550 4228)

Grey and Lewis
Suite 5, 2 Hardy Street
South Perth WA 6151

Attention: Liz Bushby

Dear Liz,

Re: Local Water Management Strategy – Lot 791 Walker Road, Serpentine

Thank you for referring the *Local Water Management Strategy - Lot 791 Walker Road, Serpentine* (LWMS) received with your correspondence on 10 December 2015. The Department of Water (DoW) apologies for the delay in responding to your submission, however DoW has reviewed the LWMS and wishes to advise that the document satisfies the requirements of *Better Urban Water Management (WAPC, 2008)*, subject to any advice from the Shire of Serpentine Jarrahdale.

Save time with Water Online
As your organisation is registered to use Water Online, we encourage you to lodge future referrals electronically via the Water Online customer portal at www.water.wa.gov.au. **Water Online** provides the fastest and most efficient process for submitting referrals or requests for planning advice. If you have any questions regarding the Water Online portal please contact our Business Support Unit on 1800 508 885 (select Option 2) or planning.enquiries@water.wa.gov.au.

If you wish to discuss the above or require further information, please contact Jane Sturgess at the DoW's Mandurah office on 9550 4228.

Yours faithfully

Brett Dunn
Program Manager – Urban Water Management
Peel Region

29 March 2016

Kwinana Peel Region
107 Breakwater Parade Mandurah Ocean Marina Mandurah Western Australia 6210
PO Box 332 Mandurah Western Australia 6210
Telephone (08) 9550 4222 Facsimile (08) 9581 4560
www.water.wa.gov.au