Structure Plan
'Serpentine Special Rural'

Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine

Prepared by
Hex Design and Planning

29A Bartlett Crescent
Karrinyup WA 6018

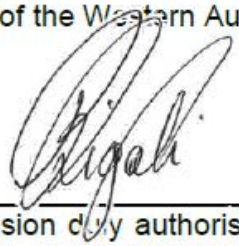
T +61 438 000 235
E admin@hexdesignplanning.com.au

ABN 34627142299
SCUDERIA HOLDINGS PTY LTDT/AS HEX DESIGN AND PLANNING

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: **05 NOVEMBER 2021**

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

09 November 2021 Date

05 November 2031 Date of Expiry

TABLE OF AMENDMENTS

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

Executive Summary

Structure Plan - Lot 9001 Utley Road and Lot 9002 Wattle Road

This report represents an application to the Shire of Serpentine Jarrahdale to consider a proposed Structure Plan Comprising Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine.

The structure plan has a total area of 91.30 ha and is situated approximately 50km south-east of the Perth CBD and 23km east of the Rockingham town centre. In a local context, the site is 2.7km west of the South Western Highway, and 2.5km south-west of the Serpentine town centre.

The Structure Plan Summary Table below details the nature and key outcomes of the Structure Plan.

Structure Plan Summary Table

ITEM	DATA	Structure Plan REF (section no.)
Total area covered by the Structure Plan	91.03 ha	Section 1.2.2, 1.2.3, 3.1.1
Area of each land use proposed: - Special Rural	85.19 ha (93.5 %)	Section 3.3.1
Total estimated lot yield	39 lots	Section 1.1
Estimated number of dwellings	39 dwellings	Section 3.3.1
Estimated population	100 persons	Section 3.3.1
Estimated residential site density	0.46 dwellings per site hectare	Section 3.3.1

Part One - Implementation

Part One - Implementation

Structure Plan - Lot 9001 Utley Road and Lot 9002 Wattle Road

1.0 Structure Plan Area

This Structure Plan shall apply to Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine. The Structure Plan area is defined by the line denoting the Structure Plan boundary on the Structure Plan Map (**Plan 1**).

2.0 Operation

The date the Structure Plan comes into effect is the date the Structure Plan is approved by the WAPC.

3.0 Staging

Staging of the Structure Plan is not dependent upon any infrastructure triggers.

4.0 Subdivision and Development Requirements

General Subdivision and Development Requirements

4.0 The Structure Plan area is zoned 'Special Rural' under the provisions Shire of Serpentine Jarrahdale Town Planning Scheme No.2.

Development shall be in accordance with Clause 5.9 of the Scheme, and any provisions for 'SR 28' listed in Appendix 4 – Special Rural Zone under the Shire of Serpentine Jarrahdale Town Planning Scheme No.2.

4.1 Subdivision within the Local Structure Plan area is to be generally in accordance with lot configuration and lot sizes prescribed by the Local Structure Plan. All indicative subdivision layouts shown in this Local Structure Plan and associated appendices are subject to further investigation and detailed design at subdivision stage.

4.2 At the subdivision stage, a minimum lot size of 2 hectares shall apply.

4.3 Land use permissibility within the Structure Plan area shall be in accordance with the corresponding zone or reserve under the Scheme.

Site Specific Subdivision and Development Requirements

4.4 Building envelopes should be positioned with regard to geotechnical investigations, retention of vegetation, wetland locations and buffers, and bushfire management.

4.5 A Site and Soil Evaluation is required to be prepared for subdivision applications, in accordance with Australian Standard 1547 On-site domestic wastewater management (AS/NZS 1547), undertaken in winter conditions, to address the requirements of the Government Sewerage Policy and be supported by the Shire of Serpentine Jarrahdale and the Department of Health.

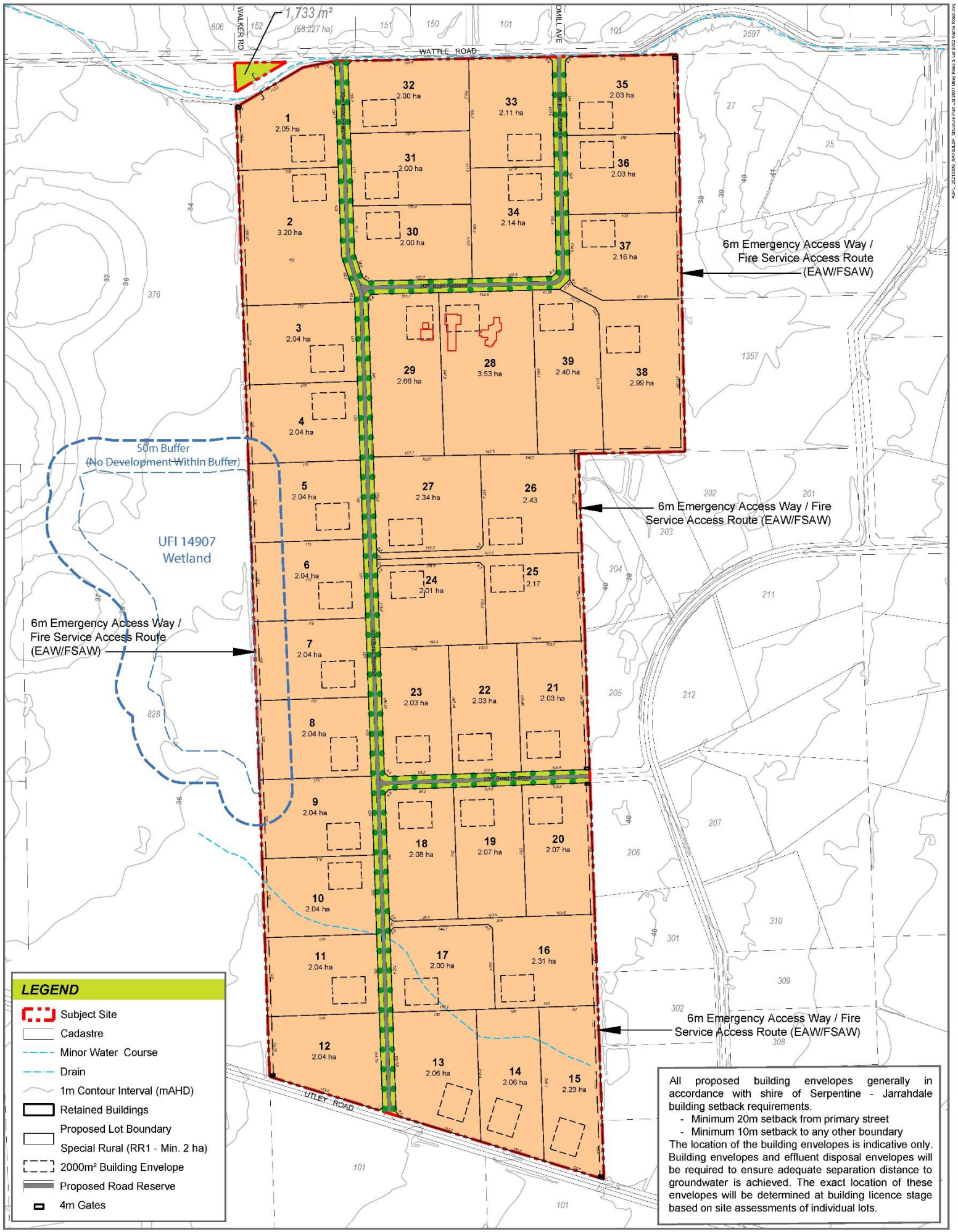
4.6 A Bushfire Management Plan addressing the bushfire protection criteria in the Guidelines for Planning in Bushfire Prone Areas is required to be provided at subdivision stage.

4.7 A Landscape Management and Revegetation Plan may be required as a condition of subdivision approval.

4.8 A Section 70A Notification to be placed on the titles of lots to notify prospective purchasers of potential noise and odour impacts associated with the operating piggery at 567 Utley Road, Hopeland.

Plan 1

Structure Plan Map



LEGEND

- Subject Site
- Cadastre
- Minor Water Course
- Drain
- 1m Contour Interval (mAHD)
- Retained Buildings
- Proposed Lot Boundary
- Special Rural (RR1 - Min. 2 ha)
- 2000m² Building Envelope
- Proposed Road Reserve
- 4m Gates

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 is 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 9001 Utley Road & Lot 9002 Wattle Road - Serpentine

50 0 50 100 250 500

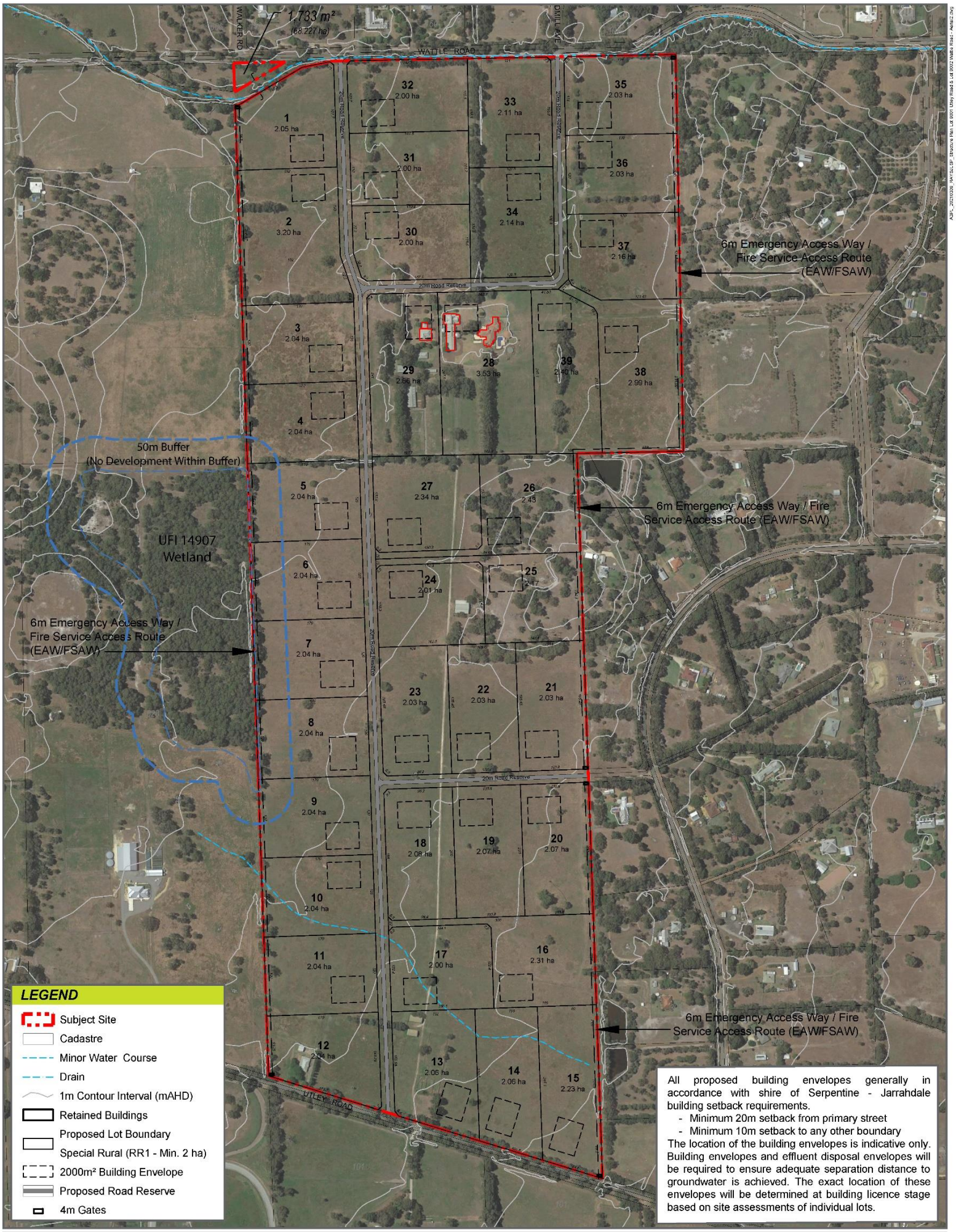
Project RAYSJLSP I Scale 1:5000@A3 I Date March 2021

HEX DESIGN | PLANNING

Source of Information

Site boundaries: Landgate
Projection: GDA94 MGA Zone 50 South

NOTE
All areas and dimensions are subject to survey, engineering and detailed design and may change without notice.



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 is 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 9001 Utley Road & Lot 9002 Wattle Road - Serpentine

50 0 50 100 250 500

Project RAYSJLSP I Scale 1:5000@A3 I Date March 2021

HEX DESIGN | PLANNING

Source of Information

Site boundaries: Landgate
Projection: GDA94 MGA Zone 50 South

NOTE
All areas and dimensions are subject to survey, engineering and detailed design and may change without notice.

Part Two—Explanatory Report

Document Summary

VERSION	Ref	COMMENT	PREPARED BY	REVIEWED BY	REVIEW DATE	APPROVED BY	ISSUE DATE
Revision 1 - Draft	RAYSJLSP	Draft	SLD	SYD	10/8/2020	SLD	10/8/20

Prepared for: ***ANDREA THOMAS RYAN & STRON PTY LTD***

Prepared by: ***Hex Design and Planning***

29a Bartlett Crescent, KARRINYUP

T: 0438000235 *E: sheldon@hexdesignplanning.com.au*

CONTENTS

Figures

Appendix

1 PLANNING BACKGROUND

1.1 Introduction and Purpose

This submission has been prepared by Hex Design and Planning on behalf of the landowners of Lots 9001 Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine. The Structure over the subject site is intended to guide future subdivision and development in accordance with the provisions of the Shire of Serpentine Jarrahdale Local Planning Scheme No.2 (LPS2).

The ultimate objective of this proposal is to facilitate the subdivision and development of the land for special rural purposes in a manner that interacts appropriately with the development that has already occurred in the immediate locality.

The lots proximity to the Serpentine townsite and surrounding Rural Living subdivisions, mirror the proposed lot layout and sizes proposed by this structure plan.

The land was previously rezoned to Special Rural (SR28) under the provisions of LPS2, facilitating the preparation of the structure plan to guide subsequent development.

The intended land uses within the Structure Plan include:

- 39 Rural Living B (2ha) lots;
- Retention of the 'homestead'
- Strategic firebreak/bridle trail along the western boundary, providing separation to the abutting Rural landholdings.

This submission is accompanied by a Structure Plan Map (**Plan 1**) prepared in accordance with the *Planning and Development (Local Planning Scheme) Regulations, 2015* which is included at Part One of this Report.

The Explanatory Section of this Structure Plan Report includes a detailed description of the proposal, provides an evaluation of the relevant town planning, environmental, fire management, local water management and servicing considerations applicable to the land, and details the rationale supporting the proposed Structure Plan.

The Structure Plan has been developed having regard to the physical features of the land, surrounding development, recommendations from technical reports and discussions with technical staff at Shire of Serpentine Jarrahdale.

The Structure Plan has been formulated by Hex Design in collaboration with a team of specialist consultants, who have provided input in relation to matters as follows:

Hex Design and Planning	-	Urban design, town planning, project coordination
Emerge Associates	-	Environmental Report / Land Capability
Emerge Associates	-	Bushfire Management Plan
Porters Engineering	-	Engineering Services Report
Emerge Associates	-	Local Water Management Strategy
Porters Engineering	-	Transport Assessment

Copies of the relevant consultant reports are included as Appendices in this report, with key findings from the respective reports incorporated within the core of this report. A Local Water Management Strategy (LWMS) has been prepared to support the Structure Plan and has been submitted concurrently to the Structure Plan Report by Emerge Associates for approval by the Department of Water. The Consultants'

Reports confirm there are no significant constraints to progressing urban development of the land, and is capable of being supported by Council.

1.2 Land Description

1.2.1 Location

The subject site is located within the suburb of Serpentine and is situated approximately is 2.7km west of the South Western Highway, and 2.5km south-west of the Serpentine town centre. (***Figure 1 & 2*** *refers*).

The site is accessed from Wattle Road to the north and Utley Road to the south. Both these roads intersect with Hall Road to the east, which abuts the railway reserve. Via Hall Road access to Karnup Road to the north is achieved, which provides a connection to the wider regional; area and road network.

Karnup Road intersects with the Kwinana Freeway to the west and South Western Highway to the east, providing regional access.

Figure 1 – Location Plan

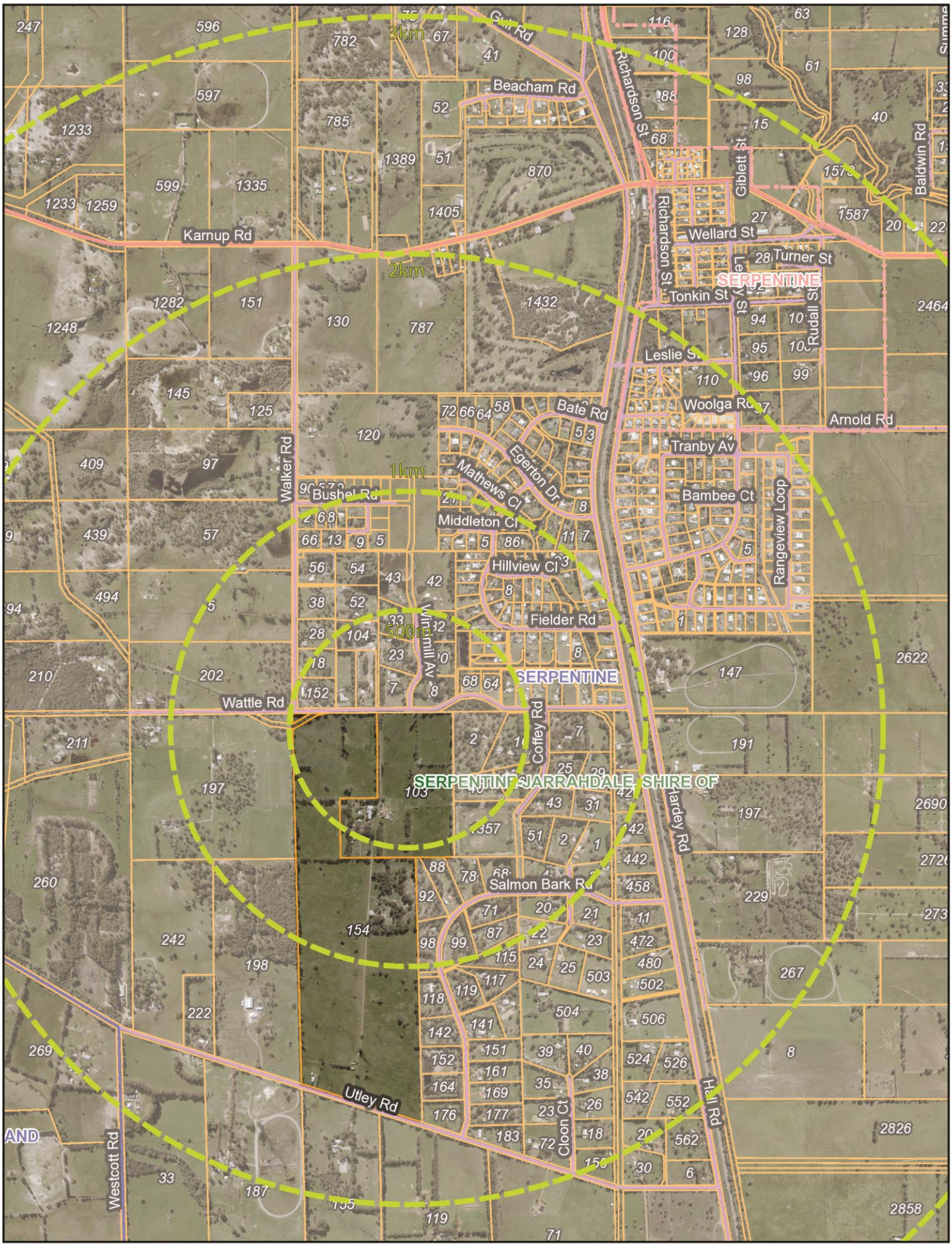
1.2.2 Area and Land Use

The subject land is located within the Shire of Serpentine Jarrahdale, bounded by Wattle Road to the north, Utley Road to the south, and private landholdings to the east and west. An existing rural living estate abuts the eastern boundary of the site, with additional road access available via Burto Close which is currently an unconstructed road reserve.

The site has a combined land area of 91.30ha.

The subject site has historically been used for equestrian land uses, with the homestead and stables still being located on-site. Surrounding land uses reflect the existing zoning under LPS2 and generally comprise rural living and low key equestrian uses.

The Aerial Photograph (***Figure 3***) shows the current state of the subject site.



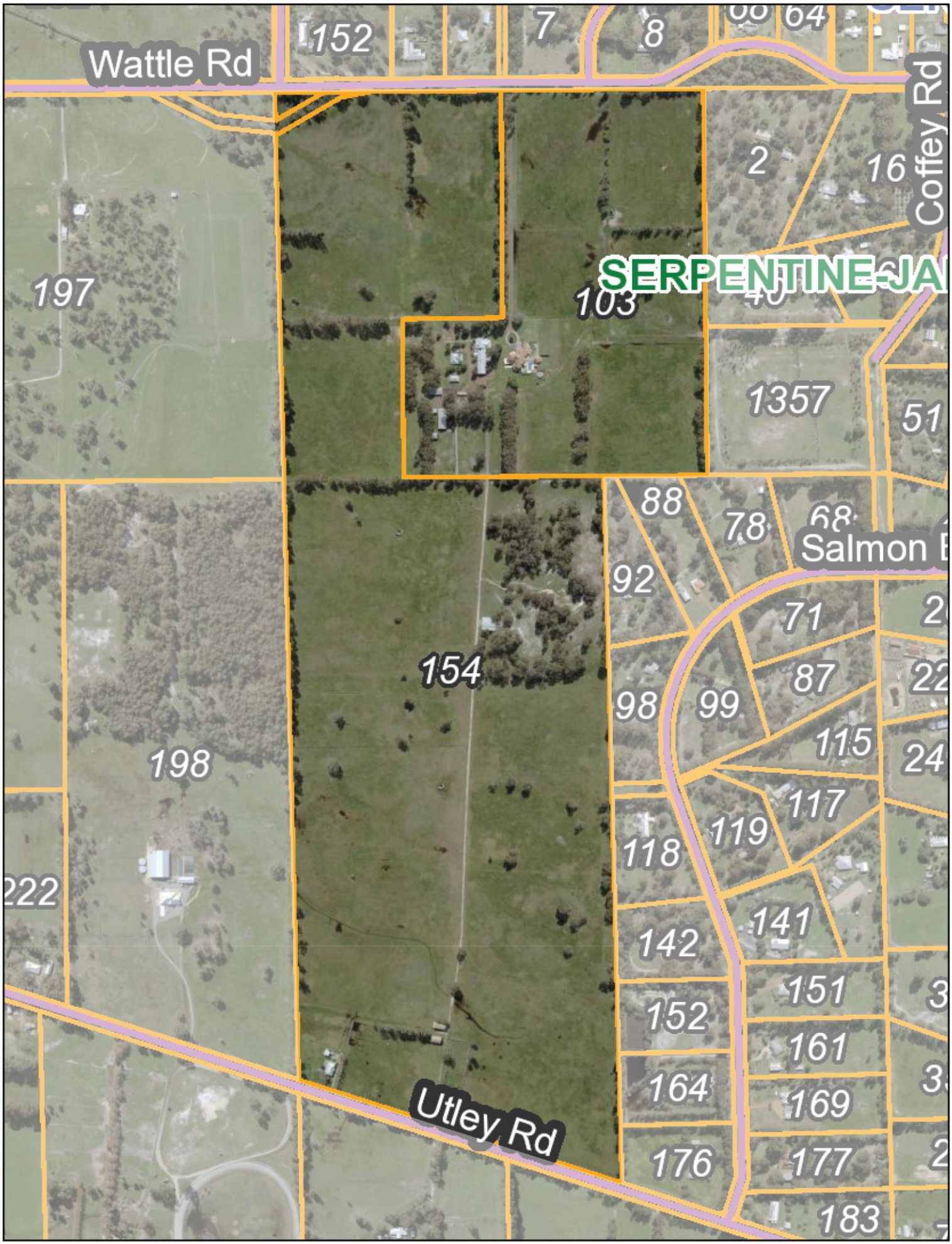
Location PLan Figure 2

Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine

0 500 1000

Scale 1:20000@A4 I Date Aug 2020 I Project RAYSJLSP-1-002

Hex Design and Planning
ABN 34 627 142 299
29 A Bartlett Crescent
Karrinyup WA 6018
T +61 8 9204 1518
M +61 438 000 235
E sheldon@hexdesignplanning.com.au



Site Aerial Figure 3
Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine

0 100 200

Scale 1:7500@A4 I Date Aug 2020 I Project RAYSJLSP-1-004

Hex Design and Planning
ABN 34 627 142 299
29 A Bartlett Crescent
Karrinyup WA 6018
T +61 8 9204 1518
M +61 438 000 235
E sheldon@hexdesignplanning.com.au

The site is currently used for Rural Residential Lifestyle and contains two (2) dwellings. These dwellings are both located in the central area of the subject site, with one being the main homestead, and the second being an ancillary dwelling. These dwellings are to be retained, though will ultimately be contained on separate allotments once subdivided.

As previously mentioned with the site having been used for equestrian purposes and horse breeding, the site also contains numerous stables and outbuildings, which may be subject to retention through future subdivisions.

The majority of the site has been cleared and there are scattered trees dispersed throughout the site. Many of the trees are introduced/planted along fence lines. The majority of the trees are capable of retention through the proposed layout reflected by this structure plan.

Existing Dwellings / Structures

Primary House

Primary House

Stables

Secondary Dwelling

1.2.3 Legal Description and Ownership

The subject site comprises two (2) lots. **Table 1** *below* provides additional details in respect of the constituent lots.

Table 1 – Legal Description and Ownership

Lot No.	Plan/ Diagram	Volume	Folio	Landowner Details	Lot Area (ha)
Lot 9001	DP 71225	2820	21	Stron Pty Ltd	68.23
Lot 9002	DP 71225	2820	22	Andrea Thomas Ryan	23.08
					91.30

Copies of the Certificates of Title are attached at **Appendix 1** of this report.

1.3 Planning Framework

1.3.1 Zoning and Reservations

1.3.1.1 Metropolitan Region Scheme (MRS)

The MRS is the statutory land use planning scheme for the Perth Metropolitan Area. The primary purpose of the MRS is to reserve and zone land and control development on reserved and zoned land at the Regional level.

The subject site is zoned 'Rural' under the provisions of the MRS. (**Figure 4**)

1.3.1.2 Shire of Serpentine Jarrahdale Local Planning Scheme No.2 (LPS2)

The subject land is currently zoned 'Special Rural' under the Shire of Serpentine Jarrahdale Local Planning Scheme No.2 (LPS2). (**Figure 4**).

In order to facilitate development and subdivision, preparation of a structure plan in accordance with the provisions of Appendix 4 – SR28 is required.

The provisions of Appendix 4 of LPS2 state;

Description of Land	Land Use
28. Lot 9001 (No. 15) Utley Road and Lot 9002 (No. 103) Wattle Road, Serpentine AMD 199 GG 24/08/18	**28.1** A structure plan shall be prepared over the land, including the identification of building envelopes and/or building exclusion areas. **28.2** The keeping of horses, sheep, goats and other grazing animals shall be subject to the prior approval of the local government. Animal stocking rates shall not exceed the stocking rates recommended by the Department of Primary Industries and Regional Development for the pasture type for the policy area.

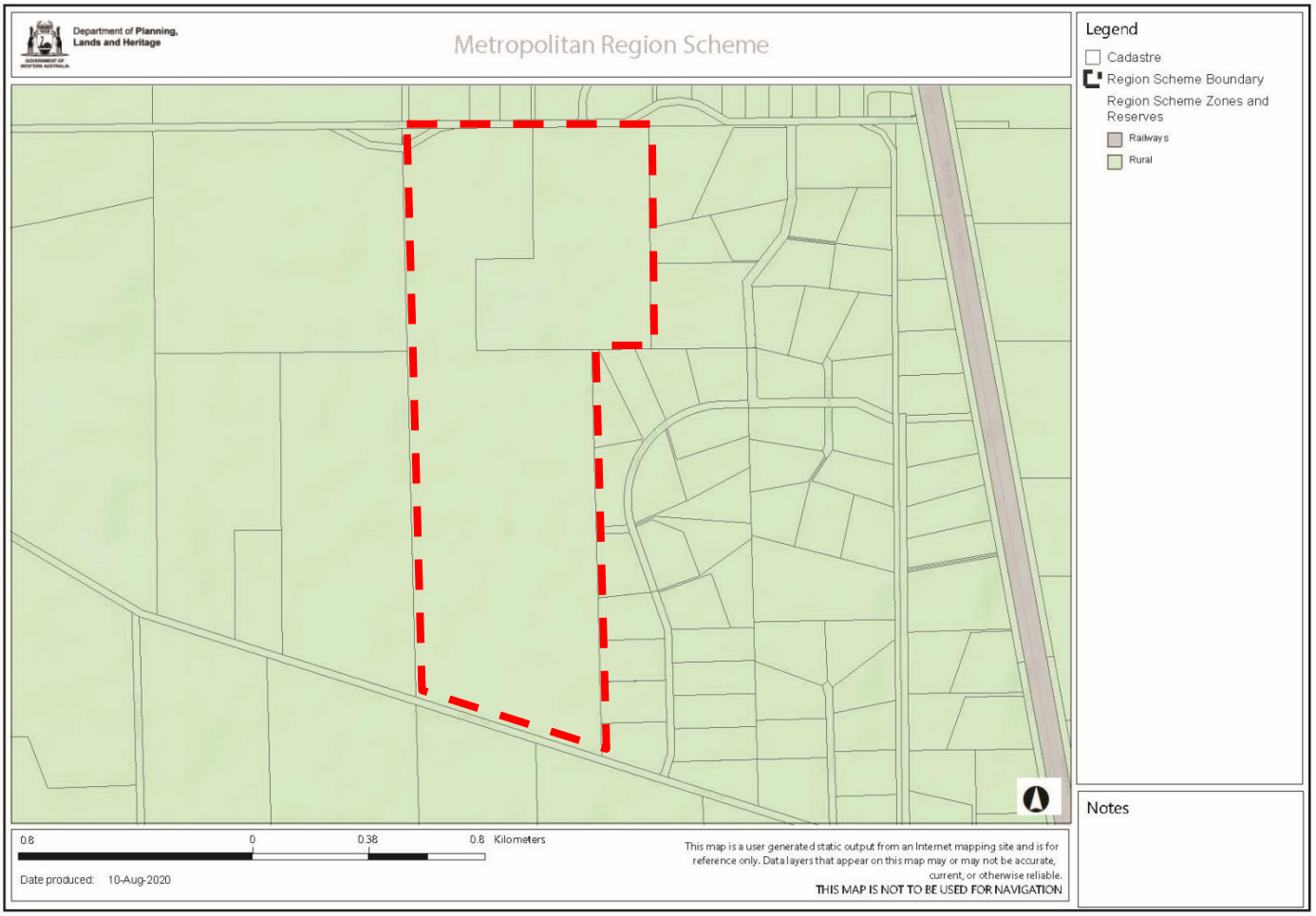
The proposed Structure Plan has been prepared having regard to the relevant provisions of the Scheme.

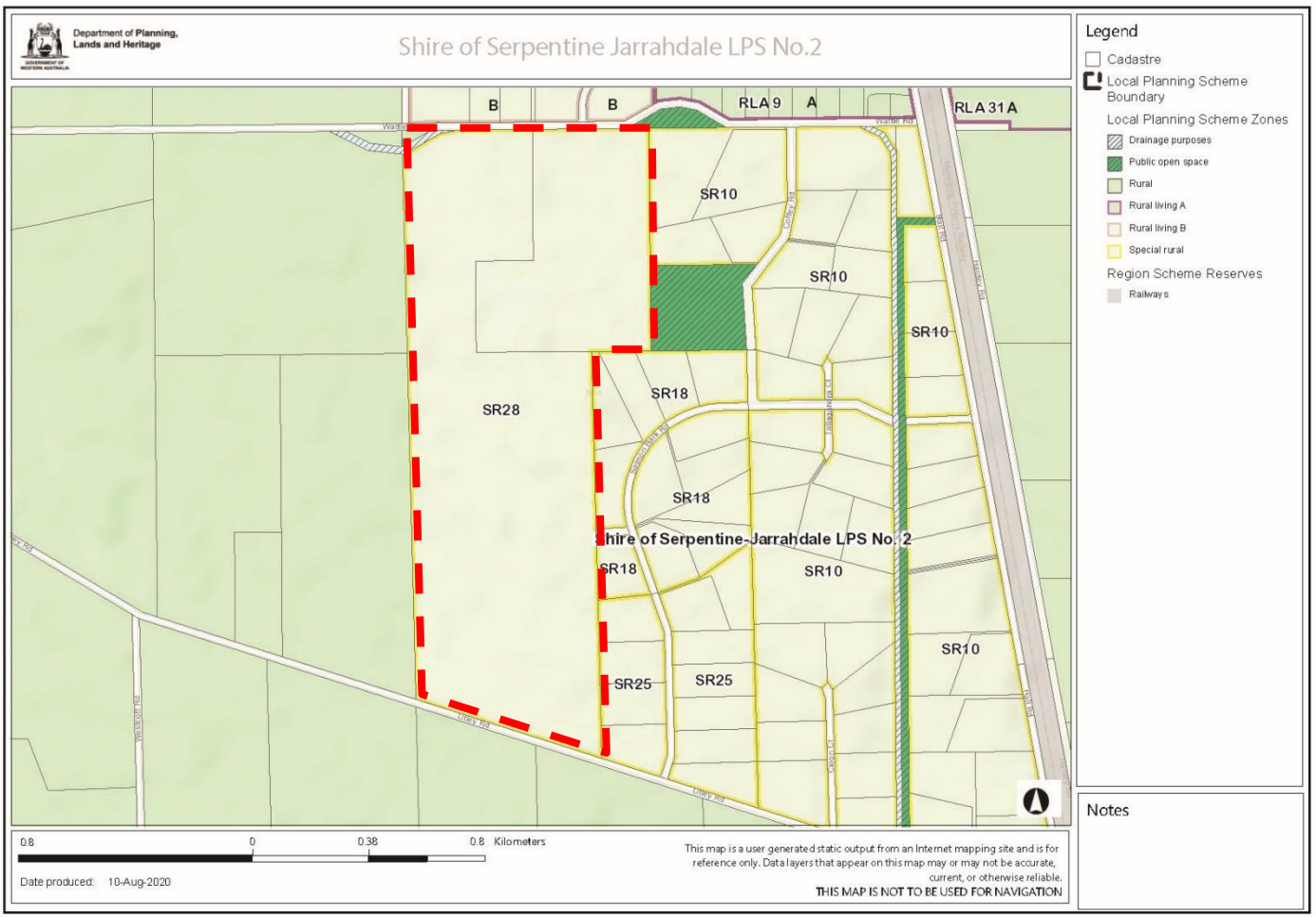
1.3.2 Regional and Sub-Regional Structure Plan

The Sub-Regional Planning Framework, released in 2018, establishes the vision for future growth of the Perth and Peel Metropolitan Regions and provides a framework to guide the delivery of housing, infrastructure and services necessary to accommodate anticipated population growth over the next 35 years.

Consistent with the draft *Perth and Peel @ 3.5 million* document, the Sub-Regional Planning Framework seeks to achieve a residential density target equivalent to 26 residential dwellings per residential site hectare.

The subject land is situated within the South Metropolitan Peel Sub-Regional Planning Framework, which identifies the land as 'Rural Residential'. Development of the subject land for residential land use is consistent with the South Metropolitan Peel Sub-Regional Planning Framework.





Zoning Figure 4
Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine

Scale NTS@A4 I Date October 2021 I Project RYASJLSP-1-005

Hex Design and Planning
ABN 34 627 142 299
29 A Bartlett Crescent
Kaminyup WA 6018
T +61 8 9204 1518
M +61 438 000 235
E sheldon@hexdesignplanning.com.au

Development of the subject land for Special Rural land use is consistent with the South Metropolitan Peel Sub-Regional Planning Framework and will facilitate planned development in the locality (**Figure 5**).

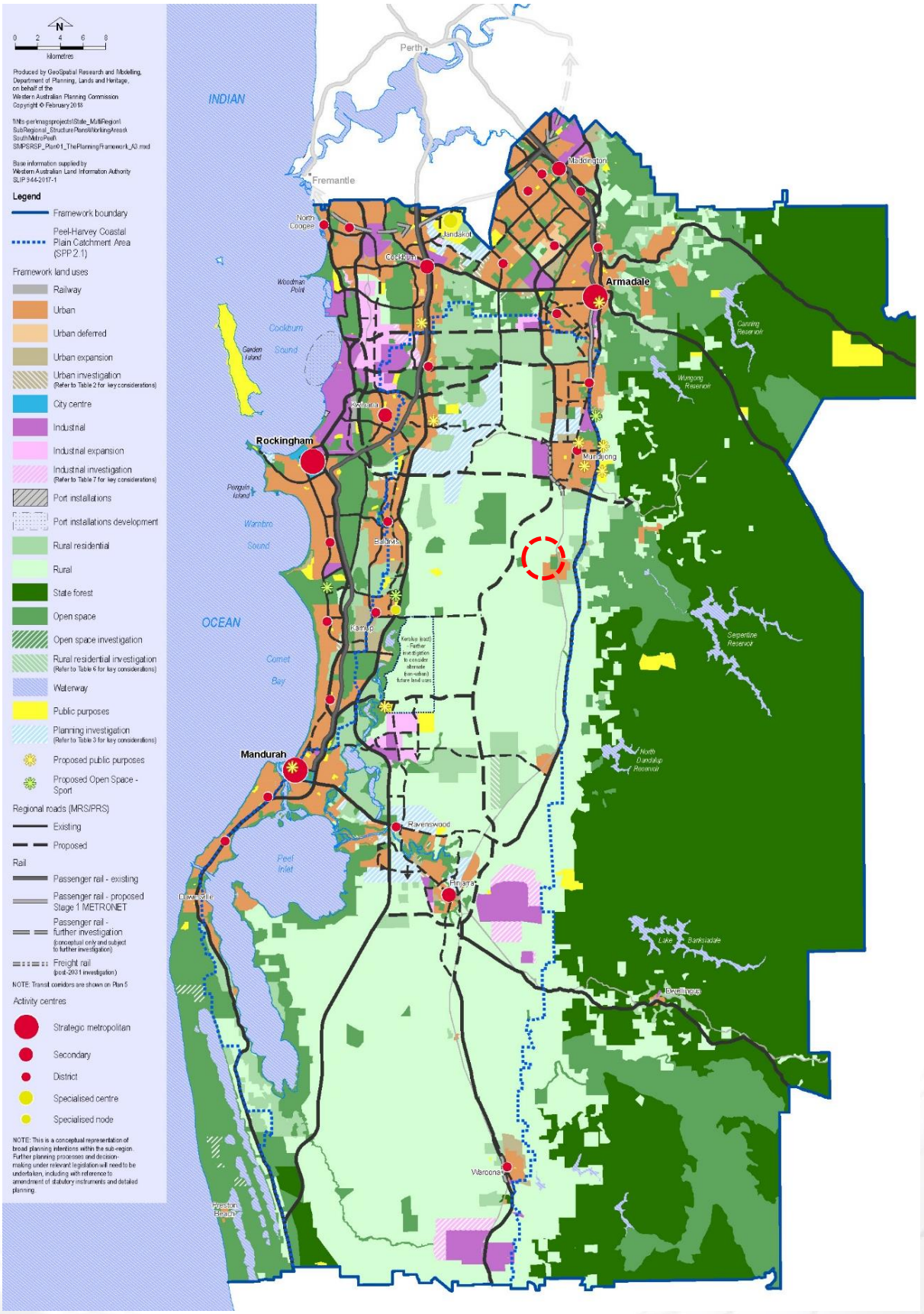


Figure 5 – South Metropolitan Peel - Sub Regional Planning Framework

1.3.3 Shire of Serpentine Jarrahdale Local Planning Strategy

The draft Shire of Serpentine Jarrahdale Local Planning Strategy was prepared in July 2019 to support LSP3 and is intended to set out the long-term planning direction for the City. The Strategy envisages the progression of Structure Plans in the area on a sub-precinct basis according to the conclusions of the necessary environmental and servicing investigations.

The subject area was identified within the LPS as Rural Residential (RR-2), reflecting its current zoning and proposing future development with a 2ha minimum lot size.

The proposed Structure Plan is consistent with the intention of the Local Planning Strategy and has been prepared having regard to the above considerations (***Figure 6***).

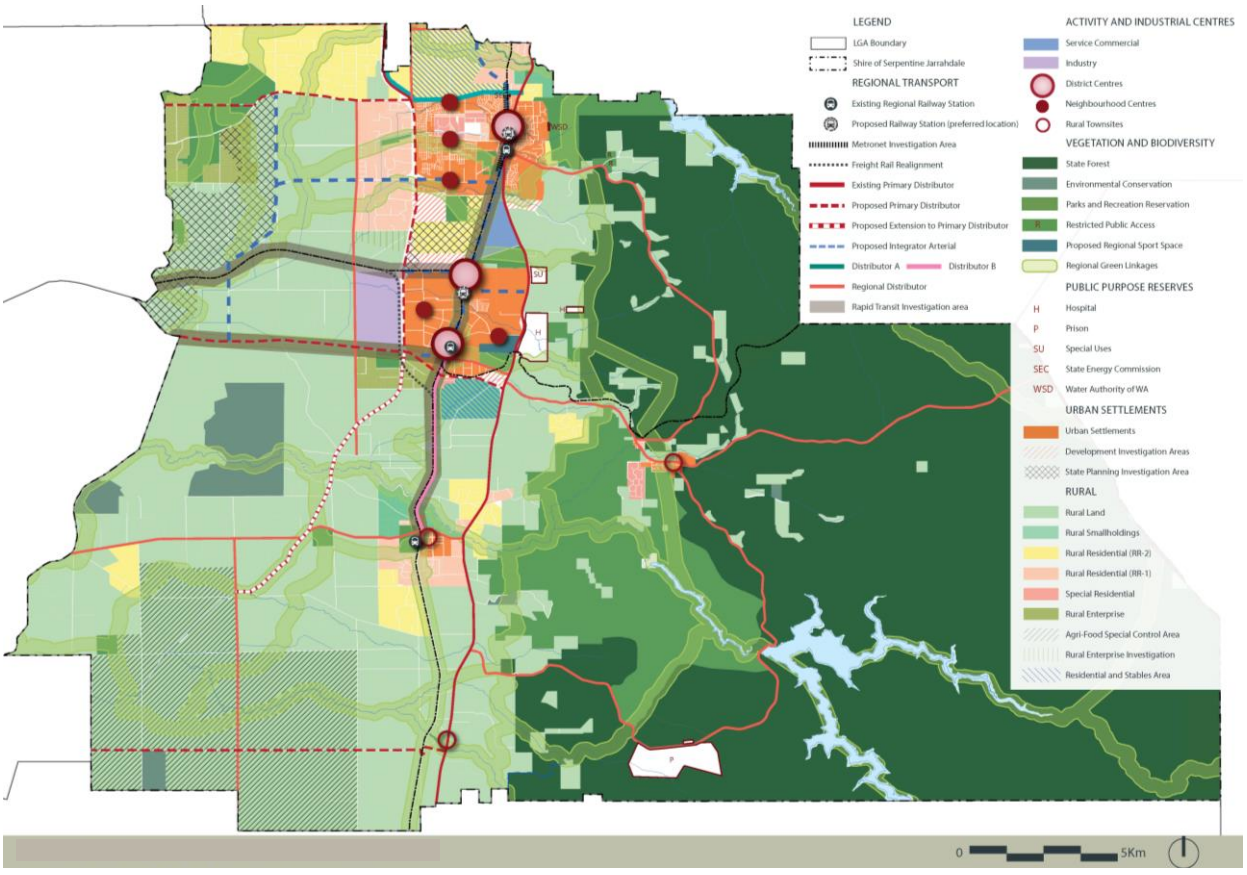


Figure 6 – Local Planning Strategy

1.3.4 Shire of Serpentine Jarrahdale Rural Land Strategy

The Rural Strategy (RS) has guided development in the Shire of Serpentine-Jarrahdale since 1994. This document was reviewed and updated in 2013, building on the previous provisions established. The RS contains objectives, an explanation of the Policy Areas and Overlays as well as a consolidated Strategy map.

The Rural Strategy focuses on the Shire's Rural Areas with the overall purpose of the Rural Strategy to preserve and enhance the Shire's rural character and its role as an important economic contributor to the Shire and broader region. Three 'key themes' emerged from significant community consultation undertaken during the latest review of the Rural Strategy which forms the basis of the future direction and development of the Shire's rural areas.

These themes are:

- Protection of natural assets (local natural areas);
- Protection of rural character; and
- Facilitate productive rural areas.

The subject site is located within the Rural Living 'B' Policy Area and is recognises a mix of land uses within this area. The Rural Living 'B' area is to comply with a 2-hectare minimum lot size, which is compatible with surrounding subdivisions and development in the locality,

The proposed Structure Plan is consistent with the intention of the RS and has been prepared having regard to the above considerations, and hence is consistent with the Local Planning Strategy.

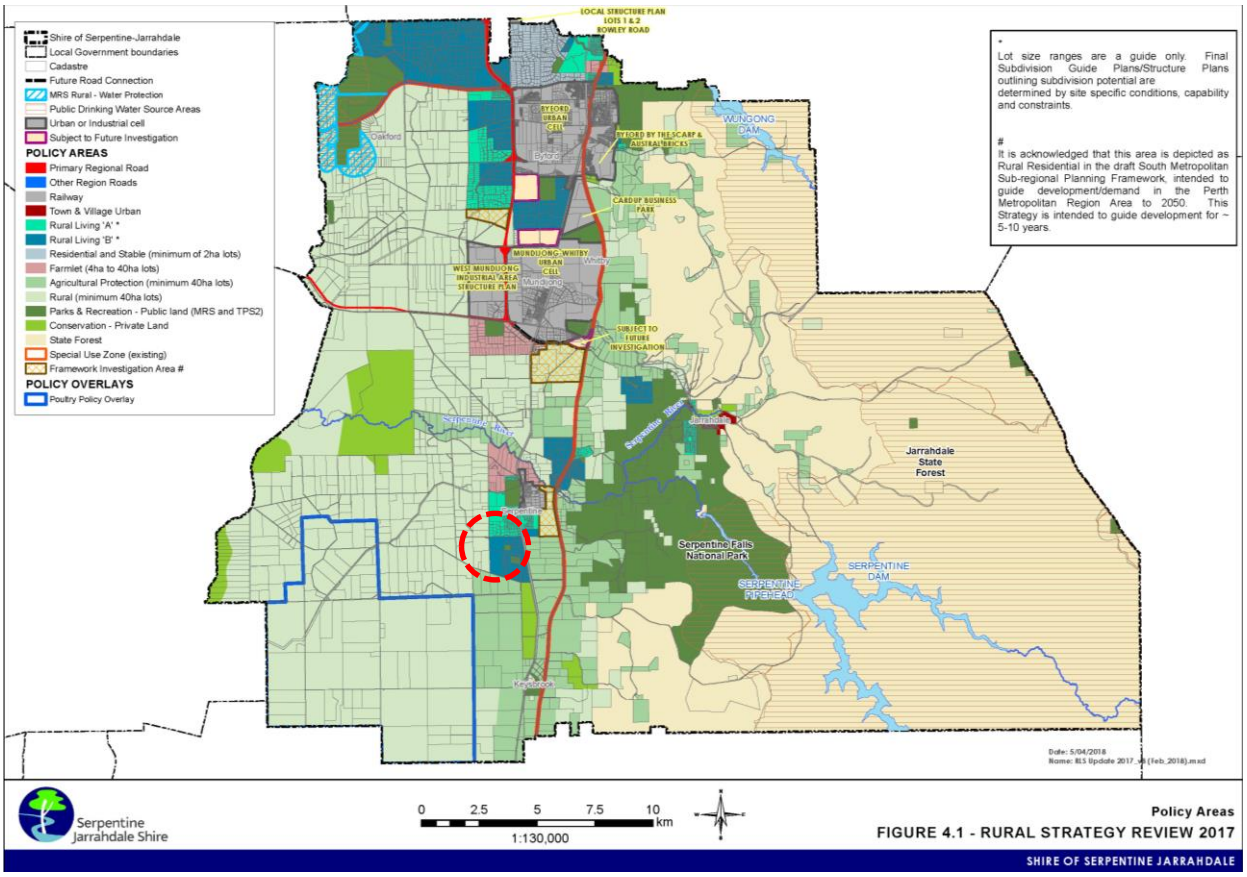


Figure 7 – Rural Land Strategy

1.3.5 Planning Policies and Guidelines

1.3.5.1 State Planning Policy 3.7 – Planning in Bushfire Prone Areas

State Planning Policy 3.7 (SPP 3.7) seeks to guide the implementation of effective risk-based land use planning and development to preserve life and reduce the impact of bushfires on property and infrastructure. SPP 3.7 applies to strategic planning proposals, including Structure Plans, overland designated as bushfire prone by the Map of Bushfire Prone Areas prepared by the Department of Fire and Emergency Services.

The subject site is designated as Bush Fire Prone, and SPP 3.7 is applicable to the Structure Plan area. The requirements of SPP 3.7 are addressed by a Bushfire Management Plan prepared in support of the Structure Plan.

Further details are provided at section 2.4 and **Appendix 3** of this Report.

1.3.5.2 Shire of Serpentine Jarrahdale Local Planning Policies

Relevant Local Planning Policies prepared by the Shire of Serpentine Jarrahdale have been considered during the preparation of the proposed Structure Plan design and documentation.

1.3.6 Other Approvals and Decisions

1.3.6.1 Scheme Amendment

The site was rezoned from 'Rural' to 'Special Rural' (SR28) in 2018 via Amendment 199. This rezoning was undertaking to facilitate the subdivision of the site following the preparation of a structure plan. This requirement formed part of the Amendment and is continued within the requirements stated in Annexure 4 of LPS2.

1.3.6.2 Pre Lodgement Consultation

Co-ordinated planning for the structure plan area has been subject of consultation with the Shire of Serpentine Jarrahdale, most recently in meetings in April 2020. The City's preliminary comments from those consultations are reflected in the Structure Plan Report and have been incorporated in the design of the Structure Plan.

From these meetings with technical staff at the Shire of Serpentine Jarrahdale, it was generally agreed;

- Road layout considered appropriate for the site;
- Backing of lots to the 'Rural' zone to the west supported. The transition of Special Rural – Rural zone to occur at the rear boundary;
- Minimum lot size of 2ha. Layout, as submitted, discussed and considered appropriate; and
- Drainage within road reserve via swales in verge appropriate.

2 SITE CONDITIONS AND CONSTRAINTS

Site conditions and constraints have been ascertained through the site-specific EAMS and Land Capability Assessment undertaken by Emerge Associates.

Land capability is the recognition of the proposed land use. A land capability assessment was undertaken in 2017 by Landform Research to accompany the Scheme Amendment (Amd 199), which demonstrated the land was capable of development for a land-use more intense than that of Rural landholdings.

A comprehensive review of the land capability previously undertaken for the site has been completed by Emerge Associates and is included at **Appendix 2**. The report includes comprehensive information on the physical environment, hydrology, flora/fauna, current and potential land uses, geotechnical and environmental factors.

The following is a summary of the main environmental characteristics of the site;

2.1 Biodiversity and Natural Area Assets

An Environmental Assessment and Management Strategy (EAMS) prepared by Emerge Associates (Emerge) at **Appendix 2** has investigated and reported on the environmental characteristics of the land within the Structure Plan area.

The site is bound by Wattle Road to the north, Utley Road to the south, existing rural-landholding to the west and special rural land estate to the east.

The relevant environmental attributes and values of the site are summarised as follows:

- Topography across the site is relatively uniform, with elevation ranging between 34 and 40 m Australian Height Datum (m AHD).
- The majority of the site has been historically cleared to allow for agricultural activities. This has resulted in over 97% (88.3ha) of vegetation within the site identified as being in 'completely degraded' condition and 3% (2.99 being classified as degraded, using methods from Keighery (1994).
- Three native plant communities were identified within the site, with vegetation condition within these communities generally being 'degraded'.
- No threatened or priority flora or fauna were identified within the site.
- No threatened ecological communities were identified within the site.
- The majority of the site is classified as having a moderate to low risk of acid sulfate soils (ASS) occurring within 3 m of the natural soil surface, with a small portion in the centre of the site identified as having a high to moderate risk of ASS occurring within 3 m of the natural soil surface.
- There are no existing land uses in proximity to the site which are incompatible with its proposed land use.
- There are no Bush forever classified sites within the Structure Plan area.

The design of the Structure Plan has been developed with consideration to the identified environmental values of the site. A number of design responses have been incorporated into the Structure Plan in this regard, including:

- Preparation of the LWMS, which outlines the groundwater and surface water management strategy for the SP.
- Preparation of the BMP, which outlines how the SP responds to the bushfire protection criteria specified in the Guidelines for Planning in Bushfire Prone Areas Version 1.3 (WAPC and DFES 2017).

The EAMS also outlines the environmental framework to be implemented across the site as part of a future subdivision and development phases of the residential development process, including:

- Preparation of an Urban Water Management Plan to support each stage of subdivision.
- Completion of detailed bushfire attack level (BAL) assessment and imposition of determined BAL ratings on affected lots.

Overall, the environmental attributes and values of the site can be accommodated within the Structure Plan design or can be managed appropriately through the future subdivision and development phases in line with the relevant state and local government legislation, policies and guidelines.

2.2 Landform and Soils

The EAMS prepared by Emerge at **Appendix 2** and Servicing report prepared by Porters at **Appendix 7** have investigated and reported on the landform and soils of the land within the Structure Plan area. The site is gently undulating, with elevation ranging from 40 m Australian Height Datum (mAHD) in the southeastern portion of the site to 34 mAHD in the northwest corner.

The topographical characteristics of the site are shown in ***Figure 8***.

The site is generally cleared with isolated clusters of trees are grouped along paddock fence lines, with a large grouping of trees in the vicinity of the homestead.

The topography of the Site is generally flat with grades from 40m AHD by the eastern boundary to 35m AHD to the north-western boundary by Wattle Road.

Based on the Perth Metropolitan Region Environmental Geology Series mapping, the mapping indicates:

- S10: Thin Bassendean Sand over Guildford formation to the northern half of the site;
- Cs: Sandy clays to the southern half of the site;
- S8: isolated pockets of Bassendean Sand to the eastern boundary.

A Land Capability report to the Site supports the geology mapping noting Bassendean Sands indicatively up to 1,000mm thick over clays.

2.3 Groundwater and Surface Water

The EAMS prepared by Emerge at **Appendix 2** has investigated and reported on the groundwater and surface water within the Structure Plan area.

The site is located beyond the extents of the online Perth Groundwater Map, however the Land Capability – Geotechnical Assessment (Landform Research 2018) for the site notes the likely maximum groundwater range is between 400 to 800 mm from the surface. However, groundwater beneath the site is not a reflection of the regional superficial aquifer but rather of infiltrated stormwater perching above the loam-clay and gravel layers.

The characteristics of groundwater underlying the site are discussed further in **Appendix 4,** the Local Water Management Strategy for this Structure Plan area. In terms of surface water, there are no existing natural waterways within the site, however there are three constructed drainage channels in the site.

Ortho Photo - Contours

Lot 9001 Utley Road & Lot 9002 Wattle Road - Serpentine

50 0 50 100 250 500

Project RAYSJLSP I Scale 1:5000@A3 I Date May 2020

HEX DESIGN | PLANNING

Source of Information

Site boundaries: Landgate
Projection: GDA94 MGA Zone 50 South

NOTE
All areas and dimensions are subject to survey, engineering and detailed design and may change without notice.

2.4 Bushfire Management

A Bushfire Management Plan (BMP) prepared by Emerge Associates (Emerge) at **Appendix 3** has identified the Structure Plan area as a 'bushfire prone area' and reported on management measures required to enable the development of the land.

The site is currently identified as a 'bushfire prone area' under the state-wide Map of Bush Fire Prone Areas prepared by the Office of Bushfire Risk Management (OBRM 2018). The identification of an area within a declared bushfire prone area necessitates a further assessment of the bushfire risk and suitability of the proposed development to be undertaken in accordance with State Planning Policy 3.7 Planning in Bushfire Prone Areas (SPP 3.7) (WAPC 2015) and the Guidelines for Planning in Bushfire Prone Areas Version 1.3 (the Guidelines) (WAPC and DFES 2017).

The purpose of SPP 3.7, and its policy intent, is best summarised as preserving life and reducing the impact of bushfires on property and infrastructure through effective risk-based land-use planning. Pursuant to SPP 3.7, this BMP examines the likely long-term bushfire risk risks and advances responses that will make the ultimate use of the land suitable for its intended purpose.

A majority of the site is cleared of native vegetation and is composed of areas of unmanaged grassland (Class G). There is an area of Woodland (Class B) located in the central portion of the site and abutting the northeast and northwest boundaries. In addition, an area of forest (Class A) vegetation abuts the western boundary of the site. Outside and to the east of the site, forest vegetation has been identified; associated with an unmanaged private landholding. Areas of grassland are located to the west.

In order to consider the likely bushfire risk applicable to development within the site, a post-development vegetation classification scenario has been assumed in which all classified vegetation, will be removed or managed to a 'low threat' standard except for the scrub vegetation in the northwest portion of the site, as part of future development in accordance with the structure plan.

Vegetation outside the site, apart from the grassland vegetation to the north-east of the site and the forest vegetation to the east, will remain the same as the pre-development assessment. The structure plan complies with the requirements of WAPC Planning for Bushfire Protection Guidelines.

The outcomes of this BMP demonstrate that as development progresses, it will be possible for an acceptable solution to be adopted for each of the applicable bushfire protection criteria outlined in the Guidelines. This includes:

- Location: future habitable buildings can be located in an area that will, on completion, be subject to a low or moderate bushfire hazard. Habitable buildings can be constructed in areas subject to a BAL rating of BAL-12.5 or less.
- Siting and Design: all future habitable buildings can be sited within the proposed development so that BAL-12.5 or less can be achieved based on the proposed structure plan.
- Vehicular Access: the proposed structure plan provides for an interconnected road network within the site that will connect to the existing public road network, specifically north to Wattle Road, and South to Utley Road.
- Water: the development will be provided with a permanent and reticulated water supply to support onsite firefighting requirements.

The measures to be implemented through this structure plan and associated future subdivision process have been outlined as part of this BMP and can be used to support future planning and development approval processes.

2.5 Heritage

The EAMS prepared by Emerge at **Appendix 2** has investigated the heritage values of the Structure Plan area and confirms that no Registered Aboriginal Heritage Sites or Other Heritage Places are mapped within the Structure Plan area.

2.6 Surrounding Zoning and Land Uses

The land to the immediate east of the subject site is zoned 'Special Rural' under the provisions of LPS2, with the land directly north of Wattle Road being zoned 'Rural Living-B'.

Both the areas have historically been developed to create 2ha lots, which the proposed structure plan aligns with. The zoning of the subject site has been undertaken on the understanding that this area is to be developed in a similar manner.

The lots are primarily rural lifestyle lots, with substantial tree planting having occurred over time.

There is also a public open space reserve located within the Special Zone to the east, abutting the structure plan area.

Land to the west and south of the site is zoned 'Rural' under the provisions of the LPS, and there is no intent for future development of that area in the foreseeable future. There Shire of Serpentine Jarrahdale RS also identifies these areas for no further development.

3 LAND USE AND SUBDIVISION REQUIREMENTS

3.1 Land Use

3.1.1 Design overview

The Structure Plan design has been developed having regard to the site-specific environmental assessment, detailed engineering investigation, local water management and fire planning requirements.

The Structure Plan has been prepared to guide the development of the 91.30 ha site for Special Rural subdivision. The Structure Plan will facilitate the development of a high quality, rural lifestyle estate.

Detailed structure planning has been informed by an integrated approach with inputs from specialist consultants to appropriately address planning, water management environmental and fire management objectives. Collectively, these factors have influenced the proposed road and lot layout, as depicted on the Structure Plan included as **Plan 1** at the Implementation section of this document.

3.2 Integration with Adjoining Lots

The Structure Plan abuts a Parks and Recreation Reserve to the east as well as an existing 2ha Special Rural land estate. This POS is accessed via a proposed cul-de-sac, ensuring a connection between this structure plan area and development to the east is maintained.

The eastern boundary of the structure plan area is backed on by 2ha Special Rural lots, and the proposed layout is sympathetic to this, proposing backing on of lots. A connection to this existing area is proposed via the extension of Burto Close.

A strategic firebreak/bridle trail is proposed along the western boundary of the structure plan area, providing a transition to the rural landholding abutting the site. The transition between the 'Special Rural' zoning of the structure plan area and the abutting 'Rural' zone is dealt with via the rear boundary of proposed lots, ensuring no interface/conflict issues.

Connection to the Rural Living B allotments on the north side of Wattle Road is provided by a 4-way connection with Windmill Avenue.

3.3 Subdivision

3.3.1 Subdivision

The structure plan will facilitate the development of 39 Special Rural lots, with a **minimum lot size of 2ha (Appendix 5)**. At the time of subdivision building envelope locations are required to be shown, demonstrating setbacks to cadastral boundaries and other site features.

The proposed layout and density is consistent with the strategic direction of the Councils planning framework and is sympathetic to the surrounding area.

3.3.2 Building Envelopes

Building envelopes have been located having regard to existing vegetation, soil types, drainage flows and the provision of the Bushfire Management Plan.

Where possible the envelopes have been positioned to maximise the separation distance to vegetation to achieve the lowest BAL rating. All building envelopes achieve compliance with acceptable BAL ratings.

Building envelopes have been positioned with a setback of 20m from the primary road and 10m from side boundaries. The building envelopes have been established at 2000m^2 in area, being 10% of the subject site. The siting of envelopes has ensured that all lots are capable of being developed upon, with a BAL level of 12.5 or lower.

Relocation of the building envelopes may be proposed during the development application process, at which time appropriate justification will be required to be submitted as part of the application.

3.4 Movement Network

3.4.1 Existing Movement Network

A Transport Impact Assessment (TIA) prepared by transport professionals Porter Consulting Engineer (Porters) at **Appendix 6** has investigated movement networks around the subject land and have forecast future transport impacts from the development and occupancy of the Structure Plan area.

3.4.1.1 Regional Road Network

Utley Road and Wattle Road are classified as access roads in accordance with Main Roads WA and as defined by Liveable Neighbourhoods. Intersection spacing along access roads are recommended to be not less than a minimum of 20m centreline to centreline of the road reserve.

3.4.1.2 Public Transport

The Site has poor access to public transport with no services within the immediate surroundings.

The closest service is Route 253 on Jacaranda Avenue in Jarrahdale some 10 kilometres away. There are 3 other services being Route 251,252 and 254 that operate between Armadale Station and suburbs to the south being Mundijong or Byford. Armadale Station is approximately 20 kilometres to the north.

3.4.1.3 Pedestrian and Cyclist Facilities

There are no existing path facilities for walking and cycling within the surrounding road network catchment.

3.4.2 Proposed Movement Network

3.4.2.1 Local Road Network

The proposed road network will result in the creation of three new intersections; two on Wattle Road and the other on Utley Road. There is a fourth connection via a direct connection to the unconstructed road link to Salmon Bark Road.

The Wattle Road western connection is located approximately 120m to the east of Walker Road.

The Wattle Road eastern connection is proposed to connect at Windmill Avenue to create a new 4-way intersection. The proposed 4-way intersection is considered acceptable due to the low volumes of traffic anticipated to use the intersection and the very low demand for cross movements at this location. By creating a 4-way intersection instead of installing a new t-junction, there is still only one potential point of conflict compared to two should a separate intersection be constructed.

The proposed roads will be a rural residential standard road, typically consisting of a 9.6m formation including 6m wide sealed pavement, with 1.2m unsealed shoulders, and roadside table drains, within the 20m road reservation. A typical indicative rural road cross-section is illustrated in **Figure 9**.

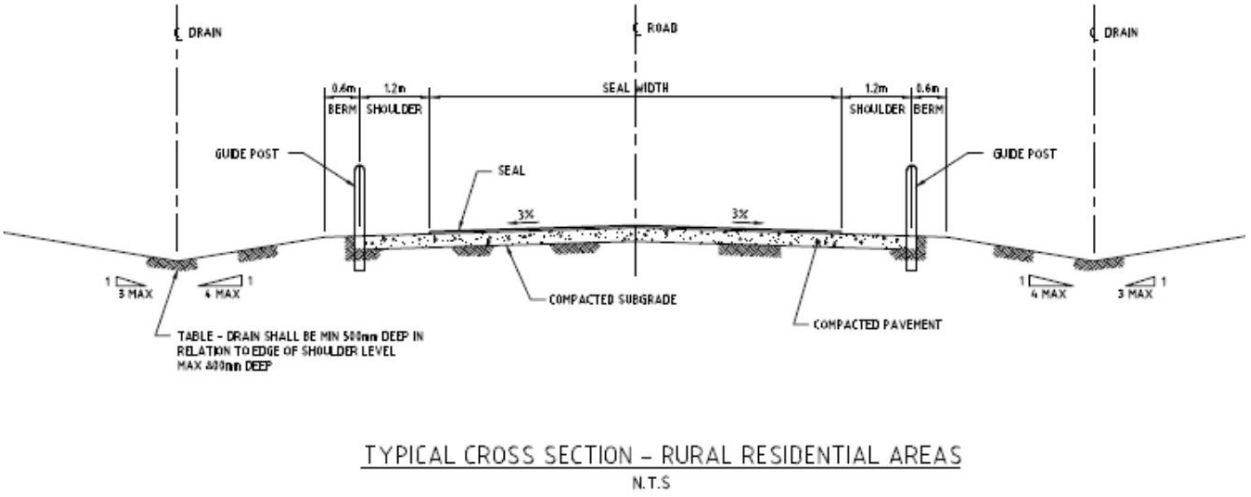


Figure 9 - Typical Road Cross Section

3.4.3 Traffic Generation

The traffic generated by the proposed structure plan is forecast using rates suggested in the Technical Direction Update August 2013 for the Guide to Traffic Generating Developments, Roads and Traffic Authority, NSW, 2002. These rates are based on surveys undertaken in the NSW regional area (compared to the urban region) and may be considered to be reflective of those likely to occur in a rural residential area. These are:

- 0.71 vehicle trips per dwelling for the am peak hour
- 0.78 vehicle trips per dwelling for the pm peak hour
- 7.4 vehicle trips per dwelling daily

There are a total of 39 single residential lots and dwellings. The additional trips are estimated to be approximately 289 daily trips corresponding to 28 am peak hour trips and 30 pm peak hour trips.

With minimal trip generation from the structure plan area, the surrounding road network is capable of accommodating the proposed traffic generation and intersection arrangements.

3.5 Water Management

The WAPC's Better Urban Water Management (BUWM) document identifies the requirement to prepare

a Local Water Management Strategy (LWMS) to support Structure Plan proposals.

An LWMS (**Appendix 4**) has been prepared by Emerge Associates to support the proposed Structure Plan in accordance with the requirements of the BUWM, The LWMS outlines the key elements required to achieve best practice stormwater management for the site. The LWMS identifies how the Structure Plan supports water sensitive urban design. The LWMS:

- Describes the predevelopment environment;
- Outlines water sustainability initiatives;
- Sets out a Stormwater Management Strategy for the precinct, including details relating to:
    (a) pre and post-development hydrology;
    (b) Management of the 1 in 1yr, 1 in 5yr and 1 in 100yr ARI events,
    (c) Finished lot levels,
    (d) Water Quality Targets,
- Outlines a Groundwater Management Strategy;
- Describes the implementation of the LWMS including requirements for subsequent investigations (i.e. Urban Water Management Plan); and
- Details pre and post-development monitoring.

Implementation of the LWMS will be facilitated by an Urban Water Management Plan required as a condition of Subdivision approval.

3.6 Infrastructure Coordination, Servicing and Staging

3.6.1 Servicing Overview

Porters Consulting Engineers have prepared an Engineering Services Report, a copy of which is included at **Appendix 7**. Details of service infrastructure available to the site are included below:

3.6.2 Power Supply

A sufficient power supply exists in the immediate area.

Along Wattle Road, there is an underground LV near the intersection with Walker Road and an underground HV near the intersection with Windmill Avenue.

Approximately 60m north of Utley Road, there is an existing overhead HV powerline that runs east-west across the site. As the proposed lots are less than 10 hectares in area, it is expected that Western Power will not allow this line to remain across the site and will require this line to be relocated to Utley Road and be converted to an underground line for the full extent of the subdivision boundary. Alternatively, Western Power may approve an easement for the underground cable across the proposed boundary of the lots abutting Utley Road, as this would avoid the need to clear existing vegetation in the roadway.

The matters will be addressed through the subdivision process.

3.6.3 Water Supply

There is an existing 180PE water main in the vicinity of Windmill Avenue and Wattle Road.

Water Corporation has undertaken a water planning review. Subsequently, with the Water Corporation advising that the existing system has enough capacity to service the development with reticulated scheme water.

3.6.4 Reticulated Sewer / ATU Systems

The Structure Plan area is not currently connected to sewer.

The Water Corporation has advised that the Site is outside of the current Water Corporation's planned wastewater scheme area, with no wastewater infrastructure in the area. Therefore, onsite wastewater treatment and effluent disposal will be required for each proposed lot, which will typically be in the form of Aerobic Treatment Units and an accompanying effluent disposal system (typically a leachate structure).

The proposed lots are required to be a minimum 2 hectares in size, which meets the Government Sewerage Policy 1-hectare minimum lot size requirement within sewerage sensitive areas where on-site effluent disposal is proposed.'

The land capability report notes the Site is suitable for onsite wastewater disposal, and that subdividing the land and change of land use will lead to significantly reduced nutrient loadings to the land.

With the maximum groundwater (perched) expected to be within 1m of the existing surface, it is expected that free-draining sand fill material will be required to form flat building pads for each residential home including the area needed for onsite sewerage disposal. The minimum level of the sand pad will be subject to achieving the greater separation requirements to the clay surface and groundwater for site classifications and effluent disposal in accordance with the Department of Health requirements.

3.6.5 Telecommunications

Based on NBN Co mapping, NBN Fixed Wireless Technology is available to the area and therefore no in-ground infrastructure is expected to be required.

There is Telstra infrastructure in Wattle Road and Utley Road.

3.6.6 Gas

There is no gas infrastructure in the area.

3.6.7 Acid Sulfate Soils

The Acid Sulphate Soils (ASS) risk mapping indicates that there is a 'Moderate to low risk of ASS occurring within 3m of natural soil surface but high to moderate risk of ASS beyond 3m of natural soil surface'.

3.7 Bushfire Management

The Structure Plan has been informed by the Bushfire Management Plan at **Appendix 3**.

The subject land is identified as having a pre-development low-moderate bushfire hazard suitable for development provided risk management strategies and designs are incorporated into the development as detailed in the Bushfire Management Plan.

3.8 Environmental Management

The Structure Plan has been informed by the Environmental Assessment and Management Strategy at **Appendix 2**, prepared by Emerge Associates**.**

This EAMS also outlines the environmental framework to be implemented across the site as part of the

future subdivision and development phases of the residential development process, including:

- Preparation of an Urban Water Management Plan to support each stage of subdivision.
- Completion of detailed bushfire attack level (BAL) assessment and imposition of determined BAL ratings on affected lots.

3.9 Implementation

The Structure Plan will ensure subdivision design is compatible with the existing established subdivision pattern in the immediate area, being generally 2ha Special Rural and Rural Living B developments. It will facilitate the development of Special Rural lots reflecting the site's zoning and will round off the smaller rural landholding precinct.

The land capability assessment within the EAMS report justifies the suitability and supports subdivision of the land.

The Structure Plan area provides the opportunity for residents to live on smaller rural landholdings in close proximity to the amenities offered by the nearby Serpentine Townsite. These future Special Rural lots

The proposed Structure Plan has been prepared in accordance with the requirements of the Planning and Development (Local Planning Schemes) Regulations 2015. Further, the Structure Plan complies with the applicable State and Local Planning Policy Framework as set out in section 1.3 of this Report.

The Planning and Development (Local Planning Schemes) Regulations 2015 stipulate the manner by which the Structure Plan will be processed by the Shire of Serpentine Jarrahdale and thereafter, the Western Australian Planning Commission to enable final approval.

Development and subdivision of the Structure Plan Area are dependent on the finalisation of the Structure Plan.

4 TECHNICAL APPENDICES INDEX

Appendix No.	Nature of Document	Assessment Agency	Approval Status
1	Certificates of Title	N/A	N/A
2	Environmental Report	LA/DPaW	N/A
3	Bushfire Management Plan	LA/DFES	For Assessment
4	Local Water Management Strategy	DoW	For Information
5	Lot Layout and Yield Plan	LA/WAPC	For Information
6	Transport Assessment	LA	For Information
7	Engineering Report	LA/ WP/ WC	For Information

Abbreviations:

LA: Local Authority

WAPC: Western Australian Planning Commission DoW: Department of Water

DPaW: Department of Parks and Wildlife

DFES: Department of Fire and Emergency Services

WP: Western Power

WC: Water Corp

DoW: Department of Water

Appendix 1

Certificates of Title

WESTERN AUSTRALIA

REGISTER NUMBER	
9001/DP71255	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
4	**12/10/2018**

VOLUME **2820** FOLIO **21**

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 9001 ON DEPOSITED PLAN 71255

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

STRON PTY LTD OF 19 KING EDWARD ROAD, OSBORNE PARK

(AF M362471) REGISTERED 5/8/2013

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

1. *L703100 NOTIFICATION CONTAINS FACTORS AFFECTING THE WITHIN LAND. LODGED 9/8/2011.
2. *L703101 NOTIFICATION CONTAINS FACTORS AFFECTING THE WITHIN LAND. LODGED 9/8/2011.
3. N895067 MORTGAGE TO WESTPAC BANKING CORPORATION REGISTERED 11/5/2018.

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:	DP71255
PREVIOUS TITLE:	537-93A, 1940-105
PROPERTY STREET ADDRESS:	154 UTLEY RD, SERPENTINE.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF SERPENTINE-JARRAHDALE

WESTERN AUSTRALIA

REGISTER NUMBER	
9002/DP71255	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	**14/8/2013**

VOLUME **2820** FOLIO **22**

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 9002 ON DEPOSITED PLAN 71255

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

ANDREA THOMAS RYAN OF 103 WATTLE ROAD SERPENTINE WA 6125

(T N876577) REGISTERED 17/4/2018

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

1. *L703100 NOTIFICATION CONTAINS FACTORS AFFECTING THE WITHIN LAND. LODGED 9/8/2011.
2. *L703101 NOTIFICATION CONTAINS FACTORS AFFECTING THE WITHIN LAND. LODGED 9/8/2011.
3. *N876578 MORTGAGE TO WESTPAC BANKING CORPORATION REGISTERED 17/4/2018.

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: DP71255
PREVIOUS TITLE: 1940-105
PROPERTY STREET ADDRESS: 103 WATTLE RD, SERPENTINE.
LOCAL GOVERNMENT AUTHORITY: SHIRE OF SERPENTINE-JARRAHDALE

NOTE 1: DUPLICATE CERTIFICATE OF TITLE NOT ISSUED AS REQUESTED BY DEALING N876578

Appendix 2

Environmental Report (EAMS)

Environmental Assessment and Management Strategy

Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Project No: EP20-064(04)

Prepared for Stron Pty Ltd
August 2020

Document Control

Doc name:	Environmental Assessment and Management Strategy Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine				
Doc no.:	**EP20-064(04)--004 GAF**				
Version	**Date**	**Author**		**Reviewer**	
1	August 2020	Grace Ferraz	GAF	Julia Morgan	JMM
	Draft issued to client and project team.				

Executive Summary

This *Environmental Assessment and Management Strategy* (EAMS) has been prepared on behalf of Stron Pty Ltd (the proponent) for Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine (herein referred to as 'the site'). HEX Design and Planning, on behalf of the proponent, have prepared a structure plan which outlines the proposed development of the site for rural-residential purposes (**Appendix A**) comprising of 39 special rural-residential lots with a minimum lot size of 2 hectares (ha).

This EAMS has been prepared to address the requirements of the Western Australian Planning Commission's (WAPC) *Structure Plan Framework* (WAPC 2015b) to support the preparation and implementation of the proposed structure plan. This report provides a synthesis of information from a range of sources regarding the environmental features, attributes and values of the site.

The site comprises a total area of approximately 91.3 ha and is located within the Shire of Serpentine-Jarradale. It is bound by Wattle Road to the north, existing rural-residential landholdings to the east, Utley Road to the south and rural land to the west

The relevant environmental attributes and values of site are summarised as follows:

- The majority of the site has been historically cleared to allow for agricultural activities.
- Topography across the site is relatively uniform, with elevation ranging between 34 and 40 m Australian Height Datum (m AHD).
- Regional geological mapping showed the site consists of sand and sandy clay. Geotechnical investigations determined the site was underlain by a sand layer (generally 700 mm below ground level) over loam-clays or gravel.
- The entire site is classified as having a moderate to low risk of acid sulfate soils (ASS) occurring within 3 m of the natural soil surface.
- Given historic clearing for agricultural land uses, native vegetation within the site has been significantly cleared/modified, with approximately 96% of the site identified as being in 'completely degraded' condition in accordance with the Keighery (1994) vegetation condition scale. Two native plant communities were identified within the balance of the site (**Cc** and **CcEm**), however these communities were also determined to be in a 'degraded' condition as the vegetation structure has been severely impacted by disturbance.
- No threatened ecological communities or priority ecological communities were identified or considered likely to occur within the site based on the degraded nature of vegetation present.
- No threatened or priority flora species have been identified within the site, nor are any likely to occur based on the degraded nature of vegetation within the site.
- Due to the degraded nature of vegetation within the site, the extent of functional fauna habitat within the site is limited and is generally only associated with the areas of degraded native vegetation. Nevertheless, two threatened fauna species, Carnaby's cockatoo (*Calyptorhynchus latirostris*) and forest red-tailed black cockatoo (*Calyptorhynchus banksii naso*), were recorded utilisnig the site. One additional threatened black cockatoo species, *Calyptorhynchus baudinii* (Baudin's cockatoo), was also considered likely to occur in the site due to presence of suitable habitat.

- One mammal species of conservation significance, quenda (Priority 4), was considered to possibly occur in the north western portion of the site.
- The *Land Capability – Geotechnical Assessment* (Landform Research 2018) for the site notes the likely maximum groundwater range is between 400 to 800 mm from the surface. However, groundwater beneath the site is not a reflection of the regional superficial aquifer but rather of infiltrated stormwater perching above the loam-clay and gravel layers.
- While there are no defined natural waterways traversing the site, multiple artificial drainage channels are present, most notably in the central portion of the site and along the driveway in the northern portion of the site.
- The *Geomorphic Wetlands of the Swan Coastal Plain* mapping identifies the northern portion of the site as intersecting one very large resource enhancement wetland (REW, UFI 15364 dampland basin) which extends across a number of surrounding landholdings, as well as a similar sized multiple use wetland (MUW, UFI 16021, plausplain flat) to the south. Nevertheless, no prominent natural wetland landform features or areas supporting intact native wetland vegetation have been recorded within the site.
- The entirety of the site is classified as a sewage sensitive area by the *Government Sewerage Policy* (DPLH 2019).
- No Registered Aboriginal Heritage Sites or Other Heritage Places are mapped within the site.
- Based on historical aerial imagery, the homestead and residence by Utley Road was constructed circa 1960's. It is understood that this homestead is intended to be retained as part of the future development of the site. However, should demolition be considered in the future, a hazardous materials assessment is recommended to be undertaken prior to demolition to determine if asbestos or hazardous materials are present and require removal.
- The site is located within the generic 5,000 m odour buffer distance from Westpork Serpentine Piggery and will likely require notification being placed on titles advising prospective purchasers of potential odour impacts within the local area.
- The majority of the site has been cleared of native vegetation and comprises unmanaged open paddocks classified as 'grassland' vegetation, with the exception a stand of remanent trees located in the central portion of the site, classified as 'woodland'. These classifications respectively represent 'moderate' and 'extreme' bushfire hazards and therefore need to be considered in regards to future development of the site.

The structure plan design has responded to site-specific environmental considerations where necessary and possible, including accommodation of water supply, surface water quality, stormwater management, groundwater management and wastewater management requirements consistent with the Local Water Management Strategy (LWMS)(Emerge Associates 2020b). The structure plan design provides opportunities for retention of native vegetation and associated habitat for black cockatoos within future rural-residential lots and wide road reserves, while still minimising bushfire risk through maintenance of bushfire hazards in accordance with the prepared Bushfire Management Plan (BMP)(Emerge Associates 2020a).

This document provides an environmental management strategy to be implemented across the site for future subdivision and development stages. The key components of this management strategy are summarised as follows.

- Acid sulfate soils: completion of an ASS self-assessment form, and if necessary, the preparation of an Acid Sulfate Soil and Dewatering Management Plan (ASSDMP).
- Native vegetation: completion of a detailed analysis of the final development design and bulk earthworks requirements to confirm any potential retention opportunities. Where clearing of vegetation is proposed, a clearing permit will need to be attained pursuant to Part V of the *Environmental Protection Act 1986* (unless a valid exemption applies).
- Native fauna: completion of a detailed analysis of the final development design and bulk earthworks requirements to confirm any potential retention opportunities. Fauna management protocols and actions will also need to be implemented prior to and during clearing activities, through future preparation and implementation of a Fauna Management Plan.
- Hydrology: stormwater management requirements will be implemented as outlined within the LWMS and through the future preparation and implementation of an Urban Water Management Plan (UWMP).
- Bushfire risks: To respond to the known bushfire hazards within and surrounding the site future development will be in accordance with the prepared BMP. This assumed that retained vegetation within the site will be managed to a 'low threat' standard in accordance with the *Australian Standard 3959-2018 Construction of buildings in bushfire prone areas*.

Overall, the environmental attributes and values of the site can be accommodated within the structure plan design, or can be managed appropriately through future development phases in line with the relevant state and local government legislation, policies and guidelines.

Table of Contents

List of Tables

List of Plates

Figures

Appendices

This page has been left blank intentionally.

1 Introduction

1.1 Background

HEX Design and Planning (HEX), on behalf of Stron Pty Ltd (the proponent), have prepared a structure plan to guide the rural-residential development of Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine (herein referred to as 'the site'). The proposed structure plan is provided in **Appendix A** and comprises 39 special rural-residential lots with a minimum lot size of 2 hectares (ha) and an integrated local road network with 20 m wide road reserves compromising a total area of approximately 5.94 ha. It is also noted that approximately four existing buildings within the central north portion of the site are intended to be retained within the future development.

The site is located within the Shire of Serpentine-Jarrahdale (SSJ), approximately 48 km south-east of the Perth Central Business District (CBD). Comprising a total area of 91.3 hectares (ha), the site is zoned 'special rural (SR28)' under the SSJ's Town Planning Scheme No. 2 (TPS 2), and 'rural' under the Metropolitan Region Scheme (MRS) as shown in **Figure 10**. It is bound by Wattle Road to the north, existing rural-residential landholdings to the east, Utley Road to the south and rural land to the west (**Figure 1**).

The site has historically been utilised for agricultural uses and is therefore mostly cleared of native vegetation.

1.2 Purpose of this report

The purpose of this Environmental Assessment and Management Strategy (EAMS) is to provide a synthesis of information regarding the environmental values and attributes of the site. Specifically, this report:

- Identifies the existing environmental values and attributes of the site (**Section 2**)
- Discusses the land use planning context and the proposed structure plan (**Section 3**)
- Discusses how the structure plan design responds to the existing environment and outlines the future environmental management framework (**Section 4**)
- Outlines how the environmental management framework will be implemented (**Section 5**)
- Outlines applicable environmental recommendations (**Section 6).**

The EAMS is the key supporting environmental document for the structure plan process to ultimately facilitate the consideration of any environmental issues by the SSJ and state government authorities. It is consistent with the Western Australian Planning Commission's *Structure Plan Framework* (WAPC 2015b).

1.3 Scope of work

Emerge Associates (Emerge) were engaged by the proponent to undertake an environmental assessment to document the existing environmental attributes and values of the site and ensure any relevant environmental values can be accommodated within the structure plan. This involved

utilising a range of information sources including local and regional reports, databases, mapping and site-specific investigations. The outcomes of these findings include information on the following attributes:

- Landforms, topography and soils
- Flora and vegetation
- Terrestrial fauna
- Hydrology
- Aboriginal and non-indigenous heritage
- Historical and existing land uses within and surrounding the site
- Bushfire hazards.

In addition to the preparation of this EAMS, Emerge have prepared the following documents to support the proposed structure plan:

- Reconnaissance Flora, Vegetation and Fauna Assessment (Emerge Associates 2020c) (provided as **Appendix B**)
- Bushfire Management Plan (Emerge Associates 2020a)
- Local Water Management Strategy (Emerge Associates 2020b)

2 Existing Environment

2.1 Landform and soils

2.1.1 Topography

The site is relatively flat, with elevation ranging from 34 m Australian Height Datum (m AHD) in the north west corner of the site, to 40 m AHD across the middle east portion of the site (DPIRD 2020). The topographical characteristics of the site are shown in **Figure 2.**

2.1.2 Landform, soils and geology

Regional soil association mapping indicates that the entire site occurs within the Guildford soil association (Churchward and McArthur 1980).

Based on regional landform mapping of the Swan Coastal Plain (DPIRD 2019), the site is situated on three landforms with multiple variations in land characteristics described in **Table 1** below.

Table 1: Regional landform mapping of the site

Landform	Description
Bassendean Sandplain	• Low rises with imperfectly drained deep or very deep grey siliceous sands. • Flat to very gently undulating with well to moderately well drained deep bleached grey sands.
Pinjarra Sandplain	• Extremely low to very low relief dunes.
Pinjarra Plain	• Flat to very gently undulating plain. • Extremely low relief dunes. • Moderately well drained shallow pale sand to sandy loam over very gravelly clay

The Geological Survey of Western Australia (Gozzard 1986) indicates the presence of 'Sandy Clay' (C_s) and 'Sand' (S_{10}) across the site. A small portion of the site (middle east portion and north east corner) also contains 'Sand' (S_8). The general descriptions of these soil units are provided in **Table 2** and their extent is shown in **Figure 3**.

Table 2: Environmental geology of the site

Map unit	Description
(C_s)	White, grey to brown, fine to coarse, sub-angular to rounded, clay of moderate plasticity; gravel and silt layers near scarp, of alluvial origin
(S_{10})	As S8 over sandy clay to clayey sand of the Guildford Formation, of eolian origin
(S_8)	white to pale grey at surface, yellow at depth; fine to medium-grained, moderately sorted sub-angular to sub-rounded minor heavy minerals, of eolian origin

2.1.3 Acid sulfate soils

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

issues when oxidised, producing sulphuric acid, which can impart a range of impacts on the surrounding environment, infrastructure and human health. Projects involving the disturbance of ASS must therefore assess the risk associated with disturbance by considering potential impacts.

The Department of Water and Environment Regulation (DWER) provides broad-scale mapping indicating areas of potential ASS risk (DWER 2017). A review of the DWER mapping indicates that the entire site is classified as having a moderate to low risk of ASS occurring within 3 m of the natural soil surface (**Figure 4**).

2.2 Biodiversity and natural assets

2.2.1 Flora and vegetation

2.2.1.1 Regional context

Native vegetation is described and mapped at different scales in order to illustrate patterns in its distribution. At a continental scale the *Interim Biogeographic Regionalisation of Australia* (IBRA) divides the Swan Coastal Plain into two floristic subregions (Environment Australia 2000).

The site is contained within the Perth subregion of the Swan Coastal Plain, which is characterised as mainly containing *Banksia* low woodland on leached sands with *Melaleuca* swamps where ill-drained; and woodland of *Eucalyptus gomphocephala* (tuart), *E. marginata* (jarrah) and *Corymbia calophylla* (marri) on less leached soils (Beard 1990).

At a regional scale, vegetation complex mapping undertaken by Heddle *et al.* (1980) indicates the site occurs within the Guildford Complex, the description of which is detailed in **Table 3**.

Table 3: Regional vegetation complex descriptions (Heddle et al. 1980)

Complex	Description
Guildford Complex	A mixture of open forest to tall open forest of Corymbia calophylla - Eucalyptus wandoo - Eucalyptus marginata and woodland of Eucalyptus wandoo (with rare occurrences of Eucalyptus lane-poolei). Minor components include Eucalyptus rudis - Melaleuca rhaphiophylla.

2.2.1.2 Site specific surveys and investigations

A reconnaissance flora, vegetation and fauna assessment was carried out by personnel from Emerge on the 23rd June 2020 and is provided in **Appendix B** and summarised below.

2.2.1.3 Plant communities

Based on the findings of the flora, vegetation and fauna survey undertaken by Emerge, three native plant communities were recorded within the site, in addition to heavily disturbed areas comprising non-native grassland and herbland with scattered native trees and lines of planted trees, which were not identified as comprising a native plant community. Descriptions of the plant communities identified within the site are provided in **Table 4** and shown on **Figure 5** with representative photographs of the communities provided in **Plates 1 to 3**.

Table 4: Plant communities identified within the site

Plant community	Description	Area (ha)
Cc	Woodland to open forest *Corymbia calophylla* over non-native closed grassland **Ehrharta* sp. and herbland **Arctotheca calendula* **(Plate 1)**	0.85
CcEm	Woodland *Corymbia calophylla* and *Eucalyptus marginata* over occasional *Xylomelum occidentale* over herbland * *Zantedeschia aethiopica* over non-native closed grassland **Ehrharta* sp. and herbland **Arctotheca calendula* **(Plate 2)**	2.14
Non-native	Occasional *Corymbia calophylla*, planted non-native trees such as *Eucalyptus camaldulensis* and *Eucalyptus grandis* and planted native trees such as *Eucalyptus rudis* over non-native closed grassland **Ehrharta* sp. and herbland **Arctotheca calendula* **(Plate 3)**	88.25

*Plate 1: Plant community **Cc** in 'degraded' condition*

*Plate 2: Plant community **CcEm** in 'degraded' condition*

*Plate 3: Plant community **non-native** in 'completely degraded' condition*

2.2.1.4 Vegetation condition

Vegetation condition within the site was assessed by Emerge using methods from Keighery (1994). Plant communities **Cc** and **CcEm** were determined to be in a 'degraded' condition as the vegetation structure has been severely impacted by disturbance. While a native canopy layer was present, the understorey was dominated by non-native species. The majority of the site (approximately 96%) was determined to be in a 'completely degraded' condition as it comprises non-native vegetation.

The extent of vegetation by condition category is detailed in **Table 5** and shown in **Figure 6**.

Table 5: Vegetation condition categories within the site

Condition category (Keighery 1994)	Size (ha)
Pristine	0
Excellent	0
Very Good	0
Good	0
Degraded	2.99
Completely Degraded	88.3

2.2.1.5 Threatened and Priority Ecological Communities

Generally, ecological communities can be described as vegetation communities that are assemblages of species that occur together in a particular type of habitat. An ecological community's structure, composition and distribution are determined by a range of environmental factors. 'Threatened ecological communities' (TECs) are ecological communities that are recognised as rare or under threat and therefore warrant special protection.

Selected TECs are afforded statutory protection at a Commonwealth level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). TECs listed under the EPBC Act are categorised as either 'critically endangered', 'endangered' or 'vulnerable'. Any action likely to have a significant impact on a TEC listed under the EPBC Act requires approval from the Commonwealth Minister for the Environment.

Within Western Australia, TECs are determined by the Western Australian Threatened Ecological Communities Scientific Advisory Committee and endorsed by the Minister for the Environment. While TECs are not afforded direct statutory protection at a state level (unlike threatened flora under the *Wildlife Conservation Act 1950* (WC Act)), their significance is acknowledged through other State environmental approval processes such as the Environmental Impact Assessment pursuant to Part IV of the *Environmental Protection Act 1986* (EP Act) and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* pursuant to Part V of the EP Act.

An ecological community under consideration for listing as a TEC in Western Australia, but which does not yet meet survey criteria or has not been adequately defined, or which is rare but not

currently threatened, is referred to as a 'priority ecological community' (PEC). Whilst PECs are not afforded statutory protection in Western Australia, they are considered during the approval process.

Following the reconnaissance flora and vegetation survey, the plant communities in the site are not considered to represent a TEC or a PEC due to their lack of structure and native species diversity.

2.2.1.6 Conservation significant flora

Certain flora species that are considered to be rare or under threat warrant special protection under Commonwealth and/or State legislation. At a Commonwealth level, flora species may be listed as 'threatened' pursuant to the EPBC Act and any action likely to have a significant impact on a listed threatened species requires approval from the Commonwealth Minister for the Environment.

At a State level, plant species may also be classed as 'threatened' under the WC Act. Species which are potentially rare or threatened, or meet the criteria for near threatened, or have recently been removed from the threatened species list are classed as 'priority' flora species. However, priority flora species are not afforded statutory protection.

A search of State and Commonwealth TEC and PEC databases was completed prior to the reconnaissance flora and vegetation survey, a full list of which is available in the flora and vegetation technical memorandum (Emerge Associates 2020c) provided in **Appendix B**. Based on the results of this search and in consideration of the existing environment of the site, no threatened or priority flora were identified as potentially occurring within the site.

2.2.2 Terrestrial fauna

2.2.2.1 Site specific surveys and investigations

A reconnaissance flora, vegetation and fauna assessment was carried out by personnel from Emerge on the 23rd June 2020 and is provided in **Appendix B** and summarised below.

2.2.2.2 Fauna habitat

Historical disturbance has significantly compromised habitat values within the site. The majority of the native vegetation has been removed and the site now comprises non-native paddocks with scattered planted trees.

Nevertheless, four fauna habitats have been identified within the site, detailed in **Table 6** and shown on **Figure 7** with representative photographs provided in **Plates 4 to 7**. The **woodland** and **woodland over herbland** comprise the highest fauna habitat values due to the presence of native trees. The **woodland over herbland** also supports dense cover of non-native understorey vegetation which may provide habitat for native ground dwelling fauna. A minor creekline occurs outside of the site adjacent to the **woodland over herbland** habitat and supports similar habitat values.

The **grassland with scattered trees** provides limited habitat for native fauna, with the scattered native *Corymbia calophylla* (marri) trees providing the most value. The **planted trees** may provide habitat for native fauna species but is considered to be of low value.

Table 6: Fauna habitats identified within the site

Fauna habitat classification	Description	Area (ha)
Grassland with scattered trees	Occasional *Corymbia calophylla* and non-native trees over non-native closed grassland **Ehrharta* sp. and herbland **Arctotheca calendula* (**Plate 4**).	85.46
Planted trees	Planted rows of trees such as **Corymbia maculata, *Eucalyptus camaldulensis* and **Eucalyptus grandis* over bare ground or non-native herb/grassland (**Plate 5**).	3.57
Woodland	Woodland *Corymbia calophylla* and *Eucalyptus marginata* (or absent) over herbland * *Zantedeschia aethiopica* (o absent) over non-native closed grassland **Ehrharta* sp. and herbland **Arctotheca calendula* (**Plate 6**).	2.15
Woodland over herbland	Woodland *Corymbia calophylla* and *Eucalyptus marginata* over closed herbland * *Watsonia meriana* var. *bulbillifera* over non-native grassland **Eragrostis curvula* (**Plate 7**).	0.06

*Plate 4: **Grassland with scattered trees** habitat*

*Plate 5: **Planted trees** habitat*

*Plate 6: **Woodland** habitat*

*Plate 7: **Woodland over herbland** habitat*

2.2.2.3 Species of conservation significance

Certain fauna species that are considered to be rare or under threat warrant special protection under state and/or federal legislation. At a federal level, fauna species may be listed as 'threatened' pursuant to the EPBC Act and any action likely to have a significant impact on a listed threatened species requires approval from the Commonwealth Minister for the Environment.

At a state level, fauna species could formerly be classed as 'threatened' under the WC Act. In addition to this, DBCA maintains a list of priority fauna species which, while not considered threatened under the WC Act and therefore not protected directly, involve some concern over their long-term survival.

Based on the results of the fauna assessment (Emerge Associates 2020c), two threatened fauna species, *Calyptorhynchus latirostris* (Carnaby's cockatoo) and *Calyptorhynchus banksii naso* (forest red-tailed black cockatoo), were recorded as utilising the site. One additional threatened black cockatoo species, *Calyptorhynchus baudinii* (Baudin's cockatoo), is also considered likely to occur in the site due to presence of suitable habitat. Potential black cockatoo breeding, foraging and roosting habitat within the site is intended to be retained within future rural-residential lots, particularly the existing stand of remnant native trees identified within the central portion of the site. This area of woodland vegetation will be managed to a low threat standard in accordance with Section 2.2.3.2 of AS 3959 and the *Serpentine Jarrahdale Firebreak and Fuel Hazard Reduction Notice*. Where the spacing of individual or groups of trees is less than 15 metres apart, or canopies of existing trees are touching, branches will be lopped to provide for a separation between tree crowns. In addition, retained trees will be low pruned to 2 m from the ground and the grassy understory will be managed

through regular mowing/slashing of grass to less than 100 millimetres (mm) in height on an ongoing basis.

Suitable habitat for three other bird species of conservation significance occurs in the site but the site is unlikely to provide core habitat for these species. One mammal species of conservation significance, quenda (P4), was considered to possibly occur in the north western portion of the site within the **woodland over herbland** habitat. Further discussion of management of native fauna is provided in **Section 4.3**.

2.2.3 Bush Forever

The Government of Western Australia's Bush Forever policy is a strategic plan for conserving regionally significant bushland within the Swan Coastal Plain portion of the Perth Metropolitan Region. The objective of Bush Forever is to protect comprehensive representations of all original ecological communities by targeting a minimum of 10% of each vegetation complex for protection (Government of WA 2000). The Bush Forever policy is only applicable within the boundary of the Metropolitan Region Scheme (MRS).

No Bush Forever sites are located within or adjacent to the site. The closest Bush Forever Site is located approximately 1.6 kilometres (km) north east of the site is Bush Forever Site No. 375 (Paul Robinson Park).

2.2.4 Ecological linkages

Ecological or biodiversity linkages are described as areas of native vegetation which provide a corridor or linkage (typically linear) between patches of vegetation to allow movement of flora and fauna and their genetic material through the landscape, helping to maintain metapopulations. Ecological linkages are often continuous or near-continuous as the more fractured a linkage is, the less ease flora and fauna have in moving within the corridor (Alan Tingay and Associates 1998).

The Perth Biodiversity Project, supported by the Western Australia Local Government Association (WALGA), has identified and mapped regional ecological linkages within the Perth Metropolitan Region (PBP 2007).

There are no ecological linkages identified within or in close proximity to the site as shown in **Figure 8.**

2.2.5 Environmentally sensitive areas

Within Western Australia, the clearing of native vegetation can only be undertaken once a Clearing Permit has been attained under Part V of the EP Act, or if the clearing activity is in accordance with a valid exemption, including:

- Exemptions listed in Schedule 6 of EP Act. These include, but are not limited to:
  - Clearing undertaken in accordance with a subdivision approval
  - Clearing that is required under other laws (for example, Local Governments may require landholders to establish and maintain firebreaks under the *Bush Fires Act 1954*).

- Exemptions listed in the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* (the Regulations). These are associated with low impact land management practices and include, but are not limited to:
  - Clearing to allow for the construction of fence-lines
  - Clearing for vehicular and walking tracks
  - Burning to reduce fire hazards
  - The collection of firewood.

'Environmentally sensitive areas' (ESAs) are prescribed under the Regulations to protect native vegetation values in proximity to significant threatened flora, ecological communities, wetlands or ecosystems. Within ESAs, exemptions listed in the Regulations (i.e. those associated with low impact land management practices) do not apply and a Clearing Permit is required to undertake such clearing activities. The relevance of ESAs is limited to this specific context.

There are no ESA's mapped within or adjacent to the site, as shown in **Figure 8.**

2.3 Hydrology

2.3.1 Groundwater

The site is located beyond the extents of the online *Perth Groundwater Map*, however the *Land Capability – Geotechnical Assessment* (Landform Research 2018) for the site notes the likely maximum groundwater range is between 400 to 800 mm from the surface. However, groundwater beneath the site is not a reflection of the regional superficial aquifer but rather of infiltrated stormwater perching above the loam-clay and gravel layers.

The characteristics of groundwater underlying the site are discussed further in the *Local Water Management Strategy* (Emerge Associates 2020b).

2.3.2 Surface water

There are no defined natural waterways traversing the site, however there are multiple artificial drainage channels, most notably in the central portion of the site and along the driveway in the northern portion of the site. The closest main watercourse is Karnet Brook, located south of Utley Road, which feeds into the Serpentine River (Emerge Associates 2020b).

2.3.3 Wetlands

Wetlands are areas which are permanently, seasonally or intermittently waterlogged or inundated with water. Naturally occurring wetland features are common across the Swan Coastal Plain and can contain fresh or salty water, which may be flowing or still.

DBCA maintains the *Geomorphic Wetlands of the Swan Coastal Plain* dataset (DBCA 2018), which categorises geomorphic wetland features into types and management categories to guide land use and conservation. Wetland types are based on landform shape and water permanence (hydro-period) and management categories of wetlands are determined based on hydrological, biological and human use features. The three management categories are described in **Table 7**.

Table 7: Management categories defined in the Geomorphic Wetlands of the Swan Coastal Plain (DBCA 2017)

Management category	Description of wetland	Management objectives
Conservation (CCW)	Support high levels of attributes	Preserve wetland attributes and functions through reservation in national parks, crown reserves and state owned land. Protection provided under environmental protection policies.
Resource enhancement (REW)	Modified or degraded but still supporting substantial attributes and functions	Restore wetland through maintenance and enhancement of wetland functions and attributes. Protection via crown reserves, state or local government owned land, environmental protection policies and sustainable management on private properties.
Multiple use (MUW)	Few remaining important wetland attributes and functions but still provide important hydrological functions	Use, development and management considered in the context of water, town and environmental planning through land care.

A review of the *Geomorphic Wetlands, Swan Coastal Plain* dataset (DBCA 2018) identifies two (2) wetlands as extending across the site as described below and shown in **Figure 9**.

- REW UFI 15364 (dampland basin) extends across the northern portion of the site.
- MUW UFI 16021 (plausplain flat) extends across the southern portion of the site. MUWs do not require specific conservation or protection measures and therefore the presence of this MUW within the site does not represent a constraint to the proposed rural-residential development.

Despite the geomorphic wetlands database indicating the presence of a REW across the northern portion of the site, no prominent natural wetland landform features or areas supporting intact native wetland vegetation have been recorded in the site survey. However, it is noted that multiple artificial drainage channels exist within the site, most notably in the central portion of the site and along the driveway in the northern portion of the site.

2.3.4 Sewage sensitive areas

The entirety of the site is classified as a sewage sensitive area by the *Government Sewerage Policy* (DPLH 2019). The policy defines sewage sensitive areas geographically based on proximity to a variety of environmental assets and sensitivity to on-site sewage disposal. The two classifications of relevance to the site define a sewage sensitive area as:

- Estuary catchments on the Swan and Scott Coastal Plains.
- The area within a boundary, which is 1 km up-groundwater-gradient and 250 m down-gradient of a significant wetland; or where the groundwater gradient is unknown within 1 km of the significant wetland.

2.4 Heritage

2.4.1 Aboriginal heritage

The *Aboriginal Heritage Inquiry System* (AHIS) is maintained pursuant to Section 38 of the *Aboriginal Heritage Act 1972* (AH Act) by the Department of Planning, Lands and Heritage (DPLH), containing

information on Registered Aboriginal Heritages Sites and Other Heritage Places throughout Western Australia.

In accordance with the *Aboriginal Heritage Due Diligence Guidelines* (DAA 2013), a search of the AHIS online database (DPLH 2018) was undertaken to support preparation of the structure plan, which did not identify any Aboriginal heritage sites as being mapped by DPLH within the site.

There are no Registered Aboriginal Sites or Other Heritage Places located within or adjacent to the site.

2.4.2 Non-indigenous heritage

In order to determine the actual or potential presence of sites or features of non-indigenous heritage significance within the site, a review of readily available information at a federal, state and local government level was undertaken to determine if any of the following occur within the site:

- World Heritage Sites
- National Heritage Places
- Commonwealth Heritage Places
- Sites listed in the State Register of Heritage Places
- Sites listed in the City of Armadale Heritage Register.

A review of the above registers did not identify any heritage features as being mapped within the site.

2.5 Land use considerations

2.5.1 Historical land uses

2.5.1.1 Changes in land use

A review of historical aerial imagery for the site between 1965 to present (Landgate 2019) was completed to understand temporal changes in land use. It is recognised that the site has been utilised for agricultural purposes and therefore has undergone historical clearing. Specifically, the southern portion of the site appears to have been historically cleared between 1985 and 2000. The central north portion of the site currently contains an extensive rural-residential dwelling and associated farming infrastructure, extended from a smaller dwelling between approximately 1995 to 2000.

Most of the site has then been retained as a predominately cleared landscape from 2011 until present, with areas of windbelt planting occurring along paddock edges and internal driveways associated with the agricultural use (cattle grazing and horse agistment with low stocking rates).

2.5.1.2 Potential contamination

A review of the *Contaminated Sites Database* indicates the site is not recorded as a contaminated site on the database, nor are there any registered sites within 2 km of the site (DWER 2018).

However, based on historical aerial imagery, the homestead and residence by Utley Road was constructed circa 1960's. It is understood that this homestead is intended to be retained as part of the future development of the site. However, should demolition be considered in the future, a hazardous materials assessment is recommended to be undertaken prior to demolition to determine if asbestos or hazardous materials are present and require removal.

2.5.2 Surrounding land uses

The site borders existing rural-residential lots of varying sizes to the north and east, with 'rural' zoned land to the west and south. The site is considered to bookend the rural-residential precinct in the southwest corner of the Serpentine Townsite.

Located approximately 3.7 km west of the site at 567 Utley Road, Hopeland is the Westpork Serpentine Piggery, a category 2 prescribed premises (intensive piggery) pursuant to the *Environmental Protection Regulations 1987*. Category 2 prescribed premises are described as 'premises on which pigs are fed, watered and houses in pens,' with a project or design capacity of 1000 animals or more. The existing Westpork Serpentine Piggery prescribed premises licence (ref. L6373/1989/10) permits a maximum stock capacity of 12,376 pigs (4% greater than average stock) to be held on site at any one time. Based on this stocking capacity, and in accordance with the EPA's Guidance Statement No. 3 *Separation Distances between Industrial and Sensitive Land Uses* (EPA 2005), a generic buffer distance of 5,000 m is therefore recommended for potential noise and odour impacts from an intensive piggery with more than 5000 pigs. The site is located within this generic buffer and may require notification being placed on titles advising prospective purchasers of potential odour impacts within the local area.

2.6 Bushfire hazard

The entire site is located within a 'bushfire prone area' under the state-wide Map of Bush Fire Prone Areas prepared by the Office of Bushfire Risk Management (OBRM 2019) as shown in **Plate 8**. *State Planning Policy 3.7 Planning in Bushfire Prone Areas* sets out a requirement for the preparation of a Bushfire Management Plan (BMP) to support any planning proposal (such as a structure plan or subdivision application) which intersects a designated bushfire prone area. On this basis, a BMP (Emerge Associates 2020a) has been prepared to support the lodgement of the proposed structure plan.

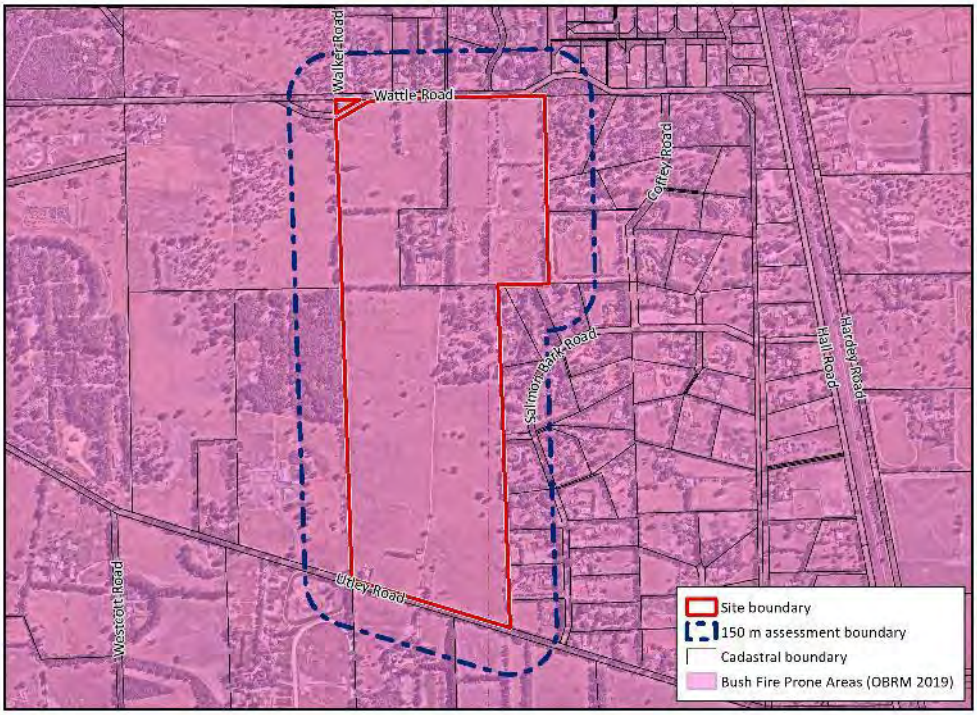


Plate 8: The entirety of the site identified as 'bushfire prone areas' (as indicated in purple) under the state-wide Map of Bush Fire Prone Areas (OBRM 2020).

As part of preparing the BMP, the existing vegetation types within the site and surrounding area (100 m) were classified in accordance with *Australia Standard 3959 Construction of buildings in bushfire-prone areas* (AS 3959). The majority of the site is cleared of trees and been classified as 'grassland' (Class G) with patches of trees classified as 'woodland' (Class B) located in the central portion of the site. External to the site, vegetation has been classified as being a mixture of 'scrub' (Class D), 'woodland' (Class B), 'forest' (Class A) and 'grassland' (Class G) located within adjacent rural-residential lots and road reserves.

Each identified vegetation type was then assigned their respective bushfire hazard rating, as specified within the *Guidelines for Planning in Bushfire Prone Areas* (WAPC and DFES 2017). Areas of forest, woodland and scrub represent an 'extreme' bushfire hazard, whilst areas of grassland represent a 'moderate' bushfire hazard.

Given portions of the site and surrounding area were identified as containing vegetation presenting moderate and extreme bushfire hazards, further consideration of bushfire risk management in relation to the proposed structure plan is required.

Based on the identified hazards and existing land management, the BMP has been able to demonstrate that within the structure plan area (and associated development layout) there is sufficient area (i.e. a development site) with which a habitable building could be located so that a BAL rating of BAL-29 or less is achieved. The outcomes of this BMP demonstrate that as development progresses, it will be possible for an acceptable solution to be adopted for three elements of the bushfire protection criteria as outlined in the *Guidelines for Planning in Bushfire Prone Areas Version 1.3* (the Guidelines) (WAPC and DFES 2017) (Element 1 (location), Element 2 (siting and design) and

Element 4 (water). This is discussed in detail in the BMP (Emerge Associates 2020), and is summarised in **Section 4.6.**

2.7 Summary of relevant environmental factors

Table 8 provides a summary of the environmental factors that have been investigated for the site and those that will require further specific consideration as part of the future development within the site. These considerations are discussed further in **Section 4**.

Table 8: Relevant environmental factors and considerations for the proposed structure plan

Environmental factor	Relevant considerations
Landform and soils	No issues posed and therefore no further consideration of this factor is required.
Acid Sulfate Soils	The site is classified as having a moderate to low risk of ASS occurring within 3 m of the natural soil surface. Further consideration of this factor is provided in **Section 0**.
Flora and vegetation	Due to the degraded nature of the site, no significant flora or vegetation values have been identified within the site that require specific spatial responses from the structure plan. Opportunities to retain vegetation or trees within future rural-residential lots or road reserves are available with the proposed structure plan layout. Further consideration of this factor is provided in **Section 4.2.**
Terrestrial fauna	Historical disturbance has significantly compromised habitat values within the site. The majority of the native vegetation has been removed and the majority of the site comprises non-native paddocks with scattered planted trees. However, two threatened fauna species (Carnaby's cockatoo and forest red-tailed black cockatoo) were recorded in the site. One additional threatened black cockatoo species (Baudin's cockatoo) is considered also likely to occur in the site due to presence of suitable habitat. Potential black cockatoo breeding, foraging and roosting habitat exists within the site and a targeted assessment would be required to confirm the black cockatoo habitat values within the site. Suitable habitat for three other bird species of conservation significance occurs in the site but the site is unlikely to provide core habitat for these species. One mammal species of conservation significance, quenda (P4), was considered to possibly occur in the north western portion of the site. Management of terrestrial fauna is further discussed in **Section 4.3.**
Bush Forever	No Bush Forever site are located within or in close proximity to the site. No further consideration of this factor is required.
Ecological linkages	Vegetation within the site is not considered to contribute to the surrounding Regional Ecological Linkage. No further consideration of this factor is required.
Environmentally sensitive areas	The site is not mapped as occurring within an ESA and therefore no further consideration of this factor is required.
Groundwater	The likely maximum groundwater range is between 400 to 800 mm from the surface, perched between the sand and clay layer. Further consideration of management of groundwater in provided in the Local Water Management Strategy (Emerge Associates 2020b) and summarised in **Section** 2.3.1.
Surface water	There are no defined natural waterways traversing the site, however there are multiple artificial drainage channels, most notably in the central portion of the site and along the driveway in the northern portion of the site. Further discussion of surface water management is provided in the Local Water Management Strategy (Emerge Associates 2020b) and summarised in **Section** 2.3.2.

Table 8: Relevant environmental factors and considerations for the proposed structure plan (continued).

Environmental factor	Relevant considerations
Wetlands	One REW (UFI 15364) is mapped as extending across the northern portion of the site in the geomorphic wetlands database (DBCA 2018). However, this mapping appears to be incorrect as no prominent natural wetland landform features or areas supporting intact native wetland vegetation have been recorded in the site survey.
Aboriginal heritage	No Registered Aboriginal Sites or Other Heritage Places are identified within or adjacent to the site. No further condition of this factor is required.
Non-indigenous heritage	No non-indigenous heritage values have been identified within, or in close proximity to the site and therefore no further consideration of this factor is required.
Historic land uses	The site has historically been utilised for agricultural purposes and therefore has undergone historical clearing. A review of the *Contaminated Sites Database* indicates the site is not recorded as a contaminated site on the database, nor are there any registered sites within 2 km of the site (DWER 2018). No further consideration of this factor is required.
Surrounding land uses	Westpork Serpentine Piggery, a category 2 prescribed premises, is located approximately 3.7 km west of the site. In accordance with the EPA's Guidance Statement No. 3 *Separation Distances between Industrial and Sensitive Land Uses* (EPA 2005), a generic buffer distance of 5,000 m is therefore recommended for potential noise and odour impacts from an intensive piggery with more than 5000 pigs. Further consideration of this factor is provided in **Section 4.5.**
Bushfire hazard	Portions of the site and surrounding area are identified as containing vegetation presenting moderate and extreme bushfire hazards. Further consideration of bushfire risk management is provided in the BMP (Emerge Associates 2020a) and summarised in **Section 4.6.**

3 Planning Framework and Proposal

3.1 Historical planning context

In order to facilitate the proposed future rural-residential development process within the site, TPS 2 Amendment 199 was initiated by the SSJ and subsequently gazetted in August 2018, which resulted in the site being rezoned from 'rural' to 'special rural 28' (SR28) under the SSJ's TPS 2.

The SSJ referred the proposed TPS 2 Amendment 199 to the Environmental Protection Authority (EPA) to determine whether environmental assessment under Part IV of the *Environmental Protection Act 1986* (EP Act) was required. In April 2018 the EPA advised the SSJ that the proposed scheme amendment was unlikely to have a significant effect on the environment and did not require formal assessment under Part IV Division 3 of the Environmental Protection Act 1986 (EP Act). For the purposes of Part IV of the EP Act the scheme is therefore defined as an assessed scheme.

Having considered the matter, the EPA advice (dated 16 April 2018) identified the following preliminary environmental factors relevant to the proposed amendment:

- Inland Waters Environmental Quality, specifically the potential for nutrient export to the Peel-Harvey catchment as there is no reticulated sewerage available.
- Flora and Vegetation & Terrestrial Fauna, specifically clearing of black cockatoo habitat. The EPA support the retention of native trees and vegetation that may provide habitat for a variety of fauna, including black cockatoos, and may assist with nutrient attenuation.

The EPA advice concluded that the scheme amendment could be managed to meet the EPA's environmental objectives through the modification and implementation of local planning scheme provisions, and subsequent structure planning process. These environmental considerations have consequently been considered during the preparation of the structure plan and the associated future environmental management strategy, as discussed in **Section 4**.

3.2 Structure Plan

Prepared for the site on behalf of Stron Pty Ltd by HEX Design & Planning, the structure plan is included in **Appendix A**. The structure plan design incorporates the inputs from a multi-disciplinary project team and the outcomes of a range of site-specific technical studies and investigations.

The structure plan proposes the following land uses:

- A total of 39 rural-residential lots with a minimum lot size of 2 ha.
- An integrated local road network with 20 m wide road reserves compromising a total area of approximately 5.94 ha.
- Approximately four existing buildings are intended to be retained towards the central north portion of the site.

Specific considerations to respond to identified environmental values include:

- Retention of native vegetation within private rural-residential lots and 20 m wide road reserves.
- Preparation of a LWMS outlining the groundwater and surface water management strategy for the structure plan.
- Preparation of a BMP outlining how the structure plan responds the bushfire protection criteria specified in the *Guidelines for Planning in Bushfire Prone Areas Version 1.3* (WAPC and DFES 2017).

3.3 Future planning approvals and environmental management framework

Subject to approval and endorsement of the structure plan by the SSJ and the WAPC, development of the site would be progressed through subdivision and/or development approvals (collectively referred to as 'future planning stages'). The key environmental values and attributes that require further consideration as part of future planning stages have been outlined in **Section 4** of this report and include:

- Acid sulfate soils
- Flora and vegetation
- Terrestrial fauna
- Hydrology
- Surrounding land uses
- Bushfire management

The WAPC can impose conditions on subdivision applications to ensure subdivision incorporates all the appropriate environmental management measures. These conditions are usually determined in accordance with WAPC's *Model Subdivision Conditions Schedule 2019* and include those relating to environmental considerations. It is envisaged that there would be future subdivision conditions applied for any subdivision within the site, that would deal with environmental, hydrological and bushfire related requirements.

4 Environmental Assessment and Management Framework

This section outlines any layout considerations within the structure plan to respond to environmental attributes and values within the site, and any future environmental management requirements that will need to be accommodated within future planning and development stages. Only those environmental values and attributes that require specific consideration based on their presence within the site, and/or the applicable legislation and policy requirements have been included in this section.

4.1 Acid sulfate soils

4.1.1 Policy framework, site context and management objectives

The Department of Water and Environmental Regulation (DWER), through the WAPC, ensures ASS are adequately managed during the land use planning and development process. The objective of the DWER's ASS policy framework is to manage ASS appropriately to prevent the release of metals, nutrients and acidity into the soil and groundwater system that may adversely affect the natural and built environment and human health.

The principal management objective for acid sulfate soils within the site is to ensure that any future development that may disturb acid sulfate soils is appropriately managed to avoid impacts on the environment.

4.1.2 Structure plan layout considerations for acid sulfate soils

ASS management does not require any spatial consideration within the structure plan, and any ASS risk can be appropriately managed through future development planning.

4.1.3 Future acid sulfate soils management requirements

The WAPC includes a standard condition on all subdivision applications (model subdivision condition EN8, WAPC 2020) which states:

An acid sulphate soils self-assessment form and, if required as a result of the self-assessment, an acid sulphate soils report and an acid sulphate soils management plan shall be submitted to and approved by the Department of Water and Environmental Regulation before any subdivision works or development are commenced. Where an acid sulphate soils management plan is required to be submitted, all subdivision works shall be carried out in accordance with the approved management plan. (Department of Water and Environmental Regulation).

4.2 Flora and vegetation

4.2.1 Policy framework and management objective

In the context of environmental impact assessment, the EPA objective for flora and vegetation is '*to protect flora and vegetation so that biological diversity and ecological integrity are maintained*'. Where a proposal may potentially impact upon flora and vegetation values, the following mitigation hierarchy should be applied to minimise potential impacts:

1. **Avoid** impacts
2. **Minimise** impacts
3. **Offset** impacts.

The vegetation across the majority (approximately 96%) of the site is in a 'completely degraded' condition. On this basis, vegetation within the site is not considered to represent intact vegetation communities, and there is a reduced level of biological diversity compared to surrounding areas where there are greater areas of remnant vegetation. Given this, the impact of future development within the site is likely to be minimal on flora and vegetation values.

Opportunities to facilitate the retention of native vegetation within the site are available due to the large (minimum 2 ha) rural-residential lot sizes.

4.2.2 Structure plan considerations for flora and vegetation

No specific spatial response to the existing vegetation within the site has been provided for in the structure plan.

4.2.3 Future flora and vegetation management requirements

Opportunities to retain vegetation or trees within future rural-residential lots or road verges are available with the proposed layout. However, any such opportunities will be considered as part of the detailed civil design process to determine if they are possible and practical.

This will also likely be required to address future subdivision approval conditions, specifically model subdivision condition EN2 (WAPC and DPLH 2020) which requires:

Measures being taken to ensure the identification and protection of any vegetation on the site worthy of retention that is not impacted by subdivisional works, prior to commencement of subdivisional works. (Local Government)

Should bulk earthworks or any other works commence within the site that requires clearing of native vegetation before subdivision approvals are gained, a clearing permit pursuant to Part V of the EP Act will be required. Otherwise, subdivision approval and associated authorised subdivision works will provide an exemption from the requirements for a clearing permit.

4.3 Terrestrial fauna

4.3.1 Policy framework and management objectives

In the context of environmental impact assessment, the EPA's objective for terrestrial fauna is *'to protect fauna so that biological diversity and ecological integrity are maintained'.* The application of the mitigation hierarchy should be applied to avoid or minimise impacts to terrestrial fauna where possible.

The EPBC Act also provides protection for listed 'threatened' species, including black cockatoos, which are known to make use of habitat within Precinct 1. Any proposed action which is considered likely to result in a 'significant' impact upon these species, identified as Matters of National Environmental Significance (MNES), should be referred to the Commonwealth Department of Agriculture, Water and Environment (DAWE).

Based on the degraded condition of vegetation within the site, there are limited fauna habitat values remaining. However, the existing stand of remnant native trees identified within the central portion of the site is intended to be retained within future rural-residential lots. This area of woodland vegetation will be managed to a low threat standard in accordance with Section 2.2.3.2 of AS 3959 and the *Serpentine Jarrahdale Firebreak and Fuel Hazard Reduction Notice*. Where the spacing of individual or groups of trees is less than 15 metres apart, or canopies of existing trees are touching, branches will be lopped to provide for a separation between tree crowns. In addition, retained trees will be low pruned to 2 m from the ground and the grassy understory will be managed through regular mowing/slashing of grass to less than 100 millimetres (mm) in height on an ongoing basis.

4.3.2 Structure plan considerations for terrestrial fauna

Due to the cleared and degraded nature of vegetation within the site, limited fauna habitat values exist. However, fauna habitat is intended to be retained within the large (minimum 2 ha) rural-residential lots or 20 m wide road reserves where feasible.

4.3.3 Future terrestrial fauna management requirements

Opportunities to retain limited fauna habitat values within future rural-residential lots or road verges are available with the proposed layout. However, any such opportunities will be considered as part of the detailed civil design process to determine if they are possible and practical.

This will also likely be required to address future subdivision approval conditions, specifically model subdivision condition EN 1 (WAPC and DPLH 2019), which requires:

Prior to the commencement of subdivisional works a fauna management plan is to be prepared and approved to ensure the protection and management of the sites environmental assets with satisfactory arrangements being made for the implementation of the approved plan. (Department of Biodiversity, Conservation and Attractions)

These management measures to be addressed in the fauna management plan include:

- Pre-clearing trapping to reduce the presence of fauna during construction.

- Pre-clearing inspection of trees to ensure that they are not being used by fauna.
- Use of a fauna spotter to direct and manage clearing works to avoid impacts to fauna wherever possible and to rescue trans-locatable fauna that are disturbed during clearing works to assist them to disperse safely or capture them for later translocation as appropriate.
- Application of correct fauna handling procedures to reduce stress on any captured animals.

Given the anticipated retention of identified black cockatoo habitat within the site, the proposed rural-residential development is unlikely to give rise to a significant adverse impact. Nevertheless, should future clearing of black cockatoo habitat be required to facilitate development of habitable buildings, individual referrals by landholders pursuant to the EPBC Act may need to be considered.

4.4 Inland Waters

4.4.1 Policy framework and management objective

In the context of environmental impact assessment, the EPA's objective for inland waters is *'to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected'.*

In addition, the *State Water Strategy for Western Australia* (Government of WA 2003) and *Better Urban Water Management* (WAPC 2008) endorse the promotion of integrated water cycle management and application of water sensitive urban design (WSUD) principles to provide improvements in the management of stormwater, and to increase the efficient use of other existing water supplies.

4.4.2 Structure plan considerations for hydrology

A LWMS (Emerge Associates 2020b) has been prepared to support the preparation of the structure plan and provides a framework for the future delivery of a best practice approach to integrated water cycle management utilising WSUD principles. As outlined in the LWMS, the structure plan responds to the requirements for water supply, surface water quality, stormwater management, groundwater management and wastewater management as follows:

- The overall approach to water supply for the site is to utilise existing reticulated scheme water services close to the site. The approach to water conservation involves reducing the amount of scheme water required within the development. Within lot, potable water consumption will be reduced by promoting fit-for-purpose water sources, water efficient fixtures and appliances and water wise gardening (WWG) principles across lots. Otherwise, roadside swales located within verge are not proposed to require ongoing irrigation.
- Surface water quality will be addressed by treating the small rainfall event (i.e. first 15 mm of runoff) from road bitumen within vegetated roadside swales. Within lots, the use of impervious surfaces should be minimised to maintain existing infiltration. A series of non-structural measures will also be implemented to minimise nutrient loading to groundwater.
- The overarching principle behind the stormwater management strategy is to maintain the existing hydrology of the site. This will be achieved by detaining runoff from road bitumen within roadside swales, maintaining an existing east-west drain to convey upstream flows,

avoiding creating barriers to overland flow within lots, and the provision of culverts beneath road reserves and drains within lots to convey runoff from east to west.
- Groundwater management will focus on providing sufficient separation distances through the use of fill and on maintaining or improving the existing groundwater quality. This will be achieved by reducing total nutrient loads originating from the development and treating stormwater water runoff as close to source as possible.
- Wastewater management focuses on providing on-site domestic and industrial wastewater services in a manner that avoids any detrimental impacts on the environment and water resources. This will be undertaken in line with the requirements of the *Government Sewerage Policy* (DPLH 2019), *Australian Standard AS/NZS 1547:2012 Onsite Domestic Wastewater Management* (Standards Australia and Standards New Zealand 2012) and *Water Quality Protection Note 51: Industrial wastewater management and disposal* (DoW 2009).

Refer to the LWMS (Emerge Associates 2020b) for further detailed information regarding these management items.

4.4.3 Future management requirements

The LWMS (Emerge Associates 2020b) provides for the environmental management framework for groundwater and surface water within the site.

It is anticipated that environmental condition D2 of the WAPC's *Model Subdivision Conditions Schedule* 2017 will be attached to future subdivision approval, requiring the preparation of an Urban Water Management Plan (UWMP) as follows:

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

Generally, an UWMP will address the following considerations:

- The detailed drainage design
- Imported fill specifications and requirements
- Implementation of water conservation strategies
- Non-structural water quality improvement measures
- Management and maintenance requirements
- Construction period management strategy
- Monitoring and evaluation program
- Status of groundwater abstraction license.

4.5 Surrounding land uses

4.5.1 Policy framework and management objective

Generally, incompatible land uses can affect the amenity of place or persons social surroundings, which is defined by the EPA as "*the social surroundings of man are his aesthetic, cultural, economic and social surroundings to the extent that those surroundings directly affect or are affected by his*

physical or biological surroundings". The EPA requires proponents to apply the mitigation hierarchy to avoid or minimise impacts where possible, and for emissions of noise, odour and dust to be considered in the context of relevant legislation, criteria and standards.

4.5.2 Structure plan considerations for surrounding landuses

Westpork Serpentine Piggery, a category 2 prescribed premises (intensive piggery) pursuant to the *Environmental Protection Regulations 1987* is located approximately 3.7 km west of the site, at 567 Utley Road, Hopeland. Category 2 prescribed premises are described as 'premises on which pigs are fed, watered and houses in pens,' with a project or design capacity of 1000 animals or more. The existing Westpork Serpentine Piggery prescribed premises licence (ref. L6373/1989/10) permits a maximum stock capacity of 12,376 pigs (4% greater than average stock) to be held on site at any one time. Based on this stocking capacity, and in accordance with the EPA's Guidance Statement No. 3 *Separation Distances between Industrial and Sensitive Land Uses* (EPA 2005), a generic buffer distance of 5,000 m is therefore recommended for potential noise and odour impacts from an intensive piggery with more than 5000 pigs.

While no specific spatial responses are required in the structure plan in relation surrounding landuses, future management of amenity issues associated with the piggery is likely to be required in the form of notification on future titles.

4.5.3 Future management requirements

Given the site is located within the generic buffer distance to Westpork Serpentine Piggery, it is anticipated that notification may be required to be placed on future titles advising prospective purchasers of potential odour impacts within the local area.

4.6 Bushfire management

4.6.1 Policy framework and management objective

State Planning Policy 3.7 Planning in Bushfire Prone Areas (WAPC 2015a) stipulates that any development proposal which occurs partly or wholly within a bushfire prone area is required to be accompanied by a bushfire management plan. The preparation of the BMP is required to incorporate the following tasks:

- Classification of existing vegetation types within the site and surrounding 100 m, in accordance with *Australia Standard 3959 Construction of buildings in bushfire-prone areas* (AS 3959) (Standards Australia 2009).
- Assessment of bushfire hazard levels within the site and surrounding 100 m, in accordance with the *Guidelines for Planning in Bushfire Prone Areas* (WAPC and DFES 2017).
- Assessment of effective slope under areas of classified vegetation.
- Completion of an indicative Bushfire Attack Level (BAL) assessment and preparation of an associated BAL contour plan.
- Assessment of the structure plan design against the bushfire protection criteria, in accordance with the *Guidelines for Planning in Bushfire Prone Areas* (WAPC and DFES 2017).

4.6.2 Structure plan considerations for bushfire management

A BMP (Emerge Associates 2020a) has been prepared to support the preparation of the structure plan. The design of the proposed structure plan responds to the bushfire protection criteria through the following design elements:

- Suitable separation can be provided between future habitable buildings and post-development classified vegetation to ensure that no habitable building exceeds a bushfire attack level rating of BAL-29.
- An integrated internal road network has been accommodated which provides at least two egress options from the site via public roads in the case of a bushfire.

In order to consider the likely bushfire risk applicable to future development within the site, a post development vegetation classification scenario has been assumed in which all classified vegetation, will be removed or managed to a 'low threat' standard. This will be enforced through a notification placed on future titles advising prospective purchasers that existing vegetation and future landscaping within each private lot is required to be maintained to a 'low threat' standard in accordance with AS 3959:2018 cl,.2.2.3.2(f). This will also support the Shire of Serpentine Jarrahdale Firebreak and Fuel Hazard Reduction Notice which requires landowners of lots greater than 1 acre (0.40 ha) to undertake clearing (i.e. removal of dead vegetation and cropping of grass) within open paddocks and along the boundaries of properties to minimise the spread of bushfire.

The measures to be implemented through the structure plan process have been outlined as part of this BMP and can be used to support future planning and development approval processes. If the current development layout changes at the future subdivision process, a revised BMP is likely to be required to support the subdivision application.

Further discussion in this regard is provided in the BMP (Emerge Associate 2020a).

4.6.3 Future bushfire management requirements

The BMP provides for the environmental management framework for bushfire risks within the site.

As outlined in the BMP, development within 100 m of classified vegetation will require a BAL assessment to be completed and certified prior to the creation of lot titles and to support the building licence stage. This BAL assessment will inform the requirement for increased construction standards in accordance with AS 3959, which will then be implemented through the building licence process. An indicative BAL assessment has been completed as part of the BMP and indicates that no lots will be subject to a BAL rating higher than BAL-29.

This will also likely be required to address future subdivision approval conditions, specifically model subdivision condition F2 (WAPC and DPLH 2019), which states:

A notification, pursuant to Section 165 of the Planning and Development Act 2005, is to be placed on the certificate(s) of title of the proposed lot(s) with a Bushfire Attack Level (BAL) rating of 12.5 or above, advising of the existence of a hazard or other factor. Notice of this notification is to be included on the diagram or plan of survey (deposited plan). The notification is to state as follows:

"This land is within a bushfire prone area as designated by an Order made by the Fire and Emergency Services Commissioner and is/ may be subject to a Bushfire Management Plan. Additional planning and building requirements may apply to development on this land" (Western Australian Planning Commission).

As stated above, given the proposal is for a rural residential development within a bushfire prone area, it is recommended that notification be placed on future titles advising prospective purchasers that existing vegetation and future landscaping within each private lot is required to be maintained to a 'low threat' standard in accordance with AS 3959:2018 cl,.2.2.3.2(f).

5 Implementation

A summary of the structure plan responses to the environmental values and attributes within the site is provided in **Table 9**. The table also outlines the proposed future management required as part of the subdivision and development process.

Table 9: Environmental management framework implementation table

Factor	Structure plan phase	Future development phase
Acid sulfate soils	• Consider ASS Risk mapping as prepared by DWER. No spatial response in structure plan required.	• Completion of ASS self-assessment and preparation of an Acid Sulfate Soil and Dewatering Management Plan, if required.
Flora and Vegetation	• Assessment of flora and vegetation values and preliminary consideration of potential retention opportunities.	• Detailed analysis of final subdivision layout to determine tree retention opportunities. • Consideration of potential requirement for Clearing Permit.
Terrestrial Fauna	• Assessment of fauna habitat and preliminary consideration of potential retention opportunities.	• Detailed analysis of final subdivision layout to determine potential habitat retention opportunities. • Preparation of a Fauna Management Plan.
Hydrology	• Preparation of a Local Water Management Strategy.	• Preparation of an Urban Water Management Plan.
Surrounding land uses	• Consideration of generic buffer distance requirements from Westpork Serpentine Piggery.	• Notification on future titles advising prospective purchasers of potential odour impacts within the local area.
Bushfire management	• Preparation of Bushfire Management Plan	• Complete detailed BAL assessments to support habitable building construction.

6 Conclusions

This EAMS has been prepared on behalf of the proponent for Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine. HEX Design and Planning, on behalf of the proponent, have prepared a Structure Plan (**Appendix A**) which outlines the proposed rural-residential development of the site.

This EAMS has been prepared to support the structure plan, together with:

- Reconnaissance Flora, Vegetation and Fauna Assessment (Emerge Associates 2020c) (provided in **Appendix B**)
- Local Water Management Strategy (Emerge Associates 2020b)
- Bushfire Management Plan (Emerge Associates 2020a)

The structure plan design has responded to site-specific environmental considerations where necessary and possible, including accommodation of water supply, surface water quality, stormwater management, groundwater management and wastewater management requirements consistent with the LWMS. The structure plan design provides opportunities for retention of native vegetation and associated habitat for black cockatoos within future rural-residential lots and wide road reserves.

This document provides an environmental management strategy to be implemented across the site for future development stages. The key components of this management strategy are summarised as follows.

- Acid sulfate soils: completion of an ASS self-assessment form, and if necessary, the preparation of an Acid Sulfate Soil and Dewatering Management Plan (ASSDMP).
- Native vegetation: completion of a detailed analysis of the final development design and bulk earthworks requirements to confirm any potential retention opportunities. Where clearing of vegetation is proposed, a clearing permit will need to be attained pursuant to Part V of the *Environmental Protection Act 1986* (unless a valid exemption applies).
- Native fauna: completion of a detailed analysis of the final development design and bulk earthworks requirements to confirm any potential retention opportunities. Fauna management protocols and actions will also need to be implemented prior to and during clearing activities, through future preparation and implementation of a Fauna Management Plan.
- Hydrology: stormwater management requirements will be implemented as outlined within the LWMS and through the future preparation and implementation of an Urban Water Management Plan (UWMP).
- Bushfire risks: To respond to the known bushfire hazards within and surrounding the site future development will be in accordance with the prepared BMP. This assumed that retained vegetation within the site will be managed to a 'low threat' standard in accordance with the *Australian Standard 3959-2018 Construction of buildings in bushfire prone areas*.

Overall, the environmental attributes and values of the site can be accommodated within the structure plan design, or can be managed appropriately through the future development phases in line with the relevant state and local government legislation, policies and guidelines and best management practices.

7 References

7.1 General references

Alan Tingay and Associates 1998, *A Strategic Plan for Perth's Greenways - Final Report*. December 1998.

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

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

Department of Aboriginal Affairs (DAA) 2013, *Aboriginal Heritage Due Diligence Guidelines (Version 3.0)*, Department of Aboriginal Affairs, Perth.

Department of Biodiversity, Conservation and Attractions (DBCA) 2017, *A methodology for the evaluation of wetlands on the Swan Coastal Plain*, draft prepared by the Wetlands Section of the Department of Biodiversity, Conservation and Attractions and the Urban Water Branch of the Department of Water and Environmental Regulation, Perth.

Department of Biodiversity, Conservation and Attractions (DBCA) 2018, *Geomorphic Wetlands, Swan Coastal Plain (DBCA-019)*.

Department of Water (DoW) 2009, *Water Quality Protection Note 51: Industrial wastewater management and disposal*, Perth.

Department of Planning, Lands and Heritage (DPLH) 2019, *Government Sewerage Policy*, Perth.

Department of Environment Regulation (DWER) 2017, *Acid Sulfate Soil Risk Map, Swan Coastal Plain*, Perth.

Emerge Associates 2020a, *Bushfire Management Plan Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine*, EP20-064(02)--005 BRB, Version 1.

Emerge Associates 2020b, *Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine Local Water Management Strategy*, EP20-064(01)--002 ASC, Version 1.

Emerge Associates 2020c, *Reconnaissance Flora, Vegetation and Fauna Assessment, Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine*, EP20-064(03)--003 RAW, Version 1.

Environment Australia 2000, *Revision of the Interim Biogeographic Regionalisation for Australia (IBRA) and Development of Version 5.1 - Summary Report*, Department of Environment and Heritage.

Government of WA 2000, *Bush Forever - Volume 1: Policies, principles and processes*, Perth.

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

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

Keighery, B. 1994, *Bushland Plant Survey: A guide to plant community survey for the community*, Wildflower Society of WA (Inc), Nedlands.

Landform Research 2018, *Land Capability - Geotechnical Assessment, Lot 9002 Wattle Road and Lot 9001 Utley Road, Serpentine*.

Perth Biodiversity Project (PBP) 2007, *Perth Biodiversity Project - Mapping and Information Instalment 2*, Western Australian Local Government Association, Perth.

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

Standards Australia and Standards New Zealand 2012, *AS/NZS 1547:2012 On-site domestic wastewater management*, Sydney, New South Wales. 2012.

Western Australian Planning Commission (WAPC) 2008, *Better Urban Water Management*, Perth.

Western Australian Planning Commission (WAPC) 2015a, *State Planning Policy 3.7 Planning in Bushfire Prone Areas*, Perth.

Western Australian Planning Commission (WAPC) 2015b, *Structure Plan Framework, Planning and Development (Local Planning Schemes) Regulations 2015*.

Western Australian Planning Commission and Department of Fire and Emergency Services (WAPC and DFES) 2017, *Guidelines for Planning in Bushfire Prone Areas Version 1.3*, Western Australia. December 2017.

Western Australian Planning Commission and Department of Planning, Lands and Heritage (WAPC and DPLH) 2019, *Model Subdivision Conditions Schedule*, Perth.

7.2 Online references

Department of Environment Regulation (DER) 2018, *Contaminated Sites Database*, viewed June 2020, <https://secure.dec.wa.gov.au/idelve/css/>.

Department of Primary Industries and Regional Development (DPIRD) 2020, *2 metre contours,* viewed June 2020, <https://maps.slip.wa.gov.au/landgate/locate/>.

Department of Primary Industries and Regional Development (DPIRD) 2019, *Soil Landscape Mapping – Best Available,* viewed June 2020, <https://maps.slip.wa.gov.au/landgate/locate/>.

Department of Water and Environmental Regulation (DWER) 2018, *Acid Sulfate Soil Risk Map, Swan Coastal Plain,* viewed June 2020, < https://maps.slip.wa.gov.au/landgate/locate/>

Department of Water and Environmental Regulation (DWER) 2017, *Perth Groundwater Map,* viewed June 2020, < https://maps.water.wa.gov.au/#/webmap/gwm>.

Landgate 2019, *Landgate Map Viewer Plus,* viewed June 2020, <https://maps.landgate.wa.gov.au/maps-landgate/registered/>.

Figures

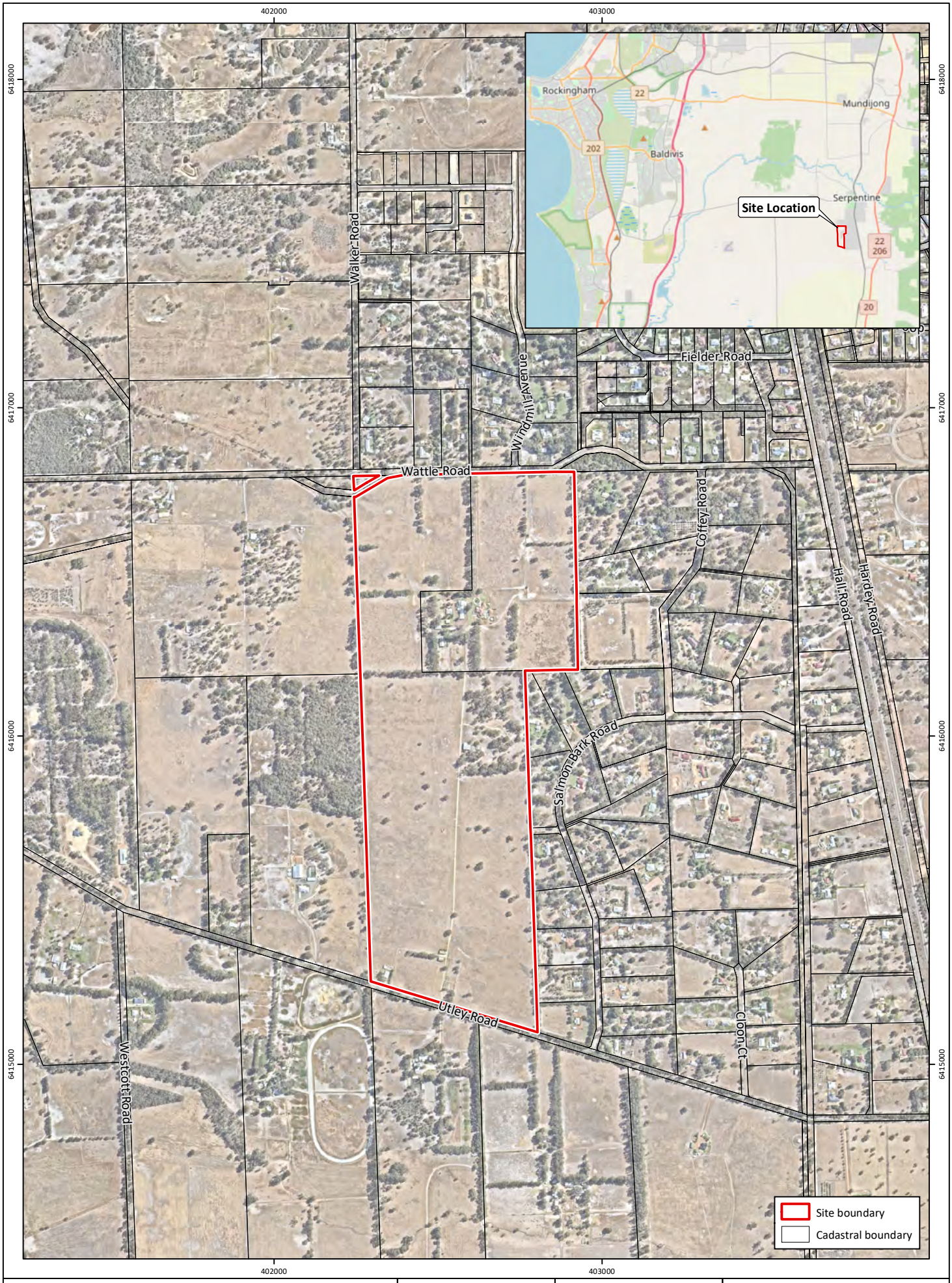


Figure 1: Site Location

Project:	Environmental Assessment and Management Strategy Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine
Client:	Stron Pty Ltd

Plan Number:
EP20-064(04)--F06

Drawn:	GAR
Date:	25/06/2020
Checked:	BRB
Approved:	JMM
Date:	14/08/2020

N

0 200 400
Metres

Scale: 1:15,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

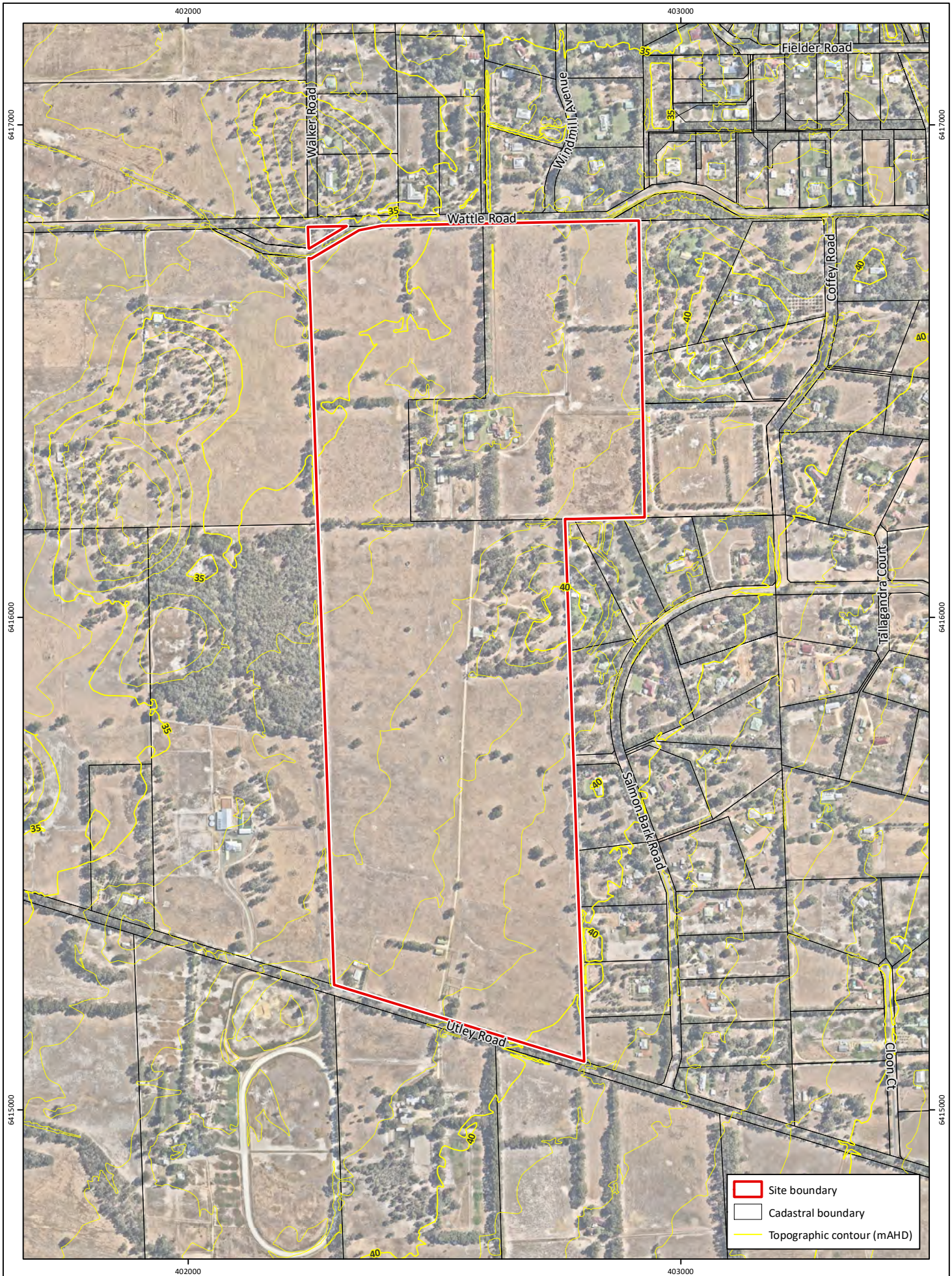


Figure 2: **Topographic Contours**

Project: Environmental Assessment and Management Strategy
Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number:
EP20-064(04)--F07

Drawn:	GAR
Date:	25/06/2020
Checked:	BRB
Approved:	JMM
Date:	14/08/2020

N

0 100 200 300
Metres

Scale: 1:10,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

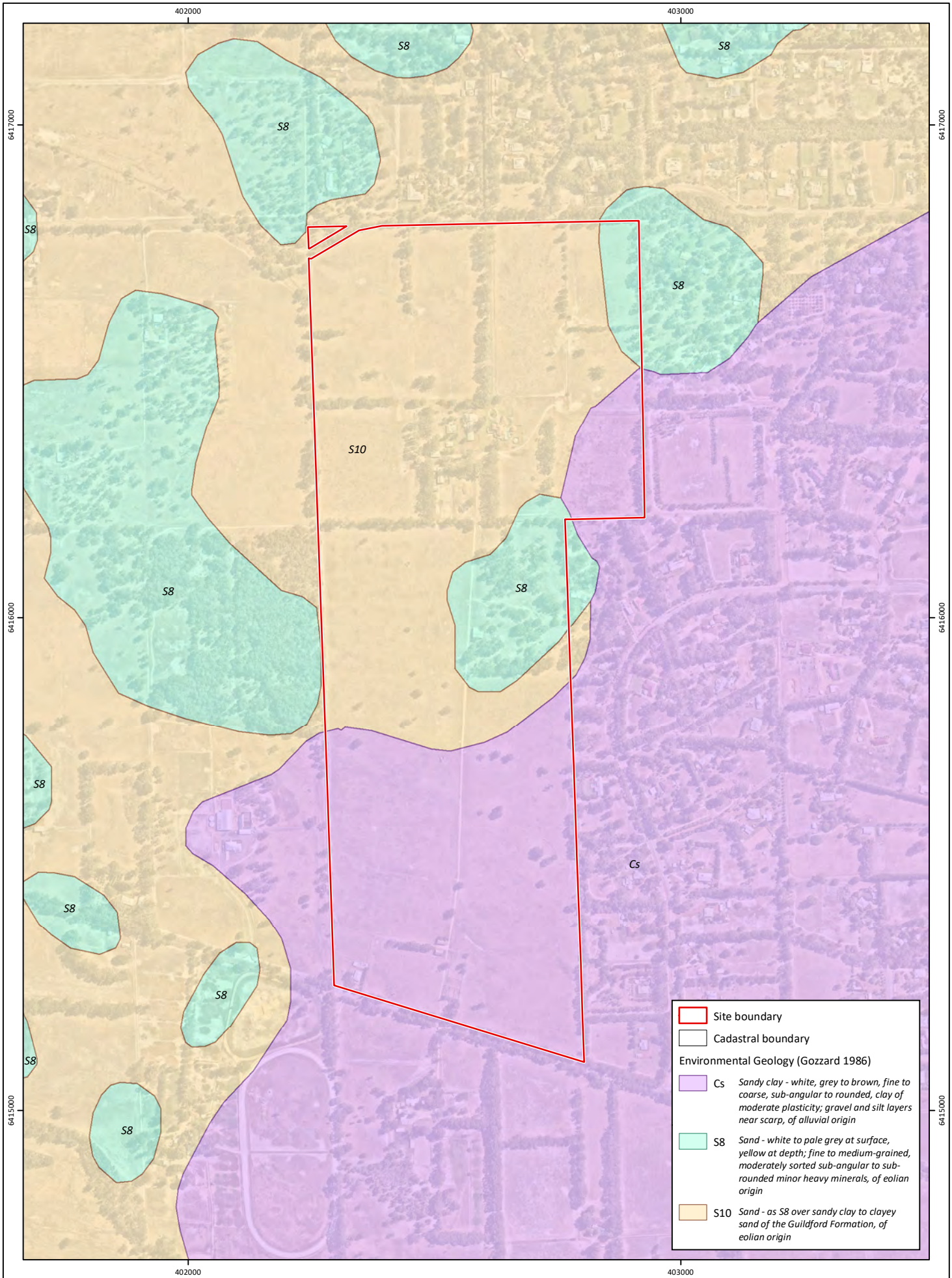


Figure 3: Environmental Geology

Project: Environmental Assessment and Management Strategy
Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number:
EP20-064(04)--F08

Drawn:	GAR
Date:	25/06/2020
Checked:	BRB
Approved:	JMM
Date:	14/08/2020

N

0 100 200 300
Metres

Scale: 1:10,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

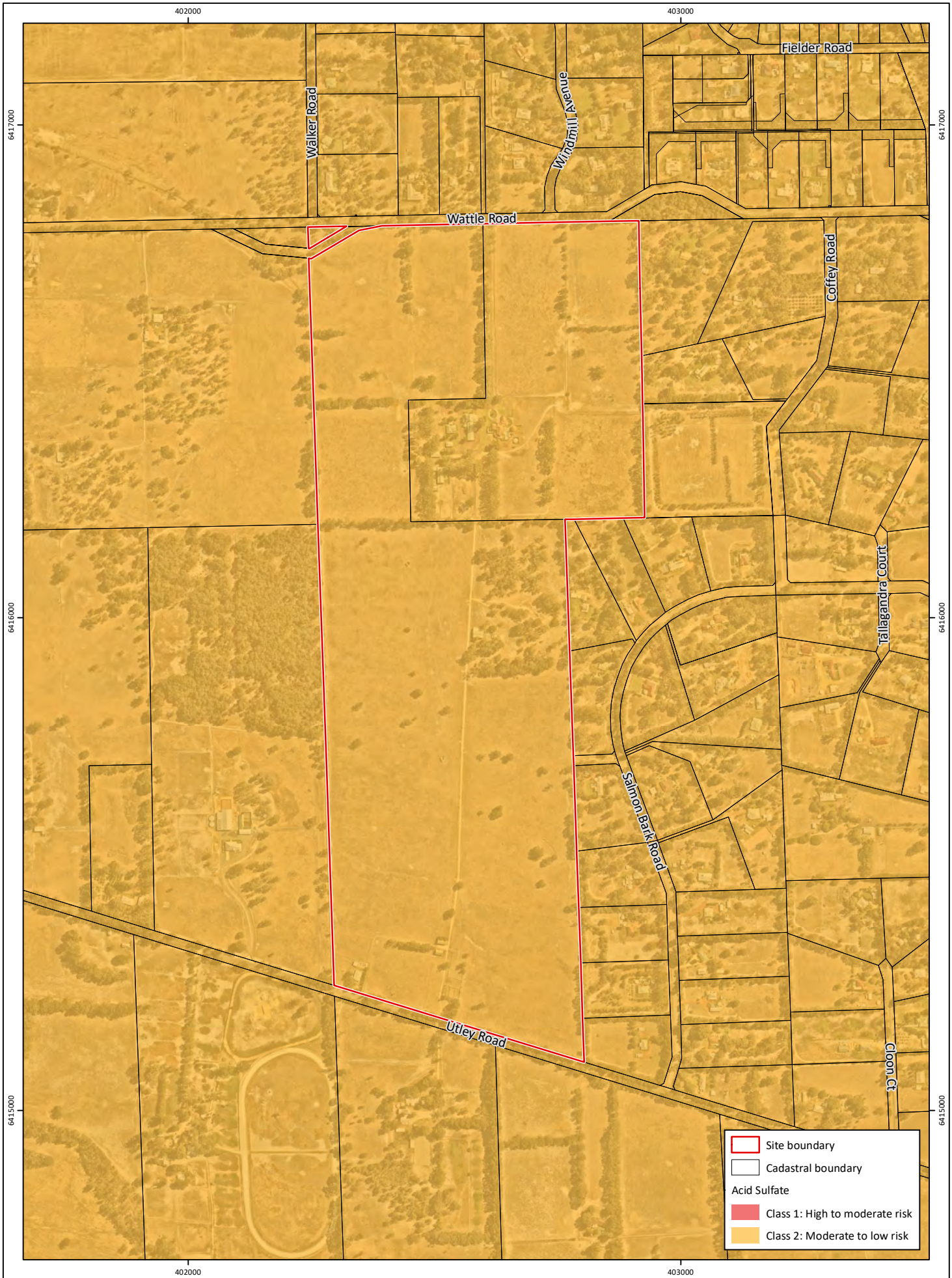


Figure 4: **Acid Sulfate Soil Mapping**

Project: Environmental Assessment and Management Strategy
Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number:
EP20-064(04)--F09

Drawn:	GAR
Date:	25/06/2020
Checked:	BRB
Approved:	JMM
Date:	14/08/2020

N

0 100 200 300
Metres

Scale: 1:10,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

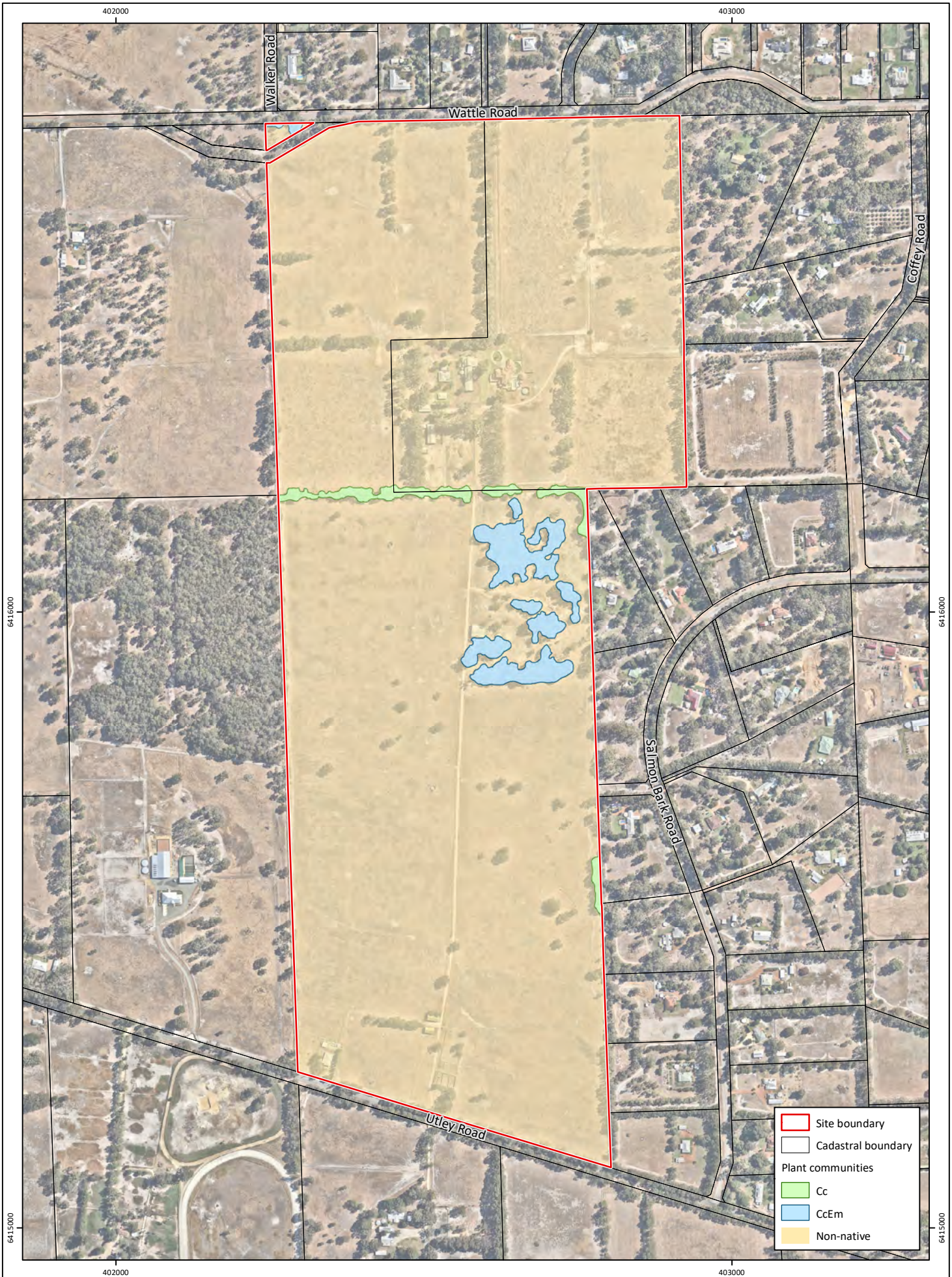


Figure 5: Plant Communities

Project: Environmental Assessment and Management Strategy
Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number: EP20-064(04)--F10

Drawn:	GAR
Date:	25/06/2020
Checked:	BRB
Approved:	JMM
Date:	14/08/2020

N

0 50 100 150 200
Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

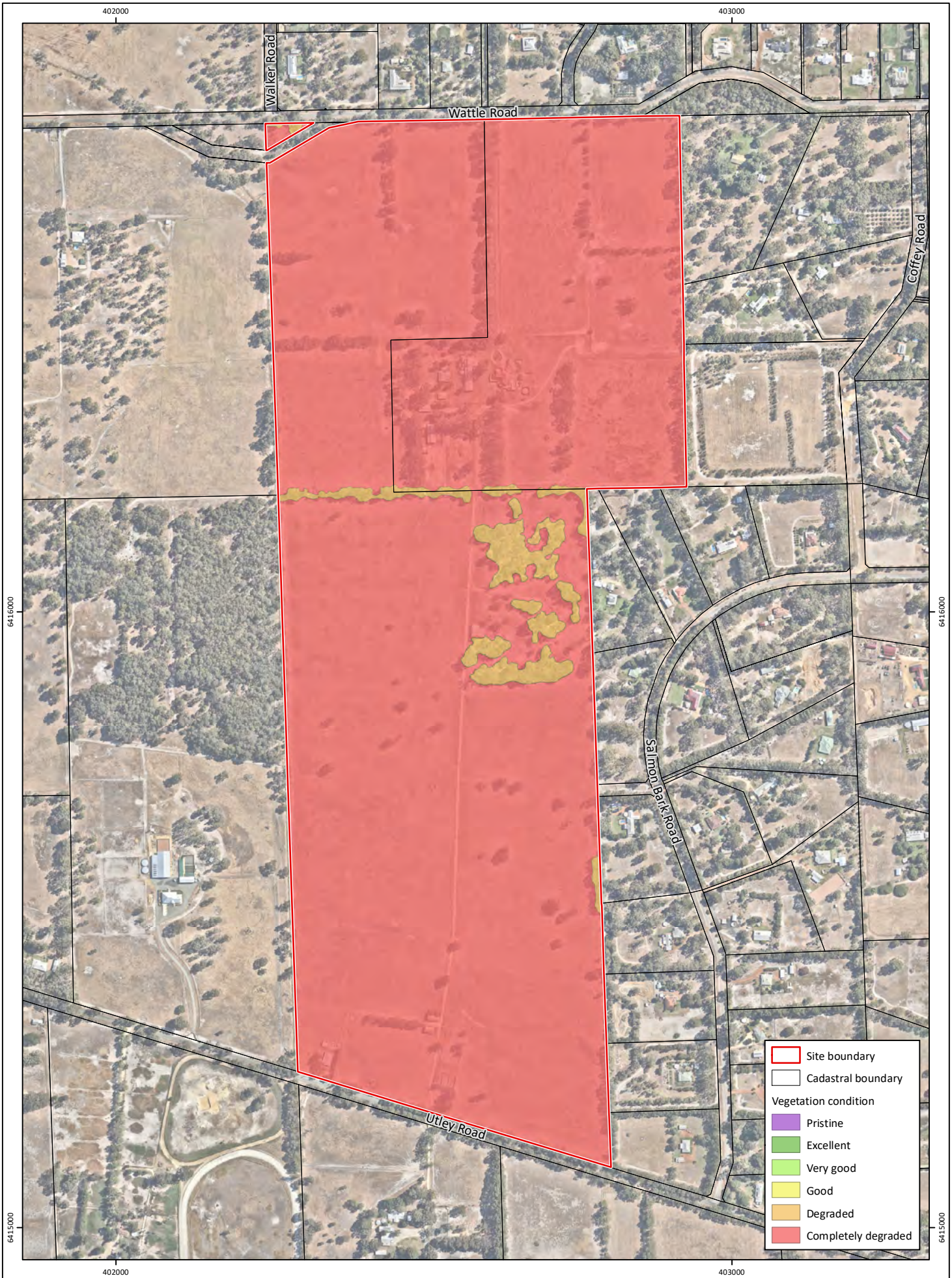


Figure 6: Vegetation Condition

Project: Environmental Assessment and Management Strategy
Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number: EP20-064(04)--F11

Drawn:	GAR
Date:	25/06/2020
Checked:	BRB
Approved:	JMM
Date:	14/08/2020

N

0 50 100 150 200
Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

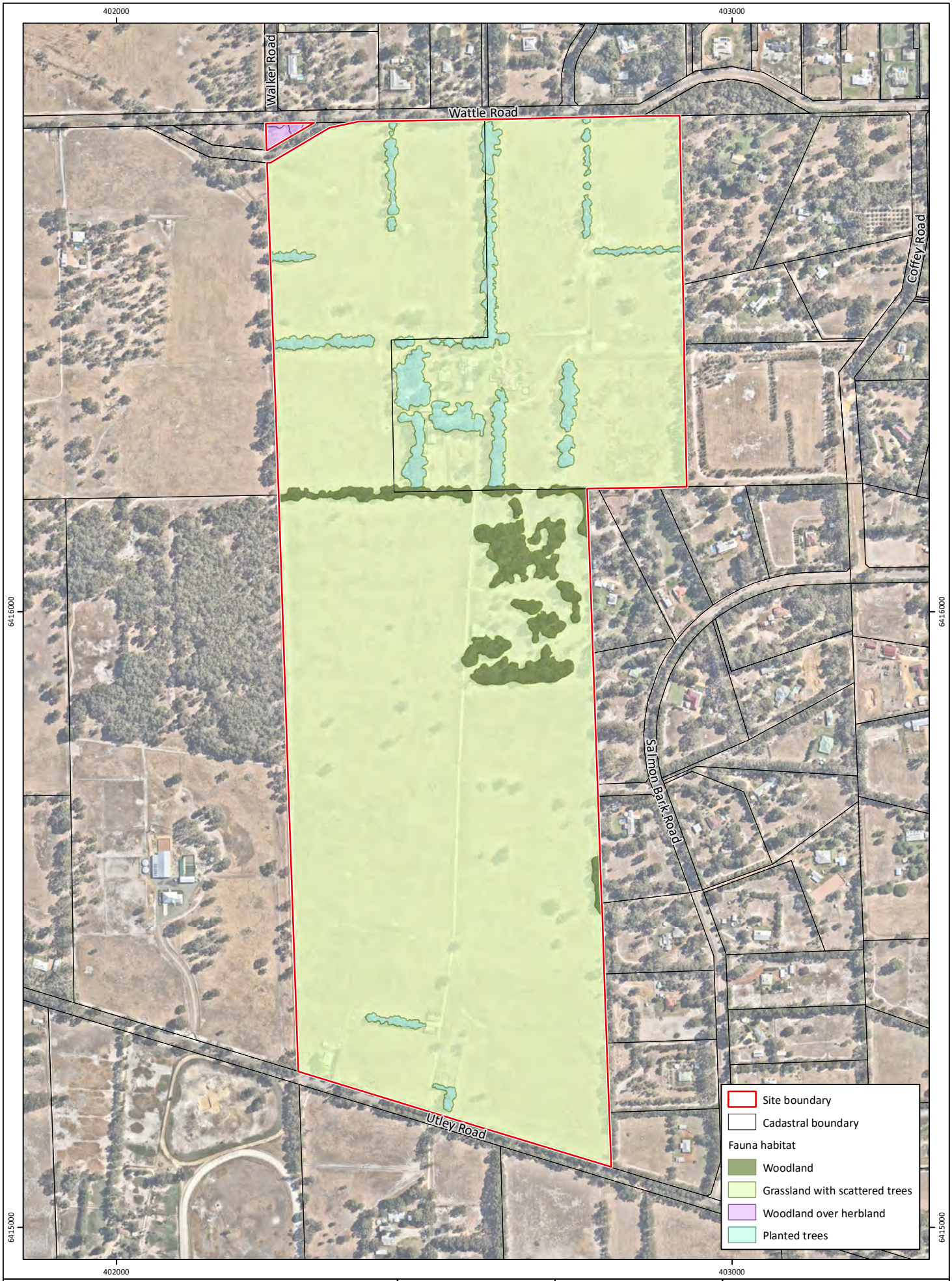


Figure 7: Potential Fauna Habitat

Project: Environmental Assessment and Management Strategy
Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number: EP20-064(04)--F12

Drawn:	GAR
Date:	25/06/2020
Checked:	BRB
Approved:	JMM
Date:	14/08/2020

N

0 50 100 150 200
Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

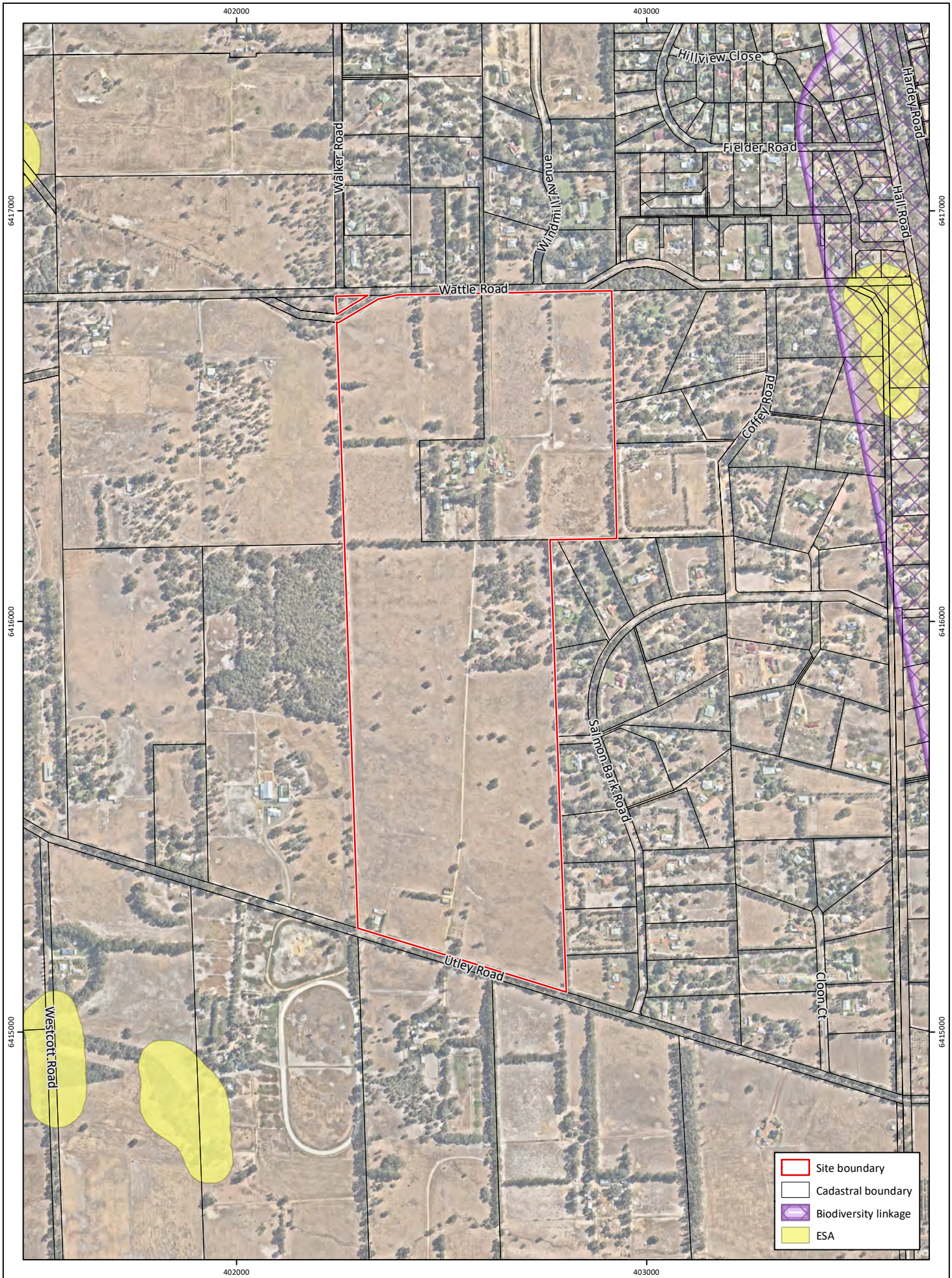


Figure 8: **Environmentally Sensitive Areas and Ecological Linkages**

Project: Environmental Assessment and Management Strategy
Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number: **EP20-064(04)--F13**

Drawn:	GAR
Date:	25/06/2020
Checked:	BRB
Approved:	JMM
Date:	14/08/2020

N

0 100 200 300
Metres

Scale: 1:12,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

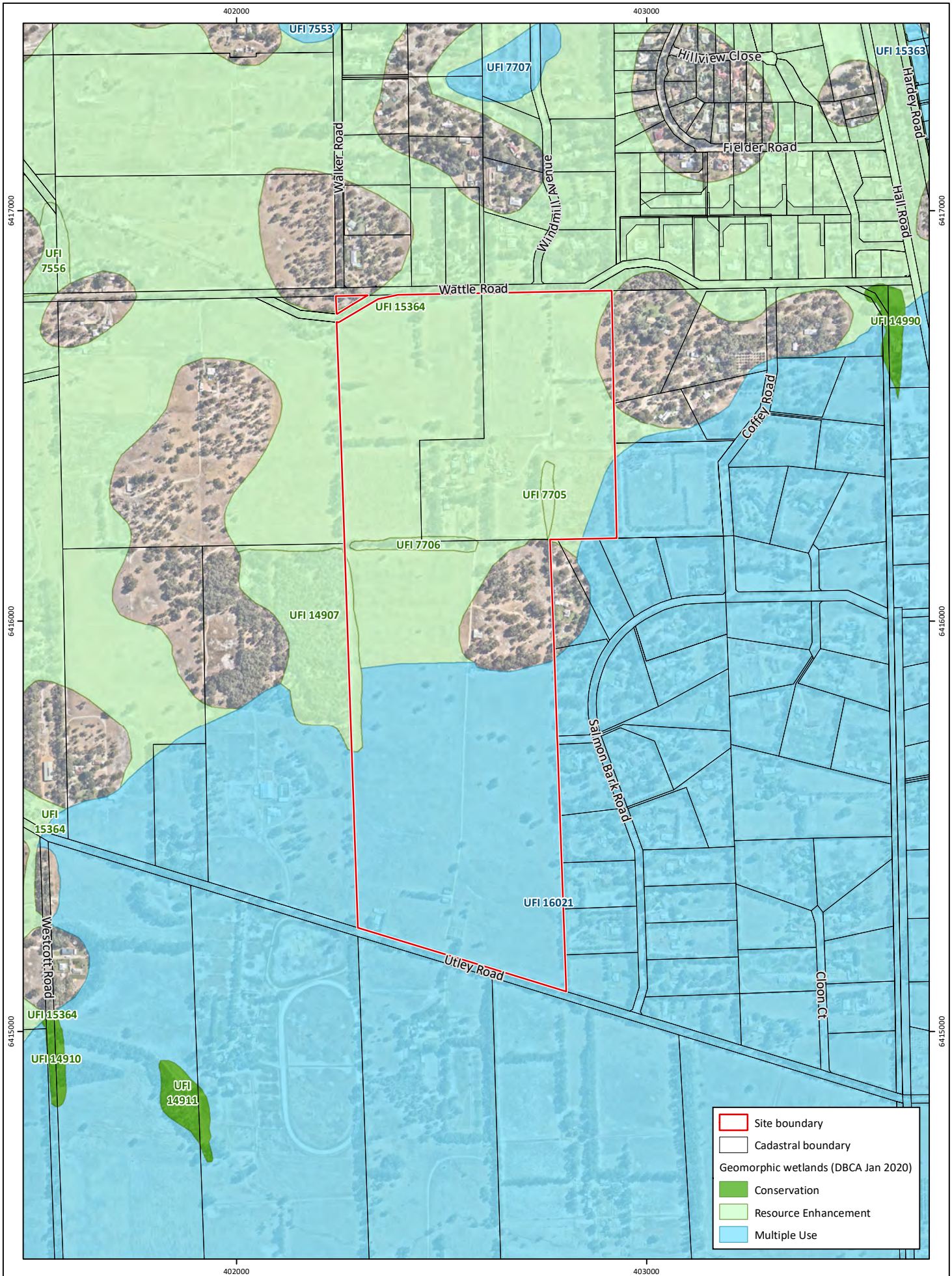


Figure 9: **Geomorphic Wetlands**

Project: Environmental Assessment and Management Strategy
Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number: EP20-064(04)--F15

Drawn:	GAR
Date:	25/06/2020
Checked:	BRB
Approved:	JMM
Date:	14/08/2020

N

0 100 200 300
Metres

Scale: 1:12,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

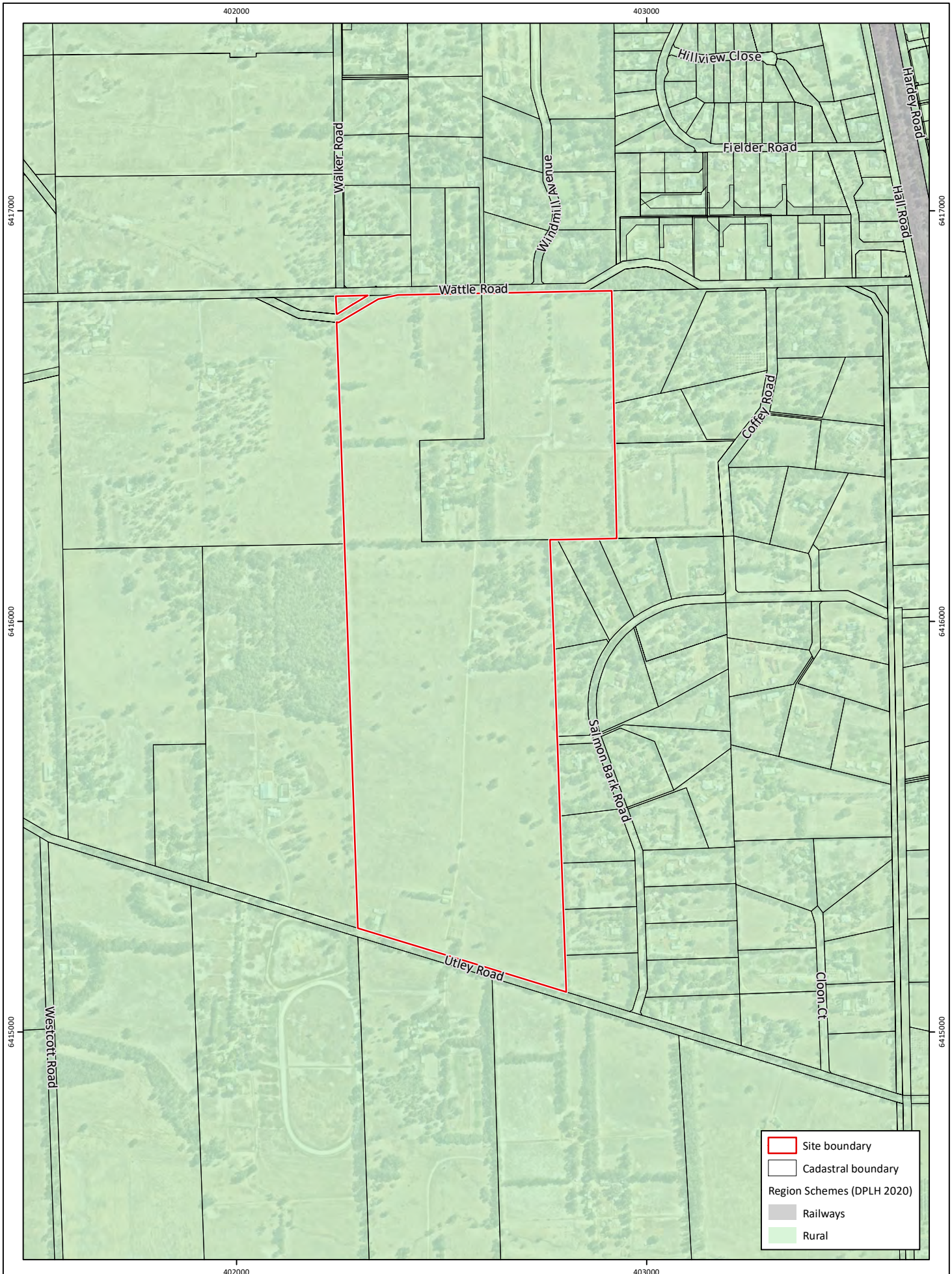


Figure 10: MRS Zones and Reserves

Project:	Environmental Assessment and Management Strategy Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine
Client:	Stron Pty Ltd

Plan Number:
EP20-064(04)--F16

Drawn:	GAR
Date:	25/06/2020
Checked:	BRB
Approved:	JMM
Date:	14/08/2020

N

0 100 200 300
Metres

Scale: 1:12,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

Appendix A

Lot 9001 Utley Road and Lot 9002 Wattle Road Structure Plan

DRAFT

WATTLE ROAD

WALKER RD

DMILL AVE

1,733 m²
(68.227 ha)

20m Road Reserve

UTLEY ROAD

SALMON BARK ROAD

1	2.05 ha
2	2.05 ha
3	2.07 ha
4	2.04 ha
5	2.04 ha
6	2.04 ha
7	2.04 ha
8	2.04 ha
9	2.04 ha
10	2.04 ha
11	2.04 ha
12	3.16 ha
13	2.06 ha
14	2.06 ha
15	2.23 ha
16	2.31 ha
17	2.00 ha
18	2.08 ha
19	2.07 ha
20	2.07 ha
21	2.23 ha
22	2.23 ha
23	2.24 ha
24	2.01 ha
25	2.17
26	2.13
27	2.01 ha
28	3.53 ha
29	2.66 ha
30	2.00 ha
31	2.00 ha
32	2.00 ha
33	2.11 ha
34	2.14 ha
35	2.03 ha
36	2.03 ha
37	2.16 ha
38	2.62 ha
39	2.36 ha

9002
23.075 ha

9001
68.054 ha
(68.227 ha)

606 152 151 150 101 101 2597 27 25 376 168 1357 828 202 201 203 204 211 205 212 207 206 310 301 309 302 308 303 307 306 304 305

SUMMARY	
Subject Site	**91.30 ha**
Lot 9001	68.23 ha
Lot 9002	23.08 ha
Zone	
Special Rural - 39 Lots (RR1 - Min 2 ha)	85.19 ha
Road Reserves	5.94 ha
Balance lot	0.17 ha

LEGEND

- Subject Site
- Cadastre
- Minor Water Course
- Drain
- Retained Buildings
- Proposed Lot Boundary
- Special Rural (RR1 - Min. 2 ha)
- Proposed Road Reserve
- Road Center Line

STRUCTURE PLAN

Lot 9001 Utley Road & Lot 9002 Wattle Road - Serpentine

50 0 50 100 250 500

Project RAYSJLSP I Scale 1:5000@A3 I Date May 2020

HEX DESIGN PLANNING

Source of Information

Site boundaries: Landgate
Projection: GDA94 MGA Zone 50 South

NOTE
All areas and dimensions are subject to survey, engineering and detailed design and may change without notice.

A3PL_20200513_RAYSJLSP_Structure Plan Lot 9001 Utley Road & Lot 9002 Wattle Road - Serpentine MGA50.dwg

Appendix B

Reconnaissance Flora, Vegetation and Fauna Assessment
(Emerge Associates 2020c)

TECHNICAL MEMORANDUM

Flora, Vegetation and Fauna Assessment
Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine

PROJECT NUMBER	EP20-064(03)	**DOC. NUMBER**	EP20-064(03)--003 RAW
PROJECT NAME	Serpentine Rural Residential Development	**CLIENT**	Stron Pty Ltd
AUTHOR	RAW	**REVIEWER**	TAA
VERSION	1	**DATE**	30/06/2020

1. INTRODUCTION

Stron Pty Ltd intend to develop Lots 9001 Utley Road and Lot 9002 Wattle Road in Serpentine for residential purposes (referred to herein as the 'site'). The site extends over approximately 91.24 ha and is located approximately 50 kilometres (km) south east of the Perth Central Business District within the Shire of Serpentine – Jarrahdale. The location of the site is shown in **Figure 1.**

1.1. Purpose and scope of work

Emerge Associates (Emerge) were engaged by Stron Pty Ltd to provide environmental consultancy services to support the structure planning process for the site. The purpose of this assessment is to provide sufficient information on the flora, vegetation and fauna values within the site to inform this process.

The scope of work was specifically to undertake the following two assessments in accordance with the Environmental Protection Authority's (EPA's) technical guidance:

- A flora and vegetation assessment to the standard required of a 'reconnaissance' survey (EPA 2016c).
- A fauna assessment to the standard required of a 'level 1' survey (EPA 2016b, d, a).

As part of this scope of work, the following tasks were undertaken:

- Desktop review of relevant background information pertaining to the site and surrounds, including database searches for conservation significant flora, communities and fauna.
- Mapping of plant communities, vegetation condition and conservation significant flora and vegetation.
- Mapping of fauna habitat.
- Identification of potential habitat for conservation significant flora, vegetation and fauna and an assessment of likelihood of occurrence.
- Documentation of the desktop assessment, survey methodology and results into a report.

2. METHODS

2.1. Flora and vegetation

2.1.1. Desktop assessment

A search was conducted for threatened and priority flora that may occur or have been recorded within a 10 km radius of the site using the *Protected Matters Search Tool* (DAWE 2020) and *NatureMap* (DBCA 2020).

A search was also conducted for TECs and PECs that may occur or have been recorded within a 10 km radius of the site using the *Protected Matters Search Tool* (DAWE 2020) and the *weed and native flora dataset* (Keighery *et al.* 2012).

Prior to undertaking the field survey, information on the habitat preferences of threatened and priority flora species and communities identified from database searches was reviewed. This was compared to existing environmental information available for the site, such as geomorphology, soils, regional vegetation and historic land use, to identify species and communities for which habitat may occur in the site.

2.1.2. Flora and vegetation survey

An ecologist from Emerge visited the site on 23 June 2020 to conduct the flora and vegetation survey. The site was traversed on foot and by vehicle and the composition and condition of vegetation was recorded. Information on abiotic conditions, such as topography, soils and rock outcropping, was also recorded while the site was traversed.

A list of plant taxa was recorded opportunistically as the botanist traversed the site. Photographs were taken throughout the field visit to show particular site conditions.

The suitability of habitat within the site for conservation significant species identified in the desktop assessment was assessed (refer **Section 2.1.1**). Where identified, areas of suitable habitat were traversed to search for conservation significant species.

All plant specimens collected during the field survey were dried, pressed and then named in accordance with requirements of the Western Australian Herbarium. Identification of specimens occurred through comparison with named material and through the use of taxonomic keys. Flora species not native to Western Australia are denoted by an asterisk ('*') in text and raw data.

Vegetation condition was assigned at each sample and changes in vegetation condition were also noted and mapped across the site. The condition of the vegetation was assessed using methods from Keighery (1994) (**Table 1**).

Table 1: Vegetation condition scale applied during the field assessment

Condition	Definition (Keighery 1994)
Pristine	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very good	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.

Table 1: Vegetation condition scale applied during the field assessment (continued)

Condition	Definition (Keighery 1994)
Completely degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

2.1.3. Mapping and data analysis

2.1.3.1. Conservation significant flora and vegetation

Based on the information recorded during the field survey, an assessment of the likelihood of occurrence of threatened and priority flora species and communities within the site was undertaken using the categories outlined in **Table 2**.

Table 2: Likelihood of occurrence assessment categories and definitions

Likelihood	Definition
Recorded	The species was recorded during the current field survey.
Likely	The site contains suitable habitat for the species and it is likely the species may occur based on presence of a recent historical record within or close to the site.
Possible	The site contains suitable habitat for the species but there is no other information to suggest that the species may occur within or close to the site.
Unlikely	The site does not contain suitable habitat for the species or the site contains suitable habitat for the species within which thorough targeted searches were completed and conclusion has been made that the species is unlikely to be present.

2.1.3.2. Plant community identification and description

The local plant communities within the site were identified from the notes collected during the field survey. The vegetation was described according to the dominant species present using the structural formation descriptions of the *National Vegetation Inventory System* (NVIS) (ESCAVI 2003). The identified plant communities were mapped on aerial photography from the notes taken in the field and boundaries were interpreted from a combination of aerial photography and notes taken in the field. Vegetation condition was mapped on aerial photography based on the notes recorded during the field survey to define areas with differing condition.

2.1.3.3. Floristic community type assignment

Statistical analysis of Gibson *et al.* (1994) 'floristic community type' (FCT) was not undertaken due to absence of detailed vegetation sampling. Where possible, likely FCTs were inferred based on flora species, vegetation structure and site location.

2.1.3.4. Threatened and priority ecological community

Areas of native vegetation potentially representing a TEC or PEC were assessed against key diagnostic characteristics and, if available, size and/or vegetation condition thresholds.

2.1.4. Limitations

It is important to note the specific constraints imposed on surveys and the degree to which these may have limited survey outcomes. An evaluation of the survey methodology against standard

constraints outlined in the EPA document *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016c) is provided in **Table 3**.

Table 3: Evaluation of survey methodology against standard constraints outlined in EPA Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment

Constraint	Degree of limitation	Details
Availability of contextual information	No limitation	Contextual information was adequate to place the site and vegetation in context.
		No previous relevant surveys are known to have been undertaken within the site.
	Limitation	Regarding assignment of FCTs, the authoritative Gibson *et al.* (1994) dataset was derived from a necessarily limited sample of vegetation from largely publicly owned land which is now more than 20 years out of date. Consequently, it is unknown to what degree official FCTs are appropriate reference to biodiverse vegetation across the Swan Coastal Plain. Furthermore, Gibson *et al.* (1994) collected data in the spring main flowering period and in many cases sampled plots multiple times to provide a complete species list. This reconnaissance survey did not include sampling due to the highly altered nature of the vegetation and lack of native flora species diversity, meaning that assignment of FCTs would not be possible.
Experience level of personnel	No limitation	This flora and vegetation assessment was undertaken by a qualified botanist with nine years of botanical experience in Western Australia. Technical review was undertaken by a senior environmental consultant with 18 years' experience in environmental science in Western Australia.
Suitability of timing	No limitation	The survey was conducted in June and thus outside of the main flowering season. The site has been subject to historical disturbance and no threatened or priority flora species are considered likely to occur due to lack of habitat. Therefore, the survey timing is acceptable for a reconnaissance level survey.
Temporal coverage	No limitation	Comprehensive flora and vegetation assessments can require multiple visits, at different times of year, and over a period of multiple, to enable observation of all species present. Although only surveyed once, the site data was considered sufficient for the level of the survey.
Spatial coverage and access	No limitation	Site coverage was comprehensive (track logged).
	No limitation	All parts of the site could be accessed as required.

2.2. Fauna

2.2.1. Desktop assessment

A search was conducted for conservation significant fauna that may occur or have been recorded within a 10 km radius of the site using the *Protected Matters Search Tool* (DAWE 2020) and *NatureMap* (DBCA 2020).

A total number of species that may occur or have been recorded within a 10 km radius of the site was calculated by adding the total count of non-conservation significant species provided by *NatureMap* to the combined number of conservation significant species provided by *NatureMap* and *Protected Matters Search Tool*.

Prior to undertaking the field survey, information on the habitat preferences of conservation significant fauna identified from database searches was reviewed. This was compared to existing

environmental information available for the site, such as geomorphology, soils, regional vegetation and historic land use, to identify species for which habitat may occur in the site.

2.2.2. Fauna survey

An ecologist from Emerge undertook the fauna survey at the same time as the flora and vegetation survey on 23 June 2020 (refer **Section 2.1.2**).

Transects were traversed across the site, during the day, and the characteristics of fauna habitat and presence of fauna species was recorded. Microhabitats such as logs, rocks and leaf litter were investigated and secondary evidence of species presence such as tracks, scats, skeletal remains, foraging evidence or calls was also noted.

An opportunistic fauna species list was compiled and fauna habitat values were described. The fauna habitats were assessed against habitat preferences of conservation significant fauna species identified during the desktop assessment (refer **Section 2.2.1**).

Taxonomy and nomenclature for vertebrate fauna species was taken from the *Western Australian Museum Checklist of the Terrestrial Vertebrate Fauna of Western Australia* (Western Australian Museum 2019). Literature listed in **Appendix A** represent the main publications used to identify fauna species and habitats within the site.

2.2.3. Mapping and data analysis

2.2.3.1. Fauna habitat

Fauna habitats were described according to the dominant flora species and vegetation type present, as determined from observations made during the field survey and the results of the flora and vegetation assessment (refer **Section 3.1**). The identified fauna habitats were mapped on aerial photography with the boundaries interpreted from aerial photography, previously identified plant communities (refer **Section 3.1.2.4**) and notes taken in the field.

2.2.3.1. Conservation significant fauna

Based on the information recorded during the field survey, an assessment of the likelihood of occurrence of conservation significant fauna species within the site was undertaken using the categories outlined in **Table 4.**

Table 4: Likelihood of occurrence assessment categories and definitions

Likelihood	Definition
Recorded	The species was recorded during the current field survey.
Likely	The site contains suitable habitat for the species and it is likely the species may occur based on presence of a recent historical record within or close to the site.
Possible	The site contains suitable habitat for the species but there is no other information to suggest that the species may occur within or close to the site.
Unlikely	The site does not contain suitable habitat for the species or the site contains suitable habitat for the species within which thorough targeted searches were completed and conclusion has been made that the species is unlikely to be present.

2.2.4. Limitations

It is important to note the specific constraints imposed on surveys and the degree to which these may have limited survey outcomes. An evaluation of the survey methodology against standard constraints outlined in the EPA document *Technical Guidance – Terrestrial Fauna Surveys* (EPA 2016b) is provided in **Table 5**.

Table 5: Evaluation of survey methodology against standard constraints outlined in EPA Technical Guidance – Terrestrial Fauna Surveys (EPA 2016)

Constraint	Degree of limitation	Details
Level of survey	No limitation	A level 1 survey (desktop study and field survey) was considered adequate given the relatively low habitat values within the site and the generally good availability of fauna information for the region.
Scope	No limitation	The survey focused on vertebrate fauna and habitat values, with particular focus on conservation significant taxa with potential to occur within the site.
Proportion of fauna identified, recorded and/or collected.	No limitation	All observed vertebrate fauna were identified.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	No limitation	Adequate information was available from database searches.
The proportion of the task achieved and further work which might be needed.	No limitation	The task was achieved in its entirety.
Experience level of personnel	Minor limitation	The fauna assessment was undertaken by a qualified ecologist with nine years' experience in environmental science. Technical review was undertaken by a senior environmental consultant with 18 years' experience in environmental science in Western Australia.
Suitability of timing	Slight limitation	Survey timing is not considered to be of great importance for Level 1 assessments.
Completeness	No limitation	The desktop assessment and field survey components were completed.
Spatial coverage and access	No limitation	Site coverage was comprehensive (track logged).
	No limitation	All parts of the site could be accessed as required.
Survey intensity	No limitation	The intensity of the survey was adequate given the size of the site and the relatively low habitat value present.
Influence of disturbance	No limitation	The site is highly modified due to historical disturbance. However, no recent disturbance was noted that may have affected outcomes of the survey.
Adequacy of resources	No limitation	All resources required to perform the survey were available.

3. RESULTS AND DISCUSSION

The site is flat to gently undulating with supports sandy grey to brown surface soils. The site has been subject to intensive long-term disturbance and is currently used for stock grazing. Vegetation within the site is dominated by non-native species including planted trees.

The site is low-lying and appears to be subject to waterlogging during winter. No prominent natural wetland landform features or areas supporting intact native wetland vegetation were recorded in the site. Multiple artificial drainage channels exist within the site, most notably in the central portion of the site and along the driveway in the northern portion of the site.

3.1. Flora and vegetation

3.1.1. Desktop assessment

The database search results identified a total of 47 flora species of conservation significance occurring or potentially occurring within a 10 km radius of the site, including 20 threatened and 27 priority flora species. Information on these species including their habitat preferences and flowering period is provided in **Appendix B**.

Based on available background information, suitable habitat for nine threatened flora species and 11 priority flora species was identified as potentially occurring within the site as shown in **Table 6.**

Table 6: Conservation significant flora species with habitat preferences considered to potentially occur in the site

Species	Level of significance		Life strategy	Habitat	Flowering period
	State	EPBC Act			
Synaphea sp. Fairbridge Farm (D. Papenfus 696)	CR	CR	P	Low woodland on grey, clayey sand with lateritic pebbles (Pinjarra Plain) near winter wet flats.	Sep-Nov
Synaphea sp. Serpentine (G.R. Brand 103)	CR	CR	P	Seasonally damp areas, loam - sand.	Sep-Oct
Synaphea sp. Pinjarra Plain (A.S. George 17182)	E	CR	P	White grey clayey sand on edges of seasonally inundated low-lying areas.	Sep-Oct
Caladenia huegelii	CR	E	PG	Well-drained, deep sandy soils in lush undergrowth in a variety of moisture levels.	Sep-early Nov
Diuris purdiei	E	E	PG	Sand to sandy clay soils in areas subject to winter inundation.	Sep-Oct but only after a summer or early autumn fire
Lasiopetalum pterocarpum	CR	E	P	Riparian community with species such as flooded gum, marri and swamp peppermint.	Aug-Nov
Verticordia plumosa var. ananeotes	CR	E	P	Sand in open jarrah woodland or sandy/clay soils with marri.	Nov-Dec
Grevillea curviloba subsp. incurva	E	E	P	Sand, sandy loam. Winter-wet heath.	Aug-Sep
Tetraria australiensis	V	V	P	Sand over clay, winter wet depressions and drainage lines.	Nov-Dec

Table 6: Conservation significant flora species with habitat preferences considered to potentially occur in the site (continued)

Species	Level of significance		Life strategy	Habitat	Flowering period
	State	EPBC Act			
Acacia lasiocarpa var. bracteolata long peduncle variant (G.J. Keighery 5026)	P1	-	P	Grey or black sand over clay in winter wet areas.	May-Aug
Stachystemon sp. Keysbrook (R. Archer 17/11/99)	P1	-	P	White grey sand.	Oct
Johnsonia pubescens subsp. cygnorum	P2	-	P	Grey white yellow sands on flats and seasonally wet areas.	Sep
Babingtonia urbana	P3	-	P	Grey sand, lateritic gravel.	Jan-Mar
Dillwynia dillwynioides	P3	-	P	Winter wet depressions on sandy soils	Aug - Dec
Drosera occidentalis	P4	-	P	Flat, brown/white/yellow moist sand/clay/peat, often near swamps.	Oct-Dec/Jan
Eryngium pinnatifidum subsp. Palustre (G.J. Keighery 13459)	P3	-	P	Grey brown sand or clay in winter wet flats.	Sep-Nov
Isopogon drummondii	P3	-	P	Yellow-grey sand.	Feb,Mar,Apr, May or June
Styphelia filifolia	P3	-	P	Brown over pale yellow sand.	Feb-Apr
Thysanotus anceps	P3	-	P	White or grey sand, lateritic gravel, laterite.	Oct-Dec
Verticordia lindleyi subsp. Lindleyi	P4	-	P	Sand and sandy clay in winter wet areas.	May or Nov-Jan

CR=critically endangered, E=endangered, V=vulnerable, P1-P4=Priority 1-Priority 4, P=perennial, PG=perennial geophyte.

The database search results identified seven TECs occurring or potentially occurring within a 10 km radius of the site. Information on these TECs is provided in **Appendix C.**

Based available background information, three TECs were considered to potentially occur in the site:

- SCP3a '*Corymbia calophylla - Kingia australis* woodlands on heavy soils of the Swan Coastal Plain' TEC which is listed as 'endangered' under the EPBC Act and 'critically endangered' in WA.
- SCP 3c '*Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands of the Swan Coastal Plain' TEC which is listed as 'endangered' under the EPBC Act and 'critically endangered' in WA.
- SCP3b '*Corymbia calophylla - Eucalyptus marginata* woodlands on sandy clay soils of the southern Swan Coastal Plain' TEC which is listed as 'vulnerable' in WA.

3.1.2. Field survey

3.1.2.1. Species inventory

A total of seven native and 19 non-native (weed) species were recorded within the site during the field survey, representing 11 families and 21 genera. The dominant family recorded was Myrtaceae (three native taxa and five non-native taxa).

A flora species list is provided as **Appendix D**.

3.1.2.2. Conservation significant flora

No threatened or priority flora were recorded in the site.

No suitable habitat for threatened or priority flora was recorded in the site. Therefore, the threatened or priority flora identified in desktop searches are considered unlikely to occur in the site, as detailed in **Appendix B**.

3.1.2.3. Declared pests

Two flora species listed as declared pests under the BAM Act, **Gomphocarpus fruticosus* (narrow-leaf cottonbush) (C3) and **Zantedeschia aethiopica* (arum lily), were recorded in the site. Scattered narrow-leaf cottonbush individuals were recorded across the site and dense stands of arum lily were recorded within plant community **CcEm** (refer **Section 3.1.2.4**).

3.1.2.4. Plant communities

Three plant communities were identified in the site. Plant community **Cc** exists mainly in the central portion of the site along a drain. A small area of **Cc** vegetation also exists in the south eastern portion of the site. Plant community **CcEm** exists mainly in the central eastern portion of the site, with a small area in the north western portion of the site. The remainder of the site was mapped as **non-native** plant community as it predominantly comprises non-native grassland and herbland with scattered native trees and lines of planted trees. The locations of the plant communities within the site are shown in **Figure 2.**

Table 7: Plant communities present within the site

Plant community	Description	Area (ha)
Cc	Woodland to open forest *Corymbia calophylla* over non-native closed grassland **Ehrharta* sp. and herbland **Arctotheca calendula* (**Plate 1**).	0.85
CcEm	Woodland *Corymbia calophylla* and *Eucalyptus marginata* over occasional *Xylomelum occidentale* over herbland * *Zantedeschia aethiopica* over non-native closed grassland **Ehrharta* sp. and herbland **Arctotheca calendula* (**Plate 2**).	2.14
Non-native	Occasional *Corymbia calophylla*, planted non-native trees such as *Eucalyptus camaldulensis* and *Eucalyptus grandis* and planted native trees such as *Eucalyptus rudis* over non-native closed grassland **Ehrharta* sp. and herbland **Arctotheca calendula* (Plant community **non-native** in 'completely degraded' condition (**Plate 3**).	88.25

*Plate 1: Plant community **Cc** in 'degraded' condition*

*Plate 2: Plant community **CcEm** in 'degraded' condition*

*Plate 3: Plant community **non-native** in 'completely degraded' condition*

3.1.2.5. Vegetation condition

Plant communities **Cc** and **CcEm** were mapped as being in 'degraded' condition as the vegetation structure has been severely impacted by disturbance. A native canopy layer was present but the understorey was dominated by non-native species. The remainder of the site was mapped as being in 'completely degraded' condition as it comprises non-native vegetation.

The extent of vegetation by condition category is detailed in **Table 8** and shown in **Figure 3.**

Table 8: Vegetation condition categories within the site

Condition category (Keighery (1994))	Size (ha)
Pristine	0
Excellent	0
Very good	0
Good	0
Degraded	2.99
Completely degraded	88.25

3.1.2.6. Floristic community types

The vegetation within the site has very low native species diversity and a highly disturbed structure which makes assigning a FCT difficult (as described in **Section 3.1.2.5**).

Given the sites' location on the eastern side of the Swan Coastal Plain and the presence of *Corymbia calophylla* (marri) trees, plant communities **Cc** and **CcEm** would probably have historically represented an ecological community like FCT 3a '*Corymbia calophylla - Kingia australis* woodlands

on heavy soils' or 3b '*Corymbia calophylla - Eucalyptus marginata* woodlands on sandy clay soils'. However, so few native species now remain that the vegetation in the site cannot be considered to represent any FCT.

3.1.2.7. Threatened and priority ecological communities

The plant communities in the site are not considered to represent a TEC or a PEC due to their lack of structure and native species diversity.

3.2. Fauna

3.2.1. Desktop assessment

A total number of 434 fauna species were identified from database searches as occurring or potentially occurring within 10 km of the site[1] as listed in **Appendix E**.

Of these species, 31 are conservation significant, including 13 threatened, seven priority, seven migratory fauna and two other specially protected species.

3.2.2. Field survey

3.2.2.1. Fauna habitat

Historical disturbance has significantly compromised habitat values within the site. The majority of the native vegetation has been removed and the majority of the site comprises non-native paddocks with scattered planted trees.

Four fauna habitats were identified in the site. The **woodland** and **woodland over herbland** comprise the highest fauna habitat values due to the presence of native trees. The **woodland** occurs as patches within the central portion of the site and the **woodland over herbland** occurs in the north western portion of the site. The **woodland over herbland** also supports dense cover of non-native understorey vegetation which may provide habitat for native ground dwelling fauna. A minor creekline occurs outside of the site adjacent to the **woodland over herbland** habitat and supports similar habitat values.

The **grassland with scattered trees** provides limited habitat for native fauna, with the scattered native *Corymbia calophylla* (marri) trees providing the most value. The **planted trees** may provide habitat for native fauna species but is considered to be of low value.

[1] Includes native and non-native species

Table 9: Fauna habitats identified within the site

Fauna habitat classification	Description	Area (ha)
Woodland	Woodland *Corymbia calophylla* and *Eucalyptus marginata* (or absent) over herbland * *Zantedeschia aethiopica* (o absent) over non-native closed grassland **Ehrharta* sp. and herbland **Arctotheca calendula* (**Plate 6**).	2.15
Woodland over herbland	Woodland *Corymbia calophylla* and *Eucalyptus marginata* over closed herbland * *Watsonia meriana* var. *bulbillifera* over non-native grassland **Eragrostis curvula* (**Plate 7**).	0.06
Grassland with scattered trees	Occasional *Corymbia calophylla* and non-native trees over non-native closed grassland **Ehrharta* sp. and herbland **Arctotheca calendula* (**Plate 4**).	85.46
Planted trees	Planted rows of trees such as **Corymbia maculata, *Eucalyptus camaldulensis* and **Eucalyptus grandis* over bare ground or non-native herb/grassland (**Plate 5**).	3.57

*Plate 4: **Grassland with scattered trees** habitat*

Plate 5: ***Planted trees*** *habitat*

Plate 6: ***Woodland*** *habitat*

*Plate 7: **Woodland over herbland** habitat*

3.2.2.2. Species inventory

A total of 14 native and one non-native fauna species were recorded in the site, including two species of conservation significance (refer **Section 3.2.2.3**).

A fauna species list is provided as **Appendix G**.

3.2.2.3. Conservation significant fauna

Two threatened fauna species, *Calyptorhynchus latirostris* (Carnaby's cockatoo) and *Calyptorhynchus banksii naso* (forest red-tailed black cockatoo), were recorded in the site. Approximately 30 Carnaby's cockatoo individuals were recorded flying and perching in the north western portion of the site and approximately 20 forest red-tailed black cockatoo individuals were recorded foraging in plant community **CcEm**.

One additional threatened fauna species, *Calyptorhynchus baudinii* (Baudin's cockatoo), was considered likely to occur in the site due to presence of suitable habitat. Suitable habitat for three other bird species of conservation significance occurs in the site, as listed in **Table 10**. One mammal species of conservation significance, quenda (P4), was considered to possibly occur in the north western portion of the site within the **woodland over herbland** habitat (refer **Section 3.2.2.1**). No other conservation significant fauna species were considered likely to occur due to the lack of suitable habitat.

The likelihood of occurrence assessment for all conservation significant fauna species identified in **Section 3.2.1** is provided as **Appendix F**.

Table 10: Conservation significant fauna species with potential to occur in the site

Species	Common name	Level of significance		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Birds					
Calyptorhynchus latirostris	Carnaby's cockatoo	EN	EN	Mainly proteaceous scrubs and heaths and adjacent eucalypt woodlands and forests; also plantations of *Pinus* spp. Attracted to seeding *Banksia* spp., *Dryandra* spp., *Hakea* spp., *Eucalyptus* spp., *Corymbia calophylla*, *Grevillea* spp., and *Allocasuarina* spp. (Johnstone and Storr 1998).	Recorded (potential breeding, roosting and foraging habitat may be present)
Calyptorhynchus banksii naso	Forest red-tailed black cockatoo	VU	VU	Eucalypt and corymbia forests, often in hilly interior. More recently also observed in more open agricultural and suburban areas including Perth metropolitan area. Attracted to seeding *Corymbia calophylla*, *Eucalyptus marginata*, introduced *Melia azdarach* and *Eucalyptus* spp. trees.	Recorded (potential breeding, roosting and foraging habitat may be present)
Calyptorhynchus baudinii	Baudin's cockatoo	EN	EN	Mainly eucalypt forests. Attracted to seeding *Corymbia calophylla*, *Banksia* spp., *Hakea* spp., and to fruiting apples and pears (Johnstone and Storr 1998).	Likely (potential breeding, roosting and foraging habitat may be present)
Apus pacificus	Pacific swift	MI	MI	Aerial, migratory species that is most often seen over inland plains and sometimes above open areas, foothills or in coastal areas. Sometimes occurs over settled areas, including towns, urban areas and cities (Pizzey & Knight 2012).	Possible (potential foraging habitat)
Motacilla cinerea	Grey wagtail	MI	MI	In Australia mostly near running water in disused quarries, sandy and rocky streams in escarpments and rainforests, sewage ponds, ploughed fields and airfields (Pizzey & Knight 2012).	Possible (potential marginal habitat present)
Falco peregrinus	Peregrine falcon	OS	-	Mainly found around cliffs along coasts, rivers, ranges and around wooded watercourses and lakes (Johnstone and Storr 1998).	Possible (potential habitat present)
Mammals					
Isoodon fusciventer	Quenda	P4	-	Dense scrubby, often swampy, vegetation with dense cover up to one metre high (DEC 2012)	Possible (suitable habitat in part of site)

EN=endangered, Vu=vulnerable, MI=migratory, OS=other specially protected species, P4=Priority 4 in WA.

3.2.2.4. Declared pests

One fauna species listed as a declared pest under the BAM Act, **Trichoglossus haematodus* (rainbow lorikeet), was recorded in the site.

4. CONCLUSIONS

4.1. Flora and vegetation

The majority of the site supports non-native vegetation and a total of seven native and 19 non-native (weed) species were recorded within the site.

No threatened or priority flora taxa were recorded in the site and none are considered likely to occur due to lack of suitable habitat.

Three plant communities were identified in the site. Plant communities **Cc** and **CcEm** extend over 2.99 ha (3.28% of the site) and were mapped as being in 'degraded' condition. The remainder of the site comprises plant community **non-native** which is dominated by non-native flora species with scattered native trees. This community extends over 88.25 ha (96.72% of the site) and was mapped as being in 'completely degraded' condition.

No TECs or PECs occur or are considered likely to occur in the site.

4.2. Fauna

The majority of the site supports low value habitat for native fauna. Four fauna habitats were identified in the site. The **woodland** and **woodland over herbland** comprise the highest relative fauna habitat values due to the presence of native trees. The **woodland over herbland** also supports dense cover of non-native understorey vegetation which may provide habitat for native ground dwelling fauna. However, the **woodland over herbland** habitat extends over a very small portion of the site (0.07%) and therefore the importance of this habitat to native fauna is likely limited. The **grassland with scattered trees** provides limited habitat for native fauna, with the scattered native *Corymbia calophylla* (marri) trees providing the most value. The **planted trees** may provide habitat for native fauna species but is considered to be of low value.

The 14 native and one introduced fauna taxa recorded within the site are all common and widespread across the Swan Coastal Plain region. One species is listed as a declared pest under the BAM Act and two are of conservation significance.

Two threatened fauna species, Carnaby's cockatoo and forest red-tailed black cockatoo, were recorded in the site. One additional threatened black cockatoo species, *Calyptorhynchus baudinii* (Baudin's cockatoo), was considered likely to occur in the site due to presence of suitable habitat. Potential black cockatoo breeding, foraging and roosting habitat exists within the site and a targeted assessment would be required to confirm the black cockatoo habitat values within the site.

Suitable habitat for three other bird species of conservation significance occurs in the site but the site is unlikely to provide core habitat for these species. One mammal species of conservation significance, quenda (P4), was considered to possibly occur in the north western portion of the site within the **woodland over herbland** habitat.

5. REFERENCES

5.1. General references

Environmental Protection Authority (EPA) 2016a, *Technical Guidance - Sampling methods for terrestrial vertebrate fauna*, Perth.

Environmental Protection Authority (EPA) 2016b, *Technical Guidance - Terrestrial Fauna Surveys*, Perth.

Environmental Protection Authority (EPA) 2016c, *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment*, Perth.

Environment Protection Authority (EPA) 2016d, *Technical Guideance - Sampling of short range endemic invertebrate fauna*, Perth, Western Australia.

ESCAVI 2003, *Australian Vegetation Attribute Manual: National Vegetation Information System, Version 6.0*, Department of the Environment and Heritage, Canberra.

Gibson, N., Keighery, B., Keighery, G., Burbidge, A. and Lyons, M. 1994, *A Floristic survey of the southern Swan Coastal Plain*, Department of Conservation and Land Management and the Conservation Council of Western Australia, Perth.

Keighery, B. 1994, *Bushland Plant Survey: A guide to plant community survey for the community*, Wildflower Society of WA (Inc), Nedlands.

Keighery, B. J., Keighery, G. J., Longman, V. M. and Clarke, K. A. 2012, *Weed and Native Flora Data for the Swan Coastal Plain*, Departments of Environmental Protection and Conservation and Land Management, Western Australia.

Western Australian Museum 2019, *WA Museum Checklist of the Terrestrial Vertebrate Fauna of Western Australia*, Perth, Western Australia.

5.2. Online references

Department of Parks and Wildlife (DBCA) 2020, *NatureMap,* viewed 18 June 2020 <https://naturemap.dpaw.wa.gov.au/>.

Department of the Environment (DAWE) 2020, *Protected Matters Search Tool*, viewed 22 June 2020 <https://www.environment.gov.au/epbc/protected-matters-search-tool>.

Figures

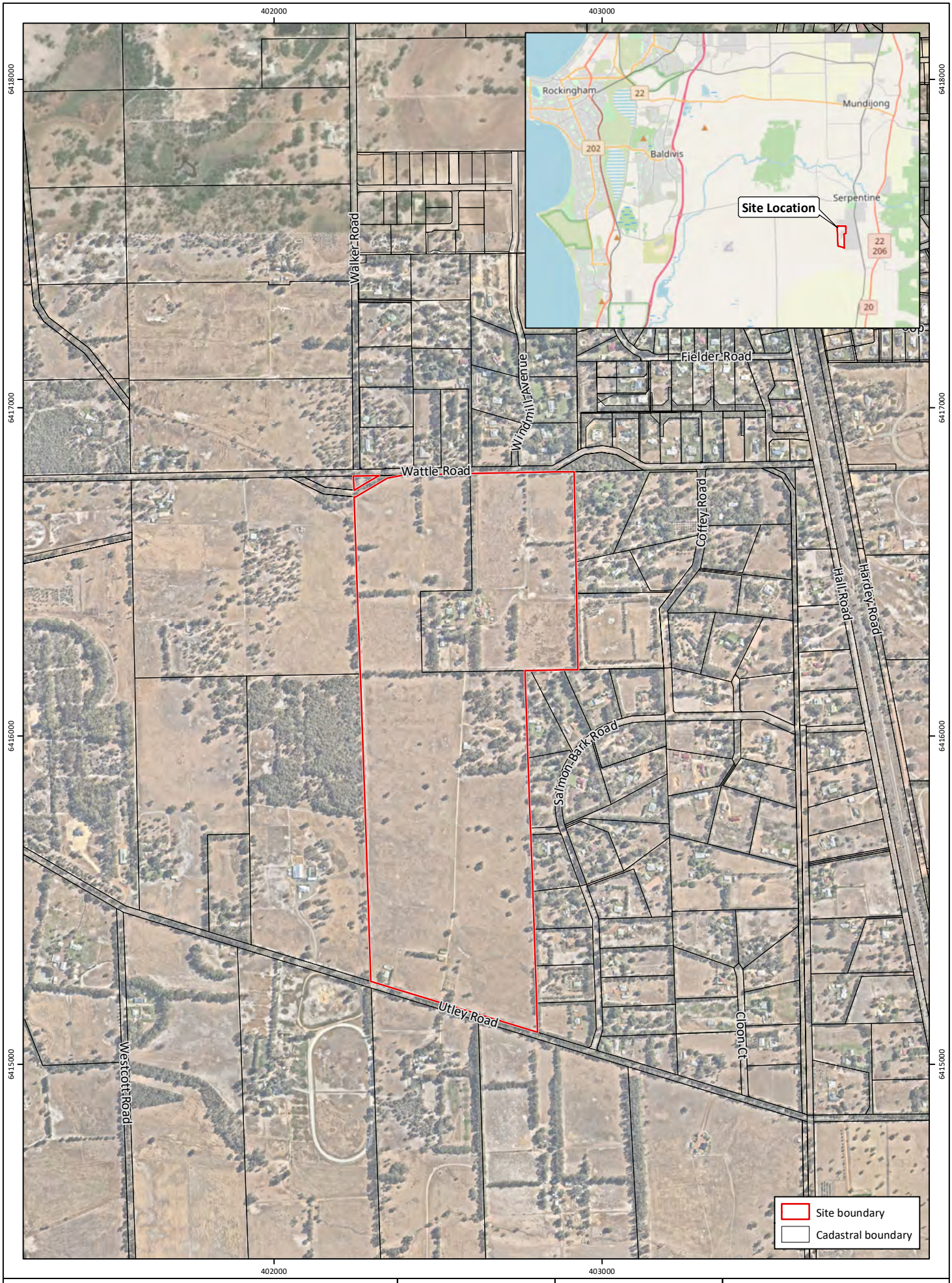


Figure 1: Site Location

Project:	Flora, Vegetation and Fauna Assessment Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine
Client:	Stron Pty Ltd

Plan Number:
EP20-064(03)--F02

Drawn:	GAR
Date:	24/06/2020
Checked:	RAW
Approved:	TAA
Date:	30/06/2020

N

0 200 400
Metres

Scale: 1:15,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

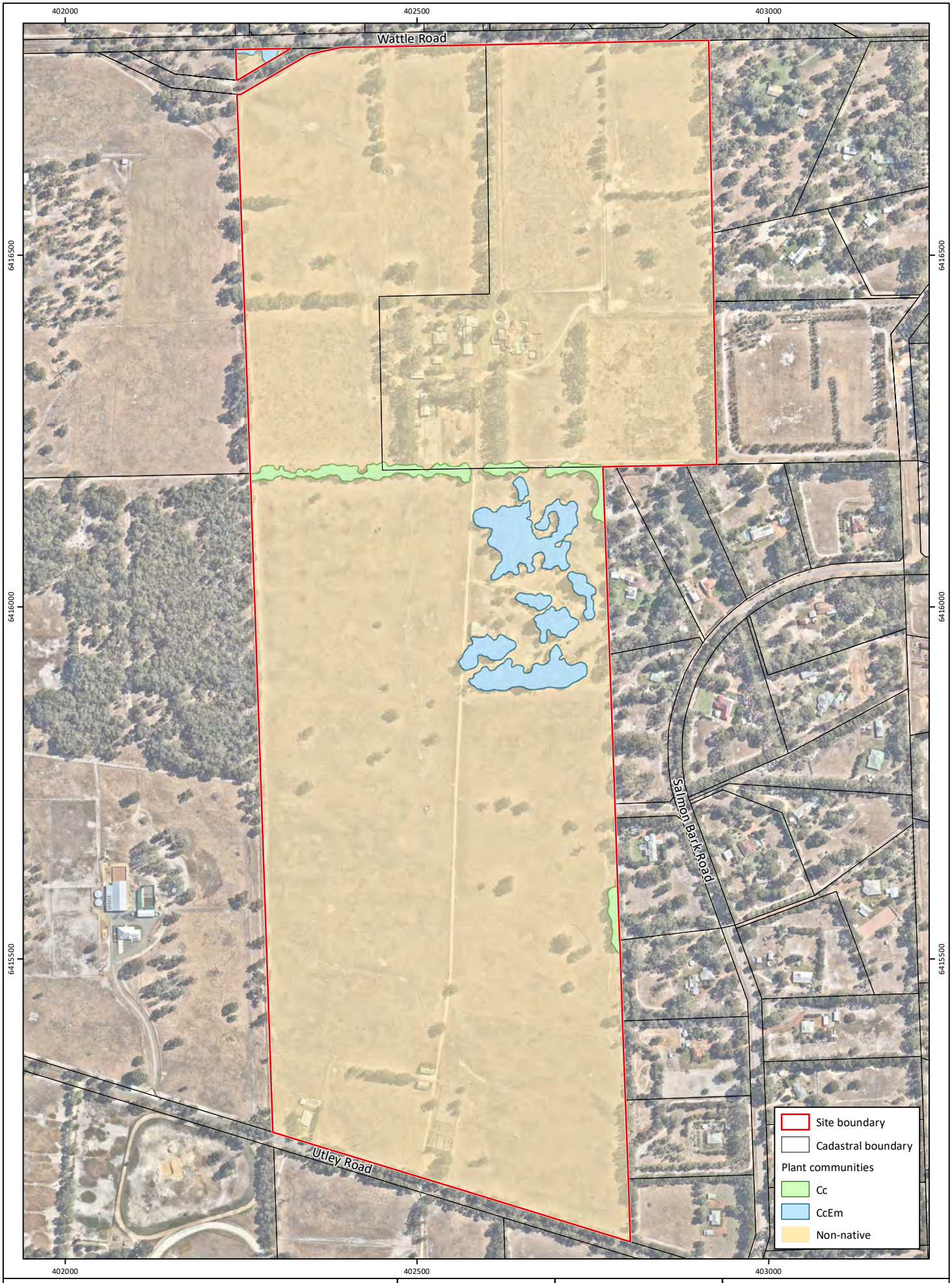


Figure 2: Plant Communities

Project:	Flora, Vegetation and Fauna Assessment Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine
Client:	Stron Pty Ltd

Plan Number:
EP20-064(03)--F03

Drawn:	GAR
Date:	24/06/2020
Checked:	RAW
Approved:	TAA
Date:	30/06/2020

N

0 100 200
Metres

Scale: 1:7,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

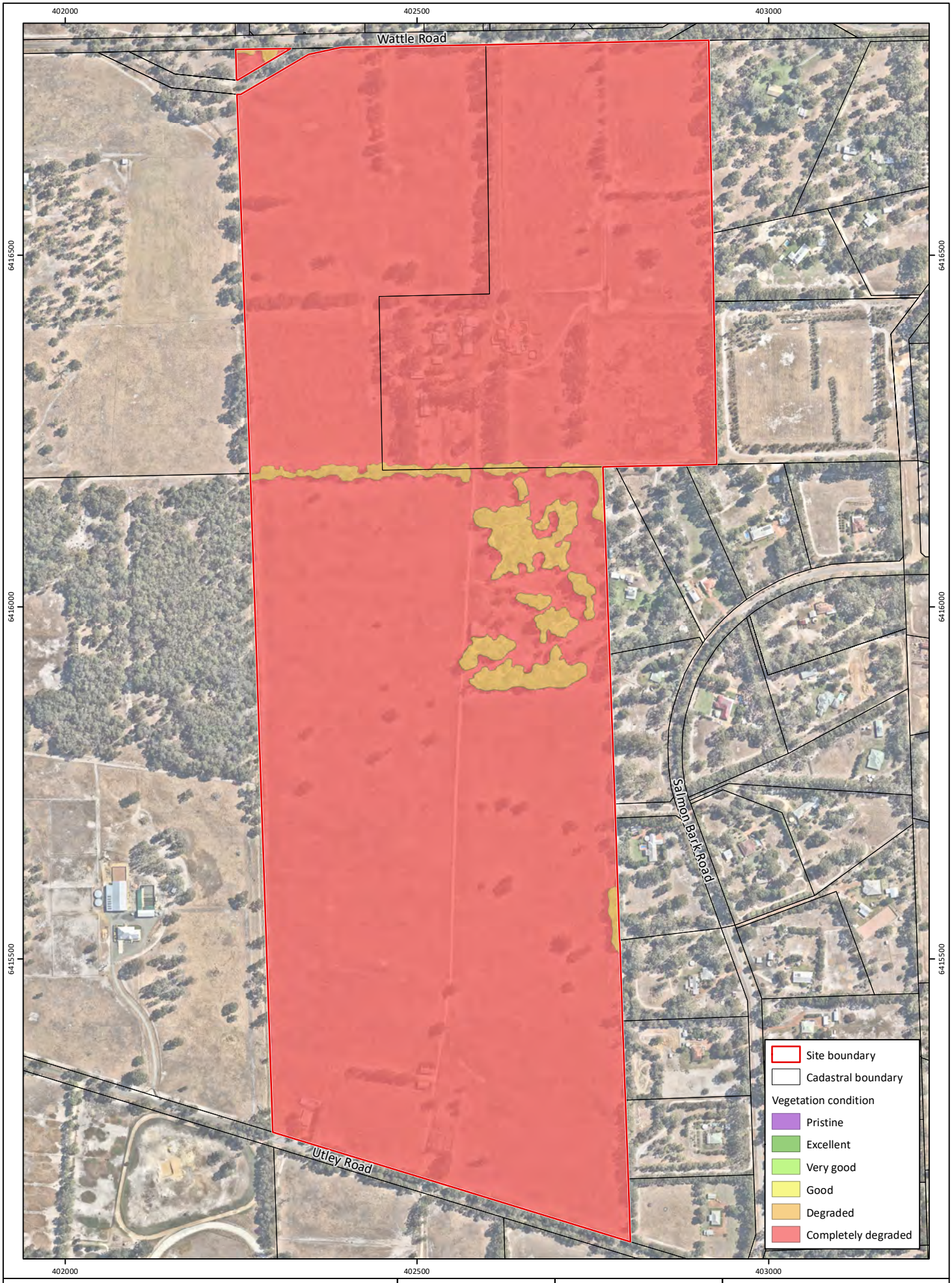


Figure 3: Vegetation Condition

Project:	Flora, Vegetation and Fauna Assessment Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine
Client:	Stron Pty Ltd

Plan Number:
EP20-064(03)--F04

Drawn:	GAR
Date:	24/06/2020
Checked:	RAW
Approved:	TAA
Date:	30/06/2020

N

0 100 200
Metres

Scale: 1:7,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

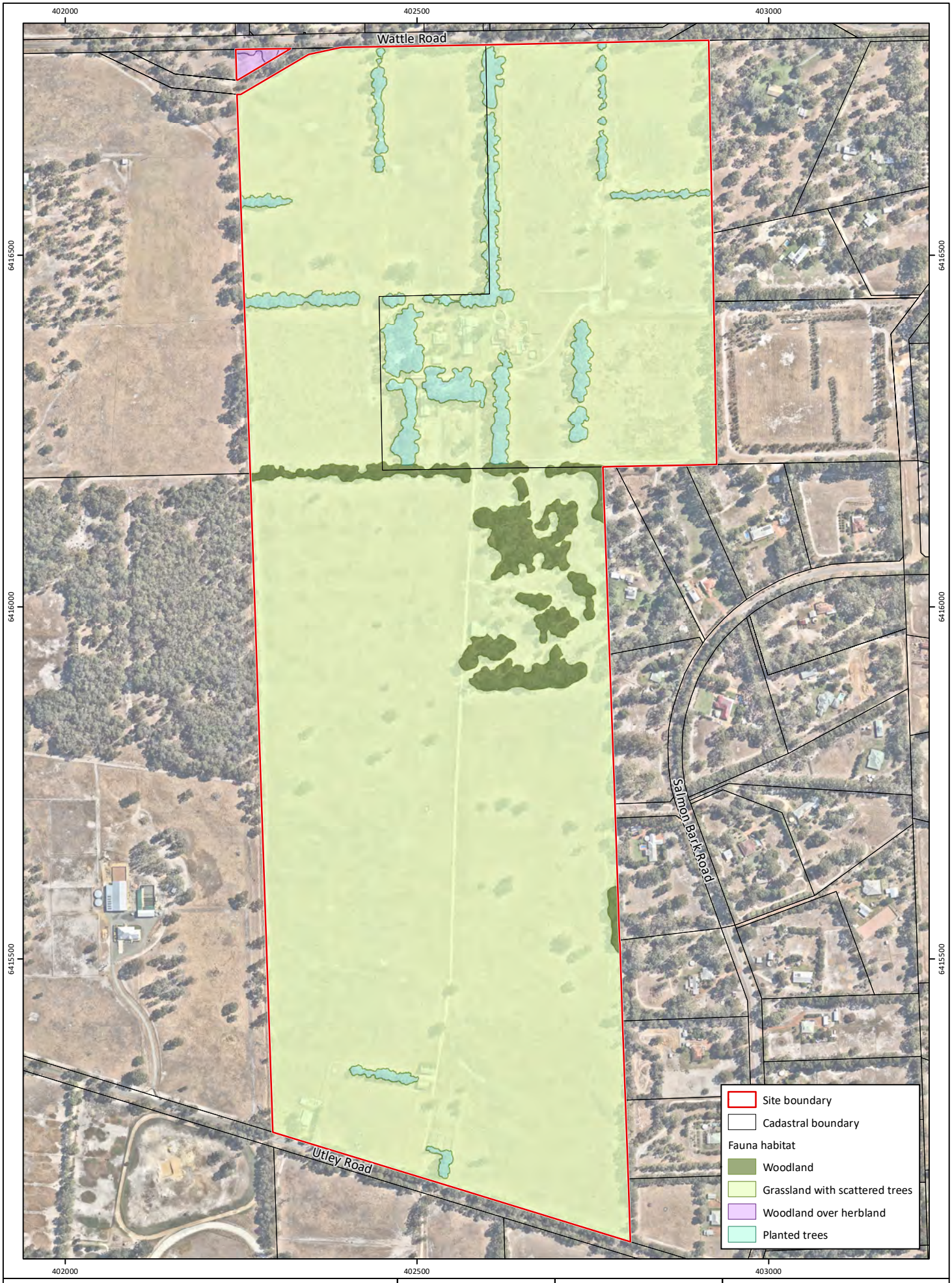


Figure 4: Fauna Habitat

Project: Flora, Vegetation and Fauna Assessment
Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number: EP20-064(03)--F05

Drawn:	GAR
Date:	24/06/2020
Checked:	RAW
Approved:	TAA
Date:	30/06/2020

N

0 100 200
Metres

Scale: 1:7,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

Appendix A

Additional Information

Conservation Significant Flora and Vegetation

Threatened and priority flora

Flora species considered rare or under threat warrant special protection under Commonwealth and/or State legislation. At the Commonwealth level, flora species can be listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Flora species considered 'threatened' pursuant to Schedule 1 of the EPBC Act are assigned categories according to their conservation status, as outlined in **Table 1**.

In Western Australia, plant taxa may be classed as 'threatened' under the *Biodiversity Conservation Act 2016* (BC Act) which is enforced by Department of Biodiversity Conservation and Attractions (DBCA). Threatened flora species are listed under sections 19(1) and 26(2) of the BC Act. It is an offence to 'take' or disturb threatened flora without Ministerial approval. Section 5(1)1 of the Act defines to take as including "… to gather, pluck, cut, pull up, destroy, dig up, remove, harvest or damage flora by any means" or to cause or permit the same to be done. The definition of threatened flora under the BC Act is provided in **Table 1**.

Section 43 of the BC Act requires that an occurrence of a threatened species or threatened ecological community is reported to DBCA where the occurrence has been identified as part of field work completed:

- as part of an assessment under Part IV of the *Environmental Protection Act 1986*; or
- in relation to an application for a clearing permit under the *Environmental Protection Act 1986* section 51E(1)(d).

Penalties apply to individuals and organisations that fail to provide accurate reports of threatened species or communities.

The *Biodiversity Conservation Regulations 2018* (BC Regulations 2018) came into effect on January 1 2019. The BC Regulations include provisions for licencing, charges, penalties and other provisions associated with the BC Act.

Flora species that may be threatened or near threatened but lack sufficient information to be listed under the BC Act may be added to the DBCA's *Priority Flora List* (DBCA 2018d). Priority flora species are considered during State approval processes. Priority flora categories and definitions are listed in **Table 1**.

Table 1: Definitions of conservation significant flora species pursuant to the EPBC Act and BC Act and on DBCA's Priority Flora List (DBCA 2018d)

Conservation code	Description
EX†	Threatened Flora – Presumed Extinct Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.
T^†	Threatened Flora – Extant Taxa which are declared to be likely to become extinct or is rare, or otherwise in need of special protection.
CR^	Threatened Flora – Critically Endangered Taxa which are considered to be facing an extremely high risk of extinction in the wild.
EN^	Threatened Flora – Endangered Taxa which are considered to be facing a very high risk of extinction in the wild.
VU^	Threatened Flora – Vulnerable Taxa which are considered to be facing a high risk of extinction in the wild.
P1	Priority One – Poorly Known Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat e.g. road verges, urban areas, farmland, active mineral leases etc., or the plants are under threat, e.g. from disease, grazing by feral animals etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
P2	Priority Two – Poorly Known Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey.
P3	Priority Three – Poorly Known Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but needs further survey.
P4	Priority Four – Rare Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

^pursuant to the EPBC Act, †pursuant to the BC Act, on DBCA's *Priority Flora List*

Threatened and priority ecological communities

'Threatened ecological communities' (TECs) are recognised as ecological communities that are rare or under threat and therefore warrant special protection. Selected TECs are afforded statutory protection at a Commonwealth level under section 181 of the EPBC Act. TECs nominated for listing under the EPBC Act are considered by the Threatened Species Scientific Committee and a final decision is made by the Commonwealth Minister for the Environment. Once listed under the EPBC Act, communities are categorised as either 'critically endangered', 'endangered' or 'vulnerable' as defined in **Table 2**. Any action likely to have a significant impact on a community listed under the EPBC Act requires approval from the Minister for the Environment.

Within Western Australia TECs are determined by the Western Australian Threatened Ecological Communities Scientific Advisory Committee (WATECSAC) and endorsed by the State Minister for the Environment. The WATECSAC is an independent group comprised of representatives from organisations including tertiary institutions, the Western Australian Museum and DBCA. The TECs endorsed by the State Minister are published by DBCA (DBCA 2018b).

TECs are assigned to one of the categories outlined in **Table 2** according to their status (in relation to the level of threat). TECs are afforded direct statutory protection at a State level under the BC Act and BC Regulations. Ecological communities are listed under Section 27(1) and 33 of the BC Act. Their significance is also acknowledged through other state environmental approval processes such as 'environmental impact assessment' pursuant to Part IV of the *Environmental Protection Act 1986* (EP Act) and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

Table 2: Categories of threatened ecological communities (English and Blyth 1997; DEC 2009).

Conservation code	Description
PD	Presumably Totally Destroyed An ecological community that has been adequately searched for but for which no representative occurrences have been located.
CE	Critically Endangered An ecological community that has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future.
E	Endangered An ecological community that has been adequately surveyed and is not critically endangered but is facing a very high risk of total destruction in the near future.
V	Vulnerable An ecological community that has been adequately surveyed and is not critically endangered or endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future.

An ecological community that is under consideration for listing as a TEC, but does not yet meet survey criteria or has not been adequately defined may be listed as a 'priority ecological community' (PEC). PECs are categorised as priority category 1, 2 or 3 as described in **Table 3**. Ecological communities that are adequately known and are rare but not threatened, or meet criteria for 'near threatened', or that have been recently removed from the threatened list, are placed in 'priority 4'. These ecological communities require regular monitoring. Conservation dependent ecological communities are placed in 'priority 5' (DEC 2009). Listed PECs are published by DBCA (DBCA 2017b).

Table 3: Categories of priority ecological communities (DEC 2013)

Priority code	Description
P1	Priority One: Poorly known ecological communities Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤ 100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
P2	Priority Two: Poorly known ecological communities Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat (within approximately 10 years) of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
P3	Priority Three: Poorly known ecological communities (i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat (within approximately 10 years), or; (iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, inappropriate fire regimes, clearing, hydrological change etc. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.
P4	Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. (i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. (ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for a higher threat category. (iii) Ecological communities that have been removed from the list of threatened communities during the past five years.
P5	Priority Five: Conservation Dependent ecological communities Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Conservation Significant Fauna

Fauna species considered rare or under threat warrant special protection under Commonwealth and/or State legislation. At the Commonwealth level, fauna species can be listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Migratory birds may be recognised under international treaties including:

- *Japan Australia Migratory Bird Agreement 1981* (JAMBA)
- *China Australia Migratory Bird Agreement 1998* (CAMBA)
- *Republic of Korea-Australia Migratory Bird Agreement 2007* (ROKAMBA)
- *Bonn Convention 1979* (The Convention on the Conservation of Migratory Species of Wild Animals).

All migratory bird species listed in the annexes to these bilateral agreements are protected in Australia as 'matters of national environmental significance' (MNES) under the EPBC Act. Fauna species considered 'threatened' pursuant to Schedule 1 of the EPBC Act are assigned categories as outlined in **Table 4**.

Table 4: Definitions of conservation significant fauna species pursuant to the EPBC Act

Conservation Code	Category
X	Threatened Fauna –Extinct There is no reasonable doubt that the last member of the species has died.
EW[#]	Threatened Fauna –Extinct in the Wild Taxa which are known only to survive in cultivation, captivity or as a naturalised population outside its past range, or taxa which have not been recorded in its known and/or expected habitat despite appropriate exhaustive surveys.
CR[#]	Threatened Fauna – Critically Endangered Taxa which are considered to be facing an extremely high risk of extinction in the wild.
EN[#]	Threatened Fauna – Endangered Taxa which are considered to be facing a very high risk of extinction in the wild.
VU[#]	Threatened Fauna – Vulnerable Taxa which are considered to be facing a high risk of extinction in the wild.
Migratory[#]	Migratory Fauna All migratory species that are: (i) native species; and (ii) from time to time included in the appendices to the Bonn Convention; and (b) all migratory species from time to time included in annexes established under JAMBA, CAMBA and ROKAMBA; and All native species from time to time identified in a list established under, or an instrument made under, an international agreement approved by the Minister.
Ma	Marine Fauna Species in the list established under s248 of the EPBC Act

[#]matters of national environmental significance (MNES) under the EPBC Act

In Western Australia, fauna taxa may be classed as 'threatened', 'extinct', or 'specially protected' under the *Biodiversity Conservation Act 2016* (BC Act), which is enforced by Department of Biodiversity Conservation and Attractions (DBCA) (DBCA 2019). The definitions of these categories are provided in **Table 5**.

Table 5: Definitions of specially protected fauna schedules under the BC Act (DBCA 2019)

Category	Conservation Code	Definition
Threatened	CR	Critically endangered Threatened species considered to be facing an extremely high risk of extinction in the wild in the immediate future.
	EN	Endangered Threatened species considered to be facing a very high risk of extinction in the wild in the near future.
	VU	Vulnerable Threatened species considered to be facing a high risk of extinction in the wild in the medium-term future.
Extinct	EX	Extinct Species where there is no reasonable doubt that the last member of the species has died.
	EW	Extinct in the wild Species that is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form. Note that no species are currently listed as EW.
Specially protected	MI	Migratory species Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth Includes birds that subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds.
	CD	Species of special conservation interest (conservation dependent fauna) Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.
	OS	Other specially protected species Fauna otherwise in need of special protection to ensure their conservation.

Fauna species that may be threatened or near threatened but lack sufficient information to be legislatively listed may be added to the DBCA's *Priority Fauna List* (DBCA 2018c). Species listed under priorities 1-3 comprise possible threatened species that do not meet survey criteria or are otherwise data deficient. Species listed under priority 4 are those that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons (DBCA 2019).

Priority fauna species are considered during State approval processes. Priority fauna categories and definitions are listed in **Table 6** (DBCA 2019).

Table 6: Definitions of priority fauna categories on DBCA's Priority Fauna List (DBCA 2019)

Conservation Code	Category
P1	Priority 1 – Poorly known Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
P2	Priority 2 – Poorly known Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
P3	Priority 2 – Poorly known Species that are known from several locations and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
P4	(a) Priority 4 – Rare species Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands. (b) Priority 4 – Near Threatened Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Priority 4 – Other Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Weeds

A number of legislative and policy documents exist in relation to weed management at state and national levels. The *Biosecurity and Agriculture Management Act 2007* (BAM Act) is the principle legislation guiding weed management in Western Australia and lists declared pest species. At a national level, the Australian government has compiled a list of 32 Weeds of National Significance (WoNS) (DoEE 2018), of which many are also listed under the BAM Act.

Declared Pests

Part 2.3.23 of the BAM Act requires a person must not; "*a) keep, breed or cultivate the declared pest; b) keep, breed or cultivate an animal, plant or other thing that is infected or infested with the declared pest; c) release into the environment the declared pest, or an animal, plant or other thing that is infected or infested with the declared pest; or d) intentionally infect or infest, or expose to infection or infestation, a plant, animal or other thing with a declared pest*".

Under the BAM Act, all declared pests are assigned a legal status, as described in **Table 7**. Species assigned to the 'declared pest, prohibited - s12' category are placed in one of three control categories, as described in **Table 8**.

The *Biosecurity and Agriculture Management Regulations 2013* specify keeping categories for species assigned to the 'declared pest - s22(2)' category, which relate to the purposes of which species can be kept, as well as the entities that can keep them. The categories are described in **Table 9**.

The Western Australian Organism List (WAOL) provides the status of organisms which have been categorised under the BAM Act (DPIRD 2020).

Table 7: Legal status of declared pest species listed under the BAM Act (DPIRD 2020)

Category	Description
Declared Pest Prohibited - s12	May only be imported and kept subject to permits. Permit conditions applicable to some species may only be appropriate or available to research organisations or similarly secure institutions.
Declared Pest s22(2)	Must satisfy any applicable import requirements when imported, and may be subject to an import permit if they are potential carriers of high-risk organisms. They may also be subject to control and keeping requirements once within Western Australia

Table 8: Control categories of declared pest species listed under the BAM Act (DPIRD 2020)

Category	Description
C1	Exclusion Not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2	Eradication Present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3	Management Established in Western Australia but it is feasible, or desirable, to manage them in order to limit their

Category	Description
	damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Table 9: Keeping categories of declared pest species listed under the BAM Act (DPIRD 2020)

Category	Description
Prohibited	Can only be kept under a permit for public display and education purposes, and/or genuine scientific research, by entities approved by the state authority.
Exempt	No permit or conditions are required for keeping.
Restricted	Organisms which, relative to other species, have a low risk of becoming a problem for the environment, primary industry or public safety and can be kept under a permit by private individuals.

References

General references

Department of Biodiversity, Conservation and Attractions (DBCA) 2017a, *A methodology for the evaluation of wetlands on the Swan Coastal Plain*, draft prepared by the Wetlands Section of the Department of Biodiversity, Conservation and Attractions and the Urban Water Branch of the Department of Water and Environmental Regulation, Perth.

Department of Biodiversity Conservation and Attractions (DBCA) 2017b, *Priority Ecological Communities for Western Australia Version 27*, Species and Communities Branch, Department of Biodiversity, Conservation and Attractions.

Department of Biodiversity, Conservation and Attractions (DBCA) 2018a, *Geomorphic Wetlands, Swan Coastal Plain (DBCA-019)*.

Department of Biodiversity, Conservation and Attractions (DBCA) 2018b, *List of Threatened Ecological Communities endorsed by the Western Australian Minister for Environment*, Perth.

Department of Biodiversity, Conservation and Attractions (DBCA) 2018c, *Threatened and Priority Fauna List 15 February 2018*, Perth.

Department of Biodiversity, Conservation and Attractions (DBCA) 2018d, *Threatened and Priority Flora List 16 January 2018*, Perth.

Department of Biodiversity Conservation and Attractions (DBCA) 2019, *Conservation Codes for Western Australian Flora and Fauna - last updated 3 January 2019*.

Department of Environment and Conservation (DEC) 2007, *Protocol for proposing modifications to the Geomorphic Wetlands Swan Coastal Plain dataset*, Perth.

Department of Environment and Conservation (DEC) 2009, *Definitions, Categories and Criteria for Threatened and Priority Ecological Communities*, Perth.

Department of Conservation (DEC) 2013, *Definitions, Categories and Criteria for Threatened and Priority Ecological Communities*, Perth.

English, V. and Blyth, J. 1997, *Identifying and Conserving Threatened Ecological Communities in the South West Botanical Province*, ANCA National Reserves System Cooperative Program, Project Number N702, Perth.

Keighery, B. 1994, *Bushland Plant Survey: A guide to plant community survey for the community*, Wildflower Society of WA (Inc), Nedlands.

Semeniuk, C. A. 1987, *Wetlands of the Darling System - a geomorphic approach to habitat classification*, Journal of the Royal Society of Western Australia, 69: 95-112.

Semeniuk, C. A. and Semeniuk, V. 1995, *A Geomorphic Approach to Global Classification for Inland Wetlands*, Vegetatio, 118(1/2): 103-124.

Online references

Department of Agriculture and Food (DAFWA) 2018, *The Western Australian Organism List* (WAOL), <https://www.agric.wa.gov.au/bam/western-australian-organism-list-waol>.

Department of Environment and Energy (DoEE) 2018, Weeds of National Significance, <http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html>.

Appendix B

Conservation Significant Flora Species and Likelihood of Occurrence Assessment

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Synaphea sp. Fairbridge Farm (D. Papenfus 696)	CR	CR	P	Low woodland on grey, clayey sand with lateritic pebbles (Pinjarra Plain) near winter wet flats.	Sep-Nov	Unlikely
Synaphea sp. Serpentine (G.R. Brand 103)	CR	CR	P	Seasonally damp areas, loam - sand.	Sep-Oct	Unlikely
Synaphea sp. Pinjarra Plain (A.S. George 17182)	EN	CR	P	White grey clayey sand on edges of seasonally inundated low lying areas.	Sep-Oct	Unlikely
Caladenia huegelii	CR	E	PG	Well-drained, deep sandy soils in lush undergrowth in a variety of moisture levels.	Sep-early Nov	Unlikely
Drakaea elastica	CR	E	PG	Bare patches of sand within otherwise dense vegetation in low-lying areas alongside winter-wet swamps.	late Sep-Oct/Nov, survey Jul-Aug	Unlikely
Eucalyptus x balanites	CR	E	P	Light coloured sandy soils over laterite. Habitat consists of gently sloping heathlands; open mallee woodland over shrubland (Population 2) or heathland with emergent mallees (population 1)	Oct - Feb	Unlikely
Lasiopetalum pterocarpum	CR	E	P	Riparian community with species such as Flooden Gum, Marri and Swamp Peppermint.	Aug-Nov	Unlikely
Synaphea stenoloba	CR	E	P	Swampy loam in depressions that are occasionally inundated.	Aug but mainly Sep-Oct	Unlikely
Thelymitra dedmaniarum	CR	E	PG	Red brown sandy loam with dolerite and granite outcrops.	Oct-Nov	Unlikely
Verticordia plumosa var. *ananeotes*	CR	E	P	Sand in open jarrah woodland or sandy/clay soils with marri.	Nov-Dec	Unlikely
Diuris purdiei	EN	E	PG	Sand to sandy clay soils in areas subject to winter inundation.	Sep-Oct but only after a summer or early autumn fire	Unlikely

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Grevillea curviloba subsp. *incurva*	EN	E	P	Sand, sandy loam. Winter-wet heath.	Aug-Sep	Unlikely
Thelymitra stellata	EN	E	PG	Sandy loam, clay or gravel over laterite or gravel.	Sep-Nov	Unlikely
Andersonia gracilis	VU	E	P	Seasonally damp, black sandy clay flats near or on the margins of swamps.	Sep-Nov	Unlikely
Drakaea micrantha	EN	V	PG	Open sandy patches often adjacent to winter-wet swamps.	Sept- early Oct	Unlikely
Anthocercis gracilis	VU	V	P	Steep granite slopes along the Darling Scarp in shallow, humis-rich sandy or loamy soils.	Sep-Oct, Apr	Unlikely
Diuris drummondii	VU	V	PG	In low-lying depressions in peaty and sandy clay swamps.	Nov-Jan	Unlikely
Diuris micrantha	VU	V	PG	Dark grey-black sandly clay-loam in winter wet depressions or swamps. Often in shallow standing water.	Aug/Sep-early Oct	Unlikely
Eleocharis keigheryi	VU	V	P	Clay or sandy loam in freshwater creeks and transient waterbodies such as seasonally wet clay pans.	Aug-Dec	Unlikely
Tetraria australiensis	VU	V	P	Sand over clay, winter wet depressions and drainage lines.	Nov-Dec	Unlikely
Acacia lasiocarpa var. *bracteolata* long peduncle variant (G.J. Keighery 5026)	P1	-	P	Grey or black sand over clay in winter wet areas.	May-Aug	Unlikely
Stachystemon sp. Keysbrook (R. Archer 17/11/99)	P1	-	P	White grey sand.	Oct	Unlikely
Synaphea odocoileops	P1	-	P	Brown orange loam and sandy clay, granite, in swamps and winter wet areas.	Aug-Oct	Unlikely
Johnsonia pubescens subsp. *cygnorum*	P2	-	P	Grey white yellow sands on flats and seasonally wet areas.	Sep	Unlikely
Acacia horridula	P3	-	P	Gravelly soils over granite, sand, rocky hillsides.	May-Aug	Unlikely

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Acacia oncinophylla subsp. oncinophylla	P3	-	P	Granitic soils	Aug-Oct	Unlikely
Babingtonia urbana	P3	-	P	Grey sand, lateritic gravel.	Jan-Mar	Unlikely
Carex tereticaulis	P3	-	P	Black peaty sand.	Sep-Oct	Unlikely
Dillwynia dillwynioides	P3	-	P	Winter wet depressions on sandy soils	Aug - Dec	Unlikely
Eryngium pinnatifidum subsp. Palustre (G.J. Keighery 13459)	P3	-	P	Grey brown sand or clay in winter wet flats.	Sep-Nov	Unlikely
Halgania corymbosa	P3	-	P	Gravelly soils, soils over granite.	Aug-Nov	Unlikely
Isopogon drummondii	P3	-	P	Yellow-grey sand.	Feb,Mar,Apr,May or June	Unlikely
Lasiopetalum glutinosum subsp. *glutinosum*	P3	-	P	Brown clay loam on slopes	Sep-Dec	Unlikely
Lepyrodia heleocharoides	P3	-	P	Moist peaty sand. Dry or seasonally inundated heath or woodland, swamps.	Dec	Unlikely
Meionectes tenuifolia	P3	-	P	Clay loam in seasonally wet areas.	Oct-Dec	Unlikely
Styphelia filifolia	P3	-	P	Brown over pale yellow sand.	Feb-Apr	Unlikely
Thysanotus anceps	P3	-	P	White or grey sand, lateritic gravel, laterite.	Oct-Dec	Unlikely
Boronia tenuis	P4	-	P	Laterite, stony soils, granite.	Aug-Nov	Unlikely
Calothamnus graniticus subsp. *leptophyllus*	P4	-	P	Clay over granite, lateritic soils. Hillsides.	Jun-Aug	Unlikely
Drosera occidentalis	P4	-	P	Flat, brown/white/yellow moist	Oct-	Unlikely
Eucalyptus rudis subsp.	P4	-	P	Loam on flats and hillsides.	Jul-Sep	Unlikely
Grevillea pimeleoides	P4	-	P	Gravelly soils over granite.	May-Nov	Unlikely
Parsonsia diaphanophleba	P4	-	P	Alluvial soils along rivers.	Jan-Feb or Apr-Sep	Unlikely
Pimelea rara	P4	-	P	Lateritic soils.	Dec-Jan	Unlikely
Senecio leucoglossus	P4	-	A	Gravelly lateritic or granitic soils on outcrops or slopes.	Aug-Dec	Unlikely
Stylidium longitubum	P4	-	A	Seasonal wetlands.	Oct-Dec	Unlikely
Verticordia lindleyi subsp. *lindleyi*	P4	-	P	Sand and sandy clay in winter wet areas.	May or Nov-Jan	Unlikely

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Note: T=threatened, CE=critically endangered, E=endangered, V=vulnerable, P1=Priority 1, P2=Priority 2, P3=Priority 3, P4=Priority 4, P=perennial, PG=perennial geophyte, A=annual. Species considered to potentially occur within the site are shaded green						

Appendix C

Conservation Significant Communities and Likelihood of Occurrence Assessment

Code	Community name	TEC/ PEC	Level of significance		Likelihood of occurrence
			State	EPBC Act	
SCP3a	*Corymbia calophylla - Kingia australis*	TEC	CR	EN	Unlikely
SCP3c	*Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands of the Swan Coastal Plain	TEC	CR	EN	Unlikely
	Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain ecological community	TEC	Multiple	CR	Unlikely
SCP20b	*Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain	TEC	EN	EN (Banksia Woodlands of the Swan Coastal Plain ecological community)	Unlikely
SCP3b	*Corymbia calophylla - Eucalyptus marginata* woodlands on sandy clay soils of the southern Swan Coastal Plain	TEC	VU	-	Unlikely
SCP10a	Shrublands on dry clay flats	TEC	EN	CR (Clay Pans of the Swan Coastal Plain)	Unlikely
SCP07	Herb rich saline shrublands in clay pans	TEC	VU		Unlikely

Note: TEC=threatened ecological community, PEC=priority ecological community, CR=critically endangered, EN=endangered, VU=vulnerable, P3=priority 3

Appendix D

Flora Species List

Flora List

Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine

Family	Status	Species
Anacardiaceae		
	*	*Schinus terebinthifolia*
	*DP (C3)	*Gomphocarpus fruticosus*
Araceae		
	*DP	*Zantedeschia aethiopica*
Asteraceae		
	*	*Arctotheca calendula*
	*	*Sonchus oleraceus*
	*	*Hypochaeris glabra*
Casuarinaceae		
		Allocasuarina fraseriana
Dasypogonaceae		
		Kingia australis
Fabaceae		
		Acacia microbotrya
	*	*Lupinus angustifolius*
Iridaceae		
	*	*Watsonia meriana var. bulbillifera*
	*	*Romulea rosea var. australis*
Myrtaceae		
		Corymbia calophylla
	*Pl	*Corymbia maculata*
	*Pl	*Eucalyptus camaldulensis*
	*Pl	*Eucalyptus gomphocephala*
	*Pl	*Eucalyptus grandis*
		Eucalyptus marginata
	Pl	*Eucalyptus rudis*
	*Pl	*Melaleuca nesophila*
Oxalidaceae		
	*	*Oxalis purpurea*
Poaceae		
	*	*Cenchrus clandestinus*
	*	*Ehrharta calycina*
	*	*Eragrostis curvula*
Proteaceae		
		Xylomelum occidentale
Xanthorrhoeaceae		
		Xanthorrhoea preissii

Note: * denotes non-native species, Pl denotes planted, DP=declared pest under the BAM Act

Appendix E

Fauna Database Search Results

Australian Government
Department of the Environment and Energy

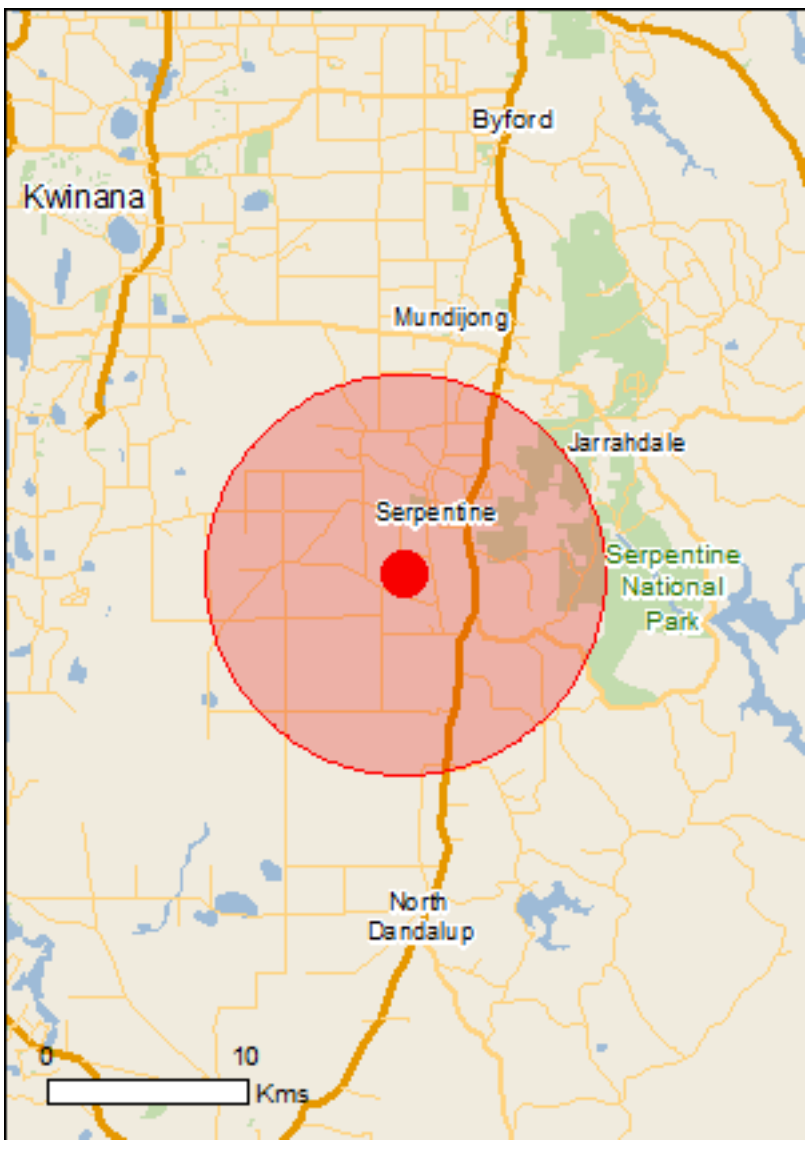
EPBC Act Protected Matters Report

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

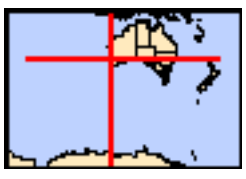
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 22/06/20 11:08:04



Coordinates
Buffer: 10.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	32
Listed Migratory Species:	9

Other Matters Protected by the EPBC Act

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

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

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	15
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	9
Regional Forest Agreements:	1
Invasive Species:	40
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar)	[Resource Information]
Name	Proximity
Peel-yalgorup system	10 - 20km upstream

Listed Threatened Ecological Communities		[Resource Information]
For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.		
Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area
Clay Pans of the Swan Coastal Plain	Critically Endangered	Community likely to occur within area
Corymbia calophylla - Kingia australis woodlands on heavy soils of the Swan Coastal Plain	Endangered	Community known to occur within area
Corymbia calophylla - Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain	Endangered	Community known to occur within area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community likely to occur within area

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Botaurus poiciloptilus		
Australasian Bittern [1001]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calyptorhynchus banksii naso		
Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Calyptorhynchus baudinii		
Baudin's Cockatoo, Long-billed Black-Cockatoo [769]	Endangered	Roosting known to occur within area
Calyptorhynchus latirostris		
Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Leipoa ocellata		
Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Mammals		
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat likely to occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Species or species habitat likely to occur within area
Setonix brachyurus Quokka [229]	Vulnerable	Species or species habitat likely to occur within area
Other		
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat known to occur within area
Plants		
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area
Anthocercis gracilis Slender Tailflower [11103]	Vulnerable	Species or species habitat may occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat known to occur within area
Diuris drummondii Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat likely to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat likely to occur within area
Drakaea elastica Glossy-leafed Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat known to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat likely to occur within area
Eleocharis keigheryi Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat may occur within area
Eucalyptus x balanites Cadda Road Mallee, Cadda Mallee [87816]	Endangered	Species or species habitat may occur within area
Grevillea curviloba subsp. incurva Narrow curved-leaf Grevillea [64909]	Endangered	Species or species habitat may occur within area
Lasiopetalum pterocarpum Wing-fruited Lasiopetalum [64922]	Endangered	Species or species habitat known to occur within area
Synaphea sp. Fairbridge Farm (D. Papenfus 696) Selena's Synaphea [82881]	Critically Endangered	Species or species

Name	Status	Type of Presence
		habitat known to occur within area
Synaphea sp. Serpentine (G.R. Brand 103) [86879]	Critically Endangered	Species or species habitat known to occur within area
Synaphea stenoloba Dwellingup Synaphea [66311]	Endangered	Species or species habitat likely to occur within area
Tetraria australiensis Southern Tetraria [10137]	Vulnerable	Species or species habitat likely to occur within area
Thelymitra dedmaniarum Cinnamon Sun Orchid [65105]	Endangered	Species or species habitat may occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat may occur within area
Verticordia plumosa var. ananeotes Tufted Plumed Featherflower [23871]	Endangered	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Tringa nebularia		
Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Karnet	WA
Lambkin	WA
NTWA Bushland covenant (0076)	WA
NTWA Bushland covenant (0086)	WA
North Dandalup	WA
Serpentine	WA
Unnamed WA46587	WA
Unnamed WA50643	WA
Unnamed WA51784	WA

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
South West WA RFA	Western Australia

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species

Name	Status	Type of Presence
		habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Solanum elaeagnifolium Silver Nightshade, Silver-leaved Nightshade, White Horse Nettle, Silver-leaf Nightshade, Tomato Weed, White Nightshade, Bull-nettle, Prairie-berry, Satansbos, Silver-leaf Bitter-apple, Silverleaf-nettle, Trompillo [12323]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-32.38842 115.96396

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of the Environment
GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Guest user on 19/06/2020

Kingdom	Animalia
Current Names Only	Yes
Core Datasets Only	Yes
Method	'By Circle'
Centre	115° 57' 50" E,32° 23' 18" S
Buffer	10km
Group By	Conservation Status

Conservation Status	Species	Records
Non-conservation taxon	403	4826
Other specially protected fauna	3	16
Priority 3	3	4
Priority 4	4	33
Rare or likely to become extinct	6	392
TOTAL	**419**	**5271**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Rare or likely to become extinct					
1.	24731	*Calyptorhynchus banksii subsp. naso (Forest Red-tailed Black Cockatoo)*		T	
2.	24733	*Calyptorhynchus baudinii (Baudin's Cockatoo, White-tailed Long-billed Black Cockatoo)*		T	
3.	24734	*Calyptorhynchus latirostris (Carnaby's Cockatoo, White-tailed Short-billed Black Cockatoo)*		T	
4.	48400	*Calyptorhynchus sp. (white-tailed black cockatoo)*		T	
5.	24092	*Dasyurus geoffroii (Chuditch, Western Quoll)*		T	
6.	34113	*Westralunio carteri (Carter's Freshwater Mussel)*		T	
Other specially protected fauna					
7.	25624	*Falco peregrinus (Peregrine Falcon)*		S	
8.	25508	*Phascogale tapoatafa (Brush-tailed Phascogale)*		S	
9.	48070	*Phascogale tapoatafa subsp. wambenger (South-western Brush-tailed Phascogale, Wambenger)*		S	
Priority 3					
10.	48579	*Euoplos inornatus (inornate trapdoor spider (northern Jarrah Forest))*		P3	
11.	34030	*Geotria australis (Pouched Lamprey)*		P3	
12.	48935	*Idiosoma sigillatum (Swan Coastal Plain shield-backed trapdoor spider)*		P3	
Priority 4					
13.	24189	*Falsistrellus mackenziei (Western False Pipistrelle, Western Falsistrelle)*		P4	
14.	24215	*Hydromys chrysogaster (Water-rat, Rakali)*		P4	
15.	48588	*Isoodon fusciventer (Quenda, southwestern brown bandicoot)*		P4	
16.	24328	*Oxyura australis (Blue-billed Duck)*		P4	
Non-conservation taxon					
17.		*? ?*			
18.	24260	*Acanthiza apicalis (Broad-tailed Thornbill, Inland Thornbill)*			
19.	24261	*Acanthiza chrysorrhoa (Yellow-rumped Thornbill)*			
20.	24262	*Acanthiza inornata (Western Thornbill)*			
21.	24265	*Acanthiza uropygialis (Chestnut-rumped Thornbill)*			
22.	24560	*Acanthorhynchus superciliosus (Western Spinebill)*			
23.		*Acariformes sp.*			
24.	25535	*Accipiter cirrocephalus (Collared Sparrowhawk)*			
25.	25536	*Accipiter fasciatus (Brown Goshawk)*			
26.		*Acritoptila margaretae*			
27.		*Acritoptila sp.*			
28.	25755	*Acrocephalus australis (Australian Reed Warbler)*			
29.		*Adversaeschna brevistyla*			
30.	25544	*Aegotheles cristatus (Australian Owlet-nightjar)*			
31.		*Aeshnidae sp.*			
32.		*Agraptocorixa sp.*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
33.		*Allothereua maculata*			
34.		*Alotanypus dalyupensis*			
35.		*Aname mainae*			
36.	24312	*Anas gracilis (Grey Teal)*			
37.	24315	*Anas rhynchotis (Australasian Shoveler)*			
38.	24316	*Anas superciliosa (Pacific Black Duck)*			
39.		*Ancylidae sp.*			
40.	25449	*Antechinus flavipes (Yellow-footed Antechinus)*			
41.	24561	*Anthochaera carunculata (Red Wattlebird)*			
42.	24562	*Anthochaera lunulata (Western Little Wattlebird)*			
43.	25670	*Anthus australis (Australian Pipit)*			
44.	24599	*Anthus australis subsp. australis (Australian Pipit)*			
45.		*Antiporus gilberti*			
46.		*Antiporus sp.*			
47.	24990	*Aprasia pulchella (Granite Worm-lizard)*			
48.	24285	*Aquila audax (Wedge-tailed Eagle)*			
49.		*Arachnura higginsi*			
50.		*Araneus cyphoxis*			
51.		*Araneus senicaudatus*			
52.	24340	*Ardea novaehollandiae (White-faced Heron)*			
53.	24341	*Ardea pacifica (White-necked Heron)*			
54.	24610	*Ardeotis australis (Australian Bustard)*			
55.		*Arrenuridae sp.*			
56.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
57.	24353	*Artamus cyanopterus (Dusky Woodswallow)*			
58.		*Aturidae sp.*			
59.		*Australopelopia prionoptera*			
60.		*Australotiphys barmutai*			
61.		*Austroagrion coeruleum*			
62.		*Austrogomphus collaris*			
63.		*Austrolestes analis*			
64.	47713	*Austronomus australis (White-striped Free-tailed Bat)*			
65.	24318	*Aythya australis (Hardhead)*			
66.		*Barnardius zonarius*			
67.		*Berosus approximans*			
68.		*Berosus discolor*			
69.		*Bibulmena kadjina*			
70.	24319	*Biziura lobata (Musk Duck)*			
71.		*Bostockia porosa*			
72.	25715	*Cacatua roseicapilla (Galah)*			
73.	25716	*Cacatua sanguinea (Little Corella)*			
74.	25598	*Cacomantis flabelliformis (Fan-tailed Cuckoo)*			
75.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
76.		*Caenidae sp.*			
77.		*Calanoida sp.*			
78.	25717	*Calyptorhynchus banksii (Red-tailed Black-Cockatoo)*			
79.		*Carabidae sp.*			
80.		*Ceinidae sp.*			
81.		*Ceratopogonidae sp.*			
82.		*Cercophonius sulcatus*			
83.	24186	*Chalinolobus gouldii (Gould's Wattled Bat)*			
84.	43380	*Chelodina colliei (South-western Snake-necked Turtle)*			
85.	24321	*Chenonetta jubata (Australian Wood Duck, Wood Duck)*			
86.	33939	*Cherax cainii (Marron)*			
87.		*Cherax destructor*			
88.		*Cherax quinquecarinatus*			
89.		*Cheumatopsyche sp. AV2 (SAP)*			
90.		*Chironominae sp.*			
91.		*Chironomus aff. alternans (V24) (CB)*			
92.		*Chironomus tepperi*			
93.	25601	*Chrysococcyx lucidus (Shining Bronze Cuckoo)*			
94.		*Cladocera (unident.)*			
95.		*Cladopelma curtivalva*			
96.		*Cladotanytarsus sp. A (SAP)*			
97.		*Cloeon sp.*			
98.		*Cloeon sp. 2 (SFM)*			
99.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
100.	24399	*Columba livia (Domestic Pigeon)*	Y		
101.		*Condocerus aptus*			
102.		*Copepoda sp.*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
103.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
104.		*Corduliidae sp.*			
105.		*Corixidae sp.*			
106.		*Cormocephalus aurantiipes*			
107.		*Cormocephalus turneri*			
108.	25592	*Corvus coronoides (Australian Raven)*			
109.	25593	*Corvus orru (Torresian Crow)*			
110.	25595	*Cracticus tibicen (Australian Magpie)*			
111.	24422	*Cracticus tibicen subsp. dorsalis (White-backed Magpie)*			
112.	25596	*Cracticus torquatus (Grey Butcherbird)*			
113.		*Cricotopus 'brevicornis'*			
114.		*Cricotopus 'parbicinctus'*			
115.	25398	*Crinia georgiana (Quacking Frog)*			
116.	25399	*Crinia glauerti (Clicking Frog)*			
117.	25400	*Crinia insignifera (Squelching Froglet)*			
118.	25401	*Crinia pseudinsignifera (Bleating Froglet)*			
119.	30893	*Cryptoblepharus buchananii*			
120.		*Cryptochironomus griseidorsum*			
121.	24883	*Ctenophorus ornatus (Ornate Crevice-Dragon)*			
122.	25049	*Ctenotus labillardieri*			
123.		*Culicidae sp.*			
124.	24322	*Cygnus atratus (Black Swan)*			
125.	30901	*Dacelo novaeguineae (Laughing Kookaburra)*	Y		
126.	25673	*Daphoenositta chrysoptera (Varied Sittella)*			
127.	25766	*Delma fraseri (Fraser's Legless Lizard)*			
128.	25607	*Dicaeum hirundinaceum (Mistletoebird)*			
129.		*Dicrotendipes conjunctus*			
130.		*Dicrotendipes jobetus*			
131.		*Dicrotendipes sp.*			
132.		*Dicrotendipes sp. A (V47) (SAP)*			
133.		*Dinocambala ingens*			
134.		*Diplacodes bipunctata*			
135.	24939	*Diplodactylus polyophthalmus*			
136.		*Dolichopodidae sp.*			
137.	24470	*Dromaius novaehollandiae (Emu)*			
138.		*Dytiscidae sp.*			
139.		*Ecnomidae sp.*			
140.	25096	*Egernia kingii (King's Skink)*			
141.		*Egretta novaehollandiae*			
142.		*Elanus axillaris*			
143.	25250	*Elapognathus coronatus (Crowned Snake)*			
144.	47937	*Elseyornis melanops (Black-fronted Dotterel)*			
145.		*Empididae sp.*			
146.		*Enchytraeidae sp.*			
147.		*Eolophus roseicapillus*			
148.	25692	*Eopsaltria australis (Yellow Robin)*			
149.	24652	*Eopsaltria georgiana (White-breasted Robin)*			
150.	24567	*Epthianura albifrons (White-fronted Chat)*			
151.		*Eucyrtops latior*			
152.		*Exocelina ater*			
153.	25621	*Falco berigora (Brown Falcon)*			
154.	25622	*Falco cenchroides (Australian Kestrel, Nankeen Kestrel)*			
155.	25623	*Falco longipennis (Australian Hobby)*			
156.	24476	*Falco subniger (Black Falcon)*			
157.	24041	*Felis catus (Cat)*	Y		
158.	25727	*Fulica atra (Eurasian Coot)*			
159.	24761	*Fulica atra subsp. australis (Eurasian Coot)*			
160.	34028	*Galaxias occidentalis (Western Minnow)*			
161.	24763	*Gallinula tenebrosa subsp. tenebrosa (Dusky Moorhen)*			
162.	24765	*Gallirallus philippensis subsp. mellori (Buff-banded Rail)*			
163.	42314	*Gavicalis virescens (Singing Honeyeater)*			
164.	25404	*Geocrinia leai (Ticking Frog)*			
165.	25530	*Gerygone fusca (Western Gerygone)*			
166.		*Gomphidae sp.*			
167.	24443	*Grallina cyanoleuca (Magpie-lark)*			
168.		*Gripopterygidae sp.*			
169.		*Gyrinidae sp.*			
170.	24295	*Haliastur sphenurus (Whistling Kite)*			
171.		*Haliplus fuscatus*			
172.		*Haliplus sp.*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
173.		*Harrisius sp. A (SAP)*			
174.		*Harrisius sp. B (SFM)*			
175.	25410	*Heleioporus eyrei (Moaning Frog)*			
176.	25411	*Heleioporus inornatus (Whooping Frog)*			
177.		*Hellyethira litua*			
178.		*Helochares tenuistriatus*			
179.		*Hemicordulia australiae*			
180.		*Hemicordulia tau*			
181.		*Hemicorduliidae sp.*			
182.	25115	*Hemiergis initialis subsp. initialis*			
183.	25119	*Hemiergis quadrilineata*			
184.		*Henicops dentatus*			
185.	47965	*Hieraaetus morphnoides (Little Eagle)*			
186.	25734	*Himantopus himantopus (Black-winged Stilt)*			
187.		*Hirudinea sp.*			
188.	24491	*Hirundo neoxena (Welcome Swallow)*			
189.		*Hydrobiosidae sp.*			
190.		*Hydrodromidae sp.*			
191.		*Hydrophilidae sp.*			
192.		*Hydropsychidae sp.*			
193.		*Hydroptilidae sp.*			
194.		*Hyphydrus elegans*			
195.		*Hyriidae sp.*			
196.		*Idiommata blackwalli*			
197.		*Isometroides vescus*			
198.		*Isopeda leishmanni*			
199.		*Karaops ellenae*			
200.		*Kiefferulus intertinctus*			
201.		*Kiefferulus martini*			
202.	24367	*Lalage tricolor (White-winged Triller)*			
203.		*Lancetes lanceolatus*			
204.		*Larsia albiceps*			
205.	24511	*Larus novaehollandiae subsp. novaehollandiae (Silver Gull)*			
206.		*Latrodectus hasseltii*			
207.		*Lectrides parilis*			
208.		*Leptoceridae sp.*			
209.		*Leptoperla australica*			
210.		*Leptophlebiidae sp.*			
211.	25131	*Lerista distinguenda*			
212.	25133	*Lerista elegans*			
213.	25148	*Lerista lineopunctulata*			
214.	25005	*Lialis burtonis*			
215.		*Libellulidae sp.*			
216.	25661	*Lichmera indistincta (Brown Honeyeater)*			
217.		*Limbodessus inornatus*			
218.		*Limbodessus shuckhardi*			
219.		*Limnesiidae sp.*			
220.	25415	*Limnodynastes dorsalis (Western Banjo Frog)*			
221.		*Limnoxenus zelandicus*			
222.	25378	*Litoria adelaidensis (Slender Tree Frog)*			
223.	25388	*Litoria moorei (Motorbike Frog)*			
224.		*Lophoictinia isura*			
225.		*Macrogyrus angustatus*			
226.		*Macrogyrus sp.*			
227.	24132	*Macropus fuliginosus (Western Grey Kangaroo)*			
228.	24326	*Malacorhynchus membranaceus (Pink-eared Duck)*			
229.	25650	*Malurus elegans (Red-winged Fairy-wren)*			
230.	25651	*Malurus lamberti (Variegated Fairy-wren)*			
231.	24551	*Malurus pulcherrimus (Blue-breasted Fairy-wren)*			
232.	25654	*Malurus splendens (Splendid Fairy-wren)*			
233.	24583	*Manorina flavigula (Yellow-throated Miner)*			
234.		*Maydenoptila baynesi*			
235.	25758	*Megalurus gramineus (Little Grassbird)*			
236.		*Megapodagrionidae sp.*			
237.		*Megaporus sp.*			
238.	25663	*Melithreptus brevirostris (Brown-headed Honeyeater)*			
239.	25184	*Menetia greyii*			
240.	24598	*Merops ornatus (Rainbow Bee-eater)*			
241.		*Microcarbo melanoleucos*			
242.	25693	*Microeca fascinans (Jacky Winter)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
243.		*Micronecta gracilis*			
244.		*Micronecta robusta*			
245.		*Micronecta sp.*			
246.		*Missulena granulosa*			
247.	25240	*Morelia spilota subsp. imbricata (Carpet Python)*			
248.	25191	*Morethia lineoocellata*			
249.	25192	*Morethia obscura*			
250.	24223	*Mus musculus (House Mouse)*	Y		
251.		*Naididae sp.*			
252.		*Nannoperca vittata*			
253.		*Necterosoma darwini*			
254.		*Necterosoma penicillatus*			
255.		*Necterosoma sp.*			
256.		*Nematoda sp.*			
257.		*Nemertini sp.*			
258.	24738	*Neophema elegans (Elegant Parrot)*			
259.	24739	*Neophema petrophila (Rock Parrot)*			
260.		*Neosilurus hyrtlii*			
261.		*Nephila edulis*			
262.		*Newmanoperla exigua*			
263.		*Notalina nr. sp. AV14*			
264.		*Notalina sp. AV17 (RCM)*			Y
265.		*Notalina spira*			
266.	25252	*Notechis scutatus (Tiger Snake)*			
267.		*Notonectidae sp.*			
268.		*Nousia sp. AV16*			
269.		*Nunciella aspera*			
270.	25564	*Nycticorax caledonicus (Rufous Night Heron)*			
271.	24194	*Nyctophilus geoffroyi (Lesser Long-eared Bat)*			
272.	24195	*Nyctophilus gouldi (Gould's Long-eared Bat)*			
273.		*Occiperipatoides gilesii*			
274.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
275.		*Oecetis sp.*			
276.		*Offadens soror (ex genus 1 WA sp. 1)*			
277.		*Oligochaeta sp.*			
278.		*Oniscidae sp.*			
279.		*Opisthopora sp.*			
280.		*Oribatida sp.*			
281.		*Orthetrum caledonicum*			
282.		*Orthocladiinae sp.*			
283.	24085	*Oryctolagus cuniculus (Rabbit)*	Y		
284.		*Ostracoda (unident.)*			
285.		*Oxidae sp.*			
286.		*Oxyethira sp.*			
287.		*Oxyopes rubicundus*			
288.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
289.		*Palaemonidae sp.*			
290.		*Parachironomus sp. 1 (VSCL35) (SAP)*			
291.		*Paracladopelma M1 [SFM)*			
292.		*Parakiefferiella sp. S1*			
293.		*Parakiefferiella variegatus*			
294.		*Paralimnophyes pullulus (V42)*			
295.		*Paramelitidae sp.*			
296.		*Paramerina levidensis*			
297.		*Parastacidae sp.*			
298.	25253	*Parasuta gouldii*			
299.	25681	*Pardalotus punctatus (Spotted Pardalote)*			
300.	25682	*Pardalotus striatus (Striated Pardalote)*			
301.	24648	*Pelecanus conspicillatus (Australian Pelican)*			
302.		*Pentaneurini genus V20*			
303.		*Perthiidae sp.*			
304.	48061	*Petrochelidon nigricans (Tree Martin)*			
305.	48066	*Petroica boodang (Scarlet Robin)*			
306.	25697	*Phalacrocorax carbo (Great Cormorant)*			
307.	25698	*Phalacrocorax melanoleucos (Little Pied Cormorant)*			
308.	24667	*Phalacrocorax sulcirostris (Little Black Cormorant)*			
309.	25699	*Phalacrocorax varius (Pied Cormorant)*			
310.	24409	*Phaps chalcoptera (Common Bronzewing)*			
311.	25587	*Phaps elegans (Brush Bronzewing)*			
312.		*Phreodrilidae sp.*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
313.	48071	*Phylidonyris niger (White-cheeked Honeyeater)*			
314.	24596	*Phylidonyris novaehollandiae (New Holland Honeyeater)*			
315.		*Physidae sp.*			
316.		*Planorbidae sp.*			
317.	24841	*Platalea flavipes (Yellow-billed Spoonbill)*			
318.	25720	*Platycercus icterotis (Western Rosella)*			
319.	24747	*Platycercus spurius (Red-capped Parrot)*			
320.	25721	*Platycercus zonarius (Australian Ringneck, Ring-necked Parrot)*			
321.		*Platynectes sp.*			
322.	25703	*Podargus strigoides (Tawny Frogmouth)*			
323.	25704	*Podiceps cristatus (Great Crested Grebe)*			
324.		*Poecilipta smaragdinea*			
325.	25510	*Pogona minor (Dwarf Bearded Dragon)*			
326.	24681	*Poliocephalus poliocephalus (Hoary-headed Grebe)*			
327.		*Polypedilum nr. convexum (SAP)*			
328.		*Polypedilum nubifer*			
329.		*Polypedilum watsoni*			
330.	25722	*Polytelis anthopeplus (Regent Parrot)*			
331.	24767	*Porphyrio porphyrio subsp. bellus (Purple Swamphen)*			
332.		*Procladius DEC sp. P1 (formerly P.paludicola P1 no U-claws)*			
333.		*Procladius paludicola*			
334.		*Procladius sp.*			
335.		*Procordulia affinis*			
336.	25511	*Pseudonaja affinis (Dugite)*			
337.	25259	*Pseudonaja affinis subsp. affinis (Dugite)*			
338.	42416	*Pseudonaja mengdeni (Western Brown Snake)*			
339.	25264	*Pseudonaja nuchalis (Gwardar, Northern Brown Snake)*			
340.	25433	*Pseudophryne guentheri (Crawling Toadlet)*			
341.	24703	*Pterodroma lessonii (White-headed Petrel)*			
342.	24173	*Pteropus scapulatus (Little Red Flying-fox)*			
343.		*Purpureicephalus spurius*			
344.	24245	*Rattus rattus (Black Rat)*	Y		
345.		*Raveniella cirrata*			
346.	24776	*Recurvirostra novaehollandiae (Red-necked Avocet)*			
347.		*Rhantus suturalis*			
348.		*Rheotanytarsus sp. (SFM)*			
349.		*Rheotanytarsus trivittatus*			
350.		*Rheotanytarsus underwoodi*			
351.	48096	*Rhipidura albiscapa (Grey Fantail)*			
352.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
353.		*Richardsonianidae sp.*			
354.		*Riethia v4*			
355.		*Riethia v5*			
356.		*Scirtidae sp.*			
357.		*Scolopendra laeta*			
358.	25534	*Sericornis frontalis (White-browed Scrubwren)*			
359.		*Simuliidae sp.*			
360.	30948	*Smicrornis brevirostris (Weebill)*			
361.	24111	*Sminthopsis gilberti (Gilbert's Dunnart)*			
362.	24645	*Stagonopleura oculata (Red-eared Firetail)*			
363.	24522	*Sterna bergii (Crested Tern)*			
364.		*Sternopriscus browni*			
365.		*Sternopriscus marginatus*			
366.		*Sternopriscus minimus*			
367.		*Sternopriscus sp.*			
368.	24329	*Stictonetta naevosa (Freckled Duck)*			
369.		*Stratiomyidae sp.*			
370.	25597	*Strepera versicolor (Grey Currawong)*			
371.	25589	*Streptopelia chinensis (Spotted Turtle-Dove)*	Y		
372.	25590	*Streptopelia senegalensis (Laughing Turtle-Dove)*	Y		
373.	24259	*Sus scrofa (Pig)*	Y		
374.		*Synsphyronus mimulus*			
375.		*Tabanidae sp.*			
376.	25705	*Tachybaptus novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
377.	24682	*Tachybaptus novaehollandiae subsp. novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
378.	24207	*Tachyglossus aculeatus (Short-beaked Echidna)*			
379.	24331	*Tadorna tadornoides (Australian Shelduck, Mountain Duck)*			
380.	30870	*Taeniopygia guttata (Zebra Finch)*			
381.		*Tandanus bostocki*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
382.		*Tanypodinae sp.*			
383.		*Tanytarsus aff manleyensis*			
384.		*Tanytarsus b1*			
385.		*Tanytarsus fuscithorax/semibarbitarsus*			
386.		*Tanytarsus nr K5*			
387.		*Tanytarsus palmatus*			
388.		*Tanytarsus sp. I (SAP)*			
389.	24167	*Tarsipes rostratus (Honey Possum, Noolbenger)*			
390.		*Taschorema pallescens*			
391.		*Tasmanocoenis tillyardi*			
392.		*Temnocephalidea sp.*			
393.		*Tetragnatha maeandrata*			Y
394.		*Thienemanniella sp. (V19) (SAP)*			
395.	24845	*Threskiornis spinicollis (Straw-necked Ibis)*			
396.	25519	*Tiliqua rugosa*			
397.	25207	*Tiliqua rugosa subsp. rugosa*			
398.		*Tillia davisae*			Y
399.		*Tipulidae sp.*			
400.	25549	*Todiramphus sanctus (Sacred Kingfisher)*			
401.	25723	*Trichoglossus haematodus (Rainbow Lorikeet)*			
402.	25521	*Trichosurus vulpecula (Common Brushtail Possum)*			
403.	24158	*Trichosurus vulpecula subsp. vulpecula (Common Brushtail Possum)*			
404.		*Triplectides australis*			
405.		*Triplectides sp. AV1 (SFM)*			
406.	48147	*Turnix varius (Painted Button-quail)*			
407.	24852	*Tyto alba subsp. delicatula (Barn Owl)*			
408.	24983	*Underwoodisaurus milii (Barking Gecko)*			
409.		*Urodacus novaehollandiae*			
410.		*Urodacus planimanus*			
411.	24386	*Vanellus tricolor (Banded Lapwing)*			
412.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			
413.	25225	*Varanus rosenbergi (Heath Monitor)*			
414.	25526	*Varanus tristis (Racehorse Monitor)*			
415.	24206	*Vespadelus regulus (Southern Forest Bat)*			
416.	24040	*Vulpes vulpes (Red Fox)*	Y		
417.		*Wheenyoides cooki*			
418.		*Xanthagrion erythroneurum*			
419.	25765	*Zosterops lateralis (Grey-breasted White-eye, Silvereye)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Appendix F

Conservation Significant Fauna Species and Likelihood of Occurrence Assessment

Species	Common name	Level of significance		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Birds					
Calyptorhynchus banksii naso	Forest red-tailed black cockatoo	VU	VU	Eucalypt and Corymbia forests, often in hilly interior. More recently also observed in more open agricultural and suburban areas including Perth metropolitan area. Attracted to seeding Corymbia calophylla, Eucalyptus marginata, introduced Melia azdarach and Eucalyptus spp. trees.	Recorded (potential breeding, roosting and foraging habitat may be present)
Calyptorhynchus baudinii	Baudin's cockatoo	EN	EN	Mainly eucalypt forests. Attracted to seeding Corymbia calophylla, Banksia spp., Hakea spp., and to fruiting apples and pears (Johnstone and Storr 1998).	Likely (potential breeding, roosting and foraging habitat may be present)
Calyptorhynchus latirostris	Carnaby's cockatoo	EN	EN	Mainly proteaceous scrubs and heaths and adjacent eucalypt woodlands and forests; also plantations of Pinus spp. Attracted to seeding Banksia spp., Dryandra spp., Hakea spp., Eucalyptus spp., Corymbia calophylla, Grevillea spp., and Allocasuarina spp. (Johnstone and Storr 1998).	Recorded (potential breeding, roosting and foraging habitat may be present)
Apus pacificus	Pacific swift	MI	MI	Aerial, migratory species that is most often seen over inland plains and sometimes above open areas, foothills or in coastal areas. Sometimes occurs over settled areas, including towns, urban areas and cities (Pizzey & Knight 2012).	Possible (potential foraging habitat)
Falco peregrinus	Peregrine falcon	OS	-	Mainly found around cliffs along coasts, rivers, ranges and around wooded watercourses and lakes (Johnstone and Storr 1998).	Possible (potential habitat present)

Species	Common name	Level of significance		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Motacilla cinerea	Grey wagtail	MI	MI	In Australia mostly near running water in disused quarries,, sandy and rocky strams in escarpments and rainforests, sewage ponds, ploughed fields and airfields (Pizzey & Knight 2012).	Possible (potential marginal habitat present)
Actitis hypoleucos	Common sandpiper	MI	MI	Edge of sheltered waters salt or fresh, e.g. estuaries, mangrove creeks, rocky coasts, near-coastal saltlakes (including saltwork ponds), river pools, lagoons, claypans, drying swamps, flood waters, dams and sewage ponds. Preferring situations wherelow perches are available (Johnstone & Storr 1998).	Unlikely (no suitable habitat)
Botaurus poiciloptilus	Australasian bittern	EN	EN	In or over water, in tall reedbeds, sedges, rushes, cumbungi, lignum. Also occurs in ricefields, drains in tussocky paddocks and occasionally in saltmarshes and brackish wetlands.	Unlikely (no suitable habitat)
Calidris acuminata	Sharp-tailed sandpiper	MI	MI	Occurs in tidal mudflats, saltmarshes and mangroves, as well as, shallow fresh,brackish or saline inland wetlands. It is also known from floodwaters, irrigated pastures and crops, sewage ponds, saltfields.	Unlikely (no suitable habitat)
Calidris ferruginea	Curlew sandpiper	CR	CR (MI)	Mainly shallows of estuaries and near-coastal saltlakes (including saltwork ponds) and drying near-coastal freshwater lakes and swamps. Also beaches and near-coastal sewage ponds.	Unlikely (no suitable habitat)

Species	Common name	Level of significance		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Calidris melanotos	Pectoral sandpiper	MI	MI	Mainly fresh waters (swamps, lagoons, river pools, irrigation channels and sewage ponds); also samphire flats around estuaries and saltlakes (Johnstone & Storr 1998).	Unlikely (no suitable habitat)
Leipoa ocellata	Mallefowl	VU	VU	Scrubs and thickets of Eucalyptus spp., Melaleuca lanceolata and Acacia linophylla; also other dense litter-forming shrublands. Attracted to fallen wheat in stubbles and along roads (Johnstone and Storr 1998).	Unlikely (locally extinct)
Numenius madagascariensis	Eastern curlew	CR	CR (MI)	Mainly tidal mudflats; also reef flats, sandy beaches and rarely near-coastal lakes (including saltwork ponds) (Johnstone and Storr 1998).	Unlikely (no suitable habitat)
Oxyura australis	Blue-billed duck	P4	-	Mainly deeper freshwater swamps and lakes; occasionally saltlakes and estuaries freshened by flood waters (Johnstone and Storr 1998).	Unlikely (no suitable habitat)
Pandion haliaetus	Osprey	MI	MI	Coasts, estuaries, bays, inlets, islands, and surrounding waters; coral atolls, reefs, lagoons, rock cliffs, stacks (Pizzey & Knight 2012).	Unlikely (no suitable habitat)
Rostratula australis	Australian painted snipe	EN	EN	Mainly shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans (Marchant and Higgins 1993).	Unlikely (no suitable habitat)
Tringa nebularia	Common greenshank	MI	MI	Mudflats, estuaries, saltmarshes, margins of lakes, wetlands, claypans (fresh amd saline), commercial saltfields, sewage ponds (Pizzey & Knight 2012).	Unlikely (no suitable habitat)

Species	Common name	Level of significance		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Fish					
Geotria australis	Pouched lamprey	P3	-	Marine, estuarine and coastal rivers and streams. Adults live in Southern Ocean and migrate upstream to spawn. Larvae live in muddy burrows in the upper reaches of streams (Bray and Gomon 2018).	Unlikely (no suitable habitat)
Invertebrates					
Westralunio carteri	Carter's freshwater mussel	VU	VU	Occurs in greatest abundance in slower flowing streams with stable sediments that are soft enough for burrowing amongst woody debris and exposed tree roots. Salinity tolerance quite low (Morgan et al. 2011).	Unlikely (no suitable habitat)
Euoplos inornatus	Inornate trapdoor spider	P3	-	Unknown.	Unlikely (species poorly understood (habitat information based only on two records). record exists 4 km north-east of the site but probably unlikely to occur in the site given the amount of disturbance that has occurred)

Species	Common name	Level of significance		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Idiosoma sigillatum	Swan Coastal Plain shield-backed trapdoor spider	P3	-	Widely distributed in sandy areas on the Swan Coastal Plain and on Rottnest Island (Prince 2003).	Unlikely (species poorly understood. limited records exist within the wider area of the site. probably unlikely to occur in the site given the amount of disturbance that has occurred)
Mammals					
Isoodon fusciventer	Quenda	P4	-	Dense scrubby, often swampy, vegetation with dense cover up to one metre high (DEC 2012)	Possible (suitable habitat in part of site)
Bettongia penicillata ogilbyi	Woylie	CR	EN	Woodlands and adjacent heaths with a dense understorey of shrubs, particularly Gastrolobium spp. (TSSC 2018).	Unlikely (no suitable habitat and locally extinct)
Dasyurus geoffroii	Chuditch	VU	VU	Wide range of habitats from woodlands, dry sclerophyll forests, riparian vegetation, beaches and deserts. Appears to utilise native vegetation along road sides in the wheatbelt (DEC 2012b).	Unlikely (no suitable habitat)
Falsistrellus mackenziei	Western false pipistrelle	P4	-	High rainfall forests dominated by jarrah, karri, marri, and tuart. Occupies hollow logs for breeding and resting (Van Dyck and Strahan 2008). Also known to utilise Banksia woodland on the Swan Coastal Plain (Hosken and O'Shea 1995).	Unlikely (no suitable habitat)
Phascogale tapoatafa wambenger	South-western brush-tailed phascogale	CD	-	Dry sclerophyll forests and open woodlands that contain hollow-bearing trees but a sparse ground cover (Triggs 2003).	Unlikely (no suitable habitat)

Species	Common name	Level of significance		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Pseudocheirus occidentalis	Western ringtail possum	CR	CR	On the Swan Coastal Plain in Agonis flexuosa woodlands and Agonis flexuosa/ Eucalyptus gomphocephala forests. Also Eucalyptus marginata forests (DBCA 2017).	Unlikely (no suitable habitat and locally extinct)
Setonix brachyurus	Quokka	VU	VU	On the mainland mostly dense streamside vegetation or shrubland and heath areas, particularly around swamps (Cronin 2007).	Unlikely (no suitable habitat and locally extinct)
Hydromys chrysogaster	Rakali	P4	-	Areas with permanent water, fresh, brackish or marine. Likely to occur in all major rivers and most of the larger streams as well as bodies of permanent water in the lower south west (Christensen et al. 1985).	Unlikely (no suitable habitat)

Note: CE=critically endangered, EN=endangered, VU=vulnerable, CD=conservation dependent, MI=migratory, OS=other specially protected, P1=Priority 1, P2=Priority 2, P3=Priority 3, P4=Priority 4. Species recorded or considered to potentially occur within the site are shaded green.

References

Bush, B., Maryan, B., Browne-Cooper, R. and Robinson, D. 2007, Reptiles and Frogs in the Bush: Southwestern Australia, UWA Press, Nedlands.
Bray, D. J. and Gomon, M. F. 2018, Pouch Lamprey, Geotria australis.
Christensen, P. and Strahan, R. 1984, The Australian Museum Complete Book of Australian Mammals, Angus and Robertson Publishers, Sydney.
Cronin, L. 2007, Cronin's Key Guide to Australian Wildlife, Oxford University Press, Oxford, United Kingdom.
Department of Biodiversity, Conservation and Attractions (DBCA) 2017, Fauna Profile: Western Ringtail Possum Pseudocheirus occidentalis, Perth, Western Australia.
Johnstone, R. E. and Storr, G. M. 1998, Handbook of Western Australian Birds. Volume 1 - Non-Passerines (Emu to Dollarbird), Western Australian Museum, Perth.
Marchant, S. and Higgins, P. J. 1993, Handbook of Australian, New Zealand and Antarctic Birds. Volume two - Raptors to Lapwings, Oxford University Press, Melbourne, Victoria.
Morgan, D. L., Beatty, S. J., Klunzinger, M. W., Allen, M. G. and Burnham, Q. E. 2011, Field Guide to the Freshwater Fishes, Crayfishes and Mussels of South Western Australia, SERCUL, Perth, Western Australia.

Species	Common name	Level of significance		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Morcombe, M. 2004, Field Guide to Australian Birds, Steve Parish Publishing, Archerfield, Queensland. Nevill, S. 2005, Guide to the Wildlife of the Perth Region, Simon Nevill Publications, Perth, Western Australia. Pizzey, G. and Knight, F. 2012, The Fieldguide to the Birds of Australia, Harper Collins Publishers, Sydney, Australia. Rentz, D. C. F. 1993, Tettigoniidae of Australia 2. The Austrosaginae, Zaprochilinae and Phasmodinae, CSIRO. Threatened Species Scientific Committee (TSSC) 2018, Conservation advice for Bettongia penicillata (woylie), Department of the Environment, Canberra. Triggs, B. 2003, Tracks, Scats and Other Traces A Field Guide to Australian Mammals, Oxford University Press Australia, Melbourne, Victoria. Department of Environment and Conservation (DEC) 2012, Fauna profiles, Quenda Isoodon obesulus (Shaw, 1797), Perth. Van Dyck, S. and Strahan, R. 2008, The Mammals of Australia, Queensland Museum, Brisbane. Wilson, S. and Swan, G. 2008, A Complete Guide to Reptiles of Australia, Reed New Holland, Sydney.					

Appendix G

Fauna Species List

Fauna List

Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine

Category	Status	Species name	Common name	Record type
Birds				
		Anthochaera carunculata	Red wattlebird	Sight
		Cacatua roseicapilla	Galah	Sight
	VU	*Calyptorhynchus banksii naso*	Forest red-tailed black cockatoo	Sight, call
	EN	*Calyptorhynchus latirostris*	Carnaby's cockatoo	Call
		Chenonetta jubata	Australian wood duck	Sight
		Cracticus tibicen	Australian magpie	Sight
		Cracticus torquatus	Grey butcherbird	Sight
		Grallina cyanoleuca	Magpie-lark	Sight
		Phaps chalcoptera	Common bronzewing	Sight
		Platycercus spurius	Red-capped parrot	Sight
		Platycercus zonarius	Australian ringneck	Sight
		Rhipidura leucophrys	Willie wagtail	Sight
		Threskiornis moluccus	Australian white ibis	Sight
	*DP	*Trichoglossus haematodus*	Rainbow lorikeet	Call
		Zosterops lateralis	Grey-breasted white-eye	Sight

Note: * denotes introduced fauna species, DP=declared pest under the BAM Act, EN=Endangered under the EPBC Act, VU=Vulnerable under the EPBC Act

Appendix 3

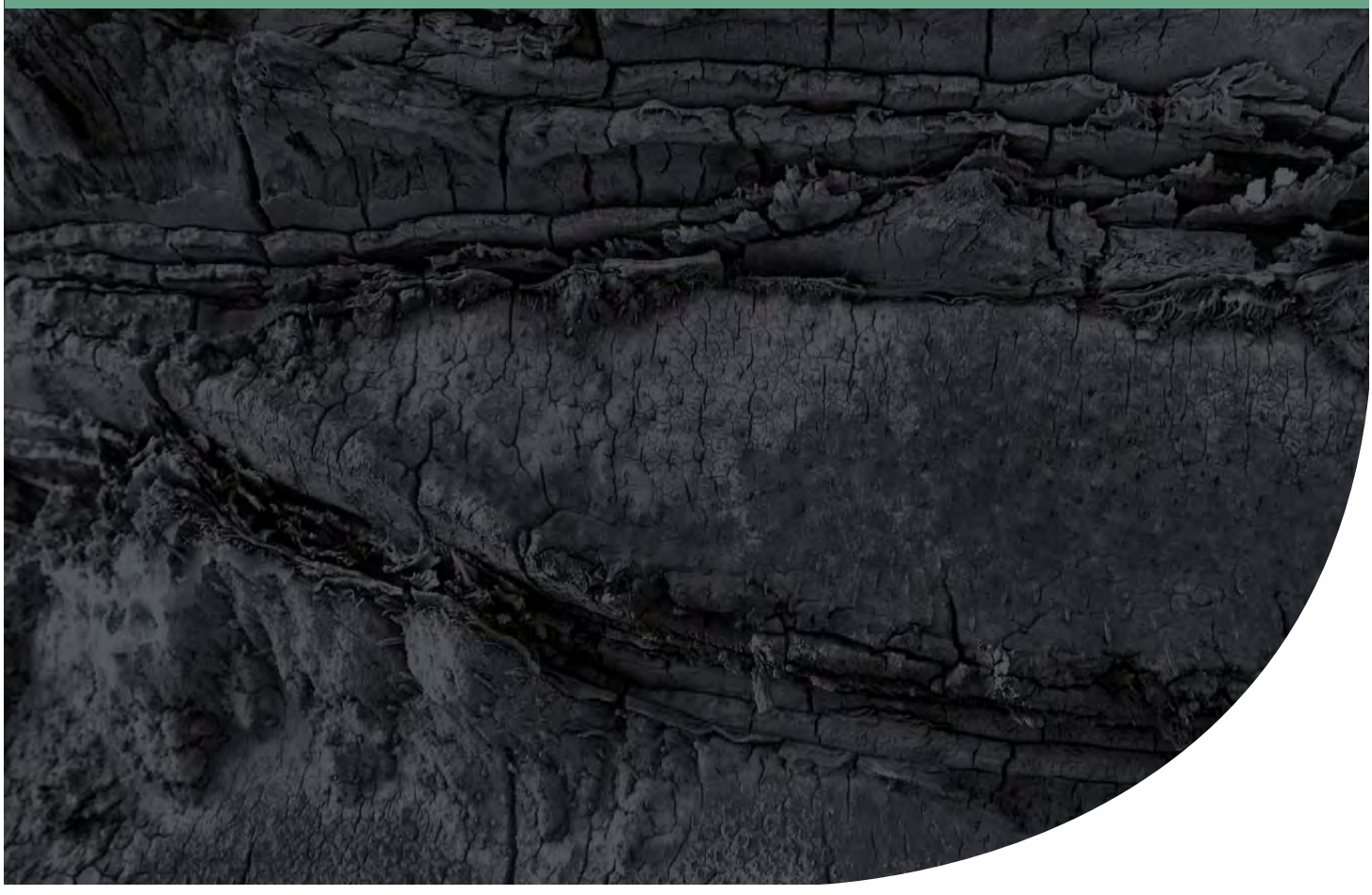
Bushfire Management Plan (BMP)

Bushfire Management Plan

Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine LSP

Project No: EP20-064(02)

Prepared for Stron Pty Ltd
October 2021



Document Control

Doc name:	Bushfire Management Plan Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine LSP				
Doc no.:	**EP20-064(02)--005**				
Version	**Date**	**Author**		**Reviewer**	
1	August 2020	Bianca Bertelli	BRB	Anthony Rowe	AJR
	Document submitted to client for review.				
A	March 2021	Bianca Bertelli	BRB	Anthony Rowe	AJR
				Kirsten Knox	KK
	Document updated in response to DFES comments				
B	October 2021	Dave Coremans	DPC	Dana Elphinstone	DAE
	Updated in response to DPLH comments.				

Disclaimer:

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

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

Notwithstanding the precautions recommended in this document, it should always be remembered that bushfires burn under a wide range of conditions which can be unpredictable. An element of risk, no matter how small, will always remain. The objective of the Australian Standard AS 3959:2018 is to "prescribe particular construction details for buildings to reduce the risk of ignition from a bushfire" (Standards Australia 2018). Building to the standards outlined in AS 3959 does not guarantee a building will survive a bushfire or that lives will not be threatened by the effects of bushfire attack.

Executive Summary

Stron Pty Ltd (the proponent) is seeking to progress the *Lot 9001 Utley Road & Lot 9002 Wattle Road - Serpentine Structure Plan* (herein referred to as the 'structure plan') prepared by HEX Design and Planning on behalf of the proponent. The structure plan outlines the proposed development for rural residential purposes over Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine (herein referred to as 'the site'). The site is approximately 91.30 hectares (ha) in size and is generally bound by Wattle Road to the north, existing rural-residential landholdings to the east, Utley Road to the South and rural land to the west.

The entire site is located within a 'bushfire prone area' under the state-wide Map of Bush Fire Prone Areas prepared by the Office of Bushfire Risk Management (OBRM 2019). The identification of a site within an area declared as bushfire prone necessitates that a further assessment of the determined bushfire risk affecting the site (in accordance with *Australian Standard 3959:2018 Construction of buildings in bushfire prone areas* (AS 3959)) and the satisfactory compliance of the proposal with the policy measures described in *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (SPP 3.7) (WAPC 2015) and the *Guidelines for Planning in Bushfire Prone Areas Version 1.3* (the Guidelines) (WAPC and DFES 2017).

The purpose of SPP 3.7, and its policy intent, is best summarised as preserving life and reducing the impact of bushfire on property and infrastructure through effective risk-based land-use planning. Pursuant to SPP 3.7, this BMP examines the likely long-term bushfire risk risks and advances responses that will make the ultimate use of the land suitable for its intended purpose.

The majority of the site is cleared of trees and been classified as 'grassland' (Class G), with patches of 'woodland' (Class B) vegetation identified in the central portion of the site. Two small areas of 'scrub' (Class D) vegetation has been identified external to the site to the north-east and west within adjacent rural residential lots, in addition to patches of 'woodland' (Class B) to the north and east. 'Forest' (Class A) vegetation has been identified to the east and west of the site within unmanaged rural landholdings and the Wattle and Utley Road reserves to the north and south of the site. 'Grassland' (Class G) vegetation has been identified surrounding the site to the north, east, south and west associated with unmanaged rural paddocks.

In order to consider the likely bushfire risk applicable to future development within the site, a post development vegetation classification scenario has been assumed in which all classified vegetation, will be removed or managed to a 'low threat' standard. This will be enforced through a notification placed on future titles advising prospective purchasers that existing vegetation and future landscaping within each private lot is required to be maintained to a 'low threat' standard in accordance with AS 3959:2018 cl,.2.2.3.2(f). This will also support the Shire of Serpentine Jarrahdale Firebreak and Fuel Hazard Reduction Notice which requires landowners of lots greater than 1 acre (0.40 ha) to undertake clearing (i.e. removal of dead vegetation and cropping of grass) within open paddocks and along the boundaries of properties to minimise the spread of bushfire. All classified vegetation outside of the site is assumed to remain in its existing condition, and all existing management of vegetation will continue in the future.

Based on the identified hazards and existing land management, the BMP has been able to demonstrate that within the structure plan area (and associated development layout) there is

sufficient area (i.e. a development site) with which a habitable building could be located so that a BAL rating of BAL-29 or less is achieved. The outcomes of this BMP demonstrate that as development progresses, it will be possible for an acceptable solution to be adopted for three elements of the bushfire protection criteria as outlined in the Guidelines (Element 1 (location), Element 2 (siting and design) and Element 4 (water)). This includes:

- **Location:** all future proposed habitable buildings can be located in an area subject to a BAL rating of BAL-29 or less. Therefore, future habitable buildings can be located in an area that will, on completion, be subject to a low or moderate bushfire hazard.
- **Siting and Design:** each lot (based on the proposed development layout) is appropriately sized to accommodate a future building that is able to achieve a BAL rating of BAL-29 or less based on the developable land. all future habitable buildings can be sited within the proposed development so that BAL-29 or less can be achieved based on the proposed structure plan through in lot setbacks.
- **Vehicular Access:** the proposed structure plan provides for an interconnected road network within the site that will connect to both Utley Road and Wattle Road. The new road network will result in the creation of three new intersections; two on Wattle Road and the other on Utley Road. A fourth connection via a direct connection to Salmon Bark Road (through an existing road reserve) will also be provided. These road connections will provide egress options to the north, east, south and west of the site.
- **Water:** the development will be provided with a permanent and reticulated water supply to support onsite firefighting requirements.

The measures to be implemented through this structure plan process have been outlined as part of this BMP and can be used to support future planning and development approval processes. If the current development layout changes at the future subdivision process, a revised BMP is likely to be required to support the subdivision application.

Table of Contents

List of Tables

List of Plates

Figures

Appendices

List of Abbreviations

Table A1: Abbreviations – General terms

General terms	
AHD	Australian Height Datum
AS	Australian Standard
APZ	Asset Protection Zone
BAL	Bushfire Attack Level
BMP	Bushfire Management Plan
BPAD	Bushfire Planning and Design
EEP	Emergency Evacuation Plan
ESL	Emergency Services Levy
FDI	Fire Danger Index
FZ	Flame Zone

Table A2: Abbreviations – Organisations

Organisations	
DBCA	Department of Biodiversity Conservation and Attractions
DoW	Department of Water (now known as Department of Water and Environment Regulation)
DFES	Department of Fire and Emergency Services
DWER	Department of Water and Environmental Regulation
OBRM	Office of Bushfire Risk Management
SES	State Emergency Services
WAPC	Western Australian Planning Commission

Table A3: Abbreviations – Legislation and policies

Legislation	
Guidelines	*Guidelines for Planning in Bushfire Prone Areas version 1.3 (WAPC and DFES 2017)*
SPP 3.7	*State Planning Policy 3.7 Planning in Bushfire Prone Areas* (WAPC 2015)

Table A4: Abbreviations – Planning and building terms

Planning and building terms	
AS 3959	*Australian Standard 3959-2018 Construction of buildings in bushfire prone areas*
TPS	Town Planning Scheme
POS	Public Open Space

1 Introduction

1.1 Background

Stron Pty Ltd (the proponent) is seeking to progress the *Lot 9001 Utley Road & Lot 9002 Wattle Road - Serpentine Structure Plan* (herein referred to as the 'structure plan') prepared by HEX Design and Planning on behalf of the proponent, provided in **Appendix A**. The Structure Plan outlines the proposed development for rural residential purposes over Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine (herein referred to as 'the site'), as shown in **Figure 1.** The site is approximately 91.30 hectares (ha) in size and is generally bound by Wattle Road to the north, existing rural-residential landholdings and Salmon Bark Road to the east, Utley Road to the south and rural land to the west.

The entire site is located within a 'bushfire prone area' under the state-wide Map of Bush Fire Prone Areas prepared by the Office of Bushfire Risk Management (OBRM 2019) as shown in **Plate 1**. The identification of a site within an area declared as bushfire prone necessitates that a further assessment of the determined bushfire risk affecting the site (in accordance with *Australian Standard 3959:2018 Construction of buildings in bushfire prone areas* (AS 3959)) (Standards Australia 2018) and the satisfactory compliance of the proposal with the policy measures described in *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (SPP 3.7) (WAPC 2015) and the *Guidelines for Planning in Bushfire Prone Areas Version 1.3* (the Guidelines) (WAPC and DFES 2017).

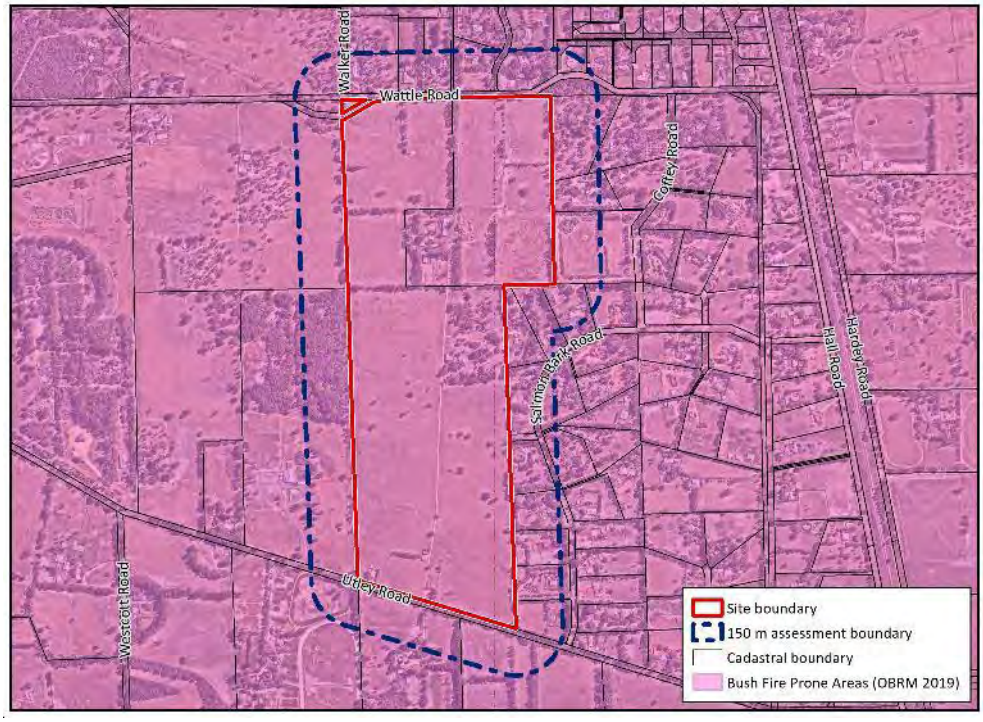


Plate 1: The entirety of the site identified as 'bushfire prone areas' (as indicated in purple) under the state-wide Map of Bush Fire Prone Areas (OBRM 2020).

1.2 Aim of this report

The purpose of this BMP is to assess bushfire hazards within the site and nearby areas and ensure that the threat posed by any identified hazards can be appropriately mitigated and managed. It has been prepared to support the proposed structure plan for the site and addresses the requirements of SPP 3.7 (WAPC 2015), the Guidelines (WAPC and DFES 2017) and AS 3959 (Standards Australia 2018). The document provides an assessment of the general bushfire management strategies to be considered as part of future development of individual dwellings within proposed lots and includes:

- An assessment of the existing classified vegetation in the vicinity of the site (within 150 m as required by SPP 3.7) and consideration of bushfire hazards that will exist in the post development scenario (**Section 3**).
- Commentary on how the future development can achieve the bushfire protection criteria outlined within the Guidelines including an indication of BAL ratings likely to be applicable to future dwellings (**Section 5**).
- An outline of the roles and responsibilities associated with implementing this BMP (see **Section 6**).

1.3 Statutory policy and framework

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

- *Bush Fires Act 1954*
- *Planning and Development Act 2005* and associated regulations
- *Building Act 2011* and associated regulations
- *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (WAPC 2015)
- *Guidelines for Planning in Bushfire Prone Areas version 1.3* (WAPC and DFES 2017)
- *Australian Standard AS 3959 – 2018 Construction of buildings in bushfire prone areas* (Standards Australia 2018)

In accordance with Section 2.2 of the Guidelines, the policy measures of SPP 3.7 and the Guidelines are not to be applied retrospectively or inflexibly. It is noted that approximately four existing buildings within the central north portion of the site are intended to be retained within the future development. Therefore, this BMP is not intended to apply to the existing habitable buildings present, only to the new habitable buildings to be constructed as part of the proposed development of the site. However, where possible bushfire risk to life, property and infrastructure associated with the existing buildings will be minimised in accordance with SPP 3.7.

1.4 Description of the proposed development

The site is proposed to be developed for rural-residential purposes, in line with the proposed structure plan layout provided in **Appendix A.** The development within the site will include:

- a total of 39 rural-residential lots with a minimum lot size of 2 hectares;
- a new public road that will connect with the existing road network.

The proposed development within the site is consistent with the 'Rural' zoning of the site under the Metropolitan Region Scheme (MRS), and the 'Special rural (SR28)' zoning under the Shire of Serpentine Jarrahdale Town Planning Scheme (TPS) No. 2.

More broadly, the site is located within an area where land uses are rural-residential. The site is located in an area with an existing public road network, with Wattle Road located to the north and Utley Road to the south of the site.

1.5 Description of land characteristics

The site is relatively flat, with elevation ranging from 34 m Australian Height Datum (m AHD) in the north west corner of the site, to 40 m AHD across the middle east portion of the site (DPIRD 2020). The topographical characteristics of the site are shown in **Figure 1**.

The site has predominantly been cleared of native vegetation, with a review of aerial imagery indicating that the majority of the site was cleared prior to 1965 for agricultural purposes, with the exception of a patch of remnant vegetation within the central portion of the site (Landgate 2019). Vegetation in the central portion of the site was gradually thinned out to allow for the construction of a rural residential dwelling and associated farming infrastructures. Most of the site has then been retained as a predominately cleared landscape from 1965 until present, with areas of windbreak planting occurring along paddock edges and internal driveways associated with the agricultural land use (cattle grazing and horse agistment with low stocking rates).

Surrounding land use includes:

- Rural-residential properties to the north and east of the site.
- Rural landholdings with intensive agricultural land use to the south and west of the site.
- The Perth – Australind rail line further to the east of the site.
- Bush Forever Site 375 'Paul Robinson Park' approximately 1.5 km to the north-east of the site.
- The primary regional South Western Highway lies approximately 2.5 km east of the site.

2 Environmental Considerations

In accordance with the *Bushfire Management Plan – BAL Contour* template prepared by the Department of Planning, Lands and Heritage (2018), this BMP has considered whether there are any environmental values that may require specific consideration through either protection, retention or revegetation. To support this, a review of publicly available databases and site-specific investigations has been undertaken, with particular reference to the Shared Location Information Platform (SLIP) databases. A summary of the search results has been provided in **Table 1**.

The majority of the site has been historically cleared to allow for agricultural activities between 1985 and 2000 (Landgate 2019). The central portion of the site currently contains farming associated infrastructure which extends from a smaller rural residential dwelling. Windbreak tree planting is located along the perimeter and transecting the centre of the site along existing driveways and lot boundaries.

A reconnaissance flora, vegetation and fauna assessment was conducted by Emerge Associates over the site on the 23rd June 2020. The survey indicated the site is largely dominated by areas of 'parkland cleared' vegetation with scattered remnant native trees in 'completely degraded' condition. No vegetation within the site has been identified as significant (i.e. threatened ecological communities or threatened flora) or of regional or local significance (Emerge Associates 2020b).

Table 1: Summary of potential environmental considerations that may be associated with the site (based on a search of the SLIP databases)

Key environmental feature (information in brackets refers to mapping data source)	Yes / no / potentially occurring within the site	If yes / potentially, describe value that may be impacted
Conservation category wetlands and buffer (Geomorphic wetlands, Swan Coastal Plain (DBCA-019)	Yes	A review of the Geomorphic Wetlands, Swan Coastal Plain dataset (DBCA 2018) identifies two wetlands extending across the site, described below: • REW UFI 15364 (damp land basin) extends across the northern portion of the site. • MUW UFI 16021 (plausplain flat) extends across the southern portion of the site. MUWs do not require specific conservation or protection measures and therefore the presence of this MUW within the site does not represent a constraint to the proposed rural residential development. Despite the geomorphic wetlands database indicating the presence of a REW across the northern portion of the site, no prominent natural wetland landform features or areas supporting intact native wetland vegetation were recorded in the site surveys (Emerge Associates 2020a). Notwithstanding, specific management/protection of the hydrological function of REWs in accordance with *Better Urban Water Management* is detailed as part the Local Water Management Strategy (LWMS) prepared to support the structure plan.
Waterways (DWER-031)	No	There are no defined natural waterways traversing the site, however, there are multiple artificial drainage channels, most notably in the central portion of the site and along the driveway in the northern portion of the site (Emerge Associates 2020a). A LWMS has been prepared to support the preparation of the structure plan and includes detailed management approaches for groundwater and stormwater drainage.

Table 1: Summary of potential environmental considerations that may be associated with the site (based on a search of the SLIP databases) (continued).

Key environmental feature (information in brackets refers to mapping data source)	Yes / no / potentially occurring within the site	If yes / potentially, describe value that may be impacted
RAMSAR wetlands (DBCA-010)	No	Not applicable. No RAMSAR wetlands are located within the site.
Threatened and priority flora (DBCA-036)	No	The flora and vegetation survey undertaken by Emerge Associates (2020b) did not identify any threatened or priority flora species within the site, and due to the historical clearing, it is unlikely that any threatened or priority flora species are likely to occur within the site.
Threatened and priority fauna (DBCA-037)	Potentially	Given the previous clearing for agriculture the site now generally consists of parkland cleared areas comprising of pasture grasses, with scattered paddock trees. Fauna habitat values are therefore limited and restricted to the scattered paddock trees, which will provide potential habitat values for opportunistic and mobile fauna species. Notwithstanding, vegetation within the site was identified as representing potential foraging and breeding habitat for three species of threatened black cockatoo species and the quenda (Priority 4) (Emerge Associates 2020b). The structure plan design provides opportunities for retention of native vegetation and associated habitat for black cockatoos within future rural-residential lots and wide road reserves, while still minimising bushfire risk through maintenance of bushfire hazards in accordance with this BMP.
Threatened ecological communities (DBCA-038)	No	Not applicable. No TECs are identified within the site. In addition, the flora and vegetation survey undertaken by Emerge Associates (2020b) did not identify any TECs within the site, and due to the historical clearing, it is unlikely that any TECs are likely to occur within the site.
Bush Forever areas (DOP-071)	No	Not applicable. It is noted Bush Forever Site 375 occurs approximately 1.6 km north-east of the site however, the proposed development of the site is not likely to impact on the site and no further consideration of this factor is required.
Clearing regulations – Environmentally Sensitive Areas (DWER-046)	No	Not applicable. The site is not mapped as occurring within an ESA and therefore no further consideration of this factor is required.
Swan Bioplan Regionally Significant Natural Areas 2010 (DWER-070)	No	Not applicable.
Aboriginal heritage (DAA-001)	No	Not applicable. There are no Registered Aboriginal Sites or Other Heritage Places located within or adjacent to the site.
Non-indigenous heritage (SHO-003)	No	Not applicable. No registered non-indigenous heritage sites were identified within or nearby to the site.

2.1 Native vegetation – modification and clearing

The existing stand of remnant native trees within the central portion of the site is proposed to be modified to low threat and retained within future rural-residential lots. Where the spacing of individual or groups of trees is less than 15 metres apart, or canopies of existing trees are touching, branches will be lopped to provide for a separation between tree crowns. In addition, retained trees will be low pruned to 2 m from the ground and the grassy understory will be managed through regular mowing/slashing of grass to less than 100 millimetres (mm) in height on an ongoing basis. Scattered windbreak trees may also be retained within future lots or road reserves where future earthworks allow.

All vegetation outside the site is assumed to remain in its existing condition. No areas of native vegetation outside the site are proposed to be cleared by the proponent as part of the future development of the site.

2.2 Revegetation and landscape plans

No revegetation is proposed as part of the development, and no areas of public open space are proposed within the site. The rural-residential lots proposed to be created in accordance with the structure plan will be adequately sized to allow for the creation of future gardens within lots. Any gardens created as part of the proposed development will be designed to achieve low threat vegetation in accordance with Section 2.2.3.2 of AS 3959. This may include the retention of existing trees within lots, which will be managed to a low threat standard. Ongoing management is likely to include:

- Regular mowing/slashing of grass to less than 100 mm in height (where present).
- Irrigation of grass and garden beds (where required).
- Regular removal of weeds and built up dead material (such as fallen branches, leaf litter etc.).
- Low pruning of trees (branches below 2 m in height removed where appropriate/applicable).
- Application of ground/surface covers such as mulch or non-flammable materials as required/applicable.

3 Bushfire Assessment Results

Bushfire risk for the site has been considered following the methods described in the Guidelines (WAPC and DFES 2017) and in AS 3959.

Appendix Two of the Guidelines provides a description for undertaking a broad level of assessment using the vegetation classifications from AS 3959. The purpose is to identify at the strategic level the Bushfire Hazard Level (BHL) and the likely impact and intensity of a bushfire attack. A BHL uses 150 m to establish the sample area from which to determine the fire run and intensity of a bushfire attack.

The objective of AS 3959 is to reduce the risk of ignition and loss of a building to bushfire. It provides a consistent method for determining a radiant heat level (radiant heat flux) as a primary consideration of bushfire attack on a building or object. It measures the Bushfire Attack Level as the radiant heat level (kWm^2) over a distance of 100 m.

Bushfire risk for the site has been appropriately considered in the specific context of the Guidelines and AS 3959.

The objective of AS 3959 is to reduce the risk of ignition and loss of a building to bushfire. It provides a consistent method for determining a radiant heat level (radiant heat flux) as a primary consideration of bushfire attack on a building or object. It also prescribes simple construction responses that can resist the determined radiant heat level at a given distance from the fire and is based on six Bushfire Attack Level (BAL) ratings: BAL-LOW, BAL-12.5, BAL-19, BAL-29, BAL-40 and BAL-FZ, although building survival is not guaranteed.

Not all vegetation is a classified bushfire risk. Vegetation and ground surfaces that are exempt from classification as a potential hazard is identified as low threat under Section 2.2.3.2 of AS 3959. Low threat vegetation includes the following:

a) Vegetation of any type that is more than 100 m from the site.
b) Single areas of vegetation less than 1 ha in area and not within 100 m of other areas of vegetation being classified.
c) Multiple areas of vegetation less than 0.25 ha in area and not within 20 m of the site, or each other or of other areas of vegetation being classified.
d) Strips of vegetation less than 20 m in width (measured perpendicular to the elevation exposed to the strip of vegetation) regardless of length and not within 20 m of the site or each other, or other areas of vegetation being classified.
e) Non-vegetated areas, that is, areas permanently cleared of vegetation, including waterways, exposed beaches, roads, footpaths, buildings and rocky outcrops.
f) Vegetation regarded as low threat due to factors such as flammability, moisture content or fuel load. This includes grassland managed in a minimal fuel condition, mangroves and other saline wetlands, maintained lawns, golf courses (such as playing areas and fairways), maintained public reserves and parklands, sporting fields, vineyards, orchards, banana plantations, market gardens (and other non-curing crops), cultivated gardens, commercial nurseries, nature strips and wind breaks.

3.1 Bushfire attack level (BAL) assessment

In accordance with Appendix Five of the Guidelines, there is an option to complete a bushfire hazard level assessment to support structure plans, Therefore, this BMP includes a bushfire hazard level assessment as well as a method 1 BAL assessment in order to determine the BAL ratings likely to be applicable to future habitable buildings based on the vegetation classifications and effective slopes detailed in **Table 2**.

3.1.1 Assessment inputs

The assignment of vegetation classifications within 150 m of the site for context and 100 m for impact is based on an assessment of vegetation structure, which includes consideration of the various fuel layers of different vegetation types. For example, fuel layers in a typical forest environment can be broken-down into five segments as illustrated in **Plate 2** below. These defined fuel layers are considered when determining the classification of vegetation and associated bushfire hazard levels.

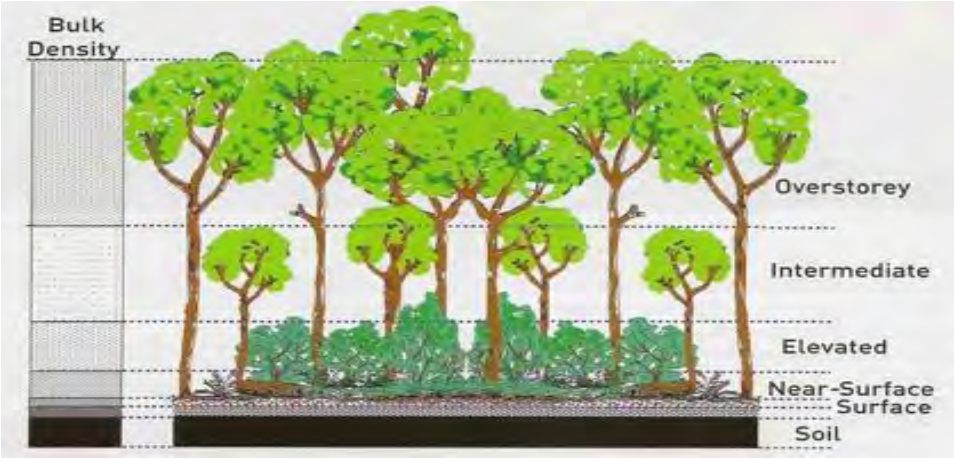


Plate 2: The five fuel layers in a forest environment that could be associated with fire behaviour (Gould et al. 2007)

An assessment of existing vegetation within the site and surrounding 150 m was undertaken on 13 December 2018 in accordance with AS 3959 and the Guidelines.

Table 2 below outlines the type of vegetation observed within and surrounding the site, the classification of each area of vegetation in accordance with Section 2.2.3 and Table 2.3 of AS 3959, and its assumed post-development classification and any associated management of this vegetation (where applicable).

As outlined in **Table 2:**

- The pre-development AS 3959 vegetation classifications (and associated photo locations) are shown in **Figure 2.**
- The post-development AS 3959 vegetation classifications are shown **Figure 3.**
- The effective slope for each area of classified vegetation present in the post-development scenario is shown in **Figure 4.**

Table 2: Vegetation classification, effective slope and future management

Pre-development (see Figure 2)			Post development (see Figure 3)	
Plot no.	**AS 3959 classification**	**Site photo/s (location points shown in Figure 2)**	**Plot no.**	**AS 3959 classification, effective slope and assumptions**
1-3	**AS 3959 classification (Figure 2):** Forest (Class A) **Bushfire hazard level:** Extreme Patches of forest vegetation are located external to the site within adjacent rural-residential landholdings and the Wattle Road and Utley Road reserves to the north and south. This vegetation is characterised by a mixture of planted *Eucalyptus spp*. and native *Corymbia calophylla* (marri) trees in addition to an understory of native shrub species. Areas of forest vegetation are characterised by surface, near-surface, elevated, intermediate and overstory fuel layers. A small stand of juvenile *Eucalyptus spp.* trees, less than 6 m in height are located to the east of the site. This patch of vegetation has been classified as Forest (Class A) vegetation based on the future growth of the trees to a height greater than 6 m.	 *Photo location 1: Forest vegetation to the north of the site abutting Wattle Road.*  *Photo location 2: Forest vegetation to the south of the site within the Utley Road reserve.*  *Photo location 3: Forest vegetation to the west of the site.*  *Photo location 24(20): Forest vegetation to the north of the site within the Wattle Road reserve.*	1-3	**AS 3959 classification (Figure 3):** Forest (Class A) **Effective slope (Figure 4):** Flat/upslope Forest vegetation external to the site within adjacent rural-residential landholdings and within the Wattle Road and Utley Road reserves will be retained as future development progresses. Therefore, this vegetation will pose a permanent bushfire risk to the site.

Table 2: Vegetation classification, effective slope and future management (continued)

Pre-development (see Figure 2)			Post development (see Figure 3)	
Plot no.	**AS 3959 classification**	**Site photo/s (location points shown in Figure 2)**	**Plot no.**	**AS 3959 classification, effective slope and assumptions**
4 & 5	**AS 3959 classification (Figure 2):** Woodland (Class B) **Bushfire hazard level:** Extreme Woodland vegetation is located within the central portion of the site surrounding an existing residential dwelling. Woodland vegetation within the site is characterised by an open woodland of *Corymbia calophylla* (marri) and *Eucalyptus marginata* (jarrah) with a 10 - 30% foliage cover over the area, growing to a height of 10 – 20 m with an understory of non-native grassland and isolated shrubs. Woodland vegetation has also been identified to the north, east and west of the site within adjacent rural-residential landholdings and is characterised principally by an overstorey of marri over an understorey of unmanaged grassland and occasional scattered native shrubs.	 *Photo location 4: Woodland vegetation within the central portion of the site.*  *Photo location 5: Woodland vegetation within the central portion of the site.*  *Photo location 6: Woodland vegetation to the north of the site.*  *Photo location 7: Woodland vegetation to the east of the site.*	10	**AS 3959 classification (Figure 3):** Low threat vegetation (Exclusion 2.2.3.2(f)) **Effective slope (Figure 4):** Not applicable The woodland vegetation within the site (Plot 4) will be converted to low threat vegetation within future lots that will be managed to a low threat standard in accordance with the Shire of Serpentine Jarrahdale Firebreak and Fuel Hazard Reduction Notice. These lots are likely to include non-vegetated areas (e.g. dwellings, private driveways and firebreaks), however as the siting of these are currently unknown, it has been identified as low threat vegetation.
			5	**AS 3959 classification (Figure 3):** Woodland (Class B) **Effective slope (**see **Figure 4):** Flat/upslope Woodland vegetation located to the north, east and west of the site is assumed to remain in its existing state and is therefore assumed to remain a bushfire risk to the site.

Table 2: Vegetation classification, effective slope and future management (continued)

Pre-development (see Figure 2)			Post development (see Figure 3)	
Plot no.	**AS 3959 classification**	**Site photo/s (location points shown in Figure 2)**	**Plot no.**	**AS 3959 classification, effective slope and assumptions**
6	**AS 3959 classification (Figure 2):** Scrub (Class D) **Bushfire hazard level:** Extreme Scrub vegetation is located to the north and east of the site within adjacent rural residential lots. Scrub vegetation to the north of the site is characterised by series of planted/regrowth scrub species growing to a height of 2 - 4 m, less than 6 m in height with continuous fuel loads from the surface and near-surface fuel layers through to the intermediate and overstorey fuel layers. Scrub vegetation to the east of the site within an adjacent rural-residential lot (**Photo location 9, 27**) comprises a ring of planted low shrub species with isolated occurrences of juvenile *Eucalypt spp*.. When mature, the *Eucalypt spp*. will form less than 10% of the mature canopy, and based on the current growth (i.e. existing conditions) and in accordance with AS 3959 the vegetation has been classified based on the dominant growth form which is scrub as the predominant vegetation will be less than 6 m in height.	 *Photo location 8: Scrub vegetation to the north of the site.*  *Photo location 9: Scrub vegetation in the foreground comprising a majority of low shrub species.*  *Photo location 27: Scrub vegetation to the east of the site showing the ring of planted shrub species*	6	**AS 3959 classification (Figure 3):** Scrub (Class D) **Effective slope (**see **Figure 4):** Flat/upslope Scrub vegetation located to the north of the site (**Photo location 8**) is assumed to remain in its existing state and is therefore assumed to remain a bushfire risk to the site.
			11	**AS 3959 classification (Figure 3):** Forest (Class A) **Effective slope (Figure 4):** Flat/upslope With regards to the scrub vegetation to the east of the site (**Photo location 9, 27**); DFES have indicated concern about the presence of juvenile eucalypts potentially at a density that may affect the vegetation classification when the trees mature. Based on site observations, the eucalypts are likely to be less than 10% of the mature canopy cover. However, to address the DFES concern, this vegetation has been identified as forest in the post development scenario.

Table 2: Vegetation classification, effective slope and future management (continued)

Pre-development (see Figure 2)			Post development (see Figure 3)	
Plot no.	**AS 3959 classification**	**Site photo/s (location points shown in Figure 2)**	**Plot no.**	**AS 3959 classification, effective slope and assumptions**
7	**AS 3959 classification (Figure 2):** Grassland (Class G) **Bushfire hazard level:** Moderate Grassland vegetation has been identified within the majority of the site associated with open areas of unmanaged rural-residential paddocks. Areas of grassland are characterised by grasses growing to a height of ~ 50 cm, with occasional scattered trees (less than 10% foliage cover). In accordance with AS 3959, this vegetation has been classified based on the understorey, due to the low overall canopy cover.	 *Photo location 10: Grassland vegetation within the northern portion of the site.*  *Photo location 11: Grassland vegetation within the central portion of the site.*  *Photo location 12: Grassland vegetation within the southern portion of the site.*  *Photo location 13: Grassland vegetation within the southern portion of the site.*	10	**AS 3959 classification (Figure 3):** Low threat vegetation (Exclusion 2.2.3.2(f)) **Effective slope (Figure 4):** Not applicable The grassland vegetation within the site will be converted to low threat vegetation within future lots that will be maintained in accordance with the Shire of Serpentine Jarrahdale Firebreak and Fuel Hazard Reduction Notice. These lots are likely to include non-vegetated areas (e.g. dwellings, private driveways and firebreaks), however as the siting of these are currently unknown, it has been identified as low threat vegetation.
			7	**AS 3959 classification (Figure 3):** Non-vegetated area (Exclusion 2.2.3.2(e)) **Effective slope (**see **Figure 4):** Not applicable Grassland vegetation within the site will be removed to facilitate the future sealed public road network which will result in currently vegetated areas being converted to non-vegetated areas comprised of bitumen.

Table 2: Vegetation classification, effective slope and future management (continued)

Pre-development (see Figure 2)				Post development (see Figure 3)	
Plot no.	**AS 3959 classification**	**Site photo/s (location points shown in Figure 2)**		**Plot no.**	**AS 3959 classification, effective slope and assumptions**
8	Continued from above. Grassland vegetation has also been identified surrounding the site associated with unmanaged adjacent rural-residential lots with grass ground to a height ~ 1 m.	 *Photo location 14: Grassland vegetation to the north of the site.*	 *Photo location 15: Grassland vegetation to the south of the site.*	8	**AS 3959 classification (Figure 3):** Grassland (Class G) **Effective slope (**see **Figure 4):** Flat/upslope Grassland vegetation external to the site to the north and east will be retained as future development progresses. Therefore, this vegetation will pose a permanent bushfire risk to the site.

Table 2: Vegetation classification, effective slope and future management (continued)

Pre-development (see Figure 2)			Post development (see Figure 3)	
Plot no.	**AS 3959 classification**	**Site photo/s (location points shown in Figure 2)**	**Plot no.**	**AS 3959 classification, effective slope and assumptions**
9	**AS 3959 classification (Figure 2):** Non-vegetated area (Exclusion 2.2.3.2(e)) **Bushfire hazard level:** Low. As required under the Guidelines, any areas within 100 m of moderate or extreme hazards have been shown as moderate, to reflect the potential increased risk. Non-vegetated areas such as roads, driveways, existing residential buildings and areas of mineral earth within and surrounding the site have been excluded in accordance with Clause 2.2.3.2(e) of AS 3959.	 *Photo location 16: Non-vegetated driveway within the northern portion of the site.*  *Photo location 17: Non-vegetated residential area within the central portion of the site.*  *Photo location 18: Non-vegetated sealed Wattle Road to the north of the site.*  *Photo location 19: Non-vegetated sealed Salmon Bark Road to the east of the site.*	9	**AS 3959 classification (Figure 3):** Non-vegetated area (Exclusion 2.2.3.2(e)) **Effective slope (**see **Figure 4):** Not applicable The existing maintenance regimes for all existing non-vegetated areas surrounding the site are assumed to continue in the long-term based on current land uses and management arrangements and/or future proposed land uses.

Table 2: Vegetation classification, effective slope and future management (continued)

Pre-development (see Figure 2)			Post development (see Figure 3)	
Plot no.	**AS 3959 classification**	**Site photo/s (location points shown in Figure 2)**	**Plot no.**	**AS 3959 classification, effective slope and assumptions**
10	**AS 3959 classification (Figure 2):** Low threat vegetation (Exclusion 2.2.3.2(f)) **Bushfire hazard level:** Low. As required under the Guidelines, any areas within 100 m of moderate or extreme hazards have been shown as moderate, to reflect the potential increased risk. Low threat vegetation has been identified within the site to the north and east associated with open paddocks managed to a low threat standard in accordance with the Shire of Serpentine Jarrahdale Firebreak and Fuel Hazard Reduction Notice.	 *Photo location 20: Low threat vegetation within a roadside swale within the northern portion of the site.*  *Photo location 21: Low threat vegetation to the north of the site.*  *Photo location 22: Low threat vegetation to the east of the site.*  *Photo location 23: Low threat vegetation to the east of the site.*	10	**AS 3959 classification (Figure 3):** Low threat vegetation (Exclusion 2.2.3.2(f)) **Effective slope (**see **Figure 4):** Not applicable The maintenance regimes for all existing managed areas outside the site are assumed to continue in the future based on current land uses and management arrangements.

3.1.1.1 Post development assumptions

The BAL assessment, to determine the predicated BAL ratings applicable to the site, has assumed the following:

- **Designated FDI**: 80
- **Flame temperature**: 1090 K
- **Vegetation classification**: Forest (Class A), woodland (Class B), scrub (Class D), and grassland (Class G) vegetation identified within the post-development scenario, see **Figure 3.**
- **Effective slope beneath classified vegetation**: flat/upslope (see **Figure 4**)
- **Setback distances**: as per Table 2.5 in AS 3959 with the relevant distances used to inform the BAL contour plan provided in **Figure 5** and summarised in **Table 3**.

In addition to the above, the following key assumptions have informed this assessment:

- All classified vegetation within the site will be removed or modified to achieve low threat in accordance with Section 2.2.3.2 of AS 3959. This will be enforced through a notification placed on future titles advising prospective purchasers that existing vegetation and future landscaping within each private lot is required to be maintained to a 'low threat' standard in accordance with AS 3959:2018 cl,.2.2.3.2(f). Management of these areas to a low threat standard are likely to require:
  - Where the spacing of individual or groups of trees is less than 15 metres apart or canopies of existing trees are touching, branches will be lopped to provide for a separation between tree crowns.
  - Retained trees will be low pruned to 2 m from the ground.
  - Regular maintenance including removal of weeds and dead material.
  - Application of ground covers such as mulch or non-flammable materials.
  - Regular mowing/slashing of grass to less than 100 millimetres (mm) in height.
- Areas of low threat vegetation outside the site will continue to be managed and/or considered to achieve low threat in accordance with Section 2.2.3.2 of AS 3959 based on the existing maintenance regimes, and/or as per the Shire of Serpentine Jarrahdale's Firebreak and Fuel Hazard Reduction Notice.
- Other classified vegetation that has been identified outside of the proponent's landholdings has been assumed to remain in its existing state.

3.1.2 Assessment outputs

The BAL assessment completed for the site indicates that a BAL rating of BAL-29 or less can be achieved for the majority of the site. BAL-40 and BAL-FZ does extend into portions of the site (due to external hazards), however with the large lot size it will be possible for all future habitable buildings to be located in an area subject to BAL-29 or less (with the majority of the site likely to be BAL-12.5 or BAL-LOW). **Table 3** provides a summary of the setback distances necessary from classified vegetation to achieve the indicated BAL ratings, with the BAL Contour Plan (**Figure 5**) being a visual representation of these distances. The setback distances are based on the post-development classified vegetation (**Figure 3**), effective slope (**Figure 4)** and are taken from Table 2.5 of AS 3959.

It is important to note that as part of future subdivision, should this area still be subject to a BAL rating greater than BAL-29, development can be designed to ensure habitable buildings achieve BAL-29 or less through in-lot setbacks or the location of public roads, and through the accommodation of setback distances provided in **Table 3**.

Table 3: Setback distances based on vegetation classification and effective slope and Table 2.5 of AS 3959, as determined by the method 1 BAL assessment

Post development plot number (see Figure 4)	Vegetation classification (see Figure 4)	Effective slope (see Figure 5)	Distance to vegetation (from Table 2.5 of AS 3959)	BAL rating
Plot 1-3 &11	Forest (Class A)	Flat/upslope	< 16 m	BAL-FZ
			16 - < 21 m	BAL-40
			21 - < 31 m	BAL-29
			31 - < 42 m	BAL-19
			42 - < 100 m	BAL-12.5
			> 100 m	BAL-LOW
Plot 5	Woodland (Class B)	Flat/upslope	< 10 m	BAL-FZ
			10 - < 14 m	BAL-40
			14 - < 20 m	BAL-29
			20 - < 29 m	BAL-19
			29 - < 100 m	BAL-12.5
			> 100 m	BAL-LOW
Plot 6	Scrub (Class D)	Flat/upslope	< 10 m	BAL-FZ
			10 - < 13 m	BAL-40
			13 - < 19 m	BAL-29
			19 - < 27 m	BAL-19
			27 - < 100 m	BAL-12.5
			> 100 m	BAL-LOW

Table 3: Setback distances based on vegetation classification and effective slope and Table 2.5 of AS 3959, as determined by the method 1 BAL assessment (continued)

Post development plot number (see Figure 4)	Vegetation classification (see Figure 4)	Effective slope (see Figure 5)	Distance to vegetation (from Table 2.5 of AS 3959)	BAL rating
Plot 8	Grassland (Class G)	Flat/upslope	< 6 m	BAL-FZ
			6 - < 8 m	BAL-40
			8 - < 12 m	BAL-29
			12 - < 17 m	BAL-19
			17 - < 50 m	BAL-12.5
			> 50 m	BAL-LOW

4 Identification of Bushfire Hazard Issues

From a bushfire hazard management perspective, the key issues that are likely to require management and/or consideration as part of future development within the site include:

- Provision of appropriate separation distance from bushfire hazards external to the site to the north, east, south and west of the site to ensure a BAL rating of BAL-29 or less can be achieved at future habitable buildings (built form).
- Ensuring that future rural-residential lots within the site are managed to achieve low threat standards, in accordance with AS 3959 and the requirements of the Shire of Serpentine Jarrahdale.
- Provision of appropriate vehicular access to ensure that when development within the site is fully constructed, egress to at least two different destinations will be available to residents, visitors, future workers and emergency personnel.

These issues are considered further in **Section 5.**

5 Assessment Against the Bushfire Protection Criteria

This BMP provides an outline of the mitigation strategies that will ensure that as planning and development is progressed within the site, an acceptable solution and/or performance-based system of control can be adopted for each of the bushfire protection criteria detailed within Appendix Four of the Guidelines (WAPC and DFES 2017). The bushfire protection criteria identified in the Guidelines and addressed as part of this BMP are:

- Element 1: Location of the development
- Element 2: Siting and design of the development
- Element 3: Vehicular access
- Element 4: Water supply.

As part of future development, it is likely that an 'acceptable solution' will be able to address the intent of all four bushfire protection criteria as part of future development within of the site. A summary of how this can be achieved and an associated compliance statement for each has been provided in **Table 4**.

Table 4: Summary of bushfire protection criteria and compliance statement

Bushfire protection criteria	Intent	Method of compliance		Proposed bushfire management strategies	Compliance statement
		Acceptable solution	Performance principle		
Element 1: Location	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.	A1.1 Development location		Based on the bushfire hazard level assessment, the site is located in an area of extreme and moderate bushfire hazard level. As development within the site is progressed, classified vegetation will be removed and development will be located within an area subject to a bushfire hazard level of low or moderate. The acceptable solution can be satisfied.	Based on the outlined management measures, future development would be able to comply with and meet the intent of Element 1: Location.
		Yes.	N/A		
Element 2: Siting and design	To ensure the siting and design of development minimises the level of bushfire impact.	A2.1 Asset Protection Zone		One of the most important bushfire protection measures influencing the safety of people and property is to create an Asset Protection Zone (APZ) around buildings. The APZ is a low fuel area immediately surrounding a building and can include non-flammable features such as irrigated landscapes, gardens, driveways and public roads. The post-development vegetation classification (**Figure 4**) identifies permanent external bushfire hazards to the north, east, south and west of the site. Based on the outcomes of the BAL assessment and the BAL contour plan (see **Figure 6**), lots along the northern, eastern, southern and western boundaries of the site will be exposed to a BAL rating exceeding BAL-29. However, due to the large lot sizes associated with the proposed rural-residential development, future habitable buildings will be subject to a BAL rating of BAL-29 or less. Future habitable buildings will be able to achieve a BAL rating of BAL-29 or less, due to the size of the lot and setbacks provided by public roads and in-lot APZs where required.	Based on the outlined management measures, future development would be able to comply with and meet the intent of Element 2: Siting and design.
		Yes.	N/A		

Table 4: Summary of bushfire protection criteria and compliance statement (continued)

Bushfire protection criteria	Intent	Method of compliance		Proposed bushfire management strategies	Compliance statement
		Acceptable solution	Performance principle		
Continued from above.	Continued from above.	Continued from above.		As discussed in **Section 3.1.1.1**, there is an area of remnant trees within the central portion site that have been identified for retention within future lots. This area of woodland vegetation is proposed to be managed to a low threat standard in accordance with Section 2.2.3.2 of AS 3959. The management of this area will include the lopping of tree branches to provide for a separation between tree crowns where canopies are connected, pruning of tree branches to 2 m off the ground, and regular maintenance of understory grasses at or below 100 mm in height. Overall, the acceptable solution can be satisfied. Class 1, 2 and 3 buildings, where located within an area subject to a BAL rating higher than BAL-12.5 will be subject to higher construction standards in accordance with AS 3959. Furthermore, where future development is subject to increased BALs, these BAL ratings can be reassessed at future building licence stage, to determine if the BAL rating has been reduced through the removal of hazards.	Continued from above.
Element 3: Vehicular access	To ensure vehicular access serving a subdivision/ development is available and safe during a bushfire event.	A3.1 Two access routes		As part of the proposed development, an internal road will be constructed connecting to the broader road network via Wattle Road to the north and Utley Road to the south, as shown on **Figure 6**. Immediate egress options will be available to the north and south of the site via Wattle Road and Utley Road, in addition to east and west of the site via Salmon Bark Road. The proposed structure plan provides for an interconnected public road network within the site creating 2 new T-junctions and one four-way intersection. A fourth connection is provided via an unconstructed road link that connects to Salmon Bark Road to the east.	Based on the outlined management measures, future development would be able to comply with and meet the intent of Element 3: Vehicular access.
		Yes.	N/A		
		A3.2 Public road		Existing public roads within the site and surrounds, as well as proposed new public roads can and will comply with the minimum standards outlined in Appendix Four of the Guidelines (WAPC and DFES 2017) and includes a minimum 6 m - wide trafficable surface. Wattle Road and Utley Road are constructed to a two-lane undivided road standard. The road reserve widths for the new internal road network are proposed to be 20 m. The existing pavement widths are in the order of 5.5 – 6 m seal width plus unsealed shoulders within a 20 m road reserve. An excerpt of the requirements (from Table 6 of Appendix Four the Guidelines) has been provided below. This can be accommodated through the subdivision process.	
		Yes.	N/A		

Table 4: Summary of bushfire protection criteria and compliance statement (continued)

<table>
<tr><th>Bushfire protection criteria</th><th>Intent</th><th colspan="2">Method of compliance</th><th>Proposed bushfire management strategies</th><th>Compliance statement</th></tr>
<tr><th></th><th></th><th>Acceptable solution</th><th>Performance principle</th><th></th><th></th></tr>
<tr><td>Continued from above.</td><td>Continued from above.</td><td colspan="2">Continued from above.</td><td>Excerpt of Table 6 from Appendix Four of the Guidelines (WAPC & DFES 2017)
<table>
<tr><th>TECHNICAL REQUIREMENTS</th><th>1 Public road</th><th>2 Cul-de-sac</th><th>3 Private driveway</th><th>4 Emergency access way</th><th>5 Fire service access routes</th></tr>
<tr><td>Minimum trafficable surface (m)</td><td>6*</td><td>6</td><td>4</td><td>6*</td><td>6*</td></tr>
<tr><td>Horizontal clearance (m)</td><td>6</td><td>6</td><td>6</td><td>6</td><td>6</td></tr>
<tr><td>Vertical clearance (m)</td><td>4.5</td><td>N/A</td><td>4.5</td><td>4.5</td><td>4.5</td></tr>
<tr><td>Maximum grade <50 metres</td><td>1 in 10</td><td>1 in 10</td><td>1 in 10</td><td>1 in 10</td><td>1 in 10</td></tr>
<tr><td>Minimum weight capacity (t)</td><td>15</td><td>15</td><td>15</td><td>15</td><td>15</td></tr>
<tr><td>Maximum crossfall</td><td>1 in 33</td><td>1 in 33</td><td>1 in 33</td><td>1 in 33</td><td>1 in 33</td></tr>
<tr><td>Curves minimum inner radius (m)</td><td>8.5</td><td>8.5</td><td>8.5</td><td>8.5</td><td>8.5</td></tr>
<tr><td colspan="6">*Refer to E3.2 Public roads: Trafficable surface</td></tr>
</table></td><td rowspan="3">Continued from above.</td></tr>
<tr><td rowspan="2"></td><td colspan="2">A3.3 Cul-de-sac (including dead-end-road)</td><td rowspan="2">Not applicable. No cul-de-sacs are proposed at this stage of planning.

If any temporary cul-de-sacs are required as part of staged development, they should be constructed to meet the minimum standards as outlined in Appendix Four of the Guidelines (WAPC and DFES 2017), including:
• A minimum trafficable surface of 6 m
• A horizontal clearance of 6 m
• Support a minimum weight of 15 tonnes
• The length of the cul-de-sac is 200 m or less
• Will have a turn-around area with a minimum 17.5 m diameter head.</td></tr>
<tr><td>N/A</td><td>N/A</td></tr>
</table>

Table 4: Summary of bushfire protection criteria and compliance statement (continued)

Bushfire protection criteria	Intent	Method of compliance		Proposed bushfire management strategies	Compliance statement
		Acceptable solution	Performance principle		
Continued from above.	Continued from above.	A3.4 Battle-axe		Four battle-axes lots are proposed in the central and southern portion of the site. The battle-axe legs for each lot are 10 m-wide and can more than accommodate the minimum 6 m-wide horizontal clearance as required by Appendix Four of the Guidelines. Additionally, the dwellings are likely to be located less than 100 m from the public road network, based on the size of the lot. All four battle-axes lots can meet the requirements outlined within Appendix Four of the Guidelines, with construction to include: • A minimum trafficable surface of 4 m. • A horizontal clearance of 6 m. • Support a minimum weight of 15 tonnes. • The length of the battle-axe access is less than 600 m. Whilst battle-axe lots should be avoided in bushfire prone areas, in this instance battle-axe legs cannot be avoided due to the location of the structure plan area within the existing road network. Internal lots without frontage onto the proposed internal road network will require battle axe-legs due to the inability to create additional road linkages abutting the existing rural residential lots to the east, and as battle axe lots can meet the requirements of Appendix Four in the Guidelines, this can be satisfied.	Continued from above.
		Yes	N/A		
		A3.5 Private driveway longer than 50 m		The exact length of the future private driveways for the future development within the site is unknown at this stage and will depend on the final location of the building envelopes within each lot. However, it is possible that the private driveways will be longer than 50 m in length based on the proposed development layout and size of the lots. If private driveways longer than 50 m in length are required, they will need to meet the minimum requirements outlined within Table 6 of Appendix Four of the Guidelines, including construction suitable for two-wheel-drive vehicles, minimum horizontal and vertical clearance, overtaking bays (if required) and appropriate turn around areas. This can be confirmed at the building licence stage.	
		Yes	N/A		
		A3.6 Emergency access way		The proposed structure plan provides for egress to at least two different destinations, therefore emergency access ways are not required as part of the proposed development of the site.	
		N/A	N/A		
		A3.7 Fire service access routes (perimeter roads)		Whilst development within the site will be provided with appropriate vehicular access, and a fire service access route is not required, the proposed Structure Plan provides for a 6 m wide Emergency Accessway/Fire Service Access Route along the western and eastern boundaries of the site, as shown in **Figure 6.** This route will provide access on the perimeter of the structure plan area for firefighters and a link between two public roads,	
		Yes	N/A		

Bushfire protection criteria	Intent	Method of compliance		Proposed bushfire management strategies	Compliance statement
		Acceptable solution	Performance principle		
				namely Wattle Road to the north and Utley Road to the south. The road will be provided as an easement, fenced on the inside and gated to ensure accessibility to the public and fire services during an emergency.	
		A3.8 Firebreak width		Due to the size of future rural-residential lots proposed as part of the development of the site, firebreaks will be required once subdivision occurs. A 6 m wide Fire Service Access Route will be constructed along the western boundary of the site, as shown in **Figure 6**, and will also serve the function of a strategic firebreak. Firebreaks will be required to satisfy the requirements as set out in the Shire of Serpentine Jarrahdale Firebreak and Fuel Hazard Reduction Notice, which includes a minimum 3 m-wide firebreak within the internal boundary of the property.	
		Yes.	N/A		
Element 4: Water	To ensure water is available to the subdivision, development or land use to enable people, property and infrastructure to be defended from bushfire.	A4.1 Reticulated areas		Development is located within an Emergency Services Levy (ESL) Category 5 area, which indicates that bushfire events are responded to by the State Emergency Service and usually a bush fire brigade. Fire response services require ready access to an adequate water supply during bushfire emergencies. The site will connect with a reticulated water supply and will include fire hydrants installed within 200 m of residential dwellings (Class 1a).	Based on the outlined management measures, future development would be able to comply with and meet the intent of Element 4: Water.
		Yes.	N/A		
		A4.2 Non-reticulated areas		Not applicable.	
		N/A	N/A		
		A4.3 Individual lots within non-reticulated areas (only for use if creating 1 additional lot and cannot be applied cumulatively)		Not applicable.	
		N/A	N/A		

5.1 Additional management strategies

5.1.1 Future approval considerations

The BAL assessment within this document is considered to be a conservative assessment of potential bushfire risk posed to future habitable buildings within the site based on the proposed management of vegetation and assumptions outlined in **Section 3**.

The measures to be implemented through this structure plan and associated future subdivision process have been outlined as part of this BMP and can be used to support future planning and development approval processes. A revised BMP is likely to be required to support any future subdivision applications, particularly if the development layout detail is different to that outlined within this document, and will need to respond to the subdivision design (and/or the stage of development).

5.1.2 Landscape management

5.1.2.1 Within the site

No areas of public open space are proposed to be developed within the site. However, future lots will be managed to a low threat standard by the future lot owners. This will be enforced through a notification placed on future titles advising prospective purchasers that existing vegetation and future landscaping within each private lot is required to be maintained to a 'low threat' standard in accordance with AS 3959:2018 cl,.2.2.3.2(f). This will also support the Shire of Serpentine Jarrahdale Firebreak and Fuel Hazard Reduction Notice which requires landowners of lots greater than 1 acre (0.40 ha) to undertake clearing (i.e. removal of dead vegetation and cropping of grass) within open paddocks and along the boundaries of properties to minimise the spread of bushfire. This will include management of any existing vegetation that is retained within lots and the ongoing maintenance of any gardens which will be developed as part of future private landholdings. Management of these areas to a low threat standard are likely to require:

- Clearing of vegetation
- Regular maintenance including removal of weeds and dead material
- Low pruning of trees
- Application of ground covers such as mulch or non-flammable materials
- Regularly mowing/slashing of grass to less than 100mm in height

5.1.2.2 Surrounding the site

Within private landholdings

The private landholdings surrounding the site are assumed to be managed by the applicable landowners in accordance with the Shire of Serpentine Jarrahdale Firebreak and Fuel Hazard Reduction Notice in perpetuity and/or in accordance with existing maintenance regimes. All other vegetation will remain in its existing condition for the foreseeable future.

5.1.3 Shire of Serpentine Jarrahdale Firebreak and Fuel Hazard Reduction Notice

As outlined previously, the Shire of Serpentine Jarrahdale releases a Firebreak and Fuel Hazard Reduction Notice annually (or as required) to provide a framework for bushfire management within the Shire. The Shire of Serpentine Jarrahdale is able to enforce this notice in accordance with Section 33 of the *Bush Fire Acts 1954* and landowners will need to ensure compliance with this notice as published. This is likely to include (but is not limited to):

- Maintenance of short cropped grass.
- Particular standards for firebreaks, including the location of the firebreak and horizontal and vertical clearances.
- Maintenance of appropriate asset protection zones around buildings and fixed assets within a landholding.

Where there is conflict in the requirements of this BMP or the Shire of Serpentine Jarrahdale Firebreak and Fuel Hazard Reduction Notice, the higher level of bushfire protection should prevail.

5.1.4 Vulnerable or high-risk land uses

There are no vulnerable or high-risk land uses, as defined under SPP 3.7, proposed within the site at part of the proposed structure plan.

5.1.5 Public education and preparedness

Community bushfire safety is a shared responsibility between individuals, the community, government and fire agencies. DFES has an extensive Community Bushfire Education Program including a range of publications, a website and Bushfire Ready Groups. The DFES website (https://www.dfes.wa.gov.au/bushfire/prepare/) provides a range of materials to help the community prepare for and survive the bushfire season.

The Shire of Serpentine Jarrahdale provides bushfire safety advice to residents available from their website http://www.sjshire.wa.gov.au/what-we-do/emergency-services/bushfires-and-fire-control/. Professional, qualified consultants also offer bushfire safety advice and relevant services to residents and businesses in high-risk areas in addition that that provided in this BMP.

In the case of a bushfire in the area, advice would be provided to residents by DFES, Department of Biodiversity Conservation and Attractions (DBCA) and/or the Shire of Serpentine Jarrahdale on any specific recommendations with regard to responding to the bushfire, including evacuation if required. However, it is highly recommended that future residents make themselves aware of their responsibilities with regard to preparing for and responding to a potential bushfire that may impact them, their family and property, regardless of the BAL rating their properties are subject to.

6 Responsibilities for Implementation and Management of Bushfire Measures

Table 5 outlines the future responsibilities of the proponent (developer), future users of the site, and the Shire of Serpentine Jarrahdale associated with implementing this BMP with reference to ongoing bushfire risk mitigation measures for existing land uses (through compliance with the Shire of Serpentine Jarrahdale Firebreak and Fuel Hazard Reduction Notice) or future mitigation measures to be accommodated as part of the structure planning process. These responsibilities will need to be considered as part of the subsequent development and implementation process.

Table 5: Responsibilities for the implementation of this BMP

Management action	Timing
Developer	
Certify BAL ratings for all lots designated as bushfire prone at the time titles are created, based on the BAL Contour Plan and/or in accordance with a BAL assessment if the site conditions are different. The certified BAL ratings can be submitted by lot owners to the Shire of Serpentine Jarrahdale to support future building licences.	As part of subdivision and development, and to support the creation of lot titles.
For each new lot created within areas exposed to a BAL rating exceeding BAL-LOW, lodge a Section 165 Notification on the Certificate of Title in order to alert purchasers and successors in title of the existence of the overarching BMP and the requirements associated with meeting AS 3959 construction standards. This should be based on the outcomes of the BAL certification process.	To support the creation of lot titles.
Given the proposal is for a rural residential development within a bushfire prone area, it is recommended that notification be placed on future titles advising prospective purchasers that existing vegetation and future landscaping within each private lot is required to be maintained to a 'low threat' standard in accordance with AS 3959:2018 cl,.2.2.3.2(f).	To support the creation of lot titles.
Ensure fire hydrants are installed by the developer within 200 m of a dwelling. Reticulated water supply and hydrants to be installed as per standard Water Corporation requirements unless otherwise agreed.	To support the creation of lot titles.
Install public roads to the standards outlined in Appendix Four of the Guidelines (WAPC and DFES 2017).	To support the creation of lot titles.
The entirety of the site or where within 100 m of titled lots (if development is to be staged), is to be maintained to a low threat standard (in accordance with Section 2.2.3.2 of AS 3959) until development progresses and/or lots are sold. Management should include (but is not limited to): • Clearing/modification of vegetation • Regular removal of weeds and built up dead material (such as fallen branches, leaf litter etc.) • Low pruning of trees (i.e. removal of branches less than 2 m in height) if individual trees are proposed for retention, particularly where these are located in future road reserves). • Application/re-application of ground/surface covers such as mulch or non-flammable materials as required. • Where the grass is present, this should be regularly cut so that the grass is maintained at or below 100 mm in height.	As part of the subdivision and to support the creation of lot titles, and ongoing where applicable.
Make a copy of the BMP and BAL certification/assessment available to each lot owner within designated bushfire prone areas.	During the lot sale process, and ongoing as required.

Table 5: Responsibilities for the implementation of this BMP (continued).

Management action	Timing
Developer (continued)	
Reticulated water supply and hydrants to be installed as per standard Water Corporation requirements, unless otherwise agreed.	To support the creation of lot titles
Ensure any temporary cul-de-sacs are constructed to the minimum standards as set out in Appendix Four of the Guidelines (WAPC and DFES 2017), as provided below: • A minimum trafficable surface of 6 m. • A horizontal clearance of 6 m. • Support a minimum weight of 15 tonnes. • Will have a turn-around area with a minimum 17.5 m diameter head.	To support the creation of lot titles
Ensure the Fire Service Access Road along the perimeter of the site is constructed to a width of 6 m and to the minimum standards as set out in Table 6 in Appendix Four of the Guidelines (WAPC and DFES 2017). This includes: • Allow for two-way traffic. • Have an all-weather surface. • Be adequately signposted • Where gates are used, these should be wide enough to accommodate type 3.4 fire appliances. • An easement in gross to the benefit of the local government is provided.	As part of subdivision and development.
Property owner/occupier	
Ensuring construction of dwelling/s complies with AS 3959, as per the applicable BAL rating, determined as part of this BMP (outlined within **Section 3** of this BMP) or through a separate BAL assessment. The BAL rating for a dwelling should not exceed BAL-29.	As part of building design and construction
Install private driveways to standards outlined in Appendix Four of the Guidelines (WAPC and DFES 2017).	To support the creation of lot titles
If dwellings are subject to additional construction in the future, such as renovations, compliance with AS 3959 is required (i.e. where located within a designated bushfire prone area and identified to have a BAL rating greater than BAL-LOW).	As part of building design and construction
The entirety of their lots is to be maintained to a low threat standard (in accordance with Section 2.2.3.2 of AS 3959). Management should include (but is not limited to): • Regular removal of weeds and built up dead material (such as fallen branches, leaf litter etc.) • Low pruning of trees (i.e. removal of branches less than 2 m in height). • Application/re-application of ground/surface covers such as mulch or non-flammable materials as required. • Where the grass is present, this should be regularly cut so that the grass is maintained at or below 100 mm in height.	Ongoing, where applicable
Ensuring that their property complies with the Shire of Serpentine Jarrahdale Firebreak and Fuel Hazard Reduction Notice as published.	Ongoing, where applicable
Ensuring that where hydrants are located, these are not obstructed and remain visible at all times.	Ongoing, where applicable.
Shire of Serpentine Jarrahdale	
Providing fire prevention and preparedness advice to landowners upon request, including the *Homeowners Bush Fire Survival Manual: Prepare, Act, Survive* (or similar suitable documentation) and the latest Shire of Serpentine Jarrahdale Firebreak and Fuel Hazard Reduction Notice.	Ongoing, as required
Maintaining public road reserves under their management to appropriate standards, where required/applicable.	Ongoing, as required

Table 5: Responsibilities for the implementation of this BMP (continued).

Management action	Timing
Water Corporation	
The Water Corporation is responsible for the ongoing maintenance and repair of water hydrants.	Ongoing, as required.

7 Applicant Declaration

7.1 Accreditation

This BMP has been prepared by Emerge Associates who have been providing bushfire risk management advice for more than six years, undertaking detailed bushfire assessments (and associated approvals) to support the land use development industry.

Anthony Rowe is a Fire Protection Association of Australia (FPAA) Level 3 Bushfire Planning and Design (BPAD) accredited practitioner (BPAD no. 36690) with over nine years' experience and is supported by a number of team members who have undertaken BPAD Level 1 and Level 2 training and are in the processing of gaining formal accreditation.

7.2 Declaration

I declare that the information provided is true and correct to the best of my knowledge.

Signature:

Name: Anthony Rowe

Company: Emerge Associates

Date: 12 March 2021

BPAD Accreditation: Level 3 BPAD no. 36690

Signature:

Name: Kirsten Knox

Company: Emerge Associates

Date: 12 March 2021

8 References

8.1 General references

Emerge Associates 2020a, Local Water Management Strategy - Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine, EP20-064(01)--001, 1.

Emerge Associates 2020b, Technical Memorandum - Flora, Vegetation and Fauna Assessment - Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine, EP20-064(03)--003 RAW, 1.

Standards Australia 2018, AS 3959:2018 Construction of buildings in bushfire-prone areas, Sydney.

Western Australian Planning Commission (WAPC) 2015, State Planning Policy 3.7 Planning in Bushfire Prone Areas, Perth.

Western Australian Planning Commission and Department of Fire and Emergency Services (WAPC and DFES) 2017, Guidelines for Planning in Bushfire Prone Areas Version 1.3, Western Australia. December 2017.

8.2 Online references

Department of Water 2008, *LIDAR derived 1 m elevation contours* dataset, Government of Western Australia.

Department of Primary Industries and Regional Development (DPIRD) 2020, *2 metre contours,* viewed June 2020, <https://maps.slip.wa.gov.au/landgate/locate/>.

Landgate 2020, *Landgate Map Viewer Plus,* viewed August 2020, <https://maps.landgate.wa.gov.au/maps-landgate/registered/>.

Landgate 2020, *Map Viewer*, viewed July 2019, <https://www0.landgate.wa.gov.au/maps-and-imagery/interactive-maps/map-viewer>

Office of Bushfire Risk Management (OBRM) 2020 Map of Bush Fire Prone Areas, viewed August 2019, <https://maps.slip.wa.gov.au/landgate/bushfireprone/>

Figures

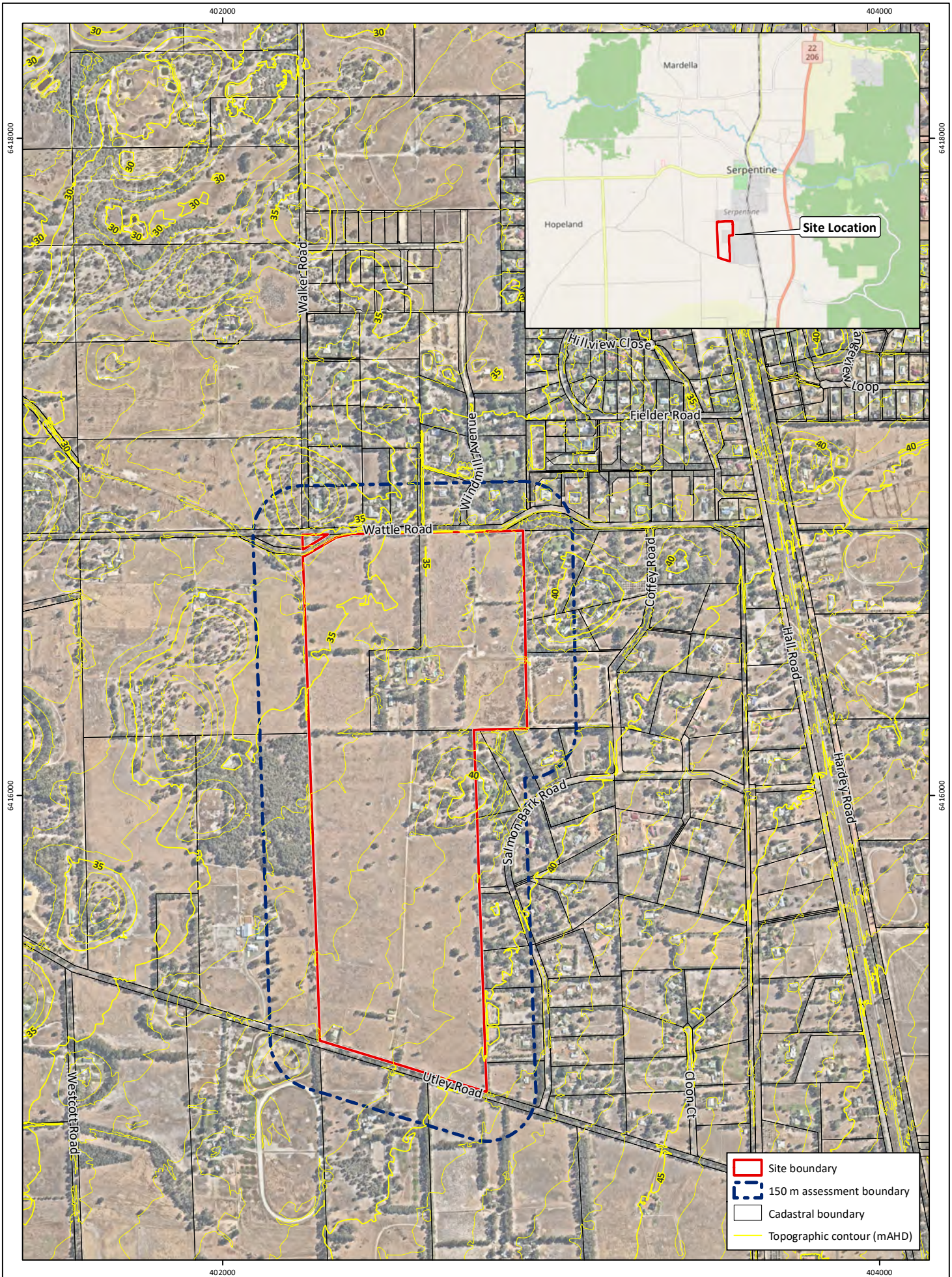


Figure 1: **Site Plan and Topographic Contours**

Project:	Bushfire Management Plan Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine
Client:	Stron Pty Ltd

Plan Number:	**EP20-064(02)--F31**
Drawn:	GAR
Date:	11/08/2020
Checked:	BRB
Approved:	BRB
Date:	14/08/2020

N

0 200 400
Metres
Scale: 1:15,000@A4
GDA 1994 MGA Zone 50

emerge ASSOCIATES

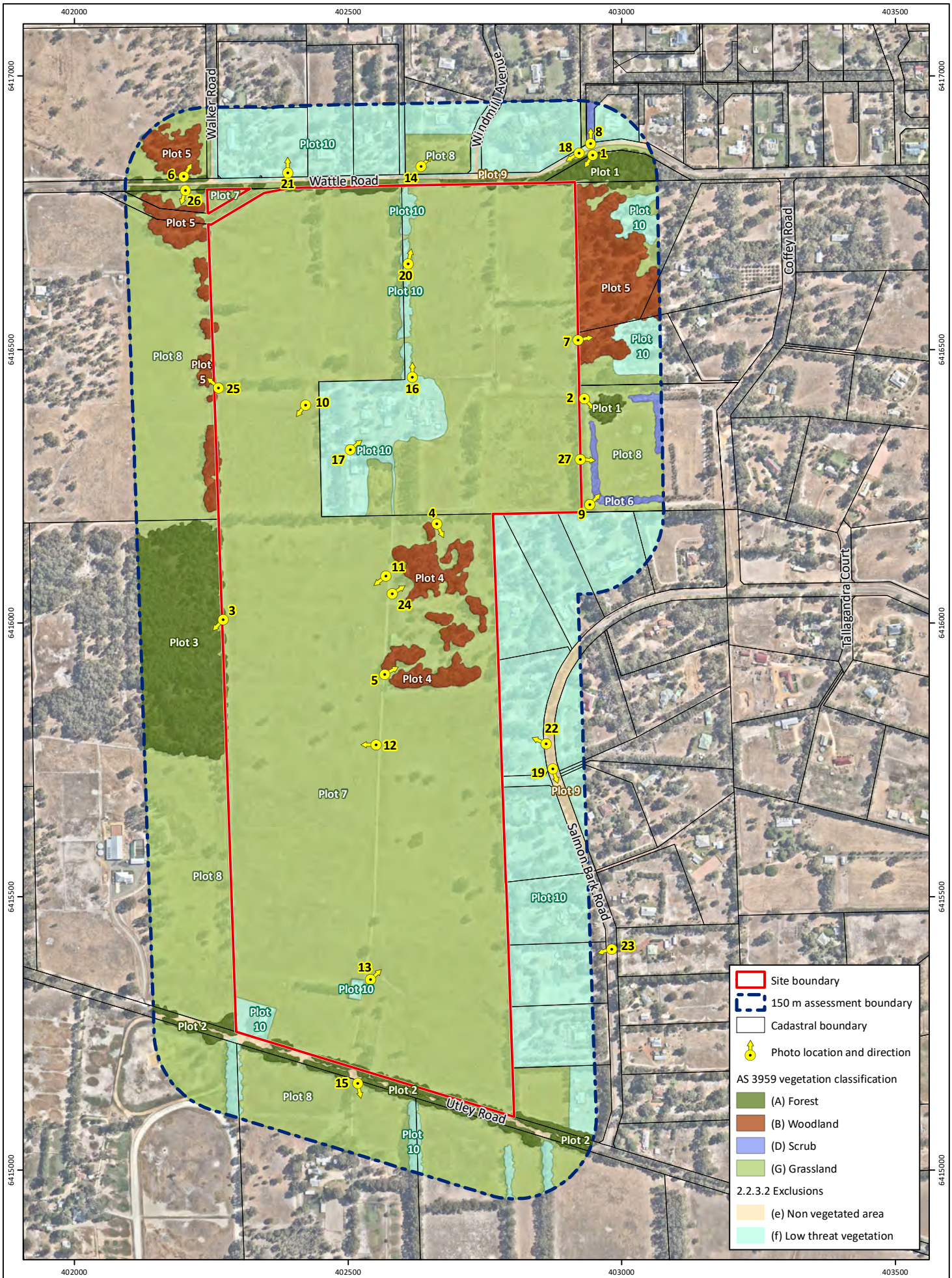


Figure 2: **Existing Site Conditions - AS 3959 Vegetation Classifications**

Project: Bushfire Management Plan
Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number: EP20-064(02)--F32a

Drawn:	GAR
Date:	10/03/2021
Checked:	BRB
Approved:	BRB
Date:	10/03/2021

N

0 100 200
Metres

Scale: 1:9,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

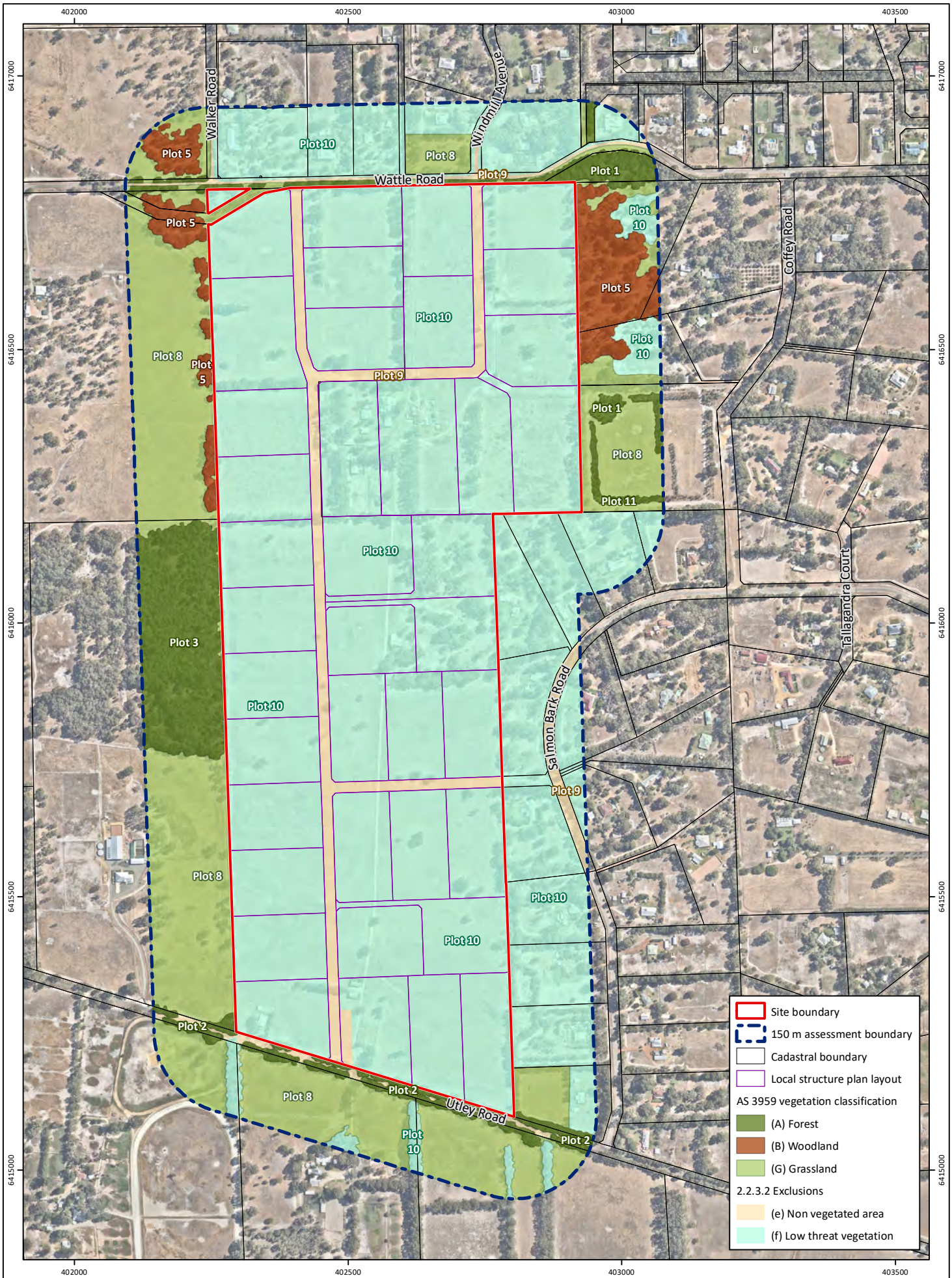


Figure 3: **Post Development Site Conditions - AS 3959 Vegetation Classifications**

Project: Bushfire Management Plan
Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number: EP20-064(02)--F33a

Drawn:	GAR
Date:	10/03/2021
Checked:	BRB
Approved:	BRB
Date:	10/03/2021

N

0 2,400 4,800
Metres

Scale: 1:9,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

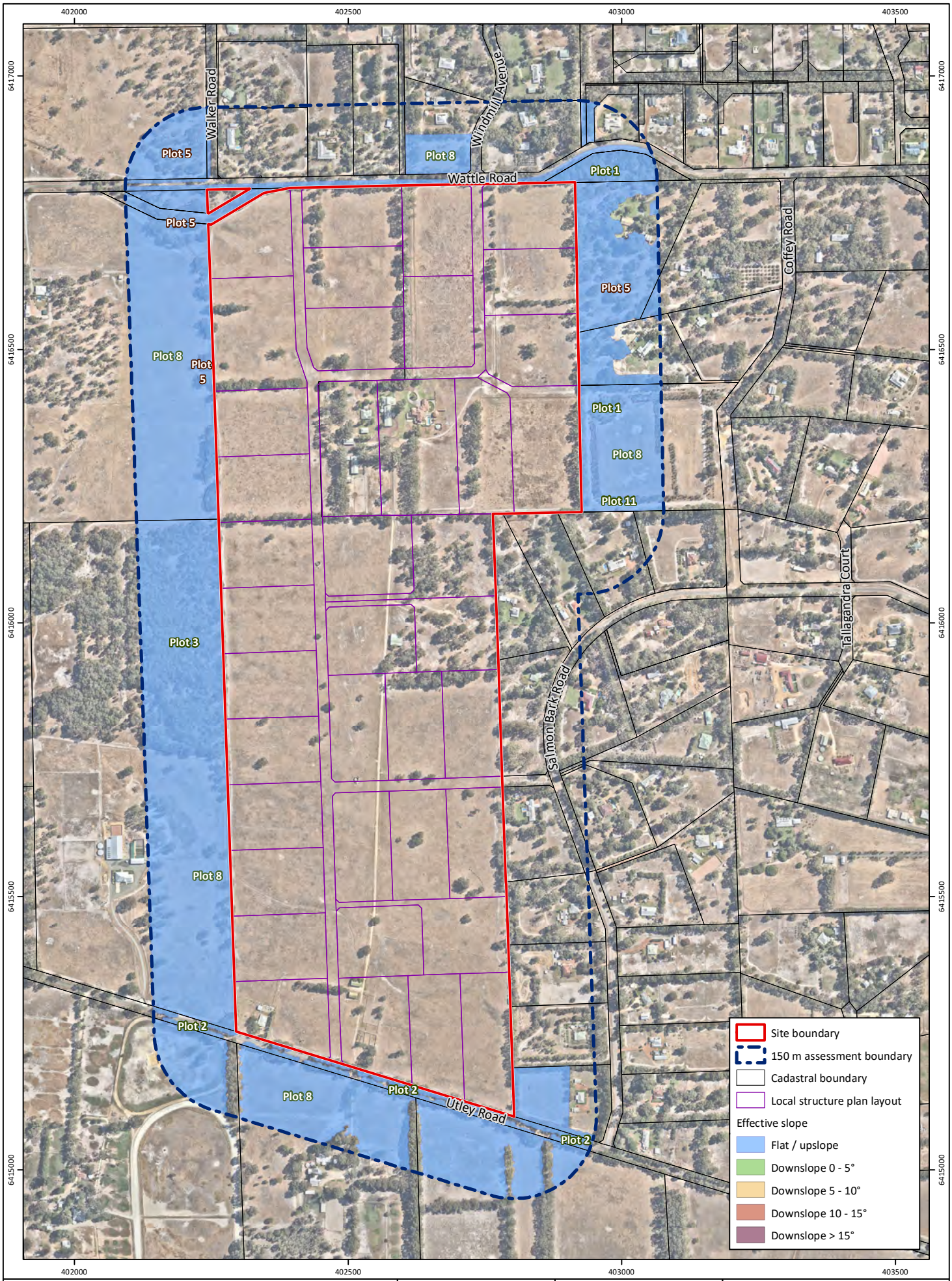


Figure 4: **Post Development Site Conditions - Effective Slope**

Project: Bushfire Management Plan
Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number: EP20-064(02)--F34a

Drawn:	GAR
Date:	10/03/2021
Checked:	BRB
Approved:	BRB
Date:	10/03/2021

N

0 2,400 4,800
Metres

Scale: 1:9,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

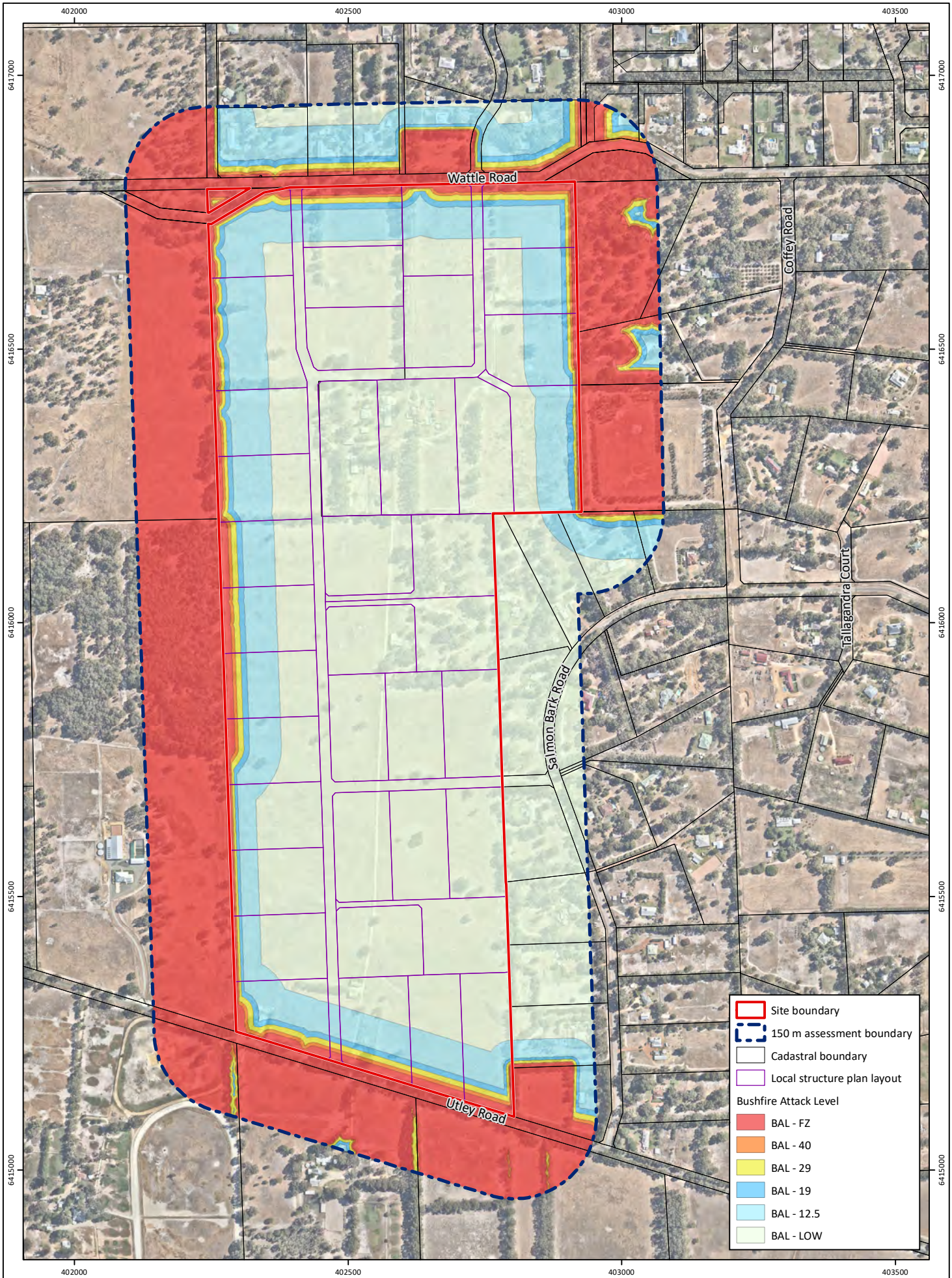


Figure 5: Bushfire Attack Level Contours

Project: Bushfire Management Plan
Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number: EP20-064(02)--F35a

Drawn:	GAR
Date:	10/03/2021
Checked:	BRB
Approved:	BRB
Date:	10/03/2021

N

0 100 200
Metres

Scale: 1:9,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

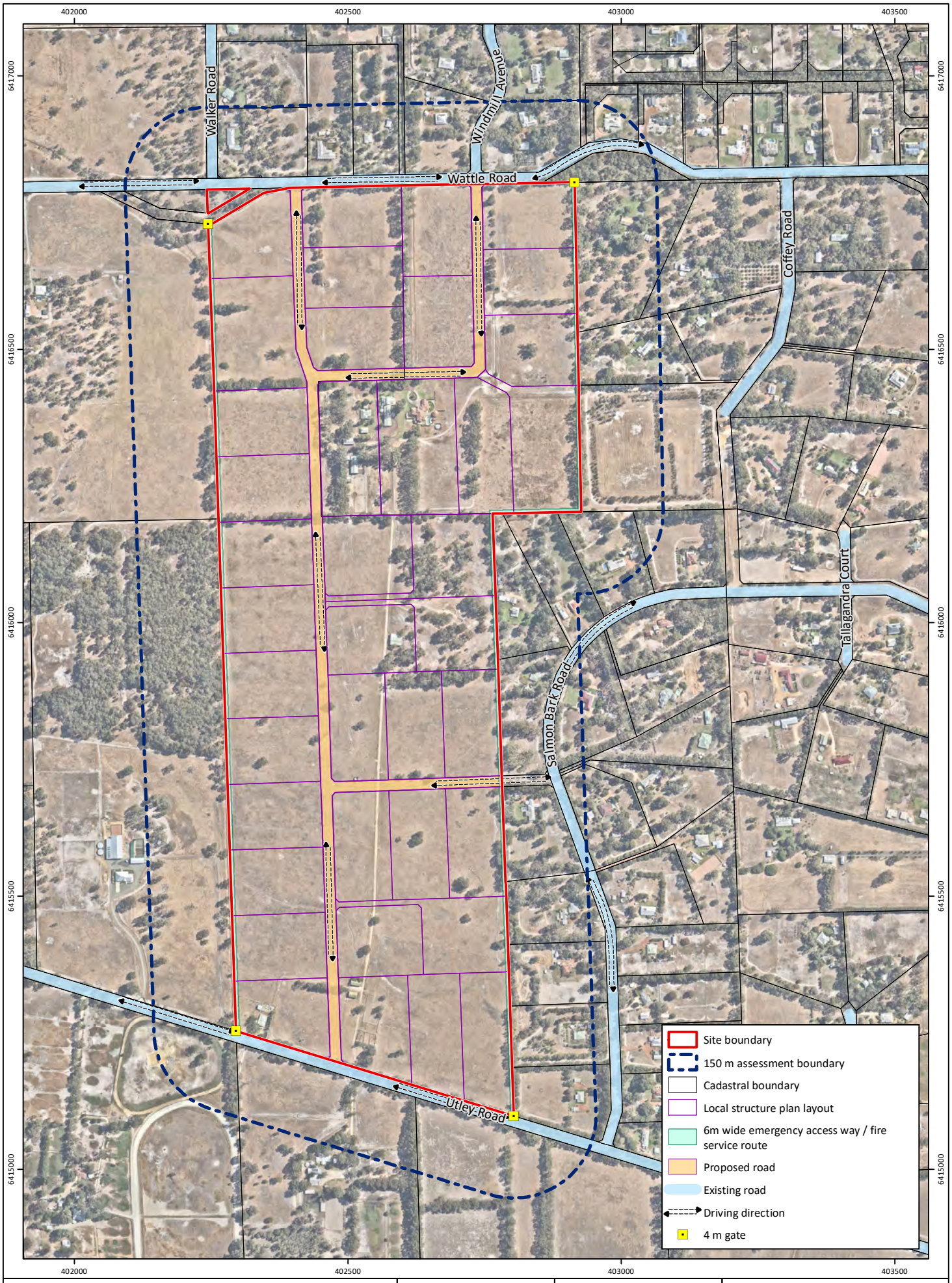


Figure 6: Vehicle Access

Project:	Bushfire Management Plan Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine
Client:	Stron Pty Ltd

Plan Number:
EP20-064(02)--F36a

Drawn:	GAR
Date:	10/03/2021
Checked:	BRB
Approved:	BRB
Date:	10/03/2021

N

0 100 200
Metres

Scale: 1:9,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

Appendix A

Lot 9001 Utley Road & Lot 9002 Wattle Road
Serpentine Structure Plan (Hex Design 2021)

DRAFT

WATTLE ROAD

WALKER RD

DMILL AVE

20m Road Reserve

UTLEY ROAD

SALMON BARK ROAD

1	2.05 ha	
2	2.05 ha	
3	2.07 ha	
4	2.04 ha	
5	2.04 ha	
6	2.04 ha	
7	2.04 ha	
8	2.04 ha	
9	2.04 ha	
10	2.04 ha	
11	2.04 ha	
12	3.16 ha	
13	2.06 ha	
14	2.06 ha	
15	2.23 ha	
16	2.31 ha	
17	2.00 ha	
18	2.08 ha	
19	2.07 ha	
20	2.07 ha	
21	2.23 ha	
22	2.23 ha	
23	2.24 ha	
24	2.01 ha	
25	2.17	
26	2.13	
27	2.01 ha	
28	3.53 ha	
29	2.66 ha	
30	2.00 ha	
31	2.00 ha	
32	2.00 ha	
33	2.11 ha	
34	2.14 ha	
35	2.03 ha	
36	2.03 ha	
37	2.16 ha	
38	2.62 ha	
39	2.36 ha	

9001
68.054 ha
(68.227 ha)

9002
23.075 ha

1,733 m²
(68.227 ha)

606 152 151 150 101 101 2597 27 25 168 376 1357 828 202 201 203 204 211 205 212 207 206 310 301 309 302 308 303 307 306 304 305

SUMMARY	
Subject Site	**91.30 ha**
Lot 9001	68.23 ha
Lot 9002	23.08 ha
Zone	
Special Rural - 39 Lots (RR1 - Min 2 ha)	85.19 ha
Road Reserves	5.94 ha
Balance lot	0.17 ha

LEGEND

- Subject Site
- Cadastre
- Minor Water Course
- Drain
- Retained Buildings
- Proposed Lot Boundary
- Special Rural (RR1 - Min. 2 ha)
- Proposed Road Reserve
- Road Center Line

STRUCTURE PLAN

Lot 9001 Utley Road & Lot 9002 Wattle Road - Serpentine

50 0 50 100 250 500

Project RAYSJLSP I Scale 1:5000@A3 I Date May 2020

HEX DESIGN PLANNING

Source of Information

Site boundaries: Landgate
Projection: GDA94 MGA Zone 50 South

NOTE
All areas and dimensions are subject to survey, engineering and detailed design and may change without notice.

A3PL_20200513_RAYSJLSP_Structure Plan Lot 9001 Utley Road & Lot 9002 Wattle Road - Serpentine MGA50.dwg

Appendix B

Additional photographs

Table B1: Additional photo points organised by plot, as shown within Figure 2.

Plot 5	
AS 3959 classification: Woodland (Class B)	
 *Photo location 24: woodland vegetation within the centreal portion of the site*	 *Photo locatiuon 25: woodland vegetation to the west of the site*
 *Photo location 26: woodland vegetation to the north-west of the site*	

Report Title

Project Title

Appendix 3

Local Water Management Strategy

Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Local Water Management Strategy

Project No: EP20-064(01)

Prepared for Stron Pty Ltd
March 2021

Document Control

Doc name:	Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine Local Water Management Strategy				
Doc no.:	EP20-064(01)--001B TEM				
Version	**Date**	**Author**		**Reviewer**	
1	August 2020	Tessa McAllister	TEM	Dave Coremans	DPC
		Aisha Chalmers	ASC		
	For project team review				
A	December 2020	Tessa McAllister	TEM	Dave Coremans	DPC
	Final updated to address SSJ comments				
B	March 2021	Tessa McAllister	TEM	Dave Coremans	DPC
	Final updated to address DWER comments				

Executive Summary

Stron Pty Ltd (the proponent) propose to develop Lot 9001 Utley Road and Lot 9002 Wattle Road, in Serpentine ('the site') for rural residential purposes. The site is approximately 91.3 ha in size and is located approximately 50 km south-east of the Perth Central Business District, within the Shire of Serpentine-Jarrahdale.

The site is currently zoned as a 'Rural' under the *Metropolitan Region Scheme* (DPLH 2020) and 'rural residential' under the SSJ *Local Planning Scheme 3* (SSJ 2020). This local water management strategy (LWMS) details the water management approach to support the SP as required in accordance with *Better Urban Water Management* (WAPC 2008).

Water will be managed using an integrated water cycle management approach. The first step in applying integrated water cycle management in rural catchments is to understand the existing environment. In summary, the environmental investigations conducted to date indicate that:

- The site is predominately pasture with some vegetation and a small cluster of buildings towards the north.
- The site receives 1,153 mm of average annual rainfall with the majority of rainfall received in May to October.
- The topography of the site generally has a westward aspect, with elevations ranging from 33 m (Australian height datum) AHD in the north-west corner up to 40 m AHD along the eastern border.
- Regional geological mapping shows that the site consists of sand and sandy clay. Geotechnical investigations determined the site was underlain by a sand layer (generally 700 mm below ground level) over loam-clays or gravel.
- The site is classified as having moderate to low risk of acid sulfate soils occurring within 3 m of natural soil surface.
- Vegetation in the site cannot be considered to represent any floristic community type given the low number of native species found and their poor condition.
- The northern half of the site comprises of a resource enhancement wetland (REW) and the southern half comprises of a multiple use wetland (MUW).
- The site is classified as a sewage sensitive area under the *Government Sewage Policy* (DPLH 2019).
- Stormwater runoff from upstream catchments flows into the site at two discrete locations and along the eastern boundary of the site at a cumulative peak flow of 3.97 m^3/s in a 1% annual exceedance probability (AEP) rainfall event.
- Stormwater runoff within the site is conveyed from the eastern side of the site towards the north west via overland flow, through culverts, and within existing drains or flow paths.
- Runoff discharges from the site towards the west and north, ultimately entering Water Corporation rural drains within adjacent lots. Total discharge from the site in the 1% AEP rainfall event at the confluence is 6.39 m^3/s.
- Aquifers beneath the site comprise of: Dirk/Karnet, Superficial Swan, Leederville and Cattamarra Coal Measures. Allocation is available in the Leederville and the Superficial Swan aquifers.
- Regional groundwater mapping provided by DWER indicates that groundwater is at or close the surface across the site.

- Groundwater beneath the site is not a reflection of the regional superficial aquifer but rather of infiltrated stormwater perching above the loam-clay and gravel layers.

The LWMS design objectives seek to deliver best practice outcomes using a water sensitive urban design (WSUD) approach, including detailed management approaches for:

- Potable water consumption
- Flood mitigation
- Stormwater quality management
- Groundwater management
- Wastewater servicing.

The overall approach to water supply is to utilise existing reticulated scheme water services close to the site. The approach to water conservation involves reducing the amount of scheme water required within the development. Within lot, potable water consumption will be reduced by promoting fit-for-purpose water sources, water efficient fixtures and appliances and water wise gardening (WWG) principles across lots. Roadside swales located within road reserves are not proposed to be irrigated.

Surface water quality will be addressed by treating the small rainfall event (i.e. first 15 mm of runoff) from road pavement within vegetated roadside swales. Within lots, the use of impervious surfaces should be minimised to maintain existing infiltration. A series of non-structural measures will also be implemented to minimise nutrient loading to groundwater.

The overarching principle behind the stormwater management strategy is to maintain the existing hydrology of the site. This will be achieved by detaining runoff from road pavement within roadside swales, maintaining an existing east-west drain to convey upstream flows, avoiding creating barriers to overland flow within lots, the provision of culverts beneath road reserves and drains within lots to convey runoff from east to west.

Groundwater management will focus on providing sufficient separation distances through the use of fill and on maintaining or improving the existing groundwater quality. This will be achieved by reducing total nutrient loads originating from the development and treating stormwater water runoff as close to source as possible.

Wastewater management focuses on providing on-site domestic and industrial wastewater services in a manner that avoids any detrimental impacts on the environment and water resources. This will be undertaken in line with the requirements of the *Government Sewerage Policy* (DPLH 2019), *Australian Standard AS/NZS 1547:2012 Onsite Domestic Wastewater Management* (Standards Australia and Standards New Zealand 2012) and *Water Quality Protection Note 51: Industrial wastewater management and disposal* (DoW 2009).

The proposed design criteria and the manner in which they are proposed to be achieved are presented in **Table E1**. This table provides a readily auditable summary of the required outcomes which can be used in the future detailed design stage to demonstrate that the agreed objectives for water management have been achieved. This LWMS demonstrates that by following the recommendations detailed in the report the site is capable of being developed for rural residential purposes.

Table E1 Water management criteria and compliance summary

Management aspect	Criteria number	Criteria description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
Water conservation	WC1	Use fit for purpose water sources	Connection to the existing Water Corporation scheme for supply of potable water	Developer	Detailed design and implementation
			Promotion and implementation of rainwater tanks (RWTs) to supplement scheme water requirements within lots	Developer	At point of sale
				Lot owner	Lot construction
	WC2	Consumption target for water of 100 kL/person/year, including not more than 40-60 kL/person/year scheme water	Mandated use of water efficient fixtures	Lot owner	Lot construction
			Promotion and implementation of water efficient appliances	Developer	At point of sale
				Lot owner	Lot construction
			Promotion and implementation of rainwater tanks within individual lots	Developer	At point of sale
				Lot owner	Lot construction
			Use of waterwise gardening (WWG) principles in roadside swales and drains	Developer	Detailed design and implementation
			Promotion and implementation of WWG principles within individual lots	Developer	At point of sale
				Lot owner	Lot construction
Stormwater management	SW1	Retain and treat the small rainfall event (i.e. first 15 mm) as close to source as possible	Treat small event runoff from road reserves within roadside swales	Developer	Detailed design and implementation
			Minimising the area of impermeable surfaces within lots to ensure infiltration continues to occur	Lot owner	Lot construction
	SW2	Maintain existing peak flow rates from the major rainfall (i.e. 1% AEP) event discharging from the development	Use of roadside swales to detain the additional major event runoff from road pavement	Developer	Detailed design and implementation

Table E1 Water management criteria and compliance summary (continued)

Management aspect	Criteria number	Criteria description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
Stormwater management	SW3	Provide conveyance of upstream flows through the development	Maintenance of the central east-west drain	Developer	Detailed design and implementation
			Provision of drains and culverts to allow runoff to flow beneath proposed road reserves towards the west	Developer	Detailed design and implementation
			Avoiding creating barriers to overland flow within lots	Lot owner	Lot construction
	SW4	Minor roads are to remain passable in the minor rainfall (i.e. 20% AEP) event	Roadside swales are sized to detain minor and major rainfall event runoff from road pavement	Developer	Detailed design and implementation
	SW5	Apply appropriate non-structural measures to reduce nutrient loads	Minimal fertiliser use to establish vegetation within roadside swales and drains and no ongoing fertiliser use within roadside swales	Developer	Detailed design and implementation
			Promotion and implementation of WWG and fertiliser use	Developer	At point of sale
				Lot owner	Lot construction
Groundwater management	GW1	Maintain the existing groundwater hydrological regime	Ensure infiltration continues to occur within road reserves through the use of roadside swales	Developer	Detailed design and implementation
			Ensure infiltration continues to occur across lots by minimising impervious areas to building envelopes, outbuildings and driveways	Lot owner	Lot construction
			Proposed drains will discharge into Water Corporation rural drains adjacent to the site at existing inverts	Developer	Detailed design and implementation
			Use of sand fill beneath road reserves and building envelopes to provide sufficient separation to highest groundwater levels	Developer	Detailed design and implementation
				Lot owner	Lot construction
	GW2	Maintain or improve groundwater quality onsite	Direct small event runoff from road pavement into roadside swales. Treatment is provided through interaction with vegetation and adsorption of nutrients to soil particles through infiltration.	Developer	Detailed design and implementation

Table E1 Water management criteria and compliance summary (continued)

Management aspect	Criteria number	Criteria description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
Stormwater management	GW2	Maintain or improve groundwater quality onsite	Vegetate proposed drains with nutrient stripping vegetation for additional treatment of stormwater runoff	Developer	Detailed design and implementation
			Minimal fertiliser use to establish vegetation within roadside swales and drains and no ongoing fertiliser use within roadside swales	Developer	Detailed design and implementation
			Promotion and implementation of WWG and fertiliser use	Developer	At point of sale
				Lot owner	Lot construction
			Implementation of on-site sewage system	Lot owner	Lot construction
Wastewater management	WW1	On-site sewage systems to be located at least 100 m from a drainage system that discharges directly into a waterway or significant wetland without treatment	All lots are able to achieve a 100 m setback from the proposed drains and Water Corporation drains. All roadside swales and drains within the site will provide treatment by utilising nutrient absorbing vegetation. Lots will be able to either achieve a 100 m setback from roadside drains or are hydrologically downstream and can achieve the minimum setback of 6 m from roadside swales.	Lot owner	Lot construction
	WW2	On-site sewage systems are not to be located in any area subject to inundation and/or flooding in a 10 % AEP rainfall event	Lot sewage systems will not be located in an area subject to inundation, and sand fill will be utilised to achieve separation to groundwater. Similarly, lot sewage systems will not be located within 6 m of any drain.	Lot owner	Lot construction
	WW3	The discharge point of the on-site sewage system should be at least 1.5 m above the highest groundwater level	The discharge point of lot sewage systems will be set at least 1.5 m above the highest perched groundwater level. Where necessary this will be achieved with imported sand fill within lots.	Lot owner	Lot construction

This page has been left blank intentionally.

Table of Contents

List of Tables

Figures

Appendices

Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
ANZECC	Australian and New Zealand Environment and Conservation Council
DoH	Department of Health
DWER	Department of Water and Environmental Regulation
SSJ	Shire of Serpentine Jarrahdale

Table A2: Abbreviations – General terms

General terms	
AEP	Average exceedance probability
AS 1547	AS/NZS 1547 On-site domestic wastewater management
ASS	Acid sulfate soil
ATU	Aerobic treatment unit
BGL	Below ground level
BUWM	Better Urban Water Management
DA	Development approval
EAMS	Environmental assessment and management strategy
LWMS	Local water management strategy
MUW	Multiple use wetland
SP	Structure plan
SSE	Site and soil evaluation
TP	Test pit
REW	Resource enhancement wetland
RWT	Rainwater tank
WEFA	Water efficient fittings and appliances
WSUD	Water sensitive urban design
WWG	Waterwise gardening

Table A3: Abbreviations – units of measurement

Units of measurement	
cm	Centimetre
°C	Degrees celcius
ha	Hectare
kL	Kilolitres
kL/year	Kilolitres per year
km	Kilometres
m	Metre
m^2	square metre
m AHD	m in relation to the Australian height datum
mm	Millimetre

Terminology Tables

Table A3: Annual exceedance probability – annual recurrence interval equivalence

Rainfall event	Annual exceedance probability	Annual recurrence interval	Depth (mm)
Small	-	1	15
Minor	20%	5	-
	10%	10	-
Major	1%	100	-

This page has been left blank intentionally.

1 Introduction

1.1 Background

Stron Pty Ltd (the proponent) propose to develop Lot 9001 Utley Road and Lot 9002 Wattle Road, in Serpentine ('the site') for rural residential purposes, as indicated in the Structure Plan (SP) provided in **Appendix A**. The site is located approximately 50 km south-east of the Perth Central Business District, within the Shire of Serpentine-Jarrahdale (SSJ). The site is approximately 91.3 ha in size and is shown in **Figure 1**.

1.2 Town planning context

The site is currently zoned as a 'Rural' under the *Metropolitan Region Scheme* (DPLH 2020) and 'rural residential' under the SSJ *Local Planning Scheme 3* (SSJ 2020).

1.3 Purpose

It is important that stormwater runoff is managed in a manner which avoids flooding and protects the environment. This approach should be clearly documented early in the planning process, and should provide framework for actions and measures to achieve the desired outcomes at subdivision and development stages.

This local water management strategy (LWMS) details the water management approach to support the SP as required in accordance with *Better Urban Water Management* (BUWM) (WAPC 2008), and the expectations of the Department of Water and Environmental Management (DWER) and SSJ. The LWMS also aids in achieving the goals and objectives outlined in the *Water Wise Perth - Two Year Action Plan* (Government of WA 2019).

1.4 Policy framework and previous studies

There are a number of Local and State Government policies of relevance to the development. These policies include:

- *A State Water Strategy for Western Australia* (Government of WA 2003)
- *State Water Plan* (Government of WA 2007)
- *State Planning Policy 2.9 Water Resources* (WAPC 2006)
- *Liveable Neighbourhoods Edition 4* (WAPC 2009a)
- *Guidance Statement No. 33: Environmental Guidance for Planning and Development* (EPA 2008a)
- *Planning Bulletin No. 64: Acid Sulfate Soils* (WAPC 2009b)
- *Government Sewerage Policy* (DPLH 2019).

In addition to the above policies, there are a number of published guidelines and standards available that provide direction regarding the water discharge characteristics that developments should aim to achieve.

These are key inputs that relate either directly or indirectly to the development and include:

- *Australian Rainfall and Runoff* (Ball J et al. 2019)
- *Australian Runoff Quality* (Engineers Australia 2006)
- *Better Urban Water Management* (WAPC 2008)
- *Developing a Local Water Management Strategy* (DoW 2008a)
- *Decision Process for Stormwater Management in Western Australia* (DWER 2017)
- *National Water Quality Management Strategy* (ANZECC and ARMCANZ 2000)
- *Stormwater Management Manual for Western Australia* (DoW 2007a)
- *AS/NZS 1547 On-site domestic wastewater management* (AS 1547) (Standards Australia and Standards New Zealand 2012)
- *Guidance on site-and-soil evaluation (SSE) for on-site sewage management* (DoH 2019)
- *Water Quality Improvement Plan for the Rivers and Estuary of the Peel-Harvey System - Phosphorus Management* (EPA 2008b).

Previous studies conducted on the site include:

- *Local Water Management Strategy* (Landform Research 2016)
- *Land Capability-Geotechnical Assessment* (Landform Research 2018).

1.5 LWMS objectives

This LWMS has been developed in consideration of the objectives and principles detailed in BUWM (WAPC 2008). It is intended to support the development within the site and is based on the following major objectives:

- Maintain the existing hydrological regime.
- Provide a broad level stormwater management framework to support future rural residential development.
- Develop a water conservation strategy for the site that will ensure the efficient use of all water resources.
- Minimise construction costs for the SP, which will result in reduced land costs for future home owners.
- Incorporate appropriate water sensitive urban design (WSUD) measures into the drainage system that address the environmental and stormwater management issues identified.
- Ensure that sufficient land area is set aside in the SP to manage urban runoff.
- Minimise ongoing operation and maintenance costs for the land owners and SSJ.
- Gain support from DWER, Water Corporation, Department of Health (DoH), and SSJ for the proposed methods to manage water within the site and to mitigate potential impacts to downstream areas.

Detailed objectives for water management within the site are further discussed in **Section 4**.

2 Proposed Development

Lot 9002 Wattle Road (68.23 ha) and Lot 9001 Utley Road (23.08 ha) are intended to be developed for rural residential purposes. A total of 39 lots are proposed with a minimum lot size of 2 ha. Approximately 5.94 ha will be developed for 20 m wide road reserves. Towards the central north of the site there are approximately four buildings which are intended to be retained. The SP is provided in **Appendix A**.

3 Existing Environment

3.1 Sources of information

The following sources of information were used to provide a broad regional environmental context to the site:

- *Weather and climate statistics (*BoM 2020*)*
- *LIDAR elevation dataset, Swan Coastal Plain* (DoW 2008b)
- *Geological survey of Western Australia* (Gozzard 1986)
- *Acid sulfate soils (ASS) risk mapping* (DWER 2020c)
- *Geomorphic wetlands of the Swan Coastal Plain database* (DBCA 2020)
- *Perth groundwater map* (DWER 2020b)
- *Water register* (DWER 2020e)
- *Landgate aerial photography* (WALIA 2020)
- *Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine Environmental Assessment and Management Strategy* (EAMS) (Emerge Associates 2020b).

3.2 Existing and historical land use

Landgate aerial photography shows the site is predominately pasture with some vegetation (WALIA 2020). A small cluster of buildings were observed towards the north of the site from 1965 onwards, with upgrades showing approximately six buildings as of 2020. Land directly adjacent to the site towards the east was subdivided between 1995 and 2000 into rural residential lots.

3.3 Climate

The south west of Western Australia experiences a Mediterranean climate of hot dry summers and cool wet winters. An average of 1,153 millimetres (mm) of rainfall is recorded annually from the closest weather station in the suburb of Karnet, which is located approximately 11 km from Serpentine. The majority of the rainfall is received between the months of May to October. Mean maximum temperatures range from 15.5^{o}C in July to 30.6^{o}C in January, while mean minimum temperatures range from 6.3^{o}C in July and August to 15.8^{o}C in February (BoM 2020).

3.4 Geotechnical conditions

3.4.1 Topography

The topography of the site has a generally westward aspect, with elevations ranging from 33 m Australian height datum (AHD) in the north-west corner up to 40 m AHD along the eastern border (DoW 2008b). Topographic contours across the site are shown in **Figure 2**.

3.4.2 Geology and Soils

National geological mapping indicates that the south half of the site is composed of the Guilford formation which is described as 'alluvial sands and clays with shallow-marine and estuarine lenses with local basal conglomerates', and the north half of the site is composed of Bassendean Sand, which is described as 'Basal conglomerate overlain by dune quartz sand with heavy mineral concentrations' (Raymond 2012). The geological survey of Serpentine, Western Australia indicated that that site is comprised of (Jordan 1986):

- Sand (S8): white to pale grey at surface, yellow at depth; fine to medium-grained, moderately sorted sub-angular to sub-rounded minor heavy minerals, of eolian origin.
- Sand (S10): S8 over sandy clay to clayey sand of the Guilford formation, of eolian origin.
- Sandy clay (C_S): white, grey to brown, fine to coarse, sub angular to rounded, clay of moderate plasticity, gravel and silt layers near scarp, of alluvial origin.

Geological mapping is shown in **Figure 3**.

A geotechnical investigation was conducted on the site by Landform Research in 2012 (Landform Research 2018) at 20 different locations with the use of a hand auger. Test pit (TP) depths ranged from 380 mm to 3,200 mm, with average depth of approximately 980 mm below ground level (BGL). Groundwater was not intersected in any TPs. In summary, Landform Research (2018) described the geology and soils underlying the site as follows:

- Soils predominantly consist of duplex soils with a sheet of sandy soil over a loam-clay base.
- The thickness of the overlying sand sheet varies. Generally the loam-clay occurs at 700 mm BGL, with the exception of TP3 and TP7 that have minor intrusions of loam-clay at around 400 mm BGL. TP5, 7, 9, 10, 13, 15, 18 and 20 did not encounter any loam-clay layer.
- Impermeable gravel was encountered at TP9, 10, 14, 15 and 20. Iron oxides were encountered below 700 mm BGL in TP4, 6, 9 and 12.

No infiltration testing was conducted on site. Soils are presumed to have a high permeability within the sand layer (from 400 m to 1000 mm BGL), however will have low permeability beyond this due to the loam-clay content. It is assumed that rainfall and stormwater that infiltrates on site will perch above this will loam-clay layer, and therefore perched groundwater is anticipated to occur in winter and spring. TP locations are shown in **Figure 3**. The full geotechnical report is provided in **Appendix B.**

3.4.3 Acid sulfate soil

Regional acid sulfate soils risk mapping (DWER 2020c) indicates that the entirety of the site is classified as moderate to low risk of ASS occurring within 3 m of natural soil surface. ASS risk mapping within and surrounding the site is shown in **Figure 4**.

3.5 Environmental assets

Emerge Associates (2020a) visited the site on 23 June 2020 to complete a reconnaissance flora, vegetation and fauna assessment. The following three plant communities were identified within the site:

- Plant community Cc exists mainly in the central portion of the site along an existing drain. A small area of Cc vegetation also exists in the south eastern portion of the site. These are in 'degraded' condition as the vegetation structure has been severely impacted by disturbance.
- Plant community CcEm exists mainly in the central eastern portion of the site, with a small area in the north western portion of the site. These are in 'degraded' condition as the vegetation structure has been severely impacted by disturbance.
- The remainder of the site was mapped as 'completely degraded' non-native plant community as it predominantly comprises non-native grassland and herbland with scattered native trees and lines of planted trees. The vegetation within the site has very low native species diversity and a highly disturbed structure which makes assigning a floristic community type (FCT) difficult (Emerge Associates 2020b).

Given the sites' location on the eastern side of the Swan Coastal Plain and the presence of *Corymbia calophylla* (marri) trees, plant communities Cc and CcEm would probably have historically represented an ecological community like FCT 3a '*Corymbia calophylla - Kingia australis* woodlands on heavy soils' or 3b '*Corymbia calophylla - Eucalyptus marginata* woodlands on sandy clay soils'. However, so few native species now remain that the vegetation in the site cannot be considered to represent any FCT (Emerge Associates 2020b).

3.5.1 Geomorphic wetlands

Geomorphic wetland mapping for the Swan Coastal Plain (DBCA 2020) identifies that the northern half of the site comprises of a resource enhancement wetland (REW) (UFI 15364), which is described as a seasonally waterlogged dampland. However, no prominent natural wetland landform features or areas supporting intact native wetland vegetation were recorded in the site survey (Emerge Associates 2020b). The southern half of the site comprises of a multiple use wetland (MUW) (UFI 16021), which is described as a flat palusplain and also seasonally waterlogged. Geomorphic wetlands are shown in **Figure 5**.

3.5.2 Sewage sensitive areas

The entirety of the site is classified as a sewage sensitive area by the *Government Sewerage Policy* (DPLH 2019). The policy defines sewage sensitive areas geographically based on proximity to a variety of environmental assets and sensitivity to on-site sewage disposal. The two classifications of relevance to the site define a sewage sensitive area as:

a) Estuary catchments on the Swan and Scott Coastal Plains.
f) The area within a boundary, which is 1 km up-groundwater-gradient and 250 m down-gradient of a significant wetland; or where the groundwater gradient is unknown within 1 km of the significant wetland.

Sewage sensitive areas are shown in **Figure 6**.

3.6 Surface water

3.6.1 Existing hydrological features

The site is located within the Serpentine River catchment, which ultimately discharges into the Peel Estuary (DWER 2020f).

The site is located within Water Corporation's Mundijong Drainage District and there are rural drains managed by the Water Corporation located beyond the site boundary (see **Figure 7**). The Serpentine River Sub-Section E1 rural drain is located to the south and west of the site and discharges into the Serpentine River Sub-Section E rural drain to the north of the site (K Purcher [Water Corporation] 2020, *pers. comm.*, 10 July).

Runoff within this rural drain network discharges into the Serpentine River approximately 6 km downstream of the site, just upstream of the Lowlands Reserve in Mardella, and again over 18 km downstream of the site, at the Lower Punrack Drain in Keralup (DWER 2020f; DWER 2020g).

In addition to these rural drains, the DWER (2020g) hydrography linear dataset shows the presence of a non-perennial watercourse flows from east to west within the southern portion of the site, as shown in **Figure 7**. Emerge Associates visited the site on two separate occasions in June 2020, which confirmed that no defined watercourse nor any environmental values could be located in this area. Therefore, the mapped watercourse is more correctly referred to as a flow path.

Landgate aerial photography shows that there are three existing basins or sumps located to the east of the site within the existing rural residential development, as shown in **Figure 7** (WALIA 2020). These were confirmed during the two site visits.

Finally, a number of culverts (ranging from small PVC pipes to larger circular concrete pipes) and existing drains or flow paths were identified during the two site visits. These are shown in **Figure 7**. The majority of the culverts are located beneath the driveway that extends from Utley Road to the existing buildings.

3.6.2 Existing hydrological regime

Surface runoff modelling was undertaken to characterise the existing hydrological regime. Modelling assumptions are detailed in **Appendix C** with results summarised in **Figure 8** and **Table 1**.

Stormwater runoff from upstream catchments, located within the existing rural residential development to the east, flows into the site at two discrete locations and along the eastern boundary of the site (see **Figure 8**). The total runoff entering the site in a 1% AEP rainfall event is 3.97 m^3/s, as shown in **Table 1**.

The site is relatively flat and therefore, stormwater runoff is conveyed via overland flow from the eastern side of the site (approximately 40 m AHD) towards the north west (approximately 34 m AHD) as illustrated by the flow path arrows shown in **Figure 8**. The existing driveway from Utley Road to the existing buildings in the north acts as a barrier to overland flow; runoff from the east is conveyed towards the west via the existing culverts. There is one existing drain that extends from the east to west of the site, which conveys runoff from one of the previously discussed upstream existing basins

or sumps. Finally, an existing drain located to the west of the existing driveway from Wattle Road to the buildings conveys runoff towards the north.

Stormwater runoff from the site discharges towards the north and west at five discrete locations (i.e. from existing drains) and along the northern and western boundaries of the site (see **Figure 8**). The total runoff from the site in a 1% AEP rainfall event at the confluence in the north-west of the site is 6.39 m^3/s, as shown in **Table 1**.

Table 1: Existing hydrological regime – peak flow rates

	Small rainfall event (63.2% AEP) peak flow (m^3/s)	Minor rainfall event (20% AEP) peak flow (m^3/s)	Major rainfall event (1% AEP) peak flow (m^3/s)
Total (cumulative) inflow	0.06	1.39	3.97
Total site discharge at confluence	0.15	2.18	6.39

3.6.3 Surface water quality

There has been no surface water quality monitoring undertaken at the site. Groundwater (discussed in **Section 3.7**) is generally close to the surface during winter and spring and consequently, groundwater quality is a reasonable indicator of likely surface water quality.

3.7 Groundwater

3.7.1 Groundwater resources

The *Water Register* (DWER 2020e) indicates that the site is located in the Serpentine groundwater area. Aquifers beneath the site comprise of the following:

- Serpentine River – Dirk/Karnet (unconfined)
- Perth – Superficial Swan (unconfined)
- Perth – Leederville (confined)
- Perth – Cattamarra Coal Measures (confined).

At the time of preparing this report (June 2020), groundwater allocation is available in the following aquifers:

- Perth – Leederville (218,751 kL available)
- Perth – Superficial Swan (1,928,592 kL available)

The proponent has an existing groundwater licence (#157049) for Lot 9002 Wattle Road for a total of 38,550 kL/yr from the Superficial Swan aquifer.

3.7.2 Groundwater levels

A review of the DWER *Water Information Reporting* dataset showed that there are no recent groundwater monitoring data available within the site (DWER 2020a). There is recent groundwater data available from a DWER monitoring bore (site reference 61410150) located to the north along Walker Road, approximately 150 m from the site (as shown on **Figure 7**). This monitoring bore has

continuous groundwater level data from the superficial swan aquifer from September 2017 to February 2020. Over this period the bore experienced a maximum groundwater level of 33 m AHD or approximately 4 m BGL.

Groundwater contours from the dataset Lower Serpentine Groundwater Contours have been provided by DWER. These contours indicate that maximum groundwater levels are at or close to the surface across the site, ranging from 34 mAHD in the northwest corner to 40 mAHD in the southeast corner.

Depth to the lower permeability loam-clay or impermeable gravel layers beneath the site ranges from 0.4 m to 3.1 m (see **Appendix B**). Given these soil conditions, along with the depth to maximum groundwater level measured along the northern boundary and the regional groundwater contours, it can be inferred that groundwater encountered within the site is not a reflection of the regional superficial aquifer but rather of infiltrated stormwater perching above these lower permeability layers. It is this perched layer that will need to be managed/considered during detailed design and any infiltration based water management approaches.

3.7.3 Groundwater quality

A review of the DWER *Water Information Reporting* shows there are no recent groundwater quality data available within or close to the site (DWER 2020a).

3.7.4 Summary of existing environment

In summary, the environmental investigations conducted to date indicate that:

- The site is predominately pasture with some vegetation and a small cluster of buildings towards the north.
- The site receives 1,153 mm of average annual rainfall with the majority of rainfall received in May to October.
- The topography of the site has a generally westward aspect, with elevations ranging from 33 m AHD north-west corner up to 40 m AHD along the eastern border.
- Regional geological mapping showed the site consists of sand and sandy clay. Geotechnical investigations determined the site was underlain by a sand layer (generally 700 mm BGL) over loam-clays or gravel.
- The site is classified as having moderate to low risk of ASS occurring within 3 m of natural soil surface.
- Vegetation within the site cannot be considered to represent any floristic community type given the low number of native species found and their condition.
- The northern half of the site comprises of a REW and the southern half comprises of a MUW.
- The site is classified as a sewage sensitive area under the Government Sewage Policy (DPLH 2019).
- Stormwater runoff from upstream catchments flows into the site at two discrete locations and along the eastern boundary of the site at a cumulative peak flow of 3.97 m^3/s in a 1% AEP rainfall event.
- Stormwater runoff within the site is conveyed from the eastern side of the site towards the north west via overland flow, through culverts, and within existing drains or flow paths.

- Runoff discharges from the site towards the west and north, ultimately entering Water Corporation rural drains within adjacent lots. Total discharge from the site in the 1% AEP rainfall event at the confluence is 6.39 m^3/s.
- Aquifers beneath the site comprise of: Dirk/Karnet, Superficial Swan, Leederville and Cattamarra Coal Measures. Groundwater allocation is available in the Leederville and the Superficial Swan aquifers.
- Regional groundwater mapping provided by DWER indicates that groundwater is at or close the surface across the site.
- Groundwater beneath the site is not a reflection of the regional superficial aquifer but rather of infiltrated stormwater perching above the loam-clay and gravel layers.

4 Design Criteria and Objectives

This section outlines the objectives and design criteria that this development must achieve. The water management strategy includes water conservation, stormwater management, groundwater management and wastewater management.

4.1 Integrated water cycle management

The *State Water Strategy* (Government of WA 2003) and *BUWM* (WAPC 2008) endorses the promotion of integrated water cycle management and application of WSUD principles to provide improvements in the management of stormwater, and to increase the efficient use of other existing water supplies.

The key principles of integrated water cycle management include:

- Considering all water sources, including wastewater, stormwater and groundwater.
- Integrating water and land use planning.
- Allocating and using water sustainably and equitably.
- Integrating water use with natural water processes.
- Adopting a whole catchment integration of natural resource use and management.

Integrated water cycle management addresses not only physical and environmental aspects of water resource use and planning, but also integrates other social and economic concerns. Stormwater management design objectives should therefore seek to deliver better outcomes in terms of:

- Potable water consumption
- Flood mitigation
- Stormwater quality management
- Groundwater management
- Wastewater servicing.

The first step in applying integrated water cycle management in developed catchments is to establish agreed environmental values for receiving environments. The existing environmental context of the site has been discussed in **Section 3** of this document. Guidance regarding environmental values and criteria is provided by a number of National and State policies and guidelines and site-specific studies undertaken in and around the site. These were detailed in **Section 1.4**.

The overall objective for preparing integrated water cycle management plans for proposed rural residential developments is to minimise pollution and maintain the hydrological regime. This objective is central to the water management approach for the site.

4.2 Water conservation

The water conservation design criteria proposed are consistent with the guidelines presented in *BUWM* (WAPC 2008) and *Developing a LWMS* (DoW 2008a). This LWMS proposes the following water conservation criteria:

Criteria WC1 Use fit for purpose water sources.

Criteria WC2 Consumption target for water of 100 kL/person/year, including not more than 40-60 kL/person/year scheme water.

The manner in which this objective will be achieved is further detailed in **Section 5**.

4.3 Stormwater management

The principle behind stormwater management at the site is to mimic the existing hydrological conditions. This principle and the guidance documents discussed in **Section 1.4** have guided the stormwater management criteria. This LWMS proposes the following stormwater design criteria:

Criteria SW1 Retain and treat the small rainfall event (i.e. first 15 mm) as close to source as possible.

Criteria SW2 Maintain existing peak flow rates from the major rainfall (i.e. 1% annual exceedance probability (AEP)) event discharging from the development.

Criteria SW3 Provide conveyance of upstream flows through the development.

Criteria SW4 Minor roads are to remain passable in the minor rainfall (i.e. 20% AEP) event.

Criteria SW5 Apply appropriate non-structural measures to reduce nutrient loads.

The manner in which these objectives will be achieved is further detailed in **Section 6**.

4.4 Groundwater management

The principle behind the groundwater management strategy is to maintain the existing groundwater hydrological regime. This LWMS proposes the following groundwater management criteria:

Criteria GW1 Maintain the existing groundwater hydrological regime.

Criteria GW2 Maintain or improve groundwater quality onsite.

The manner in which the groundwater management objectives will be achieved is further detailed in **Section 7**.

4.5 Wastewater servicing

The principle behind the wastewater management strategy for the site is to provide wastewater servicing for the development in a manner that avoids any detrimental impacts on the environment and water resources, and in a manner consistent with the requirements of the *Government Sewerage Policy* (DPLH 2019) and relevant guidelines.

Criteria WW1 On-site sewage systems to be located at least 100 m from a drainage system that discharges directly into a waterway or significant wetland unless treated prior.

Criteria WW2 On-site sewage systems are not to be located in any area subject to inundation and/or flooding in a 10 % AEP rainfall event.

Criteria WW3 The discharge point of the on-site sewage system should be at least 1.5 m above the likely maximum groundwater level.

The manner in which these objectives is achieved is further detailed in **Section 8**.

5 Water Conservation Strategy

5.1 Fit for purpose water use

Conservation of water through fit-for-purpose use and best management practices is encouraged so that scheme water is not wasted. Fit-for-purpose describes the use of water that is of a quality suitable for the required use of the water. Fit-for-purpose principles have been utilised in the water conservation strategy for the site and will achieve **Criteria WC1** and **WC2**.

5.1.1 Potable supply

The existing 180DN water main near Windmill Avenue and Wattle Road has sufficient capacity to service the rural residential lots within the development with recirculated potable water (Porter Consulting 2020).

5.1.2 Groundwater supply

The proponent's existing groundwater licence (#157049) for Lot 9002 Wattle Road for a total of 38,550 kL could be amended and utlised for establishment irrigation of vegetation within the roadside swales and drains. No ongoing irrigation of roadside swales by SSJ or drains by lot owners is required.

As discussed in **Section 3.7.1**, 1,928,592 kL is currently available from the Perth – Superficial Swan aquifer beneath the site. Groundwater could potentially be used for non-potable water uses within lots (e.g. irrigation), however it is the lot owner's responsibility to obtain any necessary a groundwater licence to facilitate the proposed use.

5.1.3 Rainwater harvesting

Collection of runoff from roof surfaces can be undertaken, with this water stored within rainwater tanks (RWT) for later use. This water is of high quality, however in urban environments this water is considered non-potable. Stored rainwater may be used for some irrigation requirements however this will need to be supplemented with scheme water during the lower rainfall months. During the higher rainfall months, the majority of the stored rainwater can be used to supplement internal building non-potable uses. The water efficiency strategy recommends that rainwater is used in washing machines, toilets and hot water systems. RWTs will not be mandated for the development however will be promoted to lot owners at point of sale.

5.2 Water conservation measures

The development will utilise water efficient fixtures and appliances (WEFA) and water wise garden (WWG) principles to reduce water use within the development. These measures will assist in achieving **Criteria WC2**.

5.2.1 Water efficient fixtures and appliances

Significant reductions in in-house water uses can be achieved with the use of WEFA. The water conservation strategy proposes that all dwellings use WEFA. Water efficient fittings are mandated as part of the building approvals process, while uptake of water efficient appliances can be encouraged through education from the proponent at point of sale. Based on typical uptake rates informed by Australian Bureau of Statistics reports (ABS 2013), 40% of residential dwellings will utilise water efficient appliances.

5.2.2 Water wise gardens

Water use efficiency measures can significantly reduce the total consumption for irrigation purposes. Water use can be reduced by employing WWG measures including:

- Retain remnant trees and vegetation where possible.
- Minimise turf areas where possible.
- Implement hydrozoning design practices, which group plant species with similar/ same irrigation requirements.
- Where required, soil shall be improved with soil conditioner certified to Australian Standard AS4454 to a minimum depth of 150 mm where turf is to be planted and a minimum depth of 300 mm for garden beds.
- Garden beds to be mulched to 75 mm with a product certified to Australian Standard AS4454.
- Irrigation systems will have emitters which disperse coarse droplets to minimise losses to evaporation.
- Utilise subsoil irrigation where appropriate.
- Minimise use of fertiliser and/or utilise slow release fertilisers.

WWG principles can be promoted to lot owners at point of sale, and where relevant will guide the approach taken for roadside swales.

5.3 Water conservation design criteria compliance summary

A summary of the proposed water conservation design criteria and how these are addressed within the site is provided in **Table 2**.

Table 2: Water conservation criteria compliance

Criteria number	Criteria description	Manner in which compliance will be achieved
WC1	Use fit for purpose water sources	Connection to the existing Water Corporation scheme for supply of potable water
		Use of groundwater for establishment irrigation of vegetation within roadside swales and drains, and for non-potable water uses within lots
		Promotion and implementation of RWTs to supplement scheme water requirements within lots

Table 2: Water conservation criteria compliance (continued)

Criteria number	Criteria description	Manner in which compliance will be achieved
WC2	Consumption target for water of 100 kL/person/year, including not more than 40-60 kL/person/year scheme water	Mandated use of water efficient fixtures
WC2	Consumption target for water of 100 kL/person/year, including not more than 40-60 kL/person/year scheme water	Promotion and implementation of RWTs within individual lots
		Use of WWG in roadside swales and drains
		Promotion and implementation of WWG principles within individual lots

6 Stormwater Management

The principle behind the stormwater management strategy for the site is to mimic the existing hydrological conditions by maintaining the existing peak flow rates leaving the site. The stormwater management strategy consists of two distinct components:

- Road reserve drainage
- Lot drainage.

Each component has been designed to achieve the objectives and criteria stated in **Section 4.3**. The sizing of each component has been determined using XPSWMM hydrological and hydraulic software. The modelling assumptions report provided in **Appendix C** presents the detailed methods and assumptions used to develop the model.

6.1 Road reserve drainage

As shown in **Appendix A**, approximately 5.94 ha of the site will be developed as 20 m wide road reserves. For the purposes of this LWMS and until confirmed by detailed civil design, it is assumed the road reserves will be constructed approximately 500 mm above existing surface (Porter Consulting 2020).

Runoff from road pavement is proposed to be both treated and detained within roadside swales located within verges. Roadside swales are proposed to be located on one side of the road reserves in order to minimise the number of culverts required to be constructed and maintained (see **Figure 9**). Roadside swales are proposed to have the following characteristics:

- 1:4 side slopes adjacent to the road pavement
- 1:3 side slopes adjacent to the lot boundary
- 300 mm deep
- Assumed infiltration rate of 2 m/day.

It is the preference of the proponent and the Shire that trees are retained wherever practicable. The design of swales will consider existing trees and where possible these will be retained.

In order to provide in-line detention, appropriate structures will need to be included as part of detailed civil design. For example, this could include rock riffles, weir structures, and/or low flow outlets.

Swales will be vegetated with reeds and rushes suitable for removing nutrients on the lot side of the drain (Payne *et al.* 2015); the side of the drain adjacent to the pavement will be seeded, consistent with SSJ requirements (C Done [SSJ] 2020, *pers. comm.*, 30 June). Where parent soils do not have sufficient phosphorous retention capability, a layer of high PRI >10 soil or engineered media should be located beneath the invert of the swale to provide treatment as runoff infiltrates towards the underlying loam-clay layer (Payne *et al.* 2015). The design approach may need to be modified to suit localised site conditions, and to maximise the retention of existing trees.

Table 3 provides the volume that will be treated and detained with the swale profile, and demonstrates that the required volume can be treated within swales located along a section of the road reserve. **Table 3** also provides the swale depths in frequent, minor and major runoff events. While the roadside swales are proposed to be 300 mm deep, only 200 mm has been utilised for detention of the major rainfall event to provide freeboard to the pavement.

Table 3: Treatment of small event runoff and detention of minor and major event runoff within roadside swales

Catchment	Length of swale (m)	Small rainfall event (62.3% AEP)		Minor rainfall event (20% AEP)		Major rainfall event (1% AEP)	
		Volume (m^3)	Water depth (m)	Volume (m^3)	Water depth (m)	Volume (m^3)	Water depth (m)
R1	320	17.1	0.126	39.2	0.189	41.3	0.194
R2	290	11.9	0.112	30.3	0.200	31.2	0.205
R3	430	17.4	0.110	52.4	0.189	55.7	0.195
R4	210	11.0	0.127	21.8	0.200	22.2	0.202
R5	440	18.1	0.111	62.7	0.204	66.1	0.210
R6	270	15.9	0.132	36.4	0.199	38.2	0.203
R7	420	25.0	0.133	58.7	0.202	62.4	0.209

Following treatment and detention of runoff, roadside swales will either discharge runoff into east-west drains (discussed in **Section 6.2** below) for conveyance towards the western site boundary and offsite or offsite at the northern site boundary. Ultimately, runoff from the roadside swales will enter the Water Corporation drains to the west and north of the site following treatment and detention.

The swale drain configuration, invert and groundwater levels at key locations is summarised **Table 4**, and shown in further detail in the Modelling Assumptions Report provided in **Appendix C**.

Table 4: Key swale/drain configuration, invert and groundwater

Location	Shape	Width (m)	Depth (m)	Invert (mAHD)	1% AEP top water level (mAHD)	Groundwater elevation (mAHD)	Comments
Serpentine River Sub-Section E1 – at Wattle Road	trapezoid	7	0.9	32.5	33.19	33.5	Existing Water Corporation drain
Proposed Drain 1 – western end	v-drain	4	0.6	34.16	35.25	34.5	Inverts to tie in with existing Water Corporation drain
Retained Drain 2 – western end	v-drain	4.2	0.7	35.50	36.29	35.5	Existing inverts
Proposed Drain 3 – western end	v-drain	3	0.5	36.4	37.25	36.5	Inverts to tie in with existing Water Corporation drain
Serpentine River Sub-Section E1 – towards Utley Road	trapezoid	6	0.9	37.09	37.89	37.5	Existing Water Corporation drain

6.2 Lot drainage

The management of drainage within lots is focused upon ensuring stormwater runoff can continue to flow from east to west. The following measures are required in order for this to be achieved:

- Minimising the area of impermeable surfaces within lots to the building envelope, outbuildings and driveway to ensure infiltration continues to occur across rural residential lots.
- Avoiding creating barriers to overland flow (see flow path arrows shown in **Figure 9**) when utilising sand fill within the lot. For example, by utilising culverts beneath driveway crossovers and maintaining existing levels (shown in **Figure 2**) at lot boundaries.
- Maintaining the existing east-west drain through the centre of the site. This ensures the discrete upstream inflow will continue to be conveyed through the site. The drain will be vegetated with reeds and rushes suitable for removing nutrients (Payne *et al.* 2015). Trees will be retained within this drainage line wherever possible, and this may require some localised design consideration to achieve greater tree retention. **Table 4** summarises the required drain configuration.
- The provision of east-west drains (see **Figure 9**) to convey runoff from upstream catchments and roadside swales (as discussed in **Section 6.1**) towards the western border. Given the existing drains located across the site have no additional environmental values (see **Section 3.6.1**), and following discussions with SSJ, the drains are proposed to be consolidated. The drains will be vegetated with reeds and rushes suitable for removing nutrients (Payne *et al.* 2015).
- The provision of culverts beneath the proposed road reserves as shown on **Figure 9** and summarised in **Table 5**. The culverts have been sized to ensure runoff in the minor rainfall event (i.e. 20% AEP) is conveyed beneath the road reserve within minimal ponding upstream (i.e. generally the eastern or southern side of the road reserves).

It is the responsibility of the proponent to design and implement the roadside swales, culverts and drains. It is the lot developer/owner's responsibility to ensure development of the lot meets the requirements outlined in this LWMS. The road reserves (including roadside swales and culverts) will ultimately be maintained by the SSJ, whereas maintenance of the drains (where they fall within private lots) will be the responsibility of the lot owner.

Proposed Drain 2 maintains an existing flow path (see **Figure 7**). Retained Drain 2 (eastern portion) utilises the existing drain and therefore, a breakout flow that represents the existing hydrological regime has been allowed for. Should the depth of Retained Drain 2 (eastern portion) be exceeded as upstream inflows enter the site, runoff will be allowed to flow across Catchment 4b into Proposed Drain 1.

Table 5: Culvert configuration requirements

Culvert name	Configuration	Size
C1	2 x box culvert	450 mm high x 1200 mm wide
C2	1 x circular pipe	375 mm diameter
C3	1 x box culvert	600 mm high x 1200 mm wide
C4	2 x box culvert	450 mm high x 900 mm wide

6.3 Drainage design assessment

The post-development catchments, location of proposed stormwater management strategies, and discharge locations (both discrete and overland flow) are shown in **Figure 9**. As detailed previously, the stormwater management strategy aims to match peak flows leaving the site in a minor and major rainfall event. **Table 6** compares the post-development peak flow rates discharging from the site achieved through the implementation of the strategies discussed in **Section 6.1** and **6.2** to the rates and volumes discussed in **Section 3.6.2**.

Post-development peak flow rates for the minor and major rainfall event are lower than (and within 10% of) the allowable peak flow rates. This is due to the hydraulics of the stormwater management plan (e.g. sizing of culverts utilising common configurations); the size of drains and culverts could be optimised at subdivision once detailed civil design for the road reserves has commenced to increase post-development peak flow rates to within 5% of existing flow rates. Modelling assumptions are discussed in **Appendix C**.

Table 6: Existing and post-development peak flow rates

Total site discharge at confluence	Small rainfall event (63.2% AEP) peak flow (m^3/s)	Minor rainfall event (20% AEP) peak flow (m^3/s)	Major rainfall event (1% AEP) peak flow (m^3/s)
Existing	0.146	2.182	6.39
Post-development	0.115	2.001	5.96
% difference	-21%	-8%	-7%

6.4 Non-structural measures

The structural measures proposed within the site provide both a treatment and detention function to stormwater runoff. A number of non-structural measures will also be implemented across the site to help reduce nutrient loads within stormwater that discharges from the development, including:

- Minimal fertiliser use to establish vegetation within roadside swales and drains. No ongoing fertiliser use is proposed within the roadside swales, as these are not proposed to require ongoing irrigation.
- Promotion and implementation of WWG principles (including fertiliser use) within lots.

6.5 Stormwater design criteria compliance summary

A summary of the proposed stormwater design criteria and how these are addressed within SP is provided in **Table 7**.

Table 7: Stormwater management compliance summary

Criteria number	Criteria description	Manner in which compliance will be achieved
SW1	Retain and treat the small rainfall event (i.e. first 15 mm) as close to source as possible	Treat small event runoff from road reserves within roadside swales
		Minimising the area of impermeable surfaces within lots to ensure infiltration occurs
SW2	Maintain existing peak flow rates from the major rainfall (i.e. 1% AEP) event discharging from the development	Use of roadside swales to detain the additional major event runoff from road pavement
SW3	Provide conveyance of upstream flows through the development	Maintenance of the central east-west drain
		Provision of drains and culverts to allow runoff to flow beneath proposed road reserves to the west
		Avoiding creating barriers to overland flow within lots
SW4	Minor roads are to remain passable in the minor rainfall (i.e. 20% AEP) event	Roadside swales are sized to detain minor and major rainfall event runoff from road pavement
SW5	Apply appropriate non-structural measures to reduce nutrient loads	Minimal fertiliser use to establish vegetation within roadside swales and drains and no ongoing fertiliser use within roadside swales
		Promotion and implementation of WWG and fertiliser use

7 Groundwater Management

The principles behind groundwater management are to maintain the existing hydrology across the site and maintain the existing groundwater quality.

7.1 Groundwater level management

As discussed in **Section 3.7.2**, the site is beyond the mapping extent of the *Perth Groundwater Map* (DWER 2020b) and hence no groundwater contours are available for the site. Due to the loam-clay layer found approximately 700 mm BGL (see **Section 3.4**) and impermeable gravels found at some test pits, it is anticipated that the highest groundwater level will occur due to seasonally perched groundwater. Design of the development will maintain the perched groundwater regime beneath the site by ensuring infiltration within road reserves is maintained through the use of roadside swales and across lots by minimising the area of impermeable surfaces to the building envelope, outbuildings and driveways.

Inverts of the east-west drains proposed as part of the stormwater management strategy (see **Section 6**) will be below existing surface levels and may intersect perched groundwater. These inverts can be set below the highest perched groundwater level, as there are no significant environmental assets within the site (see **Section 3.5.1**) (DoW 2013). However, these drains will need to discharge into existing inverts within the Water Corporation rural drains located to the north and west of the site.

The road reserves are proposed to be raised by 300 mm to 600 mm (utilising sand fill) above the existing surface levels to provide sufficient clearance to perched groundwater (Porter Consulting 2020). For the purposes of surface runoff modelling (described in **Section 6**), the road reserve was assumed to be raised by 500 mm, with the roadside swale inverts set below the road. Similarly, sand fill will be used within building envelopes to achieve the 1.5 m separation required from the highest perched groundwater level. At this stage, this is conservatively assumed to be the existing surface levels. Therefore, groundwater levels will not be altered by the construction of the road reserves nor development of building envelopes by individual lot owners.

7.2 Groundwater quality management

The main objective of the management of groundwater quality is to maintain the existing groundwater quality. This can be achieved by reducing the total nutrient load into groundwater that originates from newly developed areas and by treatment of surface water runoff prior to infiltration to groundwater. **Criteria GW5** will be achieved across the site by:

- Appropriate treatment of small rainfall event runoff from road pavement through the use of roadside swales.
- Utilisation of nutrient stripping vegetation within proposed drains.
- Minimal fertiliser use to establish vegetation within roadside swales and drains.
- Promotion and implementation of WWG principles within individual lots.
- Implementation of on-site sewage systems in accordance with *Government Sewerage Policy* (DPLH 2019), as discussed in **Section 8**.

7.3 Groundwater design criteria compliance summary

A summary of the proposed groundwater design criteria and how these are addressed within the site is provided in **Table 8**.

Table 8: Groundwater management compliance summary

Criteria number	Criteria description	Manner in which compliance will be achieved
GW1	Maintain the existing groundwater hydrological regime	Ensure infiltration continues to occur within road reserves through the use of roadside swales
		Ensure infiltration continues to occur across lots by minimising impervious areas to building envelopes, outbuildings and driveways
		Proposed drains will discharge into Water Corporation rural drains adjacent to the site at existing inverts
		Use of sand fill beneath road reserves and building envelopes to provide sufficient separation to highest groundwater levels
GW2	Maintain or improve groundwater quality onsite	Direct small event runoff from road pavement into roadside swales. Treatment is provided through interaction with vegetation and adsorption of nutrients to soil particles through infiltration.
		Plant proposed drains with nutrient stripping vegetation for additional treatment of stormwater runoff
		Minimal fertiliser use to establish vegetation within roadside swales and drains and no ongoing fertiliser use within roadside swales
		Promotion and implementation of WWG and fertiliser use
		Implementation of on-site sewage system

8 Wastewater Servicing

The development wastewater system has been designed to achieve the objectives and criteria stated in **Section 4**. The principle behind the wastewater management strategy for the site is to provide wastewater servicing for the development in a manner that avoids any detrimental impacts on the environment and water resources, and in line with the requirements of the *Government Sewerage Policy* (DPLH 2019) and relevant guidelines.

8.1 On-site sewage disposal

Reticulated sewage will not be available within the site (Porter Consulting 2020) and therefore provision for the disposal of wastewater will need to be considered and accommodated on site. Proposed developments that will not be connected to reticulated sewer are required to prepare a Site and Soil Evaluation (SSE) in accordance with AS 1547 (Standards Australia and Standards New Zealand 2012). To support a SP, the LWMS should determine minimum lot sizes, identify appropriate treatment technology and onsite sewage management systems, and establish performance criteria, which are all informed by the SSE (DoH 2019).

8.1.1 Site and soil evaluation

Section 1, **2** and **3** of this LWMS outlines the relevant planning and environmental information for the site and has formed the desktop study component of the SSE. Whilst this is a desktop study, the information provided in **Section 3** has been informed by two general site visits as well as a site-specific geotechnical investigation.

An SSE has been undertaken in accordance with the requirements of Appendix C of the AS 1547 (Standards Australia and Standards New Zealand 2012).

discusses the existing site conditions in accordance with the elements outlined in Appendix C.

Table 9: Site and soil evaluation as per Appendix C of AS/NZs 1547 (Standards Australia and Standards New Zealand 2012).

Element	Site description
Terrain-soil combinations	Two broad terrain-soil combinations can be classified within the site, being: • Palusplain – the majority of the site is as a REW or MUW (shown in **Figure 5**) and is generally flat. • Low dune – as shown in **Figure 2** and **Figure 3**, there are two elevated mounds in the east and north-east corner of the site that are composed of Bassendean Sand (S8).
Land surface shape	Due to the extent of the site, multiple land surface shapes can be classified throughout the site when topographic contours are considered on a fine scale (see **Figure 2**). Broadly, the majority of the land surface shape of the site can be described as 'linear planar – 'Natural drainage less effective from crest, no spreading or acceleration'. The low dunes can be described as either 'linear divergent – good water shedding surface, spreads runoff, but no acceleration' or 'linear convergent – relatively poor drainable expected'.
Gradient	As shown in **Figure 2** and outlined within **Section 3.4**, the site ranges from 33 m AHD within the north-west corner to 40 m AHD along the eastern perimeter. The topography of the site has low relief, with the lowest areas generally consistent with the location of existing drainage channels and farm dams. The steepest gradient within the site is approximately 3.8% associated with the central low dune, however the remainder of the site is extremely flat, with grades as low as 0.4%.
Water	The surface water regime for the two-broad terrain-soil combinations include: • Palusplain – continuous low infiltration rates and slow overland flow are expected to occur across the majority of the site given the flatter topography and underlying geology of sand over loam-clay or gravel. • Low dune – the water regime is expected to be infiltration of smaller rainfall events, given the depth of sand observed, and relatively faster overland flow rates following the topographic contours. Infiltrated stormwater is anticipated to perch above the loam-clay and gravel layers over winter and spring, as discussed in **Section 3.4**, which results in a seasonally perched groundwater regime.
Soil inspection	As discussed in **Section 3.4** and shown in **Figure 3**, The geological survey of Serpentine, Western Australia (Jordan 1986) indicated that that site is comprised of: • Sand (S8): white to pale grey at surface, yellow at depth; fine to medium-grained, moderately sorted sub-angular to sub-rounded minor heavy minerals, of eolian origin. • Sand (S10): S8 over sandy clay to clayey sand of the Guilford formation, of eolian origin. • Sandy clay (C_S): white, grey to brown, fine to coarse, sub angular to rounded, clay of moderate plasticity, gravel and silt layers near scarp, of alluvial origin. The geotechnical investigation conducted on the site by Landform research in 2012 concluded that the site has an overlying sand sheet which is generally 700 mm BGL, but range from 400 mm BGL to below 3.2 m (maximum auger depth). Impermeable gravel layers and iron oxides were also encountered.

Based on the existing environmental conditions within the site, as outlined within **Section 3** and further discussed within **Table 9**, the site has been classified on the suitability of the existing conditions for on-site sewage disposal. Favorable areas are classed as 'requires little modification to be suitable' and less favorable areas are classed as 'requires modification to be suitable'.

The areas of less favorable land identified in **Figure 10** is based on the:

- Palusplain terrain-soil combination area, which is identified as REW or MUW, generally flat, underlain by sand (S10) or sandy clay (C_S) and is anticipated to generally have a depth to the highest perched groundwater level of less than 1.5 m.
- Within 100 m of an existing drain, which are assumed to discharge directly into the adjacent Water Corporation rural drains without treatment.

Management of on-site sewage disposal for within both the favourable and less favourable areas is discussed below.

8.1.1.1 Minimum lot sizes

Lots will need to be of adequate size to provide sufficient area to locate the wastewater treatment system (e.g. aerobic treatment units (ATU)) and on-site management systems (e.g. land application area). As specified by the *Government Sewerage Policy* (DPLH 2019), developments within sewage sensitive areas are generally required to have a minimum lot size of 1 ha. The SP provided in **Appendix A** illustrates the site will have lots with a minimum size of 2 ha, while an indicative area that effluent disposal could occur and which achieves the required setback is shown in **Figure 11**.

8.1.1.2 Appropriate treatment technology and onsite sewage management systems

Waste produced from rural residential developments will be consistent with general residential uses (i.e. toilets, sinks, showers etc.) with wastewater loading rates assumed to be consistent with those stipulated in Table 1 of the DoH's *Supplement to Regulation 29 and Schedule 9 - Wastewater system loading rates* (DoH 2019a). As outlined within **Section 3.5.2**, the site is located within a sewage sensitive area, consequently, as specified by the *Government Sewerage Policy* (DPLH 2019), secondary treatment systems with nutrient removal (such as ATUs) should be utilised to ensure discharge is of sufficient quality to protect downstream environments. DoH approved systems, as listed in the *Approved secondary treatment systems* (DoH 2019b) will be utilised and installation will be carried out in line with the *Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units* (DoH 2015).

ATUs are an advanced alternative to conventional septic tanks which provide improved quality of effluent treatment. ATUs differ from conventional septic tanks in that the wastewater is treated with oxygen to assist in the breakdown of bacteria into fine organic material. The effluent is then treated with chlorine to reduce the number of bacteria in the final effluent. The final treated effluent can then be disposed of within dedicated land application systems. These include adsorption trenches/beds, evapotranspiration/adsorption/seepage beds/trenches, surface irrigation, subsurface irrigation or mounds (Standards Australia and Standards New Zealand 2012; DPLH 2019).

Land application systems should be:

- Sized appropriately based on anticipated hydraulic loading, size of the ATU system, and characteristics of the underlying soil (both existing and imported).
- Include buffer areas (to be determined as a part of site-specific assessment) and fencing between the land application area and areas of human use. These buffer areas may be reduced by use of subsurface dripper irrigation systems.

- Include warning signs advising that effluent is being used and is not suitable for human contact or consumption.
- Kept free of structures.
- Accessible for maintenance.

In addition to the requirements for irrigation disposal areas, a number of factors must be considered prior to the installation of ATUs on the site. These are outlined in the *Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units* (DoH 2015). An ATU should be at least:

- 1.2 m from any lot boundaries or buildings.
- 1.8 m from the irrigation disposal area.
- 6 m from any well, bore (not used for drinking water purposes), dam, basin, drain or roadside swale.

Indicative effluent disposal areas demonstrating setback from lot boundaries, adjacent existing basins, proposed drains and roadside swales and are illustrated in **Figure 11**.

8.1.1.3 Performance criteria

Key design criteria for on-site wastewater disposal are specified in **Section 4.5** and how these will be addressed is summarised in **Table 10**. As outlined within **Section 8.1.1**, the SSE identified the majority of the site as currently less favourable for on-site sewage disposal, as shown in **Figure 10**. On-site sewage disposal can be achieved within the less favourable areas within the site and meet the requirements of the *Government Sewerage Policy* (DPLH 2019) by:

- Installing secondary treatment systems with nutrient removal (i.e. an ATU) consistent with the requirements of the *Government Sewerage Policy* (DPLH 2019) for sewage sensitive areas.
- On-site sewage systems will not be located within 100 m from a drainage system that discharges directly into a waterway or significant wetland without treatment. As specified within **Section 3.6.1**, no natural waterways exist within the site and the Serpentine River is located either over 6 km or over 18 km downstream (via the partially vegetated Water Corporation rural drainage network) of the site. Runoff from road reserves will be treated and detained within vegetated roadside swales. Within lots, the existing hydrological regime will be maintained by ensuring runoff can continue to flow from east to west and by being collected in vegetated drains across the site (as discussed in **Section 6**). As these are not natural waterways, on-site sewage systems may be located within 100 m of the roadside swales, drains, and adjacent Water Corporation rural drains, though, as noted above should be located at least 6 m from any drain.
- Sand fill will be used within building envelopes to achieve the 1.5 m separation required from the highest perched groundwater level. At this stage, this is conservatively assumed to be the existing surface levels. However, this could be refined as part of the SSEs completed for subdivision and again for development application.
- Specifications for sand fill (identified as part of the SSEs completed for subdivision and again for development application) will need to be considered based on the requirements of the site such as hydraulic loading serviced, the size of the ATU system and characteristics of the existing underlying soil.

- On-site sewage systems will not be located in any area subject to inundation and/or flooding in a 10% AEP rainfall event. As discussed above, sand fill will be utilised to achieve separation to groundwater. As discussed in **Section 6.2**, the management of drainage within lots is focused upon ensuring runoff can continue to flow from east to west, which includes utilisation of proposed culverts and drains. Therefore, on-site systems will be located within sand fill to avoid areas subject to inundation and will not be located within 6 m of any drain.

8.1.1.4 Effluent disposal area spatial requirements

The setback requirements for effluent disposal areas have been discussed in previous sections. Given the soil types observed onsite and the use of a secondary treatment system the effluent disposal area is likely to reflect the requirements for Clay Loams, being 257m^2 per dwelling, though this could potentially increase to 300 m^2 based on site specific soil testing at the location proposed for effluent disposal. This is based on the land application areas from Schedule 2 Table 3 of the *Government Sewerage Policy* (DPLH 2019). The indicative areas for effluent disposal are shown on **Figure 11**.

8.2 Wastewater design criteria compliance summary

A summary of the proposed wastewater design criteria and how these are addressed within the site are provided in **Table 10**.

Table 10: Wastewater servicing criteria compliance

Criteria number	Criteria description	Manner in which compliance will be achieved
WW1	On-site sewage systems to be located at least 100 m from a drainage system that discharges directly into a waterway or significant wetland unless treated prior	All lots are able to achieve a 100 m setback from the proposed drains and Water Corporation drains. All roadside swales and drains within the site will provide treatment by utilising nutrient absorbing vegetation. Lots will be able to either achieve a 100 m setback from roadside drains or are hydrologically downstream and can achieve the minimum setback of 6 m.
WW2	On-site sewage systems are not to be located in any area subject to inundation and/or flooding in a 10 % AEP rainfall event	Lot sewage systems will not be located in an area subject to inundation sand fill will be utilised to achieve separation to groundwater. Similarly, lot sewage systems will not be located within 6 m of any drain, which will be inundated in a 10 % AEP event.
WW3	The discharge point of the on-site sewage system should be at least 1.5 m above the highest groundwater level	The discharge point of lot sewage systems will be set at least 1.5 m above the highest perched groundwater level. Fill within lots will be used to meet this clearance.

9 Future Subdivision and Development Approval

The strategies that have been provided within this LWMS address planning for water management within the site. Future development stages will need to clarify details not provided within this LWMS.

The requirement to undertake preparation of more detailed water management plans to support subdivision is generally imposed as a condition of subdivision. The development of any future UWMP should follow the guidance provided in *Urban Water Management Plans: Guidelines for Preparing Plans and for Complying with Subdivision Conditions* (DoW 2008c). Following subdivision, individual lots will progress to development approval (DA) when some water management measures, notably regarding wastewater servicing, will undergo detailed design.

The main areas that will require further clarification include:

- Modelling of local road drainage network
- Stormwater drainage within lots
- Roadside swale and drain configurations
- Wastewater servicing
- Implementation of water conservation strategies
- Non-structural water quality improvement measures
- Monitoring and evaluation program.

These are further detailed in the following sections.

9.1 Modelling of the drainage system

The design of the drainage system to date has been undertaken at an appropriate level for local structure planning and is based upon the SP provided in **Appendix A**. Runoff-routing computer modelling of the stormwater drainage system will be reviewed once the subdivision plan has been determined and detailed civil design for the road reserves has commenced. It is also recommended that topographical survey of the site, existing culverts and relevant Water Corporation rural drains be undertaken to refine the model. It is anticipated that this will occur during the subdivision design process and detailed within the future UWMPs.

The exception to the requirement to revise the surface runoff modelling is if the catchment details and designs are consistent with the assumptions made in this LWMS. If this were the case it would be acceptable to provide detailed civil designs for the drainage network to demonstrate compliance with the LWMS.

9.2 Stormwater drainage within lots

As discussed in **Section 6**, the management of drainage within lots is focused upon ensuring stormwater runoff can continue to flow from east to west.

The developer is responsible for designing and constructing the road reserves (including roadside swales and culverts) and drains, as required by this LWMS or updated within future UWMPs (as discussed in **Section 9.1**). Ongoing management and maintenance of the drains is the responsibility of the low owners.

A number of the measures listed will not be implemented until DA and construction within lots and are the responsibility of the lot owner. Specifically, these are minimising the area of impermeable surfaces in order to maintain existing infiltration across rural residential lots and avoiding creating barriers to overland flow when utilising sand fill within the lot, which is required to meet other design criteria.

9.3 Roadside swale and drain configurations

The exact location and invert of roadside swales and drains will still need to be specified and presented within future UWMPs or, if the surface runoff modelling is not required to be revised, detailed civil designs.

9.4 Wastewater servicing

An updated SSE may be required at subdivision stage when once the subdivision plan has been determined and more detailed civil design information is available. The SSE will be prepared in accordance with Appendix C of *AS/NZS 1547 On-site domestic wastewater management* (Standards Australia and Standards New Zealand 2012) and the requirements of the *Government Sewerage Policy* (DPLH 2019). The SSE will be required to meet the criteria outlined within **Section 8.2** and to assess whether every lot is capable of accommodating the on-site systems proposed. Additional site-specific investigations may be required to inform the SSE (e.g. measurement of highest perched groundwater levels).

At the DA stage, an SSE for individual lots will be required to prepared in accordance with Appendix D of *AS/NZS 1547 On-site domestic wastewater management* (Standards Australia and Standards New Zealand 2012) and in line with the requirements of the *Government Sewerage Policy* (DPLH 2019). The SSE at DA will need to identify potential land application and reserve areas and to gather sufficient site and soil information for the selection and design of the on-site system (including more detail on the design specifications of ATUs, including the location and discharge mechanisms i.e. land application areas or discharge outlets).

9.5 Implementation of water conservation strategies

A number of potential measures to conserve water have been presented within this LWMS. The manner in which the proponent intends to promote water conservation measures discussed in this LWMS to future lot owners will also be discussed within the future UWMP.

9.6 Non-structural water quality improvement measures

Guidance for the development and implementation of non-structural water quality improvement measures is provided within the *Stormwater Management Manual for Western Australia* (DoW 2007b). The use of vegetation within roadside swales and drains will require ongoing maintenance. It is therefore expected that the future UWMPs will set out maintenance actions (e.g. gross pollutant removal), timing (i.e. how often it will occur), locations (i.e. exactly where it will occur) and responsibilities (i.e. who will be responsible for carrying out the actions). In addition, the manner in which the proponent intends to promote non-structural water quality improvement measures (e.g. education) to future lot owners will also be discussed within the future UWMP.

9.7 Monitoring and evaluation program

Prior to the UWMP, pre-development hydrological monitoring will need to be undertaken to inform post development water quality targets. The monitoring should include groundwater levels, groundwater quality, and if possible surface water quality (noting that the surface channels within the site do not flow permanently and physical capture of water quality samples may prove problematic).

Following completion of construction, it will be necessary to confirm that the management measures that are implemented are able to fulfil their intended management purpose, and are in a satisfactory condition at a point of management handover to the SSJ. It is proposed that the overall condition of the development will be monitored on a bi-annual basis. This monitoring will be implemented after the completion of the civil and landscaping works and will continue for a period of 12 months (i.e. during the defects liability period) or until handover of road reserves to the SSJ.

A visual assessment will be undertaken to monitor the overall condition of the development, with the aim to ascertain that the maintenance activities are achieving the overall objectives for the development. The parameters that will be monitored include:

- Gross pollutants
- Terrestrial weeds
- Drainage infrastructure.

Surface water monitoring within the site is not proposed. This is due to the impracticalities associated with capturing flows within the proposed drainage features, given they will only occur during rainfall events. Any attempt to capture runoff from rainfall events is therefore unlikely to be successful in capturing active flows within the roadside swales and drains.

Post-development groundwater monitoring is not proposed. This is due to there being no actively managed public open space areas proposed and the main sources of nutrients are expected to be within individual lots. Activities within these lots are the responsibility of the lot owners and residents, and beyond the control of the proponent. The proponent is therefore unable to act on any adverse nutrient concentrations, should they be observed.

10 Implementation

The LWMS is a key supportive document for the development of the site. The preparation of the LWMS has been undertaken with the intention of providing a structure within which subsequent development can occur consistent with an integrated water cycle management approach. It is also intended to provide overall guidance to the general stormwater management principles for the area and to guide the development of future UWMPs and DAs.

10.1 Roles and responsibility

The LWMS provides a framework that the proponent can use to assist in establishing stormwater management methods that are based upon site-specific investigations, are consistent with relevant State and Local Government policies and have been endorsed by the SSJ. The responsibility for working within the framework established within the LWMS rests with the developer, although it is anticipated that any future UWMPs will be developed in consultation with the SSJ and in consideration of other relevant policies and documents.

The design and implementation of roadside swales, culverts and drains will be the responsibility of the proponent (i.e. subdivision developer). Otherwise, the design and implementation of lot measures (e.g. sand fill, lot sewage systems, driveway culvert crossing etc) will be the responsibility of the individual lot owner.

10.2 Funding

The stormwater management strategies described in this LWMS will be implemented and funded by the proponent. The implementation and funding for lot scale stormwater, groundwater and wastewater management infrastructure will be responsibility of the individual lot owner/lot developer.

10.3 Review

It is not anticipated that this LWMS will be reviewed, unless the proposed development layout undergoes significant change prior to subdivision. If the proposed development is substantially modified, surface runoff modelling undertaken for this LWMS may need to be reviewed and the proposed criteria may need to be revised to ensure that all are still appropriate.

11 References

11.1 General references

The references listed below have been considered as part of preparing this document.

Australian Bureau of Statistics (ABS) 2013, 4602.0.55.003 - *Environmental Issues: Water Use and Conservation*, March 2013, Canberra.

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC and ARMCANZ) 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, National Water Quality Management Strategy, Commonwealth of Australia, Canberra.

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M and Testoni I (Editors) 2019, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia (Geoscience Australia).

Department of Health (DoH) 2015, *Code of practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units (ATU's)*, Perth.

Department of Health (DoH) 2019, *Guidance on Site-and-soil evaluation for on-site sewage management*, Perth.

Department of Water (DoW) 2007a, *Stormwater Management Manual for Western Australia*, Perth.

Department of Water (DoW) 2007b, *Stormwater Management Manual for Western Australia*.

Department of Water (DoW) 2008a, *Interim: Developing a local water management strategy*, Department of Water, Government of Western Australia, Perth.

Department of Water (DoW) 2008b, *LiDAR Elevation Dataset, Swan Coastal Plain*, Perth.

Department of Water (DoW) 2008c, *Urban Water Management Plans: Guidelines for Preparing Plans and for Complying with Subdivision Conditions*, Perth.

Department of Water (DoW) 2009, *Water Quality Protection Note 51: Industrial wastewater management and disposal*, Perth.

Department of Water (DoW) 2013, *Water resource considerations when controlling groundwater levels in urban development*, Perth.

Department of Planning, Lands and Heritage (DPLH) 2019, *Government Sewerage Policy*, Perth.

Department of Water and Environmental Regulation (DWER) 2017, *Decision Process for Stormwater Management in Western Australia*, Government of Western Australia, Perth.

Emerge Associates 2020a, *Flora, Vegetation and Fauna Assessment, Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine*, EP20-064(03)--003 RAW.

Emerge Associates 2020b, *Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine Environmental Assessment and Management Strategy* EP20-064(04)--004 GAF, Version 1.

Engineers Australia 2006, *Australian Runoff Quality: A guide to Water Sensitive Urban Design*, National Committee for Water Engineering, Engineers Australia, Canberra.

Environmental Protection Authority (EPA) 2008a, *Guidance Statement No. 33. Environmental Guidance for Planning and Development*, Perth.

Environmental Protection Authority (EPA) 2008b, *Water Quality Improvement Plan for the Rivers and Estuary of the Peel-Harvey System - Phosphorus Management*.

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

Government of WA 2007, *State Water Plan*, Perth.

Government of WA 2019, *Waterwise Perth-Action Plan*.

Gozzard, J. R. 1986, *Perth Metropolitan Region* Geological Survey of Western Australia, Perth.

Jordan, J. E. 1986, *Serpentine Part Sheets 2033 II and 2133 III*, Perth Metropolitan Region, Environmental Geology Series. Geological Survey of Western Australia, Perth.

Landform Research 2016, *Local Water Management Strategy*.

Landform Research 2018, *Land Capability-Geotechnical Assessmet*.

Payne, E., Hatt, B., Deletic, A., Dobbie, M., McCarthy, D. and Chandrasena, G. 2015, *Adoption Guidelines for Stormwater Biofiltration Systems*, Cooperation Research Centre for Water Sensitive Cities, Melbourne.

Porter Consulting 2020, *Servicing Report Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine*, R50.20, Revision A.

Standards Australia and Standards New Zealand 2012, *AS/NZS 1547:2012 On-site domestic wastewater management*, Sydney, New South Wales. 2012.

Western Australian Planning Commission (WAPC) 2006, *State Planning Policy 2.9: Water Resources*, Gazetted in December 2006, Perth.

Western Australian Planning Commission (WAPC) 2008, *Better Urban Water Management*, Perth.

Western Australian Planning Commission (WAPC) 2009a, *Liveable Neighbourhoods (Edition 4)*, Western Australian Planning Commission and Department for Planning and Infrastructure, Perth.

Western Australian Planning Commission (WAPC) 2009b, *Planning Bulletin No. 64 Acid Sulfate Soils*, January 2009, Perth.

11.2 Online references

Bureau of Meteorology (BoM) 2020, *Climate Averages,* viewed 19th June 2020 <http://www.bom.gov.au/climate/data/>.

Department of Biodiversity, Conservation and Attractions (DBCA) 2020, *Geomorphic Wetland Database – Swan Coastal Plain*, viewed 19th June 2020, <https://catalogue.data.wa.gov.au/dataset/geomorphic-wetlands-swan-coastal-plain>.

Department of Planning Lands and Heritage (DPLH) 2020, Shire of Serpentine Jarrahdale Local Planning Strategy, viewed 25th June 2020, <https://www.dplh.wa.gov.au/serpentine-jarrahdale>

Department of Water and Environmental Regulation (DWER) 2020a, *Water Information Reporting*, viewed 19th June 2020 < http://water.wa.gov.au/maps-and-data/maps/water-information-reporting2/>.

Department of Water and Environmental Regulation (DWER) 2020b, *Perth Groundwater Map*, viewed 19th June 2020 <https://maps.water.wa.gov.au/#/webmap/gwm>.

Department of Water and Environmental Regulation (DWER) 2020c, *Acid Sulfate Soil – Swan Coastal Plain Database*, viewed 19th June 2020 <https://catalogue.data.wa.gov.au/dataset/acid-sulphate-soil-risk-map-swan-coastal-plain>.

Department of Water and Environment Regulation (DWER) 2020d, *Contaminated Sites Database*, viewed 19th June 2020, <https://secure.dec.wa.gov.au/idelve/css/>.

Department of Water and Environmental Regulation (DWER) 2020e, *Water Register*, viewed 19th June 2020, <https://maps.water.wa.gov.au/#/webmap/register>.

Department of Water and Environmental Regulation (DWER) 2020f, *Murray-Serpentine Rivers*, viewed 6th August 2020, <https://rivers.dwer.wa.gov.au/catchment/murray-serpentine-rivers/>

Department of Water and Environmental Regulation (DWER) 2020g, *Hydrography linear dataset*, viewed 19th June 2020, sourced from DWER.

Shire of Serpentine Jarrahdale (SSJ) (2020), *Intramaps Public Mapping System*, Viewed 19th June 2020, <https://maps.SSJhire.wa.gov.au/>

WALIA 2020, *Landgate Online Aerial Photography*, viewed 19th June 2020, <https://maps.landgate.wa.gov.au/maps-landgate/registered/>.

Figures

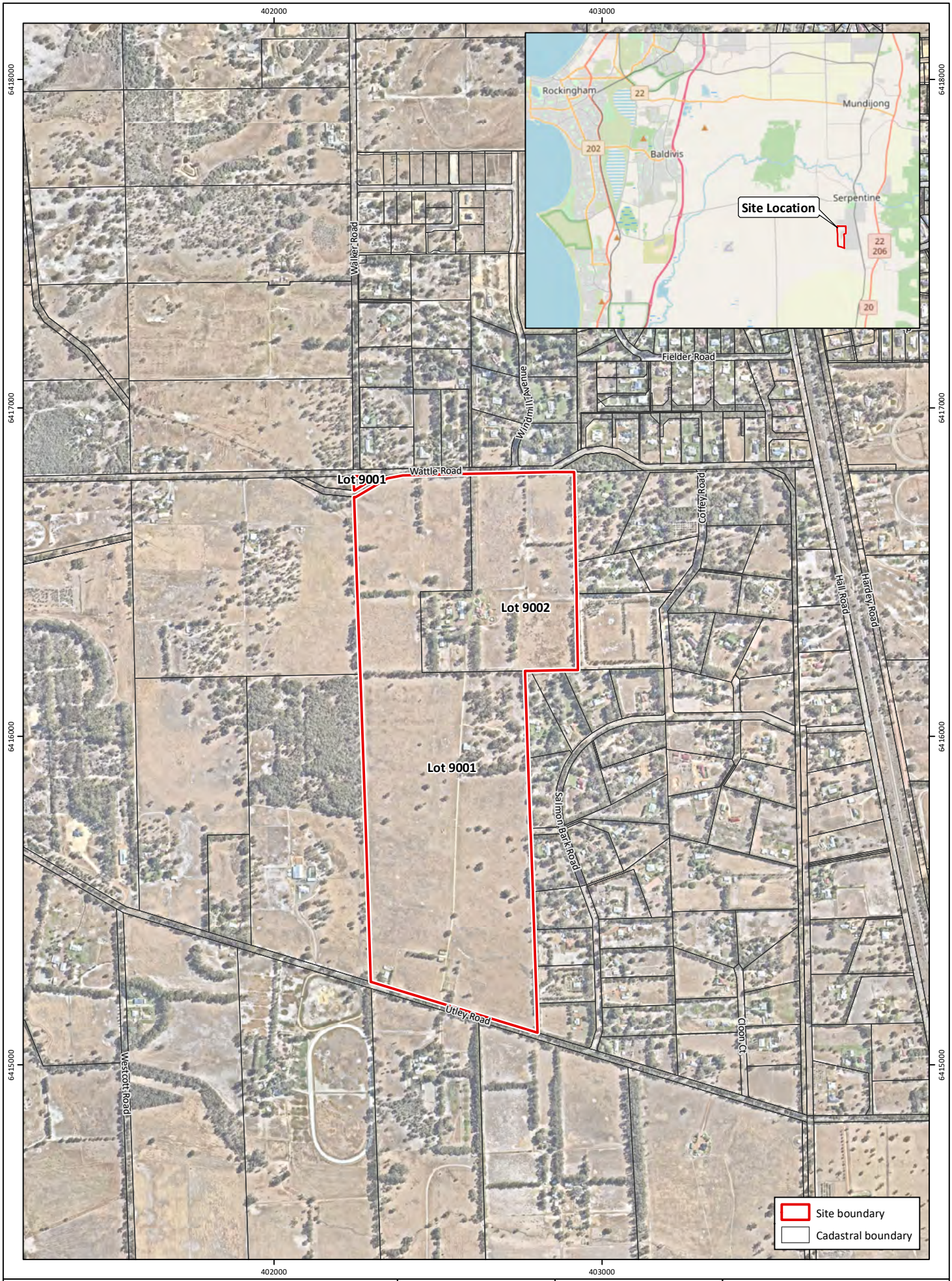


Figure 1: Site Location

Project:	Local Water Management Strategy Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine
Client:	Stron Pty Ltd

Plan Number:
EP20-064(01)--F18

Drawn:	GAR
Date:	03/07/2020
Checked:	ASC
Approved:	DPC
Date:	17/08/2020

N

0 200 400
Metres

Scale: 1:15,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

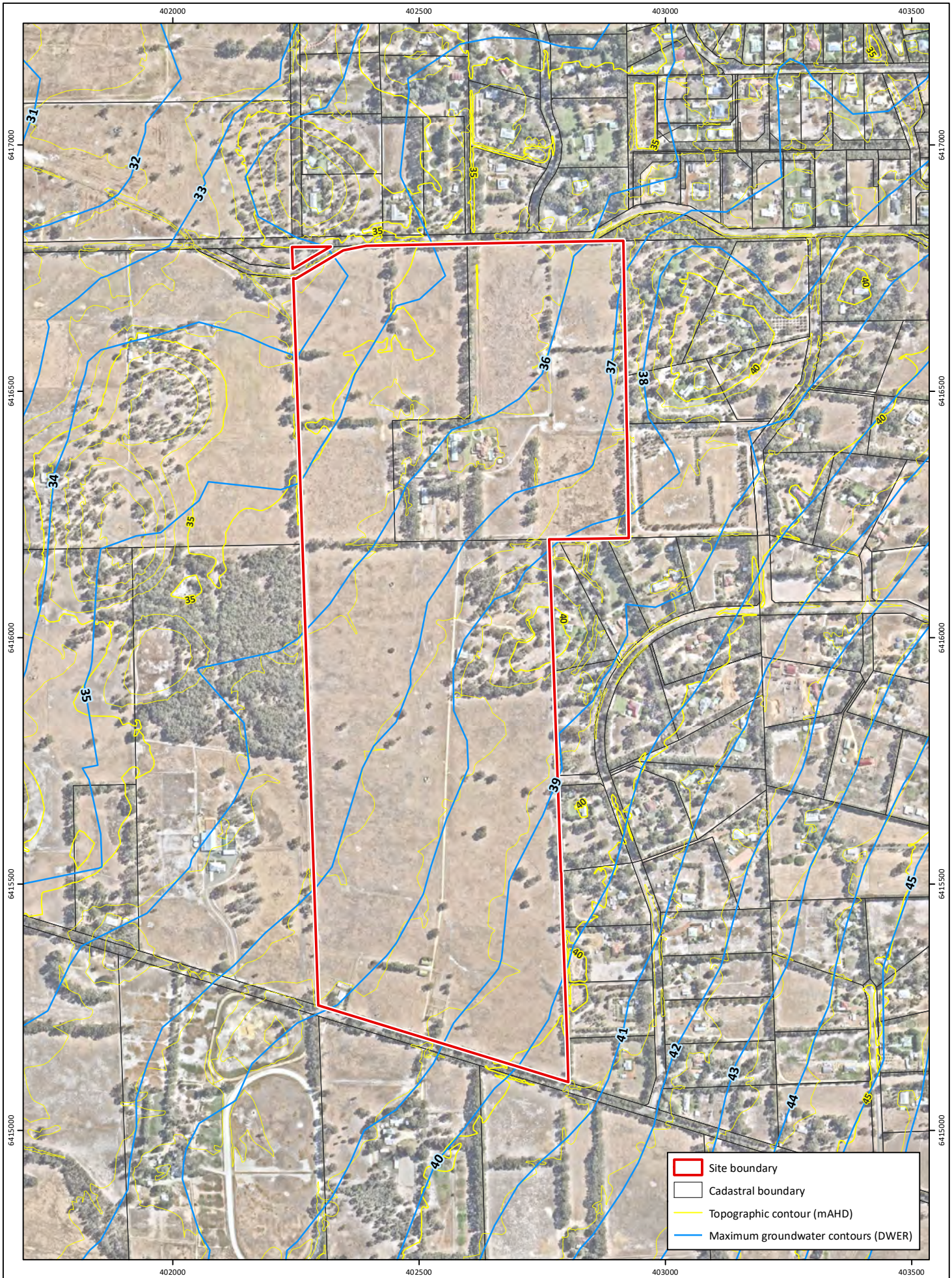


Figure 2: **Topographic Contours**

Project: Local Water Management Strategy
Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number:
EP20-064(01)--F19a

Drawn:	AFF
Date:	15/03/2021
Checked:	DPC
Approved:	DPC
Date:	15/03/2021

N

0 100 200
Metres

Scale: 1:10,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

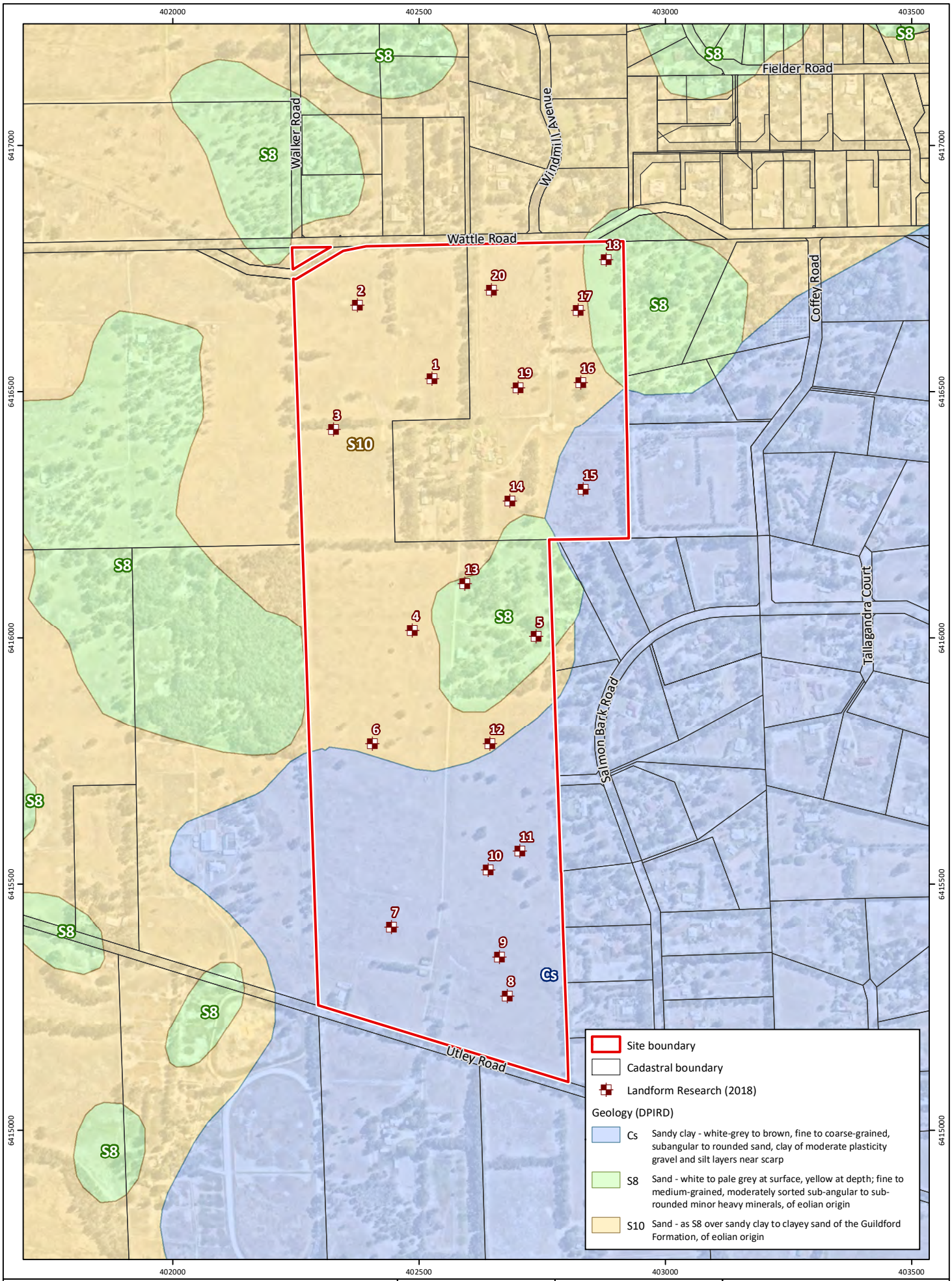


Figure 3: Environmental Geology

Project: Local Water Management Strategy
Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number:
EP20-064(01)--F20

Drawn:	AFF
Date:	06/07/2020
Checked:	ASC
Approved:	DPC
Date:	17/08/2020

N

0 100 200
Metres

Scale: 1:10,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

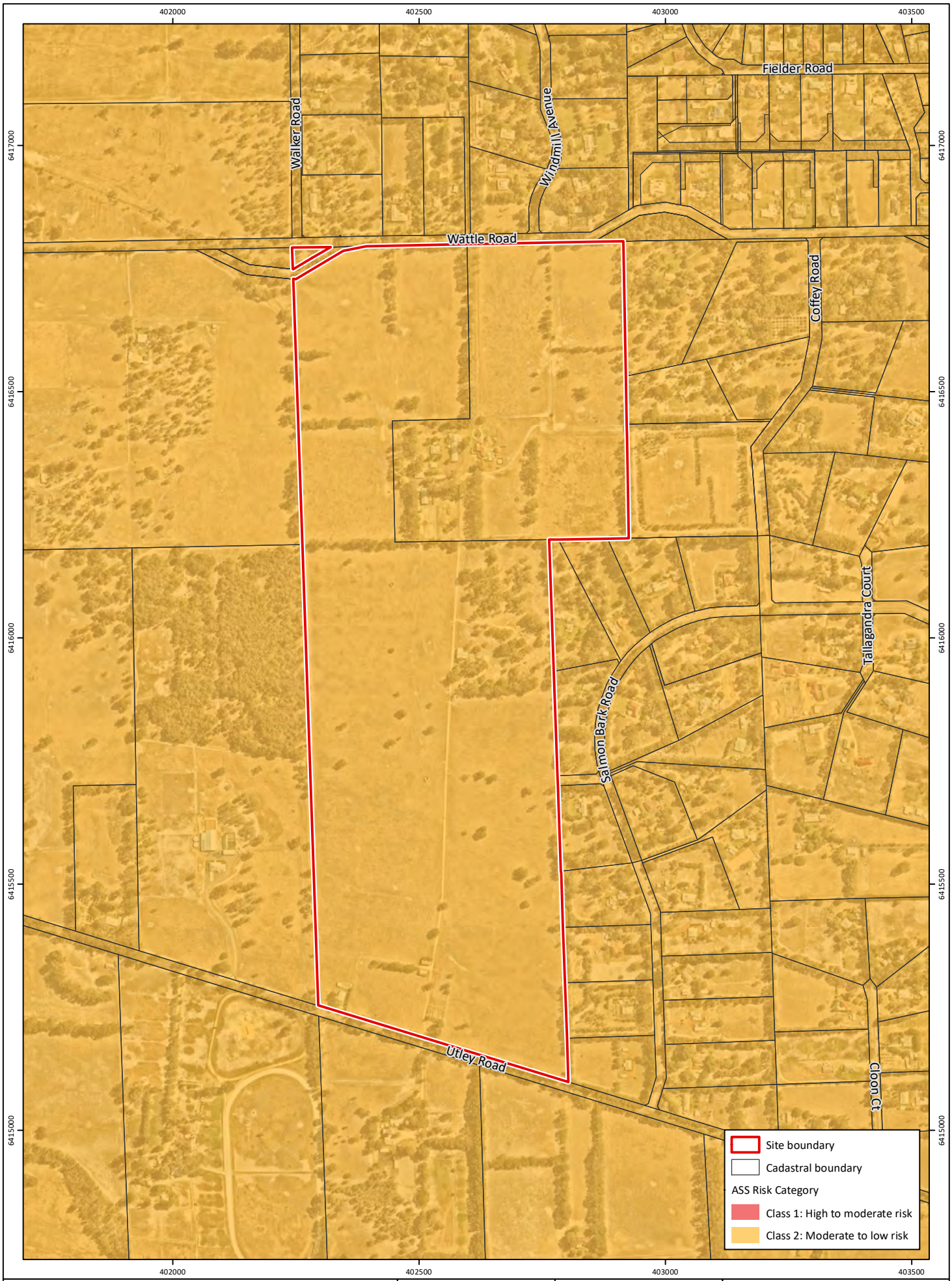


Figure 4: **Acid Sulfate Soil Risk Mapping**

Project: Local Water Management Strategy
Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number:
EP20-064(01)--F22

Drawn:	AFF
Date:	06/07/2020
Checked:	ASC
Approved:	DPC
Date:	17/08/2020

N

0 100 200
Metres

Scale: 1:10,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

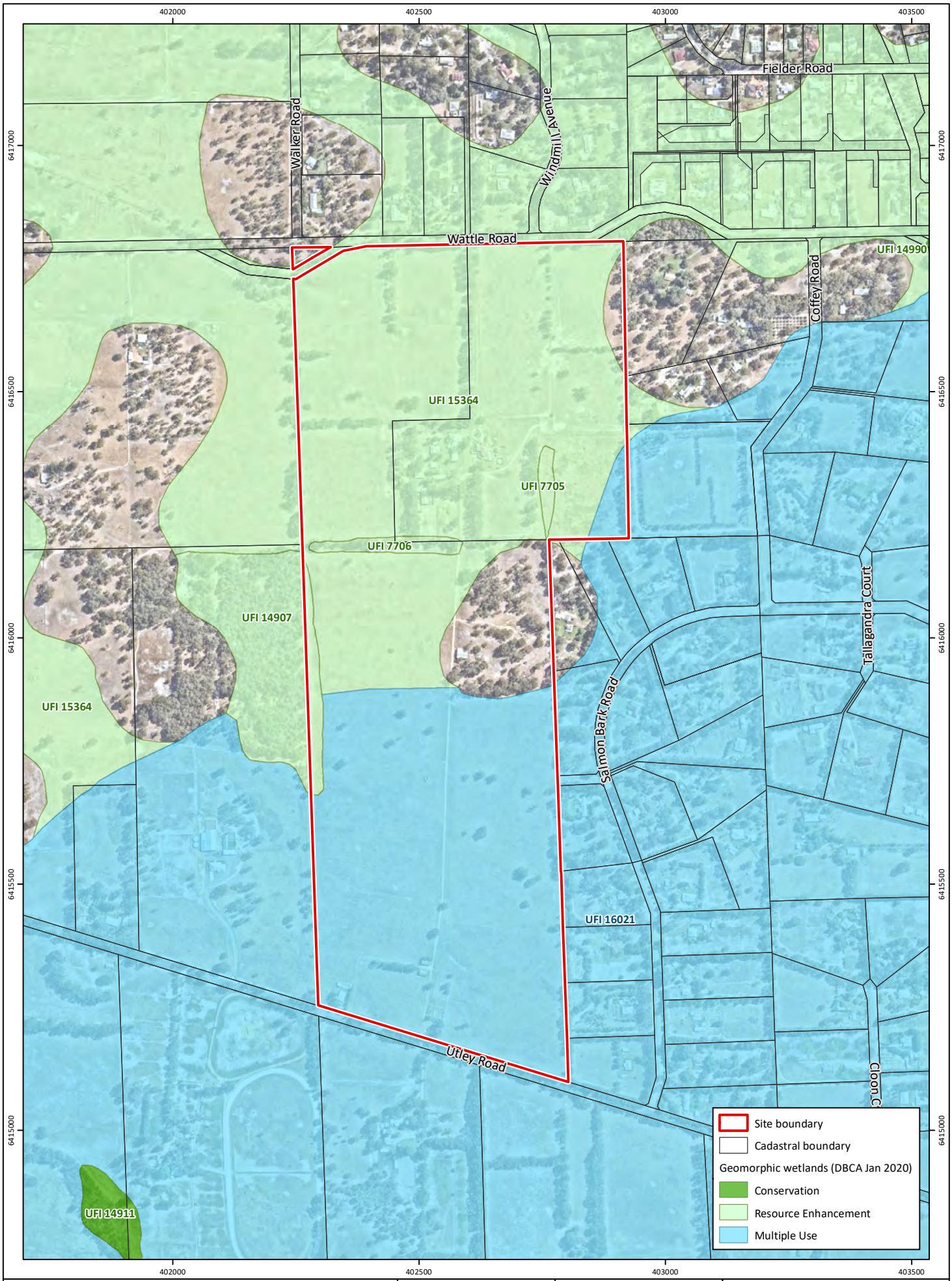


Figure 5: Geomorphic Wetlands

Project: Local Water Management Strategy
Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number: EP20-064(01)--F23

Drawn:	AFF
Date:	06/07/2020
Checked:	ASC
Approved:	DPC
Date:	17/08/2020

N

0 100 200
Metres

Scale: 1:10,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

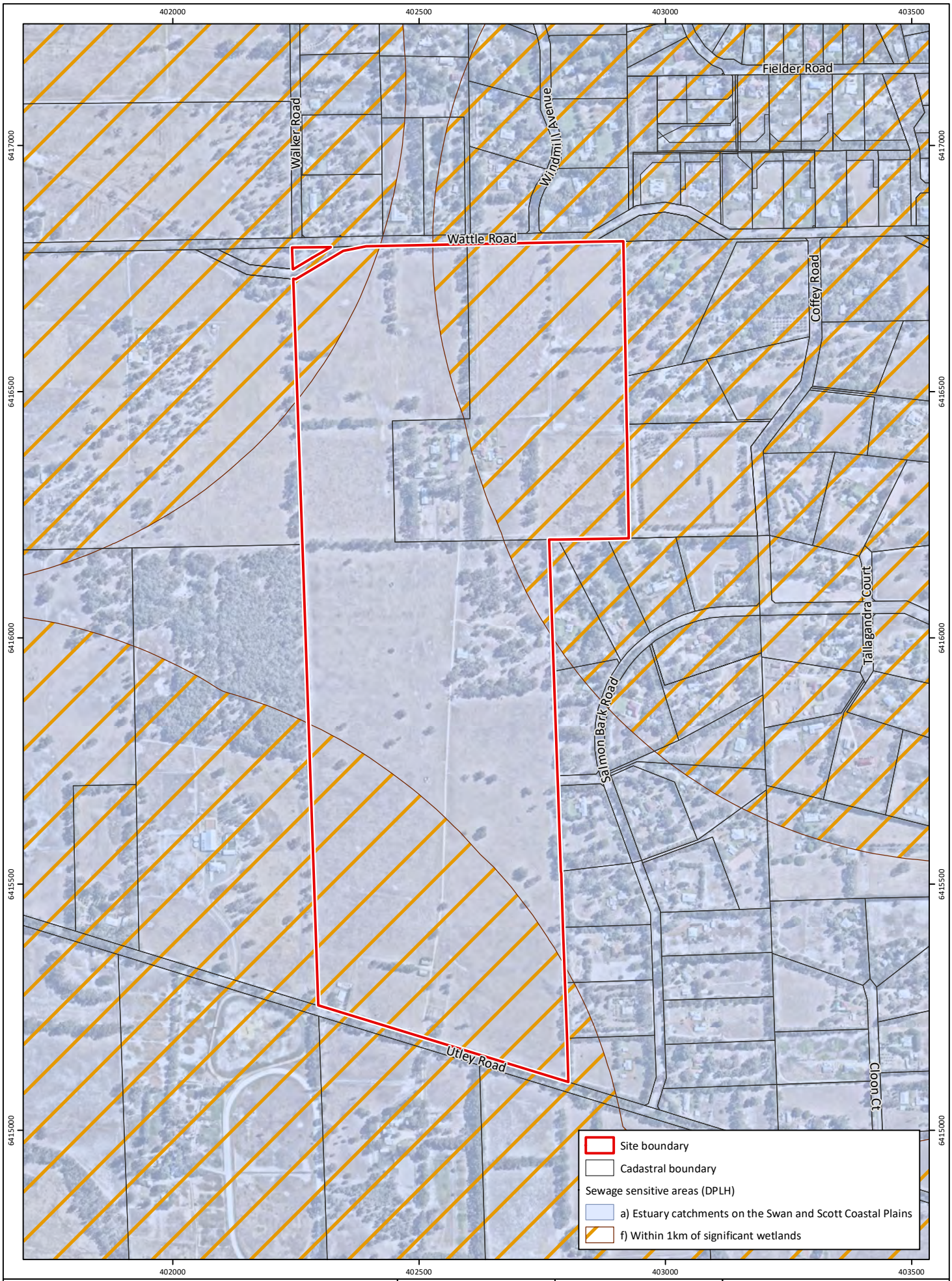


Figure 6: Sewage Sensitive Areas

Project: Local Water Management Strategy
Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number:
EP20-064(01)--F24

Drawn:	GAR
Date:	05/08/2020
Checked:	ASC
Approved:	DPC
Date:	17/08/2020

N

0 100 200
Metres

Scale: 1:10,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

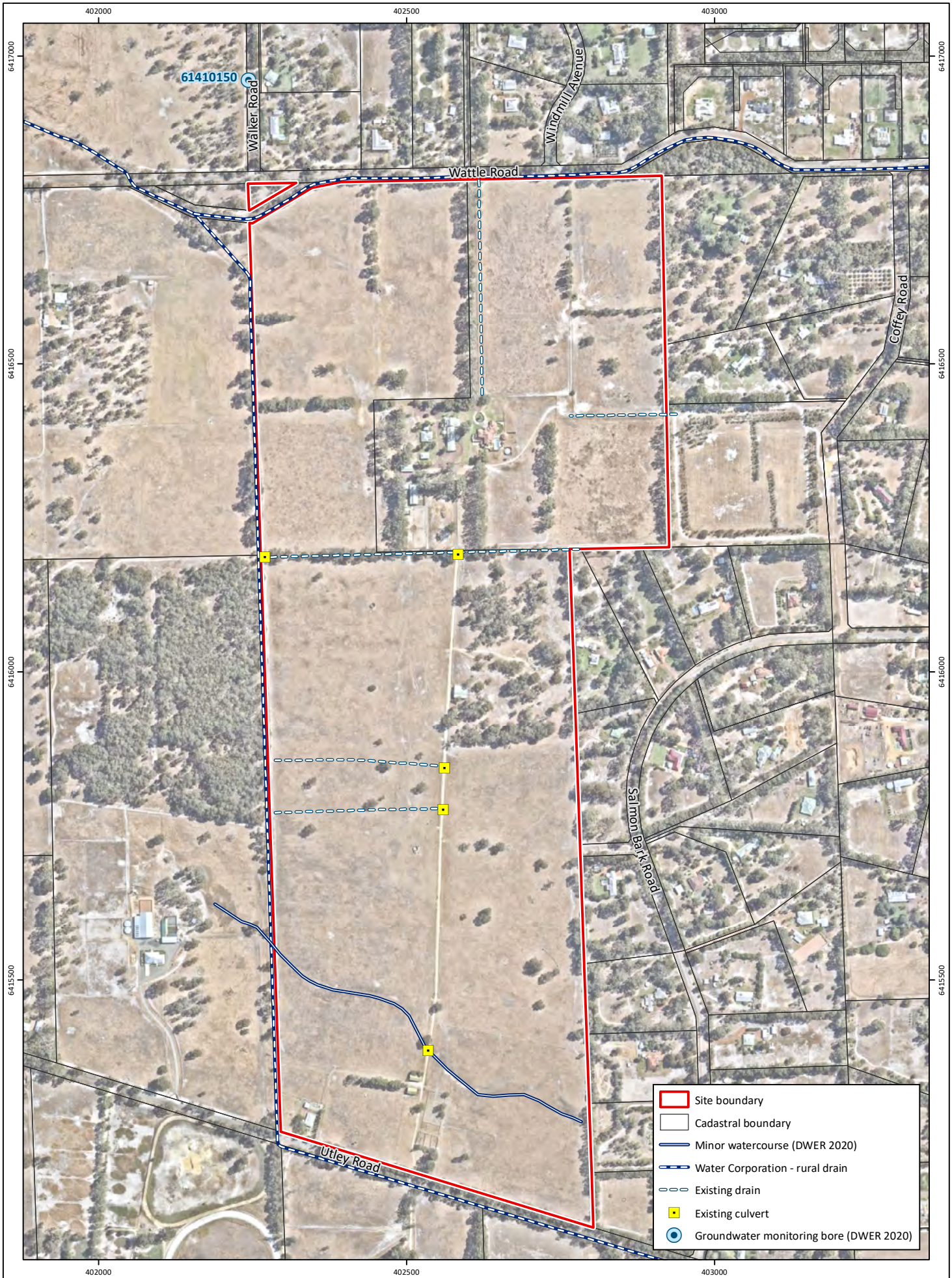


Figure 7: Existing Hydrological Features

Project:	Local Water Management Strategy Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine
Client:	Stron Pty Ltd

Plan Number:
EP20-064(01)--F25

Drawn:	GAR
Date:	05/08/2020
Checked:	ASC
Approved:	DPC
Date:	17/08/2020

N

0 100 200
Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

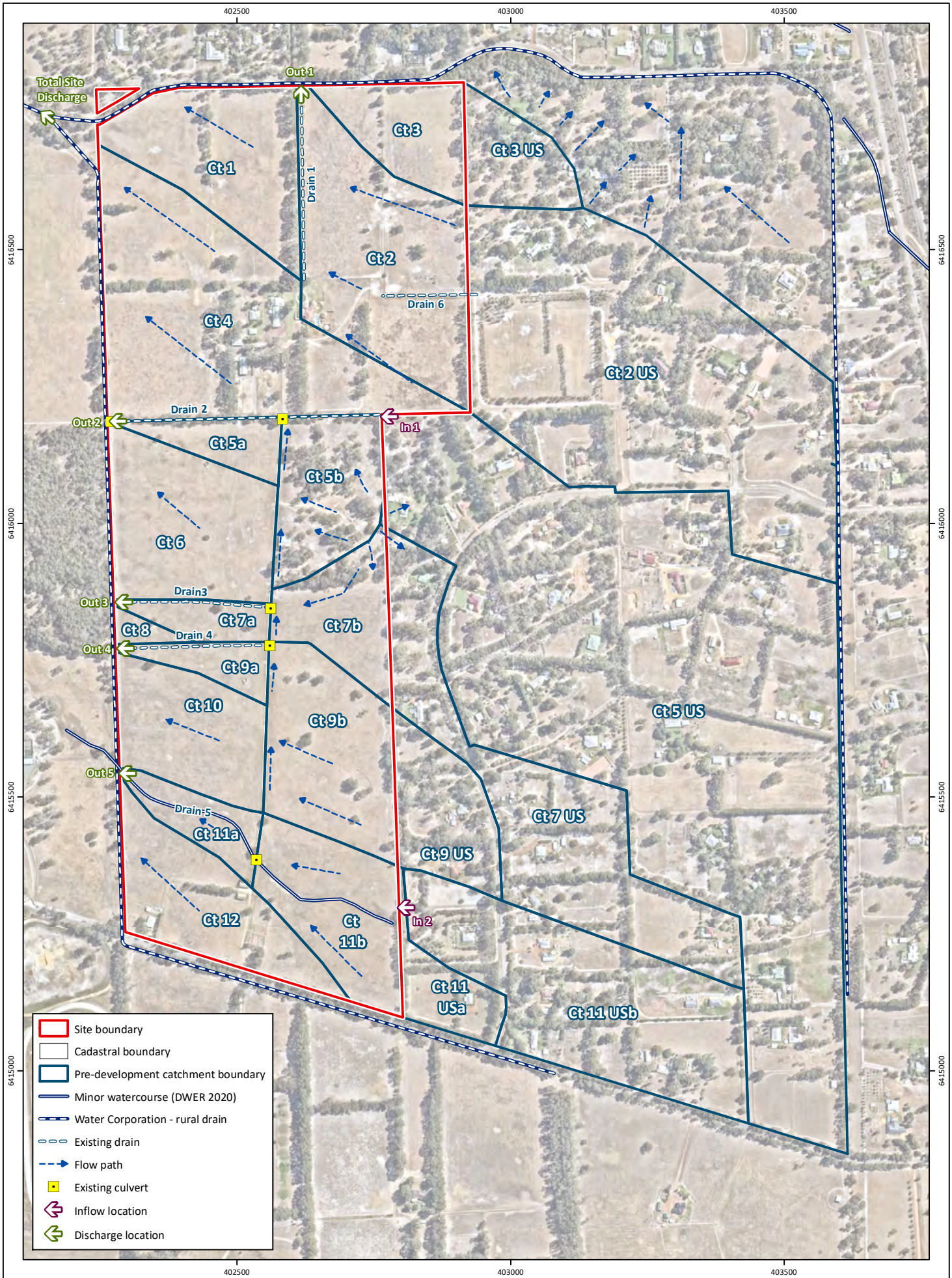


Figure 8: Existing Hydrological Regime

Project: Local Water Management Strategy
Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number: EP20-064(01)--F26

Drawn:	GAR
Date:	11/08/2020
Checked:	ASC
Approved:	DPC
Date:	17/08/2020

N

0 100 200
Metres

Scale: 1:9,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

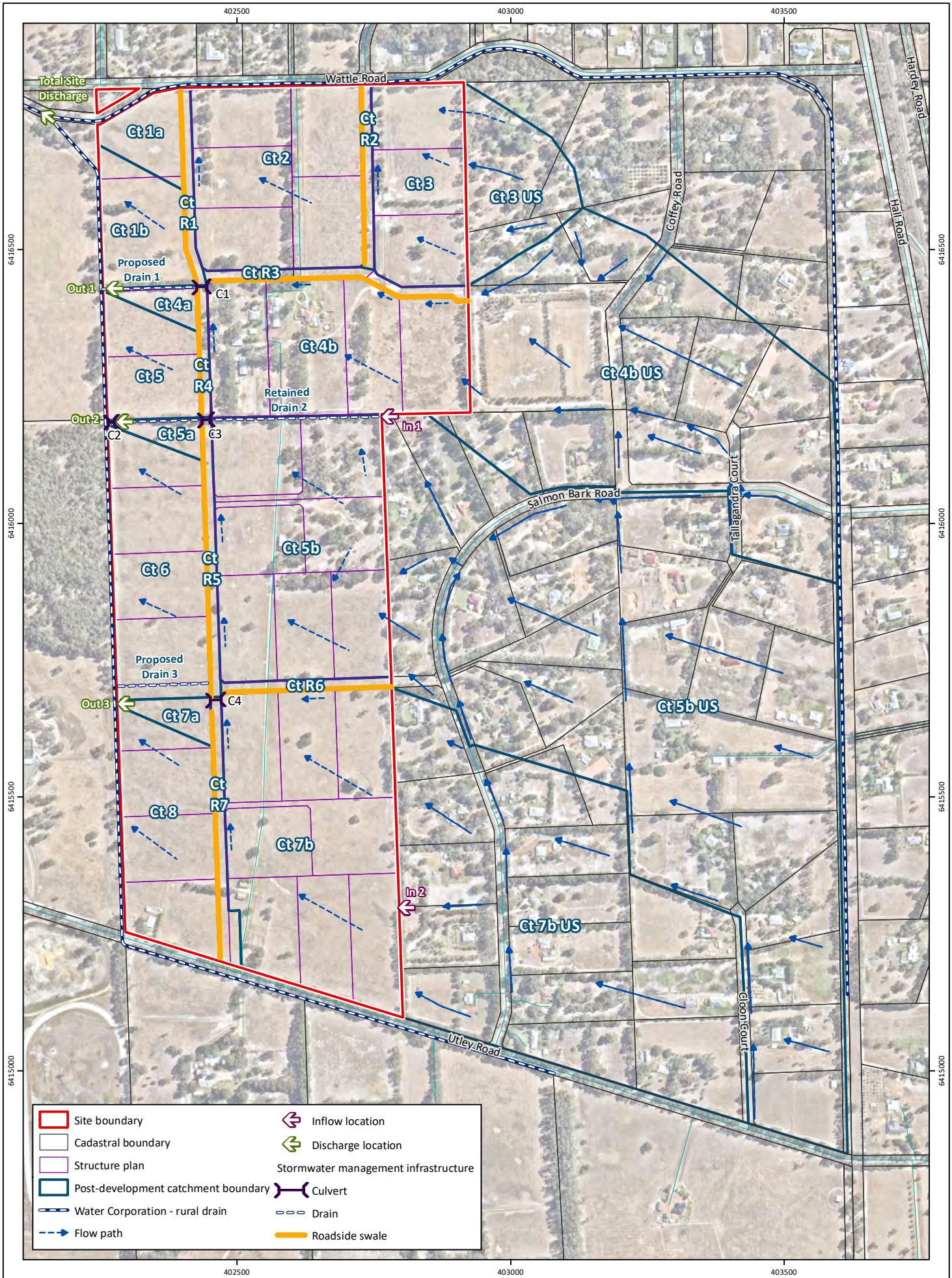


Figure 9: Stormwater Management Plan

Project: Local Water Management Strategy
Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number: EP20-064(01)--F27a

Drawn:	GAR	
Date:	15/03/2021	
Checked:	DPC	
Approved:	DPC	
Date:	15/03/2021	

N

0 100 200
Metres

Scale: 1:9,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

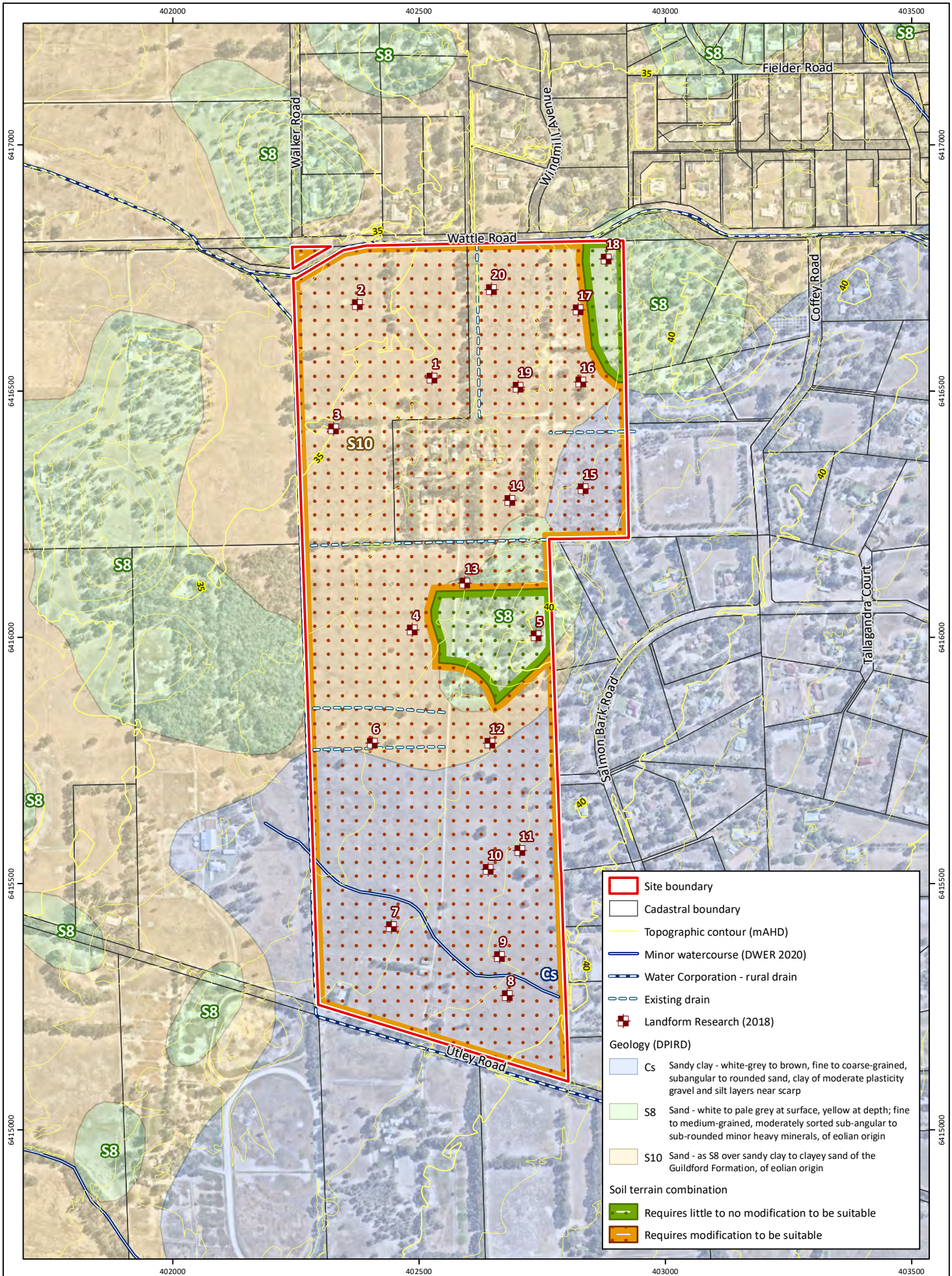


Figure 10: Site and Soil Evaluation

Project: Local Water Management Strategy
Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number: EP20-064(01)--F28

Drawn:	GAR
Date:	07/08/2020
Checked:	ASC
Approved:	DPC
Date:	17/08/2020

N

0 100 200
Metres

Scale: 1:10,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

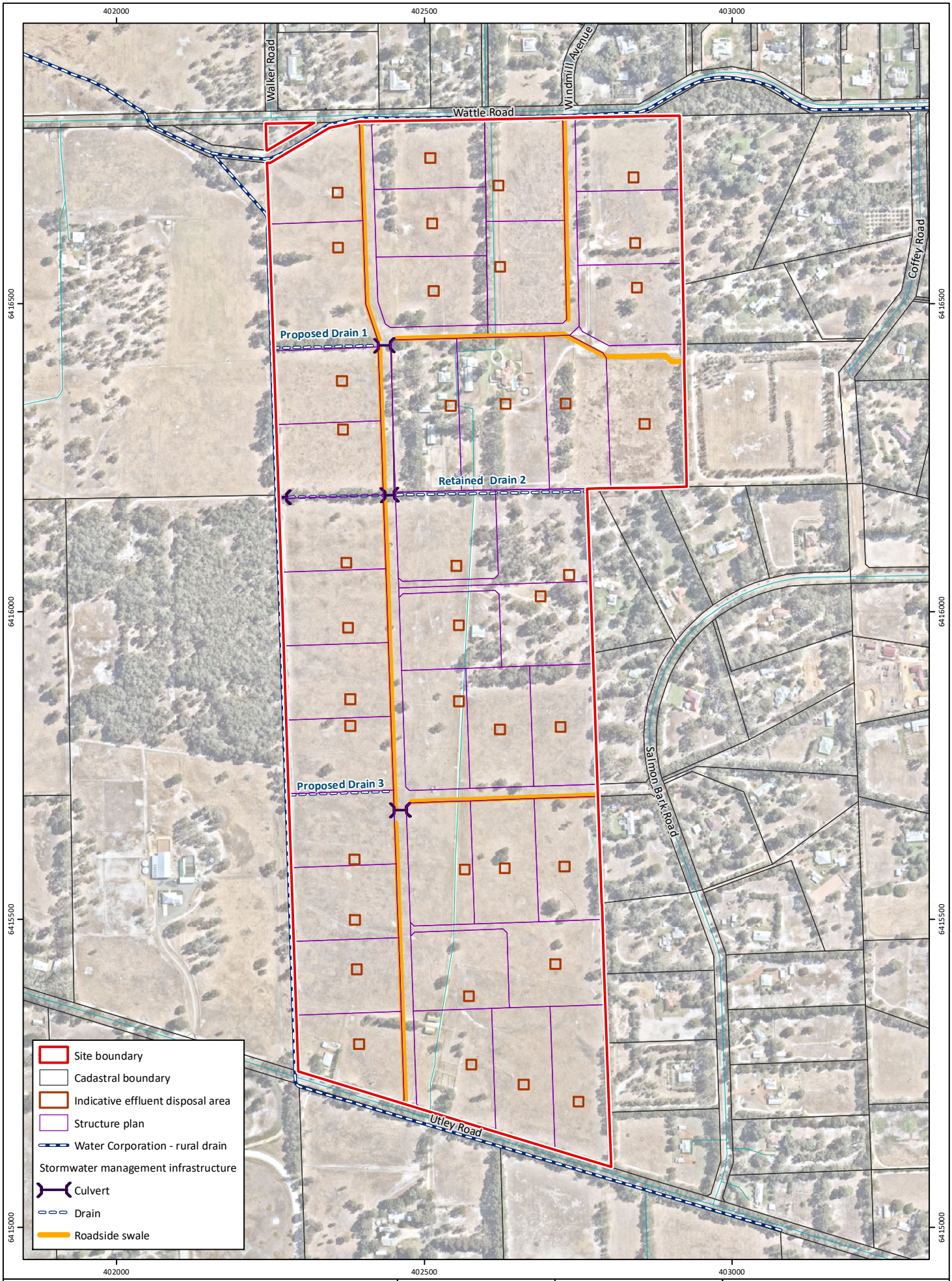


Figure 11: **Indicative On-site Wastewater Disposal Areas**

Project: Local Water Management Strategy
Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Client: Stron Pty Ltd

Plan Number: EP20-064(01)--F29a

Drawn:	GAR
Date:	15/03/2021
Checked:	DPC
Approved:	DPC
Date:	15/03/2021

N

0 100 200
Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

Appendix A

Structure Plan

WALKER RD
WATTLE ROAD
DMILL AVE
1,733 m²
(68.227 ha)
20m Road Reserve
6m Emergency Access Way / Fire Service Access Route (EAW/FSAW)
6m Emergency Access Way / Fire Service Access Route (EAW/FSAW)
6m Emergency Access Way / Fire Service Access Route (EAW/FSAW)
UTLEY ROAD

1 2.05 ha	32 2.00 ha	33 2.11 ha	35 2.03 ha				
2 3.20 ha	31 2.00 ha	34 2.14 ha	36 2.03 ha				
3 2.04 ha	30 2.00 ha	29 2.66 ha	28 3.53 ha	39 2.40 ha	37 2.16 ha	38 2.99 ha	
4 2.04 ha	5 2.04 ha	27 2.34 ha	26 2.43				
6 2.04 ha	24 2.01 ha	25 2.17					
7 2.04 ha	23 2.03 ha	22 2.03 ha	21 2.03 ha				
8 2.04 ha	9 2.04 ha	18 2.08 ha	19 2.07 ha	20 2.07 ha			
10 2.04 ha	11 2.04 ha	17 2.00 ha	16 2.31 ha				
12 2.04 ha	13 2.06 ha	14 2.06 ha	15 2.23 ha				

LEGEND

- Subject Site
- Cadastre
- Minor Water Course
- Drain
- 1m Contour Interval (mAHD)
- Retained Buildings
- Proposed Lot Boundary
- Special Rural (RR1 - Min. 2 ha)
- 2000m² Building Envelope
- Proposed Road Reserve
- 4m Gates

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 is 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 9001 Utley Road & Lot 9002 Wattle Road - Serpentine

50 0 50 100 250 500

Project RAYSJLSP I Scale 1:5000@A3 I Date March 2021

HEX DESIGN PLANNING

Source of Information

Site boundaries: Landgate
Projection: GDA94 MGA Zone 50 South

NOTE
All areas and dimensions are subject to survey, engineering and detailed design and may change without notice.

A:\PL_20210309_RAYSJLSP_Structure Plan Lot 9001 Utley Road & Lot 9002 Wattle Road.dwg

Appendix B

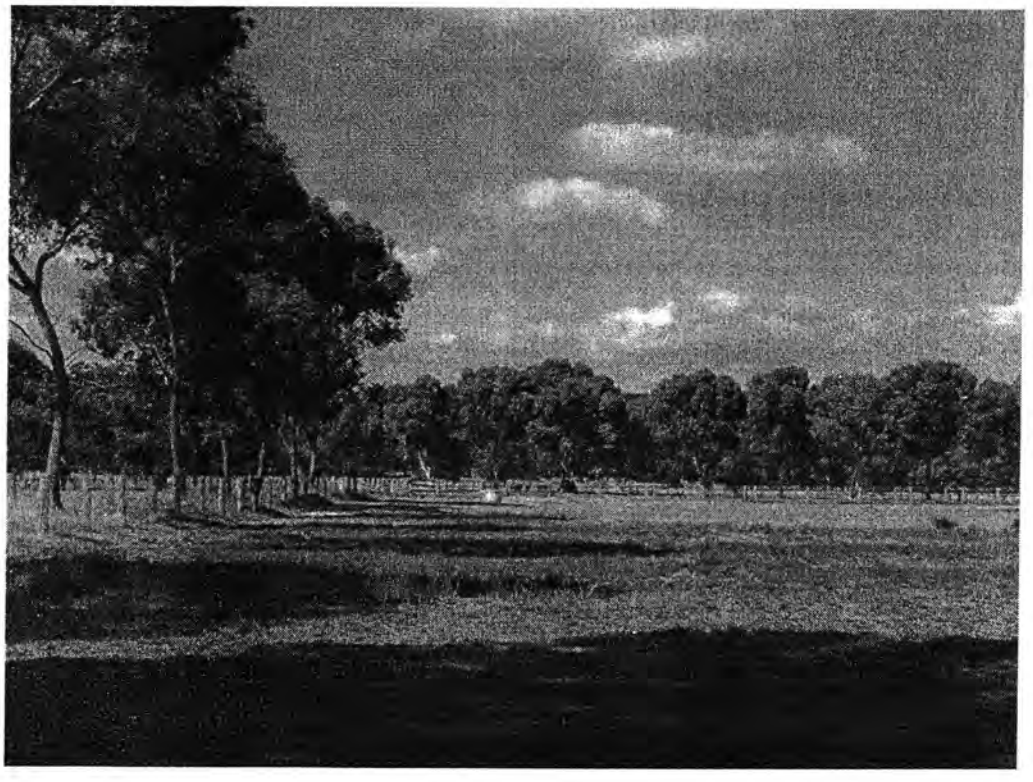
Land Capability Geotechnical Assessment (Landform Research 2018)

LAND CAPABILITY - GEOTECHNICAL ASSESSMENT

LOT 9002 WATTLE ROAD and LOT 9001 UTLEY ROAD, SERPENTINE

SHIRE OF SERPENTINE - JARRAHDALE

March 2018



LAND CAPABILITY - GEOTECHNICAL ASSESSMENT

LOT 9002 WATTLE ROAD and LOT 9001 UTLEY ROAD, SERPENTINE

SHIRE OF SERPENTINE - JARRAHDALE

Landform Research
Land Systems - Quarries - Environment
ABN 39 621 445 624

Lindsay Stephens BSc (Geology), MSc (Plant Ecology)
Mem Aus Geomechanics Soc – MEIANZ – FIQA

25 Heather Road Roleystone WA 6111
Tel 9397 5145, landform@iinet.net.au

SUMMARY OF LAND CAPABILITY AND GEOTECHNICS

Lots 9002 Wattle Road and 9001 Utley Road were 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 will depend on the actual land zoning and local planning strategy at the time of application for subdivision.

The site was assessed by hand auger on 5 April 2012 by Lindsay Stephens of Landform Research. At the time of inspection the site was relatively dry, being in autumn, although the soil properties and pasture species provided good indications of the soil structure and hydrogeology. The site was inspected several times in late winter and early spring to see if the precipitation had been sufficient to warrant additional field work to determine the highest perched water tables.

The soil moisture levels were not sufficient to achieve any better information than that gained in April 2012. Any test results conducted in the winter and spring of 2012 would not be valid in this location in providing an absolute elevation of the perched water tables, unless interpretations of the highest elevations are made.

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 site consists of one area of two lots that form one parcel of land running between Wattle Road and Utley Road. It is almost flat cleared land with a slight rise in the central parts.

The land lies in Serpentine, south west of similar land that has been subdivided just 600 metres to the north east. The townsite of Serpentine lies 2 km to the north. The site adjoins a subdivision to the east centred on Salmon Bark Road.

Proposed Land Use

Lots 9002 Wattle Road and 9001 Utley Road were 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 will depend on the actual land zoning and local planning strategy at the time of application for subdivision.

The currently proposed lot size is 2 ha with no provision of Scheme water or sewerage.

Capability

Land Capability studies identify the on site conditions on site and determine what actions are required or recommended to the permit the proposed development to occur. The critical aspect of land capability is the capability and conditions at the time of development, not in a rural setting prior to drainage and fill.

For example if water lays on the natural surface in winter under natural conditions drains will be required to enable the water to drain and not pond on the surface. After the subdivision is constructed the drainage and fill will ensure that there is no surface water ponding.

Therefore it is important to note that the soil assessments to the Australian Standards are made on the natural existing land as it was at the time of the site inspections. The reporting identifies the natural features that need to be mitigated to enable development.

Any drainage and fill requirements will be made during the detailed design for the subdivision. See Figure 8 for concept diagrams of the soil improvements through drainage.

Geotechnical

The site was assessed to AS1726 by Lindsay Stephens of Landform Research.

Foundation stability is rated as AS2870 Site Class A – S on the small area of deep sand in the central east dropping to S - M on off the ridges and M over much of the site. There is potential for Site Class H to occur in minor wet and dry areas.

The soils on site are no different to those within the adjoining subdivisions and consist of sandy over clay varying from low more sandy rises in the east down to lower elevations in the north west and south west where the soils have been drained.

The site is also suitable for the construction of roads using minor sand fill across lower elevations.

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.

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

Waste Water Disposal

The Government Draft Sewerage Policy, 2016, Department of Health Guidelines for the Reuse of Greywater in Western Australia, to Department of Health, Approved Aerobic and alternative waste water systems and Approved Greywater Systems and AS/NZS1547:2012 were used to assess the capability of the site to accept on site waste water disposal.

The average lot size of 2.0 hectares is significantly greater than the 0.2 hectare minimum recommendation contained within the Government Sewerage Policy 2016.

Alternative and nutrient waste water systems are recommended to be used that have secondary treatment and nutrient adsorption.

The land capability mapping shows the soil types in Figure 1 and the nature of the soils and recommendations in Figure 6. The Explanatory Notes of the Draft Government Sewerage Policy 2016, on page 13, third dot point under "sewerage sensitive locations" enable engineered solutions to improve the soil conditions for waste water disposal. This includes drains and detention basins to control and remove surface water from the soils in winter and the use of fill to improve the separation distances to local temporary perched water tables.

It is normal in the Peel Harvey Estuary for the sand fill to be specified as PRI > 5 which provides for significant additional phosphorus adsorption.

The site is suitable for on site waste water disposal. The existing soil conditions will be improved as a result of on site drainage and which comply with the Draft Government Sewerage Policy 2016, for engineered improvements.

Nutrient Loadings – Peel Harvey Estuary

Calculations of the nutrient loadings have been made using 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.

Currently there are no impediments to nutrient enriched water in autumn, flowing directly to the perimeter and strategic drainage systems where cattle dung and nutrients are readily washed to the drains and nutrients flow to the Estuary.

This shows that for the most likely scenario is for the current grazing land to be converted to 2 hectare lots with the likely ratio of one horse per lot. For such a scenario the nutrients will drop from the current input down to between one quarter and one third of their current inputs.

The nutrient input calculations were determined for nitrogen and phosphorus and compared between the existing and proposed land uses.

These are shown in Section 5.2 of the Land Capability Study, with the comparison loadings shown on pages 20 and 21. In addition the behaviour of the nutrients was considered in terms of how the nitrogen would be lost through denitrification and the phosphorus adsorbed onto the soils and within the amended soils of nutrient adsorbing waste water systems which are recommended and will be required.

In order to take a conservative approach 1.0 hectare and 2.0 hectare lots were considered for nutrient loading. The 1.0 hectare lots were assumed to have no stock apart from domestic animals. The 2.0 hectare lots with one horse per lot is considered a conservative loading as local assessments show that the average is under one horse per lot on average on such subdivisions.

Typical nutrient loadings proposed lot size with horses and pets

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.
2.0 hectare lot size Likely nutrient input after subdivision to 2.0 hectare lots. Nutrient adsorbing or alternative waste water system. Small garden, small fertilised lawn, dog, cat, 6 fowl or additional garden. 1 horse per lot	39.5 kg/N/ha/year 1 horse per lot	7.8 kg/P/ha/year 1 horse per lot	This is a conservative nutrient loading as field research shows that locally there are less than one horse per lot in similar subdivision.\s Significantly reduced nutrient loading and even greater reduction in nutrient export risk. The export risk depends on how the horse is housed and how much feed is introduced.

The nutrient loading from horses is anticipated to be further reduced as the Shire of Serpentine Jarrahdale requires landholders who want to retain horse submit a horse management plan. This will further potentially reduce the loading from horses as the management normally requires the removal of manure offsite.

In addition the drainage proposed, with detention basins and fill will slow and detain surface water and enable time for nutrient stripping.

Therefore not only will the nutrient loadings decrease significantly as a result of the proposed subdivision, but water that does flow from the land will be detained to enable nutrient stripping. Both of these measures are significant improvements on the current land use and management and nutrient risk to the Peel Harvey Estuary.

The nutrient from waste water disposal systems are summarised in the Department of Health Approved Treatment Units where all units are listed as being capable of removing over 50% of the phosphorus and nitrogen, up to over 97% of P and N depending in the unit chosen.

Subdividing the land will lead to significantly reduced nutrient loadings on the land, in addition better management of surface water through the use of drainage and water retaining facilities which provide additional nutrient stripping capacity.

Initial Water Management Strategy

See accompanying document

CONTENTS

ATTACHMENTS

REGOLITH AND HYDROLOGICAL LOGS

PRELIMINARY ACID SULFATE ASSESSMENT

FIGURES

1.0 INTRODUCTION

Site Assessment - Methodology

Lots 9002 Wattle Road and 9001 Utley Road were assessed to determine the potential for subdivision to rural living lots, from a geotechnical consideration down to 4 000 m2, although the lot sizes will depend on the actual land zoning and local planning strategy at the time of application for subdivision.

The site was assessed by hand auger on 5 April 2012 by Lindsay Stephens of Landform Research. At the time of inspection the site was relatively dry, being in autumn, although 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 Government Draft Sewerage Policy, 2016, Department of Health Guidelines for the Reuse of Greywater in Western Australia, to Department of Health, Approved Aerobic and alternative waste water systems and Approved Greywater Systems and AS/NZS1547:2012 were used for the assessment of the capability for waste water disposal.

The best time of year to complete soil testing is in late winter. However the winter of 2012 was relatively dry with some dry periods and surface water or near surface water did not build up to any extent on the soils.

The site was inspected several times in late winter and early spring to see if the precipitation had been sufficient to warrant additional field work to determine the highest perched water tables.

The soil moisture levels were not sufficient to achieve any better information than that gained in April 2012. Any test results conducted in the winter and spring of 2012 would not be valid in this location in providing an absolute elevation of the perched water tables, unless interpretations of the highest elevations are made.

Similarly there was no advantage in providing additional closer spaced soil test holes.

There is sufficient elevation to provide information to subdivide the land but additional soil test holes will be required in late winter to set the floor elevations, better determine the water management and drainage and determine the initial soil classification of foundation stability.

During the study 21 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 wetlands and vegetation were 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. This was completed during the field work.

Site Description

The site consists of one area of two lots that form one parcel of land running between Wattle Road and Utley Road. See Figures 1 and 3.

The sites lies in almost flat cleared land with a slight rise in the central parts.

It lies in Serpentine, south west of similar land that has been subdivided just 600 metres to the north east. The townsite of Serpentine lies 2 km to the north. The site adjoins a subdivision to the east centred on Salmon Bark Road. 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 central north with associated buildings and caretakers cottage.

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

Proposed Developments

Lots 9002 Wattle Road and 9001 Utley Road were assessed to determine the potential for subdivision to rural living lots, from a geotechnical consideration, down to 5 000 m^2, although the lot sizes will depend on the actual land zoning and local planning strategy at the time of application for subdivision.

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 5 April 2012 following a dry summer and autumn. The temperature was warm and probably in the mid 20 degree Celsius range.

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 relatively flat but drains from 42 metres AHD in the central east down to 34 metres AHD in the north western corner and 38 metres in the south western corner at Utley Road.

In this area the Karnet Brook to the south of Utley Road is the main watercourse draining from the Darling Scarp to originally disappear into the sediments of the Swan Coastal Plain, but is now picked up by the drainage system feeding to the Serpentine River to the west.

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.

Loam soils are developed on the alluvial clays and loams, such as Soil Type P1b, P1c, P1d and P3 (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 800 – over 1000 mm thick. The Department of Agriculture and Food soil types shown are B1, B2 and B4.

The mapping, and that completed by Landform Research, related 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 100 and 500 mm brown sand and earthy sand over loam clay. Can have an organo ferricrete layer and at the loam clay interface. Was subject to winter wet soils in parts prior to site drainage for the 2.0 ha lot subdivision.	P1b
HS/C	**Well Drained Sand over Clay**	Slightly higher elevations with between 500 - 1000 mm cream, brown and gravelly sand over loam clay. Well drained and not subject to winter wet conditions.	B4 and P1e
ES/C	**Earthy Sand over Clay**	Mid elevation with light coloured and grey sand grading to brown earthy sand at depths of 400 – 800 mm over loam clay. Can have a weak ferricrete layer at the loam clay interface.	P1b
WS/C	**Wet Sand over Clay**	Lower sand plain that has between 100 and 800 mm white to pale cream and brown sand over loam clay. Can have a weak ferricrete layer and gravel at the loam clay interface. Subject to winter wet conditions when water lays on the surface in excess of the capacity of the soils to drain. Parts of these soils are drained.	P1c

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 and loams have some potential for traffic compaction. The loam over clay can be self mulching. 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 loam – 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 soils are at high risk. The worst times are prior to the winter rains.	The drier sandy soil horizons could be more susceptible but are yellow and earthy which provides protection.	No issues for development apart from short term disturbance 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. Minor 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.	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	There is minor evidence of salinity in winter wet areas off the proposed subdivisions. Unlikely to be present on the approved	The use of sand fill will help negate this. Reduced by drainage as part of subdivision.

	plant growth. Normally worse where ancient soils and laterite profiles are present.	subdivisions.	
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 vary from low restriction to restricted by 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. The subdivisions are located on low 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 generally are highly workable on the more sandy soils reducing in the winter wet clays where workability is reduced.	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. They are no different to those on the already developed lots in nearby subdivisions. Foundation stability is higher on the deeper sands in the central east.	Good to moderate stability. Managed by additional fill, and footing design. 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 and 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 on the deeper sands on site. Moderate in other areas.	Managed by fill and site construction techniques. *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 generally sand over clay with minimum of 500 mm - > 1 000 mm sand.	Managed by 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 with minimum of 500 mm sand. The loam clay on the building envelopes is at depth.	Managed by fill and site construction techniques. Some basal clays will exhibit expansive qualities. *See 5.1 Foundation Stability*
WATER LOGGING - INUNDATION	Soils that become waterlogged can impact on dwellings through capillary action.	Winter waterlogging occurs on lower elevations in winter when precipitation exceeds infiltration and drainage rates.	Managed by fill 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 north western and south eastern and south western corners associated with drains and drainage lines.	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 clay with generally a minimum of 500 mm sand but some areas have less sand and others have deep sand.	Managed by fill and site construction 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 DOW bores to the north indicates permanent depth of 2 metres. The winter of 2012 was not wet enough to adequately determine the depth of the winter temporary perched water, over the whole site. The site is however little different to 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 loams or ferricrete. Low permeability 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 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.	Sandy soils have moderate microbial purification under natural conditions with 500 mm - > 1000 mm sand over loam/clay. Winter wet soils and shallow surface sand soils have low microbial purification in winter.	Managed by requirement of 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 are permeable. The underlying loam 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. No different to existing dwellings in nearby subdivisions.	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 low ridges of Bassendean Sand.

The classifications change across the soil units as the land surface rises and falls. Changes occur both laterally and vertically from sands through loams 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.

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

Foundation stability is rated as AS2870 Site Class A – S on the small area of deep sand in the central east dropping to S - M on off the ridges and M over much of the site. There is potential 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.

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.

Also Individual soil testing will be required at the time of design of footings for any dwelling, because 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.

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 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 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.

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 clay based.

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 minimized.

The gravels 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 S –M (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.

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.

These would be stable but create a deep waterbody that individual landholders would have to manage.

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 soils are however the same as those on the adjoining subdivisions which have been developed.

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

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.

In all cases the issue with potential acid sulfate conditions is the exposure of soils or sediments containing iron sulfide to the atmosphere, normally by digging up. The two main soil types at risk that are found on the Swan Coastal Plain are the clays associated with saline and estuarine conditions, normally below 5 metres AHD above sea level, and peaty swamps where exposure can occur through excessive pumping of surface or superficial water.

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. No additional drainage is proposed.

Reducing conditions will normally be temporary and due to waterlogging.

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. • 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, 2016, 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 soils are locally common and are similar to those in the adjoining 2.0 ha subdivisions.

The Government Draft Sewerage Policy, 2016, 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.

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 area are subject to winter waterlogging because the precipitation exceeds the current drainage or infiltration capacity of the soils in winter.

However these parameters were generally not exceeded in winter 2012 and little are experienced waterlogging. No late winter testing was possible to provide different results to the April 2012 assessments.

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

The site was assessed in spring 2012 in addition to autumn 2012. Test holes were not undertaken in spring because the dry winter of 2012 did not provide any more meaningful results or information on the water tables than was determined in autumn..

The soils and land capability are similar to 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 amount of surface water present on site has been reduced, with drainage assisted to the cut 1930's drains that drain to the west and Karnet Brook. The type of waste water system can be selected to match each site. Even on the pre-subdivision data Ecomax and Filtrex nutrient adsorbing waste water systems comply with Department of Health criteria for those units (see above).

The Explanatory Notes of the Draft Government Sewerage Policy 2016, on page 13, third dot point under "sewerage sensitive locations" enable engineered solutions to improve the soil conditions for waste water disposal. This includes drains and detention basins to control and remove surface water from the soils in winter and the use of fill to improve the separation distances to local temporary perched water tables.

The separation to the winter maximum perched water table in the pre-subdivision, current situation varies from 0 mm to over 3 metres with most interpreted as being in the range 500 – 800 mm

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

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 2.0 hectare lot.

See Figures 1, 5 and 7.

Setbacks from Water bodies

The Government Sewerage Policy 2016 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 only area where this is a potential issue is adjacent to the dams. The start of a watercourse occurs in the extreme south eastern corner, and in the south east adjacent to the boundary, from which originates a drainage line flowing to the south.

There are no other watercourses, with drainage 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.

Infiltration results

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

Most area sites have a minimum of 500 mm sand over the loam – clay. The loam – clay is slowly permeable.

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.

Alternative/nutrient adsorbing effluent disposal systems are also acceptable and require a waste water loading not exceeding 10 litres/m^2/day.

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

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	• Apart from the winter wet soils the whole site has a high capability for waste water disposal from conventional septic systems and alternative or nutrient adsorbing waste water systems.

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 2016.*
	• *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, 2016, 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 2016 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.

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

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 5 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.

This applies to the cleared and cultivated/grazed land only and not to the small amount of remnant vegetation in the central east.

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 2.0 hectare, but for comparison calculations are also made for 1.0 hectare and 0.4 - 0.5 hectare lots.

It should be noted that the Government Draft Sewerage Policy, 2016, permits waste water disposal from lots as small as 0.2 hectares in leached white sand with little phosphate retention capability.

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

From the above references a typical lot with a conventional septic system, small garden and lawn, dog and cat plus some chickens has a nutrient loading of 31 kg/N/year and 9.6 kg/P/year. This will be added to the soil on the building envelope. A conventional septic system 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 19 kg/N/year and 4.6 kg/P/year per lot which includes a garden, lawn, dog, cat and some chickens. See the Department of Health Approved Treatment Units where all units are listed as being capable of removing over 50% of the phosphorus and nitrogen, up to over 97% of P and N depending in the unit chosen. A 50% reduction is used in the calculations. 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.

A survey of the local lots in 2016 in the area from Nearmap high resolution aerial photography, backed up by assessments and views from the roads in the Gossage, Kargotich, Abernathy and Hopkinson Roads area shows that only around half of the larger lots (1.5 - 2.0 ha) keep horses and that when horse numbers are taken into account that a horse loading of one horse per two lots is a reasonable number. On smaller lots to 1.0 ha the percentage of lots with horses drops to below 50%.

That indicates that for 2.0 hectare lots the most common horse loading is one horse per two lots. A few lots have more than one horse and that is compensated for lots with no horses.

The other assumptions in this is that all manure is on each lot, which is usually not the case as manure is regularly taken offsite as fertiliser, and to compensate for garden fertiliser, further reducing the loading.

For the calculations and to be conservative a loading of one horse per lot is chosen which shows tat the nutrient loading is around half of the existing stocking rate, with nitrogen loading dropping from 70.0 kg/N/ha/year down to 39.5 kg/N/ha/year and the phosphorus loading dropping from down to 22.5 kg/P/ha/year down to 7.8 kg/P/ha/year. Note that this is a significant over estimation of the actual loading.

Further, in the Shire of Serpentine Jarrahdale there is a normal requirement for a landholder who proposes to keep horses to produce a horse management plan for the Keeping of Horses, specific to their lot as part of a planning application for the keeping of horses to be approved by the Shire.

Publications considered in the assessment of nutrients and the management of horses are;

- *Stocking rate guidelines for rural small holdings*; DAFWA Misc Pub 02/00
- *Shire of Chittering Local Planning Policy 24*
- *Horse Care on Small Acerages in Colarado*; Swinker
- *Pollution Control for Horse Stables and Backyard Livestock*; USEPA Region 6
- *Pasture for Horses*; Prime Fact 525, NSW
- *Managing Small-acreage Horse Farms*; Oregon State University
- *Hoofprints*, A Manual for Horse Property Management; Foyel Sustainable Resources Group, Primary Industries South Australia.
- *Horse SA, Horses, Land and Water*
- *Horse Keeping on small properties in the Mount Lofty Ranges,* Gov of South Australia, Adelaide and Mount Lofty Ranges Natural Resources Management Board
- *Action Plan and Horse Property Management Guideline,* Horse SA.

Typical nutrient loadings of the various lot sizes

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.
2.0 hectare lot size Likely nutrient input after subdivision to 2.0 hectare lots. Nutrient adsorbing or alternative waste water system. Small garden, small fertilised lawn, dog, cat, 6 fowl or additional garden. 1 horse per lot	39.5 kg/N/ha/year 1 horse per lot	7.8 kg/P/ha/year 1 horse per lot	Lower nutrient loading. Significantly reduced nutrient loading and even greater reduction in nutrient export risk. The export risk can be lower depending on manure management and how much feed is introduced.
2.0 hectare lots Likely nutrient input after subdivision to 2.0 hectare lots adsorbing or alternative waste water system. Small garden, small fertilised lawn, dog, cat, 6 fowl or additional garden. 1 horse per two lots.	24.5 kg/N/ha/year for an average of one horse per two lots.	5.05 kg/P/ha/year for an average of one horse per two lots.	Lower nutrient loading. Significantly reduced nutrient loading and even greater reduction in nutrient export risk. The export risk depends on how the horse is housed and how much feed is introduced.
Likely nutrient input after subdivision to **1.0 hectare lots.** Nutrient adsorbing or alternative waste water system. Small garden, small fertilised lawn, dog, cat, 6 fowl or additional garden. No stock.	19.0 kg/N/ha/year	4.6 kg/P/ha/year	Lower nutrient loading. Likely to be reduced nutrient export. The export risk depends on how the horse is housed and how much feed is introduced.

- 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 the most likely example.

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 -- Policy, 2016.

The sandy upper soil horizons soils can 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 and on top of the underlying loam subsoils.

Because of the low phosphate retention capability of the sandy upper soil horizons, 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, for example in the dam on the north of the site.

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). Department of Health Approved Treatment Units where all units are listed as being capable of removing over 50% of the phosphorus and nitrogen, up to over 97% of P and N depending in the unit chosen.

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. The likely scenario is 1.0 hectare lots on which an average of 0.5 horses per lot are retained and nutrient adsorbing waste water systems used.

On the other hand there may be potential for lots down to 0.4 hectares. At that lot size stock would not be permitted.

For 2.0 hectare lots the estimated phosphorus loading would reduce from 22.5 kgP/ha/year down to 7.8 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 significant reductions 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. Department of Health Approved Treatment Units where all units are listed as being capable of removing over 50% of the phosphorus and nitrogen, up to over 97% of P and N depending in the unit chosen.

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.

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.

Even so the total nitrogen loading will reduce. The likely scenario is for 1.0 hectare lots on which an average of 0.5 horses per lot are retained and nutrient adsorbing waste water systems, or the potential for lots down to 0.4 hectares with no stock.

For 2.0 hectare lots the estimated nitrogen loading would reduce from 70.0 kgP/ha/year down to 49.0 – 39.75 kgP/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 2016 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 Government Sewerage Policy, 2016.* • *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 2.0 hectare 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 lots of 1 hectare 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*) – Marri remnant trees on the deeper yellow sand in the central east with scattered *Eucalyptus (Corymbia) calophylla* trees in the east.

In the north the only trees have been planted in tree belts. These are mixed local and non local Eucalypts. See Figures 2 and 3. Compare to Figure 1.

No understory species were recorded.

The vegetation in the central east is listed as a "Geomorphic Wetland" is shown on Shire and DEC mapping. That nomination is completely wrong and must have been identified from mistaken aerial photography interpretation.

The vegetation of the "wetland", which is located on the highest land in the central east, is centred on *Eucalyptus (Corymbia) calophylla* trees and sandy soil. The site is shown in the photographs attached to this report.

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).

Controls

Smaller lots have generally been placed in already cleared areas with larger lots allocated to the remnant vegetation in better condition. Where possible fences and roads have been located in previously cleared areas, fire breaks or tracks.

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 can be protected with the use of larger lots and by locating roads and developments at a sufficient buffer.

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. This has been misidentified. See above under Remnant Vegetation. See Figures 2 and 3.

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.

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 and minor "Degraded".
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 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 generally flat nature of the land surfaces.
- The local views that can be obtained from some parts of the site.
- Proximity to Serpentine townsite.
- Setback from existing roads.
- Proximity to existing service centre.
- Ability to have horses on larger lots.
- Adjoin existing subdivided land.

The constraints of the site are;

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

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 could be any size from 0.2 hectares upwards, but planning issues are likely to determine a lot size of 0.4 – 1.0 hectares.

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 as shown by the existing plantings along fencelines in the north.

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 loam/clay which on this site are quite productive for pasture and grazing holding pasture into summer.

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.

Horse agistment on some lots is likely to continue even under rural living if lot sizes are one hectare.

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 Metalurgy.

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 Aerobic 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.

Landform Research

Lindsay Stephens BSc (Geology) MSc (Botany)
25 Heather Road Roleystone 6111
Phone 9397 5145 Fax 9397 5350

Regolith and Hydrological Logs

Project		Site Assessed by	L Stephens
Location	Lot 375 Wattle Road – Lot 826 Utley Road, Serpentine	Date of Inspections	5 April 2012

Test Hole Number	1	Natural Surface		
Location	North west	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 - 300 mm	Grey sand	
300 - 700 mm	White sand	
700 – 1400 mm	Light brown clay sand with gravelly yellow brown induration and yellow mottles. Clay increasing below 400 mm.	
1 400 - 1600 mm	White to light brown sand/clay with gravel induration	
Groundwater	Not intersected	
Comment		

Test Hole Number	2	Natural Surface		
Location	North west corner	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 - 100 mm	Grey sand	
100 - 700 mm	White sand	
700 - 1600 mm	Brown sand slightly gravelly	
1600 - >1700 mm	Gravelly sandy clay	
Groundwater	Water table not intersected	
Comment		

Test Hole Number	3	Natural Surface		
Location	West north west	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 - 100 mm	Grey sand	
100 - 400 mm	Cream sand	
400 - 800 mm	Gravelly sandy clay and clay sand	
Groundwater	Water table not intersected	
Comment		

Test Hole Number	4	Natural Surface		
Location	Central west	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 - 50 mm	Grey sand	
50 - 120 mm	Light grey sand	
120 - 700 mm	Brownish yellow sand	
700 - >1500 mm	Brownish yellow and brown clay sand with minor iron induration.	
Groundwater	Water table not intersected	
Comment		

Landform Research

Lindsay Stephens BSc (Geology) MSc (Botany)
25 Heather Road Roleystone 6111
Phone 9397 5145 Fax 9397 5350

Regolith and Hydrological Logs

Project		Site Assessed by	L Stephens
Location	Lot 375 Wattle Road – Lot 826 Utley Road, Serpentine	Date of Inspections	5 April 2012

Test Hole Number	5	Natural Surface		
Location	Central east	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 - 50 mm	Grey sand	
50 - 250 mm	White sand	
250 - 2200 mm	Yellow sand slightly earthy	
2200 – 2500 mm	Yellow sand with minor iron induration	
2500 – 3100 mm	Yellow sand slightly earthy, iron induration at 3100 mm	
3100 – 3200 mm	Iron induration and weak ferricrete.	
Groundwater	Water table not intersected	
Comment		

Test Hole Number	6	Natural Surface		
Location	Central south west	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 - 70 mm	Grey sand	
70 – 780 mm	Light yellowish brown slightly earthy sand	
780 - 860 mm	Gravelly brown and yellow sand	
860 - 900 mm	Yellowish clay sand with minor iron induration.	
Groundwater	Water table not intersected	
Comment		

Test Hole Number	7	Natural Surface		
Location	South west corner	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 - 60 mm	Grey sand	
60 - 420 mm	Light yellowish brown sand	
420 - 680 mm	Yellow and yellow brown mottled sand. Gravelly with minor clay.	
680 - >900 mm	Gravelly yellow brown and yellow mottled coarse sand; alluvial? Quartz sand grains are not rounded.	
Groundwater	Water table not intersected	
Comment		

Test Hole Number	8	Natural Surface		
Location	South eastern corner	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 - 110 mm	Light grey sand	
110 - 570 mm	Pale cream sand	
570 - 900 mm	Gravelly cream sand with iron induration at 700 mm	
900 - >1000 mm	Gravelly clayey sand near the clay base.	
Groundwater	Water table not intersected	
Comment		

Landform Research

Lindsay Stephens BSc (Geology) MSc (Botany)
25 Heather Road Roleystone 6111
Phone 9397 5145 Fax 9397 5350

Regolith and Hydrological Logs

Project		Site Assessed by	L Stephens
Location	Lot 375 Wattle Road – Lot 826 Utley Road, Serpentine	Date of Inspections	5 April 2012

Test Hole Number	9	Natural Surface		
Location	Central south east	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		
Depth	Description		Comments	
0 - 250 mm	Light yellow earthy sand			
250 - 520 mm	Yellow sand indurated with iron oxides			
>520 mm	Gravel could not penetrate.			
Groundwater	Water table not intersected			
Comment				

Test Hole Number	10	Natural Surface		
Location	Central south east	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		
Depth	Description		Comments	
0 - 80 mm	Dark grey sand			
80 – 340 mm	Yellow brown gravelly sand			
>340 mm	White sand			
800 - 1100 mm	Gravel			
Groundwater	Water table not intersected			
Comment				

Test Hole Number	11	Natural Surface		
Location	Central south east	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		
Depth	Description		Comments	
0 -70 mm	Grey sand		Elevation approximately 500 mm higher than Hole 10.	
70 - 760 mm	Brown gravelly sand			
>760 mm	Indurated gravelly sand over clay.			
Groundwater	Water table not intersected			
Comment				

Landform Research

Lindsay Stephens BSc (Geology) MSc (Botany)
25 Heather Road Roleystone 6111
Phone 9397 5145 Fax 9397 5350

Regolith and Hydrological Logs

Project		Site Assessed by	L Stephens
Location	Lot 375 Wattle Road – Lot 826 Utley Road, Serpentine	Date of Inspections	5 April 2012

Test Hole Number	12	Natural Surface		
Location	Central east	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		
Depth	Description		Comments	
0 - 50 mm	Grey sand			
50 - 740 mm	Light cream earthy sand			
740 - 950 mm	Yellow and brown clay sand with pale yellow mottles and indurated iron.			
Groundwater	Water table not intersected			
Comment				

Test Hole Number	13	Natural Surface		
Location	Central	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		
Depth	Description		Comments	
0 - 50 mm	Grey sand			
50 - 800 mm	White sand			
800 - 950 mm	Brown sand			
950 - 1050 mm	Light brown sand with minor gravel			
Groundwater	Water table not intersected			
Comment				

Test Hole Number	14	Natural Surface		
Location	Central north east	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		
Depth	Description		Comments	
0 - 400 mm	Grey sand			
400 - 730 mm	Brown sand			
730 - 810 mm	Gravelly brown sand			
>810 mm	Gravel. Could not penetrate			
Groundwater	Water table not intersected			
Comment				

Test Hole Number	15	Natural Surface		
Location	East north east	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		
Depth	Description		Comments	
0 - 60 mm	Grey sand			
60 - 300 mm	Cream sand			
300 - 380mm	Gravelly brown sand			
>380 mm	Gravel. Could not penetrate			
Groundwater	Water table not intersected			
Comment				

Landform Research

Lindsay Stephens BSc (Geology) MSc (Botany)
25 Heather Road Roleystone 6111
Phone 9397 5145 Fax 9397 5350

Regolith and Hydrological Logs

Project		Site Assessed by	L Stephens
Location	Lot 375 Wattle Road – Lot 826 Utley Road, Serpentine	Date of Inspections	5 April 2012

Test Hole Number	16	Natural Surface		
Location	North east	Base of Hole		
Test Hole Type	Hand Auger	Depth		
Diameter		Depth of static water level		
Depth	Description		Comments	
0 - 70 mm	Grey sand			
70 - 440 mm	Brown sand			
440 - 870 mm	Yellowish brown sand			
870 – 910 mm	Gravelly yellowish brown sand			
910 – 950 mm	Gravelly yellow brown clay sand			
Groundwater	Water table not intersected			
Comment				

Test Hole Number	17	Natural Surface		
Location	North east corner	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		
Depth	Description		Comments	
0 - 50 mm	Grey sand			
50 - 560 mm	Brown sand			
560 – 870 mm	Light brown sand			
870 – 940 mm	Cream clay sand			
940 – 1000 mm	Cream gravelly clay sand			
Groundwater	Water table not intersected			
Comment				

Test Hole Number	18	Natural Surface		
Location	North east corner	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		
Depth	Description		Comments	
0 - 90 mm	Grey sand			
90 - 760 mm	White sand			
760 – 1000 mm	Brown earthy sand, slightly gravelly with depth.			
Groundwater	Water not intersected			
Comment				

Test Hole Number	19	Natural Surface		
Location	North	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		
Depth	Description		Comments	
0 – 110 mm	Grey sand			
110 - 330 mm	White sand			
330 – 840 mm	Brown sand			
840 – 880 mm	Lighter brown sand with minor gravel			
880 – 950 mm	Light cream clay sand with minor induration			
Groundwater	Water table not intersected			
Comment				

Landform Research

Lindsay Stephens BSc (Geology) MSc (Botany)
25 Heather Road Roleystone 6111
Phone 9397 5145 Fax 9397 5350

Regolith and Hydrological Logs

Project		Site Assessed by	L Stephens
Location	Lot 375 Wattle Road – Lot 826 Utley Road, Serpentine	Date of Inspections	5 April 2012

Test Hole Number	20	Natural Surface		
Location	North	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 - 40 mm	Dark grey sand	
40 - 710 mm	Light brown sand	
> 710 mm	Gravel. Could not penetrate.	
Groundwater	Water table not intersected	
Comment		

Test Hole Number	21	Natural Surface		
Location	4 October 2009	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
	Grey sand over white sand at depth	
Groundwater	Water table at 450 mm	
Comment		

Landform Research
Land Systems - Quarries - Environment
ABN 29 841 445 694

ACID SULFATE ASSESSMENT FORM

This assessment sheet is modified from Planning Bulletin 64, Draft December 2003.

Location	Lots 375 Wattle Road and 826 Utley Road, Serpentine
Date	Field work 5 April 2012.

	QUESTION	YES	NO	COMMENT
STEP 1				
1	Is the land depicted in Figures 1 - 10 of the Western Australian Planning Commission's Planning Bulletin No 64: Acid Sulfate Soils, as having a "high risk of Actual Acid Sulfate Soil (AASS) and Potential Acid Sulfate (PASS) < 3 m from surface?		X	Land shown as Yellow, (moderate to low risk of acid sulphate AASS and PASS below 3 metres.
2a	Is the land located in an area whether depicted in Figures 1 - 10 or not, where site characteristics and local knowledge suggest that there is a significant risk of disturbing acid sulfate soils at this location?		X	The land and sol are well oxidised and dry out annually for a number of months. There are no wetlands or peat areas.
2b	Does site interpretation suggest that there is a significant risk of disturbing acid sulfate soils at this location; soils, peat or sulfides in rock?		X	As above. Subdivision will not involve excavation apart from some small drains. Fill will be required.
STEP 2		IF YES TO ANY OF THE ABOVE GO TO STEP 2		
3a	Are any dewatering works to be undertaken?		X	Not proposed and not necessary.
3b	Is the extraction of superficial groundwater likely to expose peaty soils?		X	Not proposed or likely. There are no peaty or organo-ferricrete conditions on site or nearby
4a	Is the surface elevation <= 5 m AHD and is excavation of >= 100 m^3 of soil proposed?		X	No.
4b	Are drainage or earthworks likely to expose subsoils potentially susceptible to acid sulfate conditions?		X	Subdivision will not involve excavation apart from some small drains. Fill will be required.
5a	Is the surface elevation > 5 m AHD and is excavation of >= 100 m^3 with an excavation depth of >=2 metres proposed in potential sulfide containing materials?		X	No reducing conditions are present. They occur for periods each winter on lower elevations but dry out and the soils are highly oxidised.
5b	Are peaty soils likely to be exposed through excavation		X	No.
5c	Are sulfide containing rocks or materials to be processed?		X	No unweathered rocks are present.
STEP 3		IF YES TO ANY OF THE ABOVE, CARRY OUT A PRELIMINARY SITE ASSESSMENT IN ACCORDANCE WITH DEPARTMENT OF ENVIRONMENT GUIDELINES		
6	Did the Preliminary Site Assessment reveal the presence of acid sulfate soils?		X	No evidence of Actual or Potential Acid sulfate.
STEP 4		IF YES, CARRY OUT A DETAILED SITE ASSESSMENT IN ACCORDANCE WITH DEPARTMENT OF ENVIRONMENT GUIDELINES		
7	Did the Detailed Site Assessment reveal the presence of acid sulfate soils?		X	No evidence of Actual or Potential Acid sulfate.
		IF YES, MODIFY THE DESIGN OF THE PROPOSAL OR PREPARE AN ACID SULFATE MANAGEMENT PLAN		

Comment	***No soils, travel or other materials at risk were identified and none likely on elevated laterite plateau.***

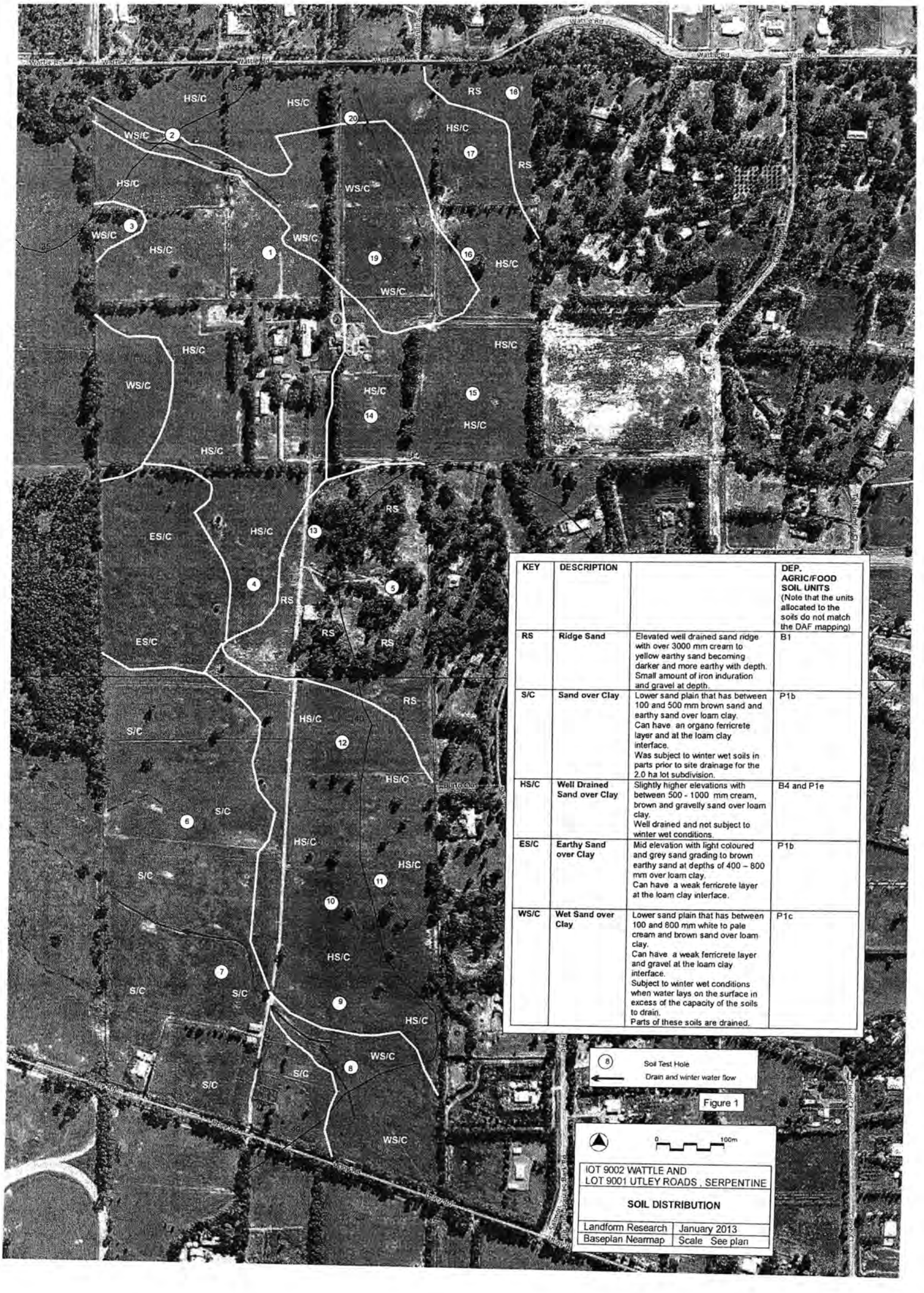
Available Reports	X	Mapping and assessment
	X	Preliminary Site Assessment Results
		Detailed Site Assessment Results and sampled assessments.
	X	The proposal has been designed to avoid disturbance of acid sulfate soils at this location
		Completed acid sulfate management plan

SIGNATURE .....DATE... 20/4/2012

ASSESSORS NAME Lindsay Stephens / Landform Research

Landform Research
25 Heather Road ,Roleystone, WA 6111,
Phone 9397 5145, Email landform@iinet.net.au

Lindsay Stephens BSc (Geology), MSc (Botany), MEIANZ, FIQA
Mem. Aus.Geomechanics Soc. - Mem. WA Env. Cons. Assoc.



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 100 and 500 mm brown sand and earthy sand over loam clay. Can have an organo ferricrete layer and at the loam clay interface. Was subject to winter wet soils in parts prior to site drainage for the 2.0 ha lot subdivision.	P1b
HS/C	Well Drained Sand over Clay	Slightly higher elevations with between 500 - 1000 mm cream, brown and gravelly sand over loam clay. Well drained and not subject to winter wet conditions.	B4 and P1e
ES/C	Earthy Sand over Clay	Mid elevation with light coloured and grey sand grading to brown earthy sand at depths of 400 – 800 mm over loam clay. Can have a weak ferricrete layer at the loam clay interface.	P1b
WS/C	Wet Sand over Clay	Lower sand plain that has between 100 and 800 mm white to pale cream and brown sand over loam clay. Can have a weak ferricrete layer and gravel at the loam clay interface. Subject to winter wet conditions when water lays on the surface in excess of the capacity of the soils to drain. Parts of these soils are drained.	P1c

(8) Soil Test Hole

Drain and winter water flow

Figure 1

0 100m

LOT 9002 WATTLE AND
LOT 9001 UTLEY ROADS , SERPENTINE

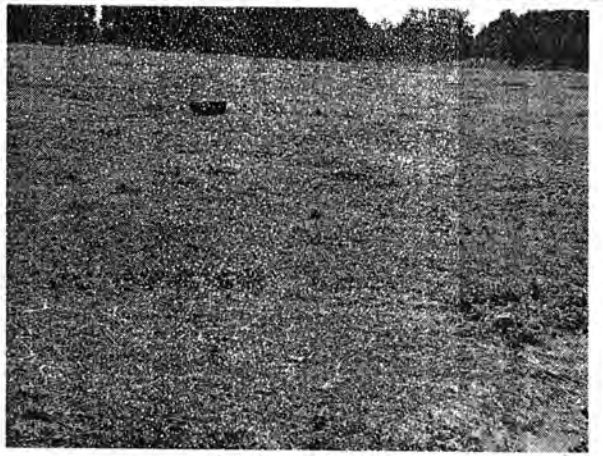
SOIL DISTRIBUTION

Landform Research	January 2013
Baseplan Nearmap	Scale See plan


Planted tree belts
Jarrah - Marri Parkland Pasture
Drain and winter flow
Jarrah - Marri incorrectly identified on Shire and DEC databases as Geomorphic Wetland
Figure 2
0
100m
IOT 9002 WATTLE AND
LOT 9001 UTLEY ROADS , SERPENTINE
VEGETATION
Landform Research
January 2013
Baseplan Nearmap
Scale See plan

Typical lower lying pasture in the central north

Pasture in the central north, view towards the north east. Note the tree belts.



Pasture in the central north west

Pasture in the north west

View from the central east towards the dwelling

The sand ridge in the central east, that is incorrectly listed as a wetland on DEC and Shire mapping

View from the central west to the ridge in the east which can be seen rising in elevation

South western pasture

Western pasture

Figure 3

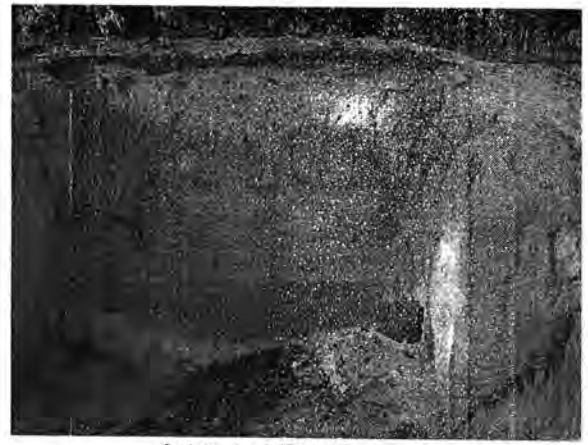
Soils that appear to be leached white sands in the central north west but are underlain by brown sand

Soil Test Hole 1. Note the underlying brown sand

Soil Test Hole 2

Soil Test Hole 4

Soil Test Hole 11



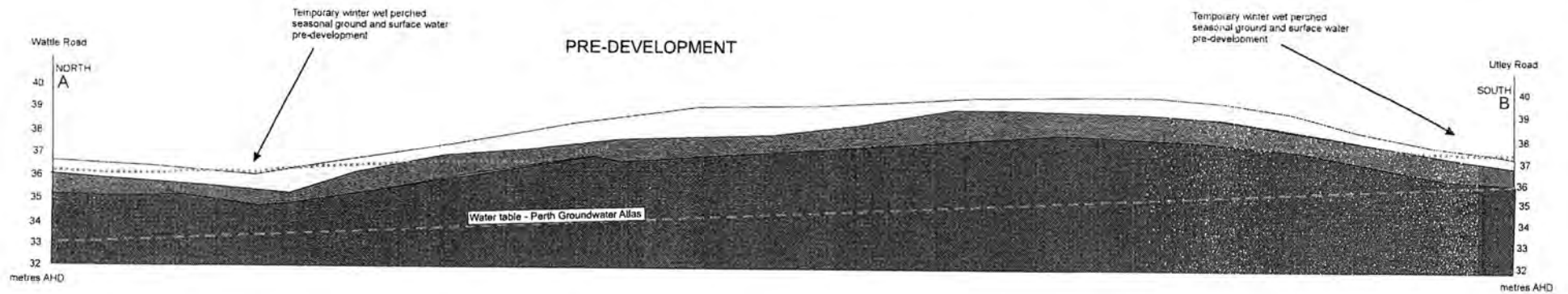
Sand excavation, Soil Test Hole 5

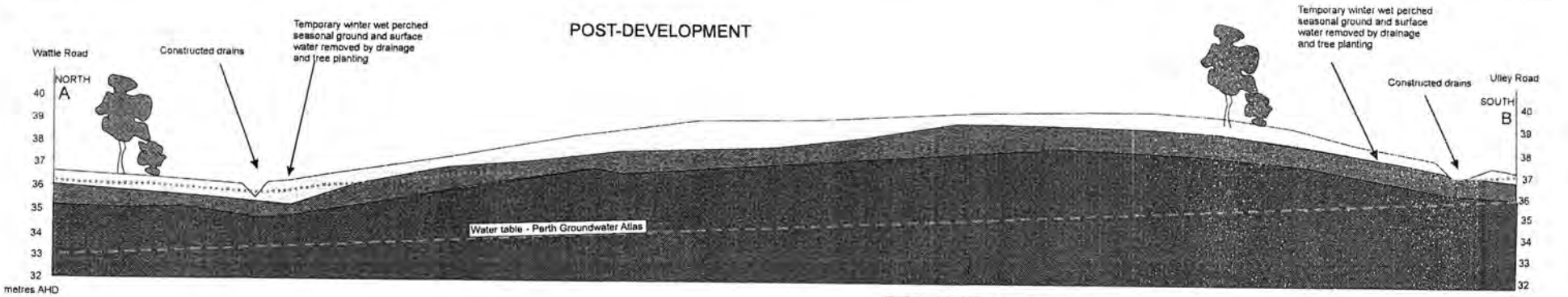
Soil Test Hole 14

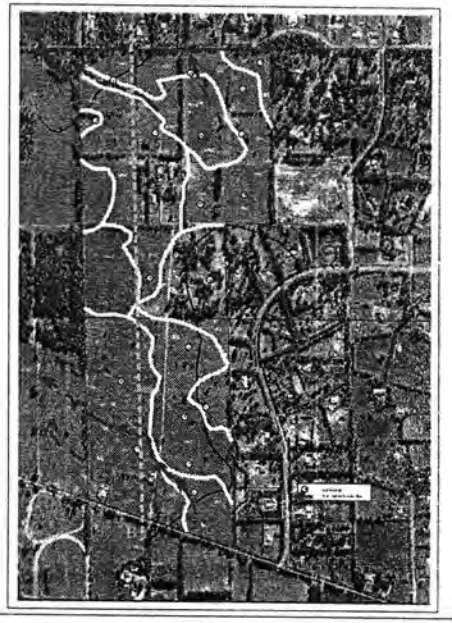
Soil Test Hole 7

Soil Test Hole 3

Figure 4

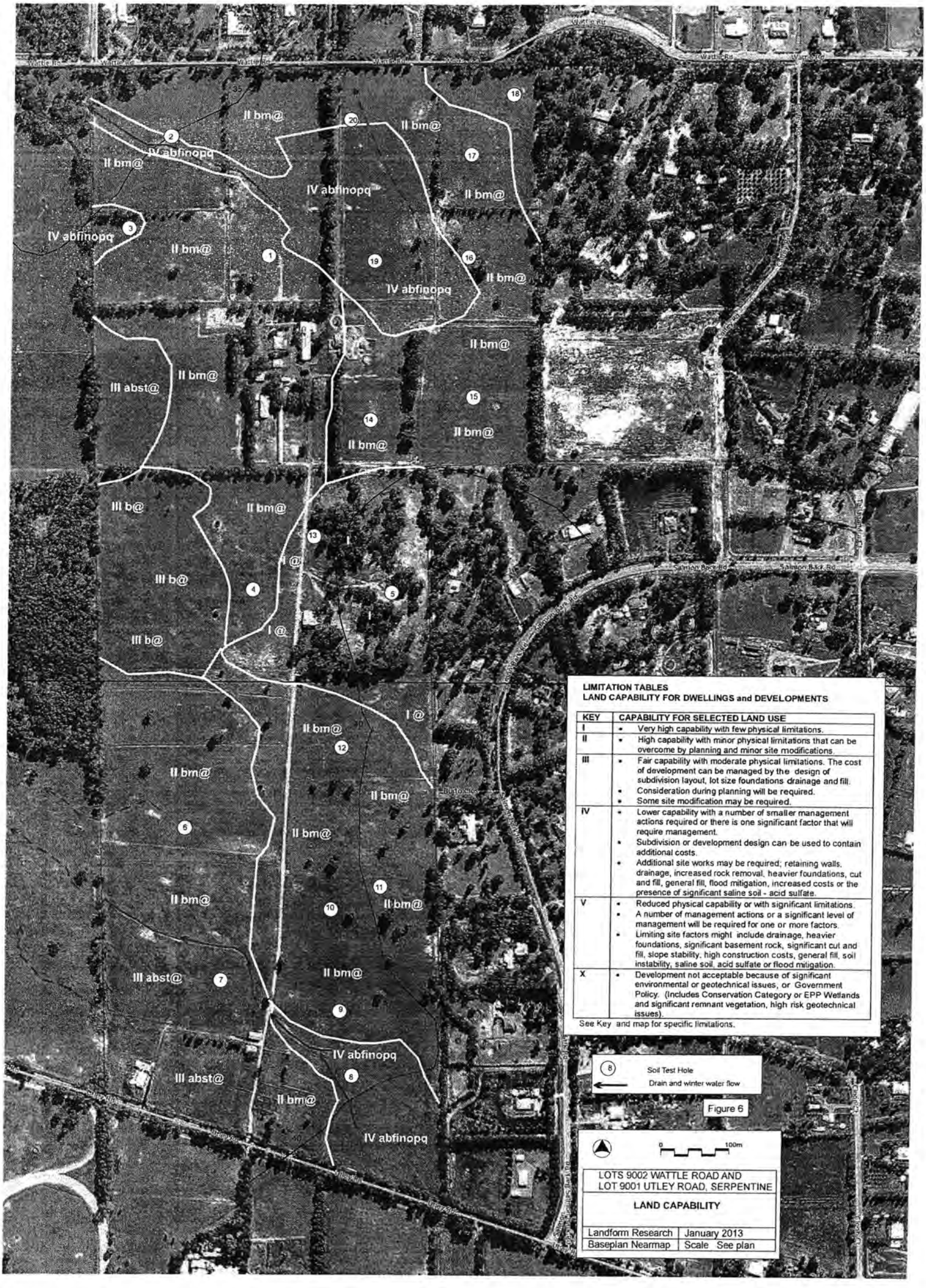






SKETCH SECTION LINES
PRE and POST DEVELOPMENT
LOT 9001 UTLEY ROAD and
LOT 9002 WATTLE ROAD

Figure 8



LIMITATION TABLES
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 planning and minor site modifications.
III	• Fair capability with moderate physical limitations. The cost of development can be managed by the design of subdivision layout, lot size foundations drainage and fill. • Consideration during planning will be required. • Some site modification may be required.
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.
V	• Reduced physical capability or with significant limitations. • A number of management actions or a significant level of management will be required for one or more factors. • Limiting site factors might include drainage, heavier foundations, significant basement rock, significant cut and fill, slope stability, high construction costs, general fill, soil instability, saline soil, acid sulfate or flood mitigation.
X	• Development not acceptable because of significant environmental or geotechnical issues, or Government Policy. (Includes Conservation Category or EPP Wetlands and significant remnant vegetation, high risk geotechnical issues).

See Key and map for specific limitations.

(8) Soil Test Hole

Drain and winter water flow

Figure 6

0 100m

LOTS 9002 WATTLE ROAD AND
LOT 9001 UTLEY ROAD, SERPENTINE

LAND CAPABILITY

Landform Research	January 2013
Baseplan Nearmap	Scale See plan

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.

Appendix C

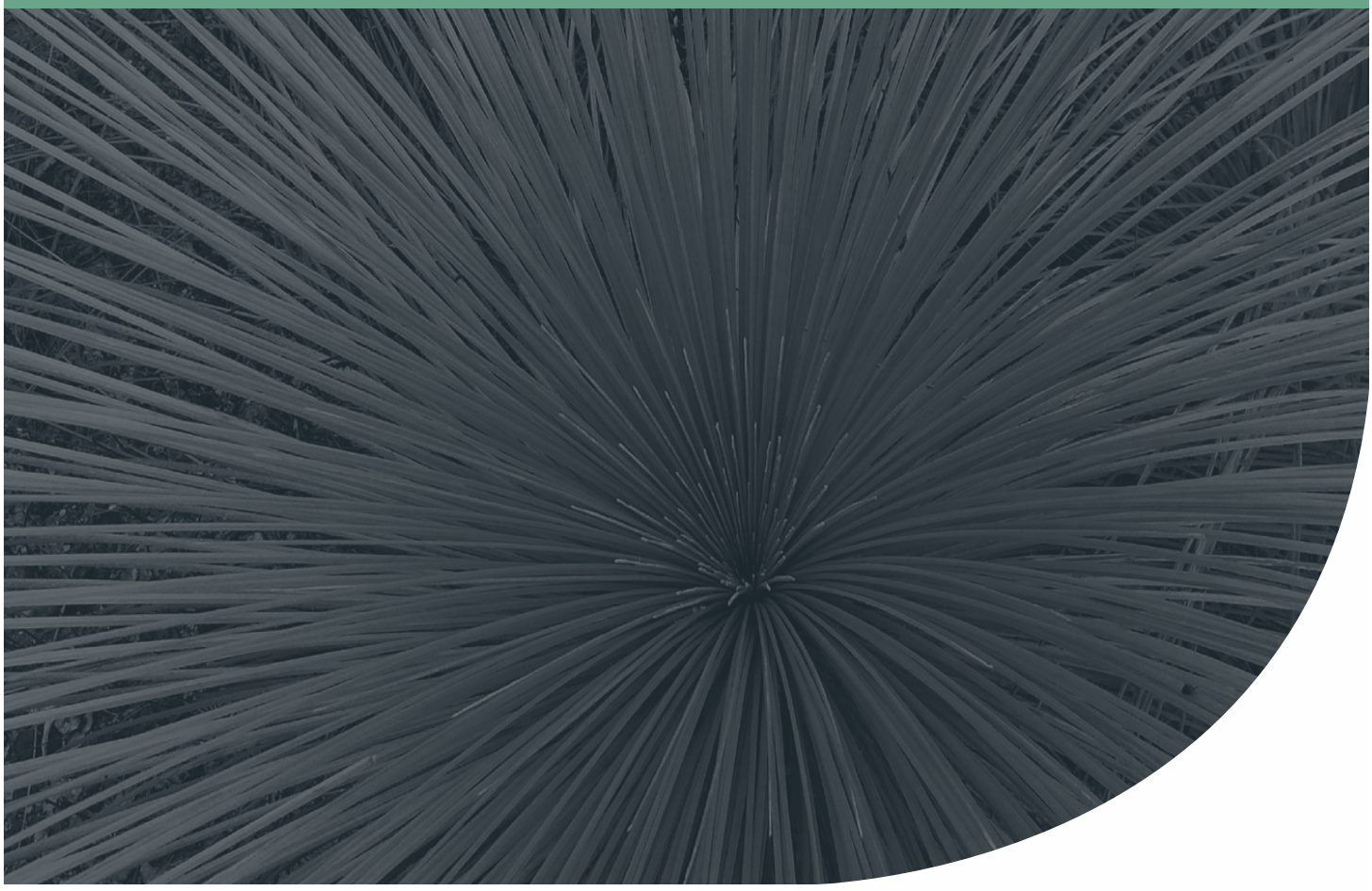
Modelling Assumptions Report

Surface Water Modelling Assumptions Report

Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine

Project No: EP20-064(01)

Prepared for Stron Pty Ltd
August 2020



Document Control

Doc name:	Surface Water Modelling Assumptions Report Lot 9001 Utley Road & Lot 9002 Wattle Road, Serpentine				
Doc no.:	**EP20-064(01)--008 JB**				
Version	**Date**	**Author**		**Reviewer**	
1	August 2020	Johanna Boonzaaier	JB	David Coremans	DPC
	For inclusion in the LWMS				

Table of Contents

List of Tables

Abbreviation Tables

Table A1: Abbreviations – general terms

General terms	
AEP	Annual exceedance probability
ARI	Average recurrence interval
AR&R	Australian Rainfall and Runoff
BoM	Bureau of Meteorology
CL	Continuing loss
IFD	Intensity, frequency and duration
IL	Initial loss

Table A2: Abbreviations – units of measurement

Units of measurement	
ha	Hectare
m/day	Metres per day
m^2	Square metre
m^3	Cubic metre
m^3/s	Cubic metre per second
mm	Millimetre
mm/hr	Millimetres per hour
%	Percentage

Table A4: Terminology – design rainfall

Equivalent average recurrence interval (ARI) terminology	Annual exceedance probability (AEP) terminology utilised
1 in 1 year ARI event	63.2% AEP event
1 in 1.5 year ARI event	50% AEP event
1 in 5 year ARI event	20% AEP event
1 in 10 year ARI event	10% AEP event
1 in 20 ARI event	5% AEP event
1 in 50 ARI event	2% AEP event
1 in 100 ARI event	1% AEP event
1 in 200 ARI event	1 in 200 AEP event
1 in 500 ARI event	1 in 500 AEP event

1 Background

Stron Pty Ltd (the proponent) propose to develop Lot 9001 Utley Road and Lot 9002 Wattle Road, in Serpentine ('the site') for rural residential purposes.

This report provides a summary of the assumptions made as part of the detailed surface water modelling that was undertaken to inform the Local Water Management Strategy.

The following tasks were undertaken:

- Pre-development modelling to establish the existing hydrological conditions.
- Post-development modelling to ensure that the post development hydrological conditions mimic the pre development hydrological conditions.

2 Modelling Methodology

2.1 Model set-up

A dynamic 1D model was set up and calibrated using XPSWMM hydrological and hydraulic modelling software.

The hydrological component of the software uses the Laurenson non-linear runoff-routing method to simulate runoff from design storm events. Key assumptions regarding the hydrological model include:

- Runoff is proportional to slope, area, infiltration and percentage imperviousness of a catchment.
- Sub-catchment areas and slopes are determined from surveyed topographical data and earthworks plans.
- Infiltration rates and percentage imperviousness have been selected based on experience with model preparation for similar soil conditions.

Runoff from each sub-catchment is routed through the catchment using the hydraulic component of XPSWMM. Generally, assumptions associated with the hydraulic component of the model include:

- Virtual links (i.e. purely for model construction, not equivalent to flow path onsite) between nodes within a sub-catchment are given the length of 10 m and slope of 0.05 to minimise the lag time of conveying the water from a sub-catchment node to a 'storage' node, a 'dummy intermediate' node or a conduit/link.
- Links between sub-catchment storages act as conveyance channels (e.g. sheet flow within roads in a 1% annual exceedance probability (AEP) event). These links are given lengths and slopes that are representative of the site conditions and actual pathway lengths between catchments.
- All channels are designed with a width of 5 m, roughness of 0.014 (Manning's n) and are trapezoidal in shape. This allows for easy conveyance and represents concrete pipes and road surfaces within the model.
- Where relevant, swales are modelled as nodal-reservoirs with infiltration depth-rating curves to account for differential infiltration rates with changing depth.

2.2 Rainfall

2.2.1 Critical duration analysis

The intensity of rainfall events were derived from the intensity, frequency and duration (IFD) charts produced by the Bureau of Meteorology (BOM) (2020). The ensemble temporal patterns obtained from the AR&R Data Hub (AR&R 2019) were used for the analysis.

Eleven durations ranging between 1 hour and 72 hours were tested, with the peak flood elevation being assessed as the determining result. Following the process suggested by AR&R (Ball J *et al.* 2019) the highest mean duration was selected as the critical duration for every catchment. AR&R also recommends that when it is not practical to run the entire ensemble array, the ensemble that produces the result closest to the mean (for the critical duration) should be adopted.

The 6 hour duration ensemble seven was selected as the design rainfall event for the 1% AEP and the 6 hour duration ensemble one was selected for the 20% AEP event for the pre-development model. For the post development model, the 6 hour duration ensemble nine was selected as the design rainfall event for the 1% AEP and the 6 hour duration ensemble one was selected for the 20% AEP event.

2.3 Pre-development model

An initial loss continuing loss model was adopted to account for catchment losses. The pre-development loss parameters used are given in **Table 1**.

Table 1: Pre-development loss parameters

Land type	Initial loss (mm)	Continual loss (mm)	Roughness	% impervious area
Existing rural residential	12	3.2	0.1	1.8
Existing pasture	10	3.2	0.1	0

Catchment analysis for pre-development scenario was based on topographic contour data, two site visits and aerial photography. Pre-development catchment areas for the various land uses are given in **Table 2**.

Table 2: Pre development land uses

Sub catchment	Area (ha)			
	Slope	Total area	Existing rural residential	Existing pasture
Ct 1	0.005	7.564	0	7.564
Ct 2	0.005	11.751	0	11.751
Ct 2 US	0.010	29.293	29.293	0
Ct 3	0.005	3.961	0	3.961
Ct 3 US	0.030	3.293	3.293	0
Ct 4	0.005	16.702	0	16.702
Ct 5 US	0.010	55.065	55.065	0
Ct 5a	0.005	2.006	0	2.006
Ct 5b	0.030	5.192	0	5.192
Ct 6	0.005	8.045	0	8.045
Ct 7 US	0.010	13.326	13.326	0

Table 2: Pre development land uses (continued)

Sub catchment	Area (ha)			
	Slope	Total area	Existing rural residential	Existing pasture
Ct 7a	0.005	1.663	0	1.663
Ct 7b	0.005	4.017	0	4.017
Ct 8	0.005	0.528	0	0.528
Ct 9 US	0.010	4.462	4.462	0
Ct 9a	0.005	1.643	0	1.643
Ct 9b	0.005	7.478	0	7.478
Ct 10	0.005	5.688	0	5.688
Ct 11 USa	0.010	2.355	2.355	0
Ct 11 USb	0.010	14.131	14.131	0
Ct 11a	0.005	2.258	0	2.258
Ct 11b	0.005	6.115	0	6.115
Ct 12	0.005	6.425	0	6.425
Total		212.959	121.924	91.036

Existing drains (see **Table 3**) were included in the pre-development model with configurations estimated from topographic contour data, two site visits and aerial photography.

Table 3: Existing drains

Channel	Length (m)	Depth (m)	Top width (m)	Bottom width (m)
Existing Drain 1 (Out 1)	361	0.5	3	1
Existing Drain 2 (Out 2)	300	0.6	4	1
Existing Drain 3 (Out 3)	290	0.5	3.5	0.5
Existing Drain 4 (Out 4)	282	0.5	3.5	0.5
Existing Drain 5 (Out 5)	670	0.3	2	0.5

2.4 Post-development model

An initial loss continuing loss model was also adopted for the post development model. **Table 4** lists the post-development loss parameters adopted.

Table 4: Post development loss parameters

Land type	Initial loss (mm)	Continual loss (mm)	Roughness	% impervious area
Road Surface	1	0.1	0.02	100
Road Verge	9	3.2	0.05	0
Existing rural residential	12	3.2	0.1	1.8
Proposed rural residential	10	3.2	0.1	0

Catchment areas (**Table 5**) for post-development land uses were informed by the structure plan.

Table 5: Post development land uses

Sub catchment	Area (ha)						
	Slope	Total area	Road reserve	Road pavement	Road verge	Existing rural residential	Proposed residential
Ct 1a	0.005	1.771	0	0	0	0	1.771
Ct 1b	0.005	3.399	0	0	0	0	3.399
Ct 2	0.005	10.268	0	0	0	0	10.268
Ct 3	0.005	6.240	0	0	0	0	6.24
Ct 3 US	0.030	4.929	0	0	0	4.929	0
Ct 4a	0.005	0.756	0	0	0	0	0.756
Ct 4b	0.005	11.233	0	0	0	0	11.233
Ct 4b US	0.010	28.852	0	0	0	28.852	0
Ct 5	0.005	3.349	0	0	0	0	3.349
Ct 6a	0.005	0.732	0	0	0	0	0.732
Ct 6b	0.005	14.989	0	0	0	0	14.989
Ct 6b US	0.01	56.664	0	0	0	56.664	0
Ct 7	0.005	7.968	0	0	0	0	7.968
Ct 8a	0.005	0.849	0	0	0	0	0.849
Ct 8b	0.005	16.91	0	0	0	0	16.91
Ct 8b US	0.01	31.444	0	0	0	31.444	0
Ct 9	0.005	6.863	0	0	0	0	6.863
Ct R1	0.005	0.729	0.729	0.292	0.438	0	0
Ct R2	0.005	0.68	0.68	0.272	0.408	0	0

Table 5: Post development land uses (continued)

Sub catchment	Area (ha)						
	Slope	Total area	Road reserve	Road pavement	Road verge	Existing rural residential	Proposed residential
Ct R3	0.005	1.021	1.021	0.408	0.613	0	0
Ct R4	0.005	0.482	0.482	0.193	0.289	0	0
Ct R5	0.005	1.023	1.023	0.409	0.614	0	0
Ct R6	0.005	0.627	0.627	0.251	0.376	0	0
Ct R7	0.005	1.178	1.178	0.471	0.707	0	0
Total		212.958	5.74	2.296	3.444	121.889	85.328

Specifications for the Proposed Drains and culverts are provided in **Table 6** and **Table 7**, respectively.

Table 6: Proposed Drain specifications

Channel	Length (m)	Depth (m)	Top width (m)	Bottom width (m)
Proposed Drain 1 (Out 1)	170	0.6	4	0
Proposed Drain 2 Upper	308.6	0.6	4.1	0.5
Proposed Drain 2 Lower (Out 2)	140	0.7	4.2	0
Proposed Drain 3 (Out 3)	176.1	0.5	3	0

Table 7: Proposed culverts

Culvert	Specifications
C1	2 x 450 mm X 1200 mm box culverts
C2	375mm pipe with an overflow
C3	1 x 600 mm X 1200mm box culvert
C4	2 x 450 mm x 900 mm box culverts

2.5 General assumptions

The following additional assumptions were incorporated into the model:

- Rural residential areas have a minor slope (i.e. will be flat) and pockets of storage are likely. This will effectively increase the initial loss (storage) and overall infiltration rate (continual loss).
- There is no infiltration on roads and paved areas. There will however be some minor absorption storage loss, which is accounted for in the initial and continuing loss values.
- A hydraulic conductivity of 2m/day is assumed for the roadside swale infiltration. Infiltration through side slopes is considered in the overall infiltration rating curve for these areas.

- Volumes leaving the system through evapotranspiration were assumed to be negligible when compared to the total runoff volume and since the duration of the model run was comparatively short. XPSWMM default evapotranspiration assumptions are therefore used.

3 References

3.1 General references

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M and Testoni I (Editors) 2019, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia (Geoscience Australia).

3.2 Online references

Australian Rainfall and Runoff (AR&R) 2019, *ARR Data Hub*, viewed 5 August 2020, Available from: <https://data.arr-software.org/>.

Bureau of Meteorology (BoM) 2019b, *Design Rainfall Data System (2016),* viewed 5 August 2020, Available from, <http://www.bom.gov.au/water/designRainfalls/revised-ifd/>.

Appendix 5

Lot Layout and Yield Plan

WATTLE ROAD

WALKER RD

DMILL AVE

20m Road Reserve

UTLEY ROAD

1 2.05 ha
2 2.05 ha
3 2.07 ha
4 2.04 ha
5 2.04 ha
6 2.04 ha
7 2.04 ha
8 2.04 ha
9 2.04 ha
10 2.04 ha
11 2.04 ha
12 3.16 ha
13 2.06 ha
14 2.06 ha
15 2.23 ha
16 2.31 ha
17 2.00 ha
18 2.08 ha
19 2.07 ha
20 2.07 ha
21 2.23 ha
22 2.23 ha
23 2.24 ha
24 2.01 ha
25 2.17
26 2.13
27 2.01 ha
28 3.53 ha
29 2.66 ha
30 2.00 ha
31 2.00 ha
32 2.00 ha
33 2.11 ha
34 2.14 ha
35 2.03 ha
36 2.03 ha
37 2.16 ha
38 2.62 ha
39 2.36 ha

6m Emergency Access Way / Fire Service Access Route (EAW/FSAW)

LEGEND

- Subject Site
- Cadastre
- Minor Water Course
- Drain
- 1m Contour Interval (mAHD)
- Retained Buildings
- Proposed Lot Boundary
- Special Rural (RR1 - Min. 2 ha)
- 2000m² Building Envelope
- Proposed Road Reserve
- Road Center Line
- 4m Gates

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 is 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 9001 Utley Road & Lot 9002 Wattle Road - Serpentine

50 0 50 100 250 500

Project RAYSJLSP I Scale 1:5000@A3 I Date August 2020

HEX DESIGN PLANNING

Source of Information

Site boundaries: Landgate
Projection: GDA94 MGA Zone 50 South

NOTE
All areas and dimensions are subject to survey, engineering and detailed design and may change without notice.

A3PL_20200827_RAYSJLSP_Structure Plan Lot 9001 Utley Road & Lot 9002 Wattle Road AERIAL.dwg

Appendix 6

Transport Assessment

Porter
Consulting Engineers

Lot 9001 Utley Road and Lot 9002 Wattle Road, Serpentine

TRANSPORT IMPACT ASSESSMENT

Porter

REPORT PREPARED FOR

Hex Design and Planning

Prepared by	**Porter Consulting Engineers**
Postal address	PO Box 1036 Canning Bridge WA 6153
Phone	(08) 9315 9955
Email	office@portereng.com.au

Job number	20-06-078
Date	18 November 2020
Our reference	R51.20B
Checked	BH

HISTORY AND STATUS OF THE DOCUMENT

Revision	Date issued	Author	Issued to	Revision type
Rev A	22/07/2020	J Hopfmueller	Hex Design and Planning	First Issue
Rev B	18/11/2020	J Hopfmueller	Hex Design and Planning	Updated from Shire comments
Rev C	12/10/2021	J Hopfmueller	Hex Design and Planning	Updated from Shire comments

CONTENTS

1.0 INTRODUCTION

1.1 Background

Porter Consulting Engineers has been engaged to prepare a Transport Impact Assessment (TIA) for a proposed subdivision Lot 9001 Utley Road and Lot 9002 Wattle Road in Serpentine in the Shire of Serpentine –Jarrahdale. The subdivision comprises of 39 special rural residential lots with a minimum lot size of 2 hectares.

The Subdivision Site is presently zoned rural residential. The area is bounded to the north by Wattle Road and to the south by Utley Road. **Figure 1** shows the Lots with respect to the surrounding rural residential lots (north and east) and general rural lots (west and south).

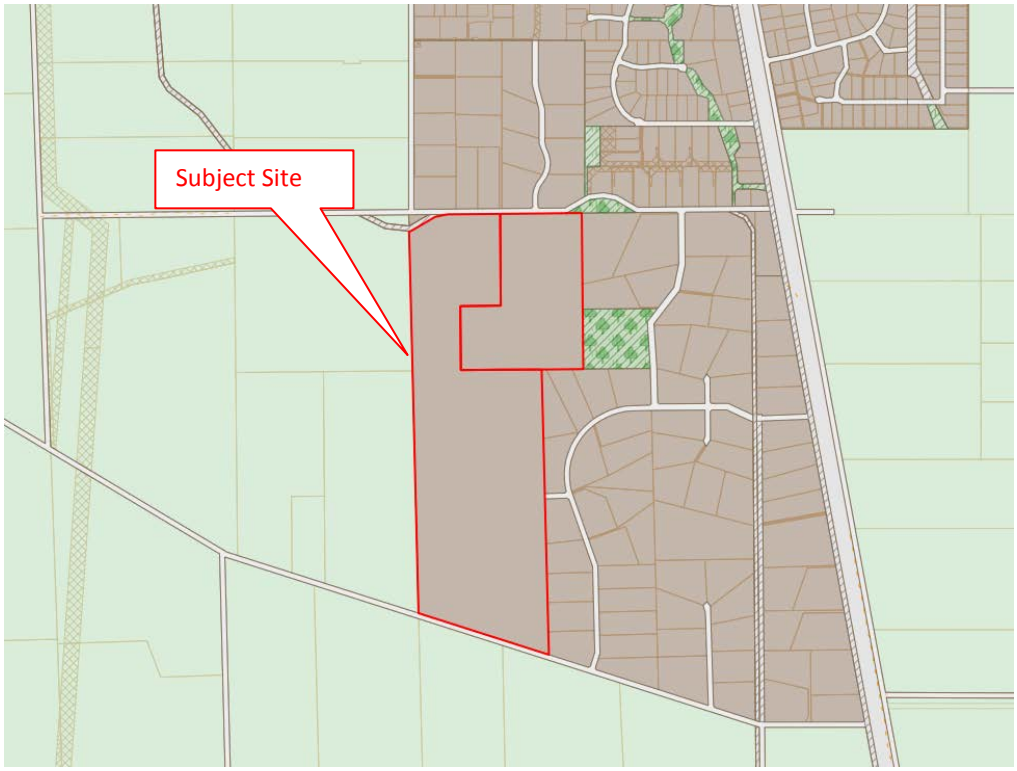


Figure 1. Lot 9001 Utle Road and Lot 9002 Wattle Road
(Shire of Serpentine – Jarrahdale Intramaps)

1.2 Scope of Assessment

This Transport Assessment has been prepared in accordance with the Western Australian Planning Commission's (WAPC) *Transport Assessment Guidelines for Developments Volume 3 Subdivisions* (2016).

The intent of this assessment is to provide the approving authority with sufficient traffic information to confirm that the proponent has adequately considered the traffic aspects of the development and that it should not have an adverse traffic impact on the surrounding area.

2.0 SUBDIVISION PROPOSAL

2.1 Subdivision Context

The Site is currently rural with some dwellings surrounded by higher density rural residential dwellings. **Figure 2** shows an aerial view of the subject Site and its immediate surrounds and its location in a local context. The proposed rural residential development will integrate with the adjacent rural residential lots to the north and east.

Figure 2. Location in a Local Context

The Site is situated approximately 30 kilometres south of Armadale and 30 kilometres east of Rockingham. Major arterial roads within close proximity include Karnup Road to the north, South Western Highway to the east and Kwinana Freeway to the west. **Figure 3** shows the Site in a broader context.

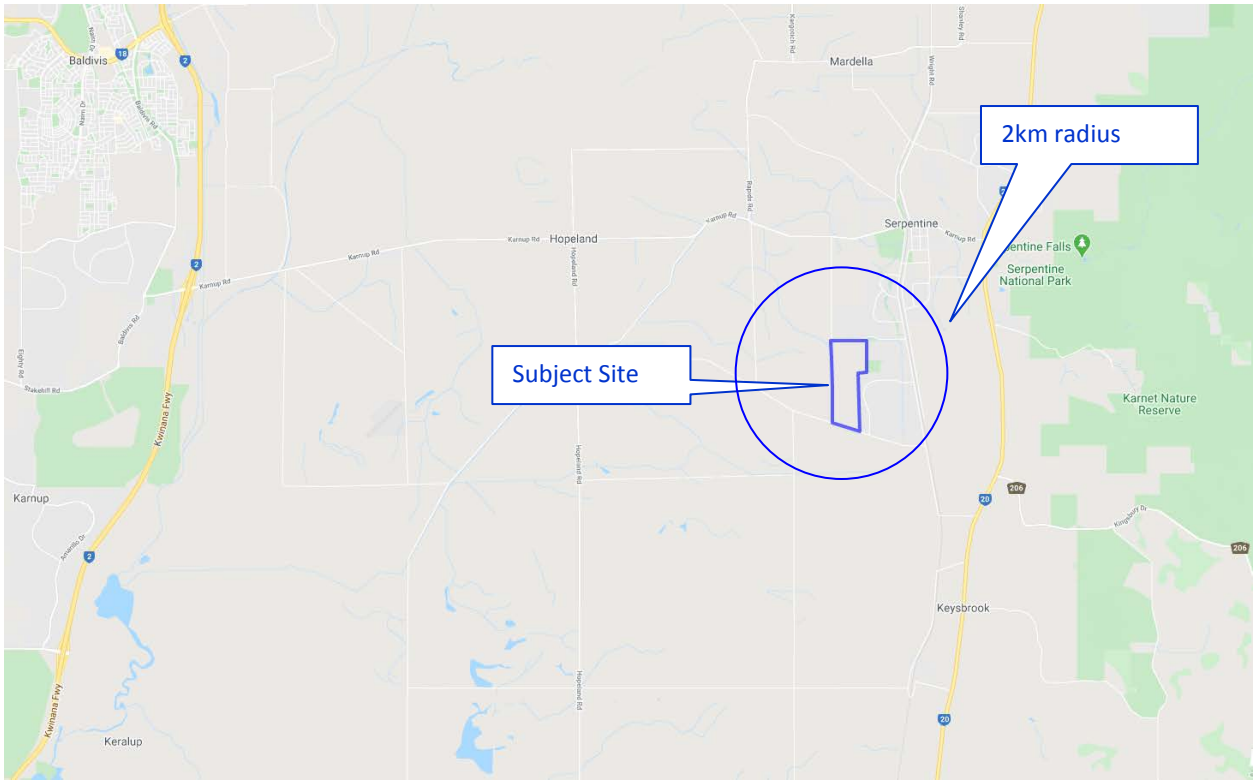


Figure 3. Location in a Regional Context

2.2 Proposed Land Uses

The Subdivision proposes rural residential zoning with a minimum lot size of 2 hectares. Based on the subdivisional lot layout it is estimated the total number of lots created will be 39.

Appendix A contains a copy of the proposed Subdivision.

2.3 Major Attractors and Generators of Traffic

Within the proposed subdivision, the rural residential lots are the major traffic generating land use. Surrounding attractors external to the Site include:

- Armadale – major retail and commercial areas (to the north)
- Rockingham – major retail and commercial areas (to the west)
- Serpentine Primary School and Byford Secondary College (to the north)

3.0 ROAD NETWORK SITUATION

3.1 Existing Road Network

Appendix A contains the proposed subdivision that illustrates the road network servicing the Subdivision. The Subdivision is bordered by two existing roads, being Utley Road (southern boundary) and Wattle Road (northern boundary). The internal road network is proposed to connect to both Utley Road and Wattle Road creating 2 new T-junctions and one four way intersection. A fourth connection is provided via a direct connection to an unconstructed road link that connects to Salmon Bark Road.

3.2 Road Infrastructure and Road Hierarchy Classification

The road hierarchy classification of the surrounding road network as defined by Main Roads WA functional road hierarchy is shown in **Figure 4**.

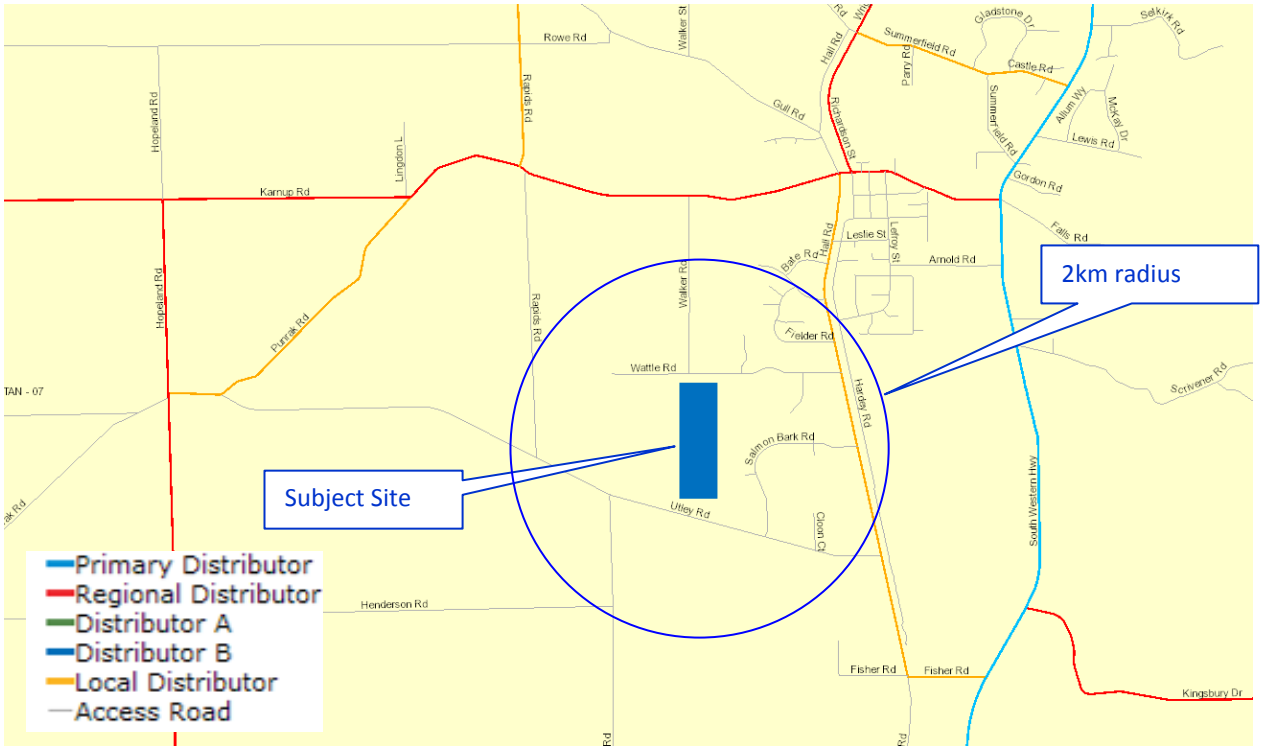


Figure 4. Functional Road Hierarchy (MRWA)

Wattle Road and Utley Road

Wattle Road and Utley Road are both local access roads whose function is defined as being "*to provide access to abutting properties with amenity, safety and aesthetic aspects having priority over the vehicle movement function.*" This road is managed by the Shire of Serpentine – Jarrahdale.

Both roads are constructed to a two lane undivided road standard. The existing pavement widths vary are in the order of 5-6m seal width plus unsealed shoulders within a 20m road

reserve. Local intersections are typically kerbed such as Wattle Road/ Windmill Avenue, Wattle Road/Walker Road and Utley Road / Salmon Bark Road. Refer **Figures 5 to 7.**

Figure 5. Utley Road, looking east adjacent to Lot 9001 Utley Road

Figure 6. Wattle Road, looking east away from its intersection with Walker Road

Figure 7. Wattle Road, looking east towards its intersection with Windmill Avenue

3.3 Existing Traffic Volumes

There is limited available traffic data on the surrounding road network within the 2km radius surrounding the site. Available traffic volumes were sourced from Main Roads WA traffic map website and the Shire of Serpentine Jarrahdale. These available counts are summarised in **Table 1** and **Figure 8.**

Utley Road, east of Punrak Road had a recorded traffic volume of 150 vehicles per day in 2017. This is some 4.5km to the west of the proposed Site. It is expected that traffic volumes on Utley Road, near Hall Road would be higher due to the higher density rural residential dwellings immediately to the north of Utley Road at this location. No existing traffic volumes are available on Wattle Road. Similarly, it is expected that traffic volumes on Wattle Road, near Hall Road are likely to be greater than 150 vehicles per day due to the surrounding rural residential dwellings.

Table 1 – Existing Traffic Volumes on the Surrounding Road Network

Location	Date	AWT	85% Speed km/h	% HV	AM Peak Volume	PM Peak Volume
Karnup Road, west of Walker Rd	2019/20 MRWA	1,966	84			
Utley Road, East of Punrak Road	Mar 2017 Shire	150	95	15%	18 (7.00am)	14 (3.00pm)
Rapids Road, South of Karnup Road	Mar 2017 Shire	135	90	19%	11 (7.00am)	10 (4.00pm)
Punrak Road, south of Karnup Road	Mar 2017 Shire	105	76	22%	10 (6.00am)	10 (3.00pm)
Hopelands Road, South of Karnup Road	Feb 2019 Shire	1,263	102	29%	105 (7.00am)	102 (4.00pm)
Yangedi Road, South of Karnup Road	Sept 2020 Shire	283	91	46%	28 (9.00am)	28 (12.00pm)
River Road, south of Karnup Road	Mar 2017 Shire	267	89	9%	25 (8.00am)	27 (3.00pm)
Wright Road, South of Watkins Road	Feb 2019 Shire	1,903	69	11%	154 (8.00am)	183 (3.00pm)
Lowlands Road, West of Wright Road	Mar 2017 Shire	333	75	14%	29 (8.00am)	21(4.00pm)
Hall Road, North of Karnup Road	2010 Shire	230	-	-	20 (8.00am)	24 (3.00pm)

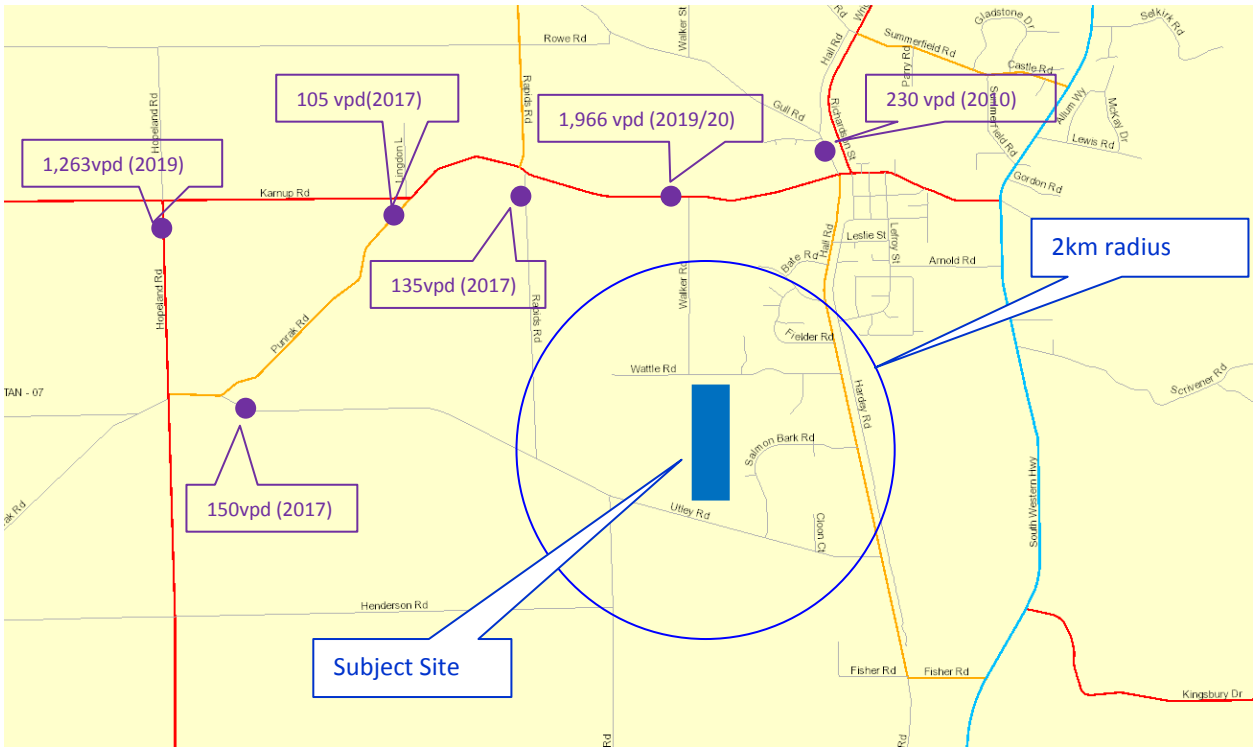


Figure 8 – Existing Traffic Volumes on the Surrounding Road Network

3.4 Crash History

A study of the recent crash history for the surrounding road network including the full lengths of Wattle Road and Utley Road has been conducted for the five year period to the end of December 2019 from the Main Roads Western Australia Integrated Road Information System (IRIS) crash database. There was only one recorded midblock crash that occurred on Utley Road (SLK 5.58) between Rapids Road and Punrak Road. The crash involved a vehicle running off a straight section of carriageway resulting in major property damage.

4.0 VEHICLE ACCESS

4.1 Internal Road Network

The proposed internal road network layout is shown in **Appendix A**. The road reserve widths for the new internal road network are proposed to be 20m.

The IPEWA *"Local Government Guidelines for Subdivisional Development", November 2017,* recommend a minimum pavement width of 6.0m with 1.2m wide shoulders for local roads which provide lot frontage and property access as the internal roads within the proposed subdivision. The road formation shall also provide a berm with a minimum width of 600mm between the shoulder edge and start of the table drain. This road cross section in shown in **Figure 9.**

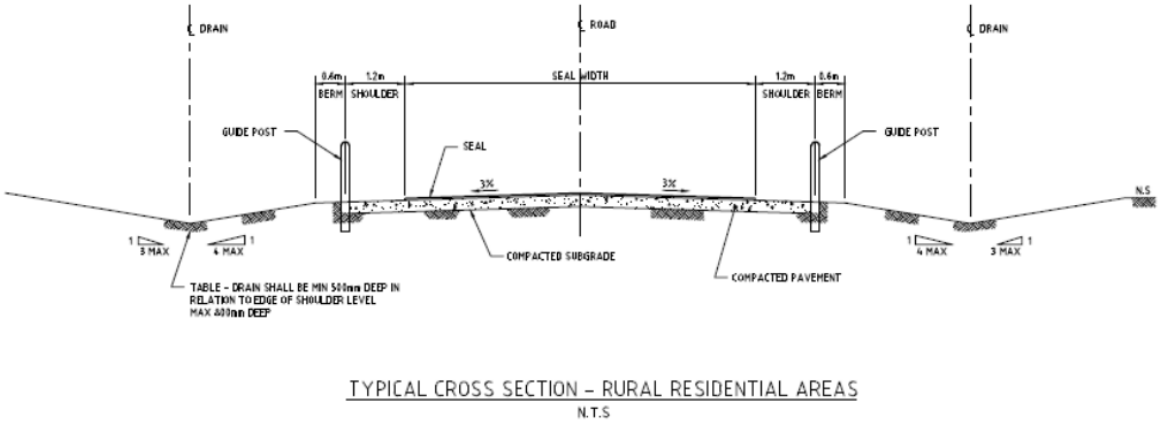


Figure 9. Indicative Road Cross Section for Internal Road Network (*IPEWA*)

The subdivision layout includes one right angle bend. Drivers may "cut the corner" on such bends increasing the crash risk. Based on the low volume of traffic on the internal road network and the subsequent design speed, the bend is likely to be considered "low risk". Good practice would be to include road widening to separate vehicular movements on the bend (or median island on higher volume roads). Truncations on the corner lots should be checked to ensure that appropriate sight lines around the bend are available for the design speed of the bend. Similarly, appropriate sight distances to/from driveways located in close proximity to the bend should be provided with property driveways typically located away from the bend.

In preparing designs for the internal road network and future intersections consideration should be given to the provision of local traffic management devices, particularly on the approach to the intersection of Wattle Road and Windmill Road. It is possible that this may become a condition of subdivision approval of particular lots.

4.2 External Road Network

The proposed road network will result in the creation of three new intersections; two on Wattle Road and the other on Utley Road. A fourth connection via a direct connection to the unconstructed road link to Salmon Bark Road. Refer **Figure 9.** Confirmation is required of the future status of this unconstructed road link.

Utley Road and Wattle Road are classified as access roads in accordance with Main Roads WA and as defined by *Liveable Neighbourhoods*. Intersection spacing along access roads are recommended to be not less than a minimum of 20m centreline to centreline of the road reserve.

The Wattle Road western connection is located approximately 120m to the east of Walker Road. The Wattle Road eastern connection is proposed to connect at Windmill Avenue to create a new 4-way intersection. The proposed 4-way intersection is considered acceptable due to the low volumes of traffic anticipated to use the intersection and the very low demand for cross movements at this location. By creating a 4-way intersection instead of installing a new t-junction, there is still only the one potential point of conflict compared to two should a separate intersection be constructed.

Figure 10. Proposed Connection to Unconstructed Road Link to Salmon Bark Road

4.3 Sight Distance

Austroads *"Guide to Road Design Part 4A:Unsignalised and Signalised Intersections"* makes recommendation on the sightlines. No existing traffic data was available from the Shire of Serpentine- Jarrahdale to confirm the operating speed on these roads hence a design speed of 60km/h was adopting being 10km/h above the 50km/h speed limit. Based on a design speed of 60km/h, the safe intersection sight distance is 123m using a reaction time of 2 seconds (minimum). Main Roads prefer to use a reaction time of 2.5 seconds (desirable) which increases the safe intersection sight distance to 131m.

Google Streetview suggests that adequate sight lines will be available along Wattle Road and Utley Road in both directions at the proposed new intersections provided vegetation within the verge area is adequately cleared as shown in **Figures 11 to 13**.

Sight distance to the east along Wattle Road is limited at the new proposed four way connection with Windmill Avenue however safe intersection sight distance of 131m is provided from the new road connection. It is apparent that the existing sight distance from Windmill Avenue is restricted below the desirable 131m (based on 2.5 seconds) due to the horizontal road alignment on Wattle Road and the existing heavy verge vegetation. It is recommended that the Shire of Serpentine Jarrahdale trim vegetation and install advanced warning signage of the approaching intersection to alert westbound drivers on Wattle Road to the presence of the intersection and potential conflict.

Figure 11. Safe Intersection Sight Lines (131m) from indicative Wattle Road western Connection

Figure 11a. Wattle Rd, looking west from indicative Wattle Rd western connection

Figure 11b. Wattle Rd, looking east from indicative Wattle Rd western connection

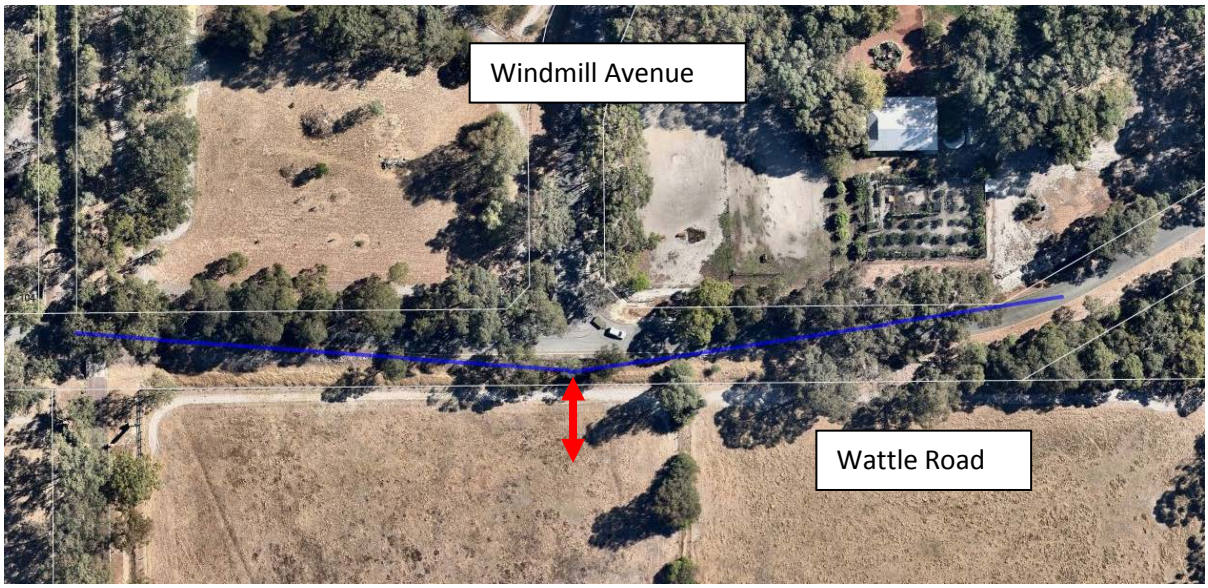


Figure 12. Safe Intersection Sight Lines (131m) from Indicative Wattle Road eastern Connection with Windmill Avenue

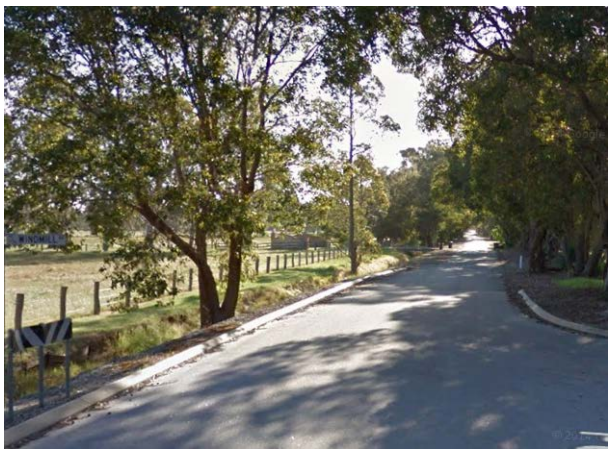


Figure 12a. Wattle Rd, looking west from Windmill Avenue

Figure 12b. Wattle Rd, looking east from Windmill Avenue

Figure 13. Safe Intersection Sight Lines (131m) from Indicative Utley Road connection

Figure 13a. Utley Rd, looking west from indicative Utley Rd connection

Figure 13b. Utley Rd, looking east from indicative Utley Rd connection

4.4 Service Deliveries

Waste from the Subdivision will be required to be collected via a kerbside collection. The proposed cul-de sac, no-Through road will need to be designed to accommodate the Shire's waste trucks. The unconstructed road link to Salmon Bark Road will need to be constructed to allow the Shire's waste vehicle to continue on its route. If this road link is not constructed a cul-de-sac end will be required to facilitate the turn-around of waste vehicles.

5.0 TRAFFIC ASSESSMENT

In order to assess the potential traffic impacts associated with the proposed development, a traffic generation exercise was undertaken. This establishes the levels of traffic that could potentially be generated from the proposed development and enables the assessment of anticipated effects that the additional traffic could have on the adjacent road network.

5.1 Traffic Generation

The traffic generated by the proposed Subdivision is forecast using rates suggested in the Technical Direction Update August 2013 for the *Guide to Traffic Generating Developments, Roads and Traffic Authority, NSW, 2002*. These rates are based on surveys undertaken in the NSW regional area (compared to urban region) and may be considered to be reflective of those likely to occur in a rural residential area. These are:

- 0.71 vehicle trips per dwelling for the am peak hour
- 0.78 vehicle trips per dwelling for the pm peak hour
- 7.4 vehicle trips per dwelling daily

There are a total of 39 single residential lots and dwellings. The additional trips are estimated to be approximately 289 daily trips corresponding to 28 am peak hour trips and 30 pm peak hour trips. The typical threshold for detailed analysis is in the order of 100 vehicles per hour. The anticipated peak hour trips are significantly below this threshold and therefore a detailed analysis is not required.

Due to the Subdivision layout only minimal non-subdivisional generated traffic is anticipated to travel through the Site's roads. This may be some residents on Salmon Bark Road (say 22 residents) should their origin or destination be to the northwest of the site.

5.2 Traffic Distribution

Of the generated daily traffic, 144 vehicle movements are assumed to be inbound and 145 vehicle movements are assumed to be outbound.

The resulting trip assignment at the external connections to the existing road network is shown in **Figure 14.** Based on the connectivity of the surrounding road network, various trip purposes, surrounding land uses and the internal road layout, it is expected that the distribution of traffic onto the external road network will be as follows:

45% new western t-junction on Wattle Road
15% new 4 way connection on Wattle Road
40% new connection of Utley Road

It is expected that minimal development traffic would use Salmon Bark Road to access the local road network as more direct, straight links are provided by Wattle Road and Utley Road. For the purpose of the traffic distribution no traffic has been shown using Salmon Bark due to it current unconstructed status.

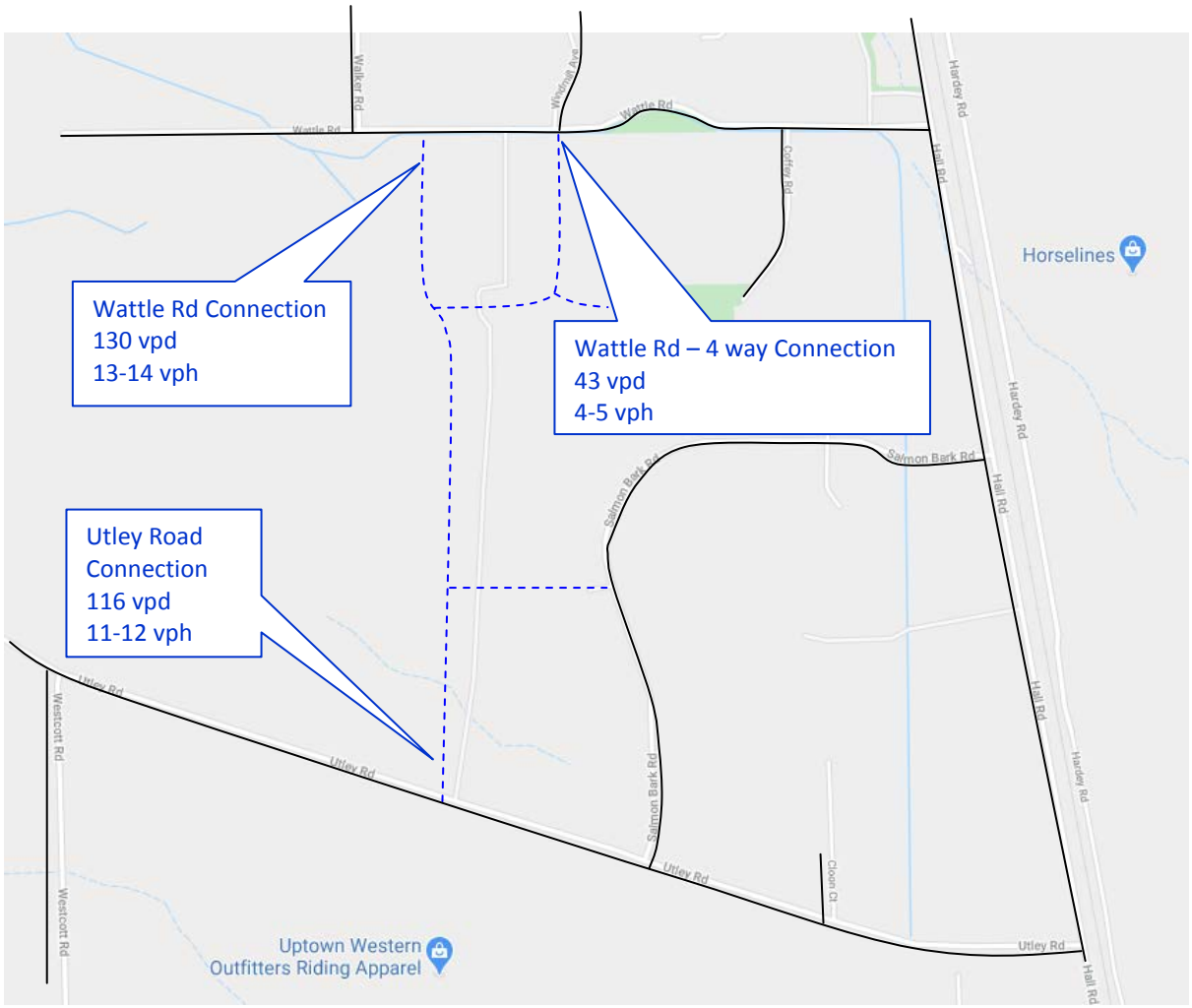


Figure 14. Development Traffic Distribution onto Existing Road Network

5.3 Impact on the Local Road Network

The Subdivision is expected to generate an approximate average of 289 vehicle trips per day. The indicative maximum volume of traffic suitable for a local access road is up to 1,000 vehicles per day. (*Liveable Neighbourhoods, WAPC 2009 and 2015*). On this basis the internal roads will carry significantly less than the indicative maximum based on function and amenity.

The surrounding road network is typically constructed to a two lane undivided carriageway standard with a 5-6m sealed width plus unsealed shoulders. This additional volume of traffic can be catered for on the existing road network in line with its capacity and road functional hierarchy.

There are no existing traffic volumes at the eastern ends of Utley Road and Wattle Road. Utley Road, east of Punrak Road had a recorded traffic volume of 150 vehicles per day in 2017. This is some 4.5km to the west of the proposed Site. Therefore it is estimated that the existing traffic volumes of Utley Road and Wattleup Road, adjacent to the Site and approaching Hall Road are likely to be in excess of 150 vehicles per day due to the

surrounding rural residential dwellings adjacent to Hall Road between Utley Road and Wattleup Road.

Austroads, Guide to Road Design Part 3:Geometric Design outline for rural roads carrying between 150 and 500 vehicles per day a traffic lane width of 6.2m (i.e. 2 x 3.1m lanes) with a minimum 1.5m shoulder including 0.5m sealed shoulder. On this basis the existing carriageway standard is likely to require upgrading to meet appropriate standards based on current traffic volumes at some stage by the Shire. Whilst the additional traffic from the proposed structure plan will add additional traffic to the road network the threshold for upgrades is likely to have already been met based on the estimated existing traffic volumes.

It is recommended that Wattle Road and Utley Road be upgraded to a local rural road standard in accordance with the Western Australian Planning Commision (WAPC) and Institute of Public Works Engineering (IPWEA) Local Government Guidelines for Subdivisional Development with consideration of native vegetation retention.

It is possible that a contribution towards road upgrade may be required as a condition of subdivision approval.

6.0 OTHER ISSUES

6.1 Public Transport

The Site has poor access to public transport with no services within the immediate surrounds. The closest service is Route 253 on Jacaranda Avenue in Jarrahdale some 10 kilometres away. There are 3 other services being Route 251,252 and 254 that operate between Armadale Station and suburbs to the south being Mundijong or Byford. Armadale Station is approximately 20 kilometres to the north.

Figure 15 outlines the available bus routes that operates to the south of Armadale Station.

The accessibility to public transport for the proposed Structure Plan is the same as that provided within the adjacent rural residential dwelling to the north and west of the Site. The addition of an additional 39 rural residential dwellings proposed is unlikely to prove the provision of public transport to the area feasible.

6.2 Pedestrian and Cyclist Facilities

There are no existing path facilities for walking and cycling within the surrounding road network catchment. There are no major trip attractors within the or nearby the Structure to create pedestrian desire lines and as such walking trips are unlikely.

The 20m road reserve with the proposed road cross section would be adequate to accommodate future path linkages if required. This is similar to the existing 20m road reserves in the adjacent rural residential development.

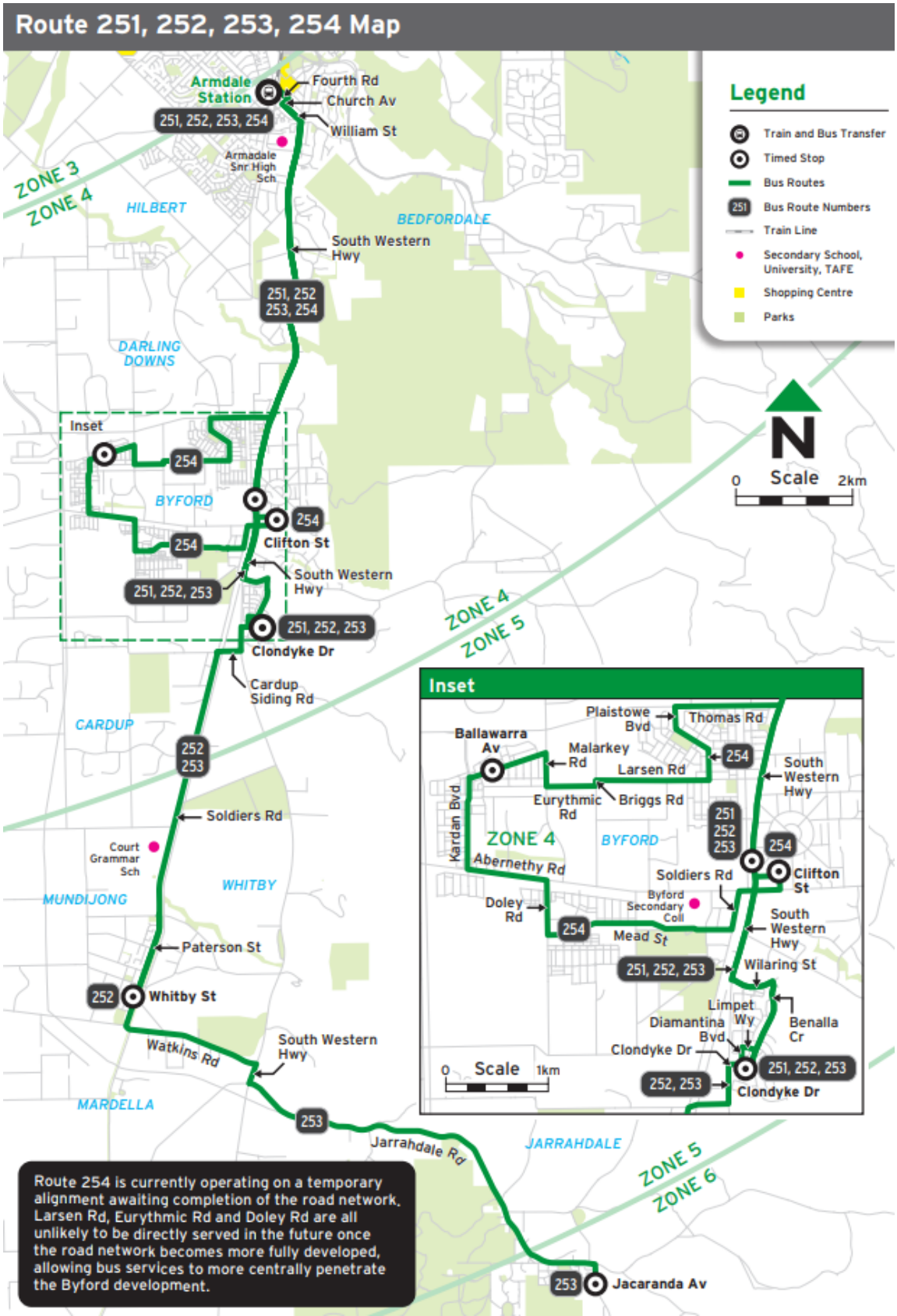


Figure 15. Existing Public Transport Routes Surrounding the Site (*Routes 251,252,253,254)*

7.0 SUMMARY AND CONCLUSION

The proposed subdivision of Lot 9001 Utley Road and Lot 9002 Wattle Road in Serpentine in the Shire of Serpentine – Jarrahdale proposes the creation of 39 special rural residential lots with a minimum lot size of 2 hectares.

The proposed road network will result in the creation of three new intersections. Two of the new intersections are t junctions, one on Wattle Road and one on Utley Road, whilst the third intersection is the creation of a 4-way intersection at the existing t-junction of Wattle Road and Windmill Avenue. A fourth connection is proposed via a direct connection to an unconstructed road link that connects to Salmon Bark Road, part of the adjoining rural residential development. Confirmation is required of the future status of this unconstructed road link.

The proposed new intersections on both Wattle Road and Utley Road are appropriately spaced and meet the requirements for safe intersection sight distance (SISD). It is noted however that whilst the appropriate SISD can be provided on the new fourth leg at the existing intersection of Wattle Road and Windmill Avenue, SISD is not currently provided along Wattle Road from the existing Windmill Avenue approach. The Wattle Road horizontal alignment and dense verge vegetation limit the available sight distance to the east. It is recommended that the Shire of Serpentine Jarrahdale trim vegetation and install advanced warning signage of the approaching intersection (Windmill Avenue) to alert westbound drivers on Wattle Road to the presence of the intersection and potential conflict.

The proposed 4-way intersection is considered acceptable due to the low volumes of traffic anticipated to use the intersection and the very low demand for cross movements at this location. By creating a 4-way intersection at the existing t-junction means that the one potential point of conflict is maintained compared to creating a separate t-junction on Wattle Road thereby introducing a second conflict point.

The subdivision layout includes one right angle bend which may assist in reducing traffic speed however it can increase the risk of side swipe crashes as vehicles “cut the corner”. Based on the low volume of traffic on the internal road network and the subsequent design speed, the bend is likely to be considered “low risk”. During detailed design, the following items will need to be addressed.

- truncations on corner lots to ensure that appropriate sight lines around the bends are available for the design speed of the bend;
- consideration of road widening to separate vehicular movement on bends;
- appropriate sight distances to/from driveways located in close proximity to the bend along the road alignment;
- the width of carriageway and radius of curves at 90-degree bends to be checked for the adequacy of waste collection vehicle swept paths; and
- local traffic management devices, particularly on the approach to the intersection of Wattle Road and Windmill Road.

The volume of traffic expected to be generated by this Subdivision is 289 vehicles per day with 28-30 peak hour trips. The additional development traffic volumes are within the spare capacity of the adjacent road network (i.e. Wattle Road and Utley Road) and the increased traffic volumes are in line with the respective road functions. The forecast traffic movements at the intersections are below those that require capacity analysis to occur.

It is estimated that the existing traffic volumes of Utley Road and Wattleup Road, adjacent to the Site and approaching Hall Road are likely to be in excess of 150 vehicles per day due to the surrounding rural residential dwellings adjacent to Hall Road between Utley Road and Wattleup Road. On this basis the existing carriageway standard is likely to require upgrading to meet appropriate standards at some stage by the Shire. Whilst the additional traffic from the proposed structure plan will add additional traffic to the road network the threshold for upgrades is likely to have already been met based on estimated existing traffic volumes. It is possible that a contribution towards road upgrade may be required as a condition of subdivision approval.

Access to public transport is poor with the nearest services some 10km away in Jarrahdale or 30km away in Armadale. There is no existing path network on the surrounding road network including the adjoining rural residential development to the north and east. The proposed 20m road reserve will however accommodate future paths if required by the Shire.

APPENDIX A

Development Site Plan

DRAFT

WALKER RD

WATTLE ROAD

DMILL AVE

1,733 m²
(68.227 ha)

20m Road Reserve

1	2.05 ha	
2	2.05 ha	
3	2.07 ha	
4	2.04 ha	
5	2.04 ha	
6	2.04 ha	
7	2.04 ha	
8	2.04 ha	
9	2.04 ha	
10	2.04 ha	
11	2.04 ha	
12	3.16 ha	
13	2.06 ha	
14	2.06 ha	
15	2.23 ha	
16	2.31 ha	
17	2.00 ha	
18	2.08 ha	
19	2.07 ha	
20	2.07 ha	
21	2.23 ha	
22	2.23 ha	
23	2.24 ha	
24	2.01 ha	
25	2.17	
26	2.13	
27	2.01 ha	
28	2.55 ha	
29	3.64 ha	
30	2.00 ha	
31	2.00 ha	
32	2.00 ha	
33	2.11 ha	
34	2.14 ha	
35	2.03 ha	
36	2.03 ha	
37	2.16 ha	
38	2.62 ha	
39	2.36 ha	

9002
23.075 ha

9001
68.054 ha
(68.227 ha)

UTLEY ROAD

SALMON BARK ROAD

SUMMARY	
Subject Site	**91.30 ha**
Lot 9001	68.23 ha
Lot 9002	23.08 ha
Zone	
Special Rural - 39 Lots (RR1 - Min 2 ha)	85.19 ha
Road Reserves	5.94 ha
Balance lot	0.17 ha

LEGEND

- Subject Site
- Cadastre
- Minor Water Course
- Drain
- Retained Buildings
- Proposed Lot Boundary
- Special Rural (RR1 - Min. 2 ha)
- Proposed Road Reserve
- Road Center Line

STRUCTURE PLAN

Lot 9001 Utley Road & Lot 9002 Wattle Road - Serpentine

50 0 50 100 250 500

Project RAYSJLSP I Scale 1:5000@A3 I Date May 2020

HEX DESIGN PLANNING

Source of Information

Site boundaries: Landgate
Projection: GDA94 MGA Zone 50 South

NOTE
All areas and dimensions are subject to survey, engineering and detailed design and may change without notice.

A3PL_20200506_RAYSJLSP_Structure Plan Lot 9001 Utley Road & Lot 9002 Wattle Road - Serpentine MGA50.dwg

APPENDIX B

WAPC Checklist

Transport Impact Assessment (Structure Plan) Checklist

ITEM	PROVIDED	COMMENTS
Summary	Yes	Section 7
Introduction / Background	Yes	Section 1.1
Structure plan proposal	Yes	Section 2.0
regional context	Yes	Section 2.1
proposed land uses	Yes	Section 2.2
table of land uses and quantities	Yes	Section 2.2
major attractors/generators	Yes	Section 2.3
specific issues		No Specific Issues
Existing situation		
existing land uses within structure plan	Yes	Section 2.1 – Rural dwellings
existing land uses within 800 metres of structure plan area	Yes	Section 2.1 – Rural dwellings
existing road network within structure plan area	N/A	Section 2.1 – Figure 3 Section 3.2 – Figure 4
existing pedestrian/cycle networks within structure plan area	N/A	Section 6.2 – No existing network within Structure Plan area
existing public transport services within structure plan area	N/A	Section 6.1 – No existing network within Structure Plan area
existing road network within 2 (or 5) km of structure plan area	Yes	Section 2.1 – Figure 3 Section 3.2 – Figure 4
traffic flows on roads within structure plan area (PM and/or AM peak hours)	n/a	No existing roads within structure plan
traffic flows on roads within 2 (or 5) km of structure plan area (AM and/or PM peak	Yes	Section 3.3 - Table 1, Figure 8
existing pedestrian/cycle networks within 800m of structure plan area	Yes	Section 6.2 – No existing facilities nearby
existing public transport services within 800m of structure plan area	Yes	Section 6.1 - No existing facilities nearby.
Proposed internal transport networks	Yes	Section 4.1
changes/additions to existing road network or proposed new road network	Yes	Section 4.1
road reservation widths	Yes	Section 4.1
road cross-sections and speed limits	Yes	Section 4.1
intersection controls	Yes	Section 4.1
pedestrian/cycle networks and crossing facilities	Yes	Section 6.2 – No existing facilities to connect to. Proposed 20m road reserve will accommodate paths if required in the future.
public transport routes	Yes	Section 6.1 – No existing routes

Transport Impact Assessment (Structure Plan) Checklist

ITEM	PROVIDED	COMMENTS
Changes to external transport networks	Yes	Section 4.2, 4.3
road network	Yes	Section 4.2, 4.3
intersection controls	Yes	Section 4.2, 4.3
pedestrian/cycle networks and crossing facilities	N/A	Section 6.2 -No existing facilities nearby
public transport services	N/A	Section 6.1 -No existing facilities nearby
Integration with surrounding area	Yes	Section 2.3
trip attractors/generators within 800 metres	Yes	Section 2.3 – beyond 800m
proposed changes to land uses within 800 metres	Yes	Section 1.1 – rural residential and rural Figure1
travel desire lines from structure plan to these attractors/generators	Yes	Section 2.3 – attractors outside 800m identified
adequacy of external transport networks	N/A	No existing path facilities or public transport services. No major trip attractors in SP or nearby to create pedestrian desire lines thus walking trips unlikley.
deficiencies in external transport networks	N/A	Rural residential area hence demand for public transport and path links is unlikely to prove a bus service viable
remedial measures to address deficiencies	N/A	Rural residential area
Analysis of internal transport networks	Yes	Section 4.1
assessment year(s) and time period(s)	N/A	Very low traffic volumes (less than the 100 veh/hr threshold for detailed analysis)
structure plan generated traffic	Yes	Section 5.1
extraneous (through) traffic	N/A	Section 5.1
design traffic flows (that is, total traffic)	Yes	Section 5.1
road cross-sections	Yes	Section 4.1
intersection controls	N/A	Appendix A - Standard intersections subject to detailed design at subdivision. Detailed analysis not required
access strategy	N/A	Very low traffic volumes (less than 500veh/hr-threshold hence all driveways ok on frontage)
pedestrian/cycle networks	N/A	Very low traffic volumes (less than 1100veh/hr threshold)
safe routes to schools	N/A	No schools within the structure plan
pedestrian permeability and efficiency	N/A	No existing external paths to connect to
access to public transport	N/A	No existing bus routes servicing the area

Transport Impact Assessment (Structure Plan) Checklist

Analysis of external transport networks		
extent of analysis	N/A	Very low traffic volumes (less than the 100 veh/hr per lane at any intersection threshold for detailed analysis)
base flows for assessment year(s)	N/A	Refer above
total traffic flows	Yes	Section 5.2, 5.3
road cross-sections	Yes	Section 5.3
intersection layouts and controls	Yes	Section 4.2, 4.3 Standard intersections subject to detailed design at subdivision.
pedestrian/cycle networks		
Conclusions	Yes	Section 7

Porter
Consulting Engineers

Level 2 Kishorn Court
58 Kishorn Road
Mount Pleasant 6153
Western Australia

PO Box 1036
Canning Bridge 6153
Western Australia

Tel: (08) 9315 9955
Email: office@portereng.com.au

www.portereng.com.au

Appendix 7

Engineering / Servicing Report

Porter
Consulting Engineers

SERVICING REPORT

LOT 9001 UTLEY ROAD & LOT 9002 WATTLE ROAD, SERPENTINE

Porter

REPORT PREPARED FOR

STRON PTY LTD
c/o HEX DESIGN AND PLANNING

Prepared by	**Porter Consulting Engineers**
Postal address	PO Box 1036 Canning Bridge WA 6153
Phone	(08) 9315 9955
Email	office@portereng.com.au

Date	13 July 2020
Our reference	R50.20
Job Number	20-06-078
Checked	*BH*

HISTORY AND STATUS OF THE DOCUMENT

Revision	Date issued	Author	Issued to	Revision type
Rev A	22 July 2020	M. Cook	HEX Design & Planning	1st issue

CONTENTS

1.0 INTRODUCTION

Porter Consulting Engineers (PCE) has been engaged by Stron Pty Ltd to prepare a servicing report for proposed 39 lot rural residential development to lot 9001 Utley Road and lot 9002 Wattle Road (the Site), in Serpentine within the Shire of Serpentine Jarradale.

The Site is bound by Wattle Road to the north, rural residential lots to the east, agricultural lots to the west and Utley Road to the south as shown in **Figure 1**. A structure plan is included in **Attachment 1**.

Figure 1: Development site (bound in blue)

2.0 LANDFORM

The Site is 91.30 hectares in total area. An existing homestead with adjacent ancillary structures occupies the northern portion of the site, an existing residence by Utley Road, and isolated sheds across the site.

The site is generally cleared with isolated clusters of trees are grouped along paddock fence lines, with a large grouping of trees in the vicinity of the homestead.

The topography of the Site is generally flat with grades from 40m AHD by the eastern boundary to 35m AHD to the north-western boundary by Wattle Road.

Based on the Perth Metropolitan Region Environmental Geology Series mapping[1], the mapping indicates:

- S_{10}: Thin Bassendean Sand over Guildford formation to the northern half of the site;
- C_s: Sandy clays to the southern half of the site;
- S_8: isolated pockets of Bassendean Sand to the eastern boundary.

A Land Capability report[2] to the Site supports the geology mapping noting Bassendean Sands indicatively up to 1,000mm thick over clays.

The Acid Sulphate Soils (ASS) risk mapping[3] indicates that there is a 'Moderate to lot risk of ASS occurring within 3m of natural soil surface but high to moderate risk of ASS beyond 3m of natural soil surface'.

The Site is beyond the extents of the online Perth Groundwater Mapping[4]. However, the Land Capability report notes the likely maximum groundwater range being within 400mm to 800mm from the surface, perched between the sand and clay layer. The report noted groundwater in only one test pit at 450mm below the surface with the report commenting that 2012 was a particular dry year with regards to rainfall.

A search of the Contaminated Sites Database[5] did not identify any known contaminates within the Site.

3.0 PLANNING

The Site is currently zoned 'Rural Residential (RR2)' for minimum 2 hectare lot sizes. The proposed Structure Plan seeks to create 39 lots with an average size of 2.18 hectares, with the minimum lot size being 2 hectares.

---

[1] Jordan J.E 1986 Serpentine Part Sheets 2033 II and 2133 III, Perth Metropolitan Region, Environmental Geology Series, Geological Survey of Western Australia.

[2] Landform Research, *Land Capability-Geotechnical Assessment lot 9002 Wattle Road and Lot 9001 Utley Road, Serpentine,* March 2018

[3] Department of Water and Environmental Regulation, *ASS risk maps,* viewed 9 July 2020, < https://www.der.wa.gov.au/your-environment/acid-sulfate-soils>

[4] Department of Water and Environmental Regulation, *Perth Groundwater Map*, viewed 9 July 2020, <https://www.water.wa.gov.au/maps-and-data/maps/perth-groundwater-atlas>

[5] Department of Water and Environmental Regulation, Contaminated Sites Database, viewed 9 July 2020, < https://www.der.wa.gov.au/your-environment/contaminated-sites/58-finding-information-on-contaminated-sites-in-western-australia>

4.0 SERVICING

4.1 Demolition

Based on historical aerial imagery[6], the homestead and residence by Utley Road was constructed circa 1960's. Consideration should be given to the potential of construction materials within the structures containing asbestos or hazardous materials. A hazardous materials assessment should be undertaken to determine if such material are present and should be removed prior to any demolition works.

4.2 Siteworks / Earthworks

Each proposed lot will require a geotechnical report and land capability assessment for wastewater effluent disposal to determine the finished level of the sand pad for the construction of the home. It is expected these investigations will be undertaken closer to the time a location for a house pad has been nominated.

The geotechnical report will be subject to the separation requirements to the clayey soils to achieve a "Class A" or "Class S" site classification in accordance with AS 2870-2011 "Residential Lots and Footings". Typically, a minimum of 1.2m of free-draining sand is needed above the clayey soils to achieve the "Class S" classification and 1.8m to achieve "Class A". The existing thin layer of sand above the clayey soils does vary in thickness across the site, but is generally in the order of 700mm thick.

The placement of fill material for the sand pad to achieve a "Class A" or "Class S" site classification will also assist in providing adequate separation in accordance with the Department of Health requirements to the maximum groundwater and clayey soils for capability to dispose of wastewater effluent via the use of infiltration drains/soakwells. The expected separation requirements from the invert of the infiltration drain/soakwell is typical a minimum of 1.2m to the clayey soils and 500mm to the maximum groundwater (whichever is greater).

Therefore, the finished sand pad level will be subject to achieving the greater separation requirements for site classifications and effluent disposal.

4.3 Roadworks

The proposed roads will be a rural residential standard road, typically consisting of a 9.6m formation including 6m wide sealed pavement, with 1.2m unsealed shoulders, and roadside table drains, within the 20m road reservation. A typical indicative rural road cross-section is illustrated in **Figure 2**.

Subject to detailed designs, it is expected that the finished road level will be nominally 300-600mm above the existing surface, providing separation from the clayey soils and groundwater.

A separate Traffic Impact Statement (R51.20) is being prepared by Porter Consulting Engineers which will provide a greater assessment of the existing and proposed roads.

[6] Landgate, *Online aerial photography,* viewed 8 July 2020, < https://www0.landgate.wa.gov.au/maps-and-imagery/imagery/aerial-photography/aerial>

As the proposed zoning is R2, the Shire's street tree policy[7] which requires developments with R5 zoning or above to plant street trees, is not applicable. However, should the Developer or purchasers of the lots seek to install street trees, this is expected to be supported by the Shire. The Shire's webpage also notes free verge plant program which operates in partnership between Landcare SJ, Roadside Care Volunteers and the Shire.

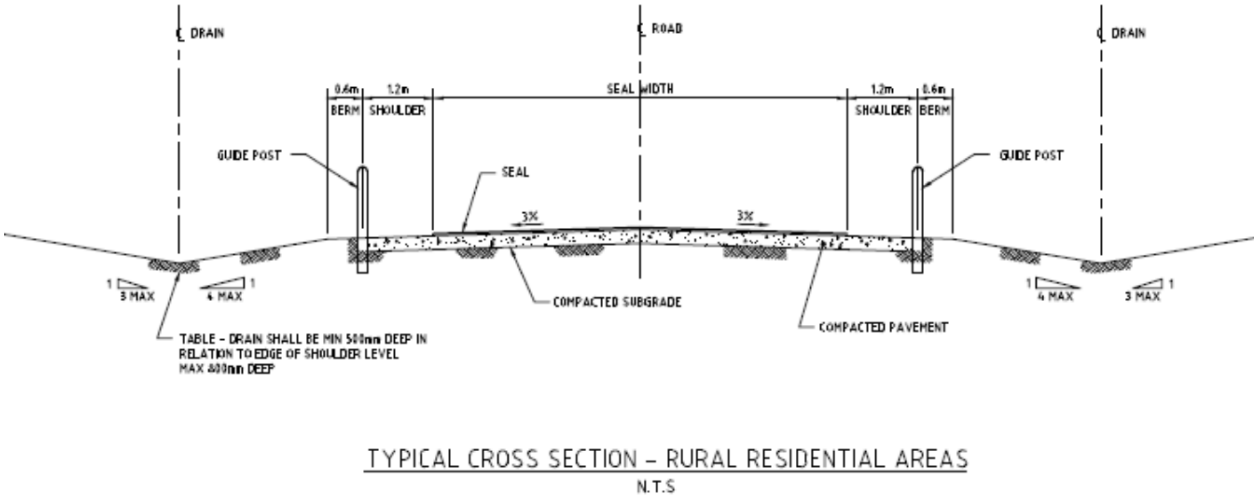


Figure 2: Typical indicative rural residential road cross section

4.4 Stormwater Drainage

The Water Corporation has advised that the Site falls within the Mundijong District Drainage system. The Serpentine River Sub E and E1 open drains run adjacent to the north and western boundaries of the Site.

It is understood Emerge Associates is preparing a Local Water Management Strategy for the Site, which will outline in detail the proposed stormwater management measures. However, in general terms it is understood that stormwater from the roadway will be managed via roadside swales and stormwater to the lots will be managed and detain stormwater in accordance with the requirements of the Water Corporation and the Department of Water Environmental Regulation.

It is expected that localised widening of the road reserve will be required to accommodate basins to dispose of the stormwater runoff from the roadways. Culverts under the proposed roads in key locations will convey stormwater from one side of the roadway to the other.

4.5 Electrical

Along Wattle Road, there is underground LV near the intersection with Walker Road and underground HV near the intersection with Windmill Avenue.

Approximately 60m north of Utley Road, there is an existing overhead HV powerline that runs east-west across the site. As the proposed lots are less than 10 hectares in area, it is expected that

[7] Shire of Serpentine Jarrahdale, *Verge and Street Trees,* viewed 14 July 2020, < https://www.sjshire.wa.gov.au/community/health-and-environment/trees/verge-and-street-trees.aspx>

Western Power will not allow this line to remain across the site and will require this line to be relocated to Utley Road and be converted to an underground line for the full extent of the subdivision boundary. Alternatively, Western Power may approve an easement for the underground cable across the proposed boundary of the lots abutting Utley Road, as this would avoid the need to clear existing vegetation in the roadway.

4.6 Communications

Based on NBN Co mapping, NBN Fixed Wireless Technology is available to the area and therefore no in-ground infrastructure is expected to be required.

There is Telstra infrastructure in Wattle Road and Utley Road.

4.7 Gas

There is no gas infrastructure in the area.

4.8 Water

There is an existing 180PE water main in the vicinity of Windmill Avenue and Wattle Road.

The Water Corporation initially advised[8] that the development would not be able to be serviced with reticulated scheme water as the site was outside of the water scheme area, and the existing mains by Wattle Road have limited capacity.

However, following requests made by PCE, the Water Corporation undertook a water planning review. Subsequently, the Water Corporation has advised[9] that the existing system has enough capacity to service the development with reticulated schem water.

Had the development not been able to be serviced with scheme water, rain water harvesting in the form of rain tanks would have been required, which is the current water source for other nearby rural residential properties.

4.9 Wastewater

The Water Corporation has advised that the Site is outside of the current Water Corporation's planned wastewater scheme area, with no wastewater infrastructure in the area. Therefore, onsite wastewater treatment and effluent disposal will be required for each proposed lot, which will typically in the form of Aerobic Treatment Units and an accompanying effluent disposal system (typically a leachate structure).

The proposed lots are nominally 2 hectare lots (20,000m^2) which is larger than the minimum 2,000m^2 requirement for onsite sewerage disposal in accordance with the Government Sewerage Policy (2019).

[8] Smith. W, *RE: Lot 9001 Utley Rd & Lot 9002 Wattle Rd Serpentine SF0008799,* email to Cook. M, 29 June 2020, <mcook@portereng.com.au>

[9] Purcher. K, RE: 9001 Utley Road Serpentine - Servicing enquiry, email to Cook. M, 17 July 2020, <mcook@portereng.com.au>

The land capability report notes the Site is suitable for onsite wastewater disposal, and that subdividing the land and change of land use will lead to significantly reduced nutrient loadings to the land.

With the maximum groundwater (perched) expected to be within 1m of the existing surface, it is expected that free draining sand fill material will be required to form flat building pads for each residential home including the area needed for onsite sewerage disposal. The minimum level of the sand pad will be subject to achieving the greater separation requirements to the clay surface and groundwater for site classifications and effluent disposal in accordance with the Department of Health requirements.

5.0 CONCLUSION

Based on the information available, there does not appear to be any significant factor that would prevent the proposed 39 lot rural residential development to the Site. However, considerations of the following should be made during the project planning phase:

a) Early liaison with Western Power regarding options for the relocation of the existing overhead HV power lines by Utley Road.
b) Liaise with the Water Corporation and Department of Water Environmental Regulation to confirm the stormwater management requirements towards a Local Water Management Strategy.
c) Further investigations to confirm groundwater levels, as there was limited groundwater data from the Land Capability report prepared by Landform Research.

ATTACHMENT 1: Structure Plan

DRAFT

WATTLE ROAD

WALKER RD

DMILL AVE

20m Road Reserve

SUMMARY	
Subject Site	**91.30 ha**
Lot 9001	68.23 ha
Lot 9002	23.08 ha
Zone	
Special Rural - 39 Lots (RR1 - Min 2 ha)	85.19 ha
Road Reserves	5.94 ha
Balance lot	0.17 ha

LEGEND

- Subject Site
- Cadastre
- Minor Water Course
- Drain
- Retained Buildings
- Proposed Lot Boundary
- Special Rural (RR1 - Min. 2 ha)
- Proposed Road Reserve
- Road Center Line

STRUCTURE PLAN

Lot 9001 Utley Road & Lot 9002 Wattle Road - Serpentine

50 0 50 100 250 500

Project RAYSJLSP I Scale 1:5000@A3 I Date May 2020

HEX DESIGN PLANNING

Source of Information

Site boundaries: Landgate
Projection: GDA94 MGA Zone 50 South

NOTE
All areas and dimensions are subject to survey, engineering and detailed design and may change without notice.

A3PL_20200506_RAYSJLSP_Structure Plan Lot 9001 Utley Road & Lot 9002 Wattle Road - Serpentine MGA50.dwg

Porter
Consulting Engineers

Level 2 Kishorn Court
58 Kishorn Road
Mount Pleasant 6153
Western Australia

PO Box 1036
Canning Bridge 6153
Western Australia

Tel: (08) 9315 9955
Email: office@portereng.com.au

www.portereng.com.au