CITY OF ALBANY

LOCAL PLANNING SCHEME NO. 1

LOT 9041 WILLYUNG ROAD WILLYUNG LOCAL STRUCTURE PLAN NO. 16 (WAPC REF SPN 2167)

AYTON BAESJOU
PLANNING

ABN: 15 061 140 172
59 Peels Place
Albany WA 6330
Ph 9842 2304 Fax 9842 8494

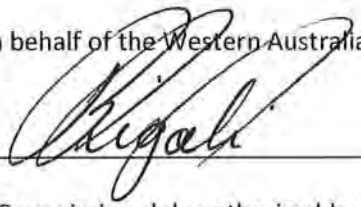
Endorsement

This structure plan is prepared under the provisions of the City of Albany Local Planning Scheme No. 1.

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

16 September 2019
_____ Date

Signed for and on behalf of the Western Australian Planning Commission:



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

M. Wieclaw
_____ Witness

17 September 2019
_____ Date

16 September 2029
_____ Date of Expiry

Amendments:

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

EXECUTIVE SUMMARY

This Local Structure Plan has been prepared to modify the original Subdivision Guide Plan for a portion of the Willyung Special Residential zone which was originally prepared in 1999. Four subsequent revisions to other portions of the original plan occurred in 2009, 2012 and 2013.

Lot 9041 is located approximately 12 kilometres from the Albany Central Area, between Willyung Road on its southern boundary and a creekline which drains into the King River on its northern boundary. One dwelling existing fronting Willyung Road and a Special Use zone located in the middle of the property has been developed with four holiday chalets. The undeveloped balance of the property is used to agist stock.

It is proposed to reduce the lot sizes shown on the original Subdivision Guide Plan, which allowed for eight lots over Lot 9041, and instead provide for 16 residential lots ranging from 4160m^2 to 1.3ha in area.

Key elements of the plan include:

- Updating of the land capability and floodway information.
- Reduction in lot sizes to create a more effective use of the land and to meet the demand for smaller lots.
- Extension of Greenwood Drive to create a loop road which will significantly improve accessibility within the area and meet the need for alternative access/egress to the area.
- Compliance with the Draft Government Sewerage Policy November 2016.

Key outcomes of the Local Structure plan are summarised in the Table below.

Table 1: Local Structure Plan Summary

Item	**Data**		**Section Number referenced within the Local Structure Plan report**
Total Area of Local Structure Plan	18.1074ha		2.1
Landuse Proposed	**Area**	**Lot Yield**	
Special Residential	11.6519	16	5.1
Special Use	6.4555	1	5.1
Estimated Dwellings		16	5.1
Estimated Holiday Chalets		12	5.1
Estimated Additional Population		37	5.1

Contents

PART 1. – STATUTORY

1.0 LOCAL STRUCTURE PLAN AREA

The Local Structure Plan (**LSP**) area relates to Lot 9041 Willyung Road, Willyung, as shown below.

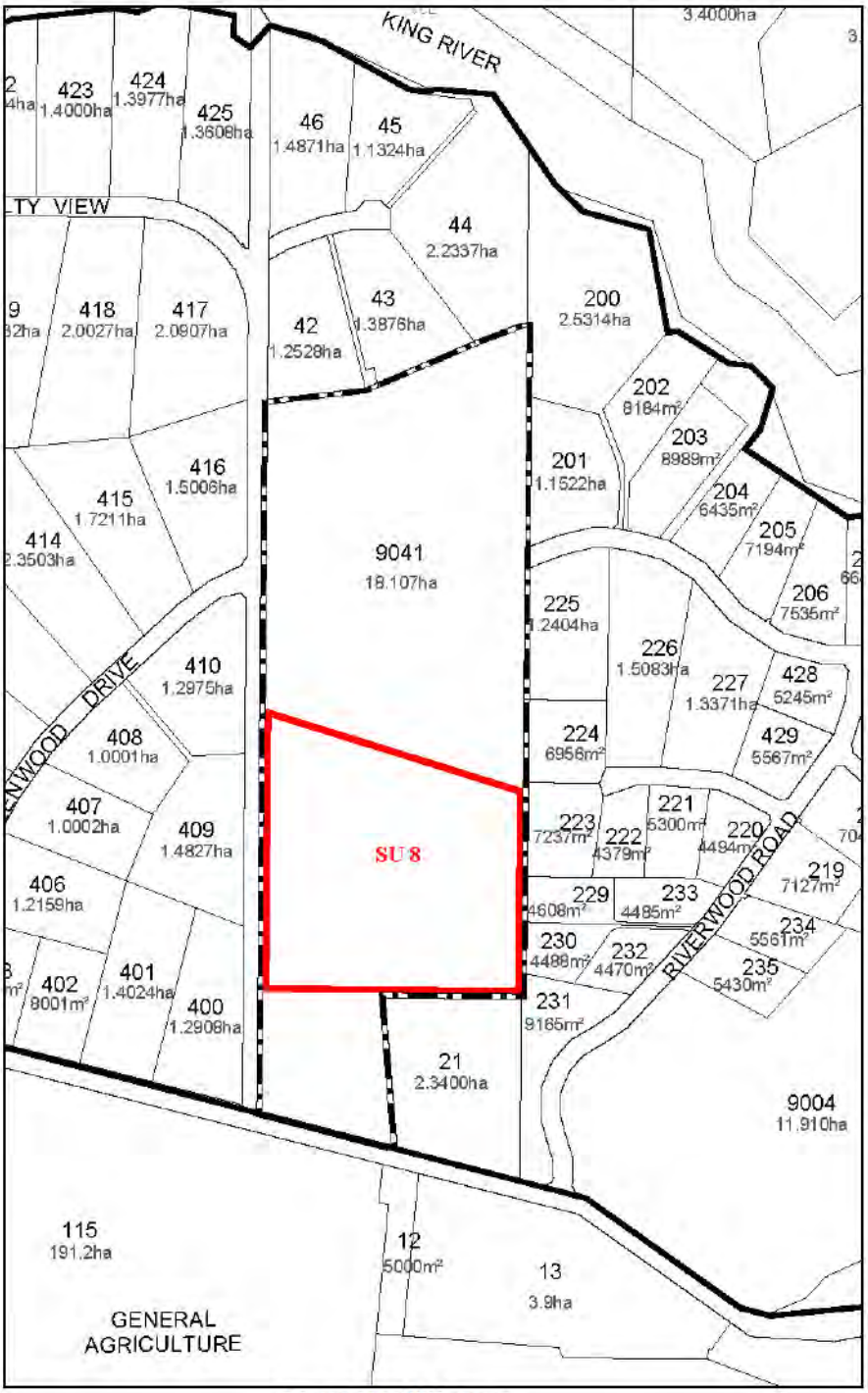


Figure 1 - LSP area

Table 2: Land Description

Land Description	Plan	Vol.	Folio	Area Ha	Street Address	Owner
Lot 9041	62317	2810	78	18.1074	208 Willyung Rd.	BJ & CC Lowrie

2.0 OPERATION

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

3.0 SUBDIVISION AND DEVELOPMENT CONDITIONS

3.1 Land Use Permissibility

Land Use permissibility within the subject land shall be in accordance with the corresponding zone and reserves under the local planning scheme and due regard shall be given to the provisions of the structure plan.

3.2 Environmental Features

At the time of subdivision, the drainage line running through proposed Lots 1-5 shall be subject to the preparation, approval and implementation of a Foreshore Management Plan, and development shall be located outside of the 1 in 100 year flood level.

3.3 Hazards and Separation Areas

a) Subdivision and development of residential lots shall have due regard to the provisions of the approved Bushfire Management Plan and BAL ratings.

b) Subdivision and development of residential lots shall have due regard to the provisions of the Government Sewerage Policy, including:
   i. Separation from the highest known seasonal groundwater level, supported by a Site and Soil Evaluation and hydrogeological assessment of the site under the wettest time of year conditions.
   ii. Separation from water resources such as waterways, surface or subsurface drainage systems.
   iii. Use of secondary treatment sewage with nutrient removal disposal systems.

3.4 Conditions of Subdivision or Development Approval

In addition to conditions relating to implementing the special provisions in LPS1, at the time of subdivision the following conditions are recommended:

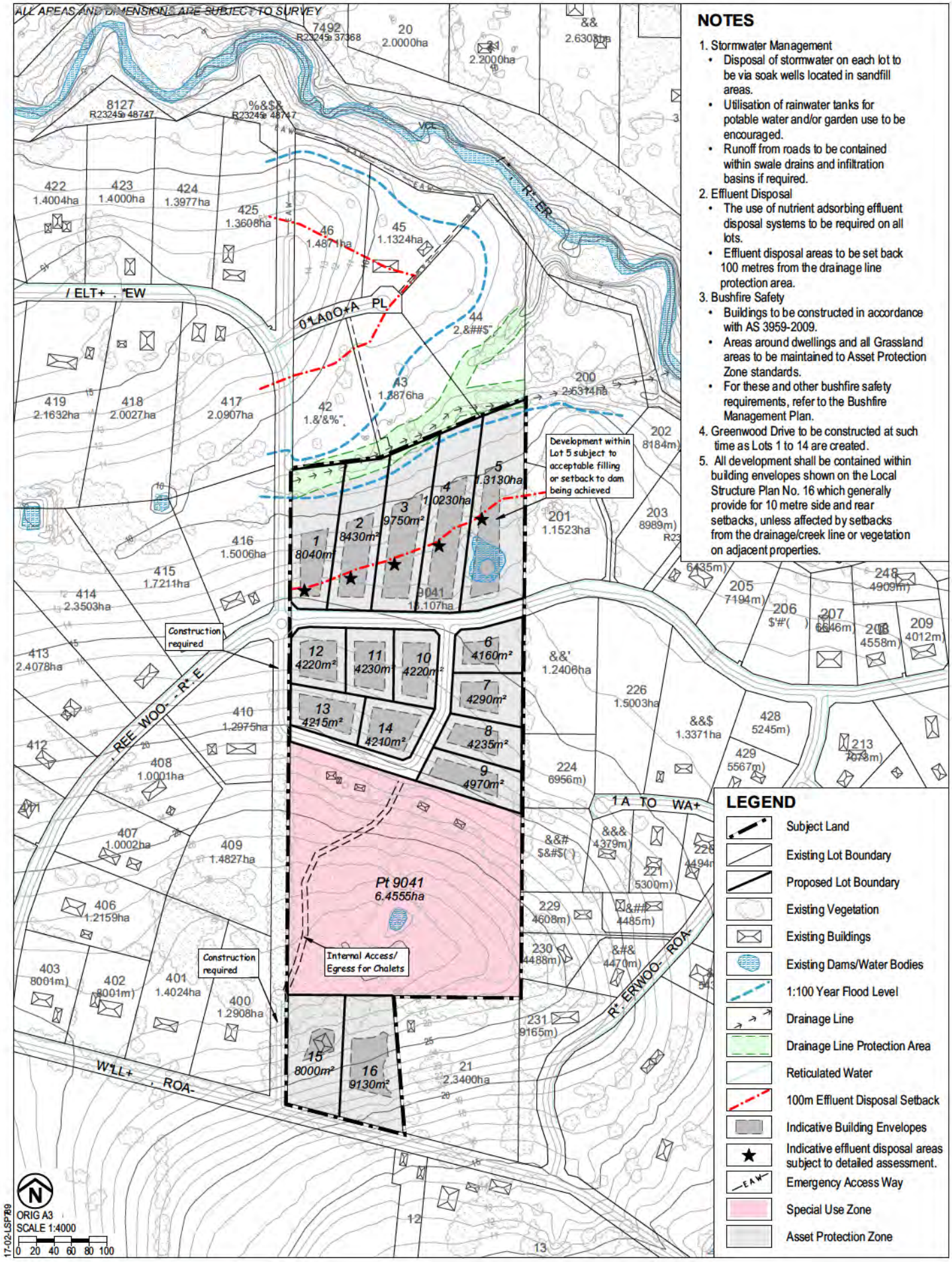
a) the preparation, approval and implementation of :
   i. Foreshore Management Plan;
   ii. Urban water management plan;
   iii. Bushfire Management Plan, including BAL Contour Plan.

b) the decommissioning and replacement of any existing septic systems with approved nutrient retaining alternative effluent disposal systems, inclusive of any servicing existing chalets.

c) notifications on title advising of:
   i. designation as a Bushfire Prone Area;
   ii. requirement for an approved nutrient retaining alternative effluent disposal system and an unencumbered area to which treated sewerage is to be distributed as part of development.
   iii. proximity to known mosquito breeding species.

d) road reserve and construction of Greenwood Drive and the new loop road servicing proposed 7-14. A roundabout may be required at the new 4-way intersection and proposed Lots 1 and 12 shall make sufficient provision for this.

e) construction of the road reserve adjacent to proposed Lot 15 shall occur at subdivision approval of proposed Lot 15 or as a condition of approval for any additional chalets, whichever occurs first.



AYTON BAESJOU
PLANNING
59 Peels Place
ALBANY WA 6330
Ph 9842 2304 Fax 9842 8494

LOCAL STRUCTURE PLAN No. 16

Lot 9041 Willyung Road
Willyung, City of Albany

Figure 2

PART 2 – EXPLANATORY

1.0 INTRODUCTION

The purpose of the LSP is to review the existing subdivision guide plan affecting Lot 9041 Willyung Road and to reduce the lot sizes in order to meet the demand for smaller lots and make more efficient use of the land.

The suitability and capability of the land has been reviewed in order to ensure the additional lots can be supported.

2.0 LAND DESCRIPTION

2.1 Location, Area and Zoning

Lot 9041 is located approximately 12 kms north of the Albany City Centre and is located between Willyung Road on its southern boundary and a creekline which drains into the King River on its northern boundary. Refer Figure 3 - Site Plan on Page 5.

Lot 9041 is 18.107ha in area with 11.65ha zoned 'Special Residential' and 6.45ha 'Special Use' (SU8), with up to 12 holiday chalets being permissible. A residence has been developed fronting Willyung Road and four chalets have been developed in the 'Special Use' zone.

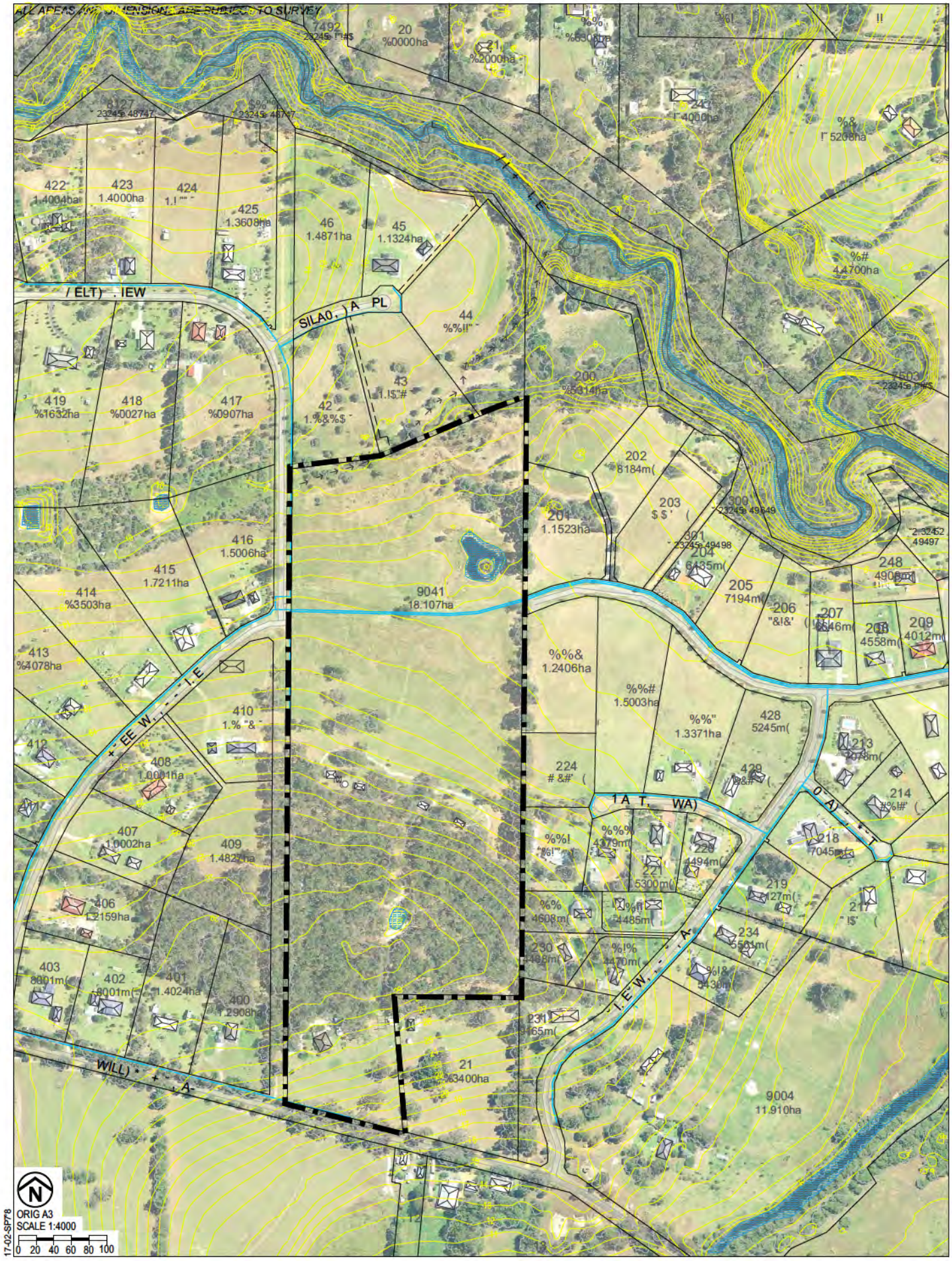
The Subdivision Guide Plan (Figure 4)for the original area, dated July 1999, provided for the Special Use area and eight residential lots on the site ranging in size from 8450m^2 to 2.3ha.

2.2 Surrounding Land Use

Land to the east and west is zoned 'Special Residential' and has been mostly subdivided into lots ranging in size from around 4000m^2 to two hectares. Four subsequent revisions to other parts of the original Subdivision Guide Plan were endorsed by the City of Albany in 2009 (twice), 2012 and 2013 (See Appendix C), with most lots subsequently subdivided. Inclusive of this structure plan, a total of approximately 200 residential lots are expected to be created within the Willyung Special Residential Area, as well as 12 chalets. Figure 5- Planning Context Map shows the current lot layout.

The King River and a Rural Residential area is located to the north and the foreshore area has been consolidated and a foreshore management plan put in place.

To the south of Willyung Road land is zoned 'General Agriculture' and used to agist stock.



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Ph 9842 2304 Fax 9842 8494

SITE PLAN

Lot 9041 Willyung Road
Willyung, City of Albany

Figure 3

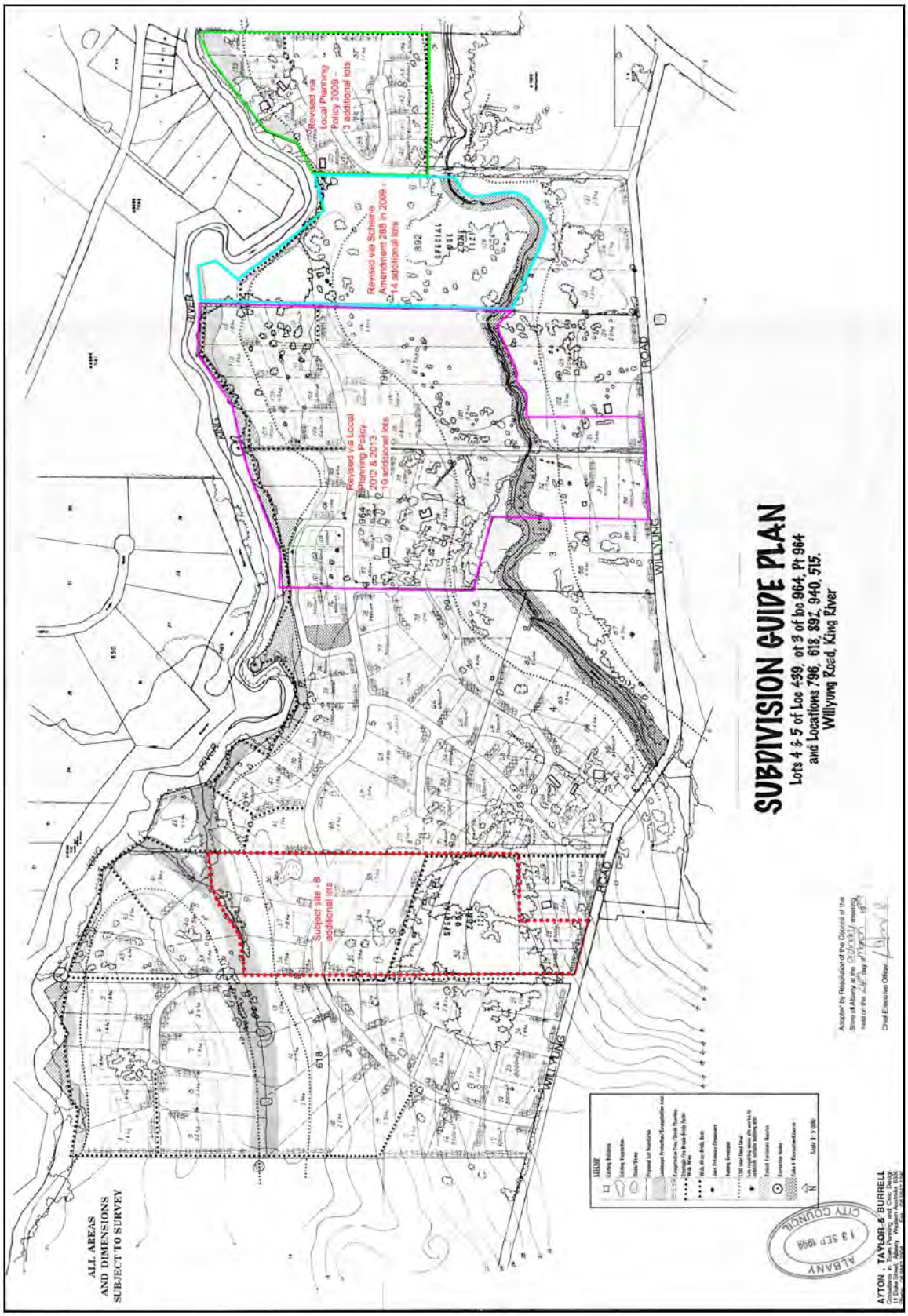
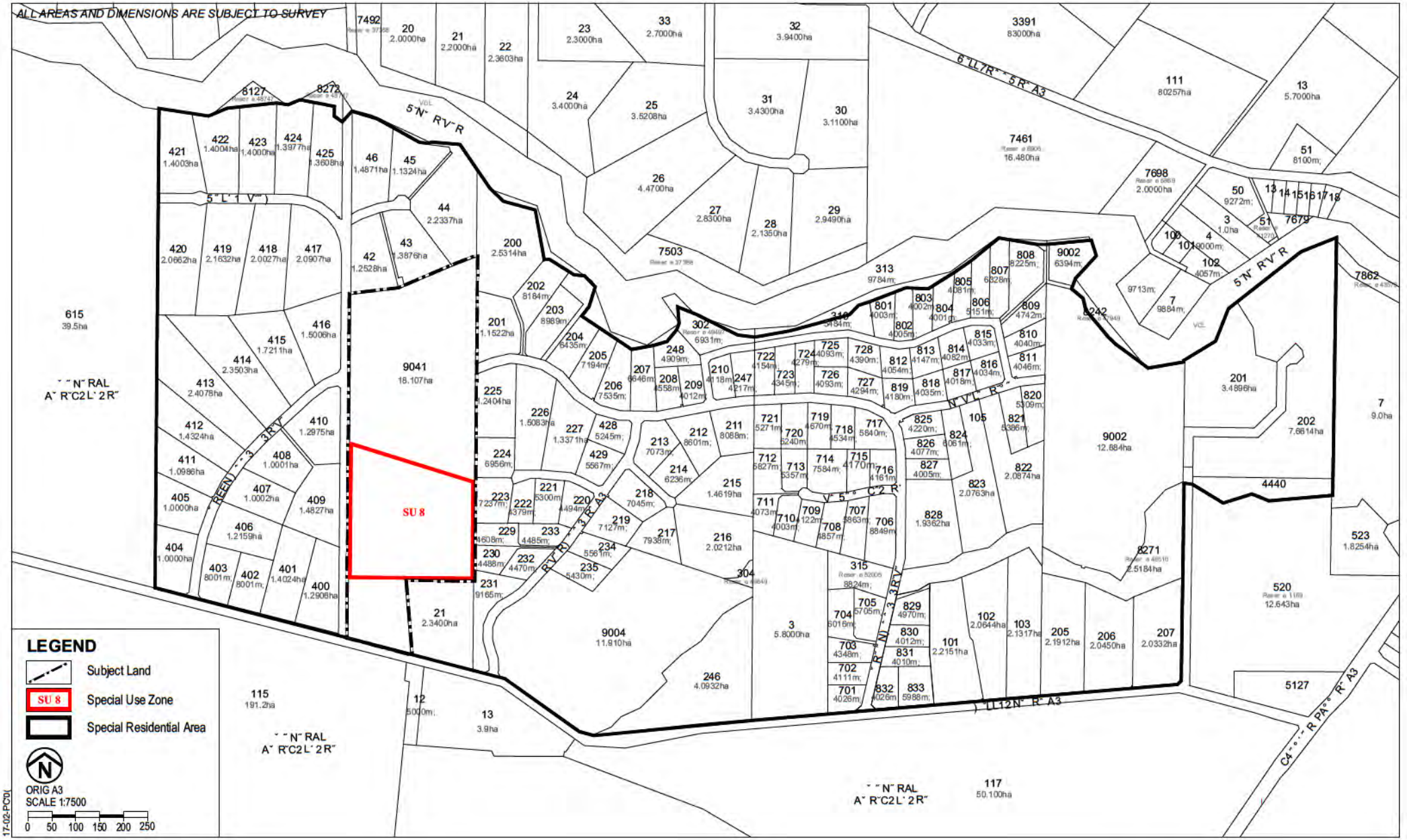


Figure 4- Original Subdivision Guide Plan endorsed July 1999
-revised areas see Appendix C.



AYTON BAESJOU
PLANNING
59 Peels Place
ALBANY WA 6330
Ph 9842 2304 Fax 9842 8494

PLANNING CONTEXT

Special Residential Area (SR 11)
)!##*ung, City of Albany

Figure 5

3.0 PLANNING CONTEXT

3.1 City of Albany Local Planning Scheme No 1

The key planning document which relates to the subject land is the City of Albany's Local Planning Scheme No 1. As noted above, the Scheme zones the property 'Special Residential' (SR11) and 'Special Use' (SU8) (Holiday Chalets).

'Schedule 15 - Special Residential Zone' Area 11 to the Scheme sets out the 'Special Provisions' applying to the site. These include:

- A Subdivision Guide Plan (as amended) which provides guidance in relation to subdivision of the property, particularly in the context of land capability and flood risk.
- A minimum lot size of 4000m^2,
- Permissible uses, and
- Building setbacks, including creekline setbacks.

These provisions are supported by general provisions contained within the Scheme which include:

- Building Design, Materials and Colours
- Fire Protection
- Modification to Building Setbacks
- Fencing
- Remnant Vegetation Protection and Clearing Controls
- Revegetation
- Drains, Soaks and Bores
- Keeping of Animals
- Effluent Disposal
- Service Infrastructure

3.2 Draft Government Sewerage Policy (November 2016) (dGSP)

This policy applies to the preparation, provision of advice and determination of planning proposals relating to, amongst other matters, structure plans, subdivision of lots less than 4 hectares.

The policy requires all subdivision and development to be connected to reticulated sewerage unless the exemptions of the policy apply.

The site is identified as a sewage sensitive area under the dGSP, due to its proximity to the King River, which discharges into Oyster Harbour. The dGSP recommends 1 ha minimum lot sizes for unsewered development in sewerage sensitive areas so to achieve nutrient targets based on catchment modelling.

The dGSP also require that the potential for cumulative impacts must also be taken into consideration, based on an estimation of the number of unsewered lots likely to be developed in the local area. As the subject land was zoned 'Special Residential' with a minimum lot size of 4000m^2 in accordance with the previous draft Country Sewerage Policy an exemption to the 1 hectare minimum lot size is requested under provision 6.2 (6) which states that:

"Land in a sewage sensitive area that is already zoned for urban use with a Residential (R)5 or R10 density coding based primarily on the provisions of the Government Sewerage Policy (Perth Metropolitan Area 1996) or draft Country Sewerage Policy may be subdivided in accordance with the existing density coding providing that the minimum site requirements as outlined in provision 6.4 are met. A secondary treatment system with nutrient removal may be required."

The Structure Plan proposes lots greater than R5 (2000m^2) and responds to the requirements of provision 6.4, which include, amongst other things, locating onsite sewage disposal systems so that:

- minimum vertical separation between the onsite sewage disposal discharge point and highest known groundwater level of 1.2-1.5 m.
- fill may be used to achieve minimum vertical separation provided the highest known groundwater level is more than 0.5m below the natural ground level, and such works are environmentally acceptable.
- minimum horizontal separation of 100m between the onsite sewage disposal discharge point and the outer edge of riparian vegetation of a waterway, wetland, or drainage system.
- areas subject to inundation and/or flooding in a 10 % AEP rainfall event are avoided.
- Secondary treatment systems with nutrient removal, which are to be used in all sewage sensitive areas.

3.3 City of Albany Local Planning Strategy

The City's Local Planning Strategy (ALPS) was endorsed by the WAPC in June 2010 and provides a framework for the Local Planning Scheme and key strategies and actions to guide the strategic direction for the City over the next 20 years.

Section 8.2 of the strategy outlines the 'Strategic Planning Objectives' for the City which includes:

SETTLEMENT (Section 8.3)

- Facilitate and manage sustainable growth for the urban area in the City of Albany
- Support the consolidation of serviced urban areas and facilitate staged fully serviced urban frontal development nodes.
- Support urban infill development based on compatibility of land uses and infrastructure capacity.
- Protect areas designated as future fully-serviced urban areas from inappropriate land uses, subdivision and development.
- In the long term encourage the efficient use of existing rural living areas, based on land capability to maximise their development potential.
- Ensure that future rural living areas are planned and developed in an efficient and coordinated manner by being located either adjacent to Albany as designated on the ALPS maps, or within existing rural townsites in accordance with Table 5 along with adequate services and community infrastructure.
- Facilitate and promote the retention and sustainable growth of existing rural settlements.

The main thrust of these objectives is to consolidate both urban and rural living development within the City. In particular, the fifth dot point encourages the efficient use of existing rural living areas, based on land capability to maximise their development potential.

This objective is repeated in Section 8.35 'Rural Living' of the Strategy. Rural Living areas are classified to include the 'Special Residential', 'Rural Residential', 'Rural Small Holdings' and Conservation zones.

Objectives for these areas are to:

- Discourage the creation of additional rural townsites for living purposes.
- Avoid the development of Rural Living areas on productive agricultural land, other important natural resource areas and areas of high bushfire risk, flooding and environmental sensitivity.
- Avoid the development of Rural Living areas on future and potential long-term urban areas.
- Provide for compact growth of selected existing rural townsites in accordance with Table 5, based on land capability and available services and facilities.
- Minimise potential for generating land-use conflicts.

ALPS supports lot sizes from 2000m^2 in new Special Residential areas and supports the subdivision of existing land zoned Special Residential in the City's current Local Planning Scheme.

Actions outlined in Section 8.3.5 include:

- Give top development priority to the subdivision of land currently zoned Special Residential and Special Rural within the City's current Town Planning Schemes and as designated on the ALPS maps. (CoA, WAPC).
- In the long term, maximise opportunities for existing rural living areas that do not have potential for future urban development to achieve higher sustainable lot yields based on land capability/suitability, service provision and local constraints. These areas would be given second priority to meet future demands (CoA, WAPC).

In relation to the 'Objectives' listed above, it is noted that Special Residential Area SR11 has already been created and will not involve development on additional productive agricultural land. Consideration has been given to managing bushfire risk, flood risk and environmental sensitivity through the Land Capability study (Appendix A) and Bushfire Management Plan (Appendix B).

3.4 State Planning Policy 3.7 - Planning in Bushfire Prone Areas (SPP 3.7)

The Bushfire Management Plan (Appendix B) demonstrates that this site can comply with the bushfire protection criteria in subsequent planning stages:

- Element 1 – Location – All proposed lots will have a building enveloped subject to BAL-29 or below
- Element 2 – Siting & Design – All proposed lots have sufficient areas surrounding the building envelopes to accommodate an asset protection zone
- Element 3 – Vehicular access - each proposed lot will have two different vehicular access routes. The through connection of Greenwood Drive and new loop road will provide each with the necessary secondary access/egress.
- Element 4 – Water - a reticulated water supply will be provided.

3.5 State Planning Policy 2.9 Water Resources (SPP 2.9)

Requirements relating to onsite effluent disposal, consideration of flood and inundations risk, as well as the preparation, approval and ongoing implementation of the foreshore management plan will assist in achieving the objectives of SPP 2.9 to protect, conserve and enhance water resources.

3.6 Draft Development Control Policy 2.5 - Special Residential zones (2018) (DC 2.5)

Draft DC 2.5 discusses the need for special residential land uses (2000m2 to 1 hectare lot sizes) to be carefully and sparingly planned for as so not create an inefficient use of land and services in comparison to conventional residential subdivisions in urban areas.

DC 2.5 requires that Special Residential zones be considered to the maximum density to which the land should be put, and any proposed 'infill' should only be the result of rezoning to residential with all services, including reticulated sewerage, being provided. As the subject land has not yet been subdivided and the proposed lot sizes meets the existing minimum lot size provided for in the Scheme, it is considered the proposal meets the policy objectives of DC 2.5

4.0 SITE CONDITIONS AND CONSTRAINTS

4.1 Biodiversity and Natural Area Assets

The majority of the site is cleared with remnant vegetation located within the Special Use zone and foreshore of the creekline so that it will not be impacted by the proposed development. Scattered shrubs and trees located within the Drainage Line Protection Area designated on the LSP will also be protected with additional revegetation to occur through the implementation of the Foreshore Management Plan.

Proposed building envelopes and roads are located in cleared areas and will not require remnant vegetation to be removed. As evident from surrounding developed areas, significant replanting of shrubs and trees will hopefully occur as the area is developed.

The King River is the most significant natural feature which is located between 200 and 400 metres to the north of the site, with the creekline discharging into the river. A foreshore reserve for the King River has already been created to protect the waterway and associated vegetation. It has been fenced and a strategic fire break/bridle path/walkway runs parallel to the reserve.

4.2 Landform and Soils

The site is undulating, rising from 18m AHD in the south east corner abutting Willyung Road and rising to a ridge line centered on the Special Use site at 30m AHD. The land then slopes down to a drainage line running west-east across the site at between 8 to 10m AHD which forms the northern boundary of the LSP. Refer Figure 3 - Site Plan on Page 5.

Soils are similar to those within the adjoining subdivisions and range from laterite duricrust and gravel, terrace sand over ferricrete/clay, sand over clay and granitic sandy loams associated with granite outcrops. A detailed description of the soils is provided by Landform Research in the Land Capability-Geotechnical Assessment (June 2018) and is attached as Appendix A.

The soils have a high capability for development with subdivision design being used to overcome any constraints such as the exclusion and setback of development from the drainage line running west-east through the north of the site.

As noted above, the soils are similar to those of the nearby and adjoining land which has already been subdivided and developed. No adverse impacts or conditions have been known to have been created by this development.

4.3 Ground Water and Surface Water

4.3.1 Ground Water

Shallow perched winter groundwater is common over the lower elevations of the site, mainly in the small creek line valley in the north. These areas are excluded from the proposed development areas. Detailed site testing has confirmed that the development areas are elevated and comply with the separations of 500mm to the highest known water tables.

The shallow winter soil moisture forms in winter when the overlying sands fill with water and the rate of precipitation exceeds the vertical infiltration rates of the subsoils. On slopes these can form seepages. The dam on proposed Lot 5 reflects these areas. Development upslope of the dam is recommended.

4.3.2 Surface Water

The main hydrological features are the King River which is located to the north of the LSP. Willyung Creek which is located further to the east and a small drainage line which drains into the King River traverses the site along the northern boundary of the LSP area drain to the east through the King River to Oyster Harbour.

Apart from the small drainage line along the northern boundary of the site, surface run off is not common because of the porosity of the soils. Surface water only exists where perched water tables on the terraces touch the surface in winter and where water logging occurs on the flood plain. Building envelopes are not proposed in these areas.

There are no wetlands located within the LSP area.

The existing dam on proposed Lot 5 may be retained provided proposed development, included onsite effluent disposal, can meet suitable horizontal and vertical setbacks, otherwise filling or an adjustment to lot boundaries may be necessary.

4.3.3 Flooding

A detailed assessment of flood levels for the subject land has been undertaken by Landform Research (Appendix A) which updates previous work carried out in 1997. The review confirms the 1997 data with some minor adjustments. The predicted flood levels are shown, together with recommended building envelopes and waste disposal areas for proposed house sites, on Figure 6.

4.4 Bushfire Hazard

Apart from the Special Uses zone which is heavily vegetated, the balance of the LSP area has largely been cleared with the exception of individual trees and vegetation associated with the drainage line in the central north of the site. A Bushfire Management Plan has been prepared for the area by Bio Diverse Solutions and is attached as Appendix B.

4.5 Heritage

An online search of the Aboriginal Heritage Inquiry System indicated that the site was not listed as a Registered Aboriginal Site or Survey Area.

A search of the Heritage Council WA data base also found no recorded sites of European heritage.

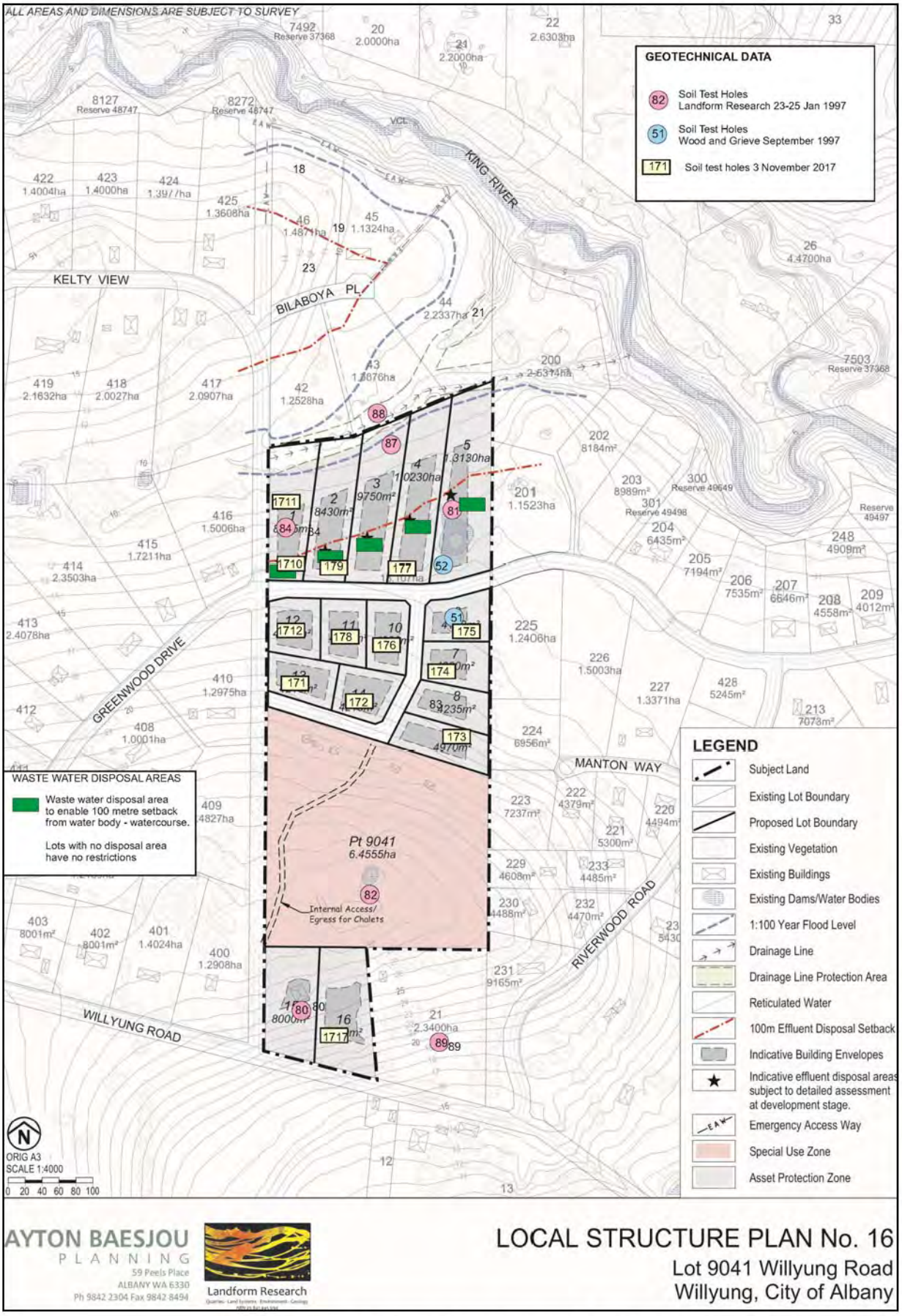


Figure 6 - Flood & Waste Water Disposal Areas plan

4.6 Servicing

4.6.1 Roads

Vehicular access is provided by Willyung Road and Greenwood Drive, which have both been constructed to a bitumen standard. Greenwood Drive is the only road which will need to be extended to support the proposed subdivision. It will link up with Greenwood Drive which has already been constructed immediately to the east of the subject land. This will complete the main subdivisional loop road which will provide an overall through access and egress to the locality. Lots 7-9. 13 and 14 will require a secondary loop road to be constructed as so to avoid battleaxe legs.

4.6.2 Water

Scheme water is available to service the proposed subdivision.

4.6.3 Effluent Disposal

As scheme sewer will not be provided, appropriate on-site effluent disposal systems will be required. Conventional septic systems are not suitable given the site is within a sewerage sensitive area. Alternative nutrient adsorbing waste water disposal systems are recommended. Indicative effluent disposal areas that meet the requirements of the dGSP and LPS1 are shown on the Structure Plan.

4.6.4 Power and Telecommunications

Power and telecommunications services have been established in the area and can be extended to service the proposed development.

4.6.5 Stormwater

The Landform Research document recommends that the best way to assist drainage is to encourage the use of rainwater collection and use for a potable supply or garden watering, and to require disposal of stormwater on each lot through soak wells located in sand fill areas. The use of swale drains in association with proposed roads is also recommended. This may negate large surface flows and reduce the need for infiltration basins. Most of the roads are already in place and associated swales have been shown to work effectively.

5.0 LAND USE AND SUBDIVISION REQUIREMENTS

The Local Structure Plan aims to further modify the original Willyung Subdivision Guide Plan which was endorsed in 1999, and amended in 2009 (twice), 2012 and 2013. In accord with the City of Albany Local Planning Strategy, it is proposed to make more efficient use of the land which is zoned for Special Residential purposes with a minimum lot size of 4000m^2. The original plan was based predominantly on lots in excess of 1.0ha.

5.1 Landuse

It is proposed to retain the existing landuse which includes:

- Special Residential lots with a minimum lot size of 4000m^2; and
- Holiday accommodation within the Special Use zone.

The Structure Plan Summary Table in the Executive Summary outlines the key outcomes of the Plan.

While no change is proposed to the Special Uses zone, the number of special residential lots will be increased from 8 to 16, an overall increase of 8 lots. Approximately 37 people will be accommodated within the additional lots.

5.2 Suitability of Proposed Landuses

The Land Capability - Geotechnical Assessment (Appendix A) concludes that the site is highly suitable for the proposed special residential subdivision with a minimum lot size of 4000m^2 for the following reasons:

- The proposed development sites are located on cleared land with no requirement to clear remnant vegetation.
- The soil types and utilisation of alternative treatment units for on-site effluent disposal are highly capable of accepting the nutrient loading and will minimise the potential for the export of nutrients from the site.
- The change in landuse from the agistment of stock to special residential lots will reduce the nutrient loading and significantly reduce the nutrient export risk.
- The predominantly cleared development areas reduce the bushfire risk.
- Essential infrastructure such as sealed bitumen roads, underground power and a scheme water supply are already available to service the development.
- Special residential development with lot sizes ranging from 4000m^2 to over one hectare is compatible with the surrounding special residential development which has been successfully established over the last eighteen years.
- The increase in number of lots created on the site represents a more efficient use of the land..
- The undulating nature of the topography, presence of pockets of remnant vegetation and backdrop of the heavily vegetated King River foreshore contributes to an area of high amenity for special residential development.
- The land is not located in the pathway of future fully serviced urban development while at the same time having reasonably convenient access to services provided in and around Albany.
- The extension of Greenwood Road will complete the main loop road serving the locality which will significantly improve access and egress to the area.

6.0 CONCLUSION

The Willyung Road Local Structure Plan further modifies the original 1999 Subdivision Guide plan to increase the number of Special Residential lots on Lot 9002 from 8 to 16. This is in line with consolidation that has been occurring within the area in response to the demand for smaller lots which has been supported by land suitability and capability assessments. The original land capability study has been revisited and additional site testing carried out. The assessment concluded that the site is highly suitable for further development and that the risk of phosphorous or nitrogen leaching into any waterway is insignificant to nil. All effluent disposal areas will be located at least 100m from creek or drainage lines and alternative nutrient absorbing effluent disposal systems are recommended.

A bushfire management plan has also been prepared to ensure the development meets current guidelines. In particular, the development will facilitate the completion of Greenwood Drive which will provide two way access and egress for a significant area of the Willyung Road Special Residential Area.

Appendix A

Land Capability-Geotechnical Assessment

Landform Research

June 2018

LAND CAPABILITY - GEOTECHNICAL ASSESSMENT

LOTS 44 and 46 BILABOYA PLACE and LOT 9041 WILLYUNG ROAD, WILLYUNG, ALBANY

CITY OF ALBANY

June 2018

LAND CAPABILITY - GEOTECHNICAL ASSESSMENT

LOTS 44 and 46 BILABOYA PLACE and LOT 9041 WILLYUNG ROAD, WILLYUNG, ALBANY

Prepared for AYTON BAESJOU PLANNING

DOCUMENT PREPARED BY

Lindsay Stephens BSc (Geology), MSc (Plant Ecology)
Mem Aus Geomechanics Soc – MEIANZ – FIQA

U1 49 Birdwood Avenue Como WA 6152
Tel 08 9474 3978, landform@iinet.net.au

SUMMARY OF LAND CAPABILITY AND GEOTECHNICS

Lots 44 and 46 Bilaboya Place and Lot 9041 Willyung Road is proposed to be subdivided to rural living lots. The surrounding land to the east and west has already been developed and roads allocated across the subject land.

The proposed subdivision is bounded by Willyung Road in the south and the King River in the north. It lies 2.3 kilometres upstream of the Upper King Bridge, 7.5 km upstream from the mouth of the King River and 7 km from the Albany townsite.

The site has been used for grazing and rural living. The land uses are the same as those on the adjoining land, prior to subdivision and development.

A chalet facility is located in a bush remnant in the central south.

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.

The site and local area has been extensively studied for environmental issues and in particular flood risk.

The site is cleared, but has scattered trees around the lower lying areas and an area of remnant vegetation in the south on which are located a series of chalets.

Currently the site is largely cleared with only small areas remaining uncleared. Land to the west has been subdivided and is in the process of being built on.

The land is used for grazing and there are currently no dwellings, although a dwelling is located on Lot 45, between Lots 44 and 46, near the King River.

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 bee drained. The chalet area is a laterite gravel covered low ridge.

With such large lots, building envelopes are able to be located adjacent to existing and proposed roads, maintaining the existing vegetation, foreshore reserves, setbacks and providing flood protection.

The suit is highly suitable for the developments proposed and is no different from the adjoining developed land.

Alternative – nutrient adsorbing waste water disposal systems are recommended.

Foundation stability is high.

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

Nutrient Loss Risk

The reduced **phosphorus** from alternative systems when compared to conventional septic systems is shown by the Department of Health Approved Treatment Units where all units are listed as being capable of removing over 50% of the phosphorus and most are capable of removing over 97% of P depending in the unit chosen.

Even soils with a PRI of 1.5 will adsorb all the phosphorus when the 100 metres minimum travel paths through the soils to the closest water bodies. At PRI 1.5 each cubic metre of soil is capable of adsorbing 2.25 kg P. Allowing for only a 1 metre wide flow path, the minimum 100 travel distance will be capable of adsorbing 225 kg P or the total phosphorus released from well over 100 years even being very conservative. In reality with the larger flow paths the phosphorus will probably never reach any waterway.

Gerritse 2002 provided PRI for soils in the King River and Lower Kalgan catchments. The lowest PRI was 8 with a surface sand of "deep sand – podsol" having a PRI of 0 but the subsoil had a PRI of 390.

The risk from phosphorus is therefore not a significant risk from alternative waste water or nutrient adsorbing systems. These reductions in phosphate export risk are in line with Government Policy.

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

The increased effectiveness of nutrient adsorbing waste water systems is demonstated in research by Envirosafe which has found that nitrogen is reduced by 75% at the edge of the waste water disposal area, (Jo Hopley Envirosafe, 31 July 2002) and then further reduced by the soils.

The dentrification provided in the alternative systems when compared to the loadings is shown by the Department of Health Approved Treatment Units where all units are listed as being capable of removing over 50% to over 97% of N depending in the unit chosen. Those reducions are achieved at the edge of the nutrient adsorbing system.

The critical factor is retaining water in the soil or on site for as long as possible. With the proposed lots and gentle slopes, treated waste water will be retained by dense pasture and slow lateral flow and a minimum travel distances of 100 metres through soils after leaving the edge of the waste water system

The risk of nitrogen loading or leaching to a waterbody is therefore regarded as insignificant to nil.

The proposed subdivision with the proposed lot sizes will not lead to any significant increases in nutrient loading to the King River or Oyster Harbour.

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TABLES

FIGURES

1.0 INTRODUCTION

Site Assessment – Methodology - History

The study site on Willyung Road was assessed by field work on 23, 24 and 25 January 1997, as part of a study for a larger subdivision area. At that time discussions were held with property owners, over 100 soil test holes were sunk, the soils were assessed and the flood potential investigated. Flood levels were determined by geomorphological mapping and discussions with local people and a comparison of earlier floods.

Wood and Grieve completed a series of soil test holes on 16 October 1998 across the wider area including on the subject land.

The best time of year to complete soil testing is in late winter for soil moisture, and a late winter survey is proposed, which in Albany late September early October timing is best as the water tables are highest at that time. This was the time that Wood and Grieve completed their study in 1998, the data from which remains valid today.

At that time the depths to the highest winter water tables were predicted from ground observations and observations of the soil profiles.

In November 2008 a 0.5 surface contour survey and spot elevations was completed by John Kinear and Associates.

Since that time extensive work has been completed on adjoining land and the Willyung Flood Study has been published, which provides indications of flood levels for the study land but does not quite impact on the land. The City of Albany commissioned a flood study of Willyung Creek and this resulted in the publication of a flood study by GHD in 2007.

As a result of the field work and considerations a subdivision was approved across the whole of the land, the subdivision constructed and the land subdivided. Generally the lots were 2 hectares in area.

The approved subdivision guide plan provided the setbacks from Willyung Creek and King River and these were reflected in the subdivision of the subject land and the adjoining land upstream and downstream.

A key part of this study was to incorporate the GHD flood study mapping into more accurate field investigations, to better define the developable area.

During this latest study the soils were surface mapped to check the boundary areas particularly near winter wet areas and areas potentially subject to flooding.

Since the original subdivision the land has been developed and some lots sold.

During the same time frame, adjoining land to the east has also been subdivided and developed with lot sizes down to less than 1.0 hectares.

The other changes that have occurred since the original subdivision are

- Recognition of the potential bushfire impacts on peri - urban land.
- The difficulty with maintaining a low bushfire risk on larger lots.
- The need to reduce lot sizes to maximise land use and consolidate developments.
- The updated Sewerage Policy which remains in draft form.

- The development of better and more efficient waste water systems with respect to usable life and nutrient management.

- The recognition of the importance of keeping developments consolidated for ease and cost of servicing and reduced environmental impacts.

In order to check whether the land can support this level and type of development a site study was completed by Lindsay Stephens of Landform Research on 3 November 2017 when further soil test holes were excavated to up to 1.8 metres on all lots to be subdivided. It should be remembered that each of these lots is currently approved for development of one dwelling with associated on site waste water disposal and all that was being assessed is whether a second dwelling could be constructed on each lot.

The soil test holes were dug with a mini excavator and the soils and depths to the water table were assessed. The results of the soils testing are attached in the soil logs which include the logs for the past holes. The timing of the soil testing was felt appropriate as the winter of 2017 in Albany received above average rainfall in months July to September inclusive, even though October was slightly below average.

The soils remained wet and the water tables remained at or near their peak winter elevation. In addition the elevation of the water tables could be compared to the data from October 1998. There was also the potential to allow for greater separations to the water table.

In all test holes the water table significantly exceeded the generic 0.5 metre separation even though the draft Sewerage Policy permits fill and drainage to achieve satisfactory separations. These constructions are not necessary.

On 3 November 2017 the now available one metre contours were used in conjunction with site geomorphological observations to refine the potential flood elevations. The elevations of the flood are set much more conservatively and are based on the potential for the King River, Willyung Creek and other watercourses all to be flooding on a situation of a high tide and wave or tidal surge. Because land above these conservative nominations is available, the building envelopes have been set back at a very conservative elevation.

Site Description

The proposed subdivision is bounded by Willyung Road in the south and the King River in the north. It lies 2.3 kilometres upstream of the Upper King Bridge, 7.5 km upstream from the mouth of the King River and 7 km from the Albany townsite.

The King River is navigable and tidal from Oyster Harbour to just downstream of the subdivision.

The site is cleared, but has scattered trees around the lower lying areas and an area of remnant vegetation in the south on which are located a series of chalets.

Current Land Use

Currently the site is largely cleared with only small areas remaining uncleared. Land to the west has been subdivided and is in the process of being built on.

The land is used for grazing and there are currently no dwellings, although a dwelling is located on Lot 45, between Lots 44 and 46, near the King River.

The land in the central south, which is occupied by remnant low forest, is a chalet development.

Proposed Developments

For the reasons listed above, the larger lots on the subject land are proposed to be split in half to produce lots varying from 0.4 hectares to over 1.0 hectares depending on the proximity to the King River and the soils.

This reduction in lot sizes is in line with current thinking for developments.

It is proposed to allocate 22 lots of larger than 1 ha on the lower elevation land with some lots averaging over 0.4 hectares on the more elevated land. The four chalets are to be retained within the remnant vegetation as a single lot.

The proposed subdivision has lots down to 0.4 hectares although counting the remnant forest there will only be 22 dwellings and 4 existing chalets on an area of around 25.8 hectares or a loading of one waste water system per hectare.

2.0 WEATHER CONDITIONS

Climate

The climate of Albany consists of cool winters followed by warm summers.

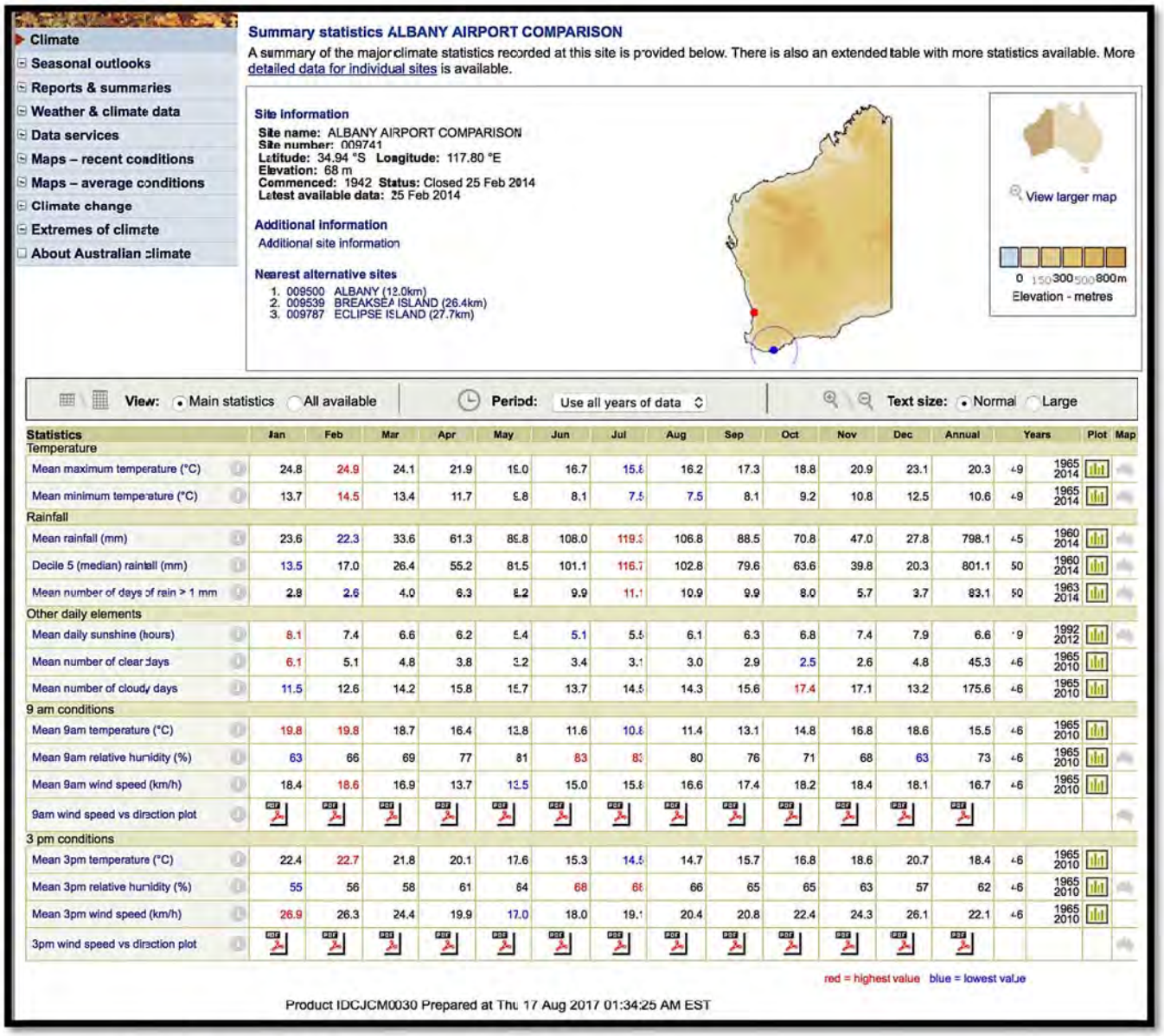
Weather data is recorded at Albany and Albany Airport.

The overall climate however is warm, dry summers with cool, wet winters. Drizzle from onshore winds is common during summer nights and mornings.

Rainfall at Albany Airport is 798 mm per year and 932 mm in the town, and 794 per year at Kalgan River. Rainfall on site will therefore be likely to be somewhere between those figures. Mean monthly rainfall varies from near 20 mm in summer months to 130 mm in the winter months.

Temperatures could be expected to have a summer maxima of 25^{o}C in the hottest months down to just over 15^{o}C in the coldest months, July and August. Minimum temperatures range down to 10^{o}C in the coldest months.

Annual evaporation is less than 1000 mm per year, with rainfall exceeding evaporation for almost nine months of the year.



- Climate
- Seasonal outlooks
- Reports & summaries
- Weather & climate data
- Data services
- Maps – recent conditions
- Maps – average conditions
- Climate change
- Extremes of climate
- About Australian climate

Summary statistics ALBANY AIRPORT COMPARISON

A summary of the major climate statistics recorded at this site is provided below. There is also an extended table with more statistics available. More detailed data for individual sites is available.

Site information

Site name: ALBANY AIRPORT COMPARISON
Site number: 009741
Latitude: 34.94 °S **Longitude:** 117.80 °E
Elevation: 68 m
Commenced: 1942 **Status:** Closed 25 Feb 2014
Latest available data: 25 Feb 2014

Additional information

Additional site information

Nearest alternative sites

1. 009500 ALBANY (12.0km)
2. 009539 BREAKSEA ISLAND (26.4km)
3. 009787 ECLIPSE ISLAND (27.7km)

View larger map

0 150 300 500 800m
Elevation - metres

View: Main statistics / All available | Period: Use all years of data | Text size: Normal / Large

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years		Plot	Map
Temperature																	
Mean maximum temperature (°C)	24.8	24.9	24.1	21.9	19.0	16.7	15.8	16.2	17.3	18.8	20.9	23.1	20.3	49	1965 2014		
Mean minimum temperature (°C)	13.7	14.5	13.4	11.7	9.8	8.1	7.5	7.5	8.1	9.2	10.8	12.5	10.6	49	1965 2014		
Rainfall																	
Mean rainfall (mm)	23.6	22.3	33.6	61.3	86.8	108.0	119.3	106.8	88.5	70.8	47.0	27.8	798.1	45	1960 2014		
Decile 5 (median) rainfall (mm)	13.5	17.0	26.4	55.2	81.5	101.1	116.7	102.8	79.6	63.6	39.8	20.3	801.1	50	1960 2014		
Mean number of days of rain > 1 mm	2.8	2.6	4.0	6.3	8.2	9.9	11.1	10.9	9.9	8.0	5.7	3.7	83.1	50	1963 2014		
Other daily elements																	
Mean daily sunshine (hours)	8.1	7.4	6.6	6.2	5.4	5.1	5.5	6.1	6.3	6.8	7.4	7.9	6.6	19	1992 2012		
Mean number of clear days	6.1	5.1	4.8	3.8	3.2	3.4	3.1	3.0	2.9	2.5	2.6	4.8	45.3	46	1965 2010		
Mean number of cloudy days	11.5	12.6	14.2	15.8	15.7	13.7	14.5	14.3	15.6	17.4	17.1	13.2	175.6	46	1965 2010		
9 am conditions																	
Mean 9am temperature (°C)	19.8	19.8	18.7	16.4	13.8	11.6	10.8	11.4	13.1	14.8	16.8	18.6	15.5	46	1965 2010		
Mean 9am relative humidity (%)	63	66	69	77	81	83	83	80	76	71	68	63	73	46	1965 2010		
Mean 9am wind speed (km/h)	18.4	18.6	16.9	13.7	12.5	15.0	15.8	16.6	17.4	18.2	18.4	18.1	16.7	46	1965 2010		
9am wind speed vs direction plot																	
3 pm conditions																	
Mean 3pm temperature (°C)	22.4	22.7	21.8	20.1	17.6	15.3	14.5	14.7	15.7	16.8	18.6	20.7	18.4	46	1965 2010		
Mean 3pm relative humidity (%)	55	56	58	61	64	68	68	66	65	65	63	57	62	46	1965 2010		
Mean 3pm wind speed (km/h)	26.9	26.3	24.4	19.9	17.0	18.0	19.1	20.4	20.8	22.4	24.3	26.1	22.1	46	1965 2010		
3pm wind speed vs direction plot																	

red = highest value blue = lowest value

Product IDCJCM0030 Prepared at Thu 17 Aug 2017 01:34:25 AM EST

Table 1 Climate Data

3.0 REGOLITH AND SOIL ASSESSMENT

3.1 Geology and Geomorphology

The site lies in gently undulating country of the southern valley side of the King River.

Much of the southern portion of the site lies on a series of alluvial terraces and floodplain associated with King River.

Elevation varies from 9 metres AHD in the central north dropping to below 7 metres at King River and a small tributary in the central north before rising to a ridge of 30 metres AHD in the central south of Lot 9041 and then dropping to 18 metres AHD at Willyung Road.

The whole site is underlain by undulating porphyritic granite basement rocks of Proterozoic age. The granite outcrops irregularly as isolated boulders across nearby land indicating that the basement is relatively close to the surface. Near the granite boulders the surface is covered by coarse sand originating from weathering of the granite.

Much of the remainder of the site is underlain by fine silty clay sand of likely Plantagenet Group origin, either resorted or deposited on the underlying materials.

The ridge in the south is occupied by laterite gravel.

Geological History

The geological history of the area is important to an understanding of the hydrology of the site.

In the Tertiary the site was an undulating land surface developed on granite. Flooding of the landscape allowed for deposition of horizontally bedded siltstones of the Plantagenet Group, infilling the valleys between the small granite hills and ridges.

With changes to sea levels a series of alluvial terraces developed, at about 8 and 15 metres, which are present across the local area. On the subject land the terraces are gently sloping as they have degraded.

The current Willyung Creek and King River reworked and eroded the alluvial terraces to form the current pattern with an incision into the previous alluvial surface. No floodplain has developed as yet for the King River in this area where steep valley slopes are present along its frontage.

It is unclear when the laterite formed but may predate the alluvial down cutting and is likely to reflect an earlier surface on which the laterite capping provided greater resistance to erosion or it may relate to laterite development on the higher land surface. The evidence seems to suggest that the gravel predates the finer covering sand in the south.

3.2 Regolith and Soils

The soils are sandy on the lower elevations with sand over the Plantagenet Group on the upper ridges and sandy loams associated with granite outcrops. Sediments exposed in the base of dams in the north west outside this location appear to be Plantagenet siltstones.

The site has widespread covering of redistributed sand which blankets the higher elevations. This was originally yellow containing a small amount of clay. Clay is leached and moves down through the profile to deposit in the lower horizons.

With weathering, organic compounds in the upper soil horizons have leached the yellow goethite covering from the sand grains moving it downwards to be deposited as ferricrete pebbles and hard pan above the clay enriched subsoils. Organic material from the surface layers is also deposited at the ferricrete layer making it slightly peaty in places, generally in the wetter areas outside the building envelopes.

In most locations the clay sub-soils may be Plantagenet sediments which outcrop to the north of the King River and in dams further to the west and could be expected to underlay the site.

The soil formation process therefore creates a leached surface layer of fine quartz sand over an organic ferricrete layer at depths of between 300 to 2 000 mm. Frequently the sand becomes more clay rich with depth, grading to clay sand or sandy clay which further restricts vertical penetration of shallow ground water. The ferricrete reduces percolation of precipitation leading to the formation of perched water tables. In addition the fine grainsize of the sands restricts horizontal drainage and leads to areas on the back of the alluvial terraces being subjected to seasonal water logging.

The leaching processes which produce the ferricrete hard pans have occurred several times in the past under seasonally wet and dry conditions and are still taking place today.

The flood plains are covered by reworked white quartz sand which is better sorted with less clay, over clays probably of alluvial origin.

Weathering of granite outcrops leads to local areas of coarser quartz sand soils.

The alluvial terraces have four soil units developed on them. The ridge is a laterite soil on elevated ground and the lower lying potentially flooded area is seasonally waterlogged.

The soils have been mapped on a number of occasions, not just across the subject land but the adjoining land and nearby land between the King River and Willyung Road, from 1997 until current by Landform Research and other consultants.

A number of soil test holes have been located across the wider area on the subject land and these are attached.

On site the soils are summarised in the table below.

Table 2 Soil Descriptions

Soil Type	Description	Broad Soil Unit
L	Laterite Duricrust and Gravel	Ridge laterite and duricrust
SL	Fine leached sand over laterite duricrust and gravel at less than 0.5 metres	Terrace sand over hardpan/clay
S	Sand over ferricrete at depths off 0.5 – 1.8 metres. Fine sand of likely Plantagenet Beds origin, either in situ or having been reworked.	Terrace sand over hardpan/clay
S/C	Sand over sandy clay, partially seasonally waterlogged.	Floodplain sand/clay
GS	Granitic sand derived from weathering granite either from the local basement or transported material predating the finer sands. Coarse quartz sand with increasing kaolin rich clay at depth.	Terrace sand over hardpan/clay
L/W	Partially waterlogged sand, predominantly leached over ferricrete at 0.5 – 1.5 metres	Terrace sand over hardpan/clay

Table 3 Soil Properties

Soil Characteristics	Terrace sand over hardpan/clay	Floodplain sand/clay	Laterite Ridge and Duricrust
Location	Alluvial terraces	Valley of the King River and small stream line in the central north.	Elevated ridge
Origin	Sand sheet over Plantagenet silty sediments with irregular granite basement at depth.	Fine sand reworked by the streams over alluvial clays	Laterite gravel and duricrust developed on granitic basement soils.
Top soil Texture	Fine grey sand	Fine grey sand	Brown laterite gravel with minor sand
Sub soil Texture	Leached white sand, yellow sand or clay sand over deep impermeable granite basement, ferricrete or clay.	Leached white sand, fine mottled sandy clay	Yellow brown laterite gravel and duricrust over granite basement at depth.
Rock in profile	Nil apart from basement material	Nil	Laterite duricrust from scattered to common.
Bedrock	Variable from 4 or more metres to 300 mm near granite outcrop	Generally deep but varying from several metres to one metre near granite outcrop	Generally deep but varying from several metres to one metre near granite outcrop
Gravel	Minor with ferricrete normally at less than 1 metre	Nil apart from ferricrete hard pan at less than 1 metre	Major component of the upper surface horizons
Hardpan	Common, organic/ ferricrete layer is widespread, at generally less than 1 metre depth	Common, organic/ ferricrete layer is widespread, at generally less than 1 metre depth	The duricrust forms a discontinuous hard pan.
pH	Neutral to acidic	Neutral to acidic	Neutral to acidic
Salinity	Low	Low	Low
Waterlogging	Generally well drained.	Some areas experience winter perching of the water tables.	Dry through winter.
Soil Permeability	Moderate to high depending on depth of impermeable layer and grainsize of sand	High in the sand but restricted by the presence of hard pan at depth	High, dropping in the clay based subsoils.
Soil Shrinkage	No expansive soils or clays were noticed but some clayey subsoils are likely to experience minor contraction on drying. Sand is not expansive.	No expansive soils or clays were noticed but some clayey subsoils are likely to experience minor contraction on drying. Sand is not expansive.	No expansive soils or clays were noticed but some clayey subsoils are likely to experience minor contraction on drying. Gravel is not expansive without significant clay being present.
Water Repellence	Minor in sands of this type, and may occur on the ridges.	Low	Low
Soil Compaction	Low	Low	Low
Dispersible Soils	Nil	Nil	Nil
Susceptibility to wind erosion	Low because of the climate	Low because of the climate	Low
Susceptibility to water erosion	Generally low but surface water directed over steeper slopes can erode	Low	Generally low but surface water directed over steeper slopes can erode
Rooting depth	The soils are sandy to depth with rooting depth restricted by the winter water table.	The soils are sandy to depth with rooting depth restricted by the winter water table.	Low but may be partially restricted by higher clay levels at depth

Water logging	Some minor winter wet areas where the underlying clay is closer to the surface or low elevations.	Some winter wet areas at low elevations.	Nil

Conclusions

The soils are no different to the soils of the approved and developed lots that adjoin to the west and east based on the soil mapping conducted by Landform Research and other consultants.

That information and data was used to gain approval of subdivisions on that land which is now well developed with dwellings showing no adverse impacts or creating any known adverse conditions.

Regolith and Soils and Recommended Management	
Regolith and Soils	• Soils have high capability for development with subdivision design being used to overcome any limitations. • The soils are similar to those already subdivided and developed in the nearby and adjoining areas. • The building envelopes are selected to avoid any deleterious conditions or conditions which will not comply with the Government Sewerage Policy. • Any adverse conditions are 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 *State Planning Policy 3.4, Natural Hazards*. The work was conducted to various standards that are listed throughout the report, but particularly to *AS 1726 Geotechnical Site Investigations, AS 2870 Residential Slabs and Footings – Construction* and *AS 3798, Guidelines on Earthworks for Commercial and Residential Developments* in addition to Guidelines produced by the *Australian Geomechanics Society*.

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

A summary of the land capability of the site is shown in the tables presented below. A number of management issues can be identified and these are highlighted in the following notes. The management of these issues is covered in more detail in the Environmental Management of the site and the Foreshore Management Plan.

The main issues with land capability have been covered by the previous land capability and geotechnical studies conducted by Landform Research and other consultants on the subject land and on the adjoining and nearby land with the same soil types and characteristics.

This study is to refine the boundaries of the developable area for the subject land.

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

Table 4 Summary of Geotechnical Properties for Development

Soil Characteristics	Terrace sand over hardpan/clay	Floodplain sand/clay	Laterite Ridge and Duricrust	Issues Potentially Requiring Management
Foundation stability	Good foundation conditions due to the deep sands over silty clay over the identified developable area.	Reduced foundation stability because of waterlogging.	High foundation stability	Areas of reduced stability are excluded from the building envelopes.
Landslip Risk	Soils are flat to gently sloping.	Soils are flat to gently sloping.	Soils are very stable and dry	No special requirements
Ease of excavation	High	High	High even where duricrust is present	No special requirements
Compaction	Sandy soils are easy to compact.	Sandy soils are easy to compact.	Yellow brown laterite gravel and duricrust over granite basement at depth.	No special requirements
Expansive soils	No expansive soils or clays were noticed but some clayey subsoils are likely to experience minor contraction on drying.	No expansive soils or clays were noticed but some clayey subsoils are likely to experience minor contraction on drying.	No expansive soils or clays were noticed but some clayey subsoils are likely to experience minor contraction on drying.	No special requirements
Phosphate retention	Phosphate retention levels are low in leached surface sands such as this. The subsoils have good phosphate retention.	Phosphate retention levels are low in leached surface sands such as this. The subsoils have good phosphate retention.	Good phosphate retention	Alternative or nutrient adsorbing waste water systems will be used and overcome any potential reduced capability
Nitrogen loss and denitrification	All soils have sufficient capability for denitrification to occur because of their denitrification potential from reducing conditions.	All soils have sufficient capability for denitrification to occur because of their denitrification potential from reducing conditions.	All soils have sufficient capability for denitrification to occur because of their denitrification potential from reducing conditions.	Managed by the waste water design and installation.

Microbial purification	Soils have low capability for this. Nutrient adsorbing/ alternative waste water systems are designed to remove microbial material.	Soils have low capability for this. Nutrient adsorbing/ alternative waste water systems are designed to remove microbial material.	High capability	Managed by the waste water design and installation.
Acid sulfate	Organo ferricrete sands were only encountered below the level at which they are likely to be disturbed by development. Deep excavations are unlikely with fill the most likely option during development. Extensive testing on adjoining properties on lower elevation land did not reveal any risk.	Organo ferricrete sands were only encountered below the level at which they are likely to be disturbed by development. Deep excavations are unlikely with fill the most likely option during development. Extensive testing on adjoining properties on lower elevation land did not reveal any risk.	Nil	The subsoils are unlikely to be exposed but rather be filled.

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 site is underlain by deeper silica sands over silty and clayey sands of the Plantagenet group with the sand over clay alluvium generally excluded from development.

Even the lower elevations have deep sand, however there is a thick layer of grass and some spongy nature to the topsoil in the upper 300 mm that can reduce foundation stability if not removed.

Removal of the top 300 mm of vegetated soil is normal, and in lower elevations when combined with fill can also provide good foundation stability.

No evidence of peat was observed although some organic and ferricrete enriched sand was observed in one hole at depths in excess of 1.2 metres. See the attached soil logs.

Natural foundation stability from the field observations is rated as AS 2870 Site Class S to M on the ridge and Site Class M on the lower lying soils. With fill and site preparation this can be managed to AS 2870.

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 clayey sands. This does not affect the laterite soils.

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 subsoils which have some clay fraction are less readily compacted if excavated and replaced as fill and will generally require additional sand fill rather than the use of sub soils.

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 minor 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 cut off 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 soil 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. On the upslope side it is recommended that the floor elevation is at least 300 mm above the upslope natural land surface to allow adequate drainage and prevent storm flooding risk.

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.

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.

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.
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 only dams and soaks are on the low lying areas outside the proposed building envelopes. A dam/soak does lie on proposed Lot 5. Soil testing in winter 1998 and on the adjoining proposed Lot 6 demonstrated that the separation to the ground water was possible up slope from the soak. There is also potential for waste water disposal down slope or to be pumped upslope.

Risk Identified with Dams and Recommended Management	
Dams	• No observed risk for the dams and none is anticipated.
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 winter wet soils are more susceptible than dry ridge soils of higher elevations in the south.

The soils on the ridge provide good foundations when correctly filled and are the same risk as those of nearby dwellings and locations on lower lying sands. Risk in this area can be mitigated by the design and construction of foundations, and is covered under Foundation Stability.

The potential for ground vibration on the lower water logged area may need to be considered during the design of footings, and included within foundations and structural stability as is normally the case on soils such as this which are common in Albany.

The lower lying more susceptible soils are excluded from the developable area, as all building envelopes are located on the slightly elevated better drained land.

Earthquake Risk Identified and Recommended Management	
Earthquake	• Covered by the considerations in 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 play an important role in reducing the sulfates within the sediments to form the iron sulfide. It is a natural phenomena, that only becomes an issue when the sulfidic materials are exposed to the atmosphere through disturbance.

Potential acid sulfate conditions most commonly form under current or past estuarine conditions, peaty conditions. The soils most at risk are normally saline/estuarine soils, gley soils, peat and some organoferricretes. The conditions may also result from weathering of some geological formations and situations which contain sulphides but these rocks are not present locally.

Materials at risk under reducing conditions are normally grey in colour or have been grey with no yellow brown or red brown iron oxides. When exposed to the atmosphere there is a change to brown iron oxides, with yellow jarosite and other alteration minerals that are distinctive.

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

Acid sulfate only becomes a potential risk when a number of circumstances are present.

- There is rock, soil or regolith present that is carrying sulfides.
- Sulfide carrying materials from below the water table are to be exposed to the atmosphere.
- Excavation below the water table is to be carried out exposing the sulfide carrying materials to oxygen in the atmosphere.
- Dewatering of the sulfide carrying materials is proposed, exposing them to oxygen.
- Exposure of peat or organoferricrete materials, that were permanently under reducing conditions, to the air.

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 and this has been incorporated into the Queensland Guidelines. Definitive survey procedure is contained in DWER 2013, Identification of Acid Sulfate Soils.

This documentation forms the basis for much of the assessment procedures in Australia, including those adopted by the Western Australian Planning Commission and the Department of Water Environment Regulation.

The key step in identifying acid sulphate conditions is a geological and regolith examination of the locality to firstly identify the any risks, chemical pathways and potential management.

Secondary to detailed field assessment, is the testing of the materials. There is no simple test for acid sulphate conditions and the tests used frequently give false positives. Therefore sample and laboratory testing should only be conducted to check, or quantify field observed risks.

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 oneweek to a month for changes to pH.

Laboratory testing is conducted using oxidation to speed up the natural oxidation of the soils on exposure to the atmosphere, using of H_2O_2 or another oxidising agent. The testing then tries to quantify the amount of oxidation and acid development.

The geology and regolith of the local have been assessed extensively and the soil test holes and soils examined by Lindsay Stephens of Landform Research to assess any likely racid soil potential, from hand assessment and composition.

WAPC Planning Bulletin Number 64, identifies the whole area as "buff coloured" on WAPC Planning Bulletin 64; "Low to no risk of AASS and PASS occurring generally at depths of >3m" for all the elevated ground. The tidal area of the King River is listed as "red" but this does not form part of the development. Low areas adjacent to the King River are shown as yellow, "Moderate to Low risk (yellow) of acid sulfate conditions (AASS and PASS) occurring below 3 metres depth".

The WAPC mapping is broad scale from aerial photography and contours and does not take into account local mapping.

The site has been inspected by Lindsay Stephens of Landform Research on many occasions Based on the materials present, the regolith and the site conditions, none of the risk factors for acid sulfate are present.

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

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

No at risk areas or "suspect" minerals or conditions have been identified during the site investigations or soil auger holes.

Acid Sulfate Risk Identified and Recommended Management	
Acid Sulfate	• WAPC Planning Bulletin Number 64, identifies the whole area as buff coloured, Low to No risk 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. No risk areas have been identified. • No deep excavation or additional drainage is required. • The building envelopes are located on elevated well drained land.
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.

Australian Standard 1726 (2017) 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.

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, Department of Health Guidelines for the Reuse of Greywater in Western Australia, to Department of Health, 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 (2012) 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.

The soils are common in the Albany area and are similar to those in the local area.

Soil Type

The soils are locally common and are similar to those in the adjoining subdivisions.

The sandy upper surface horizons have low 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 Oyster Harbour.

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 by house holders during the application stage for dwellings and must be approved by the City of Albany. 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.

These areas have been excluded from the building envelopes.

Water Table

Detailed site investigations were conducted on 23, 24 and 25 January 1997, as part of a study for a larger subdivision area when over 100 hand auger soil test holes were sunk, the soils were assessed and the flood potential investigated.

Subsequently additional soil test holes were conducted by Wood and Grieve on 16 October 1998, which refined the groundwater elevations, and as a result the subdivision guide plan was approved.

The building envelopes are elevated and comply with the separations of 500 mm to the highest known water tables, based on field mapping and the soil test holes.

In order to check whether the land can support this level and type of development a site study was completed by Lindsay Stephens of Landform Research on 3 November 2017 when further soil test holes were excavated to up to 1.8 metres on all lots to be subdivided.

It should be remembered that each of these lots is currently approved for development of one dwelling with associated on site waste water disposal and all that was being assessed is whether a second dwelling could be constructed on each lot.

The elevations of the water tables are shown on the attached soil test hole logs. All proposed lots have locations where the water table is well in excess of the generic 0.5 metre separation to the highest known groundwater elevation. This, combined with the ability for waste water systems to be constructed, demonstrate the soils on the building envelopes meet the separation requirements.

Setbacks from Water bodies

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

It is noted that Water Quality Protection Note 70 (DWER 2016) recommds a separation of 100 metre between waste water disposal and a watercourse. The subdivision is consistent with this guidelines.

The building envelopes comply with these guidelines and the King River is already provided with a foreshore reserve.

The building envelopes are adjusted to provide a 100 metre separation to the watercourses and the King River. The 100 metre line is shown on the Structure Plan as the red dotted line. The exceptions are proposed Lots 4, 8 and 9 all of which have a portion of the proposed building envelope located outside the 100 metre separation line where waste water can be disposed to.

The 100 metre setback is also consistent with the 100 metre recommended setback in the 2016 Draft Government Sewerage Policy.

Infiltration results

No infiltration tests were conducted on site. All surface sands are permeable and the underlying sand clays and clay sands are slowly permeable.

Most soil, apart from the gravel areas, has a minimum of 500 mm sand over the loam – clay. The loam – clay is slowly permeable. See the soil test holes.

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.

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.

Soil permeability tests were not conducted because the soils are sand and obviously of high permeability.

Geotechnical Assessment for Waste Water Disposal and Recommended Management	
Waste Water Disposal	• The building envelopes are suitable for 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.*
	• *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 type of waste water system and its installation can be used to ameliorate any potential problems.

A site specific consideration of the in ground behaviour of phosphorus, nitrogen and microbial inputs is undertaken as outlined below to ensure that nutrient impacts from waste water disposal can be effectively managed.

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 Oyster Harbour.

The nutrient management issues for rural living lots relate to waste water disposal and gardens and are not dependant on lot size. If stock are retained they may also have an impact on nutrient loadings.

As the proposed building envelopes comply with the separations to the water tables and the soil geotechnical capability, the issue then becomes the potential for nutrient to impact on the soils and waterbodies.

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***

In recent times the land has predominantly been used for horse agistment and some cattle grazing. Currently cattle graze on the site and there are several rural living lots plus the chalet landuse.

Existing potential nutrient export comes from the washing of fertiliser, soil particles and nutrients predominantly into the soils. Because of the sandy permeable nature of the upper soil horizons there is potential for runoff from wet and waterlogged ground.

In summer cattle spend most of their time on the green pasture and any nutrients are therefore potentially concentrated and/or lost with autumn flushes of surface and shallow groundwater in potential wet areas. The worst time for this export is during winter when the soils are wet.

The presence of dung beetles can increase the rate of nutrient recycling and thus reduce the potential for nutrient export particularly during the moist months.

Current stocking rates for arable soils of the site are estimated to be 15 DSE or 1.5 adult cow per hectare. (1 breeding cow equates to 8 – 16 sheep depending on whether N or P are compared).

This equates to 15 DSE (dry sheep equivalents) for dry pasture and where limited supplemental feed is supplied. With a current average stocking rate of 15 DSE, the estimated nutrient loading when fully stocked with equivalent numbers of stock could be 86.4 /N/ha/year and 26.4 kg/P/ha/year (Van Gool et al, 2000).

This applies to the cleared and cultivated/grazed land only and not to the small amount of remnant vegetation in the central south.

Current potential nutrient export comes from the washing of fertiliser, soil particles and manure along drainage lines. The worst time for nutrient export is during summer storms, during the first autumn flush and in winter in central parts when the soils are saturated.

Phosphorous 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. Considerations of nutrient levels and behaviour are discussed in Albany Waterways Management Authority, 1994.

- **Proposed Land Use - Rural Living**

With subdivision, lot sizes will range from around 0.4 hectares to 1.6 hectares. As the subdivision is approved the only changes relating to this proposal are the creation of an additional 16 lots over the existing subdivided land.

The chalets are present on site and their nutrient management or impacts will not change. They are located in the remnant vegetation at a low nutrient loading for that portion of land.

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

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

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

A horse has a typical loading of 11 kgP/year and 60 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 Primary Industries and Regional Development (DPIRD).

Table 5 Typical Nutrient Loading from Land Use Changes

Possible lot size and activity	Nitrogen loading per hectare	Phosphorous loading per hectare	Likely nutrient scenario
Estimated average current stocking at 15 DSE per hectare	86.4 kg/N/ha/year	26.4 kg/P/ha/year	Unlikely to be nutrient export on gravel based soils. Probable nutrient export from winter wet soils.
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. No stock.	9.5 kg/N/ha/year (No stock) 39.5 kg/N/ha/year (1 horse)	2.8 kg/P/ha/year (No stock) 8.3 kg/P/ha/year (1 horse)	Lower nutrient loading. Significantly reduced nutrient export risk. A horse will add an additional 60 kg/N and 11 kg/P per year. The nitrogen will be readily denitrified on the winter wet soils and phosphorous levels will be similar to the current impact.
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	5.6 kg/P/ha/year	Lower nutrient loading. Significantly reduced nutrient export risk. A horse will add an additional 60 kg/N and 11 kg/P per year. The nitrogen will be readily denitrified on the winter wet soils and phosphorous levels will be similar to the current impact.
Likely nutrient input after subdivision to 0.5 hectare lots. Nutrient adsorbing or alternative waste water system. Small garden, small fertilised lawn, dog, cat, 6 fowl or additional garden. No stock.	38.0 kg/N/ha/year	11.2 kg/P/ha/year	Lower nutrient loading to rural land, if no stock are permitted, and a similar nutrient loading to 2.0 hectares lots that retain one horse.

- A variety of average lot sizes and stocking rates are used to provide an indication of nutrient inputs prior to and following subdivision. Horses are used as a likely example.
- The calculations above are made on the basis of the total area averaged across cleared land and remnant vegetation.
- It should be borne in mind that the nutrient loading does not equate to the risk of nutrient export. It forms a part of the export risk which also depends on the nature of the nutrient loading, its location, the behaviour of the soils and the climate.

- **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 sand over clay sand and sandy clay subsoils have a high risk of nutrient loss in solution from the saturated leached surface sands but when the waste water is contained in the subsoils or nutrient adsorbing waste water systems the risk is low as phosphorus is retained.

On the other hand the weak ferricrete layers that often 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.

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.

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.

Therefore on this subdivision, whilst the soils can lose phosphorus under natural conditions from stock, with nutrient adsorbing waste water systems the loss is minimal to nil unless the systems fail, and it is anticipated that the nutrient loadings will drop as a result of reduced stock as shown in the nutrient loading table above.

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

The reduced phosphorus from alternative systems when compared to conventional septic systems is shown by the Department of Health Approved Treatment Units where all units are listed as being capable of removing over 50% of the phosphorus and most are capable of removing over 97% of P depending in the unit chosen.

As alternative waste water systems are proposed, phosphorus adsorbing amended soils (PRI>20) are required for the waste water disposal area. These systems are nutrient adsorbing, and designed to adsorb all or almost all the phosphorous released in waste water.

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 designed to adsorb all or almost all the phosphorus released in waste water.

The adsorption of phosphorus occurs at the outlet of the system, and does not take into account phosphorus uptake by soils and plants, Even soils with a PRI of 1.5 will adsorb all the phosphorus when the 100 metres minimum travel paths through the soils to the closest water bodies. At PRI 1.5 each cubic metre of soil is capable of adsorbing 2.25 kg P. Allowing for only a 1 metre wide flow path, the minimum 100 travel distance will be capable of adsorbing 225 kg P or the total phosphorus released from well over 100 years even being very conservative. In reality with the larger flow paths the phosphorus will probably never reach any waterway.

Gerritse 2002 provided PRI for soils in the King River and Lower Kalgan catchments. The lowest PRI was 8 with a surface sand of "deep sand – podsol" having a PRI of 0 but the subsoil had a PRI of 390.

Therefore the risk from phosphorus is therefore not a significant risk from alternative waste water or nutrient adsorbing systems. These reductions are in phosphate export risk are in line with Government Policy.

Nitrogen

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

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

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

Nitrifying bacteria are widely present in soil and obtain their carbon from $C0_2$ and energy from the oxidation of NH_4 or $N0_2$ to $N0_3$. Denitrifying bacteria on the other hand reduce $N0_2$ and $N0_3$ to gaseous N_20 and N_2 which is lost to the atmosphere.

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

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

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

The removal of nitrogen is related to the oxygen conditions of the soils in addition to the microbial material present. The ammonium compounds that exit the two tanks of the waste water system are normally high in ammonia and nitrite and lower in nitrate. With exposure to oxygen the ammonia and nitrite are converted to nitrate under the influence of nitrifying bacteria. The nitrate is then stripped of oxygen by microflora, in reducing conditions and particles in the soil, in the presence of organic matter. This converts the nitrate to nitrogen gas which is lost to the atmosphere. This occurs in all soil types and is independent of the soil type, and depends on soil oxygen levels and to a lesser extent the nature of the soil particles.

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

Gerritse et al, 1995, recorded a total of 140 mg/L nitrogen (NH_4 - 100 mg/L and $N0_2$ - 40 mg/L), exiting a leach drain. After a travel distance through shallow soils of 1 metre this had dropped to between 20 and 100 mg/L, and by 3 metres the total nitrogen had dropped to 0.03 to 0.2 mg/L. When loaded with nitrogenous compounds the microflora of soils quickly adjusts to the loading, by increases in the number and type of bacteria. For example, under anaerobic conditions with nitrogen loading, the denitrifying bacteria increase significantly. This can be expected to occur in soil aggregates within the top 2.5 metres of soil, which is regarded as the active bed and root zone for the waste water disposal areas.

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

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

The treatment and loss of nitrogen does not depend on soil type but rather the waste water contacting soils in which microbial material can develop in reducing conditions.

All soils will work, even leached silica sand, as long as they are relatively permeable, which the soils on site are. 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.

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 occurs in soil aggregates within the wetter soil horizons, which is the active bed and root zone for the waste water disposal areas.

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 are. 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. See the nutrient loading table above.

The increased effectiveness of nutrient adsorbing waste water systems is shown by research by Envirosafe which has found that nitrogen is reduced by 75% at the edge of the waste water disposal area, (Jo Hopley Envirosafe, 31 July 2002) and then further reduced by the soils.

The dentrification provided in the alternative systems when compared to the loadings is shown by the Department of Health Approved Treatment Units where all units are listed as being capable of removing over 50% to over 97% of N depending in the unit chosen. Those reductions are achieved at the edge of the nutrient adsorbing system.

The critical factor is retaining water in the soil or on site for as long as possible. With the proposed lots and gentle slopes, treated waste water will be retained by dense pasture and slow lateral flow and therefore minimum travel distances of 100 metres through soils after leaving the edge of the waste water system

The risk of nitrogen loading or leaching to a waterbody is therefore not regarded insignificant to nil.

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.

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), shows that the average BOD released from a nutrient adsorbing system should be <20 mg/litre, prior to on ground disposal. The systems used on this site may not be aerobic in nature.

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

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

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

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

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

For comparison, with conventional septic systems the microbial purification applies to raw waste water with levels typically of BOD at up to 300 mg/L. The use of nutrient adsorbing waste water systems will result in greatly reduced microbial loading on soils.

On this site the sandy soils with gentle slopes and dense pasture will retain the waste water through slow lateral flow rates allowing large time frames for adequate microbial purification. This is particularly relevant when the quality of the water exiting the system is considered.

Therefore microbial contamination is not considered a problem on a well installed and maintained waste water system.

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 with subdivision. • 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.* • *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 waste water systems is recommended.
Nutrient Export	• The soils on site are highly capable of accepting the nutrient loading on lots down to less than 0.4 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 smaller than 1 hectare.*

6.0 WATER MANAGEMENT

6.1 Purpose of Water Management

Water management relates to all aspects of water on site but in particular, for this subdivision, the flood levels of the King River.

With large rural living lots other issues such as road and development drainage are less important and are readily managed through normal construction as they have been on the adjoining subdivisions and developments.

Water Management normally aims to;

- Protect water quality,
- Protect infrastructure from flooding and inundation,
- Minimise runoff,
- Maximise local infiltration,
- Use natural drainage features,
- Minimise changes to water balance,
- Integrate stormwater treatment into the landscape,
- Convert drains to "naturalised" streams.
- Maintain water balance both on site and offsite.

Many of these issues were addressed in the Geotechnical and Land Capability mapping, the selection of building envelopes, lot sizes and the use of alternative – nutrient adsorbing waste water treatment systems.

For example in a Special Rural subdivision where the roads are not kerbed and dwellings either collect roof water for use or allow water from hard surfaces to infiltrate to pasture or gardens, and most of the above do not apply, then there may be no water to be dealt with as all surface water might infiltrate into the soils through swale drainage. This can apply even though water loading may increase slightly through the use of scheme water.

As noted above the item that could potentially carry the greatest risk is flooding by the King River.

6.2 Watercourses and Drainage

Surface Water

The main hydrological features are the King River and Willyung Creek to the south of Willyung Road at this location. There is also a small drainage line that drains to King River in the central north of the site.

These drain to the east through the King River to Oyster Harbour.

King River has a steep sided valley dropping from the alluvial terraces along its boundary. There is virtually no flood plain and none adjacent to the subject land.

On the other hand Willyung Creek has an extensive flood plain to the east of the subject land.

Apart from the streams, surface water run off is not common because of the porosity of the soils. Surface water only exists where perched water tables on the terraces touch the surface in winter and where water logging occurs on the flood plain. Perching of the water tables occurs over most of the site but the elevation of the perched water table varies.

Surface water may also occur during flooding.

Willyung Creek has a catchment of about 35 km^2, the north western creek a catchment of 2.5 km^2 and the King River a catchment of 402 km^2. The two smaller catchments are cleared, with the King River 83 % cleared in 1987 which means that flood flows are likely to rise and fall quickly, although the nature of the north western creek and King River mean that the stream flows will be slightly more spread out than Willyung Creek.

As outlined under changes to recharge below there will be no significant difference to recharge and therefore seepages to watercourses.

Flood Levels

The smaller drainage lines have relatively short lengths but large catchments which means that a heavy rainfall event results in the rapid rise and corresponding fall in the stream levels. The King River is longer and therefore rises over a period of time and falls at a slower rate. Flood levels are determined by the rainfall in the catchment and the timing of the tide in the King River which has the potential to raise the water levels slightly with an incoming tide.

Official flood data was not available for the area in the 1990's from Department of Water Environment Regulation but accurate information was obtained from the owner of Lot 940 in the east of the site, which has one of the earliest houses, in 1997.

There was a flood in the area in the early 1990's that the local residents remember, affecting in particular Willyung Creek. A series of photos was available in 1997 of Lots 940 and 9002 (previously Lot 892), together with water heights on Willyung Creek on the bridge on the eastern boundary of the subject land, and water heights of the King River on Lot 940.

The photos were matched with land marks on the ground and a flood level determined of 5.5 metres on Lot 9002 (previously Lot 892). Lot 940 did not flood in this event apart from a small low pocket in the north eastern corner and the bank of the King River to a depth of about 3.5 metres. In this case it appears that Willyung Creek would have been near the 1 : 100 year flood peak.

The largest recorded flood was in 1927 when the King River entered the dwelling and rose to the level of the piano keys. This would place the flood peak at the house at 5.7 metres.

These flood levels were then matched to the geomorphology of both the King River, the contours and interpreted water flows and volumes determined for the King River and Willyung Creek at several locations upstream by taking cross sectional areas based on the contours mapping for the watercourses.

There have been several smaller but still significant floods in Willyung Creek since 1997.

To assist planning for the City of Albany GHD modelled the flood data for Willyung Creek and determined 1 : 100 year flood levels that matched the verbally noted data provided by local people in 1997.

It is understood that GHD did not take into account flooding of the King River and the potential to back up water in Willyung Creek.

GHD also did not have the benefit of detailed surveys of various private land that has since been commissioned by the landowners to assist the study.

GHD plotted the extent of the flood from their predicted 1 : 100 year flood elevations, based on coarser contour information than is now available. As GHD did not have access to 0.5 metre contour and spot elevations they were not able to determine that the local levee banks along the northern edge of Willyung Creek and King River, which will influence flood paths.

To compare the 1997 data with current data, Lindsay Stephens completed extensive mapping and flood consideration for flood water travelling through the centre of Lots 104 - 105 and 9002 and exiting down the vegetated gullies on Lot 9002 to the east. The data matched the geomorphology and confirmed the 1997 data which was interpreted for both the King River and Willyung Creek.

The GHD data provided a check for the King River data interpreted by Landform Research in 1997. The data for Willyung creek showed that the Landform Research data was between 0.5 and 1.0 metres above the GHD data. The same might apply to the King River which was not modelled by GHD. What was also not modelled by GHD was the King River flooding at the same time as Willyung Creek which if it occurred may raise flood elevations in the lower reaches of Willyung Creek.

Similarly it is noted that the King River is tidal to just downstream of the subject land. A high tide also may not have been modelled by GHD mapping but their mapping was close to the historical 1929 high.

The Landform Research data for 1997 showed an interpreted 1 : 100 year flood elevation of 8.5 to 9.0 metres AHD at the eastern boundary of the subject land, rising to 9.5 metres AHD at the western boundary.

The 9.0 metres in the east is probably a little high because the valley of the King River spreads out on the eastern side of the study site which means that the flood levels will effectively flatten to near the elevation on the eastern side of the wide area where it enters the steeper valley again to the east which constrains the flow and raises the flood elevation. The level of this area is interpreted to be 8.5 metres AHD.

The small tributary in the central north has a small inflow, and most flood potential comes from the back up of water from the King River at around 8.5 metres AHD rising slightly with an allowance for the smaller inflows from the tributary. That is for the small creek line in the central north, a similar 8.5 to 9.0 metres AHD and a little higher in the west of the subject land at around 9.0 metres because the creek is small and the valley wides out to the eastern boundary.

The predicted flood elevations are shown on the attached plan.

The proposed subdivision has been designed the fit with these elevations. The dwelling with the smallest separation is Lot 4 which is similar to the dwelling that is already constructed on Lot 45. With dwellings having at least 300 mm floor elevation higher than the receiving land this provides for around 800 mm of separation to the predicted flood elevation and complies with normal 0.5 metre separation. There is also potential to increase the elevation even more with additional fill or by locating the dwelling at the elevation of the higher land adjacent to the road.

The separation to the conservative 1 : 100 year flood level is shown below. All lots comply with the recommended elevation separation for flooding in the 2016 Draft Government Sewerage Policy.

Table 6 Predicted Flood Elevations at Dwelling

Lot Number	Predicted flood level (Landform Research) Metres AHD	Building envelope elevation	Floor elevation of 0.3 m above the land surface, for surface water protection.	Separation to the predicted 1 : 100 year flood elevation
1	9.1	12.5	12.8	3.4
2	9.1	12.5	12.8	3.4
45 existing	8.8	9.5	9.8	1.0
3	8.5	9.0	9.3	0.8
4	8.5	9.0	9.3	0.8
5	8.5	>12.0	12.3	3.8

6	8.5	>12.0	11.3	2.8
7	8.5	>12.0	12.3	3.8
8	8.5	> 10.5	10.8	2.3
9	8.5	> 12.0	12.3	3.8

The allocated building envelopes are located at the following predicted flood elevations and separations.

Lots 18, 19 and 21 and Willyung Road are well above the flood elevations in Willyung Creek at that point of around 7.84 metres AHD (GHD Flood Study 2007).

The predicted flood levels assume that there is no development within the flood way as this will impeded the flood, and may slightly raise its elevation at that point, and the development will be subject to potentially significant water erosion in a flood.

The separation levels for other nearby lots such as Lot 19 is greater because at Lot 18 the King River valley widens considerably.

It is felt that the predicted flood elevations are conservative, and are not likely to be impacted by other additional events or occurrences. At this location the River is not tidal and will not be backed up by tides and there are no other tributaries that will cause back up of water. The main tributaries are downstream from the north and the larger Willyung Creek well to the east.

Location of Developments

In order to protect dwellings a number of "good practice" actions are normally provided in flood protection in Western Australia. See CSIRO 2000. In summary these are;

- A flooding 0.5 m allowance is made above the predicted 1 : 100 year flood elevation. This applies to roads, floor elevations and other sensitive structures.
- There should be no construction within floodways. Development can be undertaken with care in the flood fringe provided the development does not lead to rises in the flood elevation.
- Residents are to be provided with permanent access that can be used in times of peak flood.
- Developments are to be located adjacent to land that is not flooded and that has access.
- Developments should not impede the flood flow or lead to rises in the flood elevation.

The subdivision and allocation of building envelopes complies with these "best practise" guidelines. Greenwood Drive, Kelty View, Bilaboya Place and Willyung Road all remain open and well above predicted flood elevations. All building envelopes are located adjacent to the road network for easy access.

Drainage

The best way to assist drainage is to encourage the use of rainwater collection and use for a potable supply or garden watering, and to encourage the disposal of stormwater on each lot through soak wells located in sand fill areas.

The use of rainwater tends to reduce the overall water loading and the soak wells increase the soakage areas and spread infiltration across the Development Area.

This can be further helped by the use of swale drains accepting stormwater from any kerbed roads or roads. Swale drains that include infiltration may negate large surface flows and may not require infiltration basins.

The roads are either already in place or are designed, and on adjoining properties are shown to be working well.

Foreshore Reserves

The foreshore reserves for King River are already in place and are not proposed to be altered. The reserve is marked by the commencement of the remnant vegetation along the river.

As mentioned in Section 5.0 the building envelopes are adjusted to provide a 100 metre separation to the watercourses and the King River. The 100 metre line is shown on the Structure Plan as the red dotted line. The exceptions are proposed Lots 44, 8 and 9 all of which have a portion of the proposed building envelope located outside the 100 metre separation line where waste water can be disposed to. This is consistent with Water Quality Protection Note 70 (DWER 2016) which recommends a separation of 100 metres to the water courses.

Land uses will not change significantly for the cleared pasture land. The only likely change will be the planting of more trees and shrubs on the created lots, rather than pasture and parkland pasture.

Recharge and soil moisture will have increased significantly when the land was originally cleared.

With little change expected to deep rooted species, there are unlikely to be any significant changes to recharge, or soil moisture. If any changes occur they will be a slight drying due to the additional planted deep rooted species.

6.3 Ground Water

Shallow perched winter ground water is common over the lower elevations of the site, mainly in the small creek line valley in the central north. These areas are excluded from the development areas and building envelopes.

The shallow winter soil moisture forms in winter when the overlying sands fill with water and the rate of precipitation exceeds the vertical infiltration rates of the subsoils. On slopes these can form seepages. The dams in the central north reflect these areas.

The large dam on Lot 17 does raise some issues with soil moisture downslope from the dam and it is preferable that the building envelope be located up slope from the dam as shown.

As outlined under changes to recharge below there will be no significant difference to recharge and therefore no significant changes to soil moisture or the elevations of the water table.

6.4 Changes to Recharge

Recharge is the amount of water that inputs to the ground water table in the soils. As the subdivision will not be connected to scheme water the only water input is a continuation of rainfall, with the only potential changes being related to the changes in the areas of hard stand and the planting of additional trees. There are no changes to the roads or areas of hard road surface.

In turn the planting of additional deep rooted species, particularly trees, will reduce surface water through increased evapotranspiration.

The proposed subdivision, has lots down to 0.4 hectares although counting the remnant forest there will only be 22 dwellings and 4 existing chalets on an area of around 25.8 hectares or a loading of one waste water system per hectare.

The only changes to soil moisture from this type of development is the amount of hard stand that will be added

To gain some idea of the changes to recharge, the additional lots are considered. All roads are constructed so their impacts will not change.

Bureau of Meteorology data was used for the rainfall design criteria of runoff from hard surfaces such as roofs.

For pasture, rain falls on the ground and is either lost through evaporation from the soil which normally only occurs from the top 500 mm, evapotranspiration from plants to the depth of their roots with the remainder being added to the water table.

When hard stand is constructed approximately 10% of the precipitation is lost through evaporation from small rainfall events, with the rest captured in rainwater tanks from the dwellings or large sheds. This rainwater is then used in the dwelling and sent to the waste water disposal area or used for gardens.

From brick paving or driveways water from precipitation moves to the edges where it soaks into the soil. The lack of plants on the driveway slightly reduces the water loss.

On the other hand any shrubs and trees planted will result in a slight loss of water through additional evapotranspiration.

In all cases the captured water returns to the soils.

This water balance is outlined below and ends up being neutral or very minor changes. The changes are that less evapotranspiration and evaporation occurs on the hard stand, but this is balanced by the planting of additional trees and shrubs which lose water through evapotranspiration.

Building envelopes

Rainwater tanks will be used on all lots. This calculation uses the total number of dwellings of 22 and the four chalets making 26 for the sake of calculations and illustrate the changes to recharge.

For a dwelling a hard surface area of 350 m^2 is assumed, including the dwelling, driveways, sheds and garages.

To this is added 50 m^2 of driveway, to make an assumed area of hard surface per lot of 400 m^2.

The recharge from soils rises because the runoff from the roofs increases and there is no pasture or other vegetation on that footprint to lead to evapotranspiration of the water.

Normal recharge for pasture is assumed to be 40% and recharge from roofs and roads is rated at 90%. That is there will be an additional recharge of 50% for the area of hard surfaces, as a result of subdivision and house construction, because the evapotranspiration of pasture and vegetation is replaced by hard surface.

If rainfall from roofs is retained on lots, either through soakwells or rainwater tanks and on site waste water disposal, there will be no change to the water loading from development.

There may be a small change as a result of reduced evapotranspiration from hard surface areas or increased evapotranspiration as a result of additional tree planting.

If the additional water collected and not soaking into the ground is directed to soils through soakwells, rainwater and waste water the difference in loading caused by reduced evapotranspiration from pasture is 90% - 40% = 50%.

The difference in water loading is;

For each lot at 400 m^2 per lot hard surface;

400 m^2 x 0.798 m rainfall x 50% change to evapotranspiration = 159.6 m^3 or kL (increase) spread over a lot size of 1.0 hectares, which is equivalent to an additional 159.5 mm rainfall added to the soils.

The planting of additional trees and shrubs will occur as demonstrated on developed rural lifestyle lots. Trees and shrubs in a garden are likely to lead to the evapotranspiration of 80% of the rainfall. That is an increase in water use of 40% pasture – 20% trees = 20% reduction in recharge.

If the planting of deep rooted trees and shrubs changed the recharge by 20%, by converting pasture to gardens, this would be equivalent to 0.1596 m rainfall. Assuming the total area of shrubs and trees planted on each lot is 1 000 m^2 the volume of water lost through evapotranspiration will be 159.6 m3 or kL, which is exactly the same as the additional water derived by the construction of the hard surfaces.

Of course each lot will vary in the area of hard surface, the number of trees and shrubs planted, and rainfall will vary from year to year, but overall there will be no significant change to the recharge to soils.

That means water tables are not likely to rise or fall and there will not be a reduction in seepages to watercourses.

Roads

With the existing construction of the subdivision road network there are no proposed changes or additions to roads or the area of road surface. The engineered drainage will therefore not change and there will be no additional water directed to the road drainage.

It should however be recognised that the surface water will have increased in volume when the land was originally cleared so drains are required for the arable land but would not have been required when the site was vegetated with native vegetation.

6.5 Recommendations for Development

- A 0.5 m flood allowance is made with the building envelopes to be located as shown.
- A recommendation for a 300 mm elevation of the floor level above the adjoining highest natural land surface provides good surface water management from up slope surface flow and is normal practice, but in effect provides a slightly greater level of flood protection.
- There be no construction within floodways as shown on the plan.
- There should be nil or minimal construction of developments that will impede the flood flows on individual lots.

- A form of notification to the lot owners, where a floodway is present, is recommended. This might be a nomination on the title or similar mechanism to inform and protect the floodways based on current predicted levels 1 : 100 flood elevation and updated survey information.

- The building envelopes be located where placed on the plan for the lots listed above, with waste water disposal areas set back 100 metres from water bodies.

- The minimum floor elevation for the dwellings be as allocated on the attached plan or if changed, a minimum of 1.0 metres above the predicted flood elevation.

These recommendations have been taken into account when designing the current concept subdivision guide plan.

ENVIRONMENTAL ISSUE	MANAGEMENT
Flood risk	• The subdivision guide plan incorporates the flood elevations that have been predicted and calculated. • The subdivision guide plan complies with best practise (CSIRO 2000). • Bridges should remain low so they do not impede the flood flow and do not form significant visual impact. • Place a control mechanism on the land potentially affected by flooding to alert owners to the potential for flooding and to prevent construction of developments that may impact on or change the floodways and flood flow paths and set minimum floor elevations.
Waterlogging	• Occurs on the lower elevations and is excluded from the building envelopes.

7.0 BIODIVERSITY ASSESSMENT and MANAGEMENT

The majority of the site is cleared, with remnant vegetation only occurring on the ridge in the central south that will not be impacted or subject to change, the foreshore of the King River and minor scattered shrubs and trees on the site.

The proposed building envelopes are cleared and the road alignments are either in place or cleared.

Trees on the higher elevations tend to be Marri, (*Eucalyptus calophylla*), Jarrah (*Eucalyptus marginata*) and south coastal *Banksia* Woodland understorey, whereas trees in the wetter sites are almost exclusively *Melaleuca preissiana* with *M. rhaphiophylla* on the wetter areas of the flood plain.

All vegetation has been grazed and the understorey significantly depleted in most places, although the vegetation in the south east is in the most original condition.

The foreshore vegetation on the steep banks of the King River varies from good condition to partially degraded with weed and pasture species present.

King River Foreshore Terraces and Remnant Vegetation

The vegetation along the King River, terraces and flood plain does vary because of changes to the soil moisture availability. The vegetation varies from Low Forest to Thicket depending on the species and structure.

Typical species are *Acacia sp, Agonis flexuosa, Banksia seminuda?, Sphaerolobium grandiflorum, Taxandria marginata. Hakea elliptica, Jacksonia sternbergiana, Dasypogon bromeliifolius, Taxandria juniperina, Nuytsia floribunda, Kunzea ericifolia, Astartea fascicularis, Kingia australis, Callistachys lanceolata, Hakea amplexicaulis, Leucopogon verticillatus, Persoonia longifolia, Pteridium esculentum, and Leucopogon propinquus,* with *Agonis flexuosa, Melaleuca cuticularis, M. preissiana, M. rhaphiophylla* and *Juncus pallidus* occurring in wetter sites.

The dominant vegetation of the cleared areas is scattered low trees and tall shrubs of *Melaleuca preissiana, with M. rhaphiophylla* occurring along the stream lines and in wet sites where the shallow ground water reaches the surface at some time each winter. *Juncus pallidus* occurs as scattered clumps in the pasture where the soil is damp throughout the year.

Fauna

There will be small mammal fauna, birds, amphibians and reptiles in the remnant vegetation but with clearing restrictions the affect on these will be reduced. In addition owners of smaller lots generally plant many tree and shrub species which will help increase the habitat for some species such as birds. The only mammals noted were Western Grey Kangaroos (*Macropus fuliginosus*) and Rabbits.

It has been shown in numerous locations that mammals such as the Quenda, *Isoodon obesulus* can thrive near dwellings provided sufficient thicket vegetation is available and exotic predators are not active.

In any case the species in the King River, is not particularly relevant to this proposal except that any development should not adversely impact on the fauna of the estuary.

Wetlands

There are wet pasture areas but no particular wetlands apart from some wetland shrubs in the north east. No changes are proposed.

Analysis of Biodiversity and Recommended Management	
Remnant Vegetation	• No changes to the remnant vegetation are proposed.
Recommendations	• *The larger vegetation remnants are recommended to be retained in conservation areas which is proposed.* • *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.*

8.0 CAPABILITY FOR CHANGED LANDUSES

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

Current Land Uses

The site has been used for grazing and rural living. The land uses are the same as those on the adjoining land, prior to subdivision and development.

A chalet facility is located in a bush remnant in the central south.

The opportunities of the site are;

- The undulating nature of the land surfaces.
- The local views that can be obtained from most parts of the site.
- Proximity to Albany City.
- 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 flooding from the King River constrains a small portion of the land.

Potential land uses

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

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

8.1 Alternative Landuse and Land Capability

Alternative Landuses

The land is proposed for rural living to complement other such land in the local area with the chalet facility remaining.

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 are proposed to be 0.4 – 1.0 hectares.

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.*

8.2 Aesthetics

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 and the main developments being located north of the low vegetated ridge in the south.

The potential visual issues are the same as for the existing subdivisions.

Any adverse visual impacts can be solved by the planting of trees and gardens associated with the new dwellings as shown by the existing plantings at the new houses to the west and east.

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

Existing trees and vegetation are not required to be impacted.

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 on individual lots by new landholders.
- Retention of the existing trees and vegetation 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.*

8.3 Preservation of Agricultural Land

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

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

This is the last portion of land within the rural living precinct.

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	• *Not required*

8.4 Land Use Buffers

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

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

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, and no particular buffers are required.

Foreshore Reserves

These are fenced and already allocated and protected. There will be no changes to the foreshore reserves.

The allocation of building envelopes provide the setbacks to King River. The setbacks comply with Government Policy. Waste water disposal areas are available on all lots, set back 100 metres from the water bodies.

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. • There will be no changes or impacts on foreshore reserves or setbacks.

Recommendations	• *No significant buffers required.*

8.5 Fire Control

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

Fire risk is best described in FESA, 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. • The proposed lots are the same as those on the adjoining land.
Recommendations	• *Compliance with Bush Fires Control Act 1954 (as amended) and the City of Albany bylaws.* • *Compliance with any Fire Risk Assessment and Fire Management Plan is recommended.*

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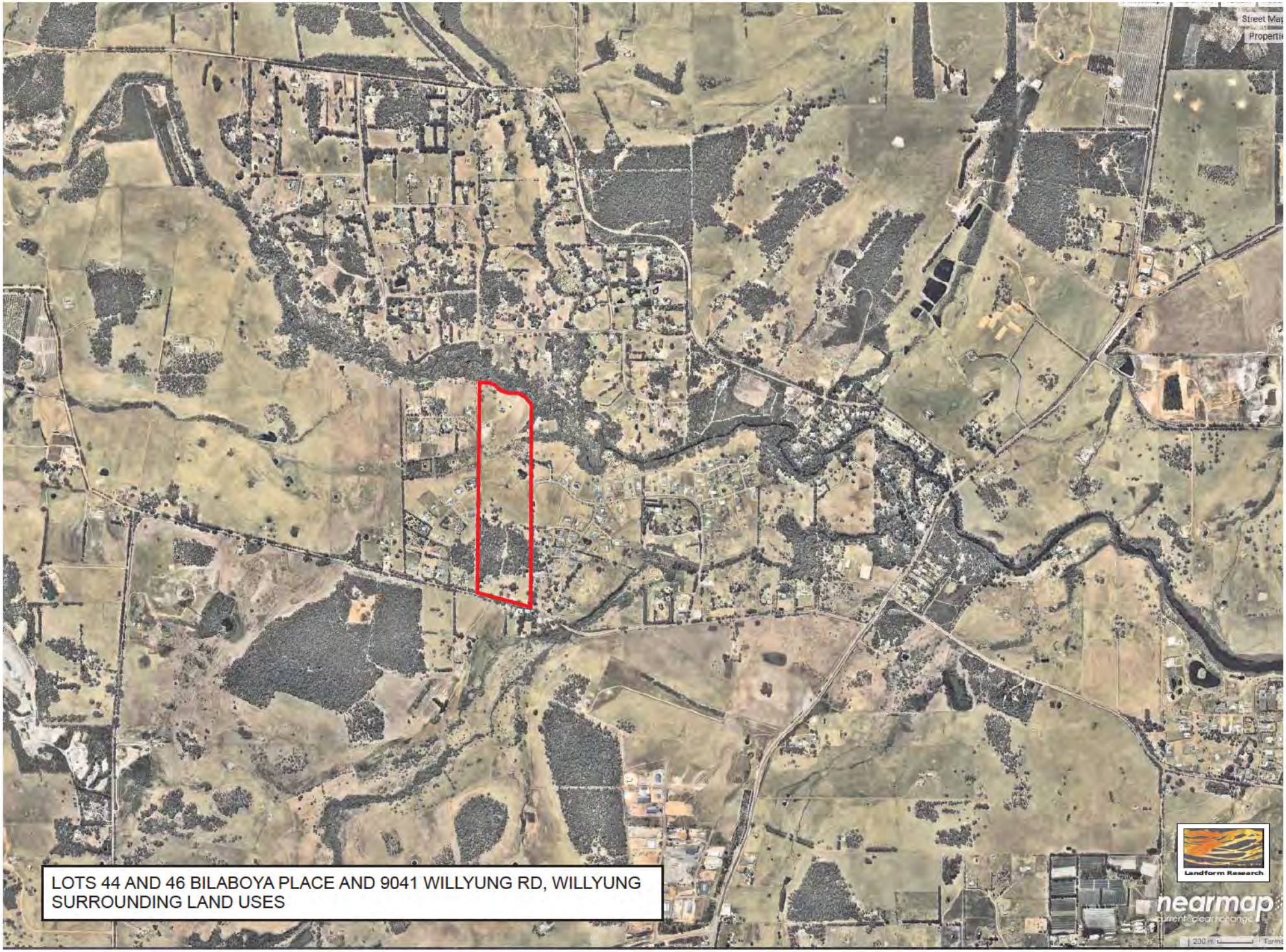
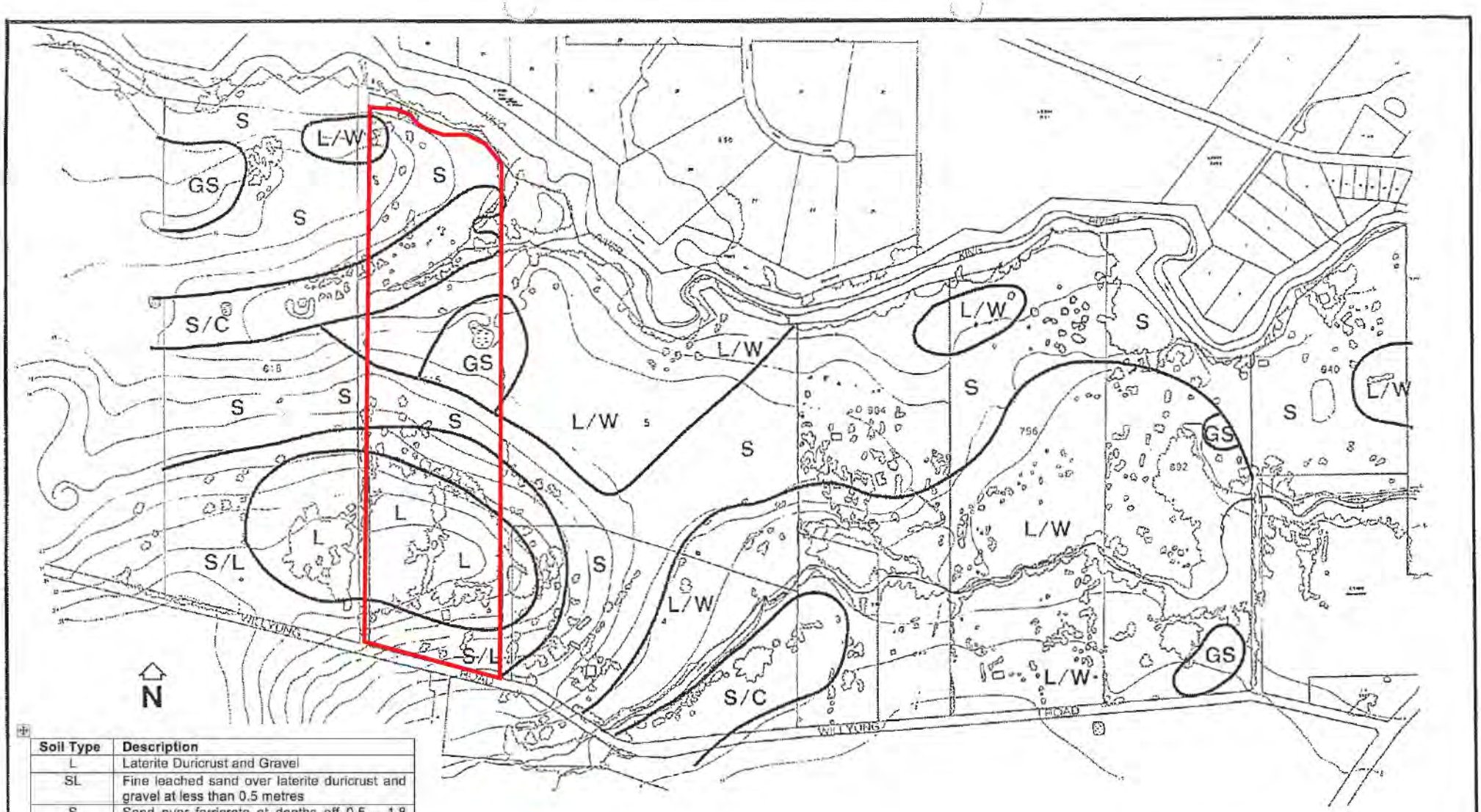

LOTS 44 AND 46 BILABOYA PLACE AND 9041 WILLYUNG RD, WILLYUNG
SURROUNDING LAND USES
Landform Research
nearmap

FIGURE 1



Soil Type	Description
L	Laterite Duricrust and Gravel
SL	Fine leached sand over laterite duricrust and gravel at less than 0.5 metres
S	Sand over ferricrete at depths off 0.5 – 1.8 metres. Fine sand of likely Plantagenet Beds origin, either in situ or having been reworked.
S/C	Sand over sandy clay, partially seasonally waterlogged.
GS	Granitic sand derived from weathering granite either from the local basement or transported material predating the finer sands. Coarse quartz sand with increasing kaolin rich clay at depth.
L/W	Partially waterlogged sand, predominantly leached over ferricrete at 0.5 – 1.5 metres

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SOIL TYPES OF THE LOCAL AREA
Mapped by Landform Research Jan 1997 and November 2017

Soil Types

Proposed Subdivision
Willyung Road, Upper King, Albany

Scale 1 : 5 000 Basemap Data Aydon Taylor-Durrell & Stephens March 1997

FIGURE 2

ALL AREAS AND DIMENSIONS ARE SUBJECT TO SURVEY

NOTES

1. Stormwater Management
   - Disposal of stormwater on each lot to be via soak wells located in sandfill areas.
   - Utilisation of rainwater tanks for potable water and/or garden use to be encouraged.
   - Runoff from roads to be contained within swale drains and infiltration basins if required.
2. Effluent Disposal
   - The use of nutrient adsorbing effluent disposal systems to be required on all lots.
   - Effluent disposal areas to be set back 100 metres from drainage/creek lines.
3. Bushfire Safety
   - Buildings to be constructed in accordance with AS 3959-2009.
   - Areas around dwellings and all Grassland areas to be maintained to Asset Protection Zone standards.
   - For these and other bushfire safety requirements, refer to the Bushfire Management Plan.
4. Greenwood Drive to be constructed such time as Lots 5,6,7,9,10,11,12,13,14,15, 16 & 17 are created.
5. The developer shall construct an EAW at such time as Lots 13, 14 16 & 17 are created.
6. All development shall be contained within building envelopes shown on the Local Structure Plan No. 16 which generally provide for 10 metre side and rear setbacks, unless affected by setbacks from the drainage/creek line or vegetation on adjacent properties.

LEGEND

- Subject Land
- Existing Lot Boundary
- Proposed Lot Boundary
- Existing Vegetation
- Existing Buildings
- Existing Dams/Water Bodies
- 1:100 Year Flood Level
- Drainage Line
- Drainage Line Protection Area
- Reticulated Water
- 100m Effluent Disposal Setback
- Indicative Building Envelopes
- Indicative effluent disposal areas subject to detailed assessment at development stage.
- Emergency Access Way
- Special Use Zone
- Asset Protection Zone

ORIG A3
SCALE 1:4000
0 20 40 60 80 100

17-02-LSP(g)

AYTON BAESJOU
PLANNING
59 Peels Place
ALBANY WA 6330
Ph 9842 2304 Fax 9842 8494

LOCAL STRUCTURE PLAN No. 16

Lots 44 & 46 Bilaboya Place
Lot 9041 Willyung Road
Willyung, City of Albany

Figure 3

ALL AREAS AND DIMENSIONS ARE SUBJECT TO SURVEY

NOTES

1. Stormwater Management
   - Disposal of stormwater on each lot to be via soak wells located in sandfill areas.
   - Utilisation of rainwater tanks for potable water and/or garden use to be encouraged.
   - Runoff from roads to be contained within swale drains and infiltration basins if required.
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   - The use of nutrient adsorbing effluent disposal systems to be required on all lots.
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6. All development shall be contained within building envelopes shown on the Local Structure Plan No. 16 which generally provide for 10 metre side and rear setbacks, unless affected by setbacks from the drainage/creek line or vegetation on adjacent properties.

FLOOD INTERPRETATION

Flood interpretation based on historic levels plus geomorphology, flood erosion patterns and assuming storm surge in in Oyster Harbour and both the King River and Willyung Creek flooding at the same time.

- Predicted 1 : 100 year flood flow
  Large flow and smaller flow
- Floodway
- Flood fringe, not interpreted to flood
- 9.5 m Flood design (above expected flood elevation)

JUNE 2018

Landform Research

LEGEND

- Subject Land
- Existing Lot Boundary
- Proposed Lot Boundary
- Existing Vegetation
- Existing Buildings
- Existing Dams/Water Bodies
- 1:100 Year Flood Level
- Drainage Line
- Drainage Line Protection Area
- Reticulated Water
- 100m Effluent Disposal Setback
- Indicative Building Envelopes
- Indicative effluent disposal areas subject to detailed assessment at development stage.
- EAW Emergency Access Way
- Special Use Zone
- Asset Protection Zone

N

ORIG A3
SCALE 1:4000
0 20 40 60 80 100

17-02-LSP(g)

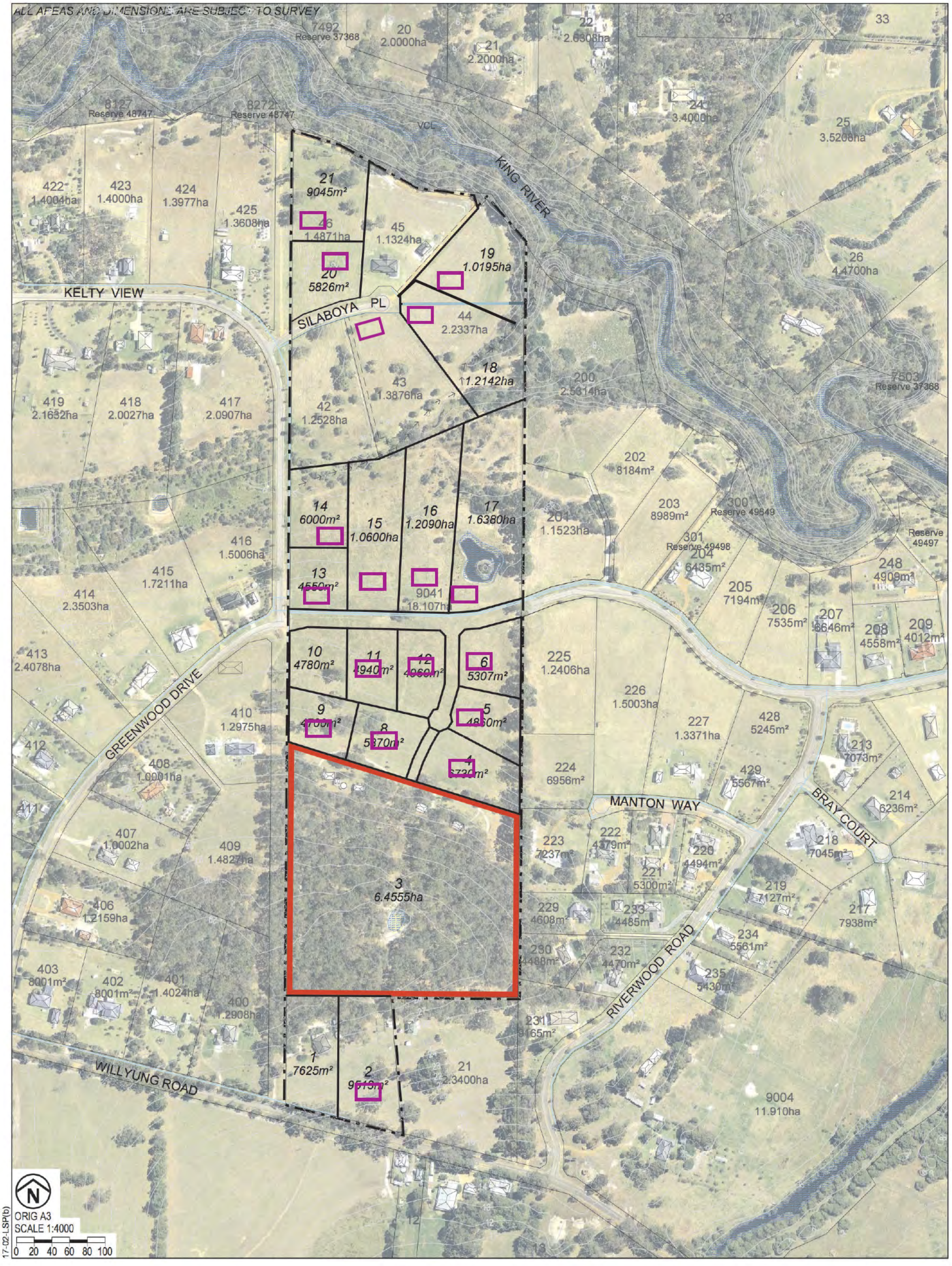
AYTON BAESJOU
PLANNING
59 Peels Place
ALBANY WA 6330
Ph 9842 2304 Fax 9842 8494

LOCAL STRUCTURE PLAN No. 16

Lots 44 & 46 Bilaboya Place
Lot 9041 Willyung Road
Willyung, City of Albany

INTERPRETED FLOOD PATHS

Figure 4



AYTON BAESJOU
PLANNING
59 Peels Place
ALBANY WA 6330
Ph 9842 2304 Fax 9842 8494

WILLYUNG ROAD LOCAL STRUCTURE PLAN

AERIAL PHOTOGRAPH I BUILDING ENVELOPES

Figure 5

Lots 44 & 46 Silaboya Place
Lot 9041 Willyung Road
Willyung, City of Albany

ALL AREAS AND DIMENSIONS ARE SUBJECT TO SURVEY

KING RIVER

KELTY VIEW

SILABOYA PL

GREENWOOD DRIVE

WILLYUNG ROAD

RIVERWOOD ROAD

MANTON W

WILLYUNG CREEK

Reserve 37368

Reserve 48747

Reserve 49649

Reserve 49498

Reserve 49497

VCL

WASTE WATER DISPOSAL AREAS

Waste water disposal area to enable 100 metre setback from water body - watercourse. (Concept - can be moved)

Lots with no disposal area have no restrictions

GEOTECHNICAL DATA

Building envelopes on lots located based on flood levels, soil texture, soil moisture, or water tables

1712 Soil Test Holes Landform Research 03-11-2017

(82) Soil Test Holes Landform Research 23-25 Jan 1997

(51) Soil Test Holes Wood and Grieve September 1997

FLOOD INTERPRETATION

Flood interpretation based on historic levels plus geomorphology, flood erosion patterns and assuming storm surge in in Oyster Harbour and both the King River and Willyung Creek flooding at the same time.

Predicted 1 : 100 year flood flow
Large flow and smaller flow

Floodway

Flood fringe, not interpreted to flood

17-02-LSP(b)

ORIG A3
SCALE 1:4000
0 20 40 60 80 100

FIGURE 3

WILLYUNG ROAD LOCAL STRUCTURE PLAN

SOIL TEST HOLES

Figure 6

Lots 44 & 46 Silaboya Place
Lot 9041 Willyung Road
Willyung, City of Albany

AYTON BAESJOU
PLANNING
59 Peels Place
ALBANY WA 6330
Ph 9842 2304 Fax 9842 8494

Test Hole on Lot 13

Test Hole on Lot 15

Test Hole on Lot 18

Test Hole on Lot 3

Test Hole on Lot 4

Test Hole on Lot 11

Test Hole on Lot 8

Test Hole on Lot 16

Willyung Road Structure Plan
Lots 44, 46 Bilaboya Place and
Lot 9041 Wuillyung Road, Willyung

Soil Test Holes 3 November 2017

Landform Research

Test Hole on Lot 17

Test Hole on Lot 14

Test Hole on Lot 6

Test Hole on Lot 12

Test Hole on Lot 7

Test Hole on Lot 15

Test Hole on Lot 14

Test Hole on Lot 10

Test Hole on Lot 1

Test Hole on Lot 1

Test Hole on Lot 2

View north actoss Lot 13

View south across Lot 14 towards the chaletc

View west from Lot 15

View north west towards the culvert from Lot 12

Lview north east across Lot 6 with some of the local residents

View east along the watercourse to the north of Lot 8

View east from Lot 9

View north east across Lot 3

View north across Lot 1

View north west across Lot 18

Landform Research

Lindsay Stephens BSc (Geology) MSc (Botany) FIQA, EIANZ
U1 49 Birdwood Avenue Como, WA 6152
Phone 08 9474 3978

Regolith and Hydrological Logs

Project	Willyung Subdivision	Site Assessed by	L Stephens
Location	Lots 44 and 46 Bilaboya Place and Lot 9041 Willyung Road, Willyung Albany	Date of Inspections	See Soil Test Holes

Test Hole Number	18	Natural Surface		
Location	Lot 21	Base of Hole		
Test Hole Type	Hand auger 23 – 25 January 1997	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 150 mm	Grey sand	
150 – 250 mm	Cream sand	
250 – 1200 mm	Pale brown yellow sand with variable leaching	
1200 – 1380mm	Grey white silty clay, very fine with ferricrete at 1380 mm	
Groundwater	Not intersected	
Comment		

Test Hole Number	19	Natural Surface		
Location	Lot 21	Base of Hole		
Test Hole Type	Hand auger 23 – 25 January 1997	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 280 mm	Grey sand	
280 – 450 mm	Cream sand	
450 – 840 mm	Cream yellow sand	
840 mm	Weathered granitic sand	
Groundwater	Not intersected.	
Comment		

Test Hole Number	20	Natural Surface		
Location	Lot 45	Base of Hole		
Test Hole Type	Hand auger 23 – 25 January 1997	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 240 mm	Grey sand	
240 – >2000 mm	Fine white sand	
Groundwater	Not intersected. Alluvial terrace	
Comment		

Test Hole Number	21	Natural Surface		
Location	Lot 44	Base of Hole		
Test Hole Type	Water Sample 23 – 25 January 1997	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
Groundwater	Water sample 440 mg/L salt - fresh	
Comment		

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Lindsay Stephens BSc (Geology) MSc (Botany) FIQA, EIANZ
U1 49 Birdwood Avenue Como, WA 6152
Phone 08 9474 3978

Regolith and Hydrological Logs

Project	Willyung Subdivision	Site Assessed by	L Stephens
Location	Lots 44 and 46 Bilaboya Place and Lot 9041 Willyung Road, Willyung Albany	Date of Inspections	See Soil Test Holes

Test Hole Number	23	Natural Surface		
Location	Lot 20	Base of Hole		
Test Hole Type	Hand auger 23 – 25 January 1997	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 200 mm	Grey white sand	
200 – 300 mm	Yellow brown sand	
300 mm	Tree root – could not penetrate	
Groundwater	Not intersected	
Comment		

Test Hole Number	80	Natural Surface		
Location	Lot 1	Base of Hole		
Test Hole Type	Hand auger 23 – 25 January 1997	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 1050 mm	Grey white sand	
1050 mm	ferricrete	
Groundwater	Not intersected	
Comment		

Test Hole Number	81	Natural Surface		
Location	Lot 1	Base of Hole		
Test Hole Type	Hand auger 23 – 25 January 1997	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 1350 mm	Grey white sand	
1350 – 1550 mm	Grey silty bluish clay sand, poorly drained	
1050 mm	ferricrete	
Groundwater	1500 mm	
Comment		

Test Hole Number	82	Natural Surface		
Location	Lot 3	Base of Hole		
Test Hole Type	Hand auger 23 – 25 January 1997	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 350 mm	Old gravel pit with dam	
Groundwater	Water sample 165 mg/L salt – fresh from dam	
Comment		

Landform Research

Lindsay Stephens BSc (Geology) MSc (Botany) FIQA, EIANZ
U1 49 Birdwood Avenue Como, WA 6152
Phone 08 9474 3978

Regolith and Hydrological Logs

Project	Willyung Subdivision	Site Assessed by	L Stephens
Location	Lots 44 and 46 Bilaboya Place and Lot 9041 Willyung Road, Willyung Albany	Date of Inspections	See Soil Test Holes

Test Hole Number	83	Natural Surface		
Location	Lot 4	Base of Hole		
Test Hole Type	Hand auger 23 – 25 January 1997	Depth		
Diameter		Depth of static water level		
Depth	Description		Comments	
0 – 800 mm	Grey white sand			
800 mm	Laterite duricrust			
Groundwater	Not intersected			
Comment				

Test Hole Number	84	Natural Surface		
Location	Lot 13 - 14	Base of Hole		
Test Hole Type	Dam – 23 - 25 January 1997	Depth		
Diameter		Depth of static water level		
Depth	Description		Comments	
0 – 1500 mm	Coarse quartz sand – close to granite basement			
Groundwater	Water sample 1925 mg/L salt –upper end of fresh. Water table at 1500 mm			
Comment				

Test Hole Number	87	Natural Surface		
Location	Lot 135- 16	Base of Hole		
Test Hole Type	Creek – 25 January 1997	Depth		
Diameter		Depth of static water level		
Depth	Description		Comments	
	Creekline bottomed in white clay			
Groundwater	Creekline			
Comment				

Test Hole Number	88	Natural Surface		
Location	Lot 43	Base of Hole		
Test Hole Type	Hand auger 23 - 25 January 1997	Depth		
Diameter		Depth of static water level		
Depth	Description		Comments	
0 – 420 mm	Coarse quartz sand – close to granite basement			
420 mm	Ferruginous material – hard pan could not penetrate			
Groundwater	Not intersected			
Comment				

Test Hole Number	89	Natural Surface		
Location	Lot 21	Base of Hole		
Test Hole Type	Hand auger – 23 – 25 January 1997	Depth		
Diameter		Depth of static water level		
Depth	Description		Comments	
0 – 700 mm	Deep sand increasing in thickness down slope			
700 mm	Laterite ferricrete			
Groundwater	Not intersected			
Comment				

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Lindsay Stephens BSc (Geology) MSc (Botany) FIQA, EIANZ
U1 49 Birdwood Avenue Como, WA 6152
Phone 08 9474 3978

Regolith and Hydrological Logs

Project	Willyung Subdivision	Site Assessed by	L Stephens
Location	Lots 44 and 46 Bilaboya Place and Lot 9041 Willyung Road, Willyung Albany	Date of Inspections	See Soil Test Holes

Test Hole Number	87	Natural Surface		
Location	Lot 54, 15 metres from wetland fence	Base of Hole		
Test Hole Type	Hand auger	Depth		
Diameter		Depth of static water level	1.2 m	

Depth	Description	Comments
0 – 450 mm	Grey sand - topsoil	
450 – 1500 mm	Cream Quartz sand	
Groundwater	1 200 mm	
Comment	1 metre elevation higher than land surface at fence	

Test Hole Number	52	Natural Surface		
Location	Lot 6	Base of Hole		
Test Hole Type	Backhoe – WG Sept 1998	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 50 mm	Topsoil	
50 – 300 mm	Sand	
300 – 700 mm	laterite	
700 – 1100 mm	White sandy clay	
Groundwater	Water table not intersected	
Comment		

Test Hole Number	53	Natural Surface		
Location	Lot 43	Base of Hole		
Test Hole Type	Backhoe – WG Sept 1998	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 100 mm	Topsoil	
10 – 1100 mm	Grey Sand	
Groundwater	600 mm	
Comment		

Test Hole Number	54	Natural Surface		
Location	Lot 19	Base of Hole		
Test Hole Type	Backhoe – WG Sept 1998	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 300 mm	Topsoil/dark grey sand	
300 – 1100 mm	Light grey sand	
Groundwater	700 mm	
Comment		

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Lindsay Stephens BSc (Geology) MSc (Botany) FIQA, EIANZ
U1 49 Birdwood Avenue Como, WA 6152
Phone 08 9474 3978

Regolith and Hydrological Logs

Project	Willyung Subdivision	Site Assessed by	L Stephens
Location	Lots 44 and 46 Bilaboya Place and Lot 9041 Willyung Road, Willyung Albany	Date of Inspections	See Soil Test Holes

Test Hole Number	55	Natural Surface		
Location	Lot 45	Base of Hole		
Test Hole Type	Backhoe – WG Sept 1998	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 300 mm	Topsoil/dark grey sand	
300 – 1100 mm	Light grey sand	
Groundwater	700 mm	
Comment		

Test Hole Number	56	Natural Surface		
Location	Lot 425 – west of subject land	Base of Hole		
Test Hole Type	Backhoe – WG Sept 1998	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 350 mm	Topsoil dark grey sand	
350 – 750 mm	Clay coffee rock	
750 – 1100 mm	Orange gravel clay	
Groundwater	300 mm	
Comment		

Test Hole Number	171	Natural Surface		
Location	Lot 9	Base of Hole		
Test Hole Type	Mini – excavator 3 Nov 2017	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 80 mm	Topsoil dark grey sand	
80 – 270 mm	Yellow brown sandy laterite	
270 – 950 mm	Light brown to cream sand	
950 – 1700 mm	Yellow fine grained sandy earth	Plantagenet Beds
Groundwater	Not intersected	
Comment		

Test Hole Number	171	Natural Surface		
Location	Lot 13	Base of Hole		
Test Hole Type	Mini – excavator 3 Nov 2017	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 80 mm	Topsoil dark grey sand	
80 – 270 mm	Yellow brown sandy laterite	
270 – 950 mm	Light brown to cream sand	
950 – 1700 mm	Yellow fine grained sandy earth	Plantagenet Beds
Groundwater	Not intersected	
Comment		

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Lindsay Stephens BSc (Geology) MSc (Botany) FIQA, EIANZ
U1 49 Birdwood Avenue Como, WA 6152
Phone 08 9474 3978

Regolith and Hydrological Logs

Project	Willyung Subdivision	Site Assessed by	L Stephens
Location	Lots 44 and 46 Bilaboya Place and Lot 9041 Willyung Road, Willyung Albany	Date of Inspections	See Soil Test Holes

Test Hole Number	172	Natural Surface		
Location	Lot 14	Base of Hole		
Test Hole Type	Mini – excavator 3 Nov 2017	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 100 mm	Topsoil dark grey sand	
100 – 350 mm	Pale grey sand	
350 – 700 mm	Yellow brown ferruginous indurated sands (laterite)	Could not penetrate
		Plantagenet Beds
Groundwater	Not intersected	
Comment		

Test Hole Number	173	Natural Surface		
Location	Lot 17	Base of Hole		
Test Hole Type	Mini – excavator 3 Nov 2017	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 220 mm	Brown grey sand	
220 – 620 mm	White fine sand	
620 – 900 mm	Brown gravelly sand	
900 – 1400 mm	Cream slightly darker yellow brown earthy sand	Plantagenet Beds
Groundwater	Not intersected	
Comment		

Test Hole Number	175	Natural Surface		
Location	Lot 15	Base of Hole		
Test Hole Type	Mini – excavator 3 Nov 2017	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 120 mm	Dark grey sand	Repeats Hole 51 of Wood and Grieve which is not available. Located next to *Juncus palidus* which indicates surface moisture in winter. This can be solved by normal development practices.
120 – 600 mm	Grey moist sand	
600 – 700 mm	Yellow brown iron indurated fine sand (laterite). Too hard to penetrate	Plantagenet Beds
Groundwater	Not intersected	
Comment		

Test Hole Number	176	Natural Surface		
Location	Lot 10	Base of Hole		
Test Hole Type	Mini – excavator 3 Nov 2017	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 310 mm	Dark grey sand	
310 – 820 mm	Grey sand	
820 – 1200 mm	Yellow brown earthy laterite sand, very moist with a perched wet zone at the base	Plantagenet Beds
Groundwater	Water seepage at 950 mm	

Landform Research

Lindsay Stephens BSc (Geology) MSc (Botany) FIQA, EIANZ
U1 49 Birdwood Avenue Como, WA 6152
Phone 08 9474 3978

Regolith and Hydrological Logs

Project	Willyung Subdivision	Site Assessed by	L Stephens
Location	Lots 44 and 46 Bilaboya Place and Lot 9041 Willyung Road, Willyung Albany	Date of Inspections	See Soil Test Holes

Comment	

Test Hole Number	177	Natural Surface		
Location	Lot 6	Base of Hole		
Test Hole Type	Mini – excavator 3 Nov 2017	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 200 mm	Topsoil dark grey fine sand	
200 – 500 mm	Cream coarse quartz sand with some iron induration	From weathered granite
500 – 1450 mm	Cream coarse grained permeable sandy clay	Weathered granite at depth.
Groundwater	Not intersected	
Comment		

Test Hole Number	178	Natural Surface		
Location	Lot 11	Base of Hole		
Test Hole Type	Mini – excavator 3 Nov 2017	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 90 mm	Topsoil dark grey sand	
90 – 730 mm	Cream brown coarse quartz sand with minor iron induration	From weathered granite
270 – 950 mm	Light brown to cream sand	
950 – 1700 mm	Yellow fine grained sandy earth	Weathered granite at depth
Groundwater	Not intersected	
Comment		

Test Hole Number	179	Natural Surface		
Location	Lot 7	Base of Hole		
Test Hole Type	Mini – excavator 3 Nov 2017	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 160 mm	Dark grey fine sand	
160 – 430 mm	Fine light grey sand	Plantagenet Beds
430 – 680 mm	Yellow brown gravelly loam with coarse sand	Granite sand
680 – 1440 mm	Pale yellow brown loam to permeable clay with brown mottles	Weathered granite
Groundwater	Not intersected	
Comment		

Landform Research

Lindsay Stephens BSc (Geology) MSc (Botany) FIQA, EIANZ
U1 49 Birdwood Avenue Como, WA 6152
Phone 08 9474 3978

Regolith and Hydrological Logs

Project	Willyung Subdivision	Site Assessed by	L Stephens
Location	Lots 44 and 46 Bilaboya Place and Lot 9041 Willyung Road, Willyung Albany	Date of Inspections	See Soil Test Holes

Test Hole Number	1710	Natural Surface		
Location	Lot 9	Base of Hole		
Test Hole Type	Mini – excavator 3 Nov 2017	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 110 mm	Very dark fine grey sand	
110 – 450 mm	Dark fine grey sand to grey sand	
450 – 600 mm	Yellow gravelly indurated earthy fine sand	
600 mm	Could not penetrate	Plantagenet Beds
Groundwater	Not intersected	
Comment		

Test Hole Number	1711	Natural Surface		
Location	Lot 8	Base of Hole		
Test Hole Type	Mini – excavator 3 Nov 2017	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 180 mm	Dark grey fine sand	
180 – 750 mm	Light cream fine sand	Plantagenet Beds
750 – 1300 mm	Coarse yellow - cream quartz sand	Granite sand
1300 – 1450 mm	Cream loam weathered granite loam with darker yellow brown mottles	Weathered granite
Groundwater	Not intersected	
Comment		

Test Hole Number	1712	Natural Surface		
Location	Lot 12	Base of Hole		
Test Hole Type	Mini – excavator 3 Nov 2017	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 120 mm	Topsoil dark grey fine sand	
120 – 370 mm	Yellow brown sandy laterite	
370 – 780 mm	Light brown to cream sand	
780 – 1360 mm	Yellow fine grained sandy earth to loam with darker yellow brown and red mottles	Plantagenet Beds
Groundwater	Not intersected	
Comment		

Test Hole Number	1713	Natural Surface		
Location	Lot 4	Base of Hole		
Test Hole Type	Mini – excavator 3 Nov 2017	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 250 mm	Topsoil dark grey fine sand	
250 – 1800 mm	Fine grey sand	Plantagenet sands that have been transported and redeposited?
Groundwater	1200 mm	
Comment		

Landform Research

Lindsay Stephens BSc (Geology) MSc (Botany) FIQA, EIANZ
U1 49 Birdwood Avenue Como, WA 6152
Phone 08 9474 3978

Regolith and Hydrological Logs

Project	Willyung Subdivision	Site Assessed by	L Stephens
Location	Lots 44 and 46 Bilaboya Place and Lot 9041 Willyung Road, Willyung Albany	Date of Inspections	See Soil Test Holes

Test Hole Number	1714	Natural Surface		
Location	Lot 3	Base of Hole		
Test Hole Type	Mini – excavator 3 Nov 2017	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 150 mm	Topsoil dark grey sand	
150 – 1850 mm	Cream fine sand	Plantagenet beds
Groundwater	1250 mm	
Comment		

Test Hole Number	1715	Natural Surface		
Location	Lot 2	Base of Hole		
Test Hole Type	Mini – excavator 3 Nov 2017	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 100 mm	Dark grey fine sand	
100 – 600 mm	Grey fine sand	
600 – 750 mm	Light yellow brown to darker iron indurated fine sand	Plantagenet beds
Groundwater	Not intersected	
Comment		

Test Hole Number	1716	Natural Surface		
Location	Lot 1	Base of Hole		
Test Hole Type	Mini – excavator 3 Nov 2017	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 520 mm	Grey sand	
520 –650 mm	Yellow brown indurated earthy sand with darker yellow brown mottles.	Plantagenet beds
650 mm	Laterite gravel. Could not penetrate.	Could not penetrate
Groundwater	Not intersected	
Comment		

Test Hole Number	1717	Natural Surface		
Location	Lot 2	Base of Hole		
Test Hole Type	Mini – excavator 3 Nov 2017	Depth		
Diameter		Depth of static water level		

Depth	Description	Comments
0 – 110 mm	Topsoil dark grey fine sand	
110 – 440 mm	Pale grey fine sand	
440 – 960 mm	Yellow brown earthy sandy gravel	
960 – 1500 mm	Yellow fine grained sandy earth to permeable silty clay with yellow brown mottles	Plantagenet Beds
Groundwater	Not intersected	
Comment		

Appendix B

Bushfire Management Plan

Bio Diverse Solutions

April 2019

Lot 9041 Willyung Road,
Albany WA 6330

Bushfire Management Plan

16/04/2019

Kathryn Kinnear

Bio Diverse Solutions

BIO DIVERSE SOLUTIONS

DOCUMENT CONTROL

TITLE

Title: Lot 9041 Willyung Road Bushfire Management Plan
Author (s): Kathryn Kinnear
Reviewer (s): Bianca Theyer, Nick Ayton
Job No.: AB0024
Client: Brian and Christine Lowrie

REVISION RECORD

Revision	Summary	Revised By	Date
Draft Id 29/11/2017	Internal QA review	B.Theyer	30/11/2017
Draft ID 1/12/2017	Draft report released to client & Ayton Baesjou Planning	C.Lowrie & N.Ayton	1/12/2017
FINAL ID 11/12/2017	Final report issued to client	K.Kinnear	11/12/2017
FINAL ID 17/5/2018	Updated to reflect APZ requirements in grasslands	K.Kinnear	17/5/2018
FINAL ID 30/1/2019	Updated to include revised structure plan	K.Kinnear	30/1/2019
FINAL ID 18/4/2019	Updated to include revised structure plan	C.Cramer	18/4/2019

BIO DIVERSE SOLUTIONS

BPAD Bushfire Planning & Design Accredited Practitioner Level 2

Bio Diverse Solutions
29 Hercules Crescent
Albany WA 6330

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1. Executive Summary

Bio Diverse Solutions (Bushfire Consultants) were commissioned to prepare a Bushfire Management Plan to guide all future bushfire management for the variation to the existing Structure Plan of Lot 9041 Willyung Road, Albany ("the Subject Site").

The proposal for Subject Site consists of 16 special residential lots ranging in size from 4,160m^2 to 10,230m^2, including the existing owners residence. The balance of land is a Special Use Zone whereby chalets are located. The publicly released Bushfire Prone Area Mapping (DFES, 2017) shows that the whole of the Subject Site is located within a Bushfire Prone Area (situated within 100m of >1 ha of bushfire prone vegetation).

Bushfire hazards identified for the site are the unmanaged forested areas along the King River foreshore (north) and grazed pastures to the south and unmanaged grasslands to the east. Remnant Forest vegetation through the central area of the Subject site is located upslope of any dwellings and therefore has a reduced radiant heat intensity. It is also surrounded by moderate hazards ("Island effect") which also reduces the intensity of the bushfire threat from this area. The Structure Plan proposes large lots which allows for adequate setbacks to the bushfire hazards.

The Subject Site was assessed as having internal areas of Grassland Type G consistent with rural farmland and a low fuel/non-vegetated area surrounding the existing dwelling (proposed Lot 15). An internal ridge of remnant Jarrah/Marri/Casuarina Forest extends central south. External bushfire risks are mostly associated with remnant vegetation along the King River to the north and to adjacent paddocks (Grassland Type G) to the south. Existing residences occur to the west and east in similar sized lifestyle lots.

Some native vegetation modification is required around the existing chalets in the Special use area to ensure that APZ areas consistent with BAL 29 or less prevails over the buildings. Occasional trees and understorey modification is required.

Blue gums are present in the central paddock area, these are "escapees" from the windbreak to the east. The client is keen to remove all Blue Gums to ensure APZ areas can be achieved and these introduced species do not continue to spread across the Subject Site.

BAL contouring across the Subject Site has allocated BAL 29 or less shall apply to any Building Envelopes within the lots. Internal areas of Grassland Type G (Plot 6) have not been mapped on the BAL Contour Plan in the northern area of the plan with BAL-FZ applicable to the whole of site. APZ setbacks associated with BAL Setbacks have been specified on the BAL Contour Plan and will apply in internal areas of Grassland Type G to ensure that all proposed buildings will be in Building Envelopes and will be subject to a BAL rating of BAL-29 to BAL-12.5. Lots 15, 16 and the Balance of land (Chalets) have an APZ area defined on the BAL Contour Plan associated with BAL 29.

All future buildings can achieve an APZ area associated with a BAL allocation of BAL 29, BAL 19 or BAL 12.5. The existing chalets require some minor clearing to achieve APZ areas of BAL 29 or less to the south of the chalets and the existing dwelling can achieve APZ areas of BAL 29.

Access will be provided to ensure that future residents have access in alternative directions to separate destinations. Water supply will be provided through the provision of reticulated water supply to WCWA standards. An assessment to the WAPC Guidelines for Planning in Bushfire Prone Areas (vers 1.3, 2017) Acceptable Solutions of the 4 bushfire protection criteria is summarised over the page.

Table 1: Bushfire protection criteria applicable to the site

Element	Acceptable Solution	Applicable or not Yes/No	Meets Acceptable Solution
Element 1 – Location	A1.1 Development Location	Yes	Compliant BAL 29 or less applied to lots, existing house and chalets BAL 29 applied.
Element 2 – Siting and Design	A2.1 Asset Protection Zone	Yes	Compliant, APZ area in BE's to BAL 29 or less. APZ area to be BAL 29 or less and can be contained within the individual lots. To WAPC APZ standards
Element 3 – Vehicular Access	A3.1 Two Access Routes A3.2 Public Road A3.3 Cul-de-sacs A3.4 Battle axes A3.5 Private driveways A3.6 Emergency Access Ways A3.7 Fire Service Access Ways A3.8 Firebreaks	Yes Yes No No Yes No No Yes	Compliant two access points to 2 destinations Compliant – meets Table 5 N/A N/A Compliant – meet Table 5 N/A N/A Compliant on parent lot, applicable to future lots
Element 4 – Water	A4.1 Reticulated areas A4.2 Non-reticulated areas A4.3 Individual lots in non-reticulated areas	Yes No No	Compliant to WCWA Standards N/A N/A

2. Proposal Details

Brian and Christine Lowrie commissioned Bio Diverse Solutions (Bushfire Consultants) to prepare a Bushfire Management Plan (BMP) to guide all future bushfire management at Lot 9041 Willyung Road Albany.

This BMP has been prepared to assess the subject site to the current and endorsed Guidelines for Planning in Bushfire Prone Areas Vers 1.3 (WAPC, 2017) and State Planning Policy 3.7 (WAPC, 2015).

Such planning takes into consideration standards and requirements specified in various documents such as Australian Standard (AS) 3959-2009, Western Australian Planning Commission (WAPC) Guidelines for Planning in Bushfire Prone Areas Vers 1.3 (WAPC, 2017) and State Planning Policy 3.7 (WAPC, 2015). These policies, plans and guidelines have been developed by WAPC to ensure uniformity to planning in designated "Bushfire Prone Areas" and consideration of the relevant bushfire hazards when identifying or investigating land for future development.

2.1. Location

Lot 9041 Willyung Road Albany is located approximately 14km northwest of the Albany CBD in the Willyung area. The Subject Site is bound by Willyung Road to the south, residential/lifestyle blocks to the east and west and rural properties to the south and north. The location of the Subject Site is shown on Figure 1.

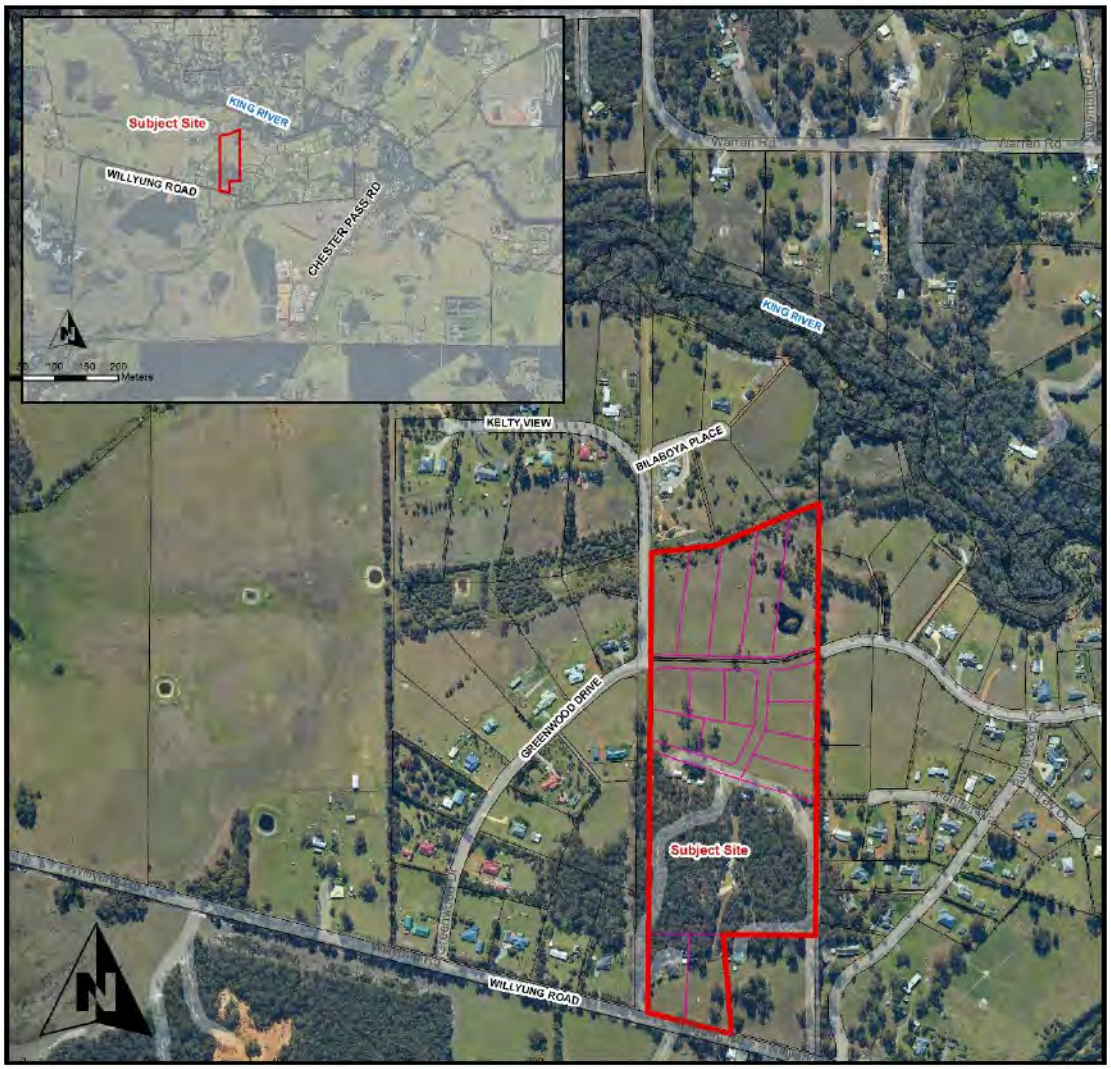


Figure 1: Location Plan

2.2. Development Proposal

This BMP addresses the variation to the existing Structure Plan of Lot 9041 Willyung Road, Albany ("the Subject Site").

The proposal for the Subject Site consists of 16 special residential lots ranging in size from 4,160m^2 to 10,230m^2, including the existing owner's residence. The balance of land is a Special Use Zone whereby chalets are located.

The BMP has been prepared to assess the site as per the Western Australian Planning Commission (WAPC) Guidelines for planning in bushfire prone areas Vers 1.3 (WAPC, 2017). Refer to the Structure Plan shown as Figure 2.

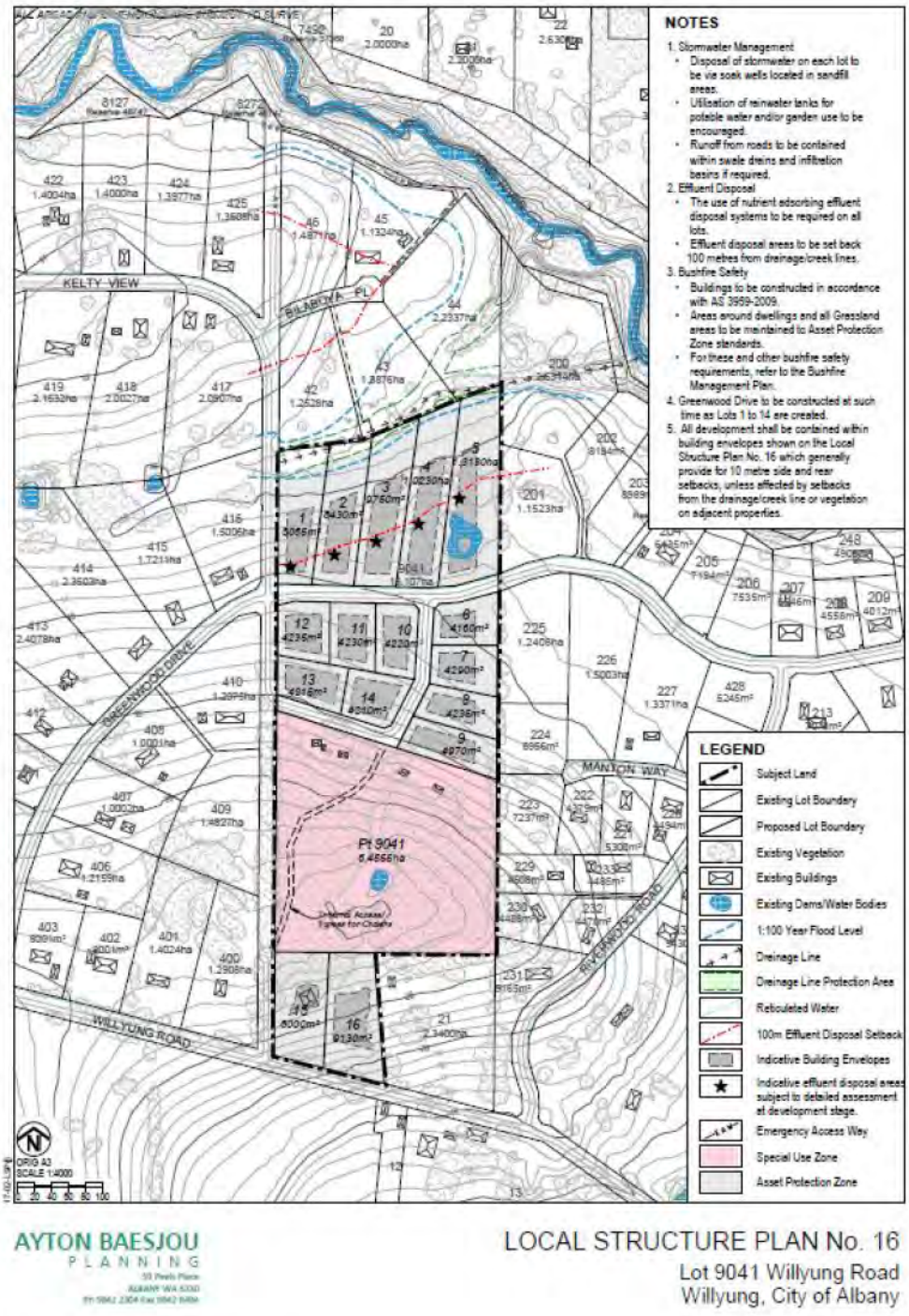


Figure 2: Structure Plan

The publicly released Bushfire Prone Area Mapping (DFES, 2018) shows the Subject Site is located within a Bushfire Prone Area (situated within 100m of >1 ha of bushfire prone vegetation). Bushfire Prone Area Mapping is shown on Figure 3.

Figure 3: Bushfire Prone Area Mapping

2.3. Statutory Framework

This document has been prepared to support a variation in the Structure Plan application to the City of Albany. This document and the recommendations contained within are aligned to the following policy and guidelines:

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

2.4. Suitably Qualified Bushfire Consultant

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

- Incident Control Systems;
- Operations Officer;
- Prescribed Burning Operations;

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

Kathryn Kinnear currently has the following tertiary Qualifications:

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

Kathryn Kinnear is an accredited Level 2 Bushfire Practitioner (Accreditation No: BPAD30794). Bio Diverse Solutions are Silver Corporate Members of the Fire Protection Australia Association. Kathryn is a member of the WA Bushfire Working Group and is a suitably qualified Bushfire Practitioner to prepare this Bushfire Management Plan. In 2018 Kathryn was awarded the Fire Protection Association Australia (FPAA) *Ron Coffey Award for Excellence in Bushfire Protection*.

3. Objectives

The objectives of this BMP are to assess the bushfire risks associated with the existing site and the proposed subdivision to reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property and the environment. It also aims to guide the subdivision design by assessing the proposed subdivision according to the Bushfire Protection Criteria Acceptable Solutions as outlined in the Guidelines for Planning in Bushfire Prone Areas Vers 1.3 (WAPC, 2017).

The BMP aims to:

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

4. Environmental Considerations

4.1. Native vegetation – modification and clearing

Some native vegetation modification is required around the existing chalets in the Special Use area to ensure that APZ areas consistent with BAL 29 or less prevails over the buildings. Occasional trees and understorey modification is required.

Blue gums are present in the central paddock area, these are "escapees" from the windbreak to the east. The client is keen to remove all Blue Gums to ensure APZ areas can be achieved and these introduced species do not continue to spread across the Subject Site.

4.2. Re-vegetation/Landscape Plans

There are no revegetation or landscape plans pertinent to this site. The "Creek Protection Area" in the north of the Subject Site is anticipated to return in the future to a Forest Type A status.

5. Bushfire Assessment results

A site inspection was conducted on the 1st November 2017 by Kathryn Kinnear to assess the current land use, topography/slope, vegetation and conditions of the site and its surroundings. Photographs of the Subject Site and surrounding areas were taken and have been presented in this report.

All vegetation within 150m of the site / proposed development was classified in accordance with Clause 2.3 and Exclusions as per Clause 2.2.3.2 of AS 3959-2009. Each distinguishable vegetation plot with the potential to determine the Bushfire Attack Level is identified over the page. Each plot is representative of the Vegetation Classification to AS3959-2009 Table 2.3 and shown on the Vegetation Classification Mapping (Figure 4 & 5).

Plot	**1**	**Classification or Exclusion Clause**	**Forest Type A**
			**Location:** Situated internal to the site to the north of the existing house and south of the Chalets. To the west in adjacent property along Greenwood Drive. External to the site subject site in the King River foreshore reserve area and to the west in adjacent property along Greenwood Drive. **Separation distance:** 50m to the north (King River), 25m to the west, 11-25m from the chalets and 21-24m from the existing dwelling. **Dominant species & description:** Jarrah and Marri trees, juvenile trees, Acacias, Hibbertia, Banksia, Emu bush, sedges and grasses. Multilayered. **Average vegetation height:** 15-18m. **Surface fuel loading:** 25-35t/ha. **Effective slope:** Upslope.
Photo Id 1: View to the west through Forest Type A adjacent to the existing building.			
Plot	**1**	**Classification or Exclusion Clause**	**Forest Type A**
			**Additional photograph of Plot 1.**
Photo Id 2: View to the north west through central forest area.			

Plot	2	Classification or Exclusion Clause	Grassland Type G
			**Location:** Located in grazed paddock areas in the south of the lot near existing house in the subject site (internal). **Separation distance:** 10m from the existing dwelling. **Dominant species & description:** Paddock grasses, kikuyu, clover, cape weed, phalaris species. **Vegetation coverage:** < 10% trees. **Average vegetation height:** 200-300mm. **Surface fuel loading:** 4.5 t/ha. **Effective slope:** Downslope >5-10 degrees.

Photo Id 3: View to the south of Grasslands adjacent to the existing dwelling in grazed paddock.

Plot	3	Classification or Exclusion Clause	Low fuel or non-vegetated areas Exclusion 2.2.3.2 (f)
			**Location:** Located around existing houses and dwellings in APZ areas. Exclusion as per AS3959-2009 Exclusion 2.2.3.2 (f) maintained lawns and gardens, evidence of upkeep displayed. **Fuel loading**: <2t/ha.

Photo Id 4: View of mowed lawns around existing building in the subject site.

Plot	3	Classification or Exclusion Clause	Low fuel or non-vegetated areas Exclusion 2.2.3.2 (f)
			**Additional photo of Plot 3.**

Photo Id 5: View from the east of one of the chalets showing low fuel mowed areas.

Plot	4	Classification or Exclusion Clause	Low fuel or non-vegetated areas Exclusion 2.2.3.2 (e)

Location: Bare areas, dams, roads and hardstand areas in and around the subject site.

Exclusions as per As3959-2009 Exclusion (e).

Photo Id 6: View of hardstand areas near existing house.

Plot	4	Classification or Exclusion Clause	Low fuel or non-vegetated areas Exclusion 2.2.3.2 (e)

Additional photo of Plot 4.

Photo Id 7: View to the south along Kelty View.

Plot	5	Classification or Exclusion Clause	Low fuel or non-vegetated areas Exclusion 2.2.3.2 (f) Windbreaks

Location: Located to the west of the existing house along unformed road reserve and neighbours fence line.

Exclusion as per AS3959-2009 Exclusion 2.2.3.2 (f) single row of trees presented with low grasses.

Fuel loading: <2t/ha.

Photo Id 8: View to the south along windbreak in existing road reserve (unformed)

Plot	6	Classification or Exclusion Clause	Grassland Type G

Location: Located in grazed paddock areas south of the Subject site.

Separation distance: 25m.

Dominant species & description: Paddock grasses, kikuyu, clover, cape weed, phalaris species.

Vegetation coverage: < 10% trees.

Average vegetation height: 200-300mm.

Surface fuel loading: 4.5 t/ha.

Effective slope: Downslope >0-5 degrees.

Photo Id 9: View to the east of grasslands in paddock areas south of the subject site.

Plot	6	Classification or Exclusion Clause	Grassland Type G

Location: Located internal and external east and west of the Subject site in grazed paddocks.

Separation distance: internal and external 0m to lot boundary.

Dominant species & description: Paddock grasses, kikuyu, clover, cape weed, phalaris species.

Vegetation coverage: < 10% trees.

Average vegetation height: 200-300mm.

Surface fuel loading: 4.5 t/ha.

Effective slope: Downslope >0-5 degrees.

Photo Id 10: View looking north in grazed paddock areas, north of chalets.

Plot	7	Classification or Exclusion Clause	Grassland Type G

Location: Located in grazed paddock areas external to the site to the west and south west.

Separation distance: 45 to 59m to the west and 31.2m to the south west lot boundary.

Dominant species & description: Paddock grasses, kikuyu, clover, cape weed, phalaris species.

Vegetation coverage: < 10% trees.

Average vegetation height: 200-300mm.

Surface fuel loading: 4.5 t/ha.

Effective slope: Upslope.

Photo Id 11: View to the south west of Grassland Type G Upslope. (note the GPS on camera did not fix, saying south east).

Plot	8	Classification or Exclusion Clause	Forest Type A

Location: Located along road reserve of Willyung Road.

Separation distance: 0m to southern boundary

Dominant species & description: Jarrah, Marri and Casuarina, some planted unidentified Eucalypts. Midstorey of juvenile trees, Taylorina, Sydney Golden Wattle, Watsonia, sedges and grasses. Multilayered.

Vegetation coverage: >30-70% foliage cover.

Average vegetation height: 8-12m.

Surface fuel loading: 25-35t/ha.

Effective slope: >0 to 5 degrees.

Photo Id 12: View to the east along Willyung Road.

Plot	9	Classification or Exclusion Clause	Woodland Type B

Location: Located to the south east of subject site in grazed/disturbed paddocks.

Separation distance: 0m to subject site boundary.

Dominant species & description: Blue gums and introduced trees, grassy understorey, not multilayered.

Vegetation coverage: 10-30% foliage cover.

Average vegetation height: 12-15m.

Surface fuel loading: 15-25t/ha.

Effective slope: Downslope >0-5 degrees.

Photo Id 13: View to the north west of Woodland Type B to the south east of the subject site.

Plot	10	Classification or Exclusion Clause	Scrub Type D

Location: Located in central creek area.

Separation distance: 25m.

Dominant species & description: Melaleuca scrub (Spearwood).

Vegetation coverage: >30% foliage cover presenting as solid layer of fuels.

Average vegetation height: 2.5-3m.

Surface fuel loading: 25t/ha.

Effective slope: Upslope.

Photo Id 14: View to south west showing vegetation height of Scrub Type D. (Note staff 4m)

Plot	11	Classification or Exclusion Clause	Forest Type A
			**Location:** Located north of the subject site along the King River in foreshore reserve areas. **Separation distance:** 6m (strategic firebreak separation). **Dominant species & description:** Jarrah, Flooded Gum and Marri trees, juvenile trees, Acacias, Hibbertia, Banksia, Emu bush, sedges and grasses. Multilayered. **Vegetation coverage:** >30-70% foliage cover. **Average vegetation height:** 16-20m. **Surface fuel loading:** 25-35t/ha. **Effective slope:** Downslope >5 to 10 degrees.

Photo Id 15: View to the north west in Forest Type A.

Plot	12	Classification or Exclusion Clause	Forest Type A
			**Location:** Located to the east along the tributary to the King River. **Separation distance:** 0m to lot boundary. **Dominant species & description:** Jarrah, Flooded gum and Marri trees, juvenile trees, Acacias, Hibbertia, Banksia, Emu bush, sedges and grasses. Multilayered. **Vegetation coverage:** >30-70% foliage cover. **Average vegetation height:** 16-20m. **Surface fuel loading:** 25-35t/ha. **Effective slope:** Downslope >0 to 5 degrees.

Photo Id 16: View to the east downstream in creek bed.

Plot	12	Classification or Exclusion Clause	Forest Type A
			**Location:** Located along the eastern boundary and in the paddock, escaped blue gums from windbreak. **Separation distance:** 0m to lot boundary. **Dominant species & description:** Blue gums and grasses understorey. **Vegetation coverage:** >30-70% foliage cover. **Average vegetation height:** 16-25m. **Surface fuel loading:** 25-35t/ha. **Effective slope:** Downslope >0 to 5 degrees. *Note to be removed inside the subject site as deemed to be weeds.*

Photo Id 17: View to the south east towards blue gums in paddock area.

Plot	13	Classification or Exclusion Clause	Forest Type A
			**Location:** Located along the creek area. Presents as Woodland Type B, however future creek protection area under scheme, therefore anticipated to become Forest A as in creek area. **Separation distance:** 0m to lot boundary. Creek protection area. **Dominant species & description:** Paperbarks and mowed grasses understorey. **Vegetation coverage:** Possibly future >30-70% foliage cover. **Average vegetation height:** 4-5m. **Surface fuel loading:** Possible future 25t/ha. **Effective slope:** Downslope >0 to 5 degrees.
Photo Id 18: View to the south west in creek protection area.			

COMMENTS ON VEGETATION CLASSIFCATIONS:

- Distances from vegetation were made based on surface fuels to edge of lot (subject site) boundary;
- Effective slopes were measured in the field using a Nikon Forestry Pro and represented on the respective plots;
- Method 1 (AS3959-2009) Simplified procedure was used for vegetation classification/Assessment process;
- All vegetation was classified within the subject site and within 150m of the lot boundaries to AS3959 Table 2.3; and
- The perimeter of the vegetation was measured using field GPS and notations on field GIS maps.

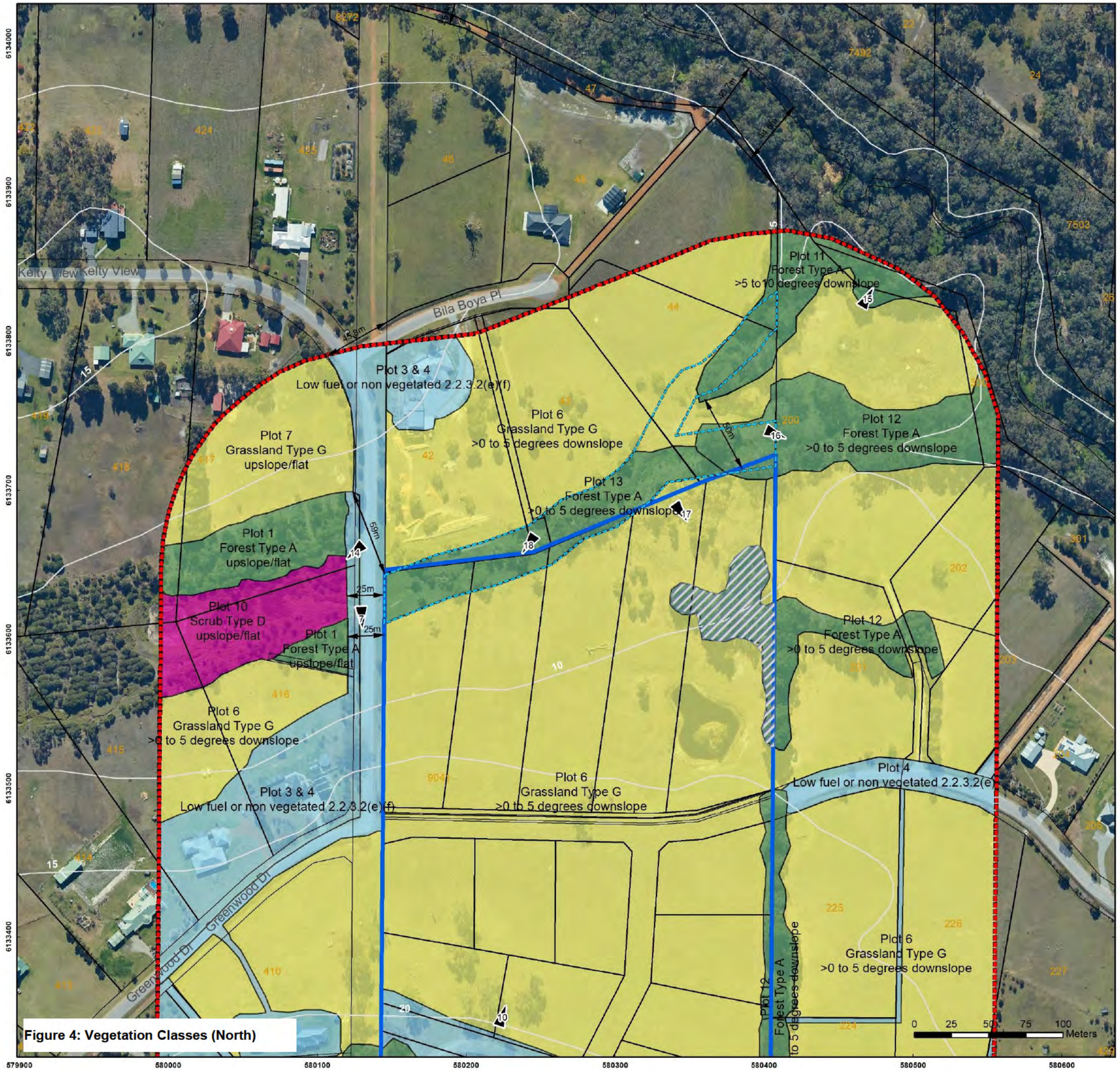


Figure 4: Vegetation Classes (North)

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

BPAD Bushfire Planning & Design Accredited Practitioner Level 2

BIO DIVERSE SOLUTIONS

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

Overview Map Scale 1:100,000

Legend

- Subject Site
- 150m Assessment Boundary
- Existing_Buildings
- Drainage Protection Area
- Cadastre
- 5m Contours
- Slope Degrees
- Separation Distance
- Photo Point
- Clearing - Area to be removed

Vegetation

- Forest Type A
- Grassland Type G
- Low fuel or non vegetated 2.2.3.2
- Scrub Type D
- Woodland Type B

Scale
1:2,500 @ A3
GDA MGA 94 Zone 50

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

CLIENT
Brian & Christine Lowrie
Lot 9041 Willyung Road
Willyung, WA 6630

Vegetation Classes (NORTH)

BAL Assessor	QA Check	Drawn by
KK	KK	BT
STATUS	**FILE**	**DATE**
FINAL	AB0024	16/04/2019

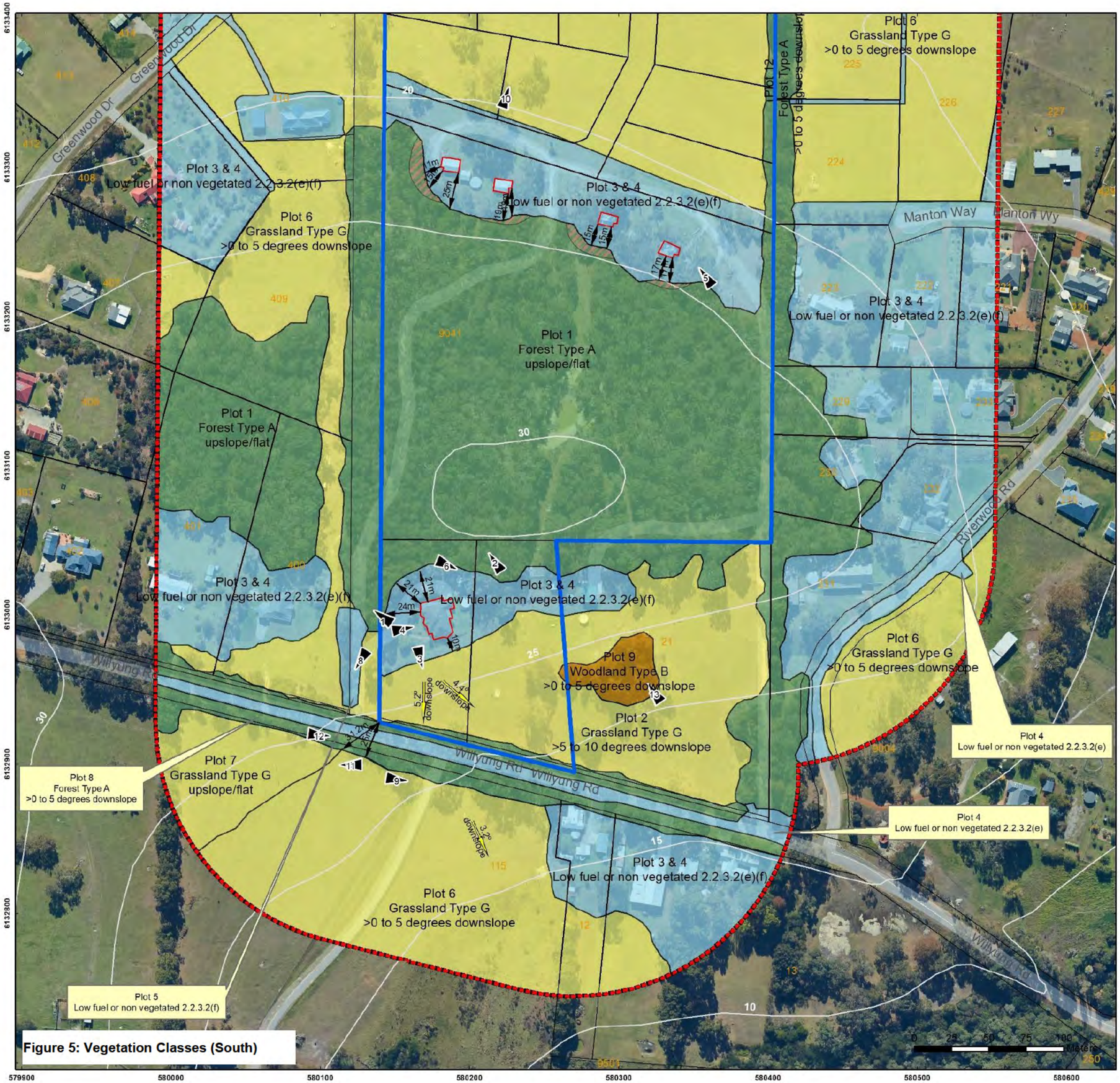


Figure 5: Vegetation Classes (South)

This BAL Plan was prepared by:
Kathryn Kinnear, Bio Diverse Solutions
Accreditation No: BPAD30784
Jurisdiction: Level 2 - WA

BPAD Bushfire Planning & Design Accredited Practitioner Level 2

BIO DIVERSE SOLUTIONS

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

Overview Map Scale 1:100,000

Legend

- Subject Site
- 150m Assessment Boundary
- Existing_Buildings
- Drainage Protection Area
- Cadastre
- 5m Contours
- Slope Degrees
- Separation Distance
- Photo Point
- Works to 21m

Vegetation

- Forest Type A
- Grassland Type G
- Low fuel or non vegetated 2.2.3.2
- Scrub Type D
- Woodland Type B

Scale
1:2,500 @ A3
GDA MGA 94 Zone 50

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

CLIENT
Brian & Christine Lowrie
Lots 44 + 46 Bilaboya Place & Lot 9041 Willyung Road
Willyung, WA 6630

Vegetation Classes (SOUTH)

BAL Assessor	*QA Check*	*Drawn by*
KK	KK	BT
STATUS	*FILE*	*DATE*
FINAL	AB0024	16/04/2019

6. Bushfire Attack Levels (BAL)

Bushfire Attack Level (BAL) is the process in AS39598-2009 for measuring the severity of a buildings potential exposure to ember attack, radiant heat and direct flame contact. The threat or risk of bushfire attack is assessed by an accredited BAL Assessor. BAL rating determinations are of 6 levels BAL-LOW, BAL-12.5, BAL-19, BAL-29, BAL-40, BAL FZ. Building is generally not recommended in BAL-40 or BAL-FZ areas. The BAL rating is determined by the distance of the building to vegetation, slope and vegetation type adjacent to the dwelling. Refer to Figure 6.

Figure 6: Building to BAL

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

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

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

6.1. Fire Danger Index

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

6.2. Vegetation Classes

All vegetation within 150m of the Subject Site was classified. The vegetation classes (as described in Section 4.4) are shown on Figure 3 and listed below.

- Forest Type A;
- Woodland Type B;
- Scrub Type D;
- Grassland Type G; and
- Exclusions 2.2.3.2 (e) and (f).

6.3. Slope Under Classified Vegetation

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

Table 2: Effective slope allocation to classified vegetation

Plot Number	Vegetation Classification	Effective Slope
1	Forest Type A	Upslope/Flat
2	Grassland Type G	Downslope >5 to 10 degrees
3	Low Fuel and Non-vegetated areas (e)	N/A
4	Low Fuel and Non-vegetated areas (f)	N/A
5	Low Fuel and Non-vegetated areas (f) Windbreaks	N/A
6	Grassland Type G	Downslope >0 to 5 degrees
7	Grassland Type G	Upslope/Flat
8	Forest Type A	Downslope >0 to 5 degrees
9	Woodland Type B	Downslope >0 to 5 degrees
10	Scrub Type D	Upslope/Flat
11	Forest Type A	Downslope >5 to 10 degrees
12	Forest Type A	Downslope >0 to 5 degrees
13	Forest Type A	Downslope >0 to 5 degrees

Plots 3, 4 and 5 are allocated exclusion Clauses 2.2.3.2 and therefore do not have an effective slope allocation.

6.4. Method 1 BAL Calculation

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

The assessed BAL ratings for the development are depicted as BAL contours, BAL ratings for the Subject Site are presented in Table 3 with BAL Contours for the Subject Site shown on Figures 7 and 8.

All proposed buildings will be located in areas subject to a BAL rating of BAL 29 or lower.

Table 3: BAL Allocation

Lot number	Vegetation Type (Table 2.3)	Slope (Table 2.4.3)	Separation distance to vegetation (m)	Highest BAL Contour	Modified BAL Contour
1	Forest Type A (Plot 13)	>0 to 5 degrees downslope	0m	BAL FZ	BAL 19 and BAL 12.5 can apply to the BE.
	Forest Type A (Plot 1)	Upslope/flat	25m	BAL 29	BAL 19 and BAL 12.5 can apply to the BE.
	Grassland Type G (Plot 6)	>0 to 5 degrees downslope	0m	BAL FZ	20m APZ and BAL 12.5 can apply to the BE.
2,3,4	Forest Type A (Plot 13)	>0 to 5 degrees downslope	0m	BAL FZ	BAL 19 (Lots 2 &3 only) and BAL 12.5 can apply to the BE.
	Grassland Type G (Plot 6)	>0 to 5 degrees downslope	0m	BAL FZ	20m APZ and BAL 12.5 can apply to the BE.
5	Forest Type A (Plot 13)	>0 to 5 degrees downslope	0m	BAL FZ	BAL 12.5 can apply to the BE.
	Forest Type A (Plot 12)	>0 to 5 degrees downslope	0m	BAL FZ	BAL 29, BAL 19 and BAL 12.5 can apply to the BE.
	Grassland Type G (Plot 6)	>0 to 5 degrees downslope	0m	BAL FZ	20m APZ and BAL 12.5 can apply to the BE.
6,7,8	Forest Type A (Plot 12)	>0 to 5 degrees downslope	0m	BAL FZ	BAL 29, BAL 19 and BAL 12.5 can apply to the BE.
	Grassland Type G (Plot 6)	>0 to 5 degrees downslope	0m	BAL FZ	20m APZ and BAL 12.5 can apply to the BE.
9	Forest Type A (Plot 12)	>0 to 5 degrees downslope	0m	BAL FZ	BAL 29, BAL 19 and BAL 12.5 can apply to the BE.
	Forest Type A (Plot 1)	Upslope/flat	0m	BAL FZ	BAL 29, BAL 19 and BAL 12.5 can apply to the BE.
	Grassland Type G (Plot 6)	>0 to 5 degrees downslope	0m	BAL FZ	20m APZ and BAL 12.5 can apply to the BE.
12	Grassland Type G (Plot 6)	>0 to 5 degrees downslope	0m	BAL FZ	20m APZ and BAL 12.5 can apply to the BE.
10,11,14	Grassland Type G (Plot 6)	>0 to 5 degrees downslope	0m	BAL FZ	20m APZ and BAL 12.5 can apply to the BE.
13	Forest Type A (Plot 1)	Upslope/flat	22m	BAL 29	BAL 19 and BAL 12.5 can apply to the BE.
	Grassland Type G (Plot 6)	>0 to 5 degrees downslope	0m	BAL FZ	20m APZ and BAL 12.5 can apply to the BE.
15 Existing House	Forest Type A (Plot 1)	>0 to 5 degrees downslope	21m to house	BAL 29 can apply	21m APZ to the north and BAL 29 can apply to the building.
	Grassland Type G (Plot 2)	>5 to 10 degrees downslope	0m	BAL FZ	23m APZ and BAL 12.5 can apply to the BE.
16	Forest Type A (Plot 1)	>0 to 5 degrees downslope	0m	BAL FZ	BAL 29, BAL 19 and BAL 12.5 can apply to the BE.
	Woodland Type B (Plot 9)	>0 to 5 degrees	0m	BAL FZ	BAL 29, BAL 19 and BAL 12.5 can apply to the BE.
	Grassland Type G (Plot 2)	>5 to 10 degrees downslope	0m	BAL FZ	23m APZ and BAL 12.5 can apply to the BE.

Where multiple BAL allocations are shown on Table 3, the highest BAL is to apply to the building.

Assumptions made in BAL Contour Mapping:

- The Subject Site will be developed according to the Structure Plan (Ayton Baesjou Planning, 2016) (Figure 1).
- Low fuel areas associated with Asset Protection Zones (APZ) are recommended as per BAL 29 or less requirements. See Section 6.2 for more detail.
- The owner of the Subject Site will maintain grasslands internal to the site (balance of land) at all times in a low fuel state (i.e. slashed to <100mm) for a minimum distance of 100m from any dwellings or construction areas.

Note on internal grassland areas:
The lot contains significant areas of internal grasslands which are mapped as bushfire hazards (refer to Vegetation Classes Map). For practical purposes and to assist in identifying areas of 'least risk', the internal grasslands (BAL Contour North) have been left off the BAL Contour Map (Plot 6). Setback distances to these areas are to be as per AS3959 and the following to apply:

Plot 6 – Grassland >0-5 degrees
9-<14m for BAL 29
14-<20m for BAL 19
20-<50m for BAL 12.5

When the final placement of the dwelling is known APZ areas are to apply as per the allocated BAL for the dwelling.

6.5. Identification of bushfire hazard issues

Bushfire hazards identified for the site are the unmanaged forested areas along the King River foreshore (north) and grazed pastures to the south and unmanaged grasslands to the east. Remnant forest vegetation through the central area of the Subject site is located upslope of any dwellings and therefore has a reduced radiant heat intensity. It is also surrounded by moderate hazards ("Island effect") which also reduces the intensity of the bushfire threat from this area. The Structure Plan proposes large lots which allows for adequate setbacks to the bushfire hazards.

APZ setback distances to internal Grassland Type G (Plot 6) are to be as per AS3959 and the following to apply:

Plot 6 – Grassland >0-5 degrees
9-<14m for BAL 29
14-<20m for BAL 19
20-<50m for BAL 12.5

Kelly View Kelly View
Bila Boya Pl
Greenwood Dr
Plot 1
Plot 6
Plot 7
Plot 10
Plot 11
Plot 12
1
2
3
4
5
6
7
8
10
11
12
13
14
9041
0 25 50 75 100 Meters
579900 580000 580100 580200 580300 580400 580500 580600
6134000 6133900 6133800 6133700 6133600 6133500 6133400

Figure 7: BAL Allocation (Contour) Plan (North)

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

BPAD Bushfire Planning & Design Accredited Practitioner Level 2
BIO DIVERSE SOLUTIONS

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

Overview Map Scale 1:100,000

Legend

- Subject Site
- 150m Assessment Boundary
- Existing Buildings
- Cadastre
- Drainage Protection Area
- Lot Layout
- Building Envelopes

BAL Contours

- BAL-FZ
- BAL-40
- BAL-29
- BAL-19
- BAL-12.5
- BAL-LOW
- Low fuel or non vegetated 2.2.3.2

Scale
1:2,500 @ A3
GDA MGA 94 Zone 50

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

CLIENT
Brian & Christine Lowrie
Lot 9041 Willyung Road
Willyung, WA 6630

BAL Contour - North (Post development)

BAL Assessor	*QA Check*	*Drawn by*
KK	**KK**	**BT**
STATUS	*FILE*	*DATE*
FINAL	**AB0024**	**16/4/2019**

APZ setback distances to internal Grassland Type G (Plot 6) are to be as per AS3959 and the following to apply:

Plot 6 – Grassland >0-5 degrees
9-<14m for BAL 29
14-<20m for BAL 19
20-<50m for BAL 12.5

6133300
6133200
6133100
6133000
6132900
6132800
6132700

580000 580100 580200 580300 580400 580500 580600

0 25 50 75 100 Meters

Figure 8: BAL Allocation (Contour) Plan (South)

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

BPAD Bushfire Planning & Design Accredited Practitioner Level 2

BIO DIVERSE SOLUTIONS

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

Overview Map Scale 1:100,000

Legend

- Subject Site
- 150m Assessment Boundary
- Existing Buildings
- Cadastre
- Drainage Protection Area
- Lot Layout
- Building Envelopes

BAL Contours

- BAL-FZ
- BAL-40
- BAL-29
- BAL-19
- BAL-12.5
- BAL-LOW
- Low fuel or non vegetated 2.2.3.2

Scale
1:2,500 @ A3
GDA MGA 94 Zone 50

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

CLIENT
Brian & Christine Lowrie
Lot 9041 Willyung Road
Willyung, WA 6630

BAL Contour - South (Post development)

BAL Assessor	*QA Check*	*Drawn by*
KK	KK	BT
STATUS	*FILE*	*DATE*
FINAL	AB0024	16/4/2019

7. Assessment to the bushfire protection criteria

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

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

(WAPC, 2017)

The Plan of subdivision(s) is required to meet the "Acceptable Solutions" of each Element of the bushfire mitigation measures (WAPC, 2017). The proposal will be assessed against the bushfire protection criteria Acceptable Solutions for Elements A1, A2, A3 and A4. A summary of the assessment is provided below in Table 4. The following sections of this report outlines how the proposal complies with the bushfire protection criteria Acceptable Solutions as per the Guidelines for Planning in Bushfire Prone Areas (WAPC, 2017).

The Subject Site was assessed against the bushfire protection criteria Acceptable Solutions for Elements A1, A2, A3 and A4. Please refer to the summary table below and the detailed assessment in Sections 6.1-6.4.

Table 4: Bushfire protection criteria applicable to the site

Element	Acceptable Solution	Applicable or not Yes/No	Meets Acceptable Solution
Element 1 – Location	A1.1 Development Location	Yes	Compliant BAL 29 or less applied to lots, existing house and chalets BAL 29 applied.
Element 2 – Siting and Design	A2.1 Asset Protection Zone	Yes	Compliant, APZ area in BE's to BAL 29 or less. APZ area to be BAL 29 or less and can be contained within the individual lots. To WAPC APZ standards
Element 3 – Vehicular Access	A3.1 Two Access Routes A3.2 Public Road A3.3 Cul-de-sacs A3.4 Battle axes A3.5 Private driveways A3.6 Emergency Access Ways A3.7 Fire Service Access Ways A3.8 Firebreaks	Yes Yes No No Yes No No Yes	Compliant two access points to 2 destinations. Compliant – meets Table 5 N/A N/A Compliant – meet Table 5 N/A N/A Compliant on parent lot, applicable to future lots
Element 4 – Water	A4.1 Reticulated areas A4.2 Non-reticulated areas A4.3 Individual lots in non-reticulated areas	Yes No No	Compliant to WCWA Standards N/A N/A

7.1. Element 1: Location

Intent: To ensure that strategic planning proposals, subdivision and development applications are located in areas with the least possible risk of bushfire to facilitate the protection of people, property and infrastructure.

Acceptable Solutions

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

Assessment to Acceptable Solutions

A1.1 Development Location: The publicly released Bushfire Prone Mapping (DFES 2017) indicates this area as bushfire prone. The BAL Contour Plan (Figure 7 and 8) prepared demonstrates the BAL Contours upon completed construction of the subdivision, demonstrating the dwellings could be subject to BAL 29, BAL 19 and BAL 12.5 in Building envelopes (BE'S). No higher than BAL 29 should apply to any proposed dwellings in the defined BE's, refer to Table 3. The existing dwelling can achieve BAL 29, some minor clearing (selective tree removal and understorey modification) is required to achieve BAL 29 on the southern side of the chalets.

Internal areas of Grassland Type G (Plot 6 and Plot 2) **have not been mapped on the BAL Contour Plan** with BAL-FZ applicable to the whole of site. APZ setbacks are specified on the BAL Contour plan to ensure BAL 29 or less prevails over these lots, depending on final placement of the house in the BE, see section 7.2 for further detail.

The "Special Use Zone" is proposed in the central portion of the site, which currently has approved chalet business. An individual Bushfire Management Plan and Bushfire Emergency Evacuation Plan's (BEEP) may be required for this area for any future Planning Approval's as tourism is defined as a "Vulnerable land use" as per SPP3.7 (WAPC, 2015).

If the subdivision is staged, then the developer may need to submit plans with the staged subdivision application outlining any site works undertaken as recommended in report (i.e. fuel reduction) and an updated BAL contour plan over the staged construction area. Staged construction is to incorporate maintenance of the balance of land in a low fuel state to ensure BAL is maintained as shown in the BAL Contour Plan.

Recommendations

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

- Development is deemed compliant to A1.1 due to:
    - No higher BAL allocation than BAL 29 will apply to buildings upon completion of subdivision;
    - The existing house can maintain BAL 29 on the building; and
    - The with some modification along the southern side the chalets can maintain BAL 29 on the buildings.
- The developer will be responsible for the implementation of a notification on title pursuant to Section 70A of the Transfer of Land Act 1893 for all lots affected by an increase in construction standards consistent with a BAL rating/AS3959-2009 allocation to the lot.
- Individual BAL assessments may be considered on the lots by the new owners when dwelling design/placement is known and can be undertaken at building approval stages with the engagement of an Accredited Level 1 BAL Assessor.

7.2. Element 2: Siting and Design

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

Acceptable Solutions

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

- ***Width:*** *Measured from any external wall or supporting post or column of the proposed building, and of sufficient size to ensure the potential radiant heat impact of a bushfire does not exceed 29kW/m² (BAL-29) in all circumstances.*
- ***Location:*** *the APZ should be contained solely within the boundaries of the lot on which the building is situated, except in instances where the neighbouring lot or lots will be managed in a low-fuel state on an ongoing basis, in perpetuity (see explanatory notes).*
- ***Management:*** *the APZ is managed in accordance with the requirements of 'Standards for Asset Protection Zones'.*

(WAPC, 2017)

An Asset Protection Zone (APZ) is an area surrounding a building that is managed to reduce the bushfire hazard to an acceptable level (WAPC, 2017). This is also defined as a "defendable zone". Any buildings will have an APZ utilising Low threat or non-vegetated areas as classified by AS3959-2009 Section 2.2.3.2. Any replanting, revegetation and landscaping across the lots is to be to an APZ standard as per WAPC Guidelines V 1.3 (WAPC, 2017) as outlined below.

WAPC Guidelines for an APZ (WAPC, 2017)

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

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

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

Trees (> 5 metres in height): trunks at maturity should be a minimum distance of 6 metres from all elevations of the building, branches at maturity should not touch or overhang the building, lower branches should be removed to a height of 2 metres above the ground and or surface vegetation, canopy cover should be less than 15% with tree canopies at maturity well spread to at least 5 metres apart as to not form a continuous canopy. See Figure 9 (WAPC Figure 16, Appendix 4) below.

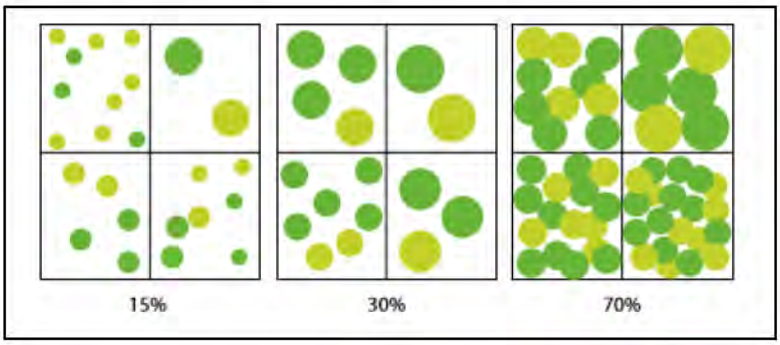


Figure 9: Tree Canopy Coverage – ranging from 15 to 70% at maturity (WAPC, 2017)

Shrubs (0.5 metres to 5 metres in height): should not be located under trees or within 3 metres of buildings, should not be planted in clumps greater than 5m² in area, clumps of shrubs should be separated from each

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

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

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

(WAPC, 2017).

Assessment to Acceptable Solutions

A2.1 Asset Protection Zone (APZ): All future buildings can achieve an APZ area associated with a BAL allocation of BAL 29, BAL 19 or BAL 12.5 in designated BE's. APZ areas for Lot 15, 16 and the balance of land are demonstrated on the BAL Contour Plan. A minimum APZ setback associated with BAL 29 or less has been applied where lots are predominantly in Grassland Type G (Plot 6) and setbacks distances are notated on the BAL Contour Plan. When the final placement of the dwelling is known, APZ areas are to apply as per the allocated BAL for the dwelling.

The existing dwelling can achieve an APZ area consistent with BAL 29. The Chalets require some minor clearing (selective tree removal and understorey modification, (see notation on Vegetation Classes mapping) to achieve BAL 29 on the southern side of the chalets. This will ensure that there is 21m setback (and BAL 29) from forest areas and will also ensure the existing buildings are complaint to the CoA Fire Management Order (Asset Protection Zone). The APZ areas are located in the individual lots and within the parent lot area.

The developer will be responsible for maintenance of the site until ownership is relinquished to new lot owners, this will include maintenance of internal grassland areas to APZ requirements to 100m from any dwellings or construction areas.

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

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

Recommendations

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

- A minimum APZ area associated with BAL 29 or less in Plot 6 is to apply to the lots in grassland areas;
- All BE's are aligned in BAL 29 or lower to adjacent bushfire risks;
- The developer is to maintain the balance of land in ownership as per APZ standards (WAPC, 2017), with grasslands to a minimum of 100m from any future dwellings or dwelling construction sites; and
- Any future landscaping, revegetation or replanting is to conform to APZ standards.

7.3. Element 3: Vehicle Access

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

Acceptable Solutions

A3.1 Two access routes: *Two different vehicular access routes are provided, both of which connect to the public road network, provide safe access and egress to two different destinations and are available to all residents/the public at all times and under all weather conditions.*

A3.2 Public road: *A public road is to meet the requirements in Table 5, Column 1.*

A3.3 Cul-de-sac (including a dead-end road): *A cul-de-sac and/or a dead end road should be avoided in bushfire prone areas. Where no alternative exists (i.e. the lot layout already exists and/or will need to be demonstrated by the proponent), the following requirements are to be achieved: Requirements in Table 5, Column 2; Maximum length: 200 metres; and Turn-around area requirements, including a minimum 17.5 metre diameter head.*

A3.4 Battle-axe: *Battle-axe access leg should be avoided in bushfire prone areas. Where no alternative exists, (this will need to be demonstrated by the proponent) all of the following requirements are to be achieved: Requirements in Table 5, Column 3; Maximum length: 600 metres; and Minimum width: 6 metres.*

A3.5 Private driveway: *longer than 50 metres A private driveway is to meet all of the following requirements: Requirements in Table 5, Column 3; Required where a house site is more than 50 metres from a public road; Passing bays: every 200 metres with a minimum length of 20 metres and a minimum width of two metres (i.e. the combined width of the passing bay and constructed private driveway to be a minimum six metres); Turn-around areas designed to accommodate type 3.4 fire appliances and to enable them to turn around safely every 500 metres (i.e. kerb to kerb 17.5 metres) and within 50 metres of a house; and any bridges or culverts are able to support a minimum weight capacity of 15 tonnes. All-weather surface (i.e. compacted gravel, limestone or sealed).*

A3.6 Emergency access way: *An access way that does not provide through access to a public road is to be avoided in bushfire prone areas. Where no alternative exists (this will need to be demonstrated by the proponent), an emergency access way is to be provided as an alternative link to a public road during emergencies. An emergency access way is to meet all of the following requirements: – Requirements in Table 4, Column 4; – No further than 600 metres from a public road; – Provided as right of way or public access easement in gross to ensure accessibility to the public and fire services during an emergency; and – Must be signposted.*

A3.7 Fire service access routes (perimeter roads): *Fire service access routes are to be established to provide access within and around the edge of the subdivision and related development to provide direct access to bushfire prone areas for fire fighters and link between public road networks for firefighting purposes. Fire service access routes are to meet the following requirements: Requirements Table 5, Column 5; Provided as right of ways or public access easements in gross to ensure accessibility to the public and fire services during an emergency; Surface: all-weather (i.e. compacted gravel, limestone or sealed) Dead end roads are not permitted; Turn-around areas designed to accommodate type 3.4 appliances and to enable them to turn around safely every 500 metres (i.e. kerb to kerb 17.5 metres); No further than 600 metres from a public road; Allow for two-way traffic and Must be signposted.*

A3.8 Firebreak width: *Lots greater than 0.5 hectares must have an internal perimeter firebreak of a minimum width of three metres or to the level as prescribed in the local firebreak notice issued by the local government.*

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

Technical requirements	Public Road	Cul-de-sacs	Private Driveways
Minimum trafficable surface (m)	*6	6	4
Horizontal clearance (m)	6	6	6
Vertical clearance (m)	4.5	4.5	4.5
Maximum grades	1 in 10	1 in 10	1 in 10
Minimum weight capacity (t)	15	15	15
Maximum crossfall	1 in 33	1 in 33	1 in 33
Curves minimum inner radius (m)	8.5	8.5	8.5
Maximum Length	N/A	200m	50m

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

Assessment to Acceptable Solutions

A3.1 Two access routes: The subdivision meets the Acceptable Solution, with the design allowing for two-way traffic and safe egress from the subdivision via the existing road network of Willyung Road, Kelty View and the extension/linking of Greenwood Drive. A proposed new public central road will link to Kelty View and Greenwood Drive. Willyung Road is a CoA managed road which provides for access to the east and the west (two separate directions) in a bushfire emergency. Refer to the Access Plan Figure 10 below.

Figure 10: Access Plan

All lots have a minimum of two alternative access options to separate destinations. If the subdivision is staged, linking two-way access is to be demonstrated on plans prior to approval of the subdivision. The Structure Plan deemed compliant with A3.1.

A3.2 Public roads: All internal public roads shall be constructed with a minimum of 21m road reserves (measured) meeting the minimum construction requirements. The Vehicular Access Standards (Refer to Table 5 – Column 1) and relevant technical information shall be detailed in civil engineering designs at subdivision stage to be approved by the Shire. The Structure Plan is deemed compliant to Acceptable Solution A3.2.

A3.3 Cul-de-sac: Cul-de-sacs are to be avoided in bushfire prone areas. No cul-de-sacs are proposed for this development. The Structure Plan not assessed to Acceptable Solution A3.3.

A3.4 Battle-axe: Battle Axes are to be avoided in bushfire prone areas. No battle axes are proposed for this development. The Structure Plan not assessed to Acceptable Solution A3.4.

A3.5 Private driveways: Private driveways will conform to the minimum technical standards as outlined in Table 6 – Column 3. Driveways do not exceed 50m, suitable cross overs are to be constructed onto public roads, with final placement of the driveway the responsibility of the new lot owner. Technical standards of driveways are to conform to Table 5, column 3.

The Structure Plan is deemed compliant to Acceptable Solution A3.5.

A3.6 Emergency access ways: Emergency Access Ways (EAW) will not apply with the public road network utilised. Not assessed to A3.6

A3.7 Fire Service Access Routes: Fire Service Access (FSA) Routes will not apply to this subdivision as the public roads will be utilised. Not assessed to A3.7.

A3.8 Firebreaks: Firebreaks are in existence on the Subject Site and maintained regularly by the current owners. These will be maintained as per the CoA Fire break notice (updated annually) until developed. Fire breaks will be required on the new lots as per the CoA Fire Management Notice – fire breaks are to be located within 20m of the property boundary and must be 3m wide with 4m vertical clearance. The new lots will need to comply with this notice.

The subdivision plan deemed compliant with A3.8.

Recommendations

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

- Is deemed compliant with Element 3 as it meets the Acceptable Solutions as outlined A3.1 to A3.8;
- The new lot owner implements the driveway construction standards as outlined in Table 6; and
- Fire breaks as per the requirements in the CoA Management Notice maintained by the owner and in the newly created lots (refer to the CoA current fire management notice, annually updated).

7.4. Element 4: Water

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

Acceptable Solutions

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

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

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

Assessment to Acceptable Solutions

A4.1 Reticulated areas: The development will be provided with reticulated scheme water in accordance with the specifications of the relevant water supply authority (Water Corporation WA (WCWA)) and DFES requirements. This will be detailed in the detailed engineering drawings and be subject to approval from WCWA and the CoA at subdivision condition stages, meeting the Acceptable Solution. Fire hydrant (street) outlets are required, these must be installed to WCWA standards installed in accordance with the *Water Corporation's No 63 Water Reticulation Standard* and are to be identified by standard pole and/or road markings and installed by the Developer.

The plan of subdivision deemed compliant to Element 4 – Water Acceptable Solution A4.1.

A4.2 Non-reticulated areas: The development not assessed to Acceptable Solution 4.2.

A4.3 Individual lots within non-reticulated areas: The development not assessed to Acceptable Solution A4.3.

Recommendations

The recommendations from assessment of the subdivision plan to Element 4: Water:

- The development will be provided with reticulated scheme water in accordance with the specifications of the relevant water supply authority (Water Corporation WA (WCWA)) and DFES requirements, detailed in plans and approved by the CoA prior to subdivision approval.

8. Other Fire Mitigation Measures

8.1. Evaporative air conditioners

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

It is also recommended that the lot owner:

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

8.2. Barrier Fencing

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

The findings of the research found that:

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

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

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

9. Responsibilities for implementation

9.1. Future Lot owner's Responsibility

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

Lot owner– Ongoing management			
No	**Implementation Action**	**Annual**	**All times**
1	Individual BAL assessments may be considered on the lots by the new owners when dwelling design/placement is known and can be undertaken at building approval stages with the engagement of an Accredited Level 1 BAL Assessor	☐	☐
2	Maintain APZ around dwellings areas at all times	☐	☑
3	The lot owner implements the driveway construction standards as outlined in Table 6, column 3.	☐	☐

9.2. Developer's responsibility

It is recommended the developer be responsible for the following:

Developer – Prior to issue of titles		
No	**Implementation Action**	**Subdivision Clearance**
1	Notification on title 70A of the Transfer of Land Act 1893 to alert prospective owners that the lots are located in a bushfire prone area and may be subject to increased construction standards to AS3959.	☐
2	Maintain balance of land in ownership in a low fuel state (APZ standards) at all times.	☐
3	Ensure Vehicle Access constructed to Table 5 standards.	☐
4	Reticulated scheme water supplied in accordance with the specifications of the relevant water supply authority (Water Corporation WA (WCWA)) and DFES requirements, detailed in plans and approved by the CoA prior to subdivision approval.	☐

9.3. Local Government Responsibility

It is recommended the CoA be responsible for the following:

LGA– Clearance of conditions		
No	**Implementation Action**	**Subdivision Clearance**
1	Ensure Vehicle Access constructed to Table 5 standards.	☐
2	If the subdivision is staged then updated BAL Contour plans and access plans may be required indicating any staged construction or deviation from this BMP Plan.	☐
3	Reticulated water and hydrant design to approval from WCWA and the CoA at subdivision clearance stages.	☐
4	Ensure the annual Fire Management Notice continues to refer to approved Bushfire Management Plans so that APZ areas in grassland are not subject to BAL FZ.	**ongoing**

10. Disclaimer

The recommendations and measures contained in this assessment report are based on the requirements of the Australian Standards 3959-2009 – Building in Bushfire Prone Areas, WAPC State Planning Policy 3.7 (WAPC, 2015), WAPC Guidelines for Planning in Bushfire Prone Areas (WAPC, 2015), and CSIRO's research into Bushfire behaviour. These are considered the minimum standards required to balance the protection of the proposed dwelling and occupants with the aesthetic and environmental conditions required by local, state and federal government authorities. They DO NOT guarantee that a building will not be destroyed or damaged by a bushfire. All surveys and forecasts, projections and recommendations made in this assessment report and associated with this proposed dwelling are made in good faith on the basis of the information available to the fire protection consultant at the time of assessment. The achievement of the level of implementation of fire precautions will depend amongst other things on actions of the landowner or occupiers of the land, over which the fire protection consultant has no control. Notwithstanding anything contained within, the fire consultant/s or local government authority will not, except as the law may require, be liable for any loss or other consequences (whether or not due to negligence of the fire consultant/s and the local government authority, their servants or agents) arising out of the services rendered by the fire consultant/s or local government authority.

AS3959-2009 disclaimer: It should be borne in mind that the measures contained within this Standard (AS3959-2009) cannot guarantee that a building will survive a bushfire event on every occasion. This is substantially due to the unpredictable nature and behaviour of fire and extreme weather condition.
(AS3959, 2009)
Building to AS39590-2009 is a standard primarily concerned with improving the ability of buildings in designated bushfire prone areas to better withstand attack from bushfire thus giving a measure of protection to the building occupants (until the fire front passes) as well as to the building itself.

SECTION 8: Certification
I hereby certify that I have undertaken the assessment of the above site and determined the Bushfire Attack Level stated above in accordance with the requirements of AS 3959-2009 (Incorporating Amendment Nos 1, 2 and 3) and the Guidelines for Planning in Bushfire Prone Areas Ver 1.3 (WAPC, 2017).

Note: this certification is from the date as shown below, the Bushfire Practitioner cannot be responsible/liable for any subsequent updates or reviews of WAPC guidelines after with, unless commissioned to review, update or withdraw this signed assessment.

SIGNED, ASSESSOR: ..... DATE: 18/4/2019

Kathryn Kinnear, Bio Diverse Solutions
Accredited Level 2 Bushfire Practitioner (Accreditation No: BPAD30794)

BPAD Bushfire Planning & Design Accredited Practitioner Level 2

11. References

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

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

City of Albany Fire Management Notice, yearly advise brochure, accessed July 2017 from: http://www.albany.wa.gov.au

Department of Fire and Emergency Services Website accessed July 2017: http://www.dfes.wa.gov.au

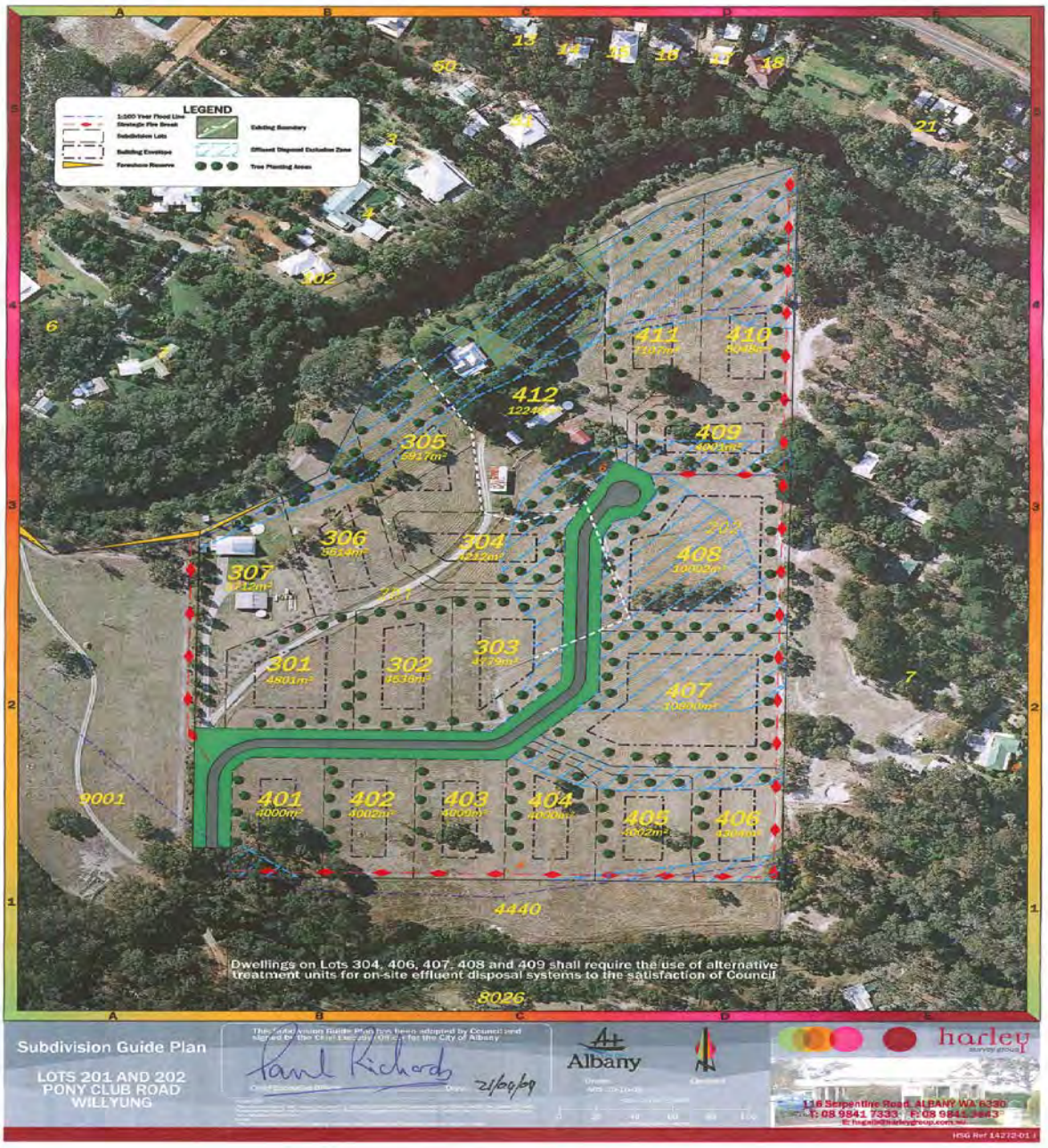
Western Australian Planning Commission (WAPC) (2017) Guidelines for Planning in Bushfire Prone Areas Version 1.3. Western Australian Planning Commission and Department of Planning WA, Government of Western Australia.

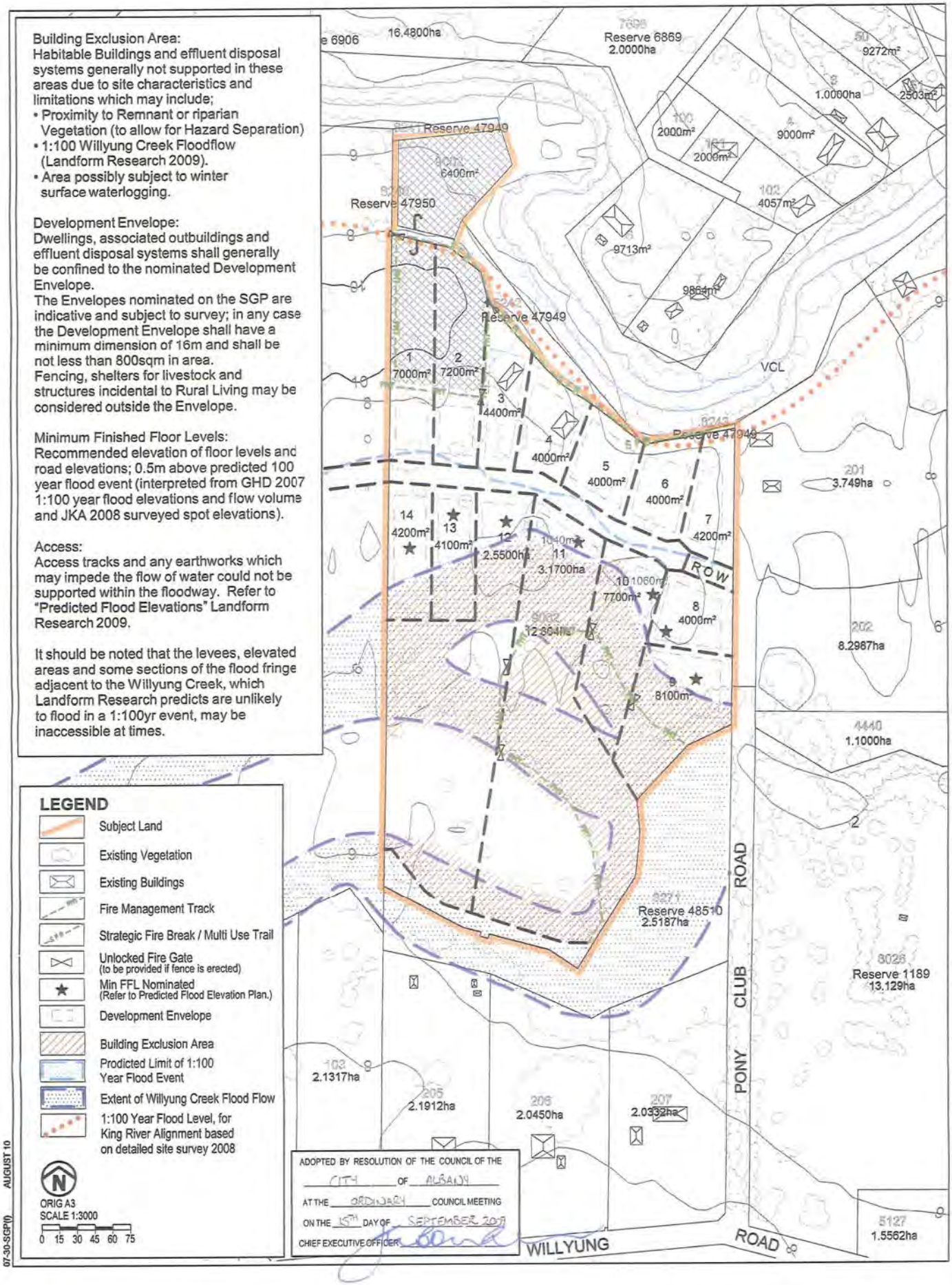
Western Australian Planning Commission (WAPC, 2015) State Planning Policy 3.2 Planning in Bushfire Prone Areas. Department of Planning WA and Western Australian Planning Commission.

State Land Information Portal (SLIP) (2018) Map of Bushfire Prone Areas. Office of Bushfire Risk Management (OBRM) data retrieved from:
https://maps.slip.wa.gov.au/landgate/bushfireprone/

Appendix C

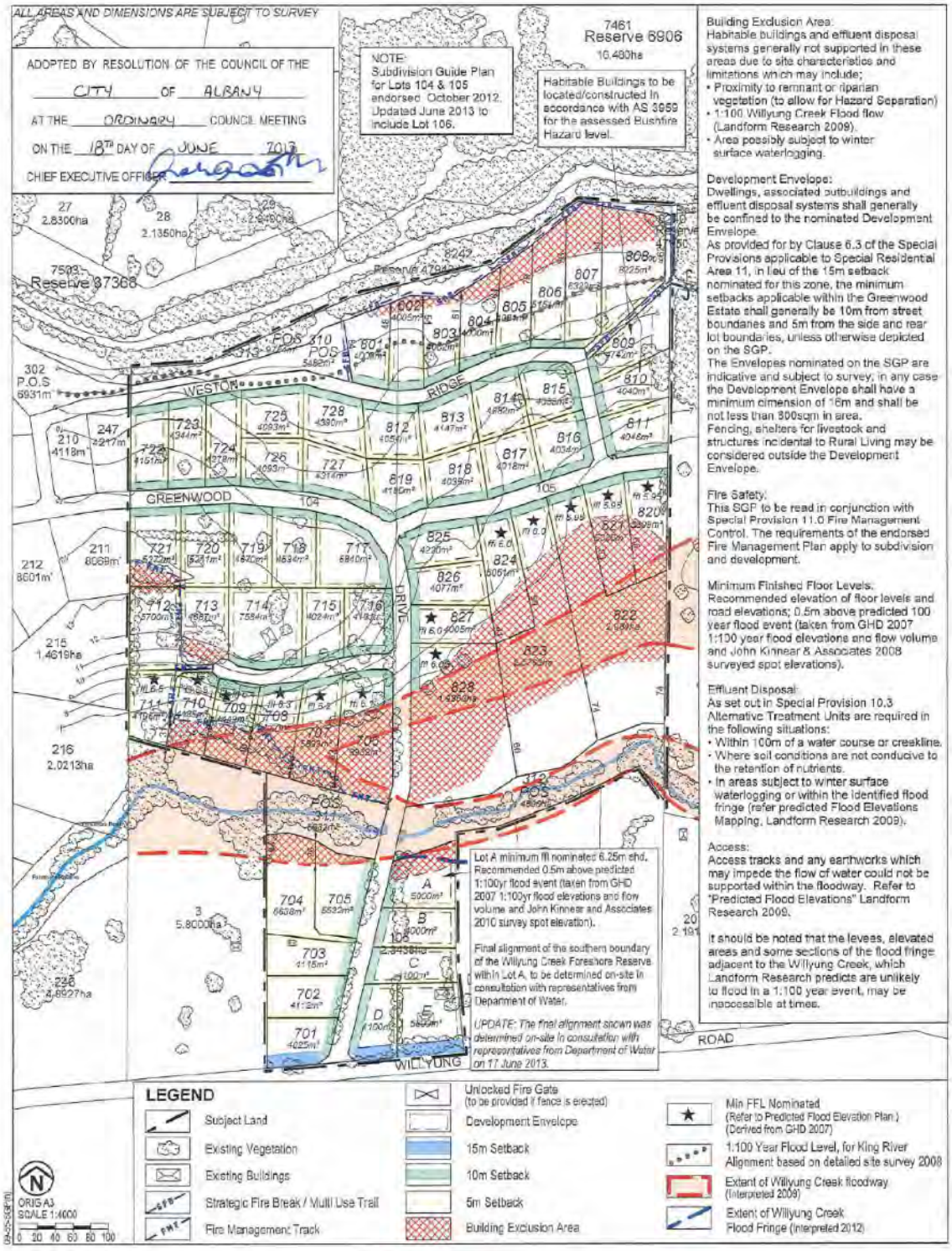
Previously Approved Revisions to original Subdivision Guide Plan


LEGEND
1:100 Year Flood Line
Strategic Fire Break
Subdivision Lots
Building Envelope
Foreshore Reserve
Existing Boundary
Effluent Disposal Exclusion Zone
Tree Planting Areas
13
14
15
16
17
18
60
21
3
1
102
6
411
410
412
409
305
306
304
408
307
303
301
302
407
7
9001
401
402
403
404
405
406
4440
Dwellings on Lots 304, 406, 407, 408 and 409 shall require the use of alternative treatment units for on-site effluent disposal systems to the satisfaction of Council
8026
Subdivision Guide Plan
LOTS 201 AND 202
PONY CLUB ROAD
WILLYUNG
Albany
harley
116 Serpentine Road, ALBANY WA 6330
HSG Ref 14272-01-1



AYTON BAESJOU
PLANNING
11 Duke Street
Albany WA 6330
Ph 9842 2304 Fax 9842 8494

SUBDIVISION GUIDE PLAN
Lot 9002 Pony Club Road
Willyung, City of Albany



AYTON BAESJOU PLANNING
11 Duke Street
Albany WA 6330
Ph 9842 2304 Fax 9842 8494

SUBDIVISION GUIDE PLAN
Lots 104, 105 &106 Willyung Road Willyung, City of Albany