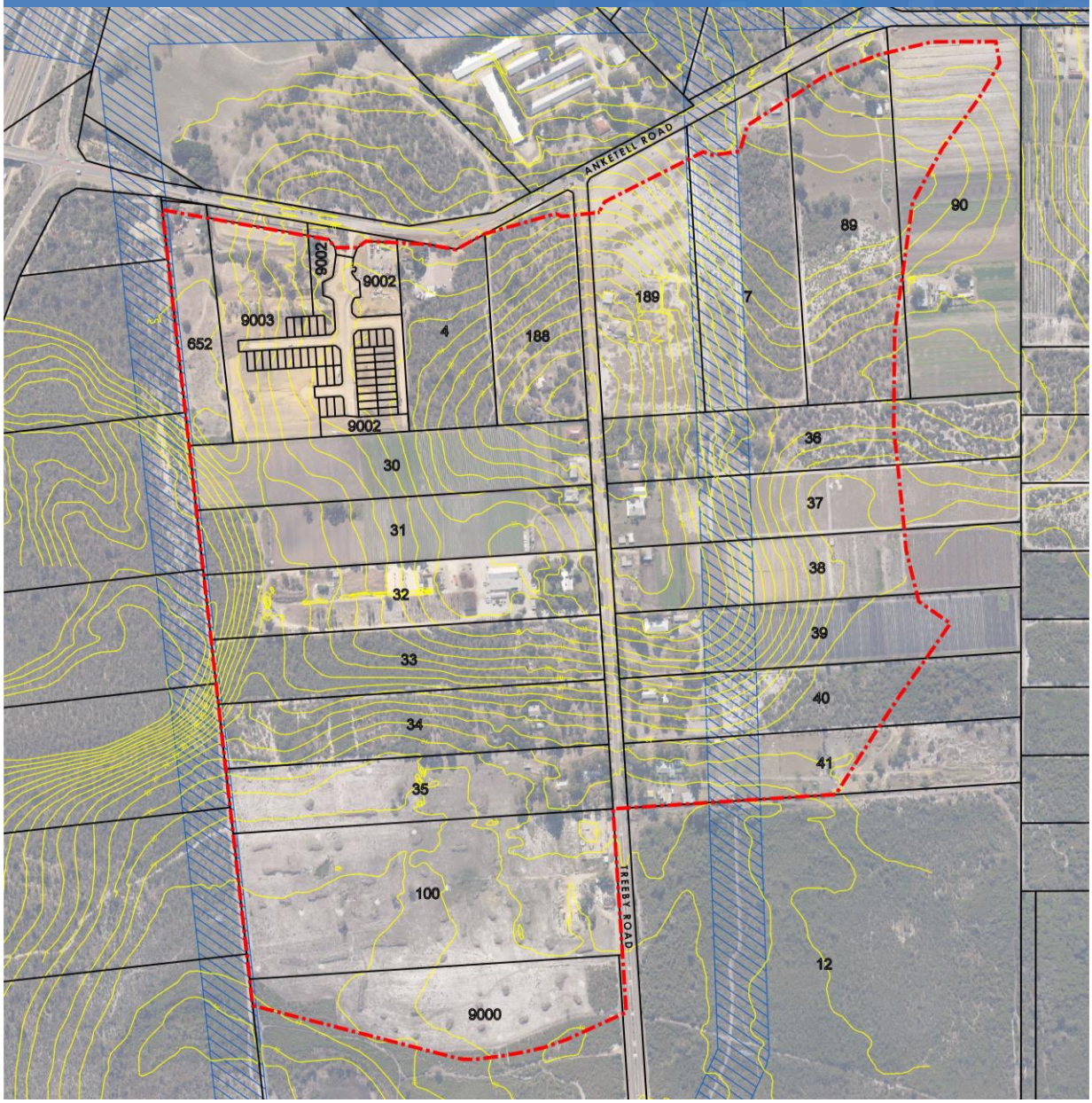
Taylor Burrell Barnett

Anketell North

STRUCTURE PLAN



Prepared for **Acumen Development Solutions on behalf of Sanpoint Pty Ltd and RPoint Land Pty Ltd**

Prepared by **Taylor Burrell Barnett**

September 2020

DOCUMENT HISTORY AND STATUS

Anketell North Structure Plan

Revision	Reviewer	Date Issued
17/091-1	RC	12/12/2018
17/091-2	RC	27/05/2019
17/091-3	RC	07/08/2020
17/091-4	JD	01/09/2020
17/091-5	JD	30/09/2020

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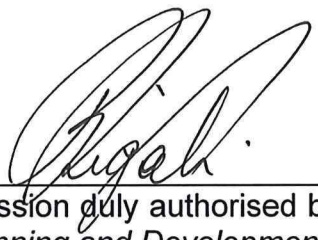
IT IS CERTIFIED THAT AMENDMENT NO. 4 TO THE ANKETELL NORTH LOCAL STRUCTURE PLAN WAS APPROVED BY RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION ON: 21 OCTOBER 2020

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.

This structure plan is prepared under the provisions of the City of Kwinana Local Planning Scheme No. 2

IT IS CERTIFIED THAT THIS STRUCTURE PLAN WAS APPROVED BY RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION ON: 17 DECEMBER 2015

DATE OF EXPIRY: 17 DECEMBER 2025

TABLE OF AMENDMENTS

AMENDMENT NO.	SUMMARY OF AMENDMENT	AMENDMENT TYPE	DATE APPROVED BY WAPC
1	Structure Plan modifications including: - Lifting of the 'Investigation Area 1' boundary over Lots 2 & 3 Anketell Road to provide for residential and commercial land uses; and - Minor modifications to residential density (R-Coding) and road layout within predominantly Lots 2 & 3 Anketell Road.	Standard	23 April 2019
2	Structure Plan modifications including: - Lifting of the 'Investigation Area 1' boundary over Lot 4 Anketell Road to provide for residential and service commercial land uses; and - Minor modifications to the residential density (R-Coding) and road layout and open space within Lot 4.	Standard	10 July 2019
3	Structure Plan modifications including: - Lifting of the 'Investigation Area 1' boundary over Lot 188 Treeby Road & Lot 652 Anketell Road to provide for residential and service commercial land uses; and - Minor modifications to residential density (R-Coding), POS design and road layout within predominantly Lot 188 Treeby Road & Lot 652 Anketell Road.	Standard	4 October 2019
4	Structure Plan modifications including: - Relocation of District Open Space; and - Modifications to the road layout, residential density (R-Codes) and public open space.	Standard	21 October 2020

TABLE OF DENSITY PLANS

Each time a density plan is approved, the plan is to be recorded in the table of density plans at the front of the Structure Plan.

DENSITY PLAN NO.	AREA OF DENSITY PLAN APPLICATION	DATE ENDORSED BY WAPC

EXECUTIVE SUMMARY

The Anketell North Structure Plan (ANSP) addresses an area of 97.8 hectares identified as 'Development Zone' within the Anketell locality approximately 5 kilometres north east of the Kwinana Town Centre. The site referred to as the 'Anketell North Structure Plan area' is bound by Anketell Road to the north, Jandakot Underground Water Pollution Control Area to the east, Bush Forever Site 270 to the south and the west.

The majority of the ANSP area was transferred to the Urban zone on 1 December 2009. The balance directly adjacent to Anketell Road was transferred on 27 May 2014 following design resolution of the final extent of the future Anketell Road reserve.

The purpose of this Structure Plan is to facilitate the development of the subject site for predominantly residential purposes.

The preparation of the ANSP has been undertaken in liaison with the City of Kwinana and government authorities.

Bush Forever Site 270 Part C, whilst external to the ANSP area, has been given due consideration through the local structure planning process. Whilst zoned 'Rural' its hydrological relationship as well as its interface with the urban area has guided the design approach for the ANSP area and is therefore detailed in the supporting reports to this Structure Plan.

Amendment 1

Amendment 1 was prepared to modify the original endorsed ANSP, and was approved by the WAPC on 23 April 2019.

The amendment provided for modifications and updates to bring the approved Structure Plan into conformity with Schedule 2 Part 4 'Structure Plans' of the *Planning and Development (Local Planning Schemes) Regulations 2015*, in addition to proposing an amendment to the approved Structure Plan.

The amendment to the approved ANSP provides for the addition of residential and service commercial land uses within the 'Investigation Area 1' affecting the northern portion of Lots 2 & 3 Anketell Road. The Structure Plan amendment also provides for minor modifications to the residential density (R-Coding) and the internal road layout predominantly within Lots 2 & 3 Anketell Road. The Amendment 1 report provides the rationale and planning framework to support the Structure Plan amendment.

The amendment provides for a mix of medium density residential and service commercial development abutting Anketell Road whilst addressing planning matters relating to transport noise. The report demonstrates that the Structure Plan amendment will not have any adverse impact on existing and/or planned development on the immediate and surrounding land. The proposed amendment is consistent with proper and orderly planning and the current planning framework.

Amendment 2

Amendment 2 proposed additional residential development and the introduction of service commercial land use within the 'Investigation Area 1' in the northern part of Lot 4, which was originally excluded from the ANSP boundary. The amendment also provides for minor modifications to the residential density (R-Coding), internal road layout and public open space.

The modifications included in Amendment 2 incorporates service commercial land use to complement the Wandi District Centre and highly exposed location. Additionally, the modifications to the residential land provides for efficient development and appropriate lot typology responding to market demand and builder expectations for the Anketell locality.

The modified Structure Plan provides for urban design best practices based on Liveable Neighbourhoods recommendations, whilst taking into consideration site constraints such as access and drainage, which create opportunities to improve amenity for future residents.

Amendment 3

Amendment 3 to the ANSP sought modifications for Lot 188 Treeby Road and Lot 652 Anketell Road, and involved an extension of the Structure Plan boundary and change to the zoning.

The purpose of this amendment is to bring forward the delivery of commercial land uses to the area and proposed a small amount of design modifications to the road network and densities to provide the best planning outcomes for the subject land.

Amendment 4

Amendment 4 sought the following key modifications to the original approved ANSP:

1. Relocating the District Open Space (DOS) to the north eastern portion of the ANSP area, co-located with the proposed Community Purpose Site.
2. Retention of the existing Treeby Road reserve alignment, with the realignment no longer required due to the modified DOS location.
3. Minor changes to the residential density codes.

The following report and associated ANSP mapping has been updated to incorporate Amendments 1-4. An updated summary of the ANSP, incorporating Amendments 1-4, is provided in the table below.

ANKETELL NORTH STRUCTURE PLAN SUMMARY

ITEM	DATA	STRUCTURE PLAN REF. (SECTION NO.)
Total area covered by the Structure Plan	99.3 ha	1.2.2
Area of each land use proposed: <u>Zones</u> • Service Commercial • Residential <u>Reserves</u> • Public Open Space & Drainage • Public Purpose - Community • Public Purpose – Primary School	 3.91 ha 48.37 ha 13.84 ha 1.65 ha 4.00 ha	3.3
Total Estimated Lot Yield	1,357 residential lots	3.3
Estimated No. of Dwellings	1,357 dwellings	3.3
Estimated Residential Site Density • Urban Site Density (dwellings per gross hectare of urban zoned land) • Residential Site Density (dwellings per resdiential site hectare – excludes non residential uses and roads)	 13.7 Dwellings per ha 28 Dwellings per ha	3.3
Estimated Population	3,800 people (avg 2.8 persons/dwelling)	3.3
No. of Primary Schools	1	3.1.0
Estimated area and percentage of Public Open Space given over to: • District Open Space • Neighbourhood Parks • Local Parks • Linear Park • Conservation – Wetland Buffer	10.1019ha Creditable (12.11%) 4.9 ha 3.2 ha 0.1 ha 4.5 ha 1.1 ha **Includes drainage & POS within easement*	3.4

TABLE OF CONTENTS

TECHNICAL APPENDICES

PART ONE
IMPLEMENTATION

1 STRUCTURE PLAN AREA

This Structure Plan shall apply to the land contained within the inner edge of the line denoting the Structure Plan boundary on the Structure Plan Map.

2 OPERATION

This Structure Plan comes into effect on the day it is approved by the Western Australian Planning Commission (WAPC).

3 STAGING

Initial development is likely to be within the northern portion of the structure plan area due to the availability of sewer connections in Anketell Road. Staging of development for the remaining land will be dictated by the proposed pumping station and outfall of sewer being built within the Structure Plan area.

4 RESIDENTIAL SUBDIVISION AND DEVELOPMENT REQUIREMENTS

a) Residential densities for the structure plan area are the residential densities shown on the Structure Plan Map.

b) Land use permissibility within the Structure Plan area shall accord with the corresponding land use classification in the City of Kwinana Local Planning Scheme No. 2 (LPS 2).

c) Public Open Space is to be provided in accordance with the Structure Plan Map.

d) This Structure Plan is supported by a Bushfire Management Plan (BMP), Bushfire Management Plan – Anketell North (May 2019) prepared by Strategen. Any land falling within 100 metres of a bushfire hazard identified in the BMP is designated as a Bushfire Prone Area for the purpose of the Building Code of Australia.

e) Notification on Title

The Council shall recommend to the WAPC that a condition be imposed on the grant of subdivision approval; for a notification to be placed on the Certificate of Title to suitably respond to the following:

i. The Bushfire Management Plan for lots with a bushfire attack level (BAL) rating of 12.5 or higher; and
ii. Existence of transport noise where noise levels exceed the outdoor noise criteria as per the State Planning Policy 5.4 – Road and Rail (draft).

f) Management Plans

The Council shall recommend to the WAPC that a condition be imposed on the grant of subdivision approval to respond to the following as identified by the Structure Plan:

i. The preparation, approval and implementation of a wetland interface management plan providing for the protection of the adjoining wetland located in Bush Forever Site 270;
ii. A mosquito and midge management plan;
iii. A Fauna Management Plan.

5 LOCAL DEVELOPMENT PLANS

Local Development Plan(s) are to be prepared for lots with one or more of the following attributes:

a) lots abutting Service Commercial use;
b) Service Commercial use (also refer to Clause 6);
c) smaller than 260m²;
d) rear vehicle access;
e) with frontages less than 10.5 metres; and
f) abutting POS.

6 SERVICE COMMERCIAL DEVELOPMENT REQUIREMENTS

a) Consolidated Development Guide Plan

All development within the area designated as Service Commercial shall generally reflect the Service Commercial Concept Plan prepared in support of Amendment 1 to the ANSP, which shall be used to guide decision making for the subdivision and/or development.

b) Easement in Gross (Right-of-Carriageway)

The City may require as either a condition of development approval or a recommendation to the WAPC for subdivision approval, the requirement for the creation and registration on title(s) of an Easement in Gross (Right of carriageway) over portions of land deemed to be necessary to facilitate a consolidated transport and pedestrian movement network for the Service Commercial land.

c) Traffic & Pedestrian Movement

A Traffic and Pedestrian Management Plan (TPMP) is to be prepared and submitted with an Application for Development Approval for Service Commercial land use. The TMP will be required to demonstrate how the design of the development and its proposed access arrangements will minimise impacts on nearby residential development, including but not limited to:

- identification of access points;
- location of parking areas;
- siting of loading areas;
- management of operations to minimise adverse impacts on abutting residential development; and
- provision for safe pedestrian/cycle connectivity between the Anketell North Local Structure Plan and the Wandi District Centre.

7 OTHER REQUIREMENTS

7.1 DEVELOPMENT CONTRIBUTION ARRANGEMENTS

Under the City of Kwinana Town Planning Scheme No. 2, the following development contribution arrangements apply:

a) Development Contribution Area 9 for the funding of community infrastructure; and
b) Development Contribution Area 4 for the funding of standard / hard infrastructure.

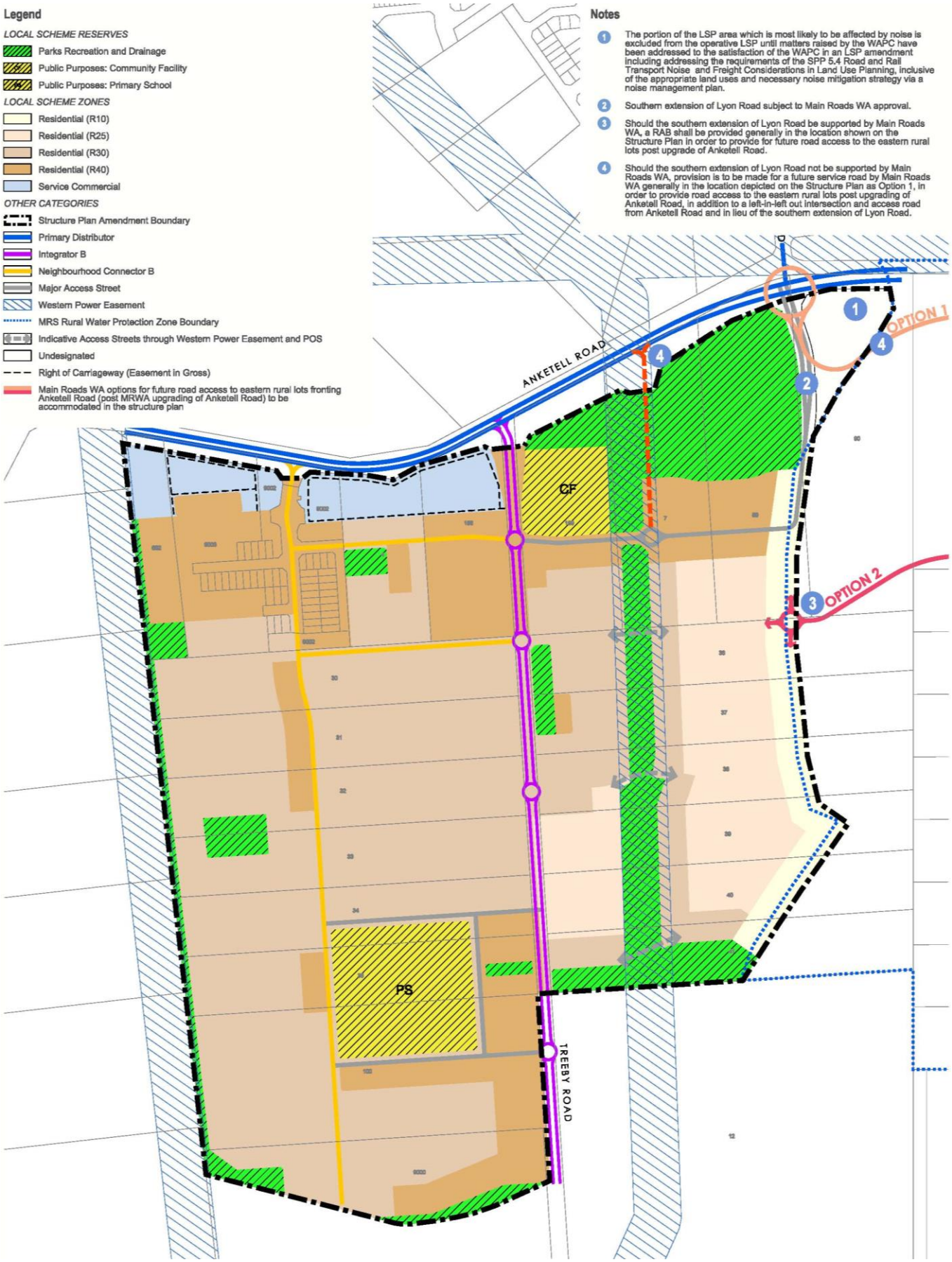


Figure 1 Anketell North Structure Plan

PART TWO
EXPLANATORY INFORMATION

1 PLANNING BACKGROUND

1.1 INTRODUCTION AND PURPOSE

The Anketell North Structure Plan (ANSP) has been prepared on behalf of various landowners in the Anketell North precinct as a precursor to subdivision for land zoned 'Development' under the City of Kwinana Local Planning Scheme No. 2.

The ANSP was originally endorsed by the Western Australian Planning Commission (WAPC) on 18 December 2015 (approved Structure Plan). Since the endorsement of the ANSP, there have been minor amendments to the Structure Plan, as well as several subdivision approvals:

- Amendment 1, to lift the 'Investigation Area 1' over Lots 2 & 3 Anketell Road (which have now been subdivided) and provide for residential and service commercial land uses, including minor modifications to residential density and road layout across these lots.
- Amendment 2, to lift the 'Investigation Area 1' over Lot 4 Anketell Road and provide for residential and service commercial land uses, including minor modifications to residential density and road layout across this lot.
- Amendment 3, to lift the 'Investigation Area 1' over Lot 188 Treeby Road & Lot 652 Anketell Road and provide for residential and service commercial land uses, including minor modifications to residential density, POS design and road layout across these lots.
- Amendment 4, to relocate the District Open Space (DOS) to the north eastern corner, adjacent the Lyon / Anketell Road intersection, co-located with the proposed Community Purpose Site and allowing the existing Treeby Road reserve alignment to be retained, and minor changes to the residential density, POS configuration and road layout across the ANSP area.
- Subdivision of Lots 35, 100 and part of Lot 9000 Treeby Road (subdivision and works have commenced).
- Subdivision approval over Lot 30 Treeby Road.

The purpose of the ANSP is to refine the provisions under the district framework and ensure a comprehensive approach to planning and development is undertaken, with input from the local community, landowners, government agencies and other key stakeholders. The ANSP will guide future land use and development within the Anketell North area, and provide a framework for more detailed planning at subdivision.

This Part Two explanatory report provides the planning framework and rationale to support the ANSP, inclusive of all approved amendments.

1.2 LAND DESCRIPTION

1.2.1 LOCATION

The ANSP area is located within the metropolitan south west corridor, in the City of Kwinana local government area. The land is approximately 31 kilometres south of Perth CBD, approximately 200 metres east of the Kwinana Freeway and approximately 11 kilometres north east of the Kwinana Town Centre.

The ANSP area is generally bounded by Anketell Road to the north, Jandakot Groundwater Mound to the east and Bush Forever Site 270 to the west and south.

Figure 2 outlines the subject land.

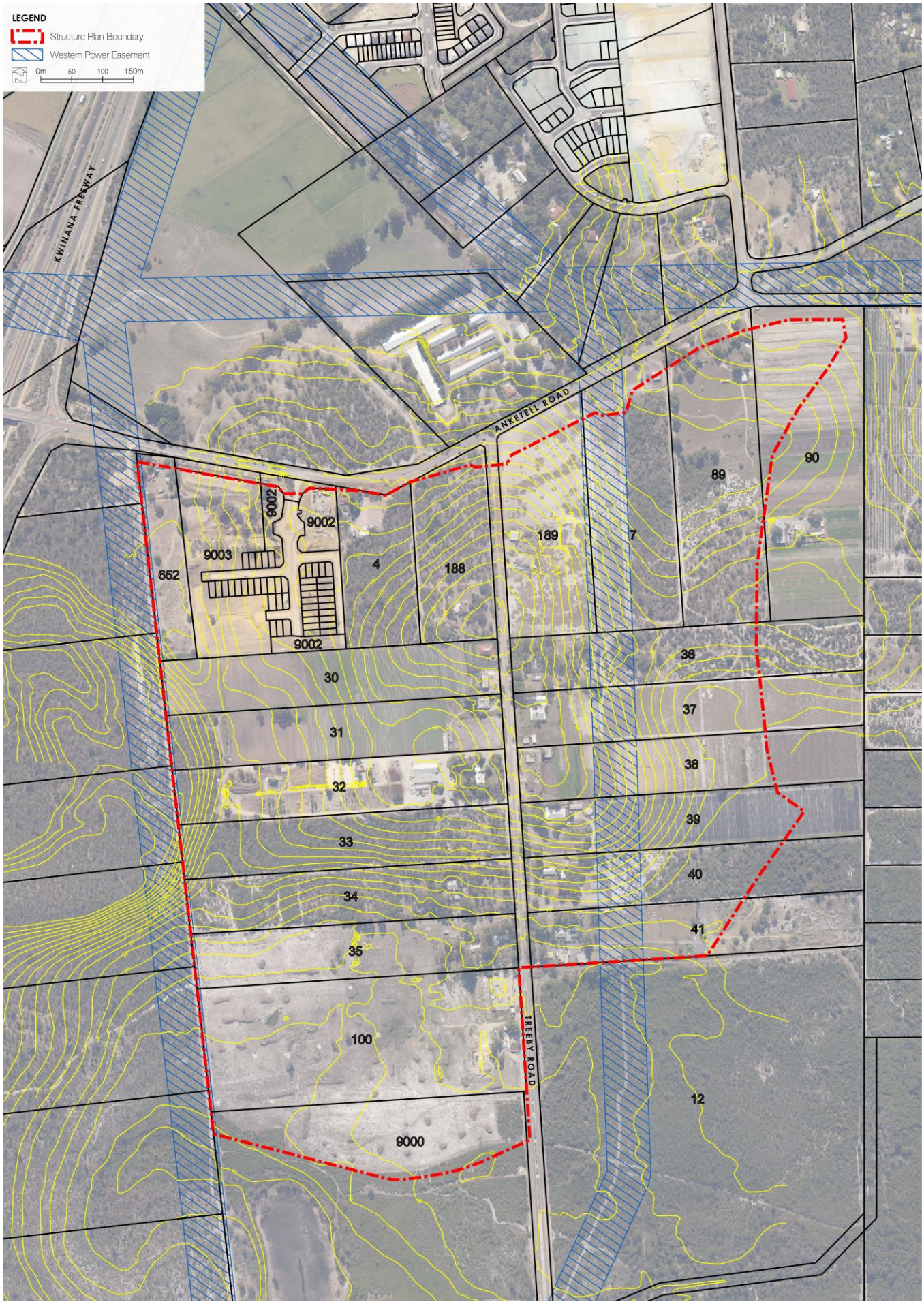


Figure 2 Location Plan

1.2.2 AREA AND LAND USE

The ANSP area comprises 99.3 hectares and is currently being utilised for predominantly agricultural purposes such as grazing, market gardening and horse agistment. Subdivision for residential purposes (in accordance with the ANSP) is progressing in the northern and southern portions of the precinct.

The ANSP boundary has been adjusted as a result of previous amendments, to include the area along Anketell Road previously identified as 'Investigation Area 1'. **Figure 3** original approved ANSP boundary and the amended ANSP boundary.

There are existing dwellings located within the ANSP area, with associated outbuildings, fences and other structures. The majority of existing improvements are intended to be demolished and removed for future development, with the exception of an existing residential dwelling on Lot 30 Treeby Road. It is understood that there is a legal agreement to retain this development on Lot 30.

Surrounding land uses are also predominately rural properties. Western Power easements run along the eastern portion of the structure plan area and externally along the western boundary.

Figure 3 Existing and Proposed Anketell North Structure Plan Boundary

1.2.3 LEGAL DESCRIPTION AND OWNERSHIP

The proposed Structure Plan comprises of nineteen (19) allotments outlined in the **Table 1** below.

Table 1 Legal Description and Ownership

LOT NUMBER	STREET ADDRESS	PLAN/DIAGRAM NO.	LAND OWNERSHIP
7	734 Anketell Road, Anketell	P004746	ANKETELL PROPERTY INVESTMENTS (WA) PTY LTD
30	36 Treeby Road, Anketell	D032446	GHT (WA) PTY LTD
31	48 Treeby Road, Anketell	D032446	RPOINT LAND PTY LTD
32	56 Treeby Road, Anketell	D032446	SANPOINT PTY LTD
33	N/A	D032446	NAARAH PTY LTD VACATION INVESTMENTS PTY LTD
34	74 Treeby Road, Anketell	D032446	GLENBROOK CIVIL ENGINEERING CONTRACTORS PTY LTD
35	82 Treeby Road, Anketell	D032446	BAZZO, TINA MICHELLE
36	35 Treeby Road, Anketell	D032446	TELFER, KENNETH BRUCE
37	49 Treeby Road, Anketell	D032446	WHITE, KERRY LEE WHITE, PETER WAYNE
38	55 Treeby Road, Anketell	D032446	SU, KUO HOA SU, FAN JYH SU, CHIOU YUEH LIN
39	63 Treeby Road, Anketell	D032446	D'ORSOGNA, CONCETTA SPRING PARK PTY LTD
40	73 Treeby Road, Anketell	D032446	DORN, KEVIN WILLIAM
41	83 Treeby Road, Anketell	D032446	COMLEY, ALANNA JOY COMLEY, KENNETH JOHN
89	748 Anketell Road, Anketell	D092985	TING, AEK YEN TING, ASHLEE TERRA AEK-LING TING, CHEN CHEE
90	758 Anketell Road, Anketell	D092984	MINCHA PTY LTD
100	96 Treeby Road, Anketell	D089861	WELL HOLDINGS PTY LTD TREVALLY INVESTMENTS PTY LTD
188	28 Treeby Road, Anketell	P025096	CHAI, CHUEN SHIUNG MESHGIN, QUMARS NGUYEN, HOA THUY TIEN
189	19 Treeby Road, Anketell	P025097	GRILLO, ANTONIO GRILLO, GIUSEPPE
9000	N/A	P408966	WELL HOLDINGS PTY LTD

1.3 PLANNING FRAMEWORK

1.3.1 ZONING AND RESERVATIONS

The majority of the land within the ANSP area is zoned Urban under the Metropolitan Region Scheme (MRS), and Development under the City of Kwinana Local Planning Scheme No. 2 (LPS 2). Anketell Road, to the north of the ANSP area is reserved as Other Regional Road under the MRS. The ANSP boundary includes a minor portion of land zoned Rural – Water Protection under the MRS and Rural Water Resource under the City's LPS 2, only for the purpose of providing a road interface (no urban development).

Land to the north of the Structure Plan is zoned Urban under the MRS and Development under the City's LPS 2. Surrounding land is zoned Parks and Recreation under the City's LPS 2, Rural and Rural-Water Protection under the MRS. Land to the south of the Structure Plan is zoned Rural A under the City's TPS 2 and Rural Water Resource to the east of the ANSP area. A Water Catchment area lies south east of the structure plan area under the City's TPS 2.

Refer **Figure 4** for an extract of the Metropolitan Region Scheme map and **Figure 5** for an extract City of Kwinana Local Planning Scheme 2 map.

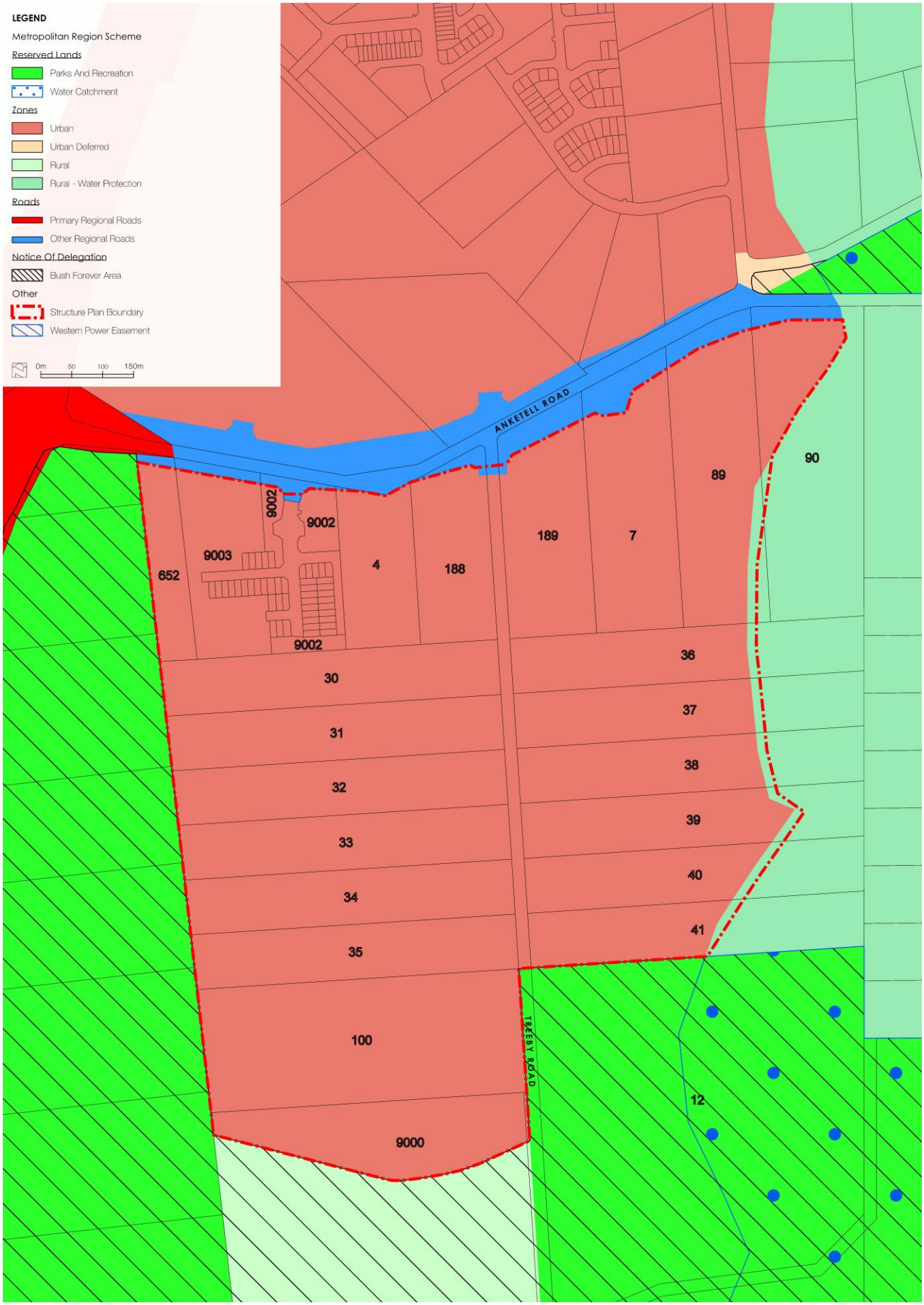


Figure 4 Metropolitan Region Scheme (extract)

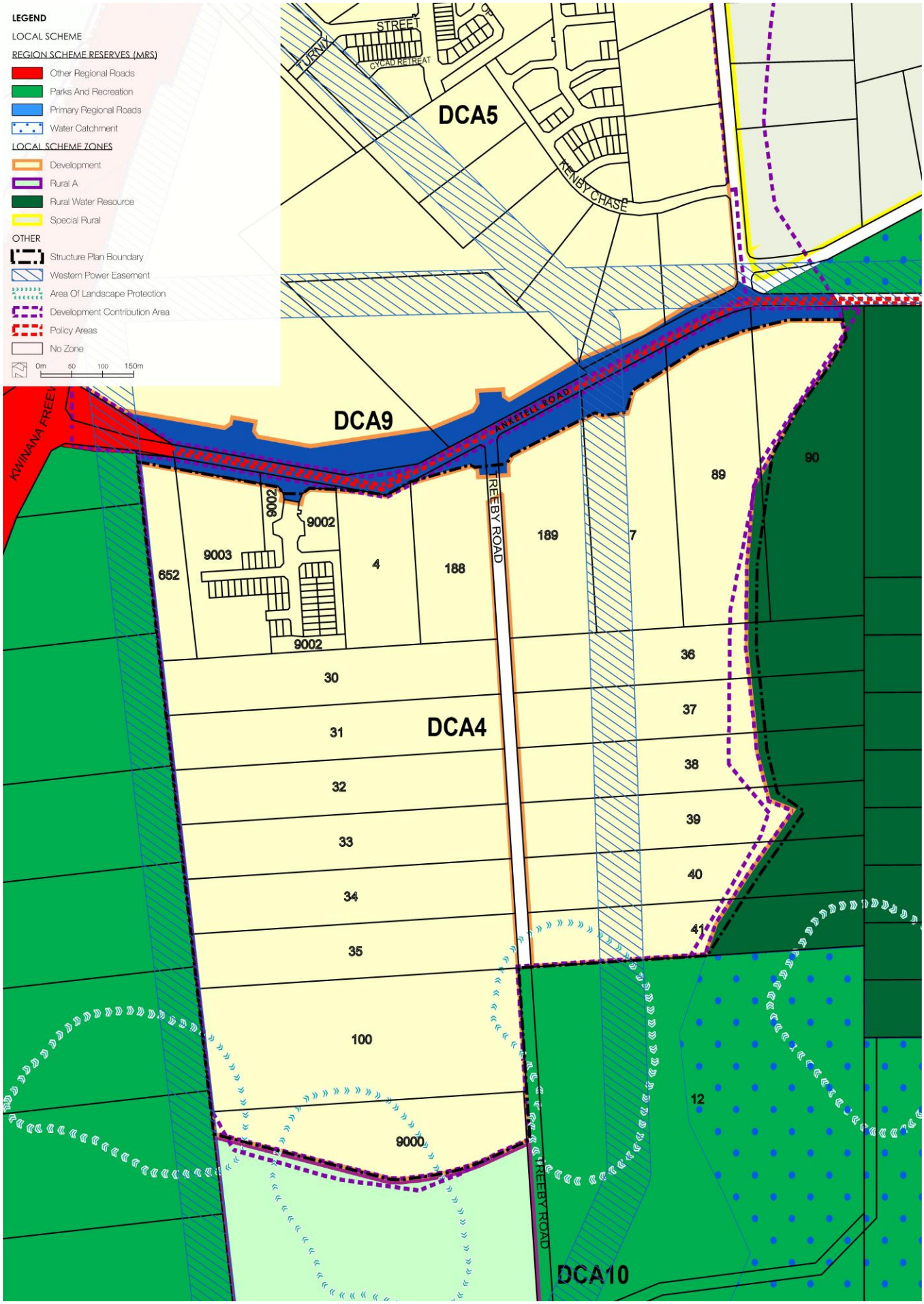


Figure 5 City of Kwinana Town Planning Scheme No. 2 (extract)

1.3.1.1 BUSH FOREVER

No Bush Forever sites are located within the ANSP area. Bush Forever Area 270 is located south of the structure plan area (refer **Figure 4**).

1.3.2 REGIONAL AND SUB-REGIONAL STRUCTURE PLAN

1.3.2.1 PERTH AND PEEL @ 3.5 MILLION & SUB-REGIONAL PLANNING FRAMEWORK

The South Metropolitan Peel Sub-Regional Planning Framework was released by the Western Australian Planning Commission in March 2018 and forms part of the suite of documents supporting the Perth and Peel @ 3.5million land use planning and infrastructure frameworks. The South Metropolitan Peel Sub-Regional Planning Framework aims to establish a long-term, integrated planning framework for land use and infrastructure to guide future growth across the sub-region.

In accordance with the South Metropolitan Peel Sub-Regional Planning Framework the City of Kwinana has a target to plan for the provision of 1,370 additional dwellings by 2050 to support a total Perth metropolitan population of 3.5 million. The ANSP supports this infill target and assists in providing housing diversity in a highly accessible location due to its proximity to the Kwinana freeway and areas of employment in Kwinana.

The Kwinana Freeway and Anketell Road are identified as Primary Freight Roads within the South Metropolitan Peel Sub-Regional Planning Framework. The Framework outlines that the freight network corridors are to be protected from encroachment of sensitive and incompatible land uses. The amended Structure Plan proposes land zoned for Service Commercial directly abutting Anketell Road, with residential development proposed well setback from Kwinana Freeway and Anketell Road.

1.3.2.2 EASTERN RESIDENTIAL INTENSIFICATION CONCEPT (ERIC)

The draft District Structure Plan, Eastern Residential Intensification Concept (ERIC) was prepared by the City of Kwinana in 2005 to provide strategic direction for future urban areas identified under the Jandakot Structure Plan. Whilst ERIC has not been adopted by Council, it provides a framework to the preparation of structure plans within the urban corridor.

ERIC identifies the following land uses within the ANSP area:

- Residential (R20);
- Residential (R25 and higher);
- Local Open Space;
- Primary School; and
- Special Residential associated with the Western Power easement.

It is noted that state strategic planning principles and objectives have been updated since the preparation of ERIC in 2005, however the ANSP has been prepared with due regard to the land use recommendations of ERIC, where appropriate.

1.3.3 PLANNING POLICIES

1.3.3.1 STATE PLANNING POLICIES

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

The intent of SPP 3.7 is to implement effective, risk-based land use planning and development to preserve life and reduce the impact of bushfire on property and infrastructure. The accompanying Guidelines for Planning in Bushfire Prone Areas provide advice on how bushfire risk is to be addressed when planning, designing or assessing a planning proposal within a designated bushfire prone area. As discussed further in **section 2.5** (and included as **Appendix B**), a Bushfire Management Plan has been prepared by Strategen to inform the ANSP and future subdivision in accordance with SPP 3.7.

State Planning Policy 5.4 Road and Rail Noise (SPP 5.4)

The key objective of SPP 5.4 is to minimise the impact of road and rail noise on noise-sensitive land uses; and protect the State's key transport corridors. In accordance with SPP 5.4, future residential development and educational establishments are considered noise-sensitive land uses. Accordingly, consideration needs to be given to the proximity of these uses to Anketell Road and the Kwinana Freeway, being Primary Regional and Other Regional Roads, and any mitigation measures required. In accordance with Table 1 of SPP 5.4, the trigger distance for consideration of potential road noise from Anketell Road, being an 'Other Regional Road' (under the MRS) is currently 200m.

Acoustic Assessments have been undertaken by Herring Storer Acoustics (refer **Appendix C**) to determine the level of noise received within the ANSP area. The assessment is based on the future alignment of Anketell Road, with future traffic volumes, and assuming no noise control along the road reserve, but including the built form of development within the Service Commercial zone, which provides a barrier to the residential lots behind. The results of the noise modelling indicates that the 'Noise Limit' (as stipulated under SPP 5.4) is met for all residential lots within the ANSP area. Some residential lots within the northern portion of the area closest to Anketell Road may exceed the 'Noise Target', thus requiring noise amelioration in the form of quiet house design and/or Notifications on Titles. The extent of any noise control requirements would need to be determined once the lot layout has been finalised (i.e. at subdivision stage). Any noise sensitive land uses proposed within the Service Commercial zone would need to demonstrate that suitable noise levels are able to be achieved through appropriate design techniques at development application stage.

State Planning Policy Activity Centres for Perth and Peel (SPP 4.2)

Under SPP 4.2, the Wandi District Centre has been identified as a key centre serving this Urban Corridor. The Wandi District Centre is proposed to be located to the north of Anketell Road.

The ANSP proposes Service Commercial development on the south side of Anketell Road and is considered to provide complementary land uses to support the Wandi District Centre. The extent of Service Commercial zoned land has been informed by market advice provided by Taktics4 (refer **Appendix D**), which concludes that an area of approximately 1.5ha of Service Commercial land is capable of accommodating a freight transport related commercial activity hub. This potential activity type would benefit from significant exposure to freight transport by virtue of its location on the future Anketell Road freight route, without creating any direct competition with the broader Wandi District Centre.

1.3.3.2 LOCAL PLANNING POLICIES

Local Planning Policy No.1 Landscape Feature and Tree Retention

LPP 1 seeks to ensure an appropriate level of information concerning significant trees and landscape features is provided at each stage of the planning framework and retention of significant trees and landscape features are optimised through the strategic and statutory planning framework to retain the character of an area.

LPP 1 states that "this policy is not intended to be applied retrospectively in areas where structure plans and subdivisions have been approved prior to the adoption of the policy." Regard has been given to LPP 1 in the preparation of recent amendments to the ANSP, in the context of mapping of significant trees and vegetation, with opportunities for tree retention within POS identified (refer to **section 2.1**). However, it is noted that the policy has limited relevance by virtue of the ANSP having been approved prior to adoption of the policy.

Local Planning Policy No. 2 Streetscapes (LPP 2)

LPP 2 aims to enhance the character of local streets through the delivery of an urban street tree canopy and to encourage attractive streetscapes and enhance neighbourhood amenity. The policy sets out minimum requirements relating to street trees, landscaping, footpaths, visitor parking for laneway lots / embayment parking, fencing and built form.

In accordance with LPP 2, a Landscape Masterplan (LMP) has been prepared by LD Total to support the ANSP (refer to **section 3.5** where further information is provided on the landscape strategy for the ANSP area).

Local Planning Policy Planning for Bushfire Protection Guidelines

The Planning for Bushfire Protection Guidelines policy aims to provide an appropriate level of protection to life and property from bushfires and avoid inappropriately located or designed land uses, subdivision and development on land where bush fire risk is identified. LPP 2 adopts the current Planning for Bush Fire Protection Guidelines (edition 2) as prepared by the WAPC.

The WAPC's SPP 3.7 has been discussed in **section 1.3.4.1** and addressed in the Bushfire Management Plan in **Appendix B**.

Local Planning Policy Public Open Space

The Public Open Space (POS) policy requires structure plans to identify areas of regional, district and neighbourhood open space in accordance with the City's Community Infrastructure Plan and to include notional locations of local open space areas in addition to other land use elements usually contained in structure planning documents. The ANSP indicates the areas and location of local parks and depicts the location of DOS in the north eastern portion of the structure plan. A minimum of 10% POS is provided within the ANSP, and the location and distribution of POS is discussed in **section 3.3.4**.

The City's POS policy outlines that the preferred location of DOS is to abut distributor roads and be no further than 1 kilometre from a residential area. The proposed DOS abuts Anketell Road, a Primary Distributor road and directly abuts residential land, consistent with the policy requirements.

Local Planning Policy No. 8 Designing Out Crime (LPP 8)

LPP 8 sets out design guidelines to reduce the likelihood of crime and anti-social behaviour within the City. The objectives of LPP 8 are to encourage urban development within the City to incorporate 'designing out crime principles'; provide guidance in relation to built form outcomes that support the reduction in actual and perceived crime and anti-social behaviour; and guidance on design and assessment of planning proposals.

Regard has been given to the five principles outlined within the LPP in the preparation of the ANSP, particularly in relation to the allocation of land uses, roads and the location of POS to maximise opportunities for surveillance. The preparation of Local Development Plans (LDPs) at the subdivision stage will enable such matters as building orientation and fencing to be addressed to further maximise opportunities for surveillance of street and open space.

Local Planning Policy No. 7 Uniform Fencing (LPP 7)

LPP 7 states Council's position regarding the provision of uniform fencing in new residential estates and developments within the City and sets out the Council's minimum requirements for uniform fencing.

The policy requirements and criteria can be addressed as a condition of subdivision / development requiring the construction of uniform fencing in key areas.

1.3.4 OTHER APPROVALS AND DECISIONS

As outlined in **section 1.1**, the ANSP has been subject to a range of amendments since its original approval in December 2015, as well as various subdivision approvals for individual landholdings. This report has been updated to reflect the outcomes of Amendments 1, 2, 3 and 4 to ensure a consolidated plan is available for the Anketell North precinct.

1.3.4.1 SURROUNDING STRUCTURE PLANNING

As shown in **Figure 6** the subject land and surrounding land has been recognised for urban development and has been subject to a significant amount of structure planning.

Located directly north of the ANSP area, Wandi South Structure Plan (SP) was approved in 2012 and has been subject to two minor amendments. The Wandi South SP area proposes only residential development with densities ranging from R20 to R60.

The Anketell South Local Structure Plan (ASLSP) (2014) lies directly south of the ANSP, and designates land predominately for residential (densities ranging between R20 to R60), Commercial and Service Commercial uses, with a community facility site fronting Thomas Road. The northern portion of ASLSP, known as Treeby Park, has been the subject of subdivision and an LDP prepared over the site.

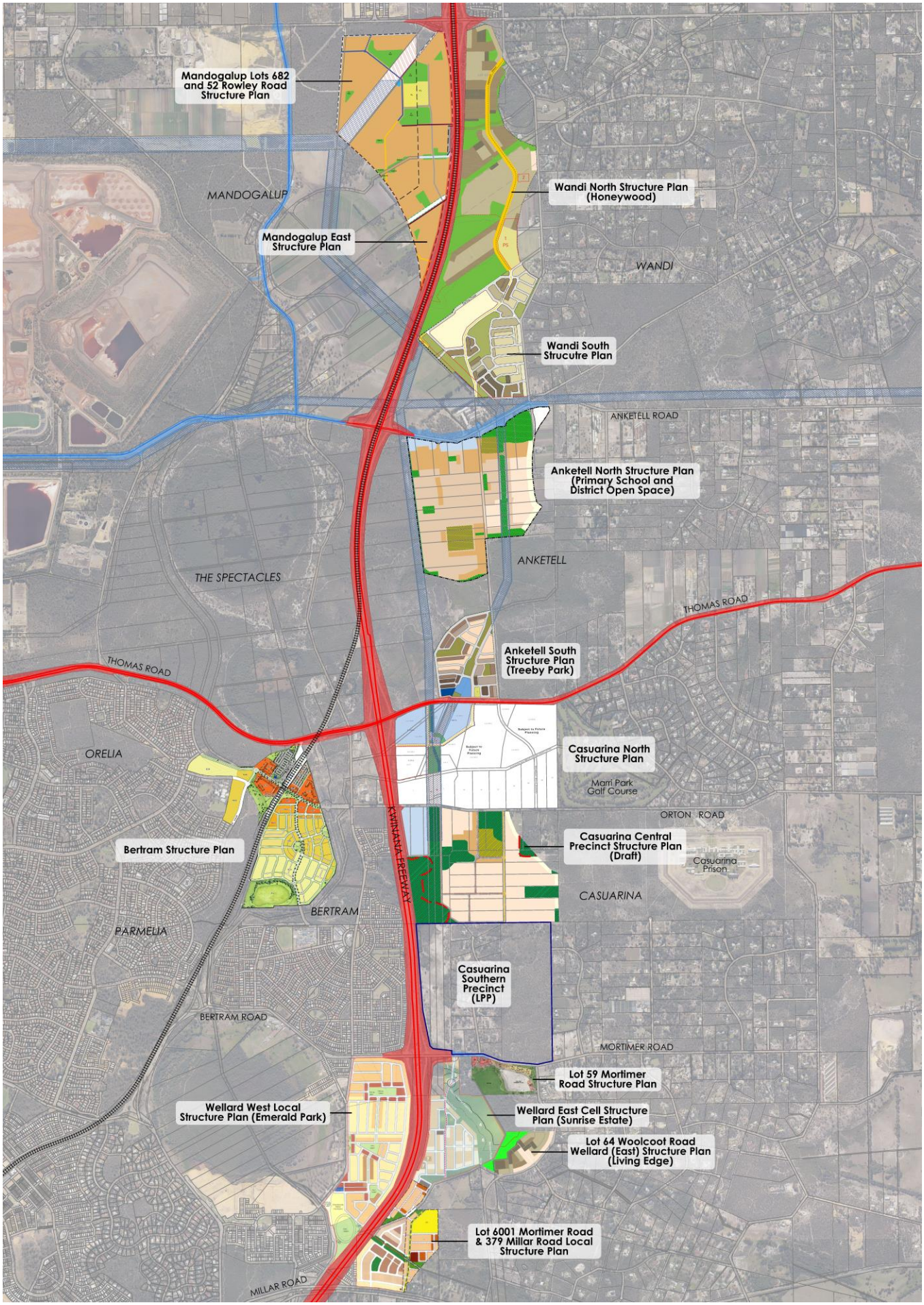


Figure 6 Regional Context - Structure Planning surrounding Anketell North Structure Plan Area

1.4 PRE-LODGEMENT CONSULTATION

Table 2 summarises the outcomes of various pre-lodgement consultation with the City of Kwinana and Department of Planning, Lands and Heritage during the preparation of the recent Structure Plan Amendments.

Table 2 Pre-lodgement Consultation

AGENCY	DATE OF CONSULTATION	CONSULTATION METHOD	SUMMARY OF OUTCOMES
Amendment 1			
City of Kwinana and Department of Planning	April 2016-July 2016	Correspondence & Meetings	As part of lodgement and assessment of WAPC 153398 subdivision of Lots 2 & 3, the modifications to the internal road layout were supported along with R-Code density changes. These have been incorporated into the proposed Structure Plan.
City of Kwinana	September 2016	Correspondence & Meetings	Preparation of Structure Plan Amendment required incorporating modifications to update existing approved Structure Plan Part One section to conform to the new Planning Regulations. City comments on proposed modifications to create a larger R80 development not supported. City's preference is for creation of larger commercial sites that could support possible bulky goods retail commercial use.
City of Kwinana	October 2016	Correspondence & Meetings	Applicant's modified Structure Plan proposal introducing a mixed use R80/commercial over Lot 2. City support in-principle subject to further assessment once structure plan application lodged.
Amendment 4			
City of Kwinana	31 July 2018 1 - 23 August 2018	Meeting Attendees: Rachel Chapman (TBB) Jarrod Rendell (Acumen - LSP proponent) Gary Williams (CoK) Brenton Scambler Nino Scidone (CoK) Phone and email conversations: Rachel Chapman (TBB) Gary Williams (CoK)	• Preliminary meeting to present the proposed Concept Plan to inform discussion of proposed modifications to the Anketell North Structure Plan. • TBB and Acumen provided rationale for the proposed ANSP amendment and solutions/benefits to the broader Anketell North area in resolving some of the issues arising from the current ANSP. • Draft Concept Plan was circulated to internal departments within the City of Kwinana. • Internal meetings resolved to support a comprehensive ANSP amendment to govern a more balanced outcome it will provide over the majority of the Anketell North ANSP area. • City provided preliminary support for the proposed modifications and modified plan, being a more comprehensive and consolidated amendments that deals with a number of key issues compared to individual amendments. • City advised that the ANSP Amendment should outline what landowners are represented and the extent of support for the Amendment. • Following the meeting, the City reviewed the Concept Plan with the relocated DOS and provided comments in the context of its revised draft CIP. No fatal flaws were identified. • TBB advised the City that, on this basis, it would proceed with preparing a comprehensive structure plan amendment including making contact with landowners.

Department of Planning Lands and Heritage	5 September 2018	Rachel Chapman (TBB) Jarrod Rendell (Acumen - LSP proponent) Paul Sewell (DoPLH) Frank Ness (DoPLH) Jason Carr (DoPLH)	Preliminary meeting to present the proposed Concept Plan, outline the landowners represented in the ANSP Amendment, concerns with the current structure plan design, considerations for the proposed amendment and the next steps for finalising a proposed ANSP Amendment. DPLH officers provided advice in relation to: • The use of Service Commercial designation in lieu of Commercial in order to ensure no residential development permitted in the area potentially impacted by road noise; • Designation of land as POS over the Western Power easement area (no need to show road reserves in this area); • ANSP Amendment to balance the risk of bushfire risk and retention of vegetation; • Inclusion of a Context Plan to show how the ANSP Amendment fits in with the surrounding area.
Department of Planning Lands and Heritage	24 October 2018	Rachel Chapman (TBB) Alice Brown (DoPLH) Arran Sutherland (DoPLH)	Briefing on the proposed Anketell North Structure Plan Amendment (following staff changes at DPLH).
City of Kwinana	October - November 2018	Meeting/phone calls Tanya Moran (GTA) Gary Williams (CoK) Nino Scidone (CoK)	• Regarding status of other proposed ANSP amendments and their potential impact on overall vehicle access. • City confirmed that they did not support the current proposal by Transcore for the Right Turn In at the first access between Kwinana Freeway and Treeby Road, however was currently still with the WAPC. • Requested feedback on the Lyons Road New Roundabout
City of Kwinana	9 April 2019 April - May 2019	Meeting Attendees: Rachel Chapman (TBB) Jarrod Rendell (Acumen - LSP proponent) Paul Neilson (CoK) Alison Trotta (CoK) Phone and email conversations: Rachel Chapman (TBB) Gary Williams (CoK) Paul Neilson (CoK) Alison Trotta (CoK)	• Subsequent meeting to discuss the proposed ANSP amendment lodged with the City in December 2018, including the City's assessment comments and concerns raised through public consultation undertaken in March - April 2019. • Key matters discussed related to the extent of Service Commercial zoned land, acoustic considerations for properties in close proximity to Anketell Road, and the proposed location of the district playing fields. • Suggested modifications to the ANSP amendment were presented by TBB to address these concerns. • It was agreed that Acumen would seek further expert advice on the extent of Service Commercial land and the acoustic impacts of Anketell Road noise. • Following the meeting, a revised ANSP concept plan, Service Commercial market advice and an acoustic assessment was provided to the City to assist in finalising its assessment of the ANSP Amendment. • Various phone and email conversations occurred between TBB and the City following this meeting to resolve any outstanding matters and confirm the timing and path forward for the ANSP Amendment.

2 SITE CONDITIONS AND CONSTRAINTS

2.1 ENVIRONMENTAL CONSIDERATIONS

An Environmental Report was completed by 360 Environmental in 2010 for the approved ANSP. An Environmental Assessment Report (2019) (EAR) has now been prepared by Strategen Environmental to support the comprehensive ANSP Amendment 4 (refer **Appendix A**).

Information regarding the existing environment, topography, soils and acid sulfate levels has been addressed within the 2019 EAR which has largely not changed from the 2010 EAR.

2.1.1 ENVIRONMENTAL ASSETS AND CONSTRAINTS

Historically, most of the site has been cleared for market garden and horticulture activities. There are pockets of remnant vegetation which have been identified as potential Local Natural Areas which will be a priority for retention in the ANSP.

Two site surveys have been conducted across the subject land in which the vegetation condition ranged from Very Good – Good in the pockets of remnant vegetation to Completely Degraded across the portions of the land cleared for market gardening and horticulture.

The Environmental Assessment Report (EAR) prepared by Strategen identifies the following environmental constraints for the subject land:

- Matters of National Environmental Significance, including:
  - 9.6 ha of Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community (TEC)
  - 6.7 ha of potential Banksia woodlands (area not assessed)
  - 9.6 ha of Black Cockatoo foraging habitat
  - 6.7 ha of potential Black Cockatoo habitat (area not assessed)

- 27 potential Black Cockatoo breeding trees (>500 mm diameter at breast height), which are delineated as:
  - 17 Tuarts
  - Eight Jarrah
  - Two *Corymbia maculate* (planted)

- A Conservation Category Wetland (CCW) (UFI 15290 and 14148) intersects with the southern portion of the subject land, however, subdivision approval exists across Lots 35, 100 and part of Lot 13 Treeby Road. The southern boundary of Lot 41 Treeby Road intersects with the CCW and will have management requirements as part of any subdivision approval.

The development of land within the ANSP will result in the clearing of Banksia TEC, potentially at thresholds requiring referral to the Department of Environment and Energy (DEE) for significant impacts. All considerations for referrals for potential significant impacts to TECs, will be conducted at development stage by the landholder in response to site conditions.

Black Cockatoo foraging habitat and significant tree retention provide the most appropriate outcome for habitat provision within the ANSP. The best quality foraging habitat and future potential habitat trees are retained within POS, and the placement of POS retains connectivity with the surrounding Bush Forever 270 and the CCW which also provide foraging and breeding habitat (this is further discussed within **section 3.4**).

2.2 GROUNDWATER AND SURFACE WATER

2.2.1 GROUNDWATER

Regional groundwater contours (historical average maximum) indicate that the groundwater flows generally in a west to south west direction and ranges from approximately 30 mAHD to 15 mAHD. The depth of groundwater ranges from approximately 20.5 m below ground level (mbgl) to 5.8 mbgl across the site.

2.2.2 SURFACE WATER & WETLANDS

The site is located within the Peel-Harvey Coastal Catchment, the Peel subdrain is located approximately 270 m south of southern boundary of the subject land (part Lot 9000 Treeby Road).

There are no Ramsar wetlands or Directory of Important Wetlands on the site. The nearest Directory of Important Wetlands site is located approximately 1.2 km to the west of the site and is known as “Spectacles Swamp”.

Regional geomorphic mapping indicates that there is a CCW (sumpland; UFI 15290 and 14148) which occurs across the southern section of the subject land. Advice from the Environmental Protection Agency (EPA) states that all CCWs be protected and that an appropriate buffer of 50 metres be applied to separate development activities from the CCW. Lots 35, 100 and part of Lot 9000 Treeby Road already have subdivision approval and therefore, CCW buffer requirements are extinguished across these lots.

2.3 VEGETATION AND FAUNA

A Level 2 Flora Survey was completed by Bennet Environmental during Spring 2009 in accordance with EPA (2004) guidance. The survey identifies the ANSP area as being a mixture of predominantly cleared farmland with patches of eucalypts. A total of six vegetation types were mapped across the site, comprising of:

1. *Banksia attenuata* Low Woodland, with *Eucalyptus marginata, Dasypogon bromeliifolius, Phlebocarya ciliate*, local *Melaleuca preissiana, Pultenaea reticulata* and *Hypocalymma angustifolium*, some other natives and, commonly, weeds.
2. *Banksia attenuata* Low Woodland with *Eucalyptus marginata, Allocasuarina fraseriana* and understoreys of *Xanthorrhoea preissii, Adenanthos cygnorum, Acacia pulchella, Stirlingia latifolia* and other natives, and of weeds; much of it regenerating after 2004 fire.
3. *Banksia attenuata* Low Woodland, with thickets of *Adenanthos cygnorum*.
4. *Eucalyptus rudis* very healthy Open Forest in soak/spring, with *Melaleuca preissiana* and *M. Rhaphiophylla* tall trees, over *Pteridium esculentum – Cyathochaeta teretifolia – Baumea articulata* Closed Herb-Sedgeland; with *Lepidosperma longitudanale, Hemarthria uncinata, Hibbertia perfoliata, Dielsia stenostachya, Baumea vaginalis, Poa serpentum*; few aliens.
5. *Eucalyptus rudis (*largely leafless) Woodland (to Open Forest) over *Kunzea glaberescens* and *Astartea sp.* Closed Tall Scrubs, dense *Pteridium esculentum* and weeds; locally with healthy *Eucalyptus marginata* and *Melaleuca preissinana* trees.
6. *Kunzea glabrescens* Closed Tall to Tall Open Scrub; with, in more open sites, *Dasypogon bromeliifolius, Phlebocarya ciliate, Euchilopsis linearis* and other natives; some weedy degraded areas and many dead shrubs over 1 metre tall.

The condition of vegetation ranges in quality across the site from Excellent to Completely Degraded, with most remnant vegetation being in Very Good to Degraded condition. Weeds are common in the majority of the bushland existing across the site.

Further to the Bennet Environmental survey, Strategen completed a supplementary reconnaissance survey (2018) for the site with a focus on Lots 36 and 40 Treeby Road. At the time of the survey, access to Lots 7 and 89 Anketell Road was not permitted/granted.

A vegetation assessment by Strategen concluded that there are no state listed threatened ecological communities (TEC) or priority ecological communities (PEC) within the subject land; however federally listed Banksia woodlands TEC is present within the subject land.

Vegetation condition ranged from Very Good to Completely Degraded with the majority of Lots 36 and 40 in Completely Degraded condition. Past and current land uses, including historical clearing and housing along with the dominance of weeds have contributed to overall vegetation condition, and have caused significant fragmentation of the vegetation. Firebreaks and informal tracks have also impacted the vegetation. Non-endemic and planted vegetation was also present at the site.

2.4 ENVIRONMENTALLY SENSITIVE AREAS

Environmentally Sensitive Areas mapping surrounds the western and southern boundary of the site, with mapping slightly extending into Lots 35, 100, part 13 and 41 Treeby Road (WALGA, 2017). ESA mapping across this area is to be associated with the known presence of the CCW and BF 270 located adjacent to the subject land. The ANSP design has considered the implications of the CCW and BF site to Lot 41 and included POS along the southern boundary to maintain appropriate setback distances. Lots 35, 100 and 900 are already the subject of subdivision approval, therefore the proposed amendment does not propose any modifications to the land within these lots that alter the impact on the adjacent CCW or Bush Forever Site 270.

2.5 BUSHFIRE HAZARD

The majority of the subject land is designated as bushfire prone on the WA Map of Bushfire Prone Areas (DFES 2018). A Bushfire Management Plan (BMP) has been prepared by Strategen in order to address the requirements under Policy Measures 6.2 and 6.3 of SPP 3.7 Planning for Bushfire Prone Areas. The BMP has been prepared in accordance with section 5.2.5 of Guidelines for Planning for Bushfire Prone Areas, which requires Structure Plan's to be accompanied by a BMP that includes the results of a strategic level Bushfire Hazard Level (BHL) assessment (refer **Appendix B**). Aside from the preparation of future BMPs to accompany future subdivision and development applications where appropriate, there are no further items to implement, enforce or review at this strategic stage of the planning process.

Following development works, the land within the ANSP area will be predominately cleared and therefore will contain land with Low and Moderate Bushfire Hazard Level (BHL). As a result, the predominant bushfire hazard to the development is associated with Bush Forever site 270 to the west, south and south-east of the project area. There is also potential for bushfire occurrence through Class B woodland to the east within private landholdings. The vegetation adjacent to the ANSP area is fragmented in areas, by agricultural land uses, major roads and tracks that would reduce the ability for fire spread and significant bushfire escalation at the development interface.

Management measures outlined in Section 5.2 of the BMP will ensure that on completion of development, all developable land will comprise either a low or moderate BHL and a rating of BAL-29 or lower will be achieved through provision of appropriate setbacks to any post development classified vegetation. The presence of perimeter roads and managed POS at the bushfire hazard interfaces will assist in achieving the required separation.

On the basis of the information contained within the BMP, Strategen considers the bushfire hazards within and adjacent to the ANSP and the associated bushfire risk is readily manageable through standard management responses outlined in the Guidelines and Australian Standards AS 3959. Strategen considers that on implementation of the proposed management measures, the project area will be able to be developed with a manageable level of bushfire risk whilst maintaining full compliance with the Guidelines and AS 3959.

The BMP outlines the detailed information required for future BMPs required at subdivision and development application stages.

2.6 HERITAGE

The Department of Planning, Lands and Heritage (DPLH) Aboriginal Heritage Inquiry System (2018) was searched, which identified there are no registered places within or adjacent the subject land. Additionally, there are no other heritage places within the subject land. The boundary for Mandogalup Swamp/ Spectacles (site ID 3427) resides within a small section of Anketell Road reserve and is known for Mythological, Hunting Place and Water source approximately 870 metres to the west.

Additionally, Treeby Road Lake (ID 3555) is located approximately 600 metres south of the ANSP boundary within Bush Forever site 270. The Heritage Council (2018) inHerit database identified no current sites within the ANSP area.

3 STRUCTURE PLAN

3.1 DESIGN PRINCIPLES

3.1.1 SITE ANALYSIS

An opportunities and constraints analysis was undertaken to inform the design considerations over the site. **Figure 7** summaries the key opportunities and constraints. Of particular note, the location of the DOS minimises earthworks, fill and retaining in comparison to the originally approved location. It also allows the existing Treeby Road reserve alignment to be retained and provides the opportunity to integrate the DOS with the community facility.

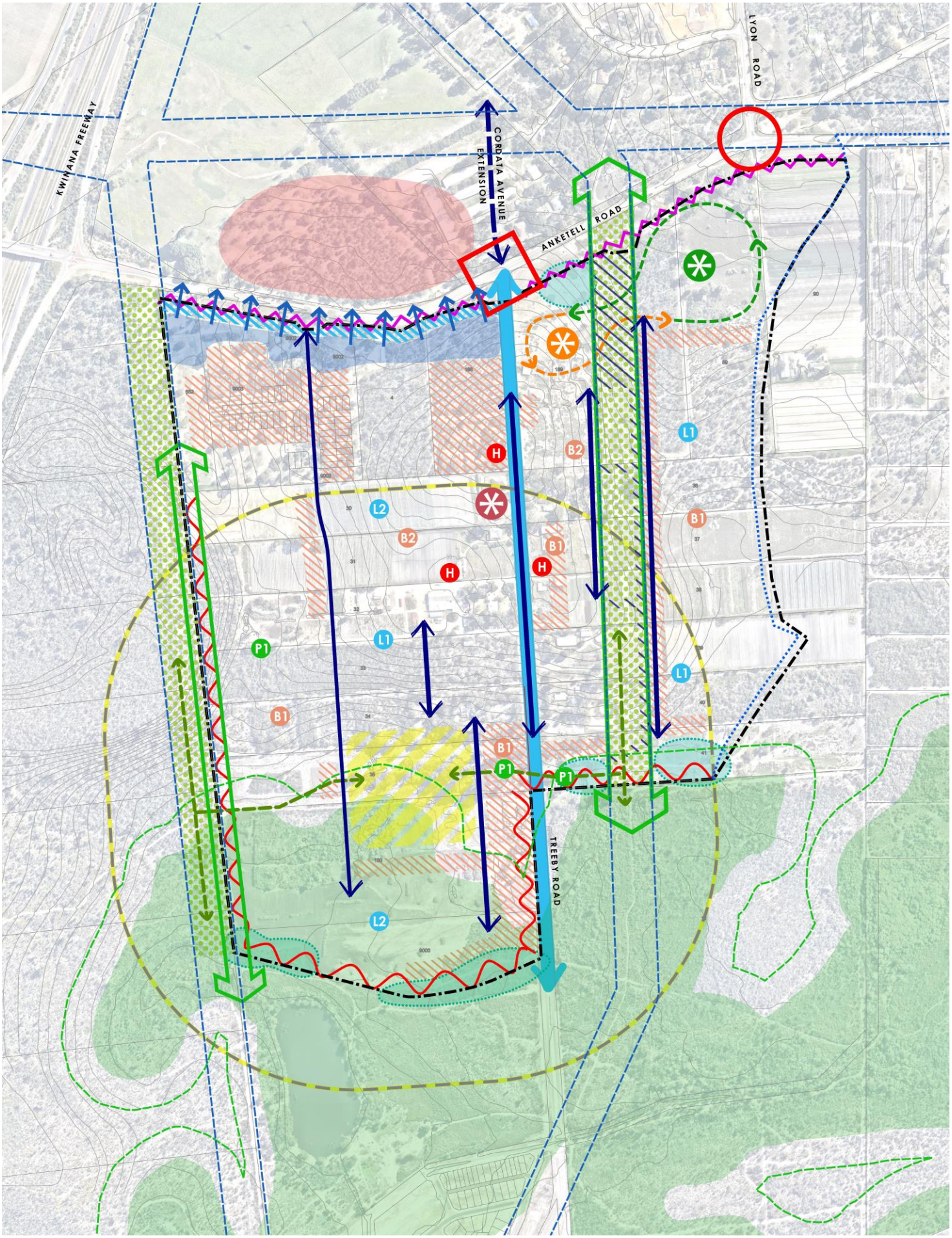


Figure 7 Opportunities and Constraints Analysis

LEGEND

Proposed Amended Structure Plan Boundary

PUBLIC REALM

Opportunities

Utilise Western Power Easement areas for public open space.

P1 Provide areas of public open space in locations that maximise identified existing trees worthy of retention.

Primary School and associated oval generally located centrally to maximise pedestrian catchment.

Provide north-south and east-west linear public open space linkages maximising pedestrian movement throughout the Structure Plan area.

Retain existing topography as much as practicable utilising lower areas for drainage catchments within public open space areas.

District Open Space located on area that is generally level minimising earthworks, fill and retaining requirements.

Constraints

P1 Possible retention of trees will set site levels at these (higher) locations.

MOVEMENT

Opportunities

Potential to provide full movement opportunity at the intersection of Anketell and Lyon Roads.

Provide full movement opportunity at the intersection of Honeywood Avenue, Anketell and Treeby Roads.

Retain existing Treeby Road reserve in current alignment.

Utilise Western Power Easement area for future access roads and car parking to maximise development opportunity.

Provide east-west public open space linkages to Primary School and proposed north-south public open spaces.

Proposed Primary School easily and conveniently accessed with proposed roads to all four sides.

Constraints

Potential noise attenuation requirements for any residential proposed in close proximity to Anketell Road.

Access and egress to land uses adjacent Anketell Road limited to side streets.

LANDUSE

Opportunities

Optimise residential density within close proximity to areas of higher amenity, Primary School, and Community Facility.

Service Commercial located adjacent high exposure to movement economy along Anketell Road.

Utilise Western Power Easement areas for public open space, future access roads and car parking to maximise development opportunity.

Opportunity to utilise lower areas for drainage catchment and conveyance to minimise disturbance to the existing landform.

Future planned District Centre

Constraints

H Existing high points require careful consideration through development scheme.

Existing Western Power Easement areas constrains and dissects residential development.

Development edge constrained by existing MRS Rural Water Protection Zone boundary (road only to be provided within this area).

L1 Fragmented landownership constrains development efficiencies and staging.

L2 Existing subdivision approval over Lots 30, 35, 100 & 9000

Conservation Category Wetland and buffer (50m) to be incorporated into POS (regard to be given to existing subdivision approvals on Lots 35, 100 & 9000)

BUILT FORM

Opportunities

Service commercial to orientate to Anketell Road.

Opportunity for the Community Facilities site to be designed and integrated with district open space site.

Optimise built form density within close proximity to areas of higher amenity, Primary School, and Community Facility.

North-south streets to respond to site topography and optimise potential for solar access.

B1 Opportunity to provide a variety of housing types and densities.

Constraints

Existing home to be retained.

B2 Management of demolition important to avoid creating further contamination.

Potential bushfire attenuation specifications required for homes in close proximity to existing bushland/Bush Forever.

3.2 DEVELOPMENT CONCEPT PLAN

The Development Concept Plan in **Figure 8** has been prepared to provide an illustration of the development intent for the ANSP area. Whilst this graphical representation is indicative only, it indicates the integration of landscaping within the ANSP area and how the road layout, streetscapes, development will occur.

The Development Concept Plan has been prepared based on the following key design considerations:

- **Structure Plan Boundary** – the extension of the structure plan boundary introduces Service Commercial land appropriately located along Anketell Road and ensures the extension of Lyon Road, consistent with approved amendments to the ANSP.
- **Public Open Space** – the DOS has been located where the natural surface area level difference requires comparatively little earthworks compared to the original approved ANSP location to create a useable space for playing fields, and is co-located with the proposed Community Purpose Site. The remaining POS has focused on the best quality vegetation across the ANSP area.
- **Road Structure** – the DOS location allows for the retention of the existing Treeby Road reserve alignment providing a direct route and efficient use of land.
- **Interface to Rural – Water Protection zone** – the Development Concept provides an appropriate interface and transition to the existing rural groundwater protection lands immediately abutting the ANSP area to the east. This is achieved through the designation of an R10 density coding to interfacing properties, and the provision of a boundary road along the eastern residential area.
- **Residential Development** – the Development Concept provides for a variety of housing choices through the R10, R25, R30 and R40 density codings. The range of lot sizes and housing types is achieved based the proposed arrangements appropriate to the current market.
- **Service Commercial** – the introduction of Service Commercial land within the north west portion of the ANSP supports the Wandi District Commercial Activity Centre located immediately opposite on the northern side of Anketell Road.
- **Integration** – the Development Plan demonstrates that the future subdivision and development of the ANSP area will not prejudice surrounding land parcels, or the planned upgrade of Anketell Road.
- **Existing Subdivision Approvals & Development Restrictions** – the Development Concept takes into consideration the existing subdivision approvals over Lots 30, 35, 100 and 9000. It is also understood that the existing house on Lot 30 is required to be retained and therefore only residential land is proposed over Lot 30 in accordance with this requirement.

Figure 8 Proposed Anketell North Concept Plan

3.3 LAND USE

The ANSP area will be predominantly developed for Residential purposes and supported by Service Commercial land uses fronting Anketell Road. The land use composition of the ANSP area is summarised in **Table 3.**

Table 3 Land Use Summary

LAND USE	PROPOSED YIELD / AREA
Residential R10	11 lots
Residential R25	184 lots
Residential R30	789 lots
Residential R40	373 lots
Total	**1,357 lots/dwellings**
Community Facility	1.65ha
Primary School	4.00ha
Service Commercial	3.9ha (19,500m² estimated NDA)
Parks and Recreation / Drainage	13.8ha

3.3.1 RESIDENTIAL

The proposed Development Concept suggests a potential yield of 1,357 residential lots, with densities ranging from R10 to R40. Lower densities are proposed along the eastern portion of the ANSP area to provide an appropriate transition to the interfacing rural residential properties. The majority of lots will be coded R30 and R40 to reflect the current market demand.

The ANSP achieves an average residential density of 13.7 dwellings per gross urban zoned land and 28 per residential zoned land. This is consistent with Liveable Neighbourhoods requirements, which stipulates a minimum average of 22 dwellings per site hectare for greenfields subdivision areas.

The ANSP however does not achieve the 15 dwellings per gross urban hectare, as set out in Directions 2031, on the basis of the following site characteristics:

- The Western Power Easement which comprises 4.5 hectares of the total gross urban area;
- The non-residential land uses within the ANSP including, the Community Facility site and the Primary School site;
- The inclusion of the City's standard playing fields design which requires additional POS provision above the 10% requirement; and
- The inclusion of the R10 interface along the eastern boundary of the ANSP area.

Given the location of the ANSP area within proximity to the Wandi District Centre, subdivision must however meet the standard 30 – 40 dwellings per site hectare within 400m of the District Centre. Based on the Development Concept and existing subdivision approvals, the proposed design and density allocation achieves 35 dwellings per site hectare within 400m of the Wandi District Centre.

The ANSP therefore allocates an R30 coding to the majority of the site, with areas of R40 allocated to lots within proximity to areas of high amenity and access to schools, and adjacent to public transport or neighbourhood connector routes. Within the eastern portion of the ANSP area, R25 is the predominant density utilised with an interface of R10 to the adjacent rural residential lots.

3.3.2 SERVICE COMMERCIAL

The introduction of Service Commercial land abutting Anketell Road provides for complementary commercial land uses to the proposed Wandi District Commercial Activity Centre (as identified in SPP 4.2) and the *South Metropolitan Sub-Regional Planning* Framework. The proposed Service Commercial land is strategically located adjacent Anketell Road which has been identified as a future freight route and therefore will appropriately accommodate the associated traffic generated by the Service Commercial land uses. This also provides flow-on benefits in providing a 'buffer' between freight traffic on Anketell Road and residential uses within the ANSP area, assisting in the reduction of acoustic impacts on residential properties.

The total area of Service Commercial zoned land is 3.9 hectares, with an estimated net developable area (NDA) of 19,500m² based on a maximum site coverage of approximately 50% of the gross area.

3.3.3 COMMUNITY FACILITY

Under the provisions of ERIC and Developer Contribution Plan 9 (DCA 9), a number of community infrastructure sites are identified within the general Wandi District Centre location. Through discussions with the City's Technical Officers it was however determined the recreation centre was ideally located at the intersection of Anketell and Treeby Roads, on the basis of the following design considerations:

- The high accessibility afforded by the signalised intersection to allow for pedestrian and cycling movements between the Wandi and Anketell Structure Plan Areas;
- Its location within close proximity to the retail core and bus routes;
- The land intensive nature of the use and the ability to maximise the residential population within a 400m walkable catchment of the Wandi District Centre, with its location south of Anketell Road;
- The ability to utilise sterilised land within the easement for parking;
- The opportunity to provide a built form statement to the Anketell North LSP area at a prominent intersection, and
- The opportunity to provide a land use buffer to Anketell Road for residential uses within the ANSP area.

As such, a site of 1.65 hectares is provided at the intersection of Anketell and Treeby Road. A Neighbourhood Park is to be located adjacent to the Community Facility, providing for informal active recreation with public amenities available such as picnic facilities. As per the approved Landscaping Plan, POS north of the community facility provides a buffer between the community facility and Anketell Road.

3.4 PUBLIC OPEN SPACE

A POS calculation has been prepared in accordance with Liveable Neighbourhood, as detailed in **Table 4** and is accompanied by a Public Open Space plan (refer **Figure 9**). A total of 10.1019 hectares (12.11%) of credited POS is provided within the proposed ANSP. The proposed POS provides for a variety of purposes and sizing including DOS (district playing fields), neighbourhood parks, local parks and linear park.

The POS will be provided in accordance with the Structure Plan and POS Schedule and will be landscaped by the developer to a standard commensurate to, or above LN requirements and to the satisfaction of the City of Kwinana. The Landscape Masterplan (**Appendix E**) provides a graphical representation of the public realm vision and indicative streetscapes for the ultimate development of the site.

Table 4 Public Open Space Schedule

PUBLIC OPEN SPACE SCHEDULE Anketell North Structure Plan August 2020 (17/091/014B)		
Site Area (ha) (excluding Treeby Road Reserve) (Gross Site Area - 99.3061 ha)		**97.6297**
Deductions		
Primary School	4.0000	
Service Commercial	3.8676	
Undesignated Area	1.2144	
Drainage (1:1yr) (excluding Basins within Power Easement)	0.6453	
D9. Western Power Easements (excl. Road Reserves)	4.5100	
Total Deductions		**14.2373**
Net Subdivisible Area		83.3924
Required Public Open Space (10%)		**8.3392**
Public Open Space Requirements		
Unrestricted public open space - minimum 80%	6.6714	
Restricted public open space - maximum 20%	1.6678	
Total		**8.3392**
PUBLIC OPEN SPACE PROVISION		
Credited Unrestricted Public Open Space		
1. Neighbourhood Park	0.5429	
2. Anketell Playing Fields	4.9005	
3. Neighbourhood Park	0.4018	
4. Neighbourhood Park	0.1655	
5. Local Park	0.0319	
8. Neighbourhood Park	0.1548	
9. Neighbourhood Park	0.2485	
10. Community Site	1.6514	
11. Neighbourhood Park	0.0317	
12. Neighbourhood Park	0.1055	
Total Credited Unrestricted POS		**8.2345**
Restricted Public Open Space		
Drainage Basins within POS areas excluding Western Power easement (1:5 yr storm event)	0.4053	
6. Conservation - wetland buffer	0.3828	
7. Conservation - wetland buffer	0.6963	
8. Portion of POS outside of western easement	0.3830	
11. Portion of POS outside of western easement	0.0946	
Total Restricted POS		**1.8674**
Total Restricted and Credited Unrestricted POS		**10.1019**
Percentage of Credited POS (Restricted and Credited Unrestricted POS Contribution)		**12.11%**

POS PROVISION SUMMARY

1	Neighbourhood Park (informal active recreation/ possible tree retention)	0.5429ha
2	District Open Space - Anketell Playing Fields (multipurpose sport recreation facility/ tree retention)	4.9005ha
3	Neighbourhood Park (local passive recreation use)	0.4018ha
4	Neighbourhood Park (local passive recreation use)	0.5593ha
5	Local Park (tree retention)	0.1366ha
6	Conservation - wetland buffer	0.3828ha
7	Conservation - wetland buffer	0.6963ha
8	Neighbourhood Park (edge treatment to Bush Forever Site)	0.7028ha
9	Neighbourhood Park (edge treatment to Bush Forever Site)	0.3915ha
10	Community Purpose Site	1.6514ha
11	Neighbourhood Park	0.3700ha
12	Neighbourhood Park	0.2529ha

DEDUCTIONS

D1	Drainage Swale (1:1 year event)	0.1150ha
D2	Drainage Swale (1:1 year event)	0.1613ha
D3	Drainage Swale (1:1 year event)	0.0450ha
D4	Drainage Swale (1:1 year event)	0.1650ha
D5	Drainage Swale (1:1 year event)	0.1430ha
D6	Primary School	4.0000ha
D7	Service Commercial	3.8676ha
D8a	Western Power Easements (excl. Road Reserves)	4.0100ha
D8b	Western Power Easements (excl. Road Reserves)	0.5000ha
D9	Undesignated	1.2144ha

Figure 9 Public Open Space Plan

Under the provisions of Liveable Neighbourhoods, a range of site responsive urban parkland is required, which appropriately addresses district, neighbourhood and local needs of residents, comprising a mixture of unrestricted and restricted open space. The ANSP therefore provides a framework for the hierarchy and location of POS areas across the site, considering the requirements for drainage and vegetation retention, defining key strategic areas of open space as identified on ANSP map. Detailed subdivision design will provide further refinement to the ANSP POS framework, defining the configuration, uses and treatment within each POS area.

The hierarchy and location of POS areas have been designed to ensure residents are within:

- 400m of a neighbourhood park; and
- 600m – 1km of a district / active playing field.

Additional POS is provided within the Western Power Easement (4.5 hectares) however does not form part of the open space calculation. This area is considered to provide an important north / south pedestrian and cycling connection, which combined with a number of strong east / west links via the road network, ensure appropriate connectivity within and external to, the ANSP area.

The ANSP proposes to locate the DOS to the north eastern corner of the ANSP area, co-located with the approved Community Facility. The DOS has been identified to facilitate a Local Sporting Ground with Community Facility Building A in accordance with the City's Draft Community Infrastructure Plan 2011-2031. The proposed DOS location sits in an area where the natural surface level difference is in the order of three metres, requiring minimal earthworks to create a useable space for sports fields.

The location of the remaining POS has focused on the best quality vegetation across the subject land and connectivity with the conservation value of Bush Forever 270 and the CCW. POS placement along the boundary of the ANSP provides suitable separation to development activities and conservation areas, whilst contributing to ecological connectivity.

3.5 LANDSCAPE DESIGN

A Landscape Masterplan has been prepared by LD Total in order to inform open space development, the LWMS (refer **Appendix F**) and Bushfire Hazard Assessment (refer **Appendix B**). The Landscape Masterplan is indicative only and subject to detailed design at subdivision stages.

As demonstrated in the Landscape Masterplan the proposed ANSP will ensure each lot frontage will be streetscaped with a minimum of one street tree to promote ecological connectivity across the ANSP and regional area. Additionally, Treeby Road will be constructed with a median strip which will be vegetated with endemic species to further increase ecological connectivity across the site. The position of POS has considered the significant trees identified within the ANSP area to ensure maximum retention across the site.

3.5.1 ENVIRONMENTAL CONSIDERATIONS

The ANSP has been strategically designed to utilise as much Completely Degraded and cleared land as practicable, although development of the site will necessitate the clearing of native vegetation ranging from Very Good – Excellent to Completely Degraded.

The completion of vegetation mapping has informed the placement of POS to capture the best quality habitat and retain connectivity with Bush Forever 270 and the CCW. The ANSP design has focused on retention of the best quality Banksia TEC and vegetation across the site. POS locations across the ANSP has considered the Black Cockatoo foraging habitat significant trees and TEC locations to maximise the retention of the best quality vegetation and reduce impacts to Black Cockatoos and TECs. Furthermore, POS placement has considered topographical features and some area of POS are located on high points in the landscape to increase the visual amenity of the POS across the site.

3.6 WATER MANAGEMENT

3.6.1 LOCAL WATER MANAGEMENT STRATEGY

A Local Management Plan Strategy (LWMS) was prepared in 2014 to support the existing approved ANSP. A revised LWMS (2019) was prepared by Bioscience (refer **Appendix F**), and a LWMS addendum prepared by Hyd2o (refer **Appendix G**) in support of Amendment 4. The LWMS has been developed to establish the concepts and broad level design measures for flood mitigation and stormwater management for the ANSP area. The intention of the LWMS is to guide the general stormwater management principles (location and size of stormwater basins). To ensure the pre-development peak discharges are maintained, a number of retention basins have been incorporated into the design to meet the requirements of the one, five and 100 year ARI events.

The LWMS provides the necessary water management strategies to guide the subsequent Urban Water Management Plan (UWMP) required at subdivision stage.

The LWMS indicates that the peak discharges for the 100 year ARI event at the Legal Point of Discharge (LDPs) are:

- LPD 1: 103 l/s (to be infiltrated directly in the soakage area) Note that LPD1 is not applicable to the proposed ANSP. No discharge from the ANSP area will occur to this discharge point.
- LPD 2: 145 l/s (Discharge north towards the Peel Sub R Drain).
- LPD 3: 371 l/s (culverts under Thomas Road).

Development of the subject land will result in a significant increase in impervious surfaces and therefore runoff volumes leaving the site. To ensure the pre-development peak discharges are maintained, drainage infrastructure will include bioretention areas, soakwells, overland flows and detention basins.

The effectiveness of the basins in maintaining the pre-development discharge flows for the 1% AEP event has been assessed. The post development basins are capable of maintaining the pre-development peak discharge for the critical storm duration for the design events with outflows regulated to those proposed in the Department of Water and Environmental Regulation (DWER; former DoW) DWMP.

A treatment train has been devised for the development that employs industry standard Best Management Practices (BMPs) and will ensure the development does not result in any adverse impacts for the downstream receiving water bodies and ecosystems. The DoW Jandakot DWMP indicates that the department is currently developing water quality targets and in the interim, treatment trains should be based on the methodology established in the Stormwater

Management Manual for Western Australia. Surface water quality should be managed through:

- On site retention of 63% AEP 1 hour event flows;
- Bioretention systems sized as 2% of the connected impervious areas, and
- Non-structural measures to reduce applied nutrient loads.

3.7 WETLANDS AND BUFFERS

3.7.1 CONSERVATION CATERGORY WETLANDS

As mentioned previously, a CCW occurs across the southern portion of the ANSP. At present, subdivision approval exists over Lots 35, 100 and part of 9000 Treeby Road, therefore CCW, mapping within these lots are no longer applicable. The CCW boundary is located along the southern boundary of Lot 41 Treeby Road.

Impacts to the CCW have been mitigated by the provision of POS within the 50 metre buffer along the southern boundary of Lot 41. Subdivision approval is likely to require the development of a Wetland Management Plan (WMP) which will include measures such as:

- revegetation within the CCW buffer
- weed control
- site water containment

The ANSP design has retained an appropriate buffer from the CCW to ensure adequate separation from the development and the CCW. With the development of the WMP, impacts on the CCW can be managed to ensure the CCW retains it high conservative value. Further subdivision approval will result in conditions which ensure development construction protects the conservation value of CCW and Bush Forever site 270.

3.8 MOVEMENT NETWORK

The Transport Impact Assessment (TIA) (2019) prepared by GTA consultants (refer **Appendix H**) concludes that the ANSP will have an acceptable impact on the surrounding roads and intersections with no major network changes required to the external transport network over and above what is proposed as part of the ANSP.

Overall, traffic volumes expected to be generated by the development is to be approximately 15,150 vehicle trips per day (vpd). Most of the vehicle trips are expected to access the ANSP area via the future Anketell Road / Treeby Road signalised intersection, with remaining trips equally distributed between the future western Road 1 and the Lyon Road / Anketell Road roundabout.

The extension of the ANSP boundary and the introduction of Service Commercial land use is not considered to compromise the traffic network as the daily traffic volumes are supported by the proposed Lyon Road / Anketell Road roundabout in addition to the Treeby Road / Anketell Road signalised intersection that was previously assessed for the potential traffic generation. Assessment of the proposed traffic and transport network has shown that the proposed connectivity will function adequately when the area is fully developed, which has been assumed and estimated to be by 2031. Therefore, no daily adverse traffic impacts on external roads is expected in terms of overall traffic volume.

3.8.1 ROAD AND INTERSECTION UPGRADES

The southern extension off Lyon Road should generally be provided in the location depicted on the Structure Plan, and be supported by updated traffic modelling and information.

The long term planning of Anketell Road identifies the future closure of the 'Left-in Left-out' intersection onto Anketell Road. The specifications of the treatment and timing may be superseded by a new design, and is subject to Main Roads WA approval.

Contributions for the progressive upgrade of road infrastructure may be obtained via conditions of subdivision, in line with any updates to Developer Contributions.

3.8.2 ACCESS

Given the ANSP proposes predominately residential land use, it is not expected any capacity issues will occur at junctions and that uncontrolled priority and roundabout intersections will be sufficient to accommodate the expected demand.

Outlined below is the access arrangements to/ from subject to the ANSP area, including:

- Access 1 – a left in / left out (LILO) on Anketell Road to the north-west of the site (already approved).

- Access 2 – a full movement signalised intersection at Anketell Road / Treeby Road to the north of the site (already approved). This intersection is currently configured as a priority-controlled T-section and will connect to the City's planned extension of Cordata Avenue to Anketell Road in the future.
- Access 3 – a 4-way roundabout access at the Lyon Road Anketell Road intersection to the north-east of the ANSP.
- Access 4 – a full movement T-intersection at Treeby Road / Thomas Road south of the site. The City's online Intramaps website confirms that Treeby Road will ultimately be extended to for a T-intersection with Thomas Road.

The locations of the proposed access intersections and road connections are shown within the TIA.

3.8.2.1 ROAD HIERARCHY

The following sections summarise the amended road hierarchy within the proposed ANSP area based on the Development Concept. The revised road hierarchy has been based on the modelling undertaken by GTA consultants (2019).

The proposed road hierarchy has been developed using the guidelines and indicative daily traffic volume limits set out in *Liveable Neighbourhoods*, together with the overall design principles and aims of the ANSP.

Primary Distributor - Anketell Road

Anketell Road is identified as a Primary Distributor. A full movement signalised intersection at Anketell Road / Treeby Road is approved and will remain so. Other intersections on Anketell Road are proposed to operate as a left in / left out and a roundabout to the west and east respectively.

Integrator B - Treeby Road

Consistent with the approved ANSP, Treeby Road is proposed as an Integrator B. The existing width of Treeby Road in 20m-22m (various along sections). This key north-south road is being proposed as a boulevard design within the already approved 25.2m indicative road reservation width. To avoid the unnecessary controlled cap roads previously identified along Treeby Road, a road cross-section similar to that of Honeywood Avenue, Honeywood (north of Anketell Road in the City of Kwinana) is appropriate with 4m wide carriageway widths, 6m wide median island restricting driveway movements to left in / left out, shared use pathways on both sides of verge and roundabouts supplemented by occasional median breaks designed for U-tuns where roundabouts are distanced apart. This is an excellent design outcome for Treeby Road in lieu of undesirable cap roads. Drainage swale in the central median will be limited to areas where the Treeby Road grades are flatter; however, this does not prohibit this boulevard concept being used.

Roundabouts are suggested along the realignment of Treeby Road to maintain safe speeds and facilitate traffic movements. This also applies to the intersections adjacent to the community facility and the commercial areas to provide effective circulation for traffic accessing these lots.

In order to support development within the ANSP area, and as identified in DCA 4 construction and upgrading of Anketell Road and Treeby Road is required. It is understood that Anketell Road will be upgraded to a dual carriageway in the future which is expected to accommodate up to 20,000 vpd, consistent with an Integrator B. Treeby Road between Anketell Road and Thomas Road is either not constructed or constructed to a rural standard. It is proposed that Treeby Road will also be required to be upgraded or constructed. The upgrade of Anketell and Treeby Roads will largely be funded through developer contribution enforced by DCA 4. The portion of Treeby Road between ANSP and Anketell South LSP will be subject to developer contribution fees for the upgrading and construction which is not included within DCA 4. Majority of the internal roads will be developed as part of the ANSP area.

Neighbourhood Connector B

The streets abutting the Service Commercial lots where the westernmost left in / left out to Anketell Road is located, are recommended to be constructed to a width of 18m to allow for on-street parking plus shared path on one verge.

Access Roads

The remainder of the local road network is classified as Access Street B, C and D or laneways with 16.5m – 14.2m road reserve. Access streets adjoining the primary school and DOS are recommended to be constructed as Access Street B (16.5m-18m) to allow for on-street parking on both sides of the street.

3.8.3 PEDESTRIAN AND CYCLING NETWORK

The ANSP has been designed in accordance with Liveable Neighbourhood and is cognisant of achieving walkable catchments and high pedestrian amenity. All streets are recommended to be provided with a footpath on at least one side and a wider footpath is appropriate adjacent to the primary school to enhance the safety of the access to the school.

Shared paths are recommended along Integrator B and Neighbourhood Connector roads, as well as along the Western Power Easement and the eastern side of the ANSP area, providing a cycling connection between the primary school and DOS.

Local access streets with daily traffic flows lower than 3,000 vehicles per day will provide sufficient opportunity for pedestrians to cross without experiencing delays. The Neighbourhood Connectors, designed as boulevards will provide greater opportunity for pedestrians to cross safely.

The Neighbourhood Connector roads are suited to on-street cycling as per the (physically separated from cars / trucks), and/or with a shared path on the verge. On 27 April 2016, WA's laws were changed to allow cyclists of all ages to use footpaths, unless otherwise signed. The amendment to the Road Traffic Code 2000 brought WA's bicycle laws into line with the rest of Australia, making it legal for parents to cycle alongside their children on footpaths, improving safety.

3.9 PUBLIC TRANSPORT

There remains to be no bus routes servicing the ANSP area. In accordance with the Transport Assessment (October 2015) prepared by Transcore, bus route 537 will run along the Treeby Road north-south connection and serve Wandi and Anketell cells and provide a good connection between Aubin Grove station and Kwinana station. Another service is planned in the future to service the Structure Plan areas to the south of Thomas Road, and provide connection to the Kwinana train station and bus interchange facility.

3.10 EDUCATION FACILITIES

In accordance with ERIC, one primary school is proposed, located generally centrally within the ANSP area. The primary school will be shared by the Anketell North and South precincts.

The provision of one primary school is consistent with the catchment requirements under the WAPC's Development Control Policy 2.4 School Sites, which recommends one primary school per 1,500-1,800 housing units for government schools. Based on current planning, it is anticipated the Anketell North and South Structure Plan areas have the potential to yield up to 1,752 lots combined.

The proposed location of the school site enables an appropriate separation distance from the Western Power Easement and Bush Forever Site as required by the Department of Education (DoE). To reinforce access for the precinct to the school, the proposed street network and linear areas of POS create direct pedestrian access.

The proposed Anketell Primary School site is bounded by three proposed Access B streets, accommodating on-street parking. The street network / street block pattern surrounding the school has been designed such that lots / dwellings shall be oriented towards the school for surveillance purposes. Subdivision design for land surrounding the school will need to demonstrate appropriate parking, public transport and walking / cycling. The subdivision application itself must address CPTED / safety principles and housing access.

A search of the DoE system identifies the Anketell area as currently being within the intake area for the Honeywood Primary School and Gilmore College, which will likely service the proposed Anketell population until such time as the Anketell Primary School and Wandi High School are delivered.

3.11 INFRASTRUCTURE COORDINATION, SERVICING AND STAGING

The following provides a summary of the infrastructure and servicing for the ANSP area, as detailed in the Engineering Report prepared by TABEC Pty Ltd (refer **Appendix I**).

3.11.1 STORMWATER DRAINAGE

Together with the preliminary earthworks plan, drainage catchments have been determined which has been utilised in the preparation of the LWMS. The report details the stormwater management strategy and how the key design elements in the proposed urban environment include the maintenance of predevelopment flow paths and catchments. While there will be some modification to the natural surface gradients, generally, the post development landform with follow the pre-development landform in relation to high and low points, therefore the current drainage catchment will remain, notwithstanding the urban development form.

In order to optimise land use, there will be a focus to utilise the power transmission line easement for infiltration of stormwater within shallow depth, unfenced basins that would minimise length of time of standing water as far as practical.

Conveyance from source to the swales / basins would be via a pit and pipe system constructed to the City's requirements. Future lots within the ANSP area will be responsible for containing stormwater on-site for events up to 18% Annual Exceedance Probability (AEP) (1:5 ARI).

3.11.2 WASTEWATER

The initial stage of development within the ANSP area is dictated by the requirement for a gravity outfall consisting of a 225mm diameter PVC pipe in Anketell Road that discharges to Thompson Lake Pump Station located east of Kwinana Freeway approximately 700 metres north of Anketell Road.

The remainder of the ANSP area has a planned gravity sewer discharge through to a recently completed sewer pumping station (PS174-04) located within the Anketell South LSP area. However, the proposed sewer servicing of the southern portion of the ANSP area is dependent on an outfall sewer constructed between the southern end of the subject land and PS174-04 adjacent to the wetland that separates Anketell North from Anketell South. This outfall is required to be funded by a developer, or developers within the catchment.

The 250mm diameter pressure main that transfers effluent from PS174-04 runs through the ANSP area, within the Treeby Road reserve.

3.11.3 WATER SUPPLY

With the recent development south of Anketell Road, water mains that will ultimately service the whole ANSP area have already been built within Anketell Road and Albina Avenue. This comprises 250mm diameter mains in Lyon Road and Anketell Road.

Within the ANSP area, a 200mm diameter water main is proposed within Treeby Road. There are also two north-south directional 150mm diameter mains proposed, one either side of Treeby Road. There rest of the mains within the area will consist of 100mm diameter pipework.

All water supply network within the ANSP area will be developer funded.

3.11.4 POWER SUPPLY

There is capacity within Western Power's network to service the development.

Although there are transmission lines that traverse the site parallel to and east of Treeby Road, there is no direct connection to these lines. Instead, power to the ANSP area will be sourced from the existing High Voltage power lines in Treeby Road. These power lines in Treeby Road will be converted to underground supply as part of the roll out of development.

Other than accommodating the power transmission line easements and physical clearance to towers, power supply does not represent an impediment to development within the area.

All roads constructed within the ANSP area will have lighting installed to the satisfaction of the City, Western Power and relevant Australian Standards.

3.11.5 TELECOMMUNICATIONS

Recent subdivision works at Albina Avenue, off Anketell Road is included in the NBNCo rollout map therefore expansion of the NBNCo rollout to the immediate surrounding area is considered to be a logical extension that would not require any extraordinary charges (other than the current $600 per lot fee) to be levied on the developer. However, under this arrangement, the developer is responsible for the design and construction of a pipe and pit network in accordance with NBNCo requirements.

3.11.6 GAS SUPPLY

Recent subdivision works at Albina Avenue, off Anketell Road has bought a gas supply pipe network to the immediate area. It is therefore expected that developers within the ANSP area will work with Atco to allow for the gas network to be extended into proposed development areas.

Under current arrangements, the developer will provide a trench in which Atco will install their pipe network. This is considered to be standard practice for subdivision works.

3.11.7 ROADWORKS

All roads within the ANSP are required to be constructed in accordance with the City's requirements. It is expected that all roads will have asphalt wearing surface with concrete kerb edge restraints.

4 TECHNICAL APPENDICES

4.1 TECHNICAL APPENDICES INDEX

APPENDIX	DOCUMENT TITLE	AUTHOR	APPROVAL STATUS
A	Environmental Assessment Report	Strategen Environmental	
B	Bushfire Management Plan	Strategen Environmental	
C	Acoustic Assessment	Herring Storer Acoustics	
D	Service Commercial Market Advice	Taktics4	N/A – for information
E	Landscaping Plan	LD Total	
F	Local Water Management Strategy	Bioscience	Approved
G	Local Water Management Strategy Addendum	Hyd2o	
H	Traffic Impact Assessment	GTA Consultants	
I	Engineering Servicing Report	TABEC	

APPENDIX A
ENVIRONMENTAL ASSESSMENT REPORT

intelligent outcomes | respected experience

Anketell North Local Structure Plan (Amendment)

Environmental Assessment Report

Prepared for
RPoint Land Pty Ltd (C/- Acumen Development Solutions)
by Strategen

May 2019

strategen
ENVIRONMENTAL

Anketell North Local Structure Plan (Amendment)

Environmental Assessment Report

Strategen is a trading name of
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Level 1, 50 Subiaco Square Road Subiaco WA 6008
ACN: 056 190 419

May 2019

Limitations

Scope of services

This report ("the report") has been prepared by Strategen Environmental Consultants Pty Ltd (Strategen) in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

Reliance on data

In preparing the report, Strategen has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, Strategen has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Strategen has also not attempted to determine whether any material matter has been omitted from the data. Strategen will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Strategen. The making of any assumption does not imply that Strategen has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. Strategen disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law of Western Australia as at the date of this report.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

Client: RPoint Land Pty Ltd (C/- Acumen Development Solutions)

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
Draft Report	A	Client review	K Cooper C Lehman / D Newsome	Electronic	30/11/2018
Final Report	0	For submission	W Oversby	Electronic	07/12/2018
Final Report	1	For re-submission	J Hyatt	Electronic	20/05/2019

Filename: ADS18136.01 R001 Rev 1 - 20 May 2019

Executive Summary

Acumen Development Solutions is proposing to amend some design aspects of the existing Anketell North Local Structure Plan, which is located approximately 28km south of the Perth Central Area within the City of Kwinana. The current Local Structure Plan (WAPC endorsed 18/12/2015) comprises approximately 98.4 hectares currently accessed by Treeby Road, which runs parallel to the Kwinana Freeway and connects to Anketell Road along the northern boundary of the Anketell North LSP area (the site).

The site is currently zoned 'Urban' under the Metropolitan Region Scheme and 'Development' under the City of Kwinana's Town Planning Scheme and comprises rural properties ranging in size from approximately 3 hectares through to 6 hectares; which are currently being utilised for agricultural purposes such as grazing, market gardening and horse agistment.

Historically most of the site has been cleared for market garden and horticulture activities, there are pockets of remnant vegetation which have been identified as potential Local Natural Areas which will be priority for retention in the Local Structure Plan.

Regional vegetation association mapping indicates one association occurs within the site, 1001 Medium very sparse woodland; jarrah, with low woodland; banksia and casuarina, of which <10% is remaining with the IBRA and 30-40%remaining within the City of Kwinana. Bassendean Complex Central South is mapped within the Local Structure Plan and it is estimated that approximately 26% of the pre-European extent remains.

Two site vegetation surveys have been conducted across the site in which the Vegetation condition across the site ranged from Very Good – Good in the pockets of remanent vegetation to Completely Degraded across the portions of the site cleared for market gardening and horticulture.

A Level 3 PEC (Low lying *Banksia attenuata* woodlands or shrublands) was confirmed as occurring on the site through a PATN analysis undertaken by Bennett Environmental.

The Environmental Assessment Report has identified the following environmental constraints for the site:

- Matters of National Environmental Significance, including;
    - 9.6 ha of Banksia Woodlands of the Swan Coastal Plain (SCP) Threatened Ecological Community (TEC)
    - 6.7 ha of potential Banksia woodlands (area not assessed)
    - 9.6 ha of Black Cockatoo foraging habitat, which can be further defined as
    - 6.7 ha of potential Black Cockatoo habitat (area not assessed)
- 27 potential Black Cockatoo breeding trees (> 500 mm DBH), which are delineated as;
    - 17 Tuarts
    - 8 Jarrah
    - 2 **Corymbia maculate* (planted)
- A CCW (UFI 15290 and 14148) intersect with the southern portion of the site; however, a subdivision approval already occurs across Lots 35, 100 and part of Lot 13 Treeby Rd, therefore, constraints for this portion of the site have been mitigated within that approval. The southern boundary of Lot 41 Treeby Rd intersects with the CCW and will have management requirements as part of any future subdivision approval

A Local Water Management Strategy (LWMS) has been developed for the site which has been used to guide the location and size of stormwater retention basins. To ensure the pre-development peak discharges are maintained a number of retention basins have been incorporated into the design to meet the requirements of the one, five and 100 year ARI events.

POS location has focused on the best quality vegetation across the site and connectivity with the conservation value of Bush Forever 270 and the CCW. POS placement along the boundary of the LSP, provided suitable separation of development activities and conservation values, whilst contributing to ecological connectivity.

The environmental assessment identified a CCW along the southern Boundary of Lot 41 Treeby Rd. Impacts to the CCW have been mitigated by the provision of POS within the 50 m buffer; subdivision approval is likely to require the development of a Wetland Management Plan (WMP)

The development of the site will result in the clearance of Banksia TEC, potentially at thresholds requiring referral to the Department of Environment and Energy (DEE) for significant impacts. All considerations for referrals for potential significant impacts to TECs, will be conducted at the development stage by the landholder in response to site conditions.

Black Cockatoo foraging habitat and significant tree retention provide the best outcome for habitat provision within the LSP. The best quality foraging habitat and future potential habitat trees are retained within POS; furthermore, the placement of POS retains connectivity with the surrounding Bush Forever 270 and the CCW which also provide foraging and breeding habitat.

Fire run through intact vegetation exist to the southwest of the project area through predominantly intact Class B woodland; there is also potential for bushfire occurrence through woodland to the east.

Bushfire risk can be appropriately managed through implementation of the BMP which supports this EAR

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1. Introduction

1.1 Overview

Acumen Development Solutions are proposing to amend some design aspects of the existing Anketell North Local Structure Plan (LSP; the site). The LSP area is located approximately 28km south of the Perth Central Area within the City of Kwinana (CoK). The site is generally bounded by Anketell Road to the north, rural development in the east and Bush Forever sites within the Southern and Western sections of the site (Figure 1).

The current LSP (WAPC endorsed 18/12/2015) comprises approximately 98.4 hectares currently accessed by Treeby Road, which runs parallel to the Kwinana Freeway and connects to Anketell Road along the northern boundary of the site (Rowe Group, 2015). The site is currently zoned 'Urban' under the Metropolitan Region Scheme (MRS) and 'Development' under the City of Kwinana's Town Planning Scheme (TPS).

All property boundaries within the site range in size from approximately 3 hectares through to 6 hectares. All properties are rural and are currently being utilised for agricultural purposes such as grazing, market gardening and horse agistment. There are existing dwellings located within the LSP area, with associated outbuildings, fences and other structures. These are intended to be demolished and removed as development progresses on site (Rowe Group, 2015).

Currently, the Anketell North Local Structure Plan (ANLSP) excludes lot 90 Anketell Rd and most of Lot 89 Anketell Rd, the exclusion was the result of concerns raise by the WAPC relating to anticipated noise levels resulting from the traffic along Anketell Rd. All concerns have been addressed and this plan seeks to include all of Lot 89 and a portion of Lot 90 Anketell Rd; furthermore, the amended structure plan removes all of Lot 3 and Lot 2 Anketell Rd from the structure plan boundary.

1.2 Planning and Environmental Overview

1.2.1 Planning

Since the endorsement of the LSP (Rowe Group 2015), there have been minor amendments to the LSP and Western Australian Planning Commission (WAPC) subdivision approvals:

- Minor North Anketell LSP amendment for Lot 188 Treeby Road and Lot 65, Lot 652 and Lot 4 Anketell Road, Anketell and involves an extension of the Structure Plan boundary and change to the zoning (CDP, 2018)
- Subdivision of Lots 35, 100 and part Lot 13 Treeby Road, (Subdivision works have commenced)
- Subdivision of approval Lot 30 Treeby Road
- Lots 2 and 3 Anketell Road (now subdivided).

Refer to Figure 2 for the amended Structure Plan.

1.2.2 Environment

An Environmental Assessment Report was completed by 360 Environmental for the original approved LSP (Rowe Group 2015).

Figure 1: Site Location

N

Scale 1:10,000 at A4

0 2 4 6 km

Coordinate System:
GDA 1994 Perth Coastal Grid 1994

Date: 7/12/2018

Legend

- Application boundary
- Cadastral boundaries
- Existing WAPC subdivision approval

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Data source: Nearmap: Aerial image, flown 06/2018. Landgate: Existing cadastre 07/2018. Client: Acumen Development Solutions. Development layout and existing cadastre, 12/2018. Created by: jcrute

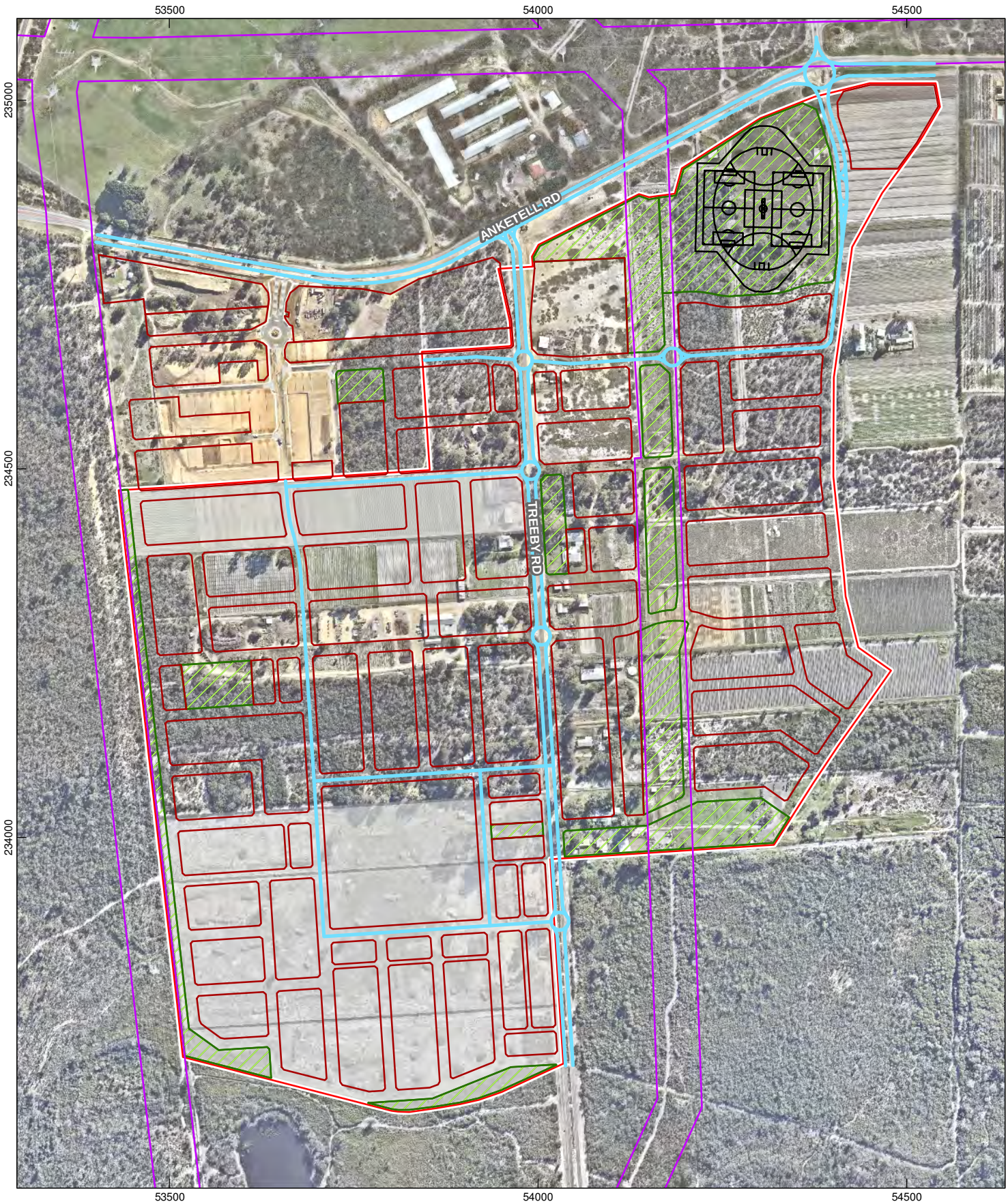

Figure 2: Anketell North Structure Plan Amendment

N

Scale 1:7,000 at A4

0 100 200 m

Coordinate System:
GDA 1994 Perth Coastal Grid 1994

Date: 17/05/2019

Legend

- Existing WAPC subdivision approval
- Western Power easement
- Public open space

Concept plan layout

- Carriageways
- Road reserve
- Sports field alternative

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Data source: Nearmap: Aerial image, flown 06/2018. Client: Acumen Development Solutions. Development layout and existing cadastre, 12/2018. Created by: c.thatcher

2. Environmental legislation, policies and guidelines

2.1 Federal

2.1.1 Environment Protection Biodiversity and Conservation Act

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) is administered by the Department of the Environment and Energy (DEE). The EPBC Act aims to protect and manage nine Matters of National Environmental Significance (MNES) throughout Australia including:

- World Heritage Properties
- National Heritage Places
- wetlands of international importance (listed under the Ramsar Convention)
- listed threatened species and ecological communities
- migratory species protected under international agreements
- Commonwealth Marine Areas
- the Great Barrier Reef Marine Park
- nuclear actions (including uranium mines).

Potential MNES applicable for the site is listed threatened species and ecological communities:

- Potential Banksia Woodlands of the Swan Coastal Plain (Banksia woodland) Threatened Ecological Community (TEC)
- Black Cockatoo foraging habitat and potential breeding trees.

Under the EPBC Act an action that could be a significant impact on any MNES in accordance with the Significant Impact Guidelines 1.1-Matters of National Significance (Department of the Environment, Water, Heritage and the Arts, 2013) should be referred to the DEE for assessment by the minister.

The referral decision (EPBC 2018/8145-10 April 2018) was not a controlled action.

2.1.2 Policy, recovery plans and conservation advice

The recovery plans and conservation advice relevant to the structure plan (SP) include the following (Table 1).

Table 1: Federal policies and guidance

Policy, recovery plan/advice	Description/Objective	Regulatory authority	Relevance
Conservation advice for the Banksia Woodlands of the Swan Coastal Plain ecological community (2016)	To mitigate the risk of extinction of the Banksia Woodlands of the Swan Coastal Plain ecological community, and help recover its biodiversity and function.	DEE, OEPA, DBCA, Department of Water and Environmental Regulation (DWER) CoK	Removal and protection/restore TEC.
Carnaby's Cockatoo (Calyptorhynchus latirostris) Recovery Plan (2013)	To stop further decline in the distribution and abundance of Carnaby's cockatoo by protecting the birds throughout their life stages and enhancing habitat critical for survival throughout their breeding and non-breeding range, ensuring that the reproductive capacity of the species remains stable or increases.	DEE, OEPA, DBCA and DWER CoK	Removal of significant fauna habitat.

Policy, recovery plan/advice	Description/Objective	Regulatory authority	Relevance
Forest Black Cockatoo (Baudin's Cockatoo Calyptorhynchus baudinii and Forest Red-tailed Black Cockatoo (Calyptorhynchus banksii naso) Recovery Plan (2008)	To stop further decline in the breeding populations of Baudin's Cockatoo and the Forest Red-tailed Black Cockatoo and to ensure their persistence throughout their range in the south-west of Western Australia.	DEE, OEPA, DBCA and DWER CoK	Removal of significant fauna habitat.
Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy (2012)	To compensate for the residual adverse impacts of an action on the environment.	DEE, CoK	

The application of management measures and recommendations as specified within the above are discussed in Section 4.

2.2 State

Applicable legislation includes *Environmental Protection Act 1986,* the *Planning and Development Act 2005* (PD Act) *and Planning and Development (Local Planning Schemes) Regulations 2015* (PD Regulations). Under the PD Regulations the City must seek comments in regard to proposed SP from any public authority or service provider that the City considers appropriate.

Other legislation relevant to the management of the SP are outlined in Table 2.

Table 2: Other relevant legislation

Legislation	Description	Regulatory authority	Relevance
Aboriginal Heritage Act 1972	Protection of amendment sites of Aboriginal heritage significance, both known and as yet unknown.	Department of Planning, Lands and Heritage (DPLH)	Disturbance to Aboriginal sites.
Bush Fires Act 1954	Minimising dangers resulting from bush fires, and the prevention, control and extinguishment of bush fires.	Department of Fire and Emergency Services (DFES) CoK	Fire management.
Conservation and Land Management Act 1984	Preservation and conservation of flora and fauna.	Department of Biodiversity, Conservation and Attractions (DBCA)	Removal of threatened flora or TECs/priority ecological communities (PECs).
Contaminated Sites Act 2003	Regulation of matters relating to the identification, assessment, recording, management and clean-up of contaminated land.	Department of Water and Environmental Regulation (DWER)	Contamination (Market garden/hobby farm), acid sulfate soils.
Rights in Water and Irrigation Act 1914	Protection and licensing of water resources.	DWER	Development within the Perth Groundwater Area.
Wildlife Conservation Act 1950 (WA) Note: This Act will eventually be replaced by the Biodiversity Conservation Act 2016	Conservation and protection of wildlife (flora and fauna). Special provisions and schedules apply to the protection and management of gazetted rare flora and fauna.	DBCA	Removal of threatened flora or TECs/PECs and fauna.

In addition to the above legislation, there are several policy and guidance documents which relate to specific environmental factors that are relevant to the development of the SP area.

Table 3: Policies and guidance statements

Statement No.	Title	Application	Relevance to project
Policy			
Peel-Harvey EPP	Environmental Protection (Peel Inlet – Harvey Estuary) Policy 1992	Environmental quality objectives for the Estuary catchment which id achieved will rehabilitate the estuary and protect it from further degradation	Water quality- phosphorus inputs and export within the catchment area
Guidance Statements			
33	Environmental Guidance for Planning and Development.	Provides guidance on the environmental protection process in respect of the land use planning and development process.	Land use planning.
Technical Guidance/guidelines			
Technical Guidance	Flora and vegetation surveys for Environmental Impact Assessment (EPA, 2016).	Provides guidance on the assessment on the biodiversity implications of vegetation clearing.	Clearing of vegetation, or impact to threatened vegetation or flora species.
Technical Guidance	Sampling methods for terrestrial vertebrate fauna (EPA, 2010).	Provides guidance on the assessment on the biodiversity implications of vegetation clearing on fauna habitat.	Clearing of vegetation, or impact to threatened fauna species.
Technical Guidance	Terrestrial fauna surveys (EPA, 2004).	Provides direction and information on general standards and protocols for terrestrial fauna surveys for environmental impact assessment.	Clearing of vegetation, or impact to threatened fauna species.
Policies			
State Planning Policy 2	Environment and Natural Resources Policy (WAPC 2003).	Provides guidance on planning developments to conserve the natural environment.	Environmental management.
State Planning Policy 2.1	Peel-Harvey Coastal Plain Catchment (WAPC 2003)	Ensures that land use changes within the Peel-Harvey estuarine system likely to cause environmental damage	Considered when the site rezoned from Rural to Urban Deferred (February 2006) and when deferment lifted on December 2009 (360 Environmental, 2010).
State Planning Policy 2.8	Bushland Policy for the Perth Metropolitan Region (WAPC 2010).	Provides guidance to ensure bushland protection in the Perth Metropolitan Region in the respect of land use planning.	Clearing of vegetation within Bush Forever sites and Local Natural Areas.
State Planning Policy 2.9	Water Resources (WAPC 2006).	Provides guidance on how to protect, conserve, enhance and manage sustainable use of water resources of environmental value.	Impact on hydrological regime Urban water management.

2.3 Local

The following local government policies, may be applicable to the SP area.

Table 4: Local Planning Policy and guidelines

Policy No.	Title	Application	Relevance to project
1	Landscape Feature and Tree Retention (2016)	This policy applies to all land within the City of Kwinana (City) Town Planning Schemes No. 2 and 3 (TPS 2 and TPS 3) and is to be implemented during the preparation and assessment of: a) District structure plans b) Local structure plans c) Local development plans d) Subdivision applications for 10 lots or more (where there is no adopted structure plan or where the adopted structure plan was approved prior to the commencement of this policy); e) Subdivision applications in areas of Landscape Protection as designated by TPS 2 f) Development applications on sites 1 hectare or greater.	City of Kwinana (2016:1) states that "*This policy is not intended to be applied retrospectively in areas where local structure plans and subdivisions have been approved prior to the adoption of the policy*". There is an existing approved SP for the area and this application is to amend Public Open Space location and Treeby road realignment. It is on this basis that due regard has been given to LPP No. 1 however, its application is not applicable.

3. Existing Environment

3.1 Topography, geology and soils

3.1.1 Topography

The natural topography of the site ranges from approximately 41mAHD in the northern section to approximately 20mAHD in the south west section.

3.1.2 Geology

The site is within the Bassendean Dune System which typically consists of low hills of quartz sand with sandy swamps in dune depressions (Gozzard, 2007). Regional environmental geology mapping indicates that the site consists of the following units:

- S7: Sand - pale yellowish brown, medium to coarse-grained sub-angular quartz, trace of feldspar, moderately sorted, of residual origin
- S8: Sand- vey light grey at the surface, yellow at depth, fine to medium-grained sub-rounded quartz moderately sorted of eolian origin.
- MS5: Sandy silt- dark brownish grey silt with disseminated fine-grained quartz sand, firm variable clay content (Gozzard 1983) (Figure 3).

There are several soil units within the site mapped and described by the Department of Agriculture and Food Western Australia (DAFWA) as:

- Spearwood 211Sp__S2a Moderately deep to deep siliceous yellow-brown sands or pale sands with yellow-brown subsoils.
- Bassendean 212Bs__B6: Deep or very deep grey siliceous sands
- Bassendean 212Bs__B2: Deep bleached grey sands with a pale yellow B horizon or a weak iron-organic hardpan 1-2 m.
- Bassendean 212Bs__B1: Deep bleached grey sands sometimes with a pale yellow B horizon or a weak iron-organic hardpan at depths generally greater than 2 m.
- Bassendean 212Bs__B3: Moderately deep, bleached sands with an iron-organic pan, or clay subsoil. Surfaces are dark grey sand or sandy loam (Figure 4).

3.1.3 Acid Sulfate Soil Risk

A search of the Swan Coastal Plain Acid Sulfate Soil (ASS) regional risk mapping (DWER 2018) indicates that a significant portion of the SP area has a no known ASS with a Moderate to Low ASS disturbance risk (<3m from surface) (Class 2) in the north-eastern section, refer to Figure 5.

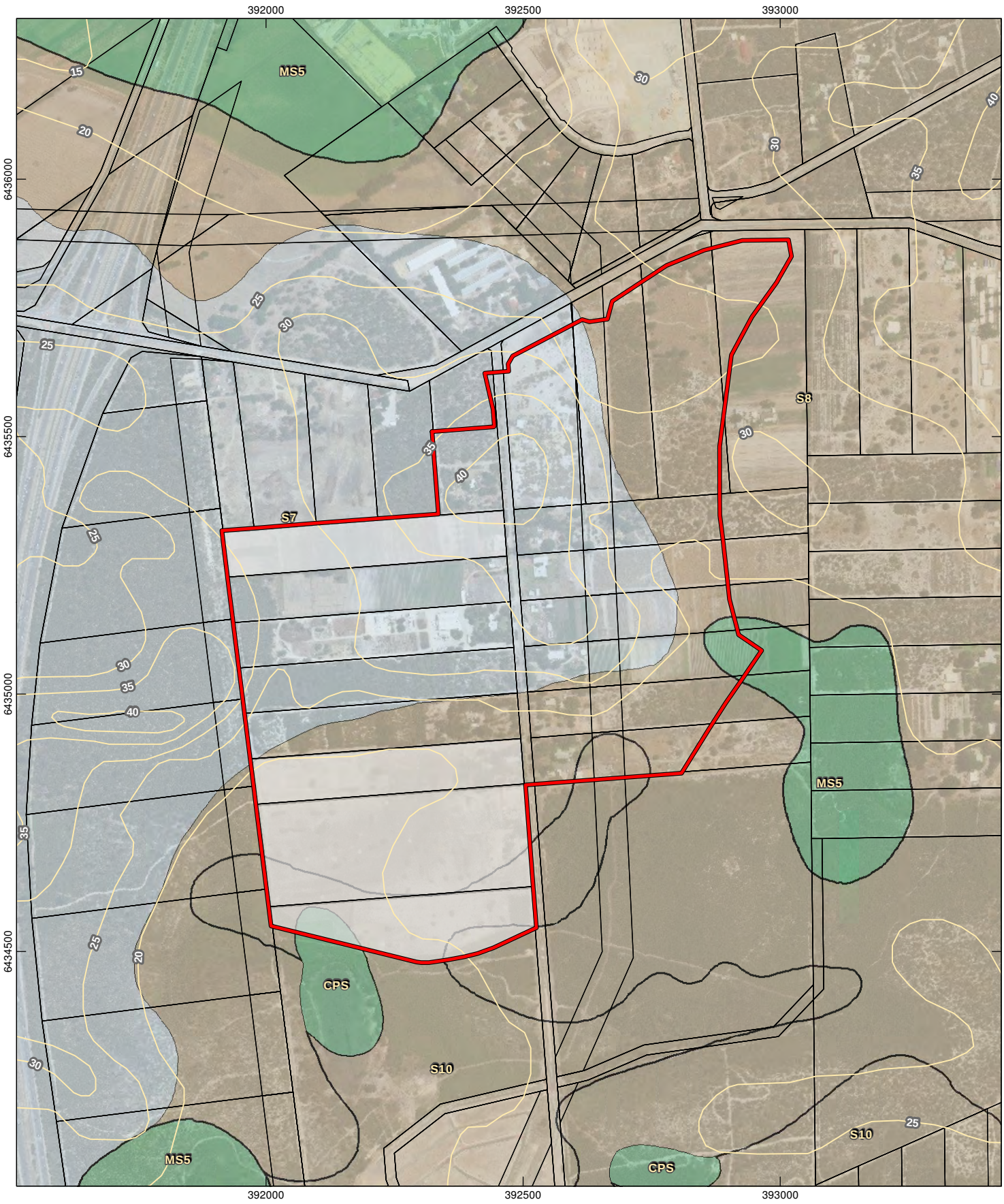

Figure 3: Topography and Geology

N

Scale 1:10,000 at A4

0 100 200 m

Coordinate System:
GDA 1994 MGA Zone 50

Date: 30/11/2018

Legend

- Application boundary
- Existing WAPC subdivision approval
- Cadastral boundaries
- Topographic contours (m)

Surface Geology (50k DMP)

- Cps
- Ms5
- S7
- S8
- S10

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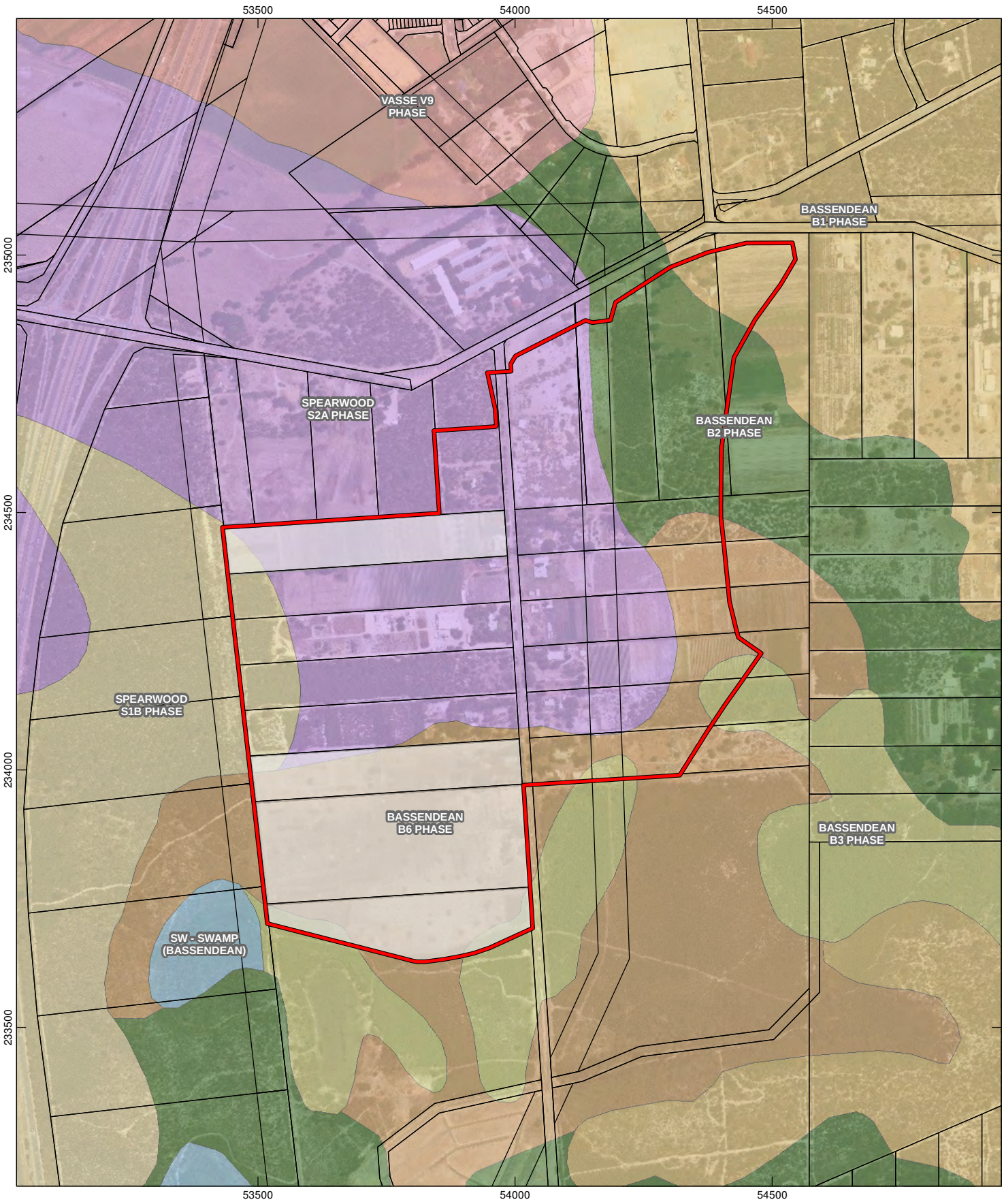

Figure 4: Soil Units

N

Scale 1:10,000 at A4

0 100 200 m

Coordinate System:
GDA 1994 Perth Coastal Grid 1994

Date: 6/11/2018

Legend

- Application boundary
- Existing WAPC subdivision approval
- Cadastral boundaries

Soil Landscape Mapping (DAFWA)

- Bassendean B1 Phase, 212Bs__B1
- Bassendean B2 Phase, 212Bs__B2
- Bassendean B3 Phase, 212Bs__B3
- Bassendean B6 Phase, 212Bs__B6
- Spearwood S1b Phase, 211Sp__S1b
- Spearwood S2a Phase, 211Sp__S2a
- Sw - Swamp (Bassendean), 212BsW_SWAMP
- Vasse V9 Phase, 211Va__V9

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Figure 5: Acid sulfate soil risk

N

Scale 1:7,000 at A4

0 100 200 m

Coordinate System:
GDA 1994 MGA Zone 50

Date: 29/11/2018

Legend

- Application boundary
- Existing WAPC subdivision approval
- Cadastre

Acid sulfate soil

- High to moderate risk
- Moderate to low risk
- Roads

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Service Layer Credits: .
Landgate: Cadastre, 11/2017. Client: Acumen Development Solutions . Development layout, 08/2018. Created by: c.thatcher

3.2 Hydrology

3.2.1 Overview

Underlying the LSP area, three aquifers are present which lie within the name of the major geological unit in which the aquifer occurs (DWER 2017). In descending order of depth from natural surface they are:

- Superficial Aquifer (unconfined)-Allocation available
- Leederville Aquifer (confined)- Limited information
- Yarragadee North (confined)- Limited information.

Regional groundwater contours (historical average maximum) indicated that the groundwater flow generally in a west to south west direction and ranges from approximately 30 mAHD to 15 mAHD. The depth of groundwater ranges across the from approximately 20.5 m below ground level (mbgl) to 5.8 mbgl across the site (Figure 6).

3.2.2 Groundwater availability

Table 5 below detail the groundwater licences within the site.

Table 5: Groundwater licences and allocation

Licence No.	Lot No./ Applicant	Expiry	Allocation (Perth-Superficial Swan)
55440	Lot 2 and 3 Anketell Rd /Sanctum Holdings Pty Ltd	14/06/2028	3,400KL
48225	677 Lyon Road/ Lot 90 on diagram 92984, Volume 2134 Folio 248, 768 Anketell Road	23/02/2024	120,650KL
180329	Lot 30 Treeby/ Gucce Holdings Pty Ltd	19/12/2024	68,000KL
101078	Lot 32 Treeby/ Fiore, Frank	06/06/2026	10,350KL
48228	Lot 34 Treeby/ Glenbrook Civil Engineering Contractors Pty Ltd	05/05/2026	19,950KL
160839	Lot 100 Treeby Rd/ Well Holdings Pty Ltd	27/11/2026	8,000 KL
160331	Lot 38 Treeby /Su, Chiou Yueh Lin, Su, Fan Jyh; Su, Kuo Hoa	01/03/2026	30,000KL
179454	Lot 39 Treeby/ Spring Park Pty Ltd	10/12/2024	61,150KL
58529	Lot 41 Treeby/ Alanna Joy Comley, Comley, Kenneth John	19/02/2027	9,200KL

3.2.3 Surface water and wetlands

The site is located within the Peel-Harvey Coastal Catchment, the Peel subdrain is located approximately 270 m south of southern boundary of the site (part Lot 13 Treeby Road).

There are no Ramsar wetlands or Directory of Important Wetlands on the site (DEE, 2018). The nearest Directory of Important Wetlands site is located approximately 1.2 km to the west of the site and is known as “Spectacles Swamp”.

Regional geomorphic mapping indicates that there is a Conservation Category Wetland (CCW) (sumpland; UFI 15290 and 14148) which occurs across the southern section of the site (Figure 6). Currently, WAPC subdivision approval exists for Lots 35, 100 and part Lot 13 Treeby Road, therefore, the CCW mapping within these lots are no longer applicable. The CCW (UFI 13506) boundary is located along the southern boundary of Lot 41 Treeby Road.

Advice from the Environmental Protection Agency (EPA) states that all CCWs be protected and that an appropriate buffer of 50 m be applied to separate development activities from the CCW. Lots 35 and 100 already have sub division approval and therefore, CCW buffer requirements are extinguished across these Lots. POS has been applied along the southern boundary of Lot 41 within the LPS (Figure 2), which adequately applies the 50 m buffer requirements for the CCW; section 4 discusses this further.

The site is adjacent to the Jandakot Public Drinking Water Source Area (PDWSA) Priority 2 zone (Figure 6). The Department of Water (DoW) (2016:3) defines the following Priority zones as:

- P2- managed to maintain or improve the quality of the drinking water source with the objective of risk minimisation. P2 areas occur within PDWSAs where the land is zoned rural and the risks need to be minimised.

A PDWSA does not occur within the site.

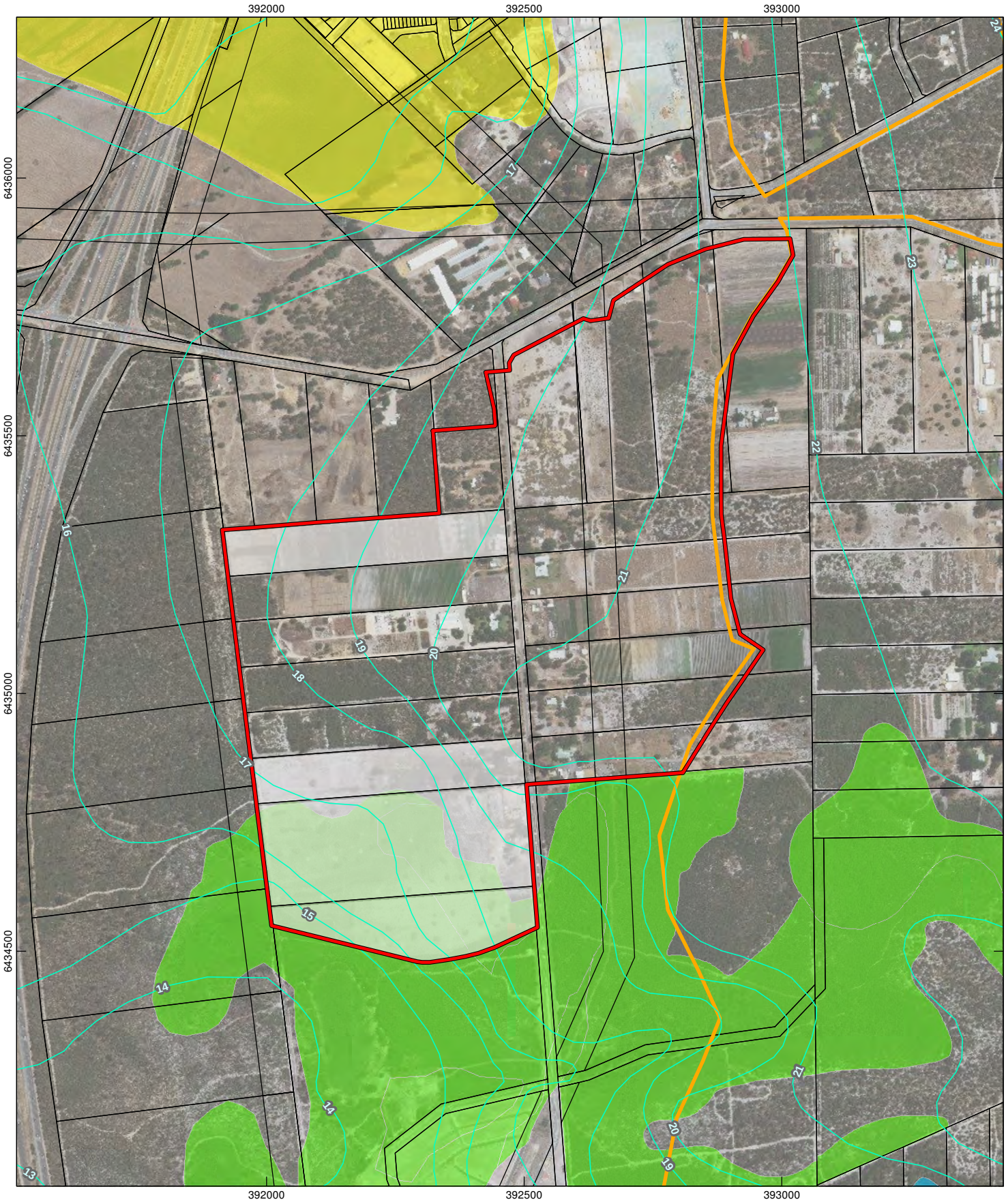

Figure 6: Hydrology

N

Scale 1:10,000 at A4

0 100 200 m

Coordinate System:
GDA 1994 MGA Zone 50

Date: 29/11/2018

Legend

- Application boundary
- Existing WAPC subdivision approval
- Cadastral boundaries

Public Drinking Water Source Areas
- P2

- Groundwater contours (max)

Geomorphic Wetlands (DBCA)
- Conservation
- Resource Enhancement
- Multiple Use
- Not Applicable

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3.3 Vegetation and flora

3.3.1 Vegetation

Regional vegetation association mapping (Beard, 1981) identified one association mapped as occurring within the site:

- 1001 Medium very sparse woodland; jarrah, with low woodland; banksia and casuarina.

WALGA (2018) reports that <10% of this association is remaining with the IBRA region (SCP Perth-SWA02) region and approximately 30-40%remaining within the CoK.

Board scale vegetation mapping indicates one vegetation complex to occur within the site:

- Bassendean Complex Central South.

Bassendean Complex Central South is characterised by woodland of jarrah-sheoak-banksia on the sand dunes, to a low woodland of *Melaleuca spp*., and sedgelands on the low-lying depressions and swamps. It includes the transition area of jarrah and pricklybark in the vicinity of Perth. *B. attenuata, B. grandis* and *B. menziesii* are common on the upper slopes; with *B. menziesii* decreasing southwards as it reaches the southern limit of its range near Mandurah. *B. ilicifolia, B. littoralis and M. preissiana* are common on the low-lying moister soils, where marri replaces jarrah in dominance. Other plant species include *Kunzea vestita, Hypocalymma angustifolium, Adenanthos obovatus* and Verticordia spp. (Heddle et al. 1986). Approximately 26% of the complex is estimated to remain compared to the pre-European extent (DBCA, 2017).

Historically a significant portion of the site has been progressively cleared, to support market garden horticulture activities, as a result, several small pockets of remnant vegetation occurs across several lots. Areas of remnant vegetation within the site has been identified as Local Natural Areas (LNA). LNA are part of the Perth Biodiversity Project to identify areas for land holders to prioritise retention during development considerations. Upon completion of the sub development stage, remaining LNA usually become the responsibility of the Local Government management (Del Marco et al. 2004). The LNA mapped by WALGA (2018) within the SP area are shown in Figure 7.

Bush forever (BF) site 270 occurs directly adjacent to the site (Figure 7). BF 270 is defined as an ESA and recognised as a regional ecological linkage as it forms connection with the Anketell and the Jandakot Regional Park.

According to Del Marco et al. (2004) the importance of ecological linkage is to connect natural areas, preferably with continuous corridors of native vegetation, which assists in fauna movement between the areas and to access resources and habitats. The protection, management and buffering of existing natural areas within an ecological linkage is a higher priority than revegetation of cleared portions of the link. Vegetation within the site has been identified within the Perth Regional Ecological Linkage network (Figure 7).

Figure 7: Bush Forever sites, Local Natural areas and ecological linkages

N

Scale 1:10,000 at A4

0 100 200 m

Coordinate System:
GDA 1994 MGA Zone 50

Date: 29/11/2018

Legend

- Application boundary
- Existing WAPC subdivision approval
- Local Natural Areas
- Bush Forever sites

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The DBCA NatureMap (Appendix 1) and Department of Environment and Energy (DEE) EPBC search tool databases were searched with 1km buffers (Appendix 2). The following significance flora species have been recorded within the vicinity of the site due to habit occurring within the area (Table 6).

Table 6: Likelihood of Threatened and Priority Flora species and Threatened Ecological Community occurring within SP area

Species	Conservation status		Habitat	Likelihood of presence within Survey Area
	WC Act	EPBC Act		
Andersonia gracilis (Slender Andersonia)	T	T	Found on seasonally damp, black sandy clay flats near or on the margins of swamps, often on duplex soils supporting low open heath vegetation with species such as *Calothamnus hirsutus*, Verticordia densiflora and *Kunzea recurva* over sedges (DEE, 2018).	**Unlikely** Not recorded within 2010 survey or Bush forever site 270 (WAPC, 2000 and not recorded within the City of Kwinana (FloraBase, 2018). Habitat not present on site- too dry.
Caladenia huegelii (Grand Spider Orchid)	T	E	Mixed woodland of jarrah (*Eucalyptus marginata*), candlestick banksia (*Banksia attenuata*), holly banksia (*B. ilicifolia*) and firewood banksia (*B. menziesii*) with scattered sheoak (*Allocasuarina fraseriana*) and marri (*Corymbia calophylla*) over dense shrubs of blueboy (*Stirlingia latifolia*), Swan River myrtle (*Hypocalymma robustum*), yellow buttercups (*Hibbertia hypericoides*), buttercups (*H. subvaginata*), balga (*Xanthorrhoea preissii*), coastal jugflower (*Adenanthos cuneatus*) and Conostylis species, from just north of Perth to the Busselton area, usually within 20 km of the coast. Throughout its range the species tends to favour areas of dense undergrowth. Soil is usually deep grey-white sand usually associated with the Bassendean sand-dune system (DEC, 2009).	**Unlikely** Not recorded within 2010 survey or Bush forever site 270 (WAPC, 2000).
Cyathochaeta teretifolia	P3	-	Grey sand, sandy clay. Swamps, creek edges (FloraBase, 2018).	**Unlikely** Not recorded within 2010 survey or Bush forever site 270 (WAPC, 2000). Habitat not present on site- too dry
Diuris micrantha	T	V	Brown loamy clay. Winter-wet swamps, in shallow water (FloraBase, 2018).	**Unlikely** Lack of winter wet swamps on site - no mapped geomorphic wetlands. Not recorded within Bush Forever site 270 (WAPC, 2000) Habitat not present on site- potentially too dry
Diuris purdiei	T	E	Grey-black sand, moist. Winter-wet swamps (FloraBase, 2018).	**Unlikely** Lack on winter wet swamps on site - no mapped geomorphic wetlands. Not recorded within 2010 survey or Bush forever site 270 (WAPC, 2000) or within City of Kwinana. Habitat not present on site- potentially too dry

Species	Conservation status		Habitat	Likelihood of presence within Survey Area
	WC Act	EPBC Act		
Dodonaea hackettiana (Hackett's Hopbush)	P4	-	Sand. Outcropping limestone (florabase, 2018)	**Possible** Recorded within Lot 4 Anketell Road (pgv Environmental, 2015), adjacent to SP area.
Drakaea elastica (Glossy-leaved Hammer Orchid)	T	E	White or grey sand. Low-lying situations adjoining winter-wet swamps (florabase, 2018).	**Unlikely** Lack on winter wet swamps on site - no mapped geomorphic wetlands. Not recorded within Bush Forever site 270 (WAPC, 2000)
Drakaea micrantha	T	V	White-grey sand (FloraBase, 2018). Usually found in cleared fire breaks or open sandy patches that have been disturbed, and where competition from other plants has been removed and occurs in infertile grey sands, in Banksia, Jarrah (*Eucalyptus marginata*) and Common Sheoak (*Allocasuarina fraseriana*) woodland or forest (Department of the Environment, Water, Heritage and the Arts 2008)	**Unlikely** Not recorded within 2010 survey or Bush forever site 270 (WAPC, 2000) or within the City of Kwinana area (FloraBase, 2018). Habitat not present on site- potentially too dry
Lepidosperma rostratum	T	E	Peaty sand, clay (FloraBase, 2018) and grows in sandy soil among low heath in a winter wet swamp Department of the Environment, Water, Heritage and the Arts (2008a)	**Unlikely** Not recorded within 2010 survey or Bush forever site 270 (WAPC, 2000) or within the City of Kwinana area (FloraBase, 2018).
Banksia Woodlands of the Swan Coastal Plain TEC	-	E	The Banksia Woodlands ecological community mainly occurs on deep Bassendean and Spearwood sands. The Banksia Woodlands ecological community mainly occurs on deep Bassendean and Spearwood sands	**Present**

3.3.2 Site survey

Previous Surveys

A site survey was completed by Bennett Environmental in Spring 2009 in accordance with EPA (2004) guidance and reported within the original LSP (Rowe Group, 2015). Site mapping was conducted by Bennett Environmental (2010) in which four vegetation units were recorded Across the current LSP area, Map 2 of Appendix 3 illustrates the four vegetation types across the site, these are described below:

- Hh: Low Forest A of *Banksia attenuata*, *Banksia menziesii* and *Allocasuarina fraseriana* over Open Scrub of *Kunzea glabrescens* over Heath B dominated by *Hibbertia hypericoides* in grey sand.
- Af: Open Low Woodland A of *Banksia attenuata and Banksia menziesii* occasionally with *Allocasuarina fraseriana* over Dense Thicket of *Kunzea glabrescens* over Herbs of *Dasypogon bromeliifolius* and *Philotheca spicata* in grey sand.
- Em: Open Tall Woodland of *Eucalyptus marginata subsp marginata* occasionally with scattered trees of *Melaleuca preissiana* over Dense Thicket of *Kunzea glabrescens* in grey sand.
- Bi: Low Woodland A of *Banksia attenuata, Banksia ilicifolia* and *Nuytsia floribunda* over Thicket of *Kunzea glabrescens* and *Melaleuca thymoides* over Low Heath D dominated by *Scholtzia uberiflora and Aotus procumbens* on a slight rise in grey sand with scattered limestone (360 Environmental, 2010) (Appendix 3).

Due to the level of disturbance on site, a significant portion of vegetation was recorded in Degraded to Completely Degraded condition. Pockets of remnant vegetation (particularly in Lots 33 and 34) were in Very Good to Good condition (Appendix 3).

Bennett Environmental (2010) reported that a Level 3 PEC (Low lying *Banksia attenuata* woodlands or shrublands) was confirmed as occurring on the site through a PATN analysis undertaken on the results of the flora and vegetation data collected.

During the survey conducted by Bennett Environmental (2010) a total of 58 vascular plant families, 125 genera and 167 taxa across the site. No Threatened flora species were recorded as occurring on the site. *Jacksonia gracillima*, a Priority 3 Flora species, was recorded outside of the LSP site within the Bush forever site No. 270 (Bennett Environmental 2009) and approximately 20 plants were recorded from each location. 360 Environmental (2010) reports that a DRF had previously been recorded within Lot 35, an extensive search was undertaken but was unable to locate this species; currently, Lot 35 has WAPC subdivision approval.

Updated survey

Further to the 2010 survey undertaken by Bennett Environmental, Strategen completed a supplementary reconnaissance survey for the site with a focus on Lots 36 and 40 Treeby Road (Strategen 2018a); at the time of survey, access to Lot 7 and 89 Anketell Road was not permitted/granted. The outcome of the reconnaissance flora assessment of Lot 36 and Lot 40 is discussed below and presented in Figure 8 and Figure 9.

Flora

A total of 30 native vascular taxa from 15 plant families were recorded within the site (Table 7), the dominant plant families were Myrtaceae (six taxa) and Proteaceae (six taxa).

Table 7: Native plant taxa recorded in the site

Family	Species
Asparagaceae	*Sowerbaea laxiflora*
Azioaceae	*Carpobrotus edulis*
Campanulaceae	*Lobelia sp.*
Casuarinaceae	*Allocasuarina fraseriana*
Colchicaceae	*Burchardia congesta*
Cyperaceae	*Mesomelaena pseudostygia*
Dilleniaceae	*Hibbertia hypericoides*
Ericaceae	*Conostephium pendulum*
Fabaceae	*Acacia saligna*
	Bossiaea eriocarpa
	Hardenbergia comptoniana
	Jacksonia furcellata
	Jacksonia sternbergiana
Haemodoraceae	*Conostylis aculeata*
	Dianella revoluta
Loranthaceae	*Nuytsia floribunda*
Myrtaceae	*Agonis flexuosa*
	Chamelaucium unicatum
	Eucalyptus gomphocephala
	Eucalyptus marginata
	Hypocalymma robustum
	Kunzea glabrescens
Proteaceae	*Adenanthos cygnorum*
	Banksia attenuata
	Banksia ilicifolia
	Banksia menziesii

Family	Species
	Petrophile linearis
	Stirlingia latifolia
Xanthorrhoeaceae	*Xanthorrhoea preissii*
Zamiaceae	*Macrozamia riedlei*

A total of 15 introduced flora taxa were recorded in the site, as follows:

- *Arctotheca calendula* (Cape Weed)
- *Avena barbata* (Wild Oats)
- **Briza maxima* (Blowfly Grass)
- *Carpobrotus edulis* (Pigface)
- **Ehrharta calycina* (Perennial Veldt Grass)
- **Ehrharta longiflora* (Annual Veldt Grass)
- **Eragrostis curvula* (African Lovegrass)
- **Euphorbia terracina* (Geraldton Carnation Weed)
- **Freesia alba* x *Leichtlinii* (Freesia)
- **Fumaria capreolata* (Fumitory)
- **Gladiolus caryohyllaceus* (Pink Gladiolus)
- **Hypochaeris glabra* (Smooth Cat's Ear)
- **Lupinus angustifolius* (Narrowleaf Lupin)
- **Oxalis pes-caprae* (Soursob)
- **Ursinia anthemoides* (Ursinia)

Vegetation

A total of six vegetation types comprising native vegetation were recorded in Lots 36 and 40 (Figure 8), which included:

- EmBa: Open forest of *Eucalyptus marginata* over low open woodland of *Banksia attenuata, Banksia menziesii* and *Allocasuarina fraseriana* over shrubland of *Xanthorrhoea preissii* and *Jacksonia sternbergiana* over low shrubland of *Bossiaea eriocarpa* and *Conestephium pendulum* over *Mesomelaeana pseudostygia* herbland/grassland on sandy soils (0.37 ha).
- AcNf: Tall shrubland of *Adenanthos cygnorum* with occasional *Nuytsia floribunda* over a weedy grassland on sandy soils (1.26 ha).
- KgXp: Thicket of *Kunzea glabrescens* and *Xanthorrhoea preissii* over mixed weeds on sandy soils (0.3 ha).
- EmKg: Isolated trees of *Banksia menziesii* over mixed weeds on sandy soils (1.16 ha).
- Eg: Scattered trees of *Eucalyptus gomphocephala* and *Agonis flexuosa* over grassy weeds on sandy soils (1.13 ha)
- Bm: Isolated trees of *Banksia menziesii* over mixed weeds on sandy soils (0.23 ha).

A vegetation assessment consulted be Strategen concluded there are no state listed TECs or PECs within the site; however, federally listed Banksia woodlands TEC is present within the site, further discussion is available below in section 3.3.3.

Vegetation condition ranged from Very Good to Completely Degraded with the majority of Lots 36 and 40 in Completely Degraded condition (3.91 ha) (Figure 9). Past and current land uses, including historical clearing and housing along with the dominance of weeds have contributed to overall vegetation condition, and caused significant fragmentation of the vegetation. Firebreaks and informal tracks have also impacted the vegetation. Non-endemic and planted vegetation was also present at the site.

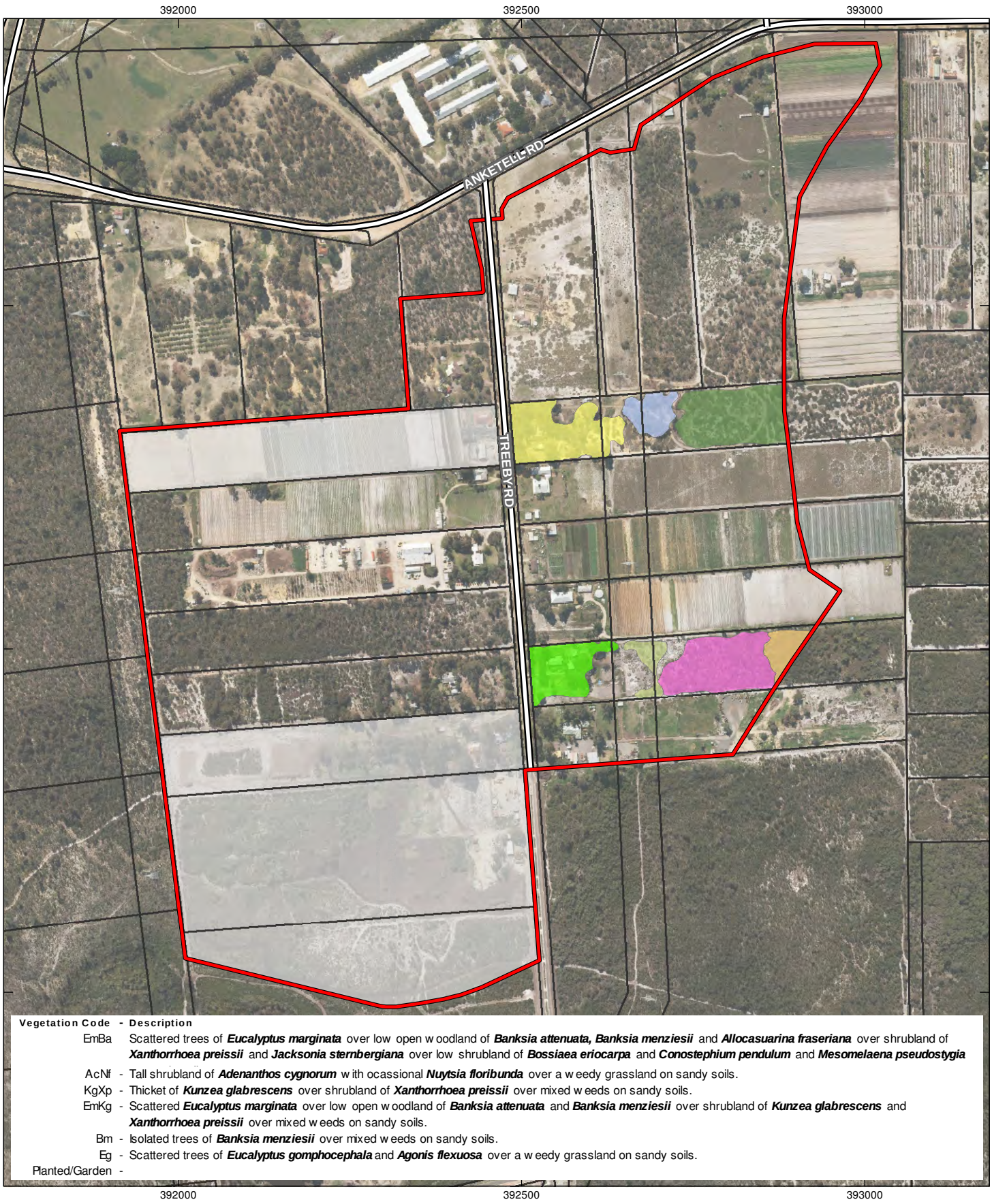

Figure 8: Vegetation types

N

Scale 1:7,500 at A4

0 100 200 m

Coordinate System:
GDA 1994 MGA Zone 50

Legend

- Application boundary
- Existing WAPC subdivision approval
- Cadastre
- Roads

Vegetation type

- AcNf
- BM
- Eg
- EmBa
- EmKg
- KgXp
- Planted garden

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Figure 9: Vegetation condition

N

Scale 1:7,000 at A4

0 100 200 m

Coordinate System:
GDA 1994 MGA Zone 50

Date: 29/11/2018

Legend

- Application boundary
- Existing WAPC subdivision approval
- Cadastre
- Roads

Vegetation condition

- Very good - good
- Good
- Good to degraded
- Degraded
- Completely degraded

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3.3.3 Banksia Woodland TEC

Overview

In 2016, Banksia Woodlands of the SCP (Banksia woodlands) were listed as a TEC under the EPBC Act with a conservation advice issued for reference which identifies key diagnostic characteristics to determine whether the remnant vegetation on site is considered to be the Banksia woodlands TEC. Four vegetation types delineated by Bennett Environmental (2009) are likely to align with the Banksia woodlands TEC (Hh, Bi, and Af) based on vegetation quadrat data sampled within these vegetation types.

The Banksia woodland in vegetation types Hh, Bi and Af within Lots 31, 32, 33, 34 and 188 are considered to be representative of FCT 28 which has a Low Risk conservation status (Gibson et al. 1994). This community is not listed as a state Priority Ecological Community, however it represents the federally listed Banksia Woodland TEC.

Site Assessment

The supplementary reconnaissance survey conducted by Strategen, identified two additional vegetation types, EmBa and EmKg which comprise Banksia woodland ranging from Good to Very Good condition in Lots 36 and 40.

The WALGA (2018) environmental tool indicates that Banksia woodlands TEC is likely to occur within the site. Vegetation (which was available to access) within the site was assessed against the key diagnostic criteria for the Banksia woodlands TEC (TSSC 2016). Remnant vegetation (Hh, Af, EmBa and EmKg) within the site, meet the diagnostic criteria provided in the approved conservation advice for the Banksia woodlands TEC.

Banksia Woodland was identified as occurring in Lot 188 by Bennett Environmental (2010) and was mapped as vegetation type 'Hh' in Very Good – Good condition. While access to this Lot was not granted for the Strategen (2018) survey, observations from current aerial imagery and additional observations made from the roadside, indicate that the condition of the vegetation may have significantly declined since the 2009 survey. Vegetation condition appears to now potentially range from Good to Completely Degraded within Lot 188 and as a result it has been mapped as 'Potential Banksia Woodland TEC' (Figure 10) based on the data and mapping from Bennett Environmental (2009).

Access was also not permitted for Lot 34 in the Strategen (2018) survey, and therefore, vegetation within Lot 34 has been mapped as 'Potential Banksia Woodland TEC' (Figure 10) based on mapping and data collected from Bennett Environmental (2009).

The key diagnostic characteristics that classify the Banksia woodlands TEC provided in Table 8 is based on the data provided in Bennett Environmental (2009) (Appendix 3) and Strategen (2018) supplementary reconnaissance survey.

Table 8: Characteristics of the Banksia woodland within the SP area compared to the key diagnostic criteria as per TSSC (2016)

Key diagnostic criteria (TSSC 2016)	Banksia woodlands within the SP area
Location: Occurs in the Swan Coastal Plain or Jarrah Forest IBRA bioregions.	Yes. Banksia woodlands within the site occur on the Swan Coastal Plain.
Soils and landform: Occurs on: • well drained, low nutrient soils on sandplain landforms, particularly deep Bassendean and Spearwood sands and occasionally on Quindalup sands • sandy colluviums and aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau • transitional substrates and sandflats.	Yes. site is located within the Bassendean Dune System and consists of Spearwood/Bassendean soil types. Refer to Section 3.1.

Key diagnostic criteria (TSSC 2016)	Banksia woodlands within the SP area
Structure: Low woodland to forest with: • a distinctive upper sclerophyllous layer of low trees (occasionally large shrubs more than 2 m tall), typically dominated or co-dominated by one or more of the banksia species identified below • emergent trees of medium or tall (>10 m) height. *Eucalyptus* or *Allocasuarina* species may sometimes be present above the banksia canopy • an often highly species-rich understorey.	Yes. Vegetation Units consist of: • Hh: Low Forest A of *Banksia attenuata, Banksia menziesii* and *Allocasuarina fraseriana* over Open Scrub of *Kunzea glabrescens* over Heath dominated by *Hibbertia hypericoides* in grey sand. • Af: Open Low Woodland A of *Banksia attenuata* and *Banksia menziesii* occasionally with *Allocasuarina fraseriana* over Dense Thicket of *Kunzea glabrescens* over Herbs of *Dasypogon bromeliifolius* and *Philotheca spicata* in grey sand (Bennett, 2010). • EmBa: Open forest of *Eucalyptus marginata* over low open woodland of *Banksia attenuata, Banksia menziesii* and *Allocasuarina fraseriana* over shrubland of *Xanthorrhoea preissii* and *Jacksonia sternbergiana* over low shrubland of *Bossiaea eriocarpa* and *Conestephium pendulum* • EmKg: Scattered *Eucalyptus marginata* over low open woodland of *Banksia attenuata* and *Banksia menziesii* over shrubland of *Kunzea glabrescens* and *Xanthorrhoea preissii* over mixed weeds
Composition: Contains at least one of the following species: 1. Banksia attenuata 2. Banksia menziesii 3. Banksia prionotes 4. Banksia ilicifolia.	Yes. Banksia woodlands within the survey area contain *Banksia attenuata, Banksia menziesii* and *Banksia ilicifolia.*
Condition (Keighery 1994): 'Pristine': no minimum patch size 'Excellent': 0.5 ha 'Very Good': 1 ha 'Good': 2 ha.	Yes, based on vegetation condition mapping from Bennett Environmental (2009) and the Strategen (2018), supplementary reconnaissance survey, vegetation containing Banksia woodland ranges from Good to Very Good.

Table 9: Additional Information to characterise the Banksia TEC

Key diagnostic characteristics	Information	Relevant content to be discussed in the referral (refer to DEE 2016)	Response and Discussion
Location and physical environments	Regional distribution and quality	Quantity/quality of vegetation community in, and in the region around, the site where the proposed action will occur (Section 2.2.2)	The site is located adjacent to Bush forever site 270 (Jandakot Regional Park) the following FCT have been recorded within the Bush forever 270: FCT21a, 21c, 22, 23a, 28 (WAPC, 2000).
Patch condition	Condition thresholds	What is the patch condition using the condition categories outlined in Section 2.2.2 Note: A patch could vary in quality over the range of the patch.	Good (Bennett Environmental 2009).

Key diagnostic characteristics	Information	Relevant content to be discussed in the referral (refer to DEE 2016)	Response and Discussion
Patch Size	Patch size in hectares	Is the patch size large enough to meet criteria in Section 2.2.3? Note: Patch boundaries are not limited to the proposal site.	Based on vegetation condition mapping from Bennett Environmental (2009) and Strategen Environmental (2018) confirmed patches of TEC total approximately: • 0.37 ha of Banksia woodland in Good condition in Lot 40 Treeby Road • 6.91 ha of Banksia woodland in Very Good - Good condition in Lot 31, 32, 33 and 40 Treeby Road • 2.019 ha of Banksia woodland vegetation in Very Good condition Lot 188 Anketell Road
	Surrounding buffer	What is the size and vegetation community of the surrounding buffer? (Section 2.2.3) and what is the connectivity to the surrounding vegetation? Note: The assessments of a patch should initially be centred on the area of highest native floristic diversity and/or cover i.e. the best condition area of the patch and one patch could be made up of several subcommunities.	Lots 31-33 Treeby road are adjacent to a Bush forever site and are considered to be within the buffer zone.
Other condition considerations	Presence/absence and spread of Phytophthora cinnamomi (dieback)	If present, how much dieback exists and is the proposed action likely to spread dieback further? (Appendix D5) If not present, can its introduction be prevented?	A formal dieback assessment has not been completed within the LSP area; both Bennett Environmental (2009) and pgv Environmental (2015) report did however suggest that dieback could be present within Lot 35 Treeby Road and Lot 4 Anketell Road due to several Banksia deaths.
	Presence/absence Weeds	Does the patch contain weeds? (Appendix D6) Which species are present and how can they be managed?	Yes, the following weed species were recorded within Lot 33, 36 and 40: • **Arctotheca calendula* • **Avena barbata* • **Briza maxima* • **Briza minor* • **Euphorbia terracina* • **Ehrharta calycina* • **Gladiolus caryophyllaceus* • **Hypochaeris glabra* • **Oxalis pes-caprae* • **Ursinia anthemoides*
	Any other notable disturbance to the site where relevant (i.e. fragmentation, fire regimes, bare patches, erosion, feral animals)	What disturbance is present which may degrade the quality of the community or species? (Appendix D) For any/each form of disturbance, what is the degree of the disturbance? Is there evidence of recruitment of key native plant species following disturbance?	Maintenance of firebreaks, existing tracks, no active management in weed control and uncontrolled access are all notable disturbances to the Banksia woodland in the site.

Key diagnostic characteristics	Information	Relevant content to be discussed in the referral (refer to DEE 2016)	Response and Discussion
	Patch isolation	Is the patch connected to other areas of Banksia Woodland or is it isolated? (Section 2.2)	• Lots 31, 32, 33 Treeby Road- are connected to Banksia Woodland west of the survey area • Lot 188 Anketell Road is connected to Lot Anketell Road which will be retained as a result of this SP amendment
Sub-community and vegetation unit	Broad scale structural unit (Beard vegetation associations)	Provide the best corresponding Beard vegetation association (s) (Appendix C1)	1001 Medium very sparse woodland; jarrah, with low woodland; banksia and casuarina
	Floristic community types (Gibson et al., 1994; Keighery et al., 2008)	Provide the closest resemblance of floristic community type(s) with reference to those discussed in Appendix C2 of the BWSCP Conservation advice (Appendix C2 and Section 1.3.2) Note: there is potential for multiple sub-communities within a patch.	Statistical analysis conducted by Bennett Environmental (2009), comparing site data with the Swan Coastal Plain dataset (Gibson et al. 1994) assigned the following FCTs to the VTs potential containing Banksia woodland: • Hh-FCT28, 21a • Af-FCT21c, 21a, 23a
Surveying	Timing of the surveying	Ideally surveys should be undertaken in spring with two sampling periods to capture early and late flowering species (Section 2.2.2). When was sampling undertaken at the proposed site? Is there any reason why the vegetation community could not be readily identified (e.g. due to recent disturbance such as fire)? Note: Section 2.2.4 of the BWSCP Conservation advice has guidance on timing/protocols for surveys (e.g. after fire).	Both the Bennet Environmental (2009) and Strategen (2018) surveys were undertaken in spring (early November), which is within the optimal survey period for the region. The data collected from the surveys is considered sufficient in determining whether the vegetation in the site is representative of the Banksia woodland TEC, based on key attributes i.e. dominant species.

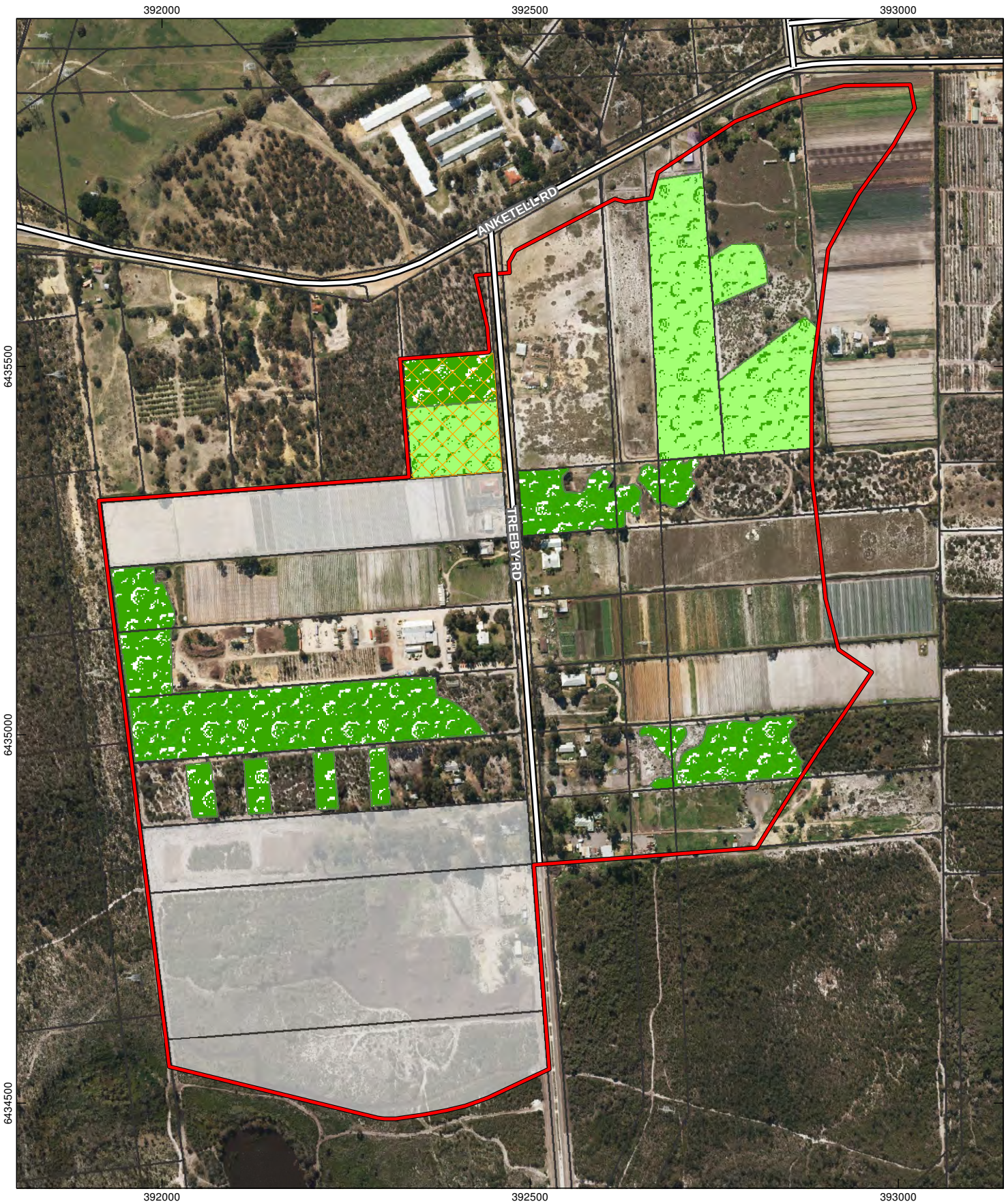

Figure 10: Potential Banksia Woodland SCP TEC

N

Scale 1:7,000 at A4

0 100 200 m

Coordinate System:
GDA 1994 MGA Zone 50

Date: 30/11/2018

Legend

- Application boundary
- Cadastre
- Existing WAPC subdivision approval
- Banksia Woodland TEC
- Potential Banksia Woodland TEC
- Strategen (2018) observation - vegetation condition potentially good to completely degraded and may not meet the criteria for the Banksia Woodland TEC
- Roads

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3.4 Fauna and habitat

Overview

A search was undertaken of the DBCA Naturemap database (DBCA 2018) for the site and a 1 km buffer (Appendix 1) and the DEE Protected Matters Search Tool (DEE 2018) for species protected under the EPBC Act (including 1km buffer) (Appendix 2). The results indicated that some significant species or their habitats are likely to occur in the vicinity of the site. These species and the likelihood of their occurrence is discussed in Table 10.

Table 10: Likelihood of Threatened and Priority Fauna species occurring within SP Area

Species	Conservation status		Habitat	Likelihood of presence within Survey Area
	WC Act	EPBC Act		
Calidris ferruginea (Curlew Sandpiper)	-	CE	It mainly occurs on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They are also recorded inland, though less often, including around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. They occur in both fresh and brackish waters. Occasionally they are recorded around floodwaters (Minister for the Environment, 2015).	**Unlikely**. Preferred habitat not present within the site.
Calyptorhynchus banksii naso (Forest Red-tailed Black-Cockatoo)	V	V	It inhabits the dense *Eucalyptus marginata* (Jarrah), *E. diversicolor* (Karri) and *Corymbia calophylla* (Marri) forests receiving more than 600mm of annual average rainfall.	**Possible to likely**. Foraging habitat present within the site and also within the modelled distribution area by DEE (2016).
Calyptorhynchus latirostris (Carnaby's Cockatoo (short-billed black-cockatoo), Carnaby's Cockatoo)	E	E	Typically occurs in woodlands and scrubs of semiarid interior of Western Australia, in non-breeding season wandering in flocks to coastal areas, especially pine plantations and Banksia woodlands. Food includes the flowers, nectar and seeds of Banksia, Dryandra, Hakea, Eucalyptus, Corymbia, Grevillea, also seeds of Pinus.	**Possible to likely**. foraging habitat present within the site and the site is within the modelled distribution for breeding range for the species (DEE, 2016).
Isoodon obesulus (Southern Brown Bandicoot)	P4	-	Scrubby, often swampy, vegetation with dense cover up to 1 m high, often feeds in adjacent forest and woodland that is burnt on a regular basis and in areas of pasture and cropland lying close to dense cover.	**Possible to likely.** WALGA (2018) mapped habitat within the site and recorded within Bush Forever Site 270 (WAPC, 2000).

Species	Conservation status		Habitat	Likelihood of presence within Survey Area
	WC Act	EPBC Act		
Leipoa ocellate (Malleefowl)		V	Found in some shrublands dominated by acacia, and occasionally in woodlands dominated by eucalypts such as Wandoo E. wandoo, Marri *Corymbia calophylla* and Mallet *E. astringens.*	**Unlikely**. Preferred habitat not present within the site.
Oxyura australis (Blue-billed Duck)	P4		Prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation	**Unlikely**. Preferred habitat (wetlands) not present within the site.
Rostratula australis (Australian Painted Snipe)	E	E	Occurs in shallow freshwater (occasionally brackish) wetlands, both ephemeral and permanent, such as lakes, swamps, claypans, inundated or waterlogged grassland/saltmarsh, dams, rice crops, sewage farms and bore drains, generally with a good cover of grasses, rushes and reeds, low scrub, *Muehlenbeckia* spp. (Minister for the Environment, 2013).	**Unlikely**. Preferred habitat not present within the project area.
Dasyurus geoffroii (Chuditch, Western Quoll)	T	V	Habitats including forest, mallee shrublands, woodland and desert. Chuditch had not been recorded on the Swan Coastal Plain since the 1930s (DEC, 2012).	**Unlikely.** Preferred habitat not present within the site.

Black Cockatoo habitat assessment

Black Cockatoo habitat was assessed during the site assessment for Lots 31, 32, 33, 36 and 40 Treeby Road (Strategen 2018). Any trees meeting the following criteria for potential breeding and foraging habitat were recorded, marked and electronically logged using a handheld Global Positioning System (GPS) unit:

- native trees (e.g. Jarrah, Tuart, Marri)
- diameter at breast height (DBH) > 500 mm (300 mm for Wandoo and Salmon Gum)
- hollows > 120 mm diameter
- evidence of feeding (chewed cones, seed and nut material)
- opportunistic observations of Black Cockatoos in the site.

During the site assessment, no Black Cockatoos were observed or were heard calling.

Foraging Habitat

A total of 9.2 ha of Black Cockatoo foraging habitat was identified at the site (Figure 11); an additional 6.7 ha of vegetation which was not included in the survey due to site access issues was identified as potential Black Cockatoo habitat and will require further investigation prior to subdivision application. The majority of which consisted of Banksia woodland with scattered Jarrah (*Eucalyptus marginata*). The dominant foraging species included *Banksia attenuata, Banksia menziesii,* Sheoak (*Allocasuarina fraseriana*), Jarrah and *Xanthorrhoea preissii* (6.56 ha).

The remaining 1.37 ha of Black Cockatoo foraging habitat consisted of isolated foraging tree species including Tuart and *Banksia menziesii.*

No foraging evidence in the form of chewed nuts were recorded in the site (Strategen 2018).

Breeding Habitat

In total, 27 potential breeding trees were observed within the site, 13 were Tuart (*Eucalyptus gomphocephala*), 10 were Jarrah and two were planted, non-endemic trees, **Corymbia maculata*.

Of the 27 potential breeding trees, two were observed to contain hollows with an estimated opening diameter of less than 120mm and were therefore, not large enough to be suitable for use by Black Cockatoos.

No evidence of breeding was recorded at the site (Strategen 2018).

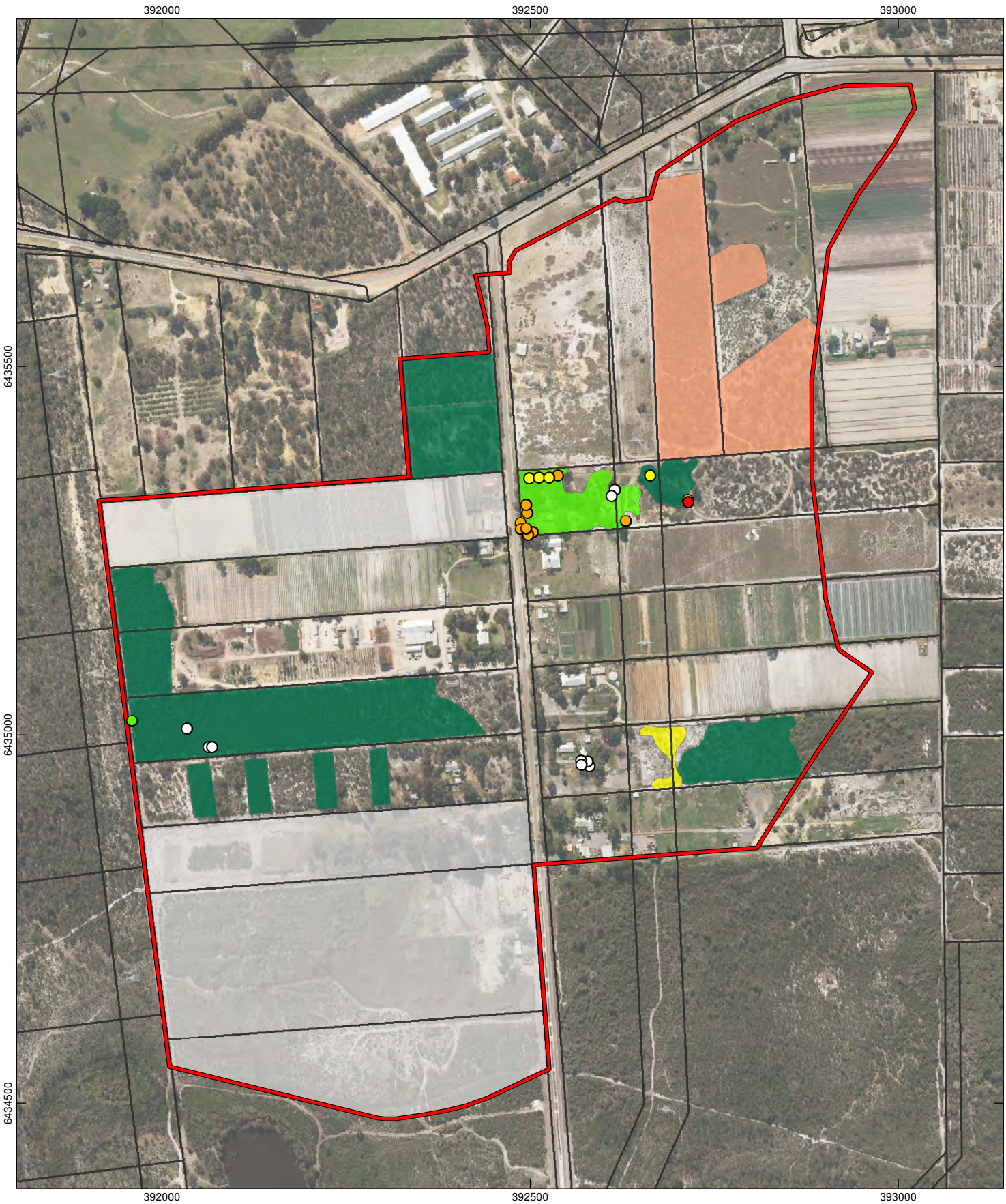

Figure 11: Black cockatoo foraging habitat and potential habitat trees

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3.5 Environmentally sensitive areas

Environmentally Sensitive Areas (ESAs) are areas that have been identified for protection due to their environmental significance as outlined in the Western Australian Environmental Protection (Environmentally Sensitive Areas) Notice 2005, which was gazetted on 8 April 2005.

Exceptions offered for clearing under Regulation 5 of the Environmental Protection (Clearing of Native Vegetation) Regulations 2004 do not apply within ESAs. ESAs are protected under the EP Act, and include the following:

- world Heritage areas
- areas included on the National Estate Register
- defined wetlands and associated buffers
- vegetation within 50 m of a listed Threatened species
- TECs.

ESA mapping surrounds the western and southern boundary of the site, with mapping slightly extending into Lots 35, 100, part 13 and 41 Treeby Road (WALGA, 2017). ESA mapping across this area is to be associated with the known presence of the CCW and BF 270 located adjacent to the site (Figure 12). LSP design has considered the implications of the CCW and BF site to Lot 41 and included POS along the southern boundary to maintain appropriate setback distances. Lots 35, 100 and part of Lot 3 are already the subject of subdivision approval and do not form part of this LPS amendment.

3.6 Heritage

The Department of Planning, Lands and Heritage (2018) Aboriginal Heritage Inquiry System was searched, which identified there are no registered places within or adjacent to the site; additionally, there are no other heritage places within the site. The boundary for Mandogalup Swamp/Spectacles (site ID 3427) resides within a small section of Anketell Road reserve an is known for Mythological, Hunting Place and Water source approximately 870 m to the west.

Additionally, another Other Heritage Place site- Treeby Road Lake (ID 3555) is located approximately 600 m south of the LSP boundary within Bush Forever site 270.

The Heritage Council (2018) InHerit database was searched for registered sites, there are currently no sites within the SP area.

3.7 Bushfire Risk

Based on regional Bush Fire Prone Area Mapping (Department of Fire and Emergency Services 2017) the site is mapped within the designated bushfire prone area. A Bushfire Management Plan (BMP) has been prepared by Strategen (2018a) to address requirements under Policy Measure 6.3 of State Planning Policy 3.7 Planning in Bushfire-Prone Areas (SPP 3.7; WAPC 2015) and Guidelines for Planning in Bushfire-Prone Areas (the Guidelines; WAPC 2017).

The BMP should be read in conjunction with this EAR.

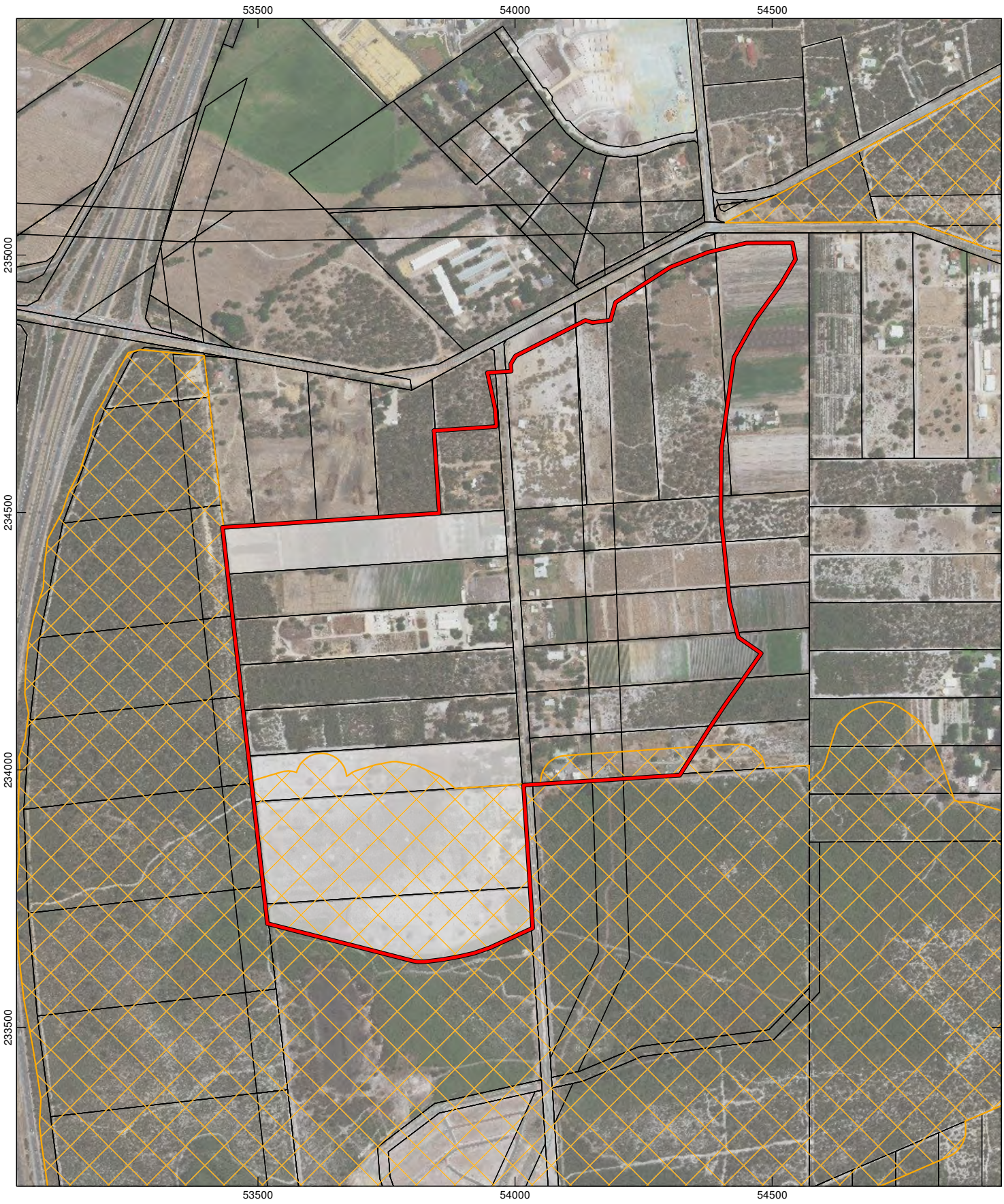

Figure 12: Environmentally Sensitive Areas

N

Scale 1:10,000 at A4

0 100 200 m

Coordinate System:
GDA 1994 Perth Coastal Grid 1994

Date: 29/11/2018

Legend

- Application boundary
- Existing WAPC subdivision approval
- Environmentally sensitive areas
- Cadastral boundaries

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4. Potential impacts and management measures

4.1 Acid Sulfate Soils

As per Section 3.1.3, a high to moderate risk and a moderate to low risk of acid sulfate soils occurring within 3 m from the surface occur within the site. Without careful consideration and appropriate investigations acid sulfate soils may impact the surrounding environment. Prior to the subdivision stage appropriate geotechnical investigations will be conducted across the site to further advise the development of appropriate acid sulfate soil management in consideration of DWER ASS guidelines.

4.2 Hydology

4.2.1 Predicted impacts

Without appropriate consideration and management, the development has the potential to impact upon the pre-development hydrological cycle and water quality, including:

- groundwater recharge and aquifer levels
- surface water characteristics
- export of pollutants such as phosphorus and nitrogen to surface or groundwater
- export of pollution from sewerage.

Development design and construction practices must also take into consideration separation to groundwater to avoid flood damage in developed areas and to prevent erosion of waterways, slopes and banks.

Development of the site will result in a significant increase in runoff volumes and flow rates leaving the site.

4.2.2 Mitigation and management

A Local Water Management Strategy (LWMS) has been developed for the site which has been used to guide the location and size of stormwater retention basins. To ensure the pre-development peak discharges are maintained a number of retention basins have been incorporated into the design to meet the requirements of the one, five and 100 year ARI events.

The environmental assessment identified a CCW along the southern Boundary of Lot 41 Treeby Rd. Impacts to the CCW have been mitigated by the provision of POS within the 50 m buffer; subdivision approval is likely to require the development of a Wetland Management Plan (WMP) which will include measures such as:

- revegetation within the CCW buffer
- weed control
- site water containment

Proposed management strategies listed below, are designed to maintain the high conservation value of the CCW, surrounding Bush Forever site 270 and ecological linkage through the site. Design considerations have included the following:

- delineation of a suitable wetland buffer associated with Treeby Lake in the form of providing POS along the southern boundary of Lot 41
- maintenance of an appropriate cycle of seasonal inundation within the Treeby Road Lake

- providing an extensive network of pedestrian and bike paths to direct the movement of pedestrians and cyclists along constructed tracks and prevent uncontrolled access to sensitive wetland and bush habitats. The alignment of the path will be specifically selected to minimise direct disturbance of wetland habitat, maintain waterbird habitat and to provide viewpoints (while also preventing visual intrusion into areas of high naturalness and scenic value)
- linear biofiltration swales that retain all events <1:1 year recurrence within the swale. Events greater than this will be directed to dampland habitat preferentially to both supplement seasonal flooding of this habitat and promote biofiltration, flood retention and nutrient removal. Discharge from the biofiltration swales will be dissipated via a series of bubble-up pits designed to promote overland flow, as well as minimise scour and erosion
- rehabilitation of any degraded portions of the retained area of CCW
- protection mechanisms between the CCW and the proposed development to ensure the wetland areas are not damaged during or post-construction
- interface treatments such as fencing and signposting between the proposed development and the CCW to prevent inappropriate access and protect against vermin and bushfire
- weed treatment of bushland areas using suitable bio-safe herbicides
- definition of management responsibilities and timeframe/success criteria for handover of future management to Town of Kwinana
- lots will not abut wetland habitats, rather boundary roads, pathways and/or biofiltration swales will provide separation between the buffer and development

A Wetland Management Plan (WMP) is likely to be required to support the development of affected lots at the subdivision stage.

4.2.3 Predicted outcome

LSP design has retained an appropriate buffer from the CCW to ensure adequate separation from the development and the CCW. With the development of the WMP, impacts the CCW can be managed to ensure the CCW retains it high conservation value. Furthermore, sub division approval will result in conditions which ensure development construction protects the conservation value of the CCW and Bush forever 270.

Site drainage has ensured appropriate retention of stormwater for nutrient detention within the site.

4.3 Vegetation and flora

4.3.1 Potential impacts

The LSP has been strategically designed to utilise as much Completely Degraded and cleared land as practicable, development of the site will necessitate the clearing native vegetation ranging from Very Good - Excellent to Completely Degraded. Banksia Woodland TEC has been identified across the site totalling 9.6 ha, which will be impacted by the development of the LPS.

Clearing of native vegetation has the potential to impact upon mapped LNAs and ecological linkages, if not appropriately factored into the development design and future management measures. Bush forever site 270 is a conservation significant area and the design of the proposed development has considered this environmentally significant area.

Clearing practices have the potential to result in the spread of *Phytophthora cinnamomi* (Dieback) to retained vegetation and vegetation in areas adjacent to the site, if not managed appropriately.

Without appropriate construction management procedures, clearing practices may also result in accidental clearing of vegetation and trees proposed for retention.

4.3.2 Mitigation and management

LSP design has focused on retention of the best quality Banksia TEC and vegetation across the site. POS locations across the SP has considered the Black Cockatoo foraging habitat significant trees and TEC locations to maximise the retention of the best quality vegetation and reduce impacts to Black Cockatoos and TECs. Furthermore, POS placement has considered topographical features and some POS have been places on high points in the landscape to increase the visual amenity of the POS across the site.

A Landscape Management Plan will be developed for the site, which will ensure each Lot will be streetscaped with a locally endemic tree to promote ecological connectivity across the LSP and regional area; furthermore, Treeby Road will be constructed with a median strip which will be vegetated with endemic species to further increase ecological connectivity across the site.

A significant tree survey has been conducted across the site and the position of POS within the site has considered the significant trees identified onsite to ensure maximum retention across the site.

The development of the site will result in the clearance of Banksia TEC, at thresholds requiring referral to the Department of Environment and Energy (DEE) for potential significant impacts. All considerations for referrals for potential significant impacts to TECs, will be conducted at the development stage by the landholder in response to site conditions.

Retention of these matters within proposed POS areas will be subject to drainage, landscaping, bushfire and engineering requirements and will be finalised during subsequent planning stages i.e. subdivision.

Dieback controls will be imposed during development which includes the delineation and restriction of access to areas of vegetation planned for retention within the site. dieback control measures will be developed as part of the subdivision approval application.

4.3.3 Predicted impacts

POS location has focused on the best quality vegetation across the site and connectivity with the conservation value of Bush Forever 270 and the CCW. POS placement along the boundary of the LSP, provided suitable separation of development activities and conservation values, whilst contributing to ecological connectivity.

Management practices started above adequately protect the high conservation values of the surrounding areas and maintain high quality bushland within the LSP. Further work in the form of referrals for significant impacts to Matters of National Environmental Significance will proceed ahead of the sub development stage; additionally, the sub-division approval will result in conditions associated with key environmental attributes of the site.

Mitigation measures proposed to be employed by the development of the site coupled with the approvals process the development of the site will be subject to, ensures the impacts to vegetation within and adjacent to the site is as minimal as is practicable.

4.4 Fauna

4.4.1 Potential impacts

A number of federally and state listed fauna species have the potential to be present at the site. In particular, the fauna survey identified the presence of suitable foraging habitat and potential habitat trees for Black Cockatoos.

While no foraging evidence was observed on-site and all potential habitat trees were absent of suitable hollows for Black Cockatoos; the removal of foraging habitat from the site couples with the loss of some potential habitat trees may result in impacts to Black Cockatoos.

4.4.2 Mitigation and management

The LSP has considered the placement of POS to capture BC foraging habitat and potential habitat trees for retention. The Landscape Management Plan will provide direction for the LPS to establish locally endemic trees suitable for foraging ie. tuarts; furthermore, a Fauna Management Plan will be prepared at the sub-division stage of development which will include:

- inspection and management procedures for trees suspected as nesting sites
- removal and relocation techniques for fauna requiring translocation from the site
- clearing management to detail the proposed clearing schedule to minimise potential impacts to fauna
- reference to other activities such as rehabilitation of areas to promote habitat retention and improvement

LSP design has been considered to reduce impacts to fauna within the site as far as practicable, the completion of vegetation mapping has informed the placement of POS to capture the best quality habitat and retain connectivity with Bush Forever 270 and the CCW.

4.4.3 Predicted impacts

Black Cockatoo foraging habitat and significant tree retention provide the best outcome for habitat provision within the LSP. The best quality foraging habitat and future potential habitat trees are retained within POS; furthermore, the placement of POS retains connectivity with the surrounding Bush Forever 270 and the CCW which also provide foraging and breeding habitat.

Prior to subdivision, consideration referral for significant impacts to MNES, will be conducted by the landholder to ensure all appropriate steps to reduce impacts to Black Cockatoos are developed and initiated; each referral will be constructed according to the conditions of the Lot.

4.5 Bushfire

4.5.1 Potential impacts

Fire run through intact vegetation exist to the southwest of the project area through predominantly intact Class B woodland; there is also potential for bushfire occurrence through woodland to the east. Overall, much of the project area and adjacent vegetation is degraded through previous agriculture / development. The pre-development BHL assessment shows that based on the existing vegetation, the site contains land with Low, Moderate and Extreme bushfire hazard levels.

Unrestrained consideration of the BALs post development presents a risk to future property owners across the LSP.

4.5.2 Mitigation and management

A BMP has been developed for the LSP which includes actions such as:

- on-site staging buffers
- fuel management within cleared vacant lots
- road verge fuel management
- notification on title
- landscaping plans
- building construction standards
- building setbacks
- consideration of Bushfire emergency and evacuation plan and Bushfire risk management plan provisions

4.5.3 Predicted impacts

Bushfire risk can be appropriately managed through implementation of the BMP which supports this EAR.

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Appendix 1
NatureMap database search (DBCA)

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Guest user on 19/06/2018

Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 115° 51' 32" E,32° 12' 54" S
Buffer 2km

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1.	3374	*Acacia huegelii*			
2.	3502	*Acacia pulchella (Prickly Moses)*			
3.	3602	*Acacia willdenowiana (Grass Wattle)*			
4.	24260	*Acanthiza apicalis (Broad-tailed Thornbill, Inland Thornbill)*			
5.	24261	*Acanthiza chrysorrhoa (Yellow-rumped Thornbill)*			
6.	24262	*Acanthiza inornata (Western Thornbill)*			
7.	24560	*Acanthorhynchus superciliosus (Western Spinebill)*			
8.	25535	*Accipiter cirrocephalus (Collared Sparrowhawk)*			
9.	25536	*Accipiter fasciatus (Brown Goshawk)*			
10.	25755	*Acrocephalus australis (Australian Reed Warbler)*			
11.		*Aira caryophyllea/cupaniana group*			
12.	1728	*Allocasuarina fraseriana (Sheoak, Kondil)*			
13.	200	*Amphipogon turbinatus*			
14.	24312	*Anas gracilis (Grey Teal)*			
15.	24315	*Anas rhynchotis (Australasian Shoveler)*			
16.	24316	*Anas superciliosa (Pacific Black Duck)*			
17.	47414	*Anhinga novaehollandiae (Australasian Darter)*			
18.	1411	*Anigozanthos manglesii (Mangles Kangaroo Paw, Kurulbrang)*			
19.	24561	*Anthochaera carunculata (Red Wattlebird)*			
20.	24562	*Anthochaera lunulata (Western Little Wattlebird)*			
21.	41324	*Ardea modesta (great egret, white egret)*			
22.	24340	*Ardea novaehollandiae (White-faced Heron)*			
23.	1264	*Arnocrinum preissii*			
24.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
25.	8779	*Asparagus asparagoides (Bridal Creeper)*	Y		
26.	6334	*Astroloma pallidum (Kick Bush)*			
27.	17234	*Austrostipa compressa*			
28.	17240	*Austrostipa flavescens*			
29.	233	*Avena barbata (Bearded Oat)*	Y		
30.	24318	*Aythya australis (Hardhead)*			
31.	36441	*Babingtonia camphorosmae (Camphor Myrtle)*			
32.	1800	*Banksia attenuata (Slender Banksia, Piara)*			
33.	1822	*Banksia ilicifolia (Holly-leaved Banksia)*			
34.	1834	*Banksia menziesii (Firewood Banksia)*			
35.		*Barnardius zonarius*			
36.	24319	*Biziura lobata (Musk Duck)*			
37.	3710	*Bossiaea eriocarpa (Common Brown Pea)*			
38.	3000	*Brassica tournefortii (Mediterranean Turnip)*	Y		
39.	244	*Briza maxima (Blowfly Grass)*	Y		
40.	245	*Briza minor (Shivery Grass)*	Y		
41.	12770	*Burchardia congesta*			
42.	25598	*Cacomantis flabelliformis (Fan-tailed Cuckoo)*			
43.	1276	*Caesia micrantha (Pale Grass Lily)*			
44.	1592	*Caladenia flava (Cowslip Orchid)*			
45.	1596	*Caladenia huegelii (Grand Spider Orchid)*		T	
46.	2848	*Calandrinia corrigioloides (Strap Purslane)*			
47.	24731	*Calyptorhynchus banksii subsp. naso (Forest Red-tailed Black Cockatoo)*		T	
48.	24734	*Calyptorhynchus latirostris (Carnaby's Cockatoo, White-tailed Short-billed Black Cockatoo)*		T	
49.	5458	*Calytrix flavescens (Summer Starflower)*			
50.	2795	*Carpobrotus edulis (Hottentot Fig)*	Y		
51.	1162	*Cartonema philydroides*			
52.	1125	*Centrolepis drummondiana*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
53.	1280	*Chamaescilla corymbosa (Blue Squill)*			
54.	24321	*Chenonetta jubata (Australian Wood Duck, Wood Duck)*			
55.	24288	*Circus approximans (Swamp Harrier)*			
56.	24774	*Cladorhynchus leucocephalus (Banded Stilt)*			
57.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
58.	4555	*Comesperma integerrimum*			
59.	15611	*Conospermum stoechadis subsp. stoechadis (Common Smokebush)*			
60.	1418	*Conostylis aculeata (Prickly Conostylis)*			
61.		*Conyza sp.*			
62.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
63.	25592	*Corvus coronoides (Australian Raven)*			
64.	1285	*Corynotheca micrantha (Sand Lily)*			
65.	25595	*Cracticus tibicen (Australian Magpie)*			
66.	25596	*Cracticus torquatus (Grey Butcherbird)*			
67.	3137	*Crassula colorata (Dense Stonecrop)*			
68.	30893	*Cryptoblepharus buchananii*			
69.	16245	*Cyathochaeta teretifolia*		P3	
70.	24322	*Cygnus atratus (Black Swan)*			
71.	30901	*Dacelo novaeguineae (Laughing Kookaburra)*	Y		
72.	7454	*Dampiera linearis (Common Dampiera)*			
73.	25673	*Daphoenositta chrysoptera (Varied Sittella)*			
74.	1218	*Dasypogon bromeliifolius (Pineapple Bush)*			
75.	24092	*Dasyurus geoffroii (Chuditch, Western Quoll)*		T	
76.	3807	*Daviesia divaricata (Marno)*			
77.	3845	*Daviesia triflora*			
78.	25766	*Delma fraseri (Fraser's Legless Lizard)*			
79.	16595	*Desmocladus flexuosus*			
80.	1259	*Dianella revoluta (Blueberry Lily)*			
81.	19649	*Disa bracteata*	Y		
82.		*Diuris corymbosa/magnifica*			
83.	4763	*Dodonaea hackettiana (Hackett's Hopbush)*		P4	
84.	1639	*Drakaea elastica (Glossy-leaved Hammer Orchid)*		T	
85.	3095	*Drosera erythrorhiza (Red Ink Sundew)*			
86.	3106	*Drosera macrantha (Bridal Rainbow)*			
87.	3118	*Drosera pallida (Pale Rainbow)*			
88.	29178	*Drosera porrecta*			
89.		*Drosera sp. "climbing"*			
90.		*Egretta novaehollandiae*			
91.		*Ehrharta ?longiflora*			Y
92.	347	*Ehrharta calycina (Perennial Veldt Grass)*	Y		
93.	349	*Ehrharta longiflora (Annual Veldt Grass)*	Y		
94.		*Ehrharta sp.*			
95.	47937	*Elseyornis melanops (Black-fronted Dotterel)*			
96.	6219	*Eryngium pinnatifidum (Blue Devils)*			
97.	24379	*Erythrogonys cinctus (Red-kneed Dotterel)*			
98.	13547	*Eucalyptus marginata subsp. marginata (Jarrah)*			
99.	4638	*Euphorbia peplus (Petty Spurge)*	Y		
100.	4648	*Euphorbia terracina (Geraldton Carnation Weed)*	Y		
101.	25622	*Falco cenchroides (Australian Kestrel, Nankeen Kestrel)*			
102.	25623	*Falco longipennis (Australian Hobby)*			
103.	25727	*Fulica atra (Eurasian Coot)*			
104.	24761	*Fulica atra subsp. australis (Eurasian Coot)*			
105.		*Fumaria sp.*			
106.	25729	*Gallinula tenebrosa (Dusky Moorhen)*			
107.	24763	*Gallinula tenebrosa subsp. tenebrosa (Dusky Moorhen)*			
108.	25530	*Gerygone fusca (Western Gerygone)*			
109.	1520	*Gladiolus caryophyllaceus (Wild Gladiolus)*	Y		
110.	3957	*Gompholobium tomentosum (Hairy Yellow Pea)*			
111.	24443	*Grallina cyanoleuca (Magpie-lark)*			
112.		*Haemodorum sp.*			
113.	1475	*Haemodorum spicatum (Mardja)*			
114.	24295	*Haliastur sphenurus (Whistling Kite)*			
115.	3961	*Hardenbergia comptoniana (Native Wisteria)*			
116.	5135	*Hibbertia hypericoides (Yellow Buttercups)*			
117.	5162	*Hibbertia racemosa (Stalked Guinea Flower)*			
118.	47965	*Hieraaetus morphnoides (Little Eagle)*			
119.	25734	*Himantopus himantopus (Black-winged Stilt)*			
120.	24491	*Hirundo neoxena (Welcome Swallow)*			
121.	6222	*Homalosciadium homalocarpum*			
122.	3966	*Hovea pungens (Devil's Pins, Puyenak)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
123.	12859	*Hovea trisperma var. trisperma*			
124.	5216	*Hybanthus calycinus (Wild Violet)*			
125.	5825	*Hypocalymma robustum (Swan River Myrtle)*			
126.	8086	*Hypochaeris glabra (Smooth Catsear)*	Y		
127.	1070	*Hypolaena exsulca*			
128.		*Iridaceae sp.*			Y
129.	917	*Isolepis marginata (Coarse Club-rush)*			
130.	48588	*Isoodon fusciventer (Quenda, southwestern brown bandicoot)*		P4	
131.	3992	*Isotropis cuneifolia (Granny Bonnets)*			
132.	4012	*Jacksonia furcellata (Grey Stinkwood)*			
133.	4029	*Jacksonia sternbergiana (Stinkwood, Kapur)*			
134.	4044	*Kennedia prostrata (Scarlet Runner)*			
135.	15498	*Kunzea glabrescens (Spearwood)*			
136.	44490	*Leontodon rhagadioloides*	Y		
137.	944	*Lepidosperma scabrum*			
138.	945	*Lepidosperma squamatum*			
139.	1653	*Leporella fimbriata (Hare Orchid)*			
140.	25133	*Lerista elegans*			
141.	6374	*Leucopogon conostephioides*			
142.	6436	*Leucopogon propinquus*			
143.		*Levenhookia pusilla/stipitata*			
144.	25661	*Lichmera indistincta (Brown Honeyeater)*			
145.		*Lomandra ?caespitosa*			
146.		*Lomandra ?preissii*			
147.	1223	*Lomandra caespitosa (Tufted Mat Rush)*			
148.	1228	*Lomandra hermaphrodita*			
149.	1232	*Lomandra micrantha (Small-flower Mat-rush)*			
150.	1234	*Lomandra nigricans*			
151.	1239	*Lomandra preissii*			
152.	1246	*Lomandra suaveolens*			
153.	8564	*Lotus subbiflorus*	Y		
154.	1198	*Luzula meridionalis (Field Woodrush)*			
155.		*Lycosa ariadnae*			
156.	36375	*Lysimachia arvensis (Pimpernel)*	Y		
157.	2839	*Macarthuria australis*			
158.	18119	*Macrozamia fraseri*			
159.	24326	*Malacorhynchus membranaceus (Pink-eared Duck)*			
160.	25654	*Malurus splendens (Splendid Fairy-wren)*			
161.	24598	*Merops ornatus (Rainbow Bee-eater)*			
162.	955	*Mesomelaena pseudostygia*			
163.	957	*Mesomelaena tetragona (Semaphore Sedge)*			
164.		*Microcarbo melanoleucos*			
165.	485	*Microlaena stipoides (Weeping Grass)*			
166.	10954	*Microtis media (Tall Mignonette Orchid)*			
167.	24223	*Mus musculus (House Mouse)*	Y		
168.	24738	*Neophema elegans (Elegant Parrot)*			
169.	492	*Neurachne alopecuroidea (Foxtail Mulga Grass)*			
170.	25252	*Notechis scutatus (Tiger Snake)*			
171.	25564	*Nycticorax caledonicus (Rufous Night Heron)*			
172.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
173.	24085	*Oryctolagus cuniculus (Rabbit)*	Y		
174.	24328	*Oxyura australis (Blue-billed Duck)*		P4	
175.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
176.	25253	*Parasuta gouldii*			
177.	25681	*Pardalotus punctatus (Spotted Pardalote)*			
178.	25682	*Pardalotus striatus (Striated Pardalote)*			
179.	1550	*Patersonia occidentalis (Purple Flag, Koma)*			
180.	4343	*Pelargonium capitatum (Rose Pelargonium)*	Y		
181.	24648	*Pelecanus conspicillatus (Australian Pelican)*			
182.	2273	*Persoonia saccata (Snottygobble)*			
183.	48061	*Petrochelidon nigricans (Tree Martin)*			
184.	48066	*Petroica boodang (Scarlet Robin)*			
185.	24659	*Petroica goodenovii (Red-capped Robin)*			
186.	2299	*Petrophile linearis (Pixie Mops)*			
187.	2301	*Petrophile macrostachya*			
188.	2312	*Petrophile striata*			
189.	25697	*Phalacrocorax carbo (Great Cormorant)*			
190.	25698	*Phalacrocorax melanoleucos (Little Pied Cormorant)*			
191.	24667	*Phalacrocorax sulcirostris (Little Black Cormorant)*			
192.	24409	*Phaps chalcoptera (Common Bronzewing)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
193.	1478	*Phlebocarya ciliata*			
194.	48071	*Phylidonyris niger (White-cheeked Honeyeater)*			
195.	24596	*Phylidonyris novaehollandiae (New Holland Honeyeater)*			
196.	16177	*Phyllangium paradoxum*			
197.	4675	*Phyllanthus calycinus (False Boronia)*			
198.	24841	*Platalea flavipes (Yellow-billed Spoonbill)*			
199.		*Poaceae sp.*			
200.	25704	*Podiceps cristatus (Great Crested Grebe)*			
201.	8175	*Podolepis gracilis (Slender Podolepis)*			
202.	8184	*Podotheca gnaphalioides (Golden Long-heads)*			
203.	24681	*Poliocephalus poliocephalus (Hoary-headed Grebe)*			
204.		*Poranthera microphylla/moorokatta*			
205.	25731	*Porphyrio porphyrio (Purple Swamphen)*			
206.	24767	*Porphyrio porphyrio subsp. bellus (Purple Swamphen)*			
207.	25511	*Pseudonaja affinis (Dugite)*			
208.	25259	*Pseudonaja affinis subsp. affinis (Dugite)*			
209.	1693	*Pterostylis recurva (Jug Orchid)*			
210.	12217	*Pterostylis sanguinea*			
211.	11260	*Ptilotus drummondii var. drummondii (Pussytail)*			
212.		*Purpureicephalus spurius*			
213.	16367	*Pyrorchis nigricans (Red beaks, Elephants ears)*			
214.	8195	*Quinetia urvillei*			
215.	24245	*Rattus rattus (Black Rat)*	Y		
216.	24776	*Recurvirostra novaehollandiae (Red-necked Avocet)*			
217.	48096	*Rhipidura albiscapa (Grey Fantail)*			
218.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
219.	1556	*Romulea rosea (Guildford Grass)*	Y		
220.	40426	*Rytidosperma occidentale*			
221.	7603	*Scaevola canescens (Grey Scaevola)*			
222.	982	*Schoenus clandestinus*			
223.	984	*Schoenus curvifolius*			
224.	6033	*Scholtzia involucrata (Spiked Scholtzia)*			
225.	25534	*Sericornis frontalis (White-browed Scrubwren)*			
226.	2909	*Silene gallica (French Catchfly)*	Y		
227.		*Siloxerus humifusus/filifolius*			
228.	30948	*Smicrornis brevirostris (Weebill)*			
229.	7022	*Solanum nigrum (Black Berry Nightshade)*	Y		
230.	8231	*Sonchus oleraceus (Common Sowthistle)*	Y		
231.	1312	*Sowerbaea laxiflora (Purple Tassels)*			
232.	39087	*Stemonitis splendens*			
233.	25597	*Strepera versicolor (Grey Currawong)*			
234.	25590	*Streptopelia senegalensis (Laughing Turtle-Dove)*	Y		
235.	7774	*Stylidium piliferum (Common Butterfly Triggerplant)*			
236.	7798	*Stylidium schoenoides (Cow Kicks)*			
237.	15532	*Synaphea spinulosa subsp. spinulosa*			
238.	33992	*Synemon gratiosa (Graceful Sunmoth)*		P4	
239.	25705	*Tachybaptus novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
240.	24682	*Tachybaptus novaehollandiae subsp. novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
241.	24331	*Tadorna tadornoides (Australian Shelduck, Mountain Duck)*			
242.	11143	*Thelymitra graminea*			
243.	24845	*Threskiornis spinicollis (Straw-necked Ibis)*			
244.	1318	*Thysanotus arbuscula*			
245.	1319	*Thysanotus arenarius*			
246.		*Thysanotus manglesianus/patersonii complex*			
247.	1351	*Thysanotus sparteus*			
248.	25519	*Tiliqua rugosa*			
249.	25207	*Tiliqua rugosa subsp. rugosa*			
250.	25549	*Todiramphus sanctus (Sacred Kingfisher)*			
251.	6280	*Trachymene pilosa (Native Parsnip)*			
252.	25521	*Trichosurus vulpecula (Common Brushtail Possum)*			
253.	24158	*Trichosurus vulpecula subsp. vulpecula (Common Brushtail Possum)*			
254.	1361	*Tricoryne elatior (Yellow Autumn Lily)*			
255.		*Unknown Annual Grasses*			
256.	8254	*Urospermum picroides (False Hawkbit)*	Y		
257.	8255	*Ursinia anthemoides (Ursinia)*	Y		
258.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			
259.		*Vulpia sp.*			
260.	7384	*Wahlenbergia capensis (Cape Bluebell)*	Y		
261.	7389	*Wahlenbergia preissii*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
262.	1256	*Xanthorrhoea preissii (Grass tree, Palga)*			
263.	6289	*Xanthosia huegelii*			
264.	2331	*Xylomelum occidentale (Woody Pear, Djandin)*			
265.	25765	*Zosterops lateralis (Grey-breasted White-eye, Silvereye)*			

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

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

Appendix 2
EPBC Act Protected Matters Search (DEE)

Australian Government
Department of the Environment and Energy

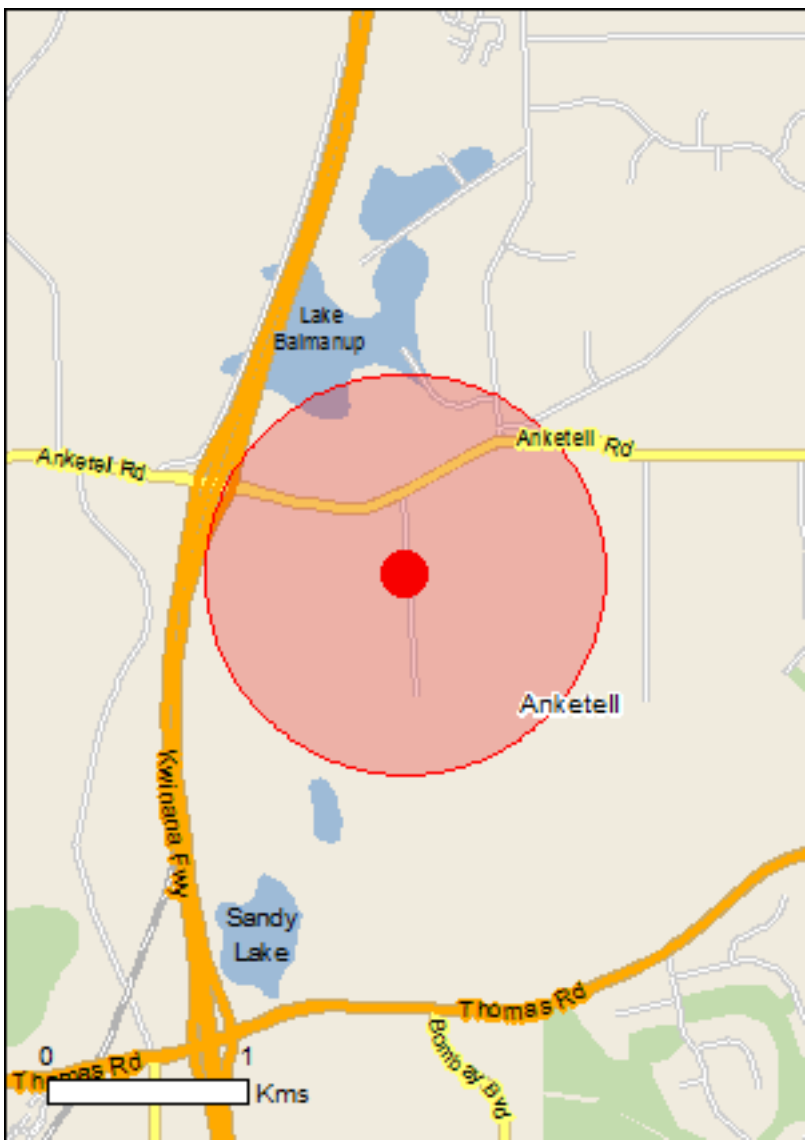
EPBC Act Protected Matters Report

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

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

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

Report created: 19/06/18 15:35:47



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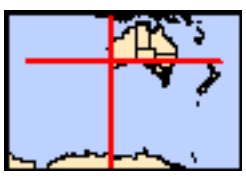

Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	2
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	1
Listed Threatened Species:	17
Listed Migratory Species:	10

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	16
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

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

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	36
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Forrestdale and thomsons lakes	Within 10km of Ramsar
Peel-yalgorup system	30 - 40km upstream

Listed Threatened Ecological Communities [Resource Information]

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

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Calyptorhynchus baudinii Baudin's Cockatoo, Long-billed Black-Cockatoo [769]	Endangered	Species or species habitat likely to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat likely to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder,	Critically Endangered	Species or species

Name	Status	Type of Presence
Ngoor, Ngoolangit [25911]		habitat likely to occur within area
Plants		
Andersonia gracilis		
Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area
Caladenia huegelii		
King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat likely to occur within area
Diuris micrantha		
Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat known to occur within area
Diuris purdiei		
Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat likely to occur within area
Drakaea elastica		
Glossy-leafed Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat likely to occur within area
Drakaea micrantha		
Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat likely to occur within area
Lepidosperma rostratum		
Beaked Lepidosperma [14152]	Endangered	Species or species habitat likely to occur within area

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea		
Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat likely to occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat likely to occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus		
Osprey [952]		Species or species

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

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat likely to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat likely to occur within area
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Extra Information

Invasive Species	[Resource Information]

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

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

Name	Status	Type of Presence
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur

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

Caveat

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

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

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

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

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

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

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-32.2134 115.85889

Acknowledgements

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

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

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

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

Department of the Environment
GPO Box 787
Canberra ACT 2601 Australia
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Appendix 3
Flora and Vegetation Assessment (Bennett Environmental Consulting 2009)

Our Ref: 702-2 AI

environmental management consultants

28 April 2010

Kim Kyle
Principal Urban Designer
Greg Rowe and Associates
Level 3, 369 Newcastle Street
NORTHBRIDGE WA 6003

Via email: kim.kyle@greg-rowe.com

Dear Kim

Jandakot Structure Plan Area: Anketell Cell

Spring 2009 Flora and Vegetation Survey

360 Environmental Pty Ltd (360 Environmental) is pleased to provide the final report for the flora and vegetation survey undertaken in Spring 2009 across the Anketell Cell in the Jandakot Structure Plan area.

The results of the survey did not find any Declared Rare Flora or Threatened Ecological Communities, however the survey did find the following:

- The results indicated the presence of a Priority Ecological Community (PEC) in the southern part of the survey area.
- The Priority 3 flora species, *Jacksonia gracillima* was observed at two locations.

Although neither the PEC or priority flora species are protected under legislation it is likely their presence may require further consultation with regulatory authorities, particularly as the vegetation is considered "Good" to Very Good" where the PEC is located. The PEC is also mostly associated with a mapped Conservation Category Wetland (CCW).

Discussions with the Department of Environment and Conservation's Species and Communities Branch indicated the DEC may request a second spring survey be undertaken to confirm the presence of the PEC. The Town of Kwinana's Local Biodiversity Strategy also recommends multiple spring surveys.

The requirement for additional surveys should be closely managed as it is becoming more common that multiple spring flora and vegetation surveys are being requested by the DEC. This is more common when flora or vegetation of conservation significance are

observed on site. Although not specifically protected under legislation, the presence of the PEC and the Priority 3 flora species will require specific management as they are considered conservation significant and the DEC has a policy that attempts, where possible, to protect conservation significant flora and vegetation. The presence of the PEC mostly associated with the CCW will add further to management actions as CCWs also have strong policy positions associated with them.

We trust this meets your requirements at this time. Should you have any questions or require further action please do not hesitate to contact Joseph Toon or the undersigned on (08) 9321 0420.

For and on behalf of
360 Environmental Pty Ltd

Tamara Smith
Principal

FLORA AND VEGETATION OF ANKETELL URBAN DEFERRED CELL

Prepared for:
360 Environmental
PO Box 14
WESTPERTH 6005

Prepared by:
Bennett Environmental Consulting Pty Ltd

Billardiera heterophylla

PO Box 341
KALAMUNDA 6926

April 2010

STATEMENT OF LIMITATIONS

Scope of Services

This report ("the report") has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Eleanor Bennett ("the Author"). In some circumstances a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services.

Reliance on Data

In preparing the report, the Author has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise stated in the report, the Author has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. The Author will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to the Author.

Environmental Conclusions

In accordance with the scope of services, the Author has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

The conclusions are based upon field data and the environmental monitoring and/or testing carried out over a limited period of time and are therefore merely indicative of the environmental condition of the site at the time of preparing the report. Also it should be recognised that site conditions, can change with time.

Within the limitations imposed by the scope of services, the field assessment and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and no other party. The Author assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of the Author or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

Other Limitations

The Author will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report. The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

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SUMMARY

Bennett Environmental Consulting Pty Ltd was commissioned by 360 Environmental to undertake a survey of the Anketell Urban Deferred Cell. The survey area consisted of several lots on Anketell and Treeby Roads of which 7 of the 23 lots included in the area had been given permission by the owners to be surveyed. Several of these lots had already been completely or partially cleared. Lot 13 at the southern extent of the survey area included a conservation category wetland which at the time of the survey, November 5th and 6th 2009 still had water. The site includes a section of Bush Forever Site 270.

A total of 58 vascular plant families, 125 genera and 167 taxa of which 38 were weeds were recorded from the survey area. The dominant plant families were Poaceae, Papilionaceae, Myrtaceae and Asteraceae. Seven of the weeds were listed as high impact on the vegetation and should be targeted for removal. These were:

- **Typha orientalis* was only recorded at the northern end of the lake;
- **Cortaderia selloana* from the southern end of Lot 13 close to where ANK01 was surveyed;
- **Bromus diandrus*, **Ehrharta calycina*, **Lagurus ovatus* and **Romulea rosea* were recorded scattered or in dense clumps across the survey area; and
- **Euphorbia terracina* was only recorded from Treeby Road verge adjacent to Lot 188.

No Declared Rare Flora but *Jacksonia gracillima*, a Priority 3 Flora was recorded from 2 quadrats, ANK07 and ANK09. About 40 plants were recorded.

No Threatened Ecological Communities were recorded by the Department of Environment and Conservation (2009b) but one Priority Ecological Community, *Banksia ilicifolia* woodlands, southern Swan Coastal Plain (floristic community type 22) was identified by the Department of Environment and Conservation as occurring at the survey area. This community was not identified during the survey.

A PATN analysis undertaken by TEH Griffin concluded that the quadrats ANK07 and ANK09 were representative of the Priority Ecological Community FCT21c. These quadrats were identified in the field as being representative of the vegetation unit Open Tall Woodland of *Eucalyptus marginata* subsp. *marginata* occasionally with scattered trees of *Melaleuca preissiana* over Dense Thicket of *Kunzea glabrescens.* This vegetation unit was common across most of the survey area. However quadrat ANK11also identified as being the same vegetation unit in the field was concluded to be FCT14 which is not a Priority Ecological Community. It is therefore possible that the area identified as Em in the southern section of the survey area may be the Priority Ecological Community FCT21c.

A total of 10 different vegetation units were described for the survey area. There were two associated with the lake margin. These were:

- Open Low Woodland A of *Eucalyptus rudis* subsp. *rudis* over Low Scrub B of *Astartea scoparia* over Tall Sedges dominated by *Juncus pallidus*;
- Low Woodland A of *Eucalyptus rudis* subsp. *rudis, Melaleuca preissiana* and *Melaleuca rhaphiophylla* over Thicket of *Kunzea glabrescens* over Dwarf Scrub of *Astartea scoparia*. Both these were located around the lake margin;

The other vegetation units were recorded away from the lake. These were:

- Open Woodland of *Eucalyptus rudis* subsp. *rudis* and *Melaleuca preissiana* over Dense Thicket of *Kunzea glabrescens* over Open Low Scrub A dominated by *Leucopogon australis.* This was the dominant vegetation in the southern section of Lot 13;
- Open Low Woodland A of *Melaleuca preissiana* over Thicket of *Kunzea glabrescens* and *Taxandria linearifolia* over Tall Sedges of *Lepidosperma longitudinale* and *Dielsia*

stenostachya. This was the vegetation associated with the minor drain through the survey area;

- Low Forest A of *Banksia attenuata, Banksia menziesii* and *Allocasuarina fraseriana* over Open Scrub of *Kunzea glabrescens* over Heath B dominated by *Hibbertia hypericoides.* This was recorded from higher ground in Lot 32 and Lot 33;
- Open Tall Woodland of *Eucalyptus marginata* subsp. *marginata* occasionally with scattered trees of *Melaleuca preissiana* over Dense Thicket of *Kunzea glabrescens.* This was the dominant vegetation over most of the survey area;
- Low Woodland A of *Banksia attenuata, Banksia ilicifolia* and *Nuytsia floribunda* over Thicket of *Kunzea glabrescens* and *Melaleuca thymoides* over Low Heath D dominated by *Scholtzia uberiflora* and *Aotus procumbens;*
- Open Low Woodland A of *Eucalyptus todtiana, Banksia menziesii* and *Banksia attenuata* over Dense Thicket of *Kunzea glabrescens* over Dwarf Scrub D of *Scholtzia uberiflora* over Open Low Grass dominated by **Vulpia bromoides* over Herbs dominated by *Trachymene pilosa* and *Drosera paleacea.* This was recorded as a very small area on the western side of Lot 13 but did continue as the main vegetation into the adjoining property;
- Open Low Woodland A of *Banksia attenuata* and *Banksia menziesii* occasionally with *Allocasuarina fraseriana* over Dense Thicket of *Kunzea glabrescens* over Herbs of *Dasypogon bromeliifolius* and *Philotheca spicata* in grey sand (Af); and
- Dense Thicket of *Kunzea glabrescens* over Open Dwarf Scrub C of *Hypocalymma angustifolium* over Very Open Low Sedges of *Dielsia stenostachya* or *Schoenus rigens* or *Hypolaena exsulca* and Open Low Grass dominated by **Vulpia bromoides*). This vegetation unit occurred as a distinct unit in Lot 13.

The conservation category wetland on Lot 13 had many tracks accessing the lake. Many of the tracks appear to originate from Thomas Road to the south and from the firebreaks along the properties and the road reserve which is the continuation of Treeby Road. By closing the tracks and allowing the area to rehabilitate naturally it should be possible to return this area to a better condition.

A deeply incised but very narrow drain cut through the lower south west section of Lot 13. The southern section had been burnt within the last 12 months but the northern section was well vegetated.

1. INTRODUCTION

1.1 Background

Bennett Environmental Consulting Pty Ltd was contracted by 360 Environmental to undertake a flora and vegetation survey of the Anketell Urban Deferred Cell. The survey area consisted of several lots on Anketell and Treeby Roads. For 7 of the 23 lots included in the area permission had been given by the owners to survey them. Several of these lots had already been completely or partially cleared. The south eastern section, Lots 13, 35 and 100, were accessed, including a conservation category wetland.

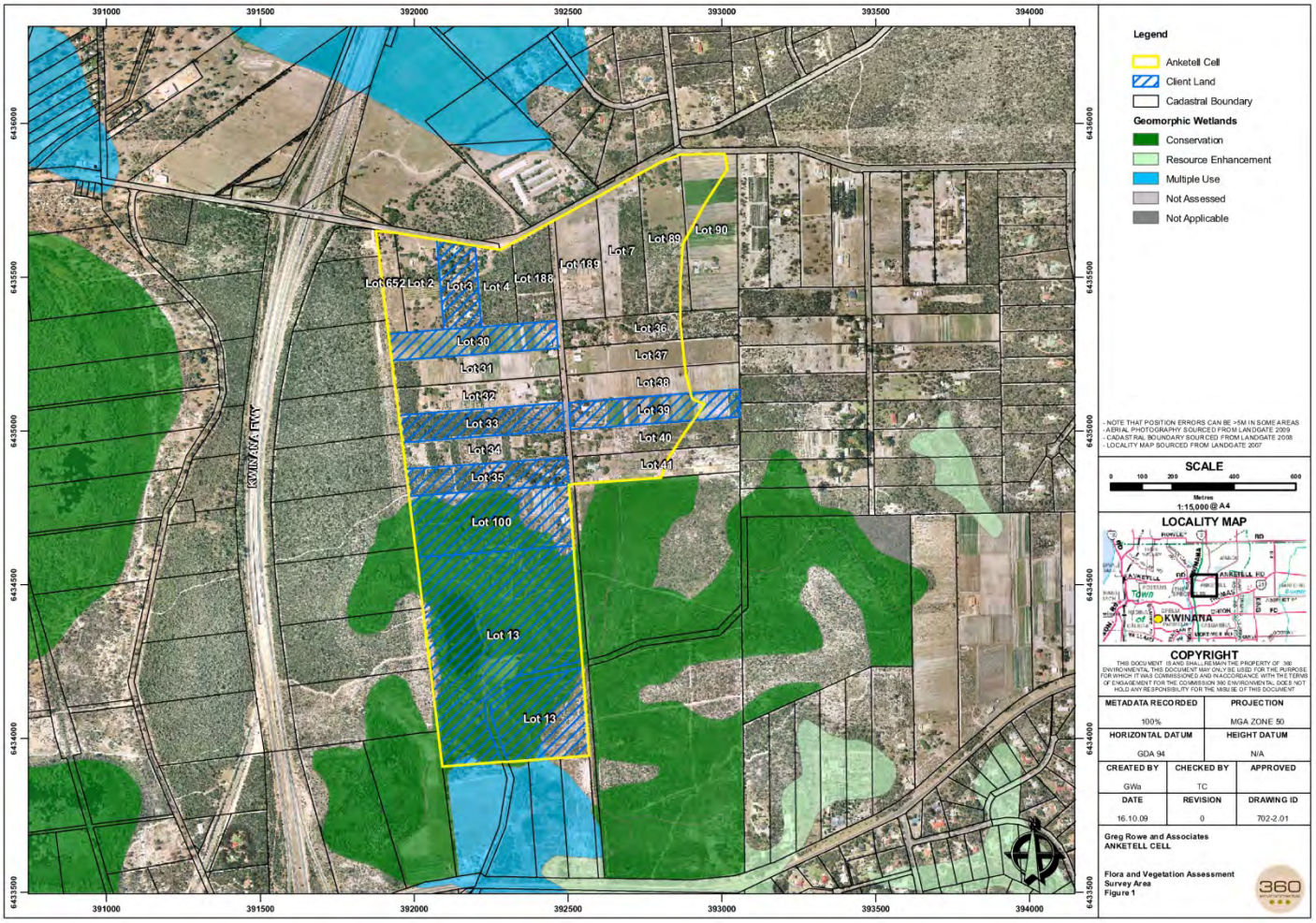

Figure 1. Study area outlined in yellow. Lots that could be accessed are hatched in blue

1.2 Scope of Works

The requirements for this project were to:

i. Record the vegetation units and associated species in the remnant bushland; and

ii. Search for and record all significant species at the survey area.

2. REGIONAL METHODOLOGY

2.1 Geology and Landform

The survey area is included in the Swan Coastal Plain Subregion of the Southwest Botanical Province (Beard, 1990). It is a low-lying, coastal plain often swampy with

sandhills. The soils are mainly recent sands or swamp deposits. This is further subdivided into 7 different units, with the study area occurring within the older, weathered dunes of the Bassendean System.

The soils of the Bassendean Dunes consist of poorly sorted quartz sand with mainly fine to medium grains. The sands are off white to pale grey at the surface and cream to yellow at depth.

2.2 Vegetation

The Interim Biogeographical Regionalisation for Australia (IBRA) (Thackway and Cresswell, 1995) recognises 85 bioregions. The IBRA is used as the common unit to compare biological and biophysical attributes. Bioregions represent a landscape based approach to classifying the land surface and each region is defined by a set of major environmental influences, which shape the occurrence of flora and fauna and their interaction with the physical environment. The survey area occurs in the Swan Coastal Plain (Mitchell *et al*., 2002) of which Perth is a subregion. The Perth subregion is composed of colluvial and Aeolian sands, alluvial river flats and coastal limestone with heath and/or Tuart woodlands on limestone, *Banksia* and Jarrah-*Banksia* woodlands on Quaternary marine dunes of various ages and Marri on colluvial sands and alluvials. The Perth subregion area also includes a complex series of seasonal wetlands. Rainfall ranges between 600 and 1000 mm annually and the climate is Mediterranean (Mitchell *et al*, 2002).

The Perth Metropolitan Area portion of the Swan Coastal Plain (approximately 20% of the whole subregion) has had a comprehensive study of the reservation status and protection requirements in the Perth's Bushplan/Bush Forever project (Government of Western Australia, 2000). This has identified regionally significant bushland for protection by reservation or within the statutory planning framework. Part of the study area is listed as Bush Forever site 270.

Prior to the above classification Beard (1981) classified the vegetation of Western Australia. Western Australia was divided into three main Botanical Provinces, Southwest, Eremaean and Northern. The study area was described by Beard (1981) as Banksia Low Woodland with scattered Jarrah (abbreviation e2bLi) Shepherd *et al.* (2002) have determined the pre-European and current extent of the vegetation associations described by Beard. In addition they have assessed the percentage of each association remaining, the amount in IUCN reserves and the percentage in other reserves. This develops an excellent picture of the extent of these remnants. The data provided by Shepherd *et al*. (2002) is provided in Table 1.

Table 1. Pre-European extent, current extent and reservation status of Beard community e2bLi

Pre-European extent	Current Extent	Remaining Vegetated	% in IUCN Reserves	% in other reserves
50,127ha	33,700ha	67.2%	57.4%	14.0%

The National Objectives and Targets for Biodiversity Conservation 2001-2005 (Commonwealth of Australia, 2001) is to conserve at least 30% of each vegetation unit. This legislation recognises that at least 30% of the original pre-clearing extent must be retained to protect Australia's biodiversity. This Beard complex has more than 30% remaining vegetated.

Heddle *et al.* (1980) described the vegetation complexes of the Darling system at a scale of 1: 250 000. There was found to be a distinct pattern of plant distribution linked to landforms, soils and climate. The most obvious trend was associated with increasing aridity from west to east on the Darling Plateau. The vegetation changes observed were a decrease in height and percentage cover of the tallest stratum and a distinct change in floristics. The study area was described as occuring in vegetation

complex, Bassendean Complex – Central and South. This is described as "Vegetation ranges from Woodland of *Eucalyptus marginata* subsp. *marginata – Allocasuarina fraseriana – Banksia* species to Low Woodland of *Melaleuca* species and Sedgelands on the moister sites." In Bush Forever (Government of Western Australia, 2000) it is estimated that within the Swan Coastal Plain portion of Metropolitan Perth there was originally 46,220 ha of Bassendean Complex – Central and South of which 10,919ha remains vegetated. This represents 24% of the original area of which it is intended to reserve 13%.

2.3 Bush Forever

The study area includes a section of Bush Forever Site 270 – Sandy Lake and Adjacent Bushland, Anketell. Bush Forever Site 270 also occurs on western sides and eastern neighbouring properties. The total size of Bush Forever Site 270 is 201.4ha of which >80% is in excellent to very good condition (Government of Western Australia, 2000).

The significant flora listed for Site 270 are *Aotus cordifolia*, a Priority 3 flora and *Dielsia stenostachya* listed in Government of Western Australia (2000) as endemic to the Swan Coastal Plain. The southern section of the study area, which includes the wetland, is located in Bush Forever Site 270.

The following Floristic Communities Type (Gibson et al., 1994) are recorded for Bush Forever Site 270 (Government of Western Australia):
FCT21c – Low-lying *Banksia attenuata* Woodlands or Shrublands; and
FCT22 – *Banksia ilicifolia* Woodlands.

3. METHODS

The remnant vegetation in the area was surveyed using the methods set out in the EPA Guidance No 51 (2004). Not all blocks within the Anketell Urban Deferred Cell could be accessed as the owner(s) had not provided permission to enter.

Temporary 10m x 10m quadrats were set up using a compass and oriented due N,S,E,W. Quadrats were placed to record the variation in the species present. The vegetation, flora and weed surveys were conducted concurrently. For each quadrat, the following was recorded in the field:

- GPS reading (WGS84, equivalent to Geocentric Datum of Australia 1994 (GDA94)) at NW corner;
- Digital photograph taken at the NW corner;
- Soil type;
- Presence, size and type of any outcropping rocks;
- Topography – eg. ridge, upper slope, middle slope, lower slope, drainage line, minor creek, major creek, wetland;
- Aspect where this is applicable;
- Percentage litter cover divided into bark, leaves, twigs and logs;
- Vegetation condition using the scale of Keighery (1994);
- Presence of any Declared Rare or Priority Flora or other significant flora;
- Additional information including dieback, age since fire, predators, erosion, weeds, grazing, tracks etc.; and
- All species were listed together with their percentage cover within the quadrat and average height.

The area outside of the quadrat was also surveyed to record additional (opportunistic) species for that vegetation unit. All species unknown in the field were collected, pressed and identified later using appropriate keys and by comparison with collections housed at the Western Australian Herbarium.

Declared Rare and Priority Flora were searched for as the area was surveyed. A collection of each Rare or Priority Flora seen was made and forms will be completed and sent to the Rare Flora section of the Department of Environment and Conservation. The pressed and dried specimens were sent to the Western Australian Herbarium for inclusion in their collection.

4. RESULTS

The vegetation survey was undertaken on 5th and 6th November 2009. The taxa recorded and a photographic record for each quadrat is provided in Appendix B and the location of each quadrat mapped in Appendix C. A total of 13 quadrats were established during the survey**.**

4.1 Taxa

A total of 58 vascular plant families, 125 genera and 167 taxa (species, subspecies and varieties) were recorded during the survey (Appendix A). The dominant families were:

Poaceae with 13 genera, 15 taxa of which 13 were weeds;
Papilionaceae with 12 genera, 16 taxa of which 1 was a weed;
Myrtaceae with 8 genera, 15 taxa of which none were weeds; and
Asteraceae with 12 genera, 14 taxa of which 10 were weeds.

These 4 families represent 6.9% of the number of families, 36% of the number of genera and 35.3% of the total number of taxa.

4.2 Vegetation Units Described from Field Survey

The vegetation units recorded from the survey area were described using the vegetation classification of Muir (1977) as described in Table 2.

Table 2. Vegetation Classification (from Muir 1977)

LIFE FORM / HEIGHT CLASS	**Canopy Cover**			
	DENSE 70 % - 100%	**MID DENSE 30% - 70%**	**SPARSE 10% - 30%**	**VERY SPARSE 2% - 10%**
Trees > 30 m	Dense Tall Forest	Tall Forest	Tall Woodland	Open Tall Woodland
Trees 15 – 30 m	Dense Forest	Forest	Woodland	Open Woodland
Trees 5 – 15 m	Dense Low Forest A	Low Forest A	Low Woodland A	Open Low Woodland A
Trees < 5 m	Dense Low Forest B	Low Forest B	Low Woodland B	Open Low Woodland B
Mallee tree form	Dense Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Mallee shrub form	Dense Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs > 2 m	Dense Thicket	Thicket	Scrub	Open Scrub
Shrubs 1.5 – 2 m	Dense Heath A	Heath A	Low Scrub A	Open Low Scrub A
Shrubs 1 - 1.5 m	Dense Heath B	Heath B	Low Scrub B	Open Low Scrub B
Shrubs 0.5 – 1 m	Dense Low Heath C	Low Heath C	Dwarf Scrub C	Open Dwarf Scrub C
Shrubs 0 - 0.5 m	Dense Low Heath D	Low Heath D	Dwarf Scrub D	Open Dwarf Scrub D
Mat plants	Dense Mat Plants	Mat Plants	Open Mat Plants	Very Open Mat Plants
Hummock grass	Dense Hummock Grass	Mid-Dense Hummock Grass	Hummock Grass	Open Hummock Grass
Bunch grass > 0.5 m	Dense Tall Grass	Tall Grass	Open Tall Grass	Very Open Tall Grass
Bunch grass < 0.5 m	Dense Low Grass	Low Grass	Open Low Grass	Very Open Low Grass
Herbaceous spp.	Dense Herbs	Herbs	Open Herbs	Very Open Herbs
Sedges > 0.5 m	Dense Tall sedges	Tall Sedges	Open Tall Sedges	Very Open Tall Sedges
Sedges < 0.5 m	Dense Low Sedges	Low Sedges	Open Low Sedges	Very Open Low Sedges
Ferns	Dense Ferns	Ferns	Open Ferns	Very Open Ferns
Mosses, liverworts	Dense Mosses	Mosses	Open Mosses	Very Open Mosses

The vegetation varied across the survey area with variations in the soil depth and distance from the lake in the south west corner. The different vegetation units are described below with the abbreviation used in mapping following in brackets.

Lake Associated Vegetation:
Open Low Woodland A of *Eucalyptus rudis* subsp. *rudis* over Low Scrub B of *Astartea scoparia* over Tall Sedges dominated by *Juncus pallidus* on the edge above the water line (Jp). This was represented by ANK03.

Low Woodland A of *Eucalyptus rudis* subsp. *rudis, Melaleuca preissiana* and *Melaleuca rhaphiophylla* over Thicket of *Kunzea glabrescens* over Dwarf Scrub C of *Astartea scoparia* around the edge of the lake (As). This was represented by ANK02. This was the vegetation surrounding the lake, but merged with Er further away.

Open Woodland of *Eucalyptus rudis* subsp. *rudis* and *Melaleuca preissiana* over Dense Thicket of *Kunzea glabrescens* over Open Low Scrub A dominated by *Leucopogon australis* (Er). This was represented by ANK01. This was the dominant vegetation in the southern area of the study survey area.

Forest
Low Forest A of *Banksia attenuata, Banksia menziesii* and *Allocasuarina fraseriana* over Open Scrub of *Kunzea glabrescens* over Heath B dominated by *Hibbertia hypericoides* in grey sand (Hh). This was represented by ANK13. This was one of the vegetation units on the higher ground.

Woodlands
Open Tall Woodland of *Eucalyptus marginata* subsp. *marginata* occasionally with scattered trees of *Melaleuca preissiana* over Dense Thicket of *Kunzea glabrescens* in grey sand (Em). This was represented by quadrats ANK07, ANK09 and ANK11.

Low Woodland A of *Banksia attenuata, Banksia ilicifolia* and *Nuytsia floribunda* over Thicket of *Kunzea glabrescens* and *Melaleuca thymoides* over Low Heath D dominated by *Scholtzia uberiflora* and *Aotus procumbens* on a slight rise in grey sand with scattered limestone (Bi). It was represented by ANK08.

Open Low Woodland A of *Eucalyptus todtiana, Banksia menziesii* and *Banksia attenuata* over Dense Thicket of *Kunzea glabrescens* over Dwarf Scrub D of *Scholtzia uberiflora* over Open Low Grass dominated by **Vulpia bromoides* over Herbs dominated by *Trachymene pilosa* and *Drosera paleacea* on the lower slope in grey sand (Et). This was represented by ANK04.

Open Low Woodland A of *Banksia attenuata* and *Banksia menziesii* occasionally with *Allocasuarina fraseriana* over Dense Thicket of *Kunzea glabrescens* over Herbs of *Dasypogon bromeliifolius* and *Philotheca spicata* in grey sand (Af). This was represented by AHK12.

Open Low Woodland A of *Melaleuca preissiana* over Thicket of *Kunzea glabrescens* and *Taxandria linearifolia* over Tall Sedges of *Lepidosperma longitudinale* and *Dielsia stenostachya* in grey sand along a minor drain (Ds). This was represented by ANK05 and ANK06.

Thicket
Dense Thicket of *Kunzea glabrescens* over Open Dwarf Scrub C of *Hypocalymma angustifolium* over Open Low Grass dominated by **Vulpia bromoides* over Very Open Low Sedges of *Dielsia stenostachya* or *Schoenus rigens* or *Hypolaena exsulca* in grey sand (Ha). This was represented by ANK10.

In addition there were two other areas identified. These are mapped as :
DEG = cultivated areas; and
? = where unable to access the Lot to determine the vegetation units present.

The vegetation units are mapped in Appendix C but the descriptions for these were only derived from Lots 33, 35, 100 and 13. Where the vegetation is mapped for other Lots it was solely assigned from viewing from adjacent properties or along the roads.

4.2 PATN Analysis

A PATN analysis was undertaken by TEH Griffin from the data supplied which is provided in full in Appendix D. The analysis is run using only presence/absence of taxa and does not take into account any vegetation cover. Two analyses were undertaken, firstly a dendrogram and then running to determine the nearest neighbour. This analysis resulted in the following summary.

Table 3. Summay of PATN Analysis

SITE	DENDROGRAM	NEAREST NEIGHBOUR	CONCLUSION
ANK12	21c	21c, 21a, 23a	21c, 21a, 23a
ANK13	21c	28, 21a	28, 21a
ANK01	11	?11	?11
ANK03	11	11,13	11,13
ANK02	11	11	11
ANK05	11	11	11
ANK06	11	11	11
ANK10	14	4, 21c, 11	4, 21c, 11
ANK11	14	?14	?14
ANK04	21c	21c, 23a	21c, 23a
ANK07	21c	21c	21c
ANK09	21c	21c	21c
ANK08	21c	21a, 23a, 21c	21a, 23a, 21c

4.3 Threatened Ecological Communities

No Threatened Ecological Communities were listed by the Department of Environment and Conservation as occurring at the survey area but there was a listing for a Priority Ecological Community (PEC) from Lot 100. This was the category 2 PEC, *Banksia ilicifolia* woodlands, southern Swan Coastal Plain (floristic community type 22). This is described by the Department of Environment and Conservation (2009b) as occurring in low lying sites generally consisting of *Banksia ilicifolia – B. attenuata* woodlands, but *Melaleuca preissiana* woodlands and scrubs are also recorded. It occurs on Bassendean and Spearwood systems in the central Swan Coastal Plain north of Rockingham. Typically it has very open understorey, and sites are likely to be seasonally waterlogged. However using the PATN analysis this PEC was not concluded, yet the same location where this PEC had been recorded by DEC was relocated. Quadrat ANK08 was placed in this unit. The unit was recorded between the eastern side of the survey area stretching across the survey area from east to west and ending just before the lake. It therefore traversed from a slight rise through lower ground, some of which would definitely have been inundated during winter. This was also the only community at the survey area where *Melaleuca thymoides* was recorded although this taxon, has been recorded from several different habitats elsewhere.

The level 3, Priority Ecological Community, Floristic Community Type (FCT) 21c has been concluded by using PATN as occurring at the survey area. It is represented by quadrats ANK07 and ANK09 which are included in the vegetation unit Em. This would indicate that the whole extent of the Em in that southern area is possibly representative of the PEC, FCT21c. Quadrat ANK11 was also identified in the field as being representative of vegetation unit Em but has been identified as closest to FCT14 so is separated in the mapping as EMN.

Quadrats ANK04, ANK12, ANK10 and ANK08, although not conclusive may also be representative of FCT21c. Floristic Community Type 21c is described by the Department of Environment and Conservation (2009b) as tending to occur in lower lying wetter areas and is variously dominated by *Melaleuca preissiana, Banksia attenuata, Banksia menziesii, Regelia ciliata, Eucalyptus marginata* subsp. *marginata* or *Corymbia calophylla*. It is restricted to the Bassendean system, occurring sporadically between Gingin and Bunbury.

4.4 Vegetation Condition

Bushland has been historically subject to ongoing degradation and is especially susceptible to disturbances arising as a result of indirect impacts from surrounding developments and human activity. Degradation is caused by a wide range of factors, including isolation, edge effects, weed invasion, plant diseases, changes in fire frequency, landscape fragmentation, increased predation on native fauna by feral animals, decrease in species richness and general modification of ecological function. These issues can affect the biodiversity rating and ecological viability of areas of remnant vegetation and should be assessed in line with conservation values.

Vegetation condition was rated according to the vegetation condition scale used in Keighery (1994). The vegetation condition recorded for each quadrat is included in Appendix B and mapped in Appendix C.

Table 4. Explanation of Vegetation Condition Rating (Keighery, 1994)

Rating	Description	Explanation
1	Pristine	Pristine or nearly so, no obvious signs of disturbance.
2	Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
3	Very Good	Vegetation structure altered, obvious signs of disturbance.
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it.
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.
6	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.

Using the vegetation condition rating explained in Table 4 most of the area was in good or very good vegetation condition. Tracks through the bushland varied from degraded to good depending upon the weed cover, condition of the endemic taxa and frequency of use. Table 5 provides the vegetation condition of the quadrats surveyed.

Table 5. Vegetation Condition of quadrats and Lots that could not be accessed

CONDITION	QUADRAT NUMBER
Very good	ANK01, ANK02, ANK06, ANK08, ANK12, ANK13
Good to Very Good	ANK03, ANK07, ANK09, ANK10, ANK11
Good	ANK04, ANK05, Lot 4
Degraded to Good	Lot 188
Degraded	Lot 3
Completely Degraded	Lot 652, Lot 2, Lot 189, Lot30, Lot 31, Lot 32, Lot 34, Lot 37, Lot 38, Lot 41

In addition to weeds there was rubbish scattered and dumped in the bushland, particularly in Lot 13. There appear to be many vehicles accessing that Lot, possibly from Thomas Road to the south, although it is private land.

Lot 3 was surveyed for the vegetation unit as well as condition but there were very few native trees on the property. Many non-endemic trees had been planted. The understorey was nearly non-existent having been replaced by weeds.

Lot 188 was viewed from the road edge. The road verge included several plants of **Euphorbia terracina* as well as a dense cover of grass weeds.

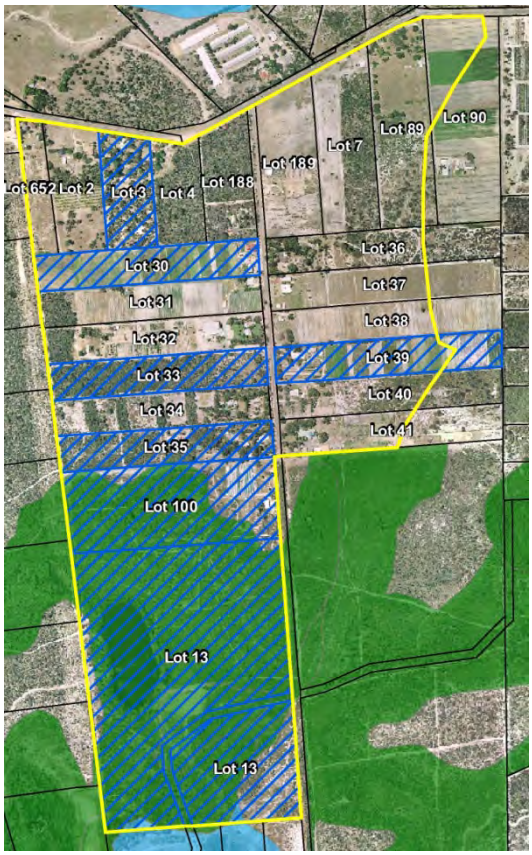

Diagram 2. From this aerial view of the study area the following Lots can be seen to be completely or nearly devoid of all vegetation: Lots 652, 2, 189, 7, 90 (along Anketell Road) , Lots 30, 31, 32, 37, 38, 39, 34 and 41 (along Treeby Road). The lots where access was permitted generally had the better natural vegetation

Photograph 1. Illustrates rubbish dumped around the edge of the lake and adjacent to the vegetation.

Photograph 2 illustrates a recent vehicle bashed track through remnant bushland close to the lake

Photograph 3 illustrating the width of some tracks through the area and a vehicle accessing one of these.

4.5 Significant Flora

Species of flora are defined as rare or priority conservation status where their populations are restricted geographically or threatened by local processes. The Department of Environment and Conservation recognises these threats of extinction and consequently applies regulations towards population and species protection. Rare Flora are gazetted under subsection 2 of section 23F of the Wildlife Conservation Act (1950) and therefore it is an offence to "take" or damage rare flora without approval from the Minister for the Environment. Prior to undertaking the field work a search of the Department of Environment and Conservation Rare and Priority Flora database was undertaken for potential Declared Rare and Priority flora that may occur at the study survey area (Table 6). This resulted in four declared rare flora, two priority 1 flora, four priority 3 flora and four priority 4 flora. The interpretation of the code is set out in Table 7.

Table 6. Potential Declared Rare and Priority Flora that may occur at the study area (Department of Environment and Conservation, 2009a). Department of the Environment, Water, Heritage and Arts (2009a) code in brackets. Description obtained from FloraBase (Western Australian Herbarium, 2009a)

TAXON	CODE	DESCRIPTION
Caladenia huegelii	R (E)	Tuberous, perennial, herb, 0.25–0.6 m high. Fl. green, cream, red, Sep–Oct. Grey or brown sand, clay loam.
Diuris micrantha	R (V)	Tuberous, perennial, herb, 0.3–0.6 m high. Fl. yellow, brown, Sep–Oct. Brown loamy clay. Winter-wet swamps, in shallow water.
Diuris purdiei	R (E)	Tuberous, perennial, herb, 0.15–0.35 m high. Fl. yellow, Sep–Oct. Grey-black sand, moist. Winter-wet swamps.
Drakaea elastica	R (E)	Tuberous, perennial, herb, 0.12–0.3 m high. Fl. red, green, yellow, Oct–Nov. White or grey sand. Low-lying situations adjoining winter-wet swamps.
Boronia juncea	1	Slender or straggly shrub, pedicels and sepals glabrous. Fl. pink, Apr. Sand. Low scrub.
Eremaea asterocarpa subsp. *brachyclada*	1	Shrub, to 0.7 m high. Fl. orange. Deep grey sand.
Aotus cordifolia	3	Erect or straggling shrub, 0.3–1.5 m high. Fl. yellow, Aug–Jan. Peaty soils. Swamps.
Cyathochaeta teretifolia	3	Rhizomatous, clumped, robust perennial, grass-like or herb (sedge), to 2 m high, to 1.0 m wide. Fl. brown. Grey sand, sandy clay. Swamps, creek edges.
Jacksonia gracillima	3	No description.
Stylidium longitubum	3	Erect annual (ephemeral), herb, 0.05–0.12 m high. Fl. pink, Oct–Dec. Sandy clay, clay. Seasonal wetlands.
Aponogeton hexatepalus	4	Rhizomatous or cormous, aquatic perennial, herb, leaves floating. Fl. green, white, Jul–Oct. Mud. Freshwater: ponds, rivers, claypans.
Dodonaea hackettiana	4	Erect shrub or tree, 1–5 m high. Fl. yellow, green, red, Jul–Oct. Sand. Outcropping limestone.
Stylidium ireneae	4	Lax perennial, herb, (0.06–)0.1–0.28 m high, Leaves oblanceolate, 0.4-2 cm long, 1-3 (-5) mm wide, apex subacute to acuminate, margin entire, glandular. Scape glandular. Inflorescence racemose. Fl. pink, Oct–Dec. Sandy loam. Valleys near creek lines, woodland, often with *Agonis*.
Verticordia lindleyi subsp. *lindleyi*	4	Erect shrub, 0.2–0.75 m high. Fl. pink, May/Nov–Jan. Sand, sandy clay. Winter-wet depressions.

Table 7. Code and description of Rare and Priority Flora categories (Wildlife Conservation Act (1950) (Department of Environment and Conservation, 2009a)

Code	Description of Declared Rare and Priority Flora Categories
R	DRF (Declared Rare Flora) -Extant Taxa. Taxa, which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection.
X	DRF (Declared Rare Flora) -Presumed Extinct Taxa. Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently.
1	Priority One -Poorly Known Taxa. Taxa, which are known from one or a few (generally <5) populations, which are under threat.
2	Priority Two -Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat.
3	Priority Three -Poorly Known Taxa. Taxa, which are known from several populations, at least some of which are not believed to be under immediate threat.
4	Priority Four -Rare Taxa. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.

Table 7 presents the definitions of Declared Rare and the four Priority Flora ratings under the Wildlife Conservation Act (1950) as extracted from Department of Environment and Conservation (2009a). Table 8 presents the definitions of the threatened species under the Environmental Protection and Diversity Conservation Act, 1999 (Department of the Environment, Water, Heritage and Arts (2009a).

Table 8. Categories of Threatened Flora Species (Environmental Protection and Biodiversity Conservation Act, 1999) (Department of the Environment, Water, Heritage and Arts (2009a)

Code	Code Declared Rare and Priority Flora Categories
Ex	Extinct Taxa which at a particular time if, at that time, there is no reasonable doubt that the last member of this species has died.
ExW	Extinct in the Wild Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	Critically Endangered Taxa which at any particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	Endangered Taxa, which is not critically endangered, and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	Vulnerable Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	Conservation Dependent Taxa which at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

Jacksonia gracillima a Priority 3 Flora, was recorded from 2 quadrats, ANK07 and ANK09. About 20 plants were recorded from each location. The plants at quadrat ANK07 were vegetative whereas those at quadrat ANK09 were in flower. It is a spreading somewhat lax shrub up to 1m in height. It is readily overlooked in dense vegetation.

Photograph 4 of the Priority 3 Flora, *Jacksonia gracillima*

No other Declared Rare or Priority Flora were recorded during the survey although a Declared Rare Flora has previously been recorded from Lot 35. An extensive search was undertaken of that Lot but if the DRF was an orchid species it may not have been visible in November.

4.6 Weeds

A total of 38 weeds were recorded from the survey area. All have been determined as weeds by the Western Australian Herbarium (2009a) and Department of Conservation and Land Management (1999). The rating allocated to each weed by CALM is based on three criteria:

Invasiveness – ability to invade natural bushland in good to excellent condition or ability to invade waterways.

Distribution – wide current or potential distribution including consideration of known history of wide spread distribution elsewhere in the world.

Environmental impacts – Ability to change the structure, composition and function of ecosystems. In particular an ability to form a monoculture in a vegetation community.

Ratings indicate the following:

High indicates this weed is prioritised for control and/or research ie prioritising funding to it.

Moderate indicates control or research effort should be directed to it if funds are available, however it should be monitored (possibly a reasonably high level of monitoring).

Mild indicates monitoring of the weed and control where appropriate.

Low indicates that this species would require a low level of monitoring

Table 9. Weeds recorded from the survey area

SCIENTIFIC NAME	COMMON NAME	CALM RATING	INVASIVENESS	IMPACTS
**Bromus diandrus*	Great brome	High	✓	✓
**Cortaderia selloana*	Pampas grass	High	✓	✓
**Ehrharta calycina*	Perennial veldt grass	High	✓	✓
**Euphorbia terracina*	Geraldton carnation weed	High	✓	✓
**Lagurus ovatus*	Hares tail grass	High	✓	✓
**Romulea rosea*	Guildford grass	High	✓	✓

SCIENTIFIC NAME	COMMON NAME	CALM RATING	INVASIVENESS	IMPACTS
**Typha orientalis*	Bullrush	High	✓	✓
**Acacia longifolia*	Sydney wattle	Moderate	✓	
**Aira caryophyllea*	Silvery hair grass	Moderate	✓	
**Anagallis arvensis* var. *arvensis*	Pimpernel	Moderate	✓	
**Arctotheca calendula*	Cape weed	Moderate	✓	
**Avena barbata*	Bearded oat	Moderate	✓	
**Briza maxima*	Blowfly grass	Moderate	✓	
**Briza minor*	Shivery grass	Moderate	✓	
**Carpobrotus edulis*	Hottentot fig	Moderate	✓	
**Cirsium vulgare*	Slender thistle	Moderate	✓	
**Disa bracteata*	South African orchid	Moderate	✓	
**Ehrharta longiflora*	Annual veldt grass	Moderate	✓	
**Gladiolus caryophyllaceus*	Wild gladiolus	Moderate	✓	
**Hypochaeris glabra*	Flatweed	Moderate	✓	
**Juncus bufonius*	Toad rush	Moderate	✓	
**Lolium rigidum*	Annual rye grass	Moderate	✓	
**Orobanche minor*	Lesser broomrape	Moderate	✓	
**Polypogon monspeliensis*	Annual beardgrass	Moderate	✓	
**Pseudognaphalium luteoalbum*	Jersey cudweed	Moderate	✓	
**Senecio diaschides*		Moderate	✓	
**Solanum americanum*	Glossy nightshade	Moderate	✓	
**Solanum nigrum*	Black berry nightshade	Moderate	✓	
**Sonchus asper*	Prickly sowthistle	Moderate	✓	
**Sonchus oleraceus*	Common sowthistle	Moderate	✓	
**Ursinia anthemoides*	Ursinia	Moderate	✓	
**Vulpia bromoides*	Squirrels tail fescue	Moderate	✓	
**Phytolacca octandra*	Inkweed	Mild		
**Arundo donax*	Bamboo	Low		
**Conyza bonariensis*	Flaxleaf fleabane	Low		
**Lotus subbiflorus*	Lotus	Low		
**Cotula coronopifolia*	Waterbuttons	To be assessed		
**Isolepis marginata*	Coarse club rush	To be assessed		

Seven of the weeds were rated as High, indicating that these weeds should be targeted for removal. **Typha orientalis* was only recorded at the northern end of the lake; **Cortaderia selloana* from the southern end of Lot 13 close to where ANK01 was surveyed; **Bromus diandrus, *Ehrharta calycina, *Lagurus ovatus* and **Romulea rosea* were recorded scattered or in dense clumps across the survey area and **Euphorbia terracina* was only recorded on Treeby Road verge adjacent to Lot 188.

5. DISCUSSION

The Anketell Urban Deferred Area consists of 23 different lots all of which are privately owned of which access into 7 was permitted. From the aerial photograph provided 9 lots were completely degraded as they were being farmed, another 6 were extensively cleared but did appear to retain a small area of remnant bushland. Of the 8 Lots with an extensive cover of remnant bushland, access was permitted into 5 of them, including Lot 13 which covered the largest area.

A total of 58 vascular plant families, 125 genera and 167 taxa of which 38 were weeds were recorded from the survey area. The dominant plant families were Poaceae, Papilionaceae, Myrtaceae and Asteraceae.

A total of 10 different vegetation units were described for the survey area. These were:

- Open Low Woodland A of *Eucalyptus rudis* subsp. *rudis* over Low Scrub B of *Astartea scoparia* over Tall Sedges dominated by *Juncus pallidus*;
- Low Woodland A of *Eucalyptus rudis* subsp. *rudis, Melaleuca preissiana* and *Melaleuca rhaphiophylla* over Thicket of *Kunzea glabrescens* over Dwarf Scrub of *Astartea scoparia*.;
- Open Woodland of *Eucalyptus rudis* subsp. *rudis* and *Melaleuca preissiana* over Dense Thicket of *Kunzea glabrescens* over Open Low Scrub A dominated by *Leucopogon australis.* This was the dominant vegetation in the southern section of Lot 13;
- Open Low Woodland A of *Melaleuca preissiana* over Thicket of *Kunzea glabrescens* and *Taxandria linearifolia* over Tall Sedges of *Lepidosperma longitudinale* and *Dielsia stenostachya*. This was the vegetation associated with the minor drain through the survey area;
- Low Forest A of *Banksia attenuata, Banksia menziesii* and *Allocasuarina fraseriana* over Open Scrub of *Kunzea glabrescens* over Heath B dominated by *Hibbertia hypericoides.* This was recorded from higher ground in Lot 32 and Lot 33;
- Open Tall Woodland of *Eucalyptus marginata* subsp. *marginata* occasionally with scattered trees of *Melaleuca preissiana* over Dense Thicket of *Kunzea glabrescens.* This was the dominant vegetation over most of the survey area;
- Low Woodland A of *Banksia attenuata, Banksia ilicifolia* and *Nuytsia floribunda* over Thicket of *Kunzea glabrescens* and *Melaleuca thymoides* over Low Heath D dominated by *Scholtzia uberiflora* and *Aotus procumbens.* This was the vegetation of the Priority Ecological Community;.
- Open Low Woodland A of *Eucalyptus todtiana, Banksia menziesii* and *Banksia attenuata* over Dense Thicket of *Kunzea glabrescens* over Dwarf Scrub D of *Scholtzia uberiflora* over Open Low Grass dominated by **Vulpia bromoides* over Herbs dominated by *Trachymene pilosa* and *Drosera paleacea.* This was recorded as a very small area on the western side of Lot 13 but did continue as the main vegetation into the adjoining property;
- Open Low Woodland A of *Banksia attenuata* and *Banksia menziesii* occasionally with *Allocasuarina fraseriana* over Dense Thicket of *Kunzea glabrescens* over Herbs of *Dasypogon bromeliifolius* and *Philotheca spicata* in grey sand (Af). This was from Lot 35; and
- Dense Thicket of *Kunzea glabrescens* over Open Dwarf Scrub C of *Hypocalymma angustifolium* over Open Low Grass dominated by **Vulpia bromoides* over Very Open Low Sedges of *Dielsia stenostachya* or *Schoenus rigens* or *Hypolaena exsulca*. This vegetation unit occurred as a distinct unit in Lot 13.

No Threatened Ecological Communities were recorded by the Department of Environment and Conservation (2009b) but one Priority Ecological Community, *Banksia ilicifolia* woodlands, southern Swan Coastal Plain (floristic community type 22) was recorded as being present at the survey area by the Department of Environment and Conservation. The accuracy of the Department of Environment and Conservation data location for this FCT is questionable as indicated in correspondence to T. Cowell (360 Environmental) from M. Hunter (Department of Environment and Conservation).

A PATN analysis was undertaken by TEH Griffin (see Appendix D) identified the level 3, Priority Ecological Community FCT21c as occurring at the survey area. Using PATN, quadrats ANK07 and ANK09 were concluded to be FCT21c, which were described in Section 4.2 as vegetation unit Em. Quadrat FCT11 was also identified in Section 4.2 as being representative of vegetation unit Em but in the PATN analysis was assessed to be FCT14, so is mapped as a slightly different unit, EmN.

ANK08 which was specifically placed in the area identified by the Department of Environment and Conservation as representative of FCT22, was determined using PATN to be FCT 21a, 23a, 21c. Therefore FCT22 could not be confirmed at the site.

No Declared Rare Flora were observed but a Priority 3 Flora, *Jacksonia gracillima* was recorded from two areas within the survey area with a total of about 40 plants being recorded. This is a shrub about 1m tall with the typical yellow and orange flowers of *Jacksonia* species. When in flower it is readily observed but when vegetative it blends into the surrounding bushland.

The survey area included a conservation category wetland. There are many tracks accessing the lake as visible in Diagram 3 below. These appear to originate from Thomas Road to the south, from the firebreaks along the properties, the road reserve and the continuation of Treeby Road. Although these have opened the area the majority of the surrounding bushland is in good or very good condition. By closing the tracks and allowing the area to rehabilitate naturally it should be possible to return it to a better condition. In several of the quadrats assessed seedlings of the trees were recorded.

Diagram 3. Lake illustrating tracks accessing the lake

A total of 38 weeds were recorded from the survey area of which 7 were rated as high. These are the weeds that should be targeted for removal. These were:
**Typha orientalis* – recorded from the northern end of the lake;
**Cortaderia selloana* – recorded from the southern end of Lot 13;
**Euphorbia terracina* – recorded from the verge of Treeby Road adjacent to Lot 188; and
**Bromus diandrus, *Ehrharta calycina, *Lagurus ovatus* and **Romulea rosea*- recorded scattered throughout the survey area.

Lot 13 has the largest area of remnant bushland, and it also includes the lake and the narrow, deeply incised drain. Lot 100 immediately to the north of Lot 13 also has a good cover of remnant bushland. The only other lot that was surveyed that still retained a reasonable area of remnant bushland was Lot 33. The majority of Lots have been fully or partially developed for agriculture/horticulture.

6. RECOMMENDATION

As the Priority Ecological Community FCT21c was identified at the site it is recommended, on the advice of V. English (Department of Environment and Conservation) that an additional spring survey be undertaken early in spring and the data be re-run using PATN. This will provide more clarity on the distribution of the Priority Ecological Community. A second spring survey is also recommended by the Town of Kwinana Local Biodiversity strategy.

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APPENDIX A

Species listed under vascular plant families

ABBREVIATION	INTERPRETATION
subsp.	Subspecies
var.	Variety
forma	Form
sp.	Species as unable to identify to species due to having vegetative material only
*	weed
?	unsure if taxon name applied is correct as plants only vegetative

VASCULAR PLANT FAMILY
Taxon

Dennstaedtiaceae
Pteridium esculentum
Zamiaceae
Macrozamia riedlei
Typhaceae
**Typha orientalis*
Poaceae
**Aira caryophyllea*
Amphipogon turbinatus
**Arundo donax*
Austrostipa compressa
**Avena barbata*
**Briza maxima*
**Briza minor*
**Bromus diandrus*
**Cortaderia selloana*
**Ehrharta calycina*
**Ehrharta longiflora*
**Lagurus ovatus*
**Lolium rigidum*
**Polypogon monspeliensis*
**Vulpia bromoides*
Cyperaceae
**Isolepis marginata*
Lepidosperma longitudinale
Lepidosperma squamatum
Mesomelaena pseudostygia
Schoenus rigens
Restionaceae
Dielsia stenostachya
Hypolaena exsulca
Desmocladus flexuosus
Anarthriaceae
Lyginia barbata
Centrolepidaceae
Centrolepis drummondii
Juncaceae
**Juncus bufonius*
Juncus pallidus
Asparagaceae
Chamaescilla corymbosa
Laxmannia grandiflora subsp. *grandiflora*
Lomandra caespitosa
Lomandra hermaphrodita
Sowerbaea laxiflora
Thysanotus patersonii
Thysanotus thyrsoides
Dasypogonaceae
Dasypogon bromeliifolius
Xanthorrhoeaceae
Xanthorrhoea preissii

VASCULAR PLANT FAMILY
Taxon

Colchicaceae
Burchardia umbellata
Hemerocallidaceae
Caesia parviflora
Dianella revoluta var. *divaricata*
Haemodoraceae
Anigozanthos humilis subsp. *humilis*
Anigozanthos manglesii
Conostylis aculeata
Conostylis juncea
Haemodorum spicatum
Phlebocarya ciliata
Iridaceae
**Gladiolus caryophyllaceus*
Patersonia occidentalis
**Romulea rosea*
Orchidaceae
Caladenia flava
Caladenia macrostylis
**Disa bracteata*
Diuris corymbosa
Diuris sp.
Microtis media
Pterostylis pyramidalis
Pterostylis vittata
Thelymitra pauciflora
Casuarinaceae
Allocasuarina fraseriana
Proteaceae
Adenanthos cygnorum
Banksia attenuata
Banksia ilicifolia
Banksia menziesii
Persoonia saccata
Petrophile linearis
Stirlingia latifolia
Synaphea spinulosa
Sapindaceae
Nuytsia floribunda
Polygonaceae
Persicaria ? *decipiens*
Phytolaccaceae
**Phytolacca octandra*
Aizoaceae
**Carpobrotus edulis*
Molluginaceae
Macarthuria australis
Lauraceae
Cassytha racemosa forma *racemosa*

VASCULAR PLANT FAMILY
Taxon

Droseraceae
Drosera erythrorhiza
Drosera macrantha
Drosera paleacea
Drosera pallida
Drosera stolonifera
Crassulaceae
Crassula colorata
Mimosaceae
Acacia huegelii
**Acacia longifolia*
Acacia pulchella var. *glaberrima*
Acacia saligna
Papilionaceae
Aotus gracillima
Aotus intermedia
Aotus procumbens
Bossiaea eriocarpa
Daviesia divaricata
Euchilopsis linearis
Gastrolobium capitatum
Gompholobium tomentosum
Hardenbergia comptoniana
Hovea trisperma
Jacksonia furcellata
Jacksonia gracillima
Jacksonia sternbergiana
Kennedia prostrata
**Lotus subbiflorus*
Pultenaea reticulata
Rutaceae
Philotheca spicata
Euphorbiaceae
**Euphorbia terracina*
Poranthera microphylla
Stackhousiaceae
Stackhousia monogyna
Tripterococcus brunonis
Dilleniaceae
Hibbertia hypericoides
Hibbertia racemosa
Hibbertia subvaginata
Thymelaeaceae
Pimelea rosea subsp. *rosea*
Myrtaceae
Astartea scoparia
Eremaea pauciflora
Eucalyptus marginata subsp. *marginata*
Eucalyptus rudis subsp. *rudis*
Eucalyptus todtiana
Hypocalymma angustifolium

VASCULAR PLANT FAMILY
Taxon

Myrtaceae (cont.)
Hypocalymma robustum
Kunzea glabrescens
Melaleuca preissiana
Melaleuca rhaphiophylla
Melaleuca teretifolia
Melaleuca thymoides
Scholtzia involucrata
Scholtzia uberiflora
Taxandria linearifolia

Apiaceae
Centella asiatica
Daucus glochidiatus
Hydrocotyle callicarpa
Trachymene pilosa

Epacridaceae
Astroloma pallidum
Brachyloma preissii
Conostephium pendulum
Leucopogon australis
Leucopogon conostephioides
Lysinema ciliatum

Primulaceae
**Anagallis arvensis* var. *arvensis*

Loganiaceae
Phyllangium paradoxum

Solanaceae
**Solanum americanum*
**Solanum nigrum*

Orobanchaceae
**Orobanche minor*

Plantaginaceae
Gratiola pubescens

Rubiaceae
Opercularia vaginata

Campanulaceae
Wahlenbergia ? *multicaulis*

Lobeliaceae
Lobelia alata
Lobelia rhytidosperma

Goodeniaceae
Dampiera linearis
Lechenaultia floribunda

Stylidiaceae
Levenhookia stipitata
Stylidium brunonianum
Stylidium paludicola
Stylidium perpusillum
Stylidium repens
Stylidium utricularioides

VASCULAR PLANT FAMILY *Taxon*
Asteraceae
**Arctotheca calendula*
**Cirsium vulgare*
**Conyza bonariensis*
**Cotula coronopifolia*
**Hypochaeris glabra*
Pithocarpa pulchella var. *pulchella*
Podotheca angustifolia
Podotheca chrysantha
**Pseudognaphalium luteoalbum*
**Senecio diaschides*
Siloxerus humifusus
**Sonchus asper*
**Sonchus oleraceus*
**Ursinia anthemoides*

APPENDIX B

Quadrat Data

ABBREVIATION	INTERPRETATION
subsp.	Subspecies
var.	Variety
forma	Form
sp.	Species as unable to identify to species due to having vegetative material only
*	weed
?	unsure if taxon name applied is correct as plants only vegetative

QUADRAT ANK01

Location: Lot 13 , south west corner
Datum (WGS84): 392117E; 6433948N
Soil: Grey sand
Litter: Leaves 50%; Branches 30%
Topography: Flat
Vegetation Description: Open Woodland of *Eucalyptus rudis* subsp. *rudis* over Dense Thicket of *Kunzea glabrescens* over Open Low Scrub A dominated by *Leucopogon australis*
Vegetation Condition: 3 but most surrounding area is 3-4
Other Notes: Close by are *Melaleuca preissiana* trees. Lot of rubbish dumped. Many juvenile *Eucalyptus rudis* subsp. *rudis*

TAXON	HEIGHT (CM)	% COVER
Astartea scoparia	200	1
Austrostipa compressa	25	<1
**Briza maxima*	50	3
Cassytha racemosa forma *racemosa*	twiner	1
Daucus glochidiatus	10	<1
**Ehrharta longiflora*	30	<1
Eucalyptus rudis subsp. *rudis*	1600	10
Hypocalymma angustifolium	50	3
**Hypochaeris glabra*	25	1
Kunzea glabrescens	400	80
Leucopogon australis	250	5
**Lolium rigidum*	20	<1

TAXON	HEIGHT (CM)	% COVER
**Lotus subbiflorus*	10	<1
Pultenaea reticulata	175	1
**Solanum americanum*	200	<1
**Solanum nigrum*	50	1
**Sonchus asper*	60	1
**Sonchus oleraceus*	70	3
Thysanotus patersonii	200	<1
**Acacia longifolia*	Opportunistic	
Acacia pulchella var. *glaberrima*	Opportunistic	
Adenanthos cygnorum	Opportunistic	
**Aira caryophyllea*	Opportunistic	
**Arctotheca calendula*	Opportunistic	
Banksia ilicifolia	Opportunistic	
**Briza minor*	Opportunistic	
**Bromus diandrus*	Opportunistic	
Burchardia umbellata	Opportunistic	
Carpobrotus edulis	Opportunistic	
**Cirsium vulgare*	Opportunistic	
Conostylis juncea	Opportunistic	
**Conyza bonariensis*	Opportunistic	
**Cortaderia selloana*	Opportunistic	
Crassula colorata	Opportunistic	
Dampiera linearis	Opportunistic	
Dianella revoluta var. *divaricata*	Opportunistic	
Dielsia stenostachya	Opportunistic	
**Disa bracteata*	Opportunistic	
Diuris corymbosa	Opportunistic	
**Ehrharta calycina*	Opportunistic	
**Gladiolus caryophyllaceus*	Opportunistic	
Gompholobium tomentosum	Opportunistic	
**Isolepis marginata*	Opportunistic	
**Juncus bufonius*	Opportunistic	
Lepidosperma longitudinale	Opportunistic	
Melaleuca preissiana	Opportunistic	
Melaleuca rhaphiophylla	Opportunistic	
Microtis media	Opportunistic	
Orobanche minor	Opportunistic	
Phlebocarya ciliata	Opportunistic	
**Phytolacca octandra*	Opportunistic	
Pimelea rosea subsp. *rosea*	Opportunistic	
Pteridium esculentum	Opportunistic	
**Romulea rosea*	Opportunistic	
Scholtzia uberiflora	Opportunistic	
Senecio diaschides	Opportunistic	
Stylidium repens	Opportunistic	
**Ursinia anthemoides*	Opportunistic	
**Vulpia bromoides*	Opportunistic	

QUADRAT ANK02

Location: Lot 13, on east side of lake
Datum (WGS84): 392223E; 6434362N
Soil: Grey loam
Litter: Leaves 30%
Topography: Lake edge
Vegetation Description: Low Woodland A of *Eucalyptus rudis* subsp. *rudis*, *Melaleuca preissiana* and *Melaleuca rhaphiophylla* over Thicket of *Kunzea glabrescens* over Dwarf Scrub C of *Astartea scoparia*
Vegetation Condition: 3, tracks through the area 3-4
Other Notes: Lot of rubbish on lake edge and in the water. Edge of lake very weedy. Vegetation is common around the lake edge.

TAXON	HEIGHT (CM)	% COVER
Acacia pulchella var. *glaberrima*	60	5
**Anagallis arvensis* var. *arvensis*	10	<1
Astartea scoparia	60	15
**Briza maxima*	50	3
**Briza minor*	30	10
**Carpobrotus edulis*	10	1
Cassytha racemosa forma *racemosa*	twiner	30
Centella asiatica	20	<1
Dielsia stenostachya	50	1
Eucalyptus rudis subsp. *rudis*	1000	10
Hypocalymma angustifolium	30	1
Juncus pallidus	70	1
Kunzea glabrescens	300	70
**Lotus subbiflorus*	15	5
Melaleuca preissiana	800	2
Melaleuca teretifolia	300	2
**Vulpia bromoides*	30	10
**Aira caryophyllea*	Opportunistic	
**Arundo donax*	Opportunistic	
Dampiera linearis	Opportunistic	

TAXON	HEIGHT (CM)	% COVER
Hydrocotyle callicarpa	Opportunistic	
**Isolepis marginata*	Opportunistic	
Lepidosperma longitudinale	Opportunistic	
Melaleuca rhaphiophylla	Opportunistic	
Phyllangium paradoxum	Opportunistic	
Siloxerus humifusus	Opportunistic	
Stylidium perpusillum	Opportunistic	
Stylidium utricularioides	Opportunistic	
Thelymitra pauciflora	Opportunistic	

QUADRAT ANK 03

Location: Lot 13, northern tip of lake
Datum (WGS84): 392135E; 6434470N
Soil: Black peaty sand, damp
Litter: Leaves 15%; Logs 5%
Topography: Lake edge
Vegetation Description: Open Low Woodland A of *Eucalyptus rudis* subsp. *rudis* over Low Scrub B of *Astartea scoparia* over Tall Sedges dominated by *Juncus pallidus*
Vegetation Condition: 3-4
Other Notes: This vegetation unit only a small section at the northern edge of the lake. Most of the surrounding lake vegetation is as described at ANK02

TAXON	HEIGHT (CM)	% COVER
Astartea scoparia	150	15
**Avena barbata*	70	5
**Briza maxima*	50	2
**Briza minor*	20	25
Cassytha racemosa forma *racemosa*	twiner	15
Cotula coronopifolia	20	5
Eucalyptus rudis subsp. *rudis*	1000	5
Gratiola pubescens	20	<1
**Hypochaeris glabra*	30	2
**Isolepis marginata*	10	<1
Juncus pallidus	125	70

TAXON	HEIGHT (CM)	% COVER
Lobelia alata	30	<1
**Lolium rigidum*	35	<1
**Lotus subbiflorus*	25	25
Persicaria? decipiens	80	<1
**Polypogon monspeliensis*	70	<1
Senecio diaschides	70	1
**Sonchus asper*	70	1
**Sonchus oleraceus*	70	1
**Typha orientalis*	70	5
**Vulpia bromoides*	50	3
Aotus gracillima	Opportunistic	
**Arctotheca calendula*	Opportunistic	
**Carpobrotus edulis*	Opportunistic	
**Lagurus ovatus*	Opportunistic	
Melaleuca rhaphiophylla	Opportunistic	
Microtis media	Opportunistic	

QUADRAT ANK04

Location: Lot 13, on western edge of survey area
Datum (WGS84): 392089E; 6434150N
Soil: Grey sand
Litter: Leaves 70%; Branches 15%
Topography: Lower slope
Vegetation Description: Open Low Woodland A of *Eucalyptus todtiana*, *Banksia menziesii* and *Banksia attenuata* over Dense Thicket of *Kunzea glabrescens* over Dwarf Scrub D of *Scholtzia uberiflora* over Open Low Grass dominated by **Vulpia bromoides* over Herbs dominated by *Trachymene pilosa* and *Drosera paleacea*
Vegetation Condition: 4
Other Notes: Higher ground consisting of narrow strip to the west of the lake on the boundary. Continues into the property on the west

TAXON	HEIGHT (CM)	% COVER
Austrostipa compressa	70	<1
Banksia menziesii	800	2
Burchardia umbellata	50	<1
**Carpobrotus edulis*	20	3
Crassula colorata	15	5
Drosera paleacea	5	30
Gompholobium tomentosum	20	<1
Hibbertia subvaginata	70	1
**Hypochaeris glabra*	25	5
**Isolepis marginata*	10	<1

TAXON	HEIGHT (CM)	% COVER
Kunzea glabrescens	600	75
Scholtzia uberiflora	30	15
Stylidium perpusillum	30	<1
Stylidium repens	25	<1
Trachymene pilosa	25	20
**Vulpia bromoides*	40	30
Banksia attenuata	Opportunistic	
**Briza maxima*	Opportunistic	
**Ehrharta calycina*	Opportunistic	
**Ehrharta longiflora*	Opportunistic	
Eucalyptus todtiana	Opportunistic	

QUADRAT ANK05

Location: Lot 13
Datum (WGS84): 392242E; 6434107N. Also resurveyed at 392255E; 6434122N
Soil: Grey sand
Litter: Leaves 10%; Branches 5%
Topography: Minor drain
Vegetation Description: Low Woodland A of *Melaleuca preissiana* and *Eucalyptus rudis* subsp. *rudis* over Low Scrub A of *Kunzea glabrescens* over Open Tall Sedges of *Lepidosperma longitudinale* over Open Ferns of *Pteridium esculentum*
Vegetation Condition: 4
Other Notes: Drain bed. First site burnt about 18 months where there were a large number of *Eucalyptus rudis* subsp. *rudis* seedlings. Narrow quadrat done down the drain. Second site was denser vegetation

TAXON	HEIGHT (CM)	% COVER
Acacia pulchella var. *glaberrima*	70	15
Austrostipa compressa	70	1
**Briza maxima*	70	1
**Carpobrotus edulis*	10	<1
Centrolepis drummondii	60	3
Crassula colorata	10	2

TAXON	HEIGHT (CM)	% COVER
Dielsia stenostachya	60	10
Eucalyptus rudis subsp. *rudis*	1200	5
**Hypochaeris glabra*	70	<1
**Isolepis marginata*	5	<1
Kunzea glabrescens	50	20
Lepidosperma longitudinale	60	10
**Lotus subbiflorus*	20	1
Melaleuca preissiana	1200	10
Melaleuca teretifolia	90	2
Opercularia vaginata	40	2
Pteridium esculentum	200	20
Stylidium utricularioides	2	<1
**Vulpia bromoides*	50	3
Acacia saligna	Opportunistic	
**Arctotheca calendula*	Opportunistic	
Hypocalymma angustifolium	Opportunistic	
Juncus pallidus	Opportunistic	
Taxandria linearifolia	Opportunistic	

QUADRAT NUMBER ANK06

Location: Lot 13
Datum (WGS84): 392356E; 6434197N. Also surveyed at 392542E; 6434243N
Soil: Grey sand
Litter: Leaves 50%; Branches 80%; Logs 5%
Topography: Minor drain
Vegetation Description: Open Low Woodland A of *Melaleuca preissiana* over Thicket of *Kunzea glabrescens* and *Taxandria linearifolia* over Tall Sedges of *Lepidosperma longitudinale* and *Dielsia stenostachya*
Vegetation Condition: 3
Other Notes: Drain consists of several channels. Not burnt. Drain dry, deeply incised

TAXON	HEIGHT (CM)	% COVER
Acacia pulchella var. *glaberrima*	10	<1
Aotus gracillima	175	5
Astartea scoparia	100	2
Dielsia stenostachya	60	15
Gratiola pubescens	10	1
Hypocalymma angustifolium	90	1
**Hypochaeris glabra*	30	1
Kunzea glabrescens	1000	25
Lepidosperma longitudinale	100	25
Lobelia alata	30	1
Melaleuca preissiana	1200	10
Melaleuca rhaphiophylla	1000	1
Taxandria linearifolia	220	15
Lobelia rhytidosperma	Opportunistic	
**Vulpia bromoides*	Opportunistic	

QUADRAT NUMBER ANK07

Location: Lot 13, south east area
Datum (WGS84): 392466E; 6434139N
Soil: Grey sand
Litter: Leaves 60%; Branches 35%
Topography: Lower slope
Vegetation Description: OpenTall Woodland of *Eucalyptus marginata* subsp. *marginata* over Dense Thicket of *Kunzea glabrescens*
Vegetation Condition: 3-4
Other Notes: Possibly same unit as ANK04. Several *Eucalyptus marginata* subsp. *marginata* seedlings. Several stumps from trees previously cut down.

TAXON	HEIGHT (CM)	% COVER
Acacia pulchella var. *glaberrima*	50	<1
Banksia ilicifolia	40	<1
**Briza maxima*	30	<1
Caladenia flava	20	<1
Conostylis juncea	40	<1
Crassula colorata	10	1
0Drosera erythrorhiza	5	3
Drosera pallida	twiner	<1
**Ehrharta calycina*	70	<1
Eucalyptus marginata subsp. *marginata*	1800	10
Gompholobium tomentosum	50	1
**Hypochaeris glabra*	10	2
Jacksonia gracillima	35	<1
Kennedia prostrata	10	<1
Kunzea glabrescens	500	75
**Lotus subbiflorus*	5	<1
Microtis media	20	<1
Poranthera microphylla	10	<1
Pterostylis vittata	20	<1
Thysanotus patersonii	twiner	<1
Trachymene pilosa	20	<1

TAXON	HEIGHT (CM)	% COVER
**Ursinia anthemoides*	30	<1
**Vulpia bromoides*	25	5
Allocasuarina fraseriana	Opportunistic	
Banksia menziesii	Opportunistic	
Banksia attenuata	Opportunistic	
**Carpobrotus edulis*	Opportunistic	
**Gladiolus caryophyllaceus*	Opportunistic	

QUADRAT ANK08

Location: Lot 13
Datum (WGS84): 392411E; 6434596E
Soil: Grey sand with limestone close to the surface
Litter: Leaves 40%; Branches 20%; Logs 5%
Topography: Upper slope on slight rise
Vegetation Description: Low Woodland A of *Banksia attenuata*, *Banksia ilicifolia* and *Nuytsia floribunda* over Thicket of *Kunzea glabrescens* and *Melaleuca thymoides* over Low Heath D dominated by *Scholtzia uberiflora* and *Aotus procumbens*
Vegetation Condition: 3
Other Notes: Priority Ecological Community. Tall *Nuytsia floribunda* outside of the quadrat. Continues close to edge of lake

No photograph taken

TAXON	HEIGHT (CM)	% COVER
Aotus procumbens	50	10
Astroloma pallidum	60	3
Banksia attenuata	1000	5
Banksia ilicifolia	1600	10
Bossiaea eriocarpa	50	5
**Briza maxima*	50	3
Caladenia macrostylis	25	<1
**Carpobrotus edulis*	30	1
Dasypogon bromeliifolius	70	5
Diuris sp.	30	<1
Drosera pallida	twiner	<1
Ehrharta longiflora	50	5
Hibbertia racemosa	50	2
Hovea trisperma	70	<1
Hypocalymma robustum	50	<1
**Hypochaeris glabra*	10	<1
Hypolaena exsulca	70	2
Kunzea glabrescens	500	30
Lomandra caespitosa	40	3
Lyginia barbata	70	<1
Lysinema ciliatum	70	<1
Melaleuca thymoides	300	30
Microtis media	15	<1
Nuytsia floribunda	50	1
Phlebocarya ciliata	70	3
Pterostylis pyramidata	15	<1
Pterostylis vittata	20	<1
Scholtzia uberiflora	30	10
Stackhousia monogyna	40	<1
**Vulpia bromoides*	50	5
Allocasuarina fraseriana	Opportunistic	
Banksia menziesii	Opportunistic	

QUADRAT ANK09

Location: Lot 13
Datum (WGS84): 392412E; 6434474N
Soil: Grey sand
Litter: Leaves 30%; Branches 25%
Topography: Flat
Vegetation Description: Dense Thicket of *Kunzea glabrescens* over Open Dwarf Scrub C of *Hypocalymma angustifolium* over and Open Low Grass dominated by **Vulpia bromoides* Over Very Open Low Sedges of *Dielsia stenostachya*
Vegetation Condition: 3-4
Other Notes: Occasional *Melaleuca preissiana*

TAXON	HEIGHT (CM)	% COVER
Acacia pulchella var. *glaberrima*	50	<1
**Carpobrotus edulis*	10	2
Conostylis juncea	30	<1
Crassula colorata	10	<1
Dielsia stenostachya	50	10
Gompholobium tomentosum	50	1
Hypocalymma angustifolium	70	5
**Hypochaeris glabra*	40	2
Jacksonia gracillima	50	1
Kunzea glabrescens	500	85
Phlebocarya ciliata	50	3
Thysanotus patersonii	twiner	<1
**Vulpia bromoides*	20	5
Austrostipa compressa	Opportunistic	
Banksia ilicifolia	Opportunistic	
Melaleuca preissiana	Opportunistic	
Philotheca spicata	Opportunistic	

QUADRAT ANK10

Location: Lot 13 on eastern edge
Datum (WGS84): 392488E; 6434479N
Soil: Grey sand
Litter: Leaves 10%; branches 10%
Topography: Flat
Vegetation Description: Open Scrub of *Kunzea glabrescens* over Dwarf Scrub C of *Hypocalymma angustifolium* over Open Tall Sedges dominated by *Hypolaena exsulca* and *Schoenus rigens*
Vegetation Condition: 3-4
Other Notes: Possibly a disturbance area

TAXON	HEIGHT (CM)	% COVER
Acacia pulchella var. *glaberrima*	60	1
Aotus intermedia	50	<1
Austrostipa compressa	70	2
**Briza maxima*	40	5
**Briza minor*	30	<1
Conostylis juncea	50	<1
Dampiera linearis	15	<1
Euchilopsis linearis	50	2
Hypocalymma angustifolium	60	20
Hypolaena exsulca	80	5
Kunzea glabrescens	220	5
Mitrasacme paradoxa	10	<1
Phlebocarya ciliata	70	3
Pseudognaphalium luteoalbum	2	<1
Schoenus rigens	80	5
Stylidium paludicola	70	1
Stylidium utricularioides	2	<1
Melaleuca preissiana	Opportunistic	

QUADRAT ANK11

Location: Lot 100
Datum (WGS84): 392305E; 6434772N
Soil: Grey sand
Litter: Leaves 70%; Branches 30%
Topography: Flat
Vegetation Description: Open Woodland of *Eucalyptus marginata* subsp. *marginata* and *Melaleuca preissiana* over Dense Thicket of *Kunzea glabrescens*
Vegetation Condition: 3-4
Other Notes: Regrowth thicket of *Kunzea glabrescens*

TAXON	HEIGHT (CM)	% COVER
Acacia pulchella var. *glaberrima*	70	1
Aotus intermedia	60	1
**Briza minor*	30	15
**Ehrharta calycina*	70	2
**Ehrharta longiflora*	40	1
Eucalyptus marginata subsp. *marginata*	1400	5
Hypocalymma angustifolium	50	2
**Hypochaeris glabra*	10	3
Kunzea glabrescens	600	98
Melaleuca preissiana	1600	5
**Arctotheca calendula*	Opportunistic	
**Carpobrotus edulis*	Opportunistic	
Euchilopsis linearis	Opportunistic	
**Phytolacca octandra*	Opportunistic	

QUADRAT ANK12

Location: Lot 35
Datum (WGS84): 392108E; 6434826N
Soil: Grey sand
Litter: Bark 25%; Leaves 40%; Branches 25%
Topography: Lower slope
Vegetation Description: Open Low Woodland A of *Banksia attenuata* and *Banksia menziesii* over Dense Thicket of *Kunzea glabrescens* over Herbs of *Dasypogon bromeliifolius* and *Philotheca spicata*
Vegetation Condition: 3
Other Notes: From the track on the eastern side of this Lot there appears to be dieback as there are several *Banksias* dead.
Lot 34 condition 4 but along western edge is condition 3.
Lot 33 condition 4. More *Eucalyptus marginata* subsp. *marginata* in this Lot. Becomes condition 3 near western edge

TAXON	HEIGHT (CM)	% COVER
Amphipogon turbinatus	50	1
Astroloma pallidum	70	10
Banksia attenuata	600	5
Banksia menziesii	600	2
Bossiaea eriocarpa	50	5
Burchardia umbellata	70	<1
Conostephium pendulum	40	1
Conostylis juncea	40	<1
Dasypogon bromeliifolius	70	15
Drosera pallida	twiner	<1
Gompholobium tomentosum	50	3
Hypolaena exsulca	40	5
Kunzea glabrescens	600	75
Levenhookia stipitata	5	<1
Loxocarya flexuosa	40	10
Lyginia barbata	50	15
Melaleuca thymoides	90	3
Patersonia occidentalis	70	5

TAXON	HEIGHT (CM)	% COVER
Philotheca spicata	70	20
Scholtzia uberiflora	30	3
Stylidium brunonianum	10	<1
Trachymene pilosa	20	<1
Xanthorrhoea preissii	120	10
Acacia huegelii	Opportunistic	
Acacia pulchella var. *glaberrima*	Opportunistic	
Adenanthos cygnorum	Opportunistic	
Allocasuarina fraseriana	Opportunistic	
Anigozanthos manglesii	Opportunistic	
Aotus procumbens	Opportunistic	
Austrostipa compressa	Opportunistic	
Banksia ilicifolia	Opportunistic	
Brachyloma preissii	Opportunistic	
**Carpobrotus edulis*	Opportunistic	
Conostylis aculeata	Opportunistic	
Crassula colorata	Opportunistic	
Dampiera linearis	Opportunistic	
Dianella revoluta var. *divaricata*	Opportunistic	
Drosera macrantha	Opportunistic	
Eremaea pauciflora	Opportunistic	
Eucalyptus marginata subsp. *marginata*	Opportunistic	
**Gladiolus caryophyllaceus*	Opportunistic	
Haemodorum spicatum	Opportunistic	
Hibbertia hypericoides	Opportunistic	
Hibbertia racemosa	Opportunistic	
**Isolepis marginata*	Opportunistic	
Jacksonia sternbergiana	Opportunistic	
Laxmannia grandiflora	Opportunistic	
Lechenaultia floribunda	Opportunistic	
Lepidosperma squamatum	Opportunistic	
Leucopogon conostephioides	Opportunistic	
Lomandra caespitosa	Opportunistic	
Lomandra hermaphrodita	Opportunistic	
Macrozamia riedlei	Opportunistic	
Microtis media	Opportunistic	
Persoonia saccata	Opportunistic	
Petrophile linearis	Opportunistic	
Phlebocarya ciliata	Opportunistic	
Pithocarpa pulchella var. *pulchella*	Opportunistic	
Pultenaea reticulata	Opportunistic	
Stirlingia latifolia	Opportunistic	
Stylidium repens	Opportunistic	
Thysanotus patersonii	Opportunistic	
Thysanotus thyrsoideus	Opportunistic	
Tripterococcus brunonis	Opportunistic	
**Ursinia anthemoides*	Opportunistic	
**Vulpia bromoides*	Opportunistic	

QUADRAT ANK13

Location: Lot 33
Datum (WGS84): 391966E; 6435028N
Soil: Grey sand with yellow sand beneath
Litter: Leaves 30%; Branches 20%; Logs 5%
Topography: Middle slope
Vegetation Description: Low Forest A of *Banksia attenuata*, *Banksia menziesii* and *Allocasuarina fraseriana* over Open Scrub of *Kunzea glabrescens* over Heath B dominated by *Hibbertia hypericoides*
Vegetation Condition: 3

TAXON	HEIGHT (CM)	% COVER
Acacia pulchella var. *glaberrima*	90	1
Adenanthos cygnorum	500	5
Allocasuarina fraseriana	1400	10
Amphipogon turbinatus	40	2
Astroloma pallidum	20	<1
Austrostipa compressa	50	<1
Banksia attenuata	1000	15
Banksia menziesii	1000	15
Brachyloma preissii	70	1
**Briza maxima*	50	1

TAXON	HEIGHT (CM)	% COVER
**Briza minor*	15	<1
Burchardia umbellata	90	<1
Caesia parviflora	70	<1
Chamaescilla corymbosa	10	<1
Conostephium pendulum	50	1
Conostylis aculeata	40	1
Crassula colorata	10	<1
Daviesia divaricata	70	3
Diuris sp.	50	<1
Drosera pallida	twiner	<1`
Drosera stolonifera	30	<1
**Ehrharta calycina*	80	1
Gastrolobium capitatum	50	1
**Gladiolus caryophyllaceus*	70	<1
Hardenbergia comptoniana	twiner	<1
Hibbertia hypericoides	70	60
Hypocalymma robustum	60	5
**Hypochaeris glabra*	30	1
Jacksonia furcellata	300	5
Jacksonia sternbergiana	300	5
Kunzea glabrescens	300	2
Levenhookia stipitata	5	<1
Loxocarya flexuosa	50	5
Macarthuria australis	20	<1
Mesomelaena pseudostygia	60	10
Patersonia occidentalis	70	5
Petrophile linearis	50	1
Podotheca angustifolia	15	<1
Poranthera microphylla	5	<1
Scholtzia involucrata	40	10
Siloxerus humifusus	2	<1
Sowerbaea laxiflora	70	<1
Stylidium brunonianum	70	<1
Synaphea spinulosa	50	1
Thysanotus patersonii	twiner	<1
Trachymene pilosa	20	1
Wahlenbergia ? multicaulis	25	<1
Anigozanthos humilis subsp. *humilis*	Opportunistic	
Anigozanthos manglesii	Opportunistic	
Caladenia flava	Opportunistic	
Carpobrotus edulis	Opportunistic	
Centrolepis drummondii	Opportunistic	
Eucalyptus marginata subsp. *marginata*	Opportunistic	
Gompholobium tomentosum	Opportunistic	
Kennedia prostrata	Opportunistic	
Laxmannia grandiflora subsp. *grandiflora*	Opportunistic	
Lobelia rhytidosperma	Opportunistic	
Lomandra caespitosa	Opportunistic	
Macrozamia riedlei	Opportunistic	
Persoonia saccata	Opportunistic	
Podotheca chrysantha	Opportunistic	

TAXON	HEIGHT (CM)	% COVER
Stirlingia latifolia	Opportunistic	
**Ursinia anthemoides*	Opportunistic	
Xanthorrhoea preissii	Opportunistic	

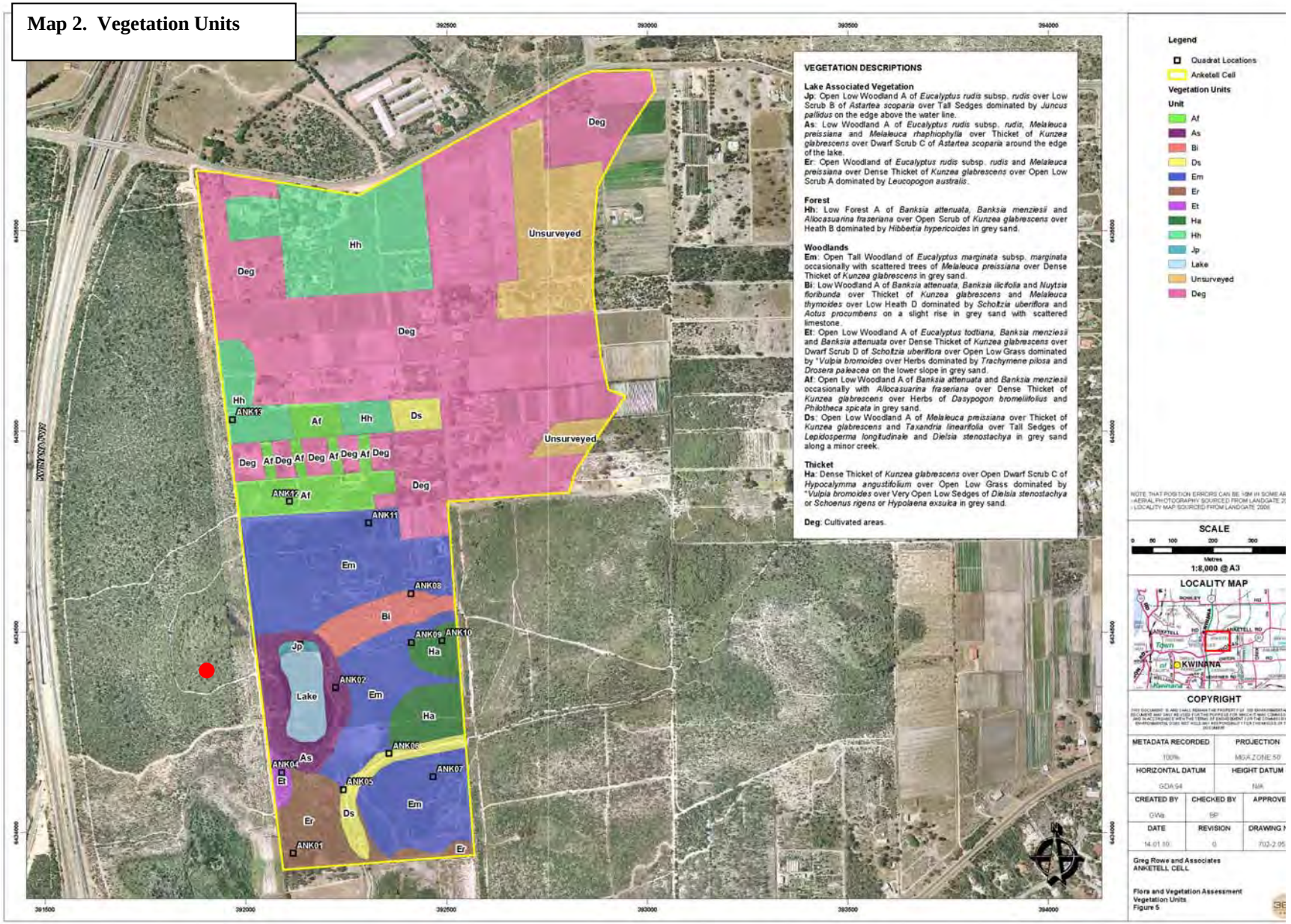
APPENDIX C

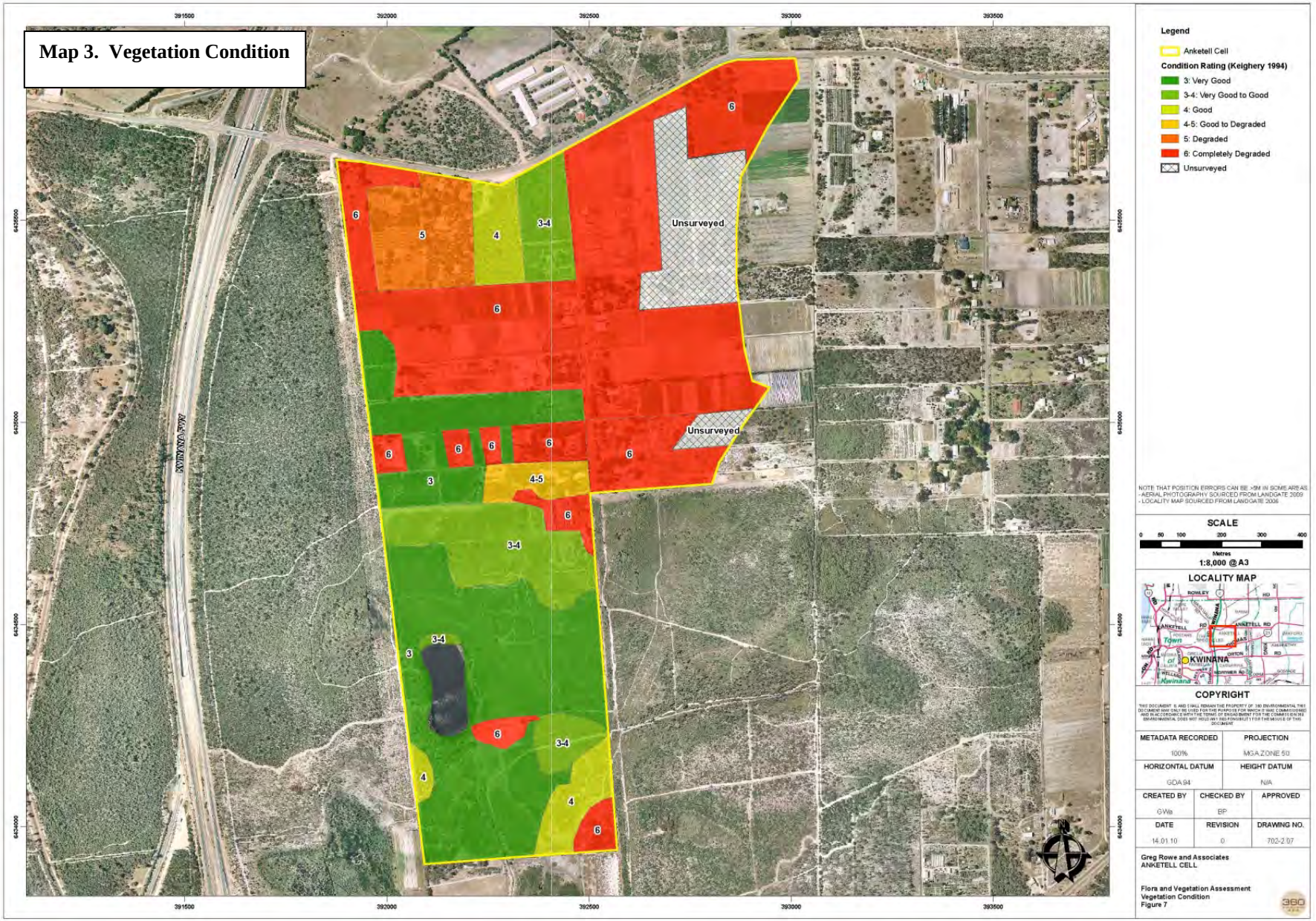
Maps

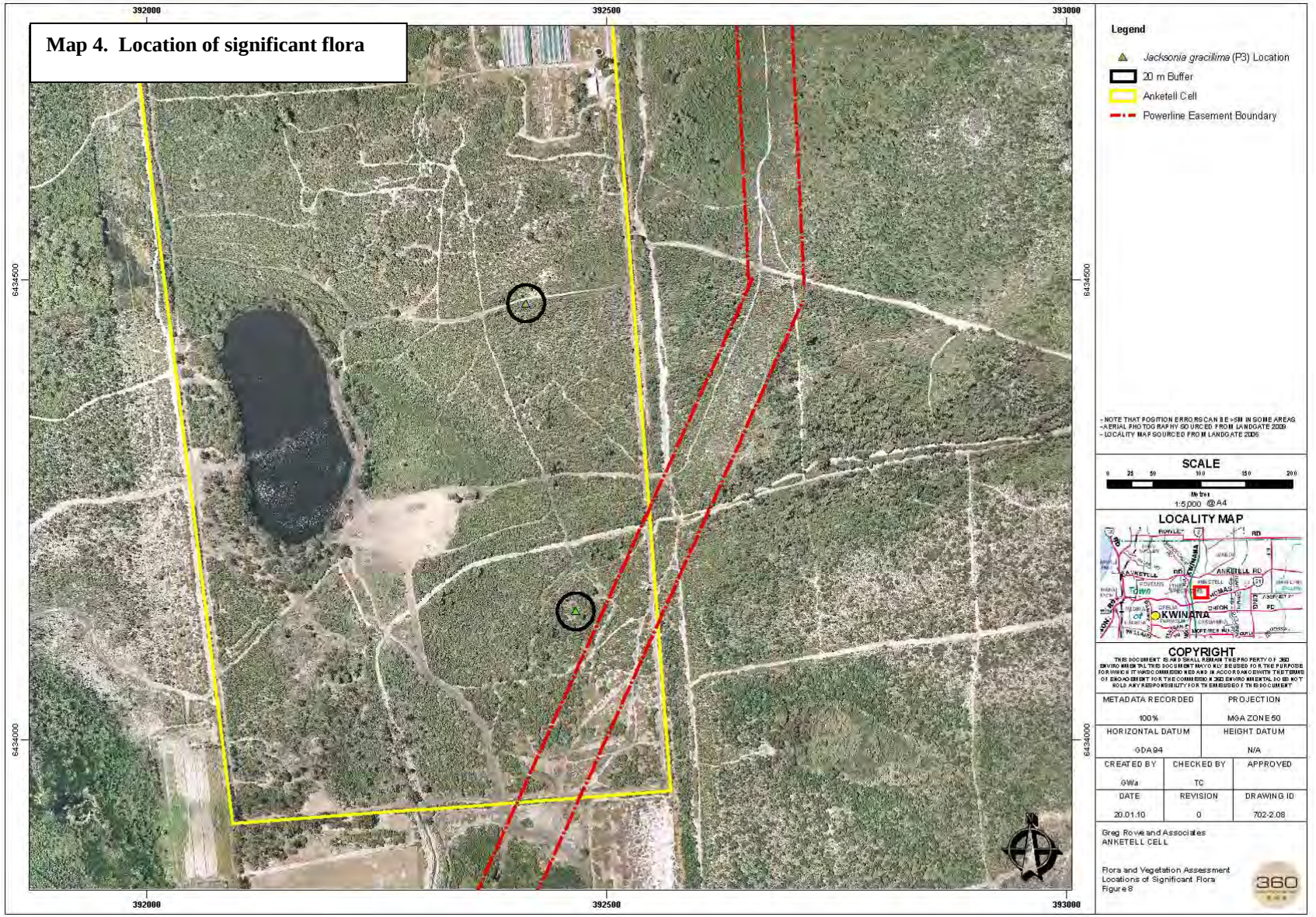
1. Location of quadrats
2. Vegetation Units
3. Vegetation Condition
4. Location of Priority Flora
5. Location of Priority Ecological Community

Map 1. Location of quadrats

Map 2. Vegetation Units




Map 3. Vegetation Condition
391500
392000
392500
393000
393500
6435500
6435000
6434500
6434000
KWINANA FWY
Unsurveyed
Unsurveyed
6
5
4
3-4
4-5
3
Legend
Anketell Cell
Condition Rating (Keighery 1994)
3: Very Good
3-4: Very Good to Good
4: Good
4-5: Good to Degraded
5: Degraded
6: Completely Degraded
Unsurveyed
NOTE THAT POSITION ERRORS CAN BE >9M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2009
- LOCALITY MAP SOURCED FROM LANDGATE 2006
SCALE
0 50 100 200 300 400
Metres
1:8,000 @ A3
LOCALITY MAP
ROWLEY
ANKETELL RD
KWINANA
COPYRIGHT
METADATA RECORDED
100%
PROJECTION
MGA ZONE 50
HORIZONTAL DATUM
GDA 94
HEIGHT DATUM
N/A
CREATED BY
GWa
CHECKED BY
BP
APPROVED
DATE
14.01.10
REVISION
0
DRAWING NO.
702-2.07
Greg Rowe and Associates
ANKETELL CELL
Flora and Vegetation Assessment
Vegetation Condition
Figure 7


Map 4. Location of significant flora
392000
392500
393000
6434500
6434000
Legend
Jacksonia gracilima (P3) Location
20 m Buffer
Anketell Cell
Powerline Easement Boundary
- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2009
- LOCALITY MAP SOURCED FROM LANDGATE 2006
SCALE
0 25 50 100 150 200
Metres
1:5,000 @ A4
LOCALITY MAP
ANKETELL RD
KWINANA
COPYRIGHT
METADATA RECORDED
100%
PROJECTION
MGA ZONE 50
HORIZONTAL DATUM
GDA 94
HEIGHT DATUM
N/A
CREATED BY
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Flora and Vegetation Assessment
Locations of Significant Flora
Figure 8
360

APPENDIX D

PATN ANalysis

1.0 INTRODUCTION

1.1 Purpose of this report

The current report is intended to help clarify the assignment of Floristic Community type (FCT) designation to vegetation community (site) data. FCTs were defined by Gibson et al (1994) based on site data collected from vegetation on the Swan Coastal Plain. In particular, the potential that a Threatened Ecological Community (English and Blyth 1997) is represented by the data collected needs to be clarified.

1.2 Location of Anketell Sites

The sites were ???.

1.3 Brief background to floristic analysis of vegetation on the Swan Coastal Plain

Floristic analysis (ie., analysis of variation in vegetation based on the species present, rather than description of structural variation and dominance) as a significant component of the understanding of the variation present in the native vegetation of the Swan Coastal Plain dates to Gibson *et al* (1994 – all references to the SCP survey in the current report refer to this publication), the first publication to document the floristics of the vegetation of a large part of the Swan Coastal Plain. While the SCP survey is based on a very significant amount of work, it must be viewed as a "first pass" survey, limited, in the context of the great variety of vegetation present in the very large area surveyed, by the relatively limited number (509) of sites (quadrats) it is based on. To a limited degree, this limitation has subsequently been addressed in an "update" to the work of the SCP survey (which describes additional units). However, there is no detailed publication of the results of this update available and the additional data used are not readily available in an appropriate form (ie., one that would enable ready comparison of new data to the overall data set).

The units described by the SCP survey are a series of "floristic community types", a "unit" whose rank is defined by the use within a study. The SCP survey surveyed a very large survey area and defined a relatively small number of floristic community types. Consequently, the floristic community types they have described are of a very high order (see Trudgen 1999, volume 1, for further discussion of this point). This is an extremely important point to fully grasp in interpreting the analysis presented by the SCP survey and in understanding the meaning of analysis of other data sets when they are compared to the floristic community types of the SCP survey.

The important effects of the limited size data set used by the SCP survey and of the relatively small number of floristic community types defined by them, can be summarised by the following points:

1. the definition of all but two of the Threatened Ecological Communities for vegetation on the Swan Coastal Plain (English and Blyth 1997) has been based on the floristic community types of the SCP survey. It therefore follows, that with two exceptions, only vegetation units from one study that are different at a very high order of floristics are treated as rare by Government. No account is taken of other important differences, such as differences in structure and dominance;

2. for the definition of floristic community types to be robust, a sufficient sized database is needed to give adequate precision in their definition. About half of the floristics community types (or sub types) of the SCP survey are based on less than 10 sites. It is likely that with a larger data set there would be significant alteration in the classification of those floristic community types from the SCP survey based on small numbers of sites.

3. as noted above, many (if not most) of the floristic community types defined by the SCP survey are very broad. They contain very significant variation in floristics, structure and dominance. Some (or in more highly cleared parts of the Swan Coastal Plain much) of this variation may be rare by any reasonable definition, but it is currently "buried" within larger groups;
4. there is likely to be significant variation not sampled by the SCP survey. This includes some variation at a high level of floristic difference (see Trudgen 1999, volume 1, for an example of this) and undoubtedly quite significant (large!) amounts of variation at "medium" and "low" levels.

5. the document, and its use by Government, has focussed attention in the environmental impact assessment process on the high level of units described, deflecting attention from the layers of variation beneath these units that also have significant conservation value.

From these points it is obvious that there is a need for a major "upgrade" to the floristic analysis of the vegetation of the Swan Coastal Plain to provide a more detailed floristic classification that considers not only more of the variation present, but explicitly recognises more of the variation present in formally described units.

Obviously, such a reworking would have some effect on what vegetation is considered rare on the Swan Coastal Plain. It needs to be stressed that it would be very unlikely to find that any of the vegetation currently considered to be rare on the basis of the SCP survey*'s* classification was not rare. On the other hand, it is likely that such a review would very probably consider to be rare some vegetation which is not currently considered rare.

1.4 Data provided

It is very important in comparing different sets of floristic data that they are comparable in the application of names, in the intensity of the survey (ie., the effort of searching resulting in similar proportion of the flora at sites being recorded) and in the size of the site recorded. If the data from different data sets is not comparable in these ways, it reduces the clarity of the results of the analyses carried out. If the discrepancy in the comparability of the data sets is large, the results may become meaningless.

It was noted that the sites were recorded in summer and the likely under representation of some species because of that. Some differences in representation is shown in Appendix 2 for comparison.

2.0 METHODS

2.1 Data Preparation

The data from the Anketell sites were provided in a spreadsheet. These were incorporated into a standard MS Access based database designed for this type of data. One virtue of the database is that the species recorded at each site are stored against standard codes (numbers, those used by the Western Australian Herbarium) for each species. This facilitates ready comparison of data from different surveys stored in the same system.

After the data were incorporated into the database, a process of reconciliation of flora species names with those used in the SCP survey was undertaken. This step was necessary at least because of changes in nomenclature over the last ten years and the potential of survey specific variations in the application of names. The reconciliation involved:

- reducing some infra-specific names to the relevant species name, and
- combining some taxa where confusion is known to have occurred in field observations and identifications.

The reconciliation process was relatively straightforward as most of the names had already been standardised. Most reconciliation was to conform with the methods that the SCP survey used to manage confusing taxa plus some nomenclatural changes.

2.2 Comparability of datasets

It was concluded that the quadrat datasets were probably reasonably compatible in nomenclature. The richness of sites are moderate in some quadrats given most were dampland related (see extract of dendrogram in results.) The number of species from families often overlooked (eg Orchidaceae) tended to be lower than that of quadrats in SCP dataset for similar vegetation (Appendix 2).

2.3 Comparisons made

The data therefore from the 13 quadrats plus the 509 sites from the SCP survey of the southern part of the Swan Coastal Plain (south of Gingin) were combined. This enabled various analyses to be performed.

The main purpose was intended to assign the individual sites to the Floristic Community Types (FCTs) defined in the SCP survey. These data are provided in Anketell.mdb.)

2.4 Analyses carried out

The approach was the use of numerical classification techniques (PATN) based on the similarity of the floristic composition of the Anketell quadrats to sites in the SCP survey data set.

2.4.1 PATN

Several modules of the numerical classification package PATN (Belbin 1987) were used for the analyses. The parameter values were the same as used by the SCP survey to ensure consistency of analysis with that study.

The PATN modules used were ASO (calculation of similarity matrix), FUSE (classification based on the results of ASO), DEND (representation of classification) and NNB (determination of sites most similar to each site – nearest neighbours). The results of the analyses were imported into a database (Anketell.mdb) so that site characteristics and previous classifications (eg., Floristic Community Types derived in earlier classifications) could be associated and various analyses based on these data could be performed.

The assignment of floristic community types to the Anketell quadrats was made by summarising the results of two different methods:

- the classification, and
- the twenty nearest neighbours.

Experience demonstrates that the results of these are likely to vary, but that from nearest neighbours is likely to make more sense for it is not directly influenced by group membership. On the other hand the nearest neighbour analysis often is ambiquous as it provides several options.

To the classification dendrogram of the combined dataset, the FCT assigned by the SCP survey was associated with the SCP survey sites. The apparent FCTs were assigned to the Anketell quadrats by interpreting the position of these sites in the dendrogram (particularly by the way they joined to the SCP sites).

The 20 sites in the combined data set that were most similar to each of Anketell quadrats were obtained from the nearest neighbour method (NNB). By associating those nearest neighbours from the SCP survey, the most likely FCTs from this method for each of the Anketell quadrats were determined.

It is common for there to appear tob inconsistencies in the affinietie indicated by these methods. Classification can be strongly influenced by the membership of groups which can “draw” a site “away” from another that it appears similar to. An attempt was then made to reconcile these different assignments of a Floristic Community Type. The relevant portion of the site by species matrix was examined to seek clarity in some cases.

3.0 LIMITATIONS

It has been found in earlier projects that the addition of new sites to the SCP survey data set to produce a combined classification disrupts the original classification. The more data added, the higher the level of the disruption. This is particularly the case with wetland sites, partly because there are relatively few of these in the SCP data set and these communities are often very distinctive. This problem can make it difficult to assign Floristic Community Types to new sites using this method.

Secondly, it is common for new data to group to their cohorts. In some cases this has proven to result from common deficiencies in the data, ie. whole groups of species

missing. This absence tends to draw them together. The more sites in the added batch, the tighter they draw together.

The analyses are conducted without personal knowledge of the sites.

4.0 RESULTS

4.1 Determination of floristic community type by classification

The Anketell sites occurred largely in one cluster with a few of the SCP sites. This suggests that there was something about these sites which were different from the SCP sites, eg a common disturbance history or a low survey effort.

While these combined with some sites from SCP, it is notable that these SCP sites were split from their cohorts from the same FCT. Thus, the Anketell sites were only similar to some from the respective FCTs.

Generally, the Anketell sites appeared related to FCTs 11 and 21c.

Figure 1. Relevant portions of Dendrogram

site	FCT	sp	dendrogram
			0.2050 0.3678 0.5306 0.6933 0.8561 1.0189
			| | | | | |
ANK12		66	
ANK13		64	
DEJONG-c	21c	41	
FL-5	21c	41	
FL-6	21c	38	
hymus03	21c	30	
ANK01		59	
ANK03		27	
ANK02		29	
ANK05		24	
ANK06		15	
hymus01	11	21	
ANK10		18	
ANK11		14	
YAN-21	14	18	
C71-1	11	51	
MODO-3	11	16	
HARRY-6	11	25	
ANK04		21	
ANK07		28	
ANK09		17	
MODO-2	21c	35	
PLINE-7	21c	32	
ANK08		32	
hymus04	21c	26	
card10	6	29	
card11	6	24	
card4	6	26	

4.2 Determination of floristic community type using Nearest Neighbour method

The summary of the nearest neighbour results presented in Table 1 are presented in Table 2. Like the classification most tended to be related to sites from FCTs 11 and 21c.

Table 1. Results of Nearest Neighbour analysis

s	s1	f1	v1	s2	f2	v2	s3	f3	v3	s4	f4	v4	s5	f5	v5
ANK01	ANK02		0.571	ANK05		0.575	ANK09		0.589	ANK03		0.590	ANK07		0.619
ANK02	ANK05		0.423	ANK01		0.571	hymus02	11	0.576	ANK06		0.581	MODO-3	11	0.590
ANK03	ANK01		0.590	ANK02		0.6	ANK05		0.647	hymus02	11	0.647	McLART-1	13	0.65
ANK04	ANK07		0.551	hymus03	21c	0.607	PLINE-7	21c	0.622	ANK09		0.631	YULE-1	23a	0.636
ANK05	ANK02		0.423	ANK09		0.512	ANK06		0.538	ANK01		0.575	hymus01	11	0.6
ANK06	ANK05		0.538	ANK09		0.562	ANK11		0.571	ANK02		0.581	hymus01	11	0.611
ANK07	ANK09		0.511	ANK13		0.538	low06a	21c	0.542	ANK04		0.551	MODO-2	21c	0.587
ANK08	ANK12		0.587	ANK07		0.593	NINE-2	21a	0.6	HARRY-4	23a	0.616	low07	21c	0.638
ANK09	ANK07		0.511	ANK05		0.512	ANK06		0.562	ANK10		0.588	ANK01		0.589
ANK10	ANK11		0.533	ANK09		0.588	ANK02		0.644	MODO-6	4	0.644	MODO-2	21c	0.653
ANK11	ANK10		0.533	ANK06		0.571	ANK09		0.6	ANK05		0.621	YAN-21	14	0.677
ANK12	ANK13		0.426	DEJONG	21c	0.457	NINE-2	21a	0.483	REDL-1	21a	0.488	WAND-1	23a	0.495
ANK13	ANK12		0.426	HARRY-2	28	0.460	WELL-2	21a	0.477	HARRY-5	21a	0.530	ANK07		0.538

Table 1 (cont)

s	s6	f6	v6	s7	f7	v7	s8	f8	v8	s9	f9	v9	s10	f10	v10
ANK01	ANK04		0.636	ANK12		0.639	hymus01	11	0.662	YULE-1	23	0.678	WARI-1	28	0.681
ANK02	ANK03		0.6	hymus01	11	0.632	ANK10		0.644	CAPEL-8	12	0.681	FL-9	4	0.682
ANK03	hymus01	11	0.666	ANK06		0.666	HARRY-6	11	0.692	AUSTB-3	11	0.703	hymus05	11	0.719
ANK04	ANK01		0.636	MODO-2	21c	0.642	ANK05		0.644	low07	21c	0.645	WHITE-1	23a	0.645
ANK05	ANK11		0.621	ANK04		0.644	ANK03		0.647	ANK10		0.658	hymus02	11	0.666
ANK06	ANK03		0.666	MODO-3	11	0.677	ANK10		0.687	KOOLJ-1	4	0.714	ANK01		0.718
ANK07	ANK08		0.593	low07	21c	0.594	ANK12		0.617	ANK01		0.619	hurst03	23a	0.621
ANK08	MODO-5	23a	0.645	low01	21c	0.647	hymus04	21c	0.649	REDL-1	21	0.653	ANK04		0.653
ANK09	ANK11		0.6	MODO-2	21c	0.615	ANK04		0.631	PLINE-7	21c	0.673	hymus01	11	0.684
ANK10	ANK05		0.658	C58-1	4	0.660	ANK06		0.687	MODO-3	11	0.697	ANK01		0.726
ANK11	ANK04		0.705	ANK07		0.707	ANK02		0.707	ANK01		0.710	GUTHR-4	5	0.714
ANK12	WARB-3	23a	0.496	dard02	21b	0.503	YULE-1	23a	0.508	FL-5	21c	0.514	MODO-4	23a	0.515
ANK13	low04	21a	0.541	KING-2	28	0.543	YULE-1	23a	0.546	BANK-2	23	0.548	dard02	21b	0.549

s – the site being compared
s1 to s10 – the 1st to 10th most similar sites
f1 to f10 – the FCT of the similar sites (only for SCP sites)
v1 to v10 – the dissimilarity value between the site and the similar sites (values above 0.6 tend to indicate low similarity)

4.3 Combining the results

There was modest accord between the classification and the Nearest Neighbour analyses. The Nearest Neighbour tends to be more reliable as it is less influences by its cohort sites.

Table 2 Summary of FCT assignment

	Dendrogram	Nearest Neighbour	Conclusion
ANK12	21c	21c,21a,23a	21c,21a,23a
ANK13	21c	28,21a	28,21a
ANK01	11	?11	?11
ANK03	11	11,13	11,13
ANK02	11	11	11
ANK05	11	11	11
ANK06	11	11	11
ANK10	14	4,21c,11	4,21c,11
ANK11	14	?14	?14
ANK04	21c	21c,23a	21c,23a
ANK07	21c	21c	21c
ANK09	21c	21c	21c
ANK08	21c	21a,23a,21c	21a,23a,21c

5.0 REFERENCES

Belbin, L. (1987) *PATN Reference Manual* (313p), *Users Guide* (79p), *Command Manual* (47p), and *Example Manual* (108p). CSIRO Division of Wildlife and Ecology, Lynham, ACT.

English, V., and Blyth, J. (1997) *Identifying and conserving threatened ecological communities (TECs) in the South West Botanical Province*. ANCA National Reserves System Cooperative Program: Project Number N702, Australian National Conservation Agency, Canberra

Gibson, N.G., Keighery, B.J., Keighery, G.J., Burbidge, A.H. and Lyons, M (1994). *A Floristic Survey of the Southern Swan Coastal Plain*. Unpublished report by the Department of Conservation and Land Management and the Conservation Council of Western Australia to the Australian Heritage Commission.

Trudgen, M.E. (1999). *A flora and vegetation survey of Lots 46 and 47 Maralla Road and Lexia Avenue, Ellenbrook*. Volumes 1-4. Unpublished report prepared for the Crown Solicitors Office, Government of Western Australia. December 1999.

APPENDIX1

Names combined for reconcilliation

FCODE	Species	Lookup
031	Aira caryophyllea	Aira caryophyllea/cupaniana group
031	Arundo donax	omitted
031	Avena barbata	Avena barbata/fatua
031	Cortaderia selloana	omitted
039	Loxocarya flexuosa	Loxocarya cinerea
054E	Dianella revoluta var. divaricata	Dianella revoluta
054F	Caesia parviflora	Caesia micrantha
054F	Laxmannia grandiflora subsp. grandiflora	Laxmannia grandiflora
054F	Thysanotus patersonii	Thysanotus patersonii/manglesianus
054J	Burchardia umbellata	Burchardia umbellata/congesta
055	Anigozanthos humilis subsp. humilis	Anigozanthos humilis
066	Diuris corymbosa	Diuris longifolia
066	Diuris sp.	omitted
066	Monadenia bracteata	Disa bracteata
066	Pterostylis pyramidalis	Pterostylis aff nana
109	Phytolacca octandra	omitted
131	Cassytha racemosa forma racemosa	Cassytha racemosa
163	Acacia longifolia	omitted
163	Acacia pulchella var. glaberrima	Acacia pulchella
165	Aotus intermedia	Aotus gracillima
165	Hovea trisperma	Hovea trisperma var. trisperma
165	Jacksonia gracillima	Jacksonia furcellata
165	Lotus subbiflorus	Lotus suaveolens
165	Nemcia capitata	Gompholobium capitatum
263	Pimelea rosea subsp. rosea	Pimelea rosea
273	Astartea scoparia	Astartea aff. fascicularis
273	Eucalyptus marginata subsp. marginata	Eucalyptus marginata
273	Eucalyptus rudis subsp. rudis	Eucalyptus rudis
273	Kunzea glabrescens	Kunzea ericifolia
273	Scholtzia uberiflora	Scholtzia involucrata
281	Centella asiatica	Centella cordifolia
293	Anagallis arvensis var. arvensis	Anagallis arvensis
302	Mitrasacme paradoxa	Mitrasacme palustris
316	Gratiola pubescens	Gratiola peruviana
339	Wahlenbergia multicaulis	Wahlenbergia preissii
340	Lobelia rhytidosperma	Lobelia tenuior
343	Stylidium paludicola	omitted
345	Pithocarpa pulchella var. pulchella	Pithocarpa pulchella
345	Senecio diaschides	Senecio quadridentatus

Appendix 2 Comparison of average species per family per site for relevant FCTs.

FCT:		54C	54D	54E	54F	54J	66	143	281	343	sum
4		1.75	0.75	0.06	1.94	0.63	1.38	1.44	1.31	3.13	12
11		0.15	0.15	0.08	1.23	0.08	1	0.15	0.69	0.92	4
13					0.22	0.33	0.11	0.33	0.44	0.22	2
14				0.5		0.5	3		0.5		5
21a		3.67	0.46	0.13	3.67	0.82	3.05	2.33	2.33	1.77	18
21c		2.25	0.56	0.06	2.56	0.63	2.44	1.56	1.31	1.94	13
23a		3.11	0.58		4.26	0.89	2.42	2.16	1.68	3.68	19
Site:											
ANK12	21c,21a,23a	3	1	1	3	1	1	2	1	3	16
ANK13	28,21a	1	1		5	1	2	2	1	2	15
ANK01	?11			1	1	1	3		1	1	8
ANK03	11,13						1				1
ANK02	11						1		2	2	5
ANK05	11									1	1
ANK06	11										0
ANK10	4,21c,11									2	2
ANK11	?14										0
ANK04	21c,23a					1		1	1	2	5
ANK07	21c				1		3	2	1		7
ANK09	21c				1						1
ANK08	21a,23a,21c	2					5	1			8

APPENDIX B
BUSHFIRE MANAGEMENT PLAN

intelligent outcomes | respected experience

Anketell North Local Structure Plan

Bushfire Management Plan

Prepared for
Acumen Development Solutions
by Strategen

May 2019

BPAD Bushfire Planning & Design Accredited Practitioner Level 2

strategen ENVIRONMENTAL

Anketell North Local Structure Plan

Bushfire Management Plan

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May 2019

Limitations

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Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

Document control

Client: Acumen Development Solutions

Report Version	Revision No.	Purpose	Strategen author/reviewer and accreditation details	Submitted to Client	
				Form	Date
Draft Report	Rev A	For review by Client	B Mastrangelo (BPAD45985) / C Turner	Electronic (email)	30/11/2018
Final Report	Rev 0	To accompany submission of the structure plan	W Oversby / L Wears (BPAD19809)	Electronic (email)	07/11/2018
Final Report	Rev 1	To accompany submission of the structure plan	B Mastrangelo (BPAD 45985) / L Wears (BPAD19809)	Electronic (email)	14/01/2019
Final Report	**Rev 2**	**To accompany submission of the revised structure plan**	**C O'Brien / L Wears (BPAD19809)**	**Electronic (email)**	**22/05/2019**

Filename: ADS18136_03 R001 Rev 2 - 21 May 2019

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1. Proposal details

Acumen Development Solutions (the proponent), intends to lodge a Local Structure Plan (LSP) application (Figure 1) to guide future land use and development within the Anketell North LSP area (the project area; Figure 2). The project area is approximately 98.4 ha and is currently zoned "Urban" under the Metropolitan Region Scheme (MRS) and "Development" under the City of Kwinana Town Planning Scheme No. 2 (TPS2). The project area comprises twenty-three lots under separate ownership is located within the municipality of the City of Kwinana.

The project area is located just south of Anketell Road, being bordered to the west and south by Bush Forever Site 270 and to the east by Jandakot Groundwater Mound. Land directly west and southeast is zoned "Parks and Recreation", while land directly south and west is zoned "Rural Water Protection". The southern portion of the project area is classified as a Conservation Category Wetland (CCW) however a subdivision approval exists over this portion of the project area. Agricultural and horticultural land uses predominate the project area although several residential properties exist as well. Western Power easements extend the eastern portion of the project area as well as external to the western boundary.

The project area is partially situated within a designated bushfire prone area according to the DFES State Map of Bush Fire Prone Areas (DFES 2017; refer to Plate 1), which triggers bushfire planning requirements under Policy Measure 6.2 and 6.3 of *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (SPP 3.7; WAPC 2015). This Bushfire Management Plan (BMP) has been prepared in accordance with Section 5.2.5 of *Guidelines for Planning in Bushfire Prone Areas* (the Guidelines; WAPC 2017), which requires SPs to be accompanied by a BMP that includes the results of a strategic level Bushfire Hazard Level (BHL) assessment.

The SP submission has also been accompanied by an Environmental Assessment Report (Strategen 2018) and a Local Water Management Strategy (Bioscience 2018).

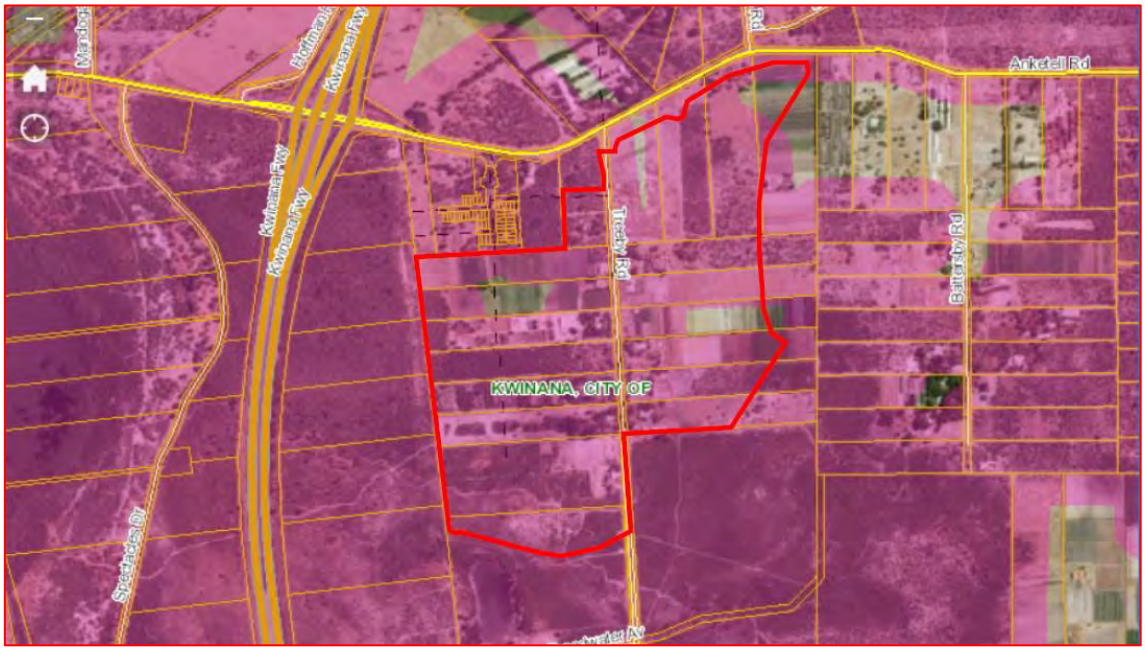

Plate 1: Map of Bush Fire Prone Areas (as indicated in pink)

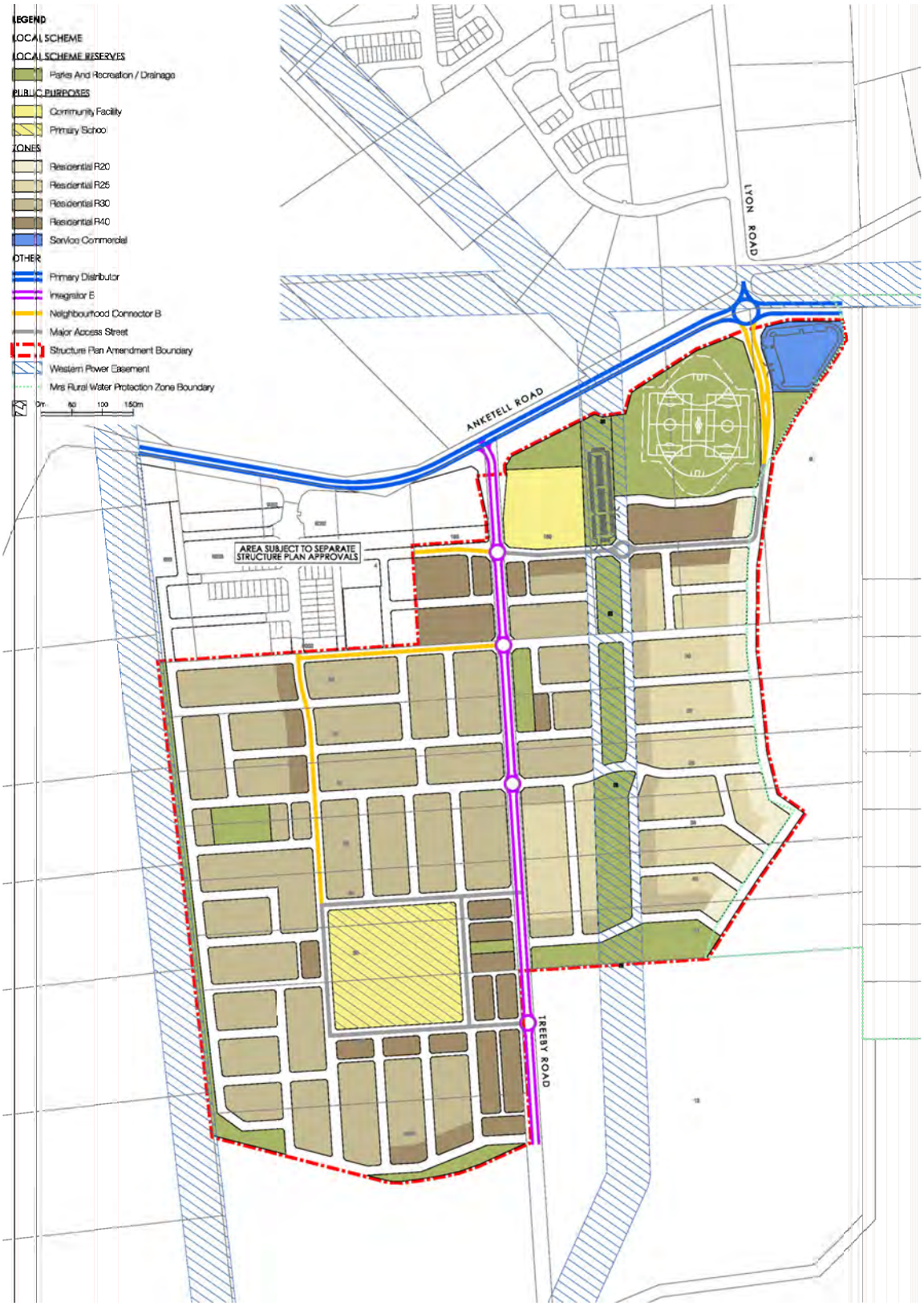

Figure 1: Concept plan

Date: 16/05/2019

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Data source: Taylor Burrell Barnett (TBB), 12/2018. Created by: h.sullivan

Figure 2: Location plan

N

Scale 1:8,000 at A4

0 100 200 m

Coordinate System:
GDA 1994 Perth Coastal Grid 1994

Date: 30/11/2018

Legend

- Project area
- 100m Assessment area
- 150m Assessment are
- Cadastre
- Existing WAPC subdivision approval
- Conservation
- Bush Forever site

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Data source: Nearmap: Aerial image, flown 06/2018. Landgate: Cadastre, 11/2017. Client: Acumen Development Solutions. Development layout, 10/2018. Created by: c.thatcher

2. Environmental considerations

The project area currently comprises a combination of cleared agricultural land and native bushland. Flora and vegetation surveys conducted by Strategen Environmental in 2018 confirmed that the project area contains areas of Banksia Woodlands Threatened Ecological Community (TEC) and black cockatoo habitat.

A search of publicly available environmental data concluded that:

- the southern portion of the project area contains a mapped CCW (refer to Figure 2)
- the southern portion of the project area is mapped as being an Environmentally Sensitive Area (ESA), however ESAs are only relevant in the context of clearing exemptions
- the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) listed Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community (TEC) has been confirmed to occur within the project area through site specific surveys
- the project area contains mapped confirmed roosting areas (buffered) for the EPBC listed Carnaby's Black Cockatoo as well as potential feeding areas
- Bush Forever site 270 is situated directly west and south of the project area (refer to Figure 2)

Future development within the project area will require the removal of native vegetation to accommodate future urban land uses and associated infrastructure. The extent of native vegetation to be retained within the project area will be determined at future planning stages through the allocation of Public Open Space (POS). It is expected that some native vegetation will be retained within the POS and drainage areas, which will be configured to a low-threat standard in accordance with a relevant under AS3959 Clause 2.2.3.2.

Strategen understands that the relevant environmental approvals for the proposed development, including referral under the EPBC Act will be sought as part of ongoing planning stages.

2.1 Native vegetation – modification and clearing

Proposed development of the site will result in the clearing of the majority of on-site vegetation. Vegetation may be retained in pockets throughout future POS areas for landscape amenity purposes and/or throughout drainage basins to serve the required drainage functions for the site. Street-scaping along future road reserves may also result in retention of individual trees. However, it is likely that any areas catering for vegetation to be retained/introduced would be strategically designed in a manner that does not unnecessarily impede future development from a bushfire hazard perspective, and, as such, the intent would be to have any such vegetation excluded from classification under appropriate sections of Clause 2.2.3.2 of AS 3959. This would need to be confirmed as part of future planning stages (subdivision or Development Application (DA)) and accompanying landscape concept plans. Should any on-site vegetation not be excludable, then BAL contour assessment at the subdivision stage would identify the likely BAL impact on proposed development to inform compliance with the relevant bushfire protection criteria.

2.2 Revegetation / Landscape Plans

A high-level landscape masterplan has been prepared for the proposed development (Appendix 1).

Future landscaping plans would identify greater detail regarding the nature and location of proposed vegetation to be retained/ introduced and would be prepared at the subdivision or DA stage.

3. Bushfire hazard level assessment

3.1 Assessment inputs

A Bushfire Hazard Level (BHL) assessment has been undertaken for the project area and adjacent 150 m in accordance with Appendix 2 of the Guidelines. A site assessment was completed on 3 October 2018 to confirm classified vegetation, effective slope and exclusions within the project area and adjacent 150 m. Assessment inputs and outputs are discussed in the following subsections, including provision of Figure 3, which depicts the spatial location and extent of pre-development classified vegetation, exclusions, topography and georeferenced site photos. The site photos are presented in Table 1 and plot numbers summarised in Table 2. The post-development vegetation extent is depicted in Figure 4.

It is noted that effective slope does not form part of a BHL assessment except where slope is greater than 10 degrees. There are no areas of slope exceeding 10 degrees within the project area.

Table 1: BHL assessment inputs

Photo ID: 1 **Plot number:** 1 **Existing vegetation classification or exclusion clause:** Class B woodland **Proposed vegetation classification or exclusion clause:** Class B woodland **Description / justification for classification:** trees 5-10 m in height, low shrub/grass understorey, low surface fuel loads, lacking a multi-tiered fuel profile **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	
Photo ID: 2 **Plot number:** 1 **Existing vegetation classification or exclusion clause:** Class B woodland **Proposed vegetation classification or exclusion clause:** Class B woodland **Description / justification for classification:** trees 5-10 m in height, low shrub/grass understorey, low surface fuel loads, lacking a multi-tiered fuel profile **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	

Photo ID: 3 **Plot number:** 1 **Existing vegetation classification or exclusion clause:** Class B woodland in background **Proposed vegetation classification or exclusion clause:** Excluded under Clause 2.2.3.2 (b), (c), (d), (e) or (f) **Description / justification for classification:** Vegetation within POS areas, proposed residential development and road reserves will be cleared and engineered through the landscape design process to be excluded under a combination of Clause 2.2.3.2 (b), (c), (d), (e) and (f). **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	
Photo ID: 4 **Plot number:** 1 **Existing vegetation classification or exclusion clause:** Class B woodland **Proposed vegetation classification or exclusion clause:** Class B woodland **Description / justification for classification:** trees 5-10 m in height, low shrub/grass understorey, low surface fuel loads, lacking a multi-tiered fuel profile **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	
Photo ID: 5 **Plot number:** 1 **Existing vegetation classification or exclusion clause:** Class B woodland in background **Proposed vegetation classification or exclusion clause:** Excluded under Clause 2.2.3.2 (b), (c), (d), (e) or (f) **Description / justification for classification:** Vegetation within POS areas, proposed residential development and road reserves will be cleared and engineered through the landscape design process to be excluded under a combination of Clause 2.2.3.2 (b), (c), (d), (e) and (f). **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	
Photo ID: 6 **Plot number:** 1 **Existing vegetation classification or exclusion clause:** Class B woodland in background **Proposed vegetation classification or exclusion clause:** Excluded under Clause 2.2.3.2 (b), (c), (d), (e) or (f) **Description / justification for classification:** Vegetation within POS areas, proposed residential development and road reserves will be cleared and engineered through the landscape design process to be excluded under a combination of Clause 2.2.3.2 (b), (c), (d), (e) and (f). **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	

Photo ID: 7 **Plot number:** 1 **Existing vegetation classification or exclusion clause:** Class B woodland **Proposed vegetation classification or exclusion clause:** Excluded under Clause 2.2.3.2 (b), (c), (d), (e) or (f) **Description / justification for classification:** Vegetation within POS areas, proposed residential development and road reserves will be cleared and engineered through the landscape design process to be excluded under a combination of Clause 2.2.3.2 (b), (c), (d), (e) and (f). **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	
Photo ID: 8 **Plot number:** 1 **Existing vegetation classification or exclusion clause:** Class B woodland **Description / justification for classification:** trees 10-20 m in height, low shrub understorey, low surface fuel loads, lacking a multi-tiered fuel profile **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	
Photo ID: 9 **Plot number:** N/A **Existing vegetation classification or exclusion clause:** Excluded under Clause 2.2.3.2 (e) and (f) **Description / justification for classification:** Cleared land with sparse retention of trees adjacent to a low threat road reserve. **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	
Photo ID: 10 **Plot number:** 1 **Existing vegetation classification or exclusion clause:** Class B woodland **Description / justification for classification:** trees 5-20 m in height, grassy understorey and lacking a multi-tiered fuel profile. **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	

Photo ID: 11 **Plot number:** 2 **Existing vegetation classification or exclusion clause:** Class D scrub **Proposed vegetation classification or exclusion clause:** Excluded under Clause 2.2.3.2 (b), (c), (d), (e) or (f) **Description / justification for classification:** Vegetation within POS areas, proposed residential development and road reserves will be cleared and engineered through the landscape design process to be excluded under a combination of Clause 2.2.3.2 (b), (c), (d), (e) and (f). **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	
Photo ID: 12 **Plot number:** 1 **Existing vegetation classification or exclusion clause:** Class B woodland in background **Proposed vegetation classification or exclusion clause:** Excluded under Clause 2.2.3.2 (b), (c), (d), (e) or (f) **Description / justification for classification:** Vegetation within POS areas, proposed residential development and road reserves will be cleared and engineered through the landscape design process to be excluded under a combination of Clause 2.2.3.2 (b), (c), (d), (e) and (f). **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	
Photo ID: 13 **Plot number:** 1 **Existing vegetation classification or exclusion clause:** Class B woodland in background **Proposed vegetation classification or exclusion clause:** Excluded under Clause 2.2.3.2 (b), (c), (d), (e) or (f) **Description / justification for classification:** Vegetation within POS areas, proposed residential development and road reserves will be cleared and engineered through the landscape design process to be excluded under a combination of Clause 2.2.3.2 (b), (c), (d), (e) and (f). **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	
Photo ID: 14 **Plot number:** 1 **Existing vegetation classification or exclusion clause:** Class B woodland in background **Proposed vegetation classification or exclusion clause:** Excluded under Clause 2.2.3.2 (b), (c), (d), (e) or (f) **Description / justification for classification:** Vegetation within POS areas, proposed residential development and road reserves will be cleared and engineered through the landscape design process to be excluded under a combination of Clause 2.2.3.2 (b), (c), (d), (e) and (f). **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	

Photo ID: 15 **Plot number:** 4 **Existing vegetation classification or exclusion clause:** Class G grassland in background **Proposed vegetation classification or exclusion clause:** Excluded under Clause 2.2.3.2 (b), (c), (d), (e) or (f) **Description / justification for classification:** Vegetation within POS areas, proposed residential development and road reserves will be cleared and engineered through the landscape design process to be excluded under a combination of Clause 2.2.3.2 (b), (c), (d), (e) and (f). **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	
Photo ID: 16 **Plot number:** 4 **Existing vegetation classification or exclusion clause:** Class G grassland **Proposed vegetation classification or exclusion clause:** Excluded under Clause 2.2.3.2 (b), (c), (d), (e) or (f) **Description / justification for classification:** Vegetation within POS areas, proposed residential development and road reserves will be cleared and engineered through the landscape design process to be excluded under a combination of Clause 2.2.3.2 (b), (c), (d), (e) and (f). **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	
Photo ID: 17 **Plot number:** 4 **Existing vegetation classification or exclusion clause:** Class B woodland **Description / justification for classification:** Trees 5-20 m in height with a grassy understorey. **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	
Photo ID: 18 **Plot number:** 4 **Existing vegetation classification or exclusion clause:** Class G grassland **Description / justification for classification:** Dominated by grasses and a fine fuel structure adjacent to low crops and a low threat road reserve. **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	

Photo ID: 19 **Plot number:** N/A **Existing vegetation classification or exclusion clause:** Firebreak excluded under Clause 2.2.3.2 (e) and (f) **Description / justification for classification:** Vegetation within POS areas, proposed residential development and road reserves will be cleared and engineered through the landscape design process to be excluded under a combination of Clause 2.2.3.2 (b), (c), (d), (e) and (f). **Description / justification for classification:** Excluded under Clause 2.2.3.2 (e) and (f) **Effective slope:** N/A.	
Photo ID: 20 **Plot number:** 4 **Existing vegetation classification or exclusion clause:** Excluded under Clause 2.2.3.2 (e) and (f) **Proposed vegetation classification or exclusion clause:** Excluded under Clause 2.2.3.2 (b), (c), (d), (e) or (f) **Description / justification for classification:** Vegetation within POS areas, proposed residential development and road reserves will be cleared and engineered through the landscape design process to be excluded under a combination of Clause 2.2.3.2 (b), (c), (d), (e) and (f). **Effective slope:** N/A. Effective slope calculations do not form part of a BHL assessment except where slope is >10 degrees. Contour lines have been provided in Figure 3.	

Table 2: Summary of pre-development vegetation classification and effective slope

Vegetation area / plot	Applied vegetation classification	Effective slope under the classified vegetation
1	Class B woodland	<10 degrees
2	Class D scrub	<10 degrees
3	Class C shrubland	<10 degrees
4	Class G grassland	<10 degrees
5	Excluded under Clause 2.2.3. 2 (b), (c), (d), (e) and (f)	N/A

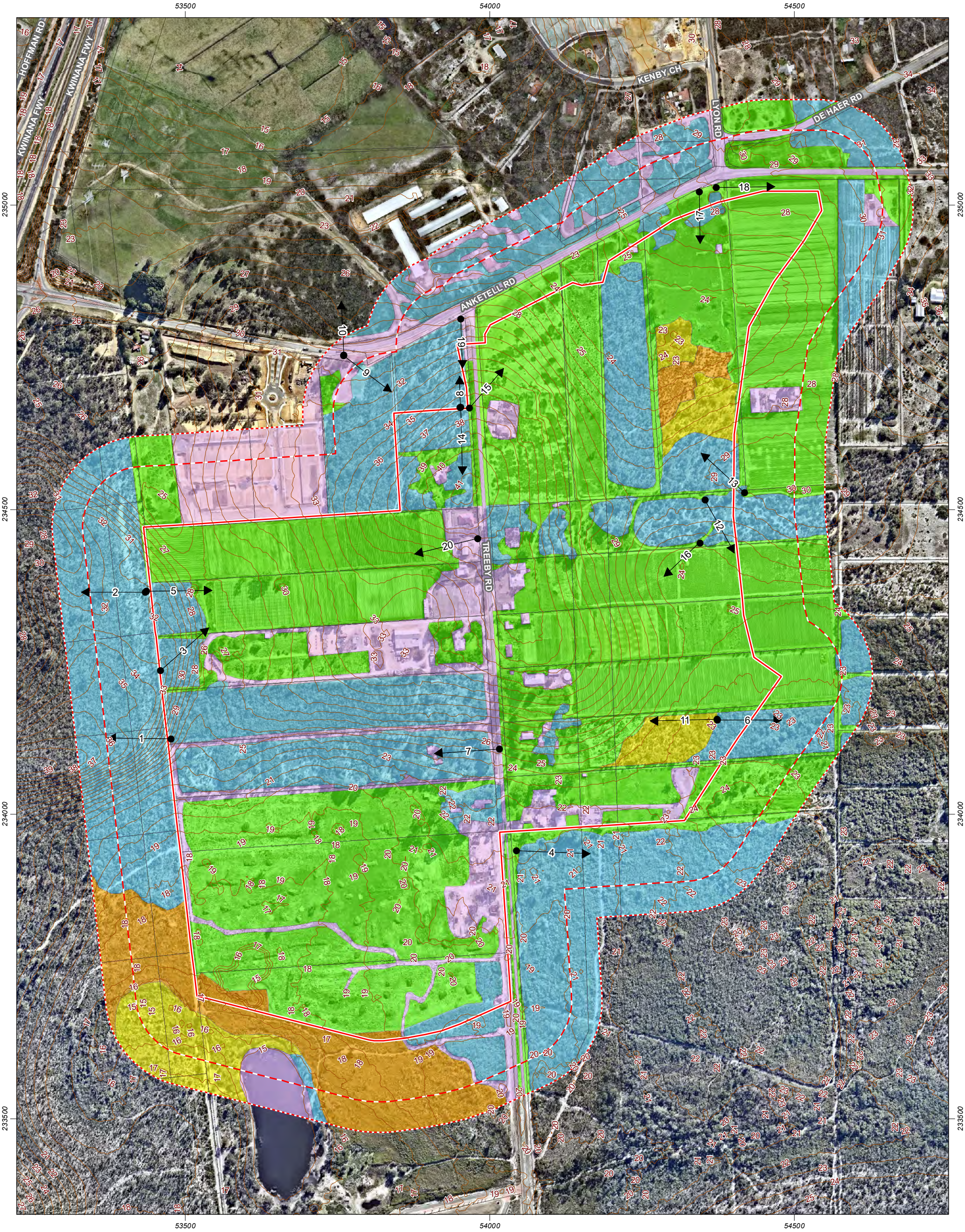

Figure 3: Pre-development vegetation classification and topography

N

Scale 1:5,800 at A3

0 100 200 m

Coordinate System: GDA 1994 Perth Coastal Grid 1994

Date: 13/12/2018

Legend

- Photo point and direction
- Surface elevation (mAHD)
- Project area
- 100m Assessment area
- 150m Assessment are
- Cadastre

Vegetation class

- Plot 1: Class B woodland
- Plot 2: Class D scrub
- Plot 3: Class C shrubland
- Plot 4: Class G grassland
- Plot 5: Excluded under Clauses 2.2.3.2. (e) and (f)

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Data source: Nearmap: Aerial image, flown 08/2018. Landgate: Cadastre, 11/2017. Client: Acumen Development Solutions. Development layout, 08/2018. Created by: jcrute

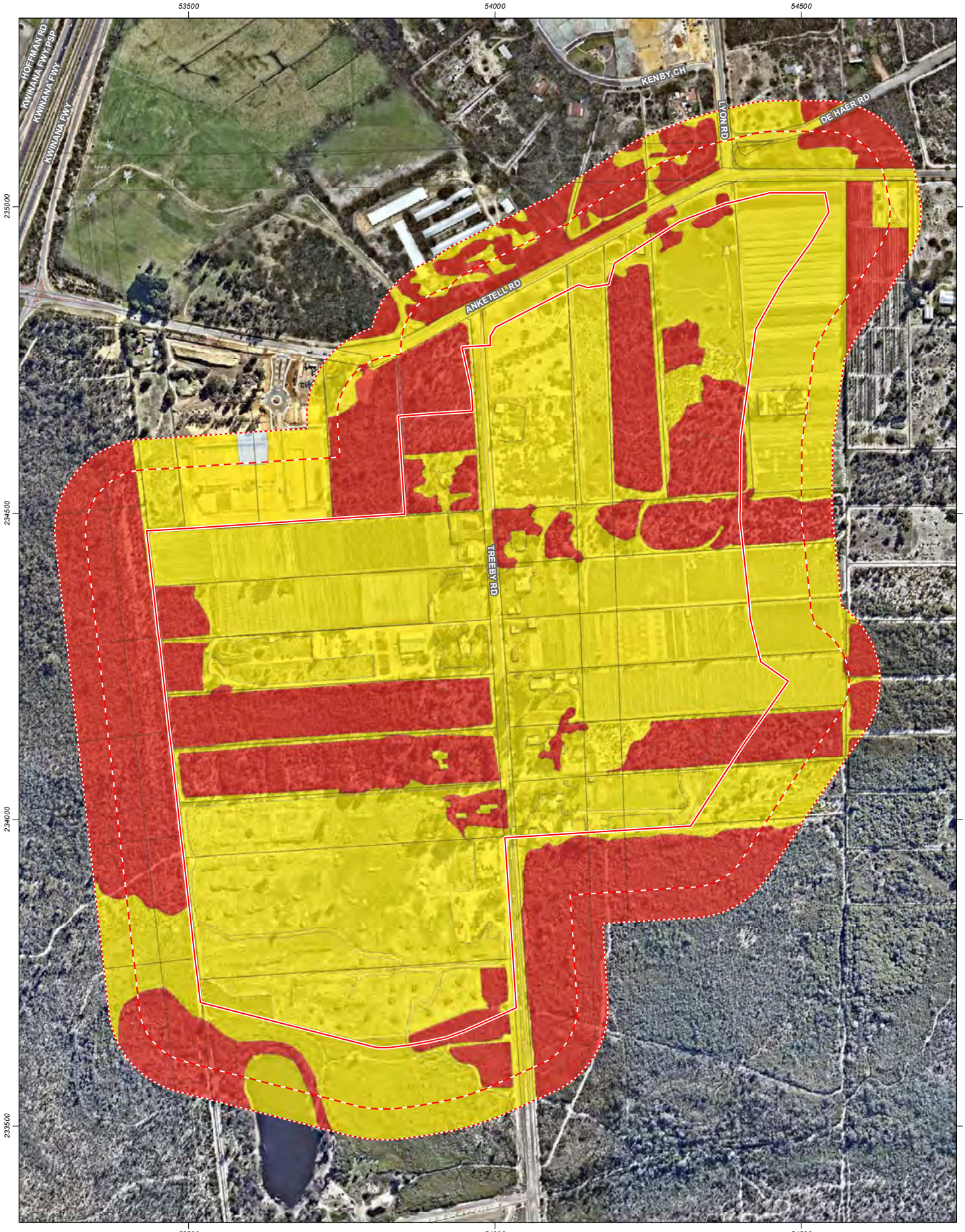

Figure 4: Pre-development Bushfire Hazard Level assessment

N

Scale 1:5,800 at A3

0 100 200 m

Coordinate System: GDA 1994 Perth Coastal Grid 1994

Date: 7/11/2018

Legend

- Project area
- 100m Assessment area
- 150m Assessment are
- Cadastre

Bushfire Hazard Level

- Extreme
- Moderate
- Low

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Data source: Nearmap: Aerial image, flown 08/2018. Landgate: Cadastre, 11/2017. Client: Acumen Development Solutions. Development layout, 08/2018. Created by: jcrute

3.2 Assessment outputs

Strategen has mapped the pre-development BHLs within the project area and adjacent 150 m in accordance with methodology outlined in Appendix 2 of the Guidelines (refer to Figure 4). The BHLs have been assessed on the basis of the pre-development vegetation classification outlined in Figure 3. As mentioned previously, there are no areas of the site which exhibit a slope greater than 10 degrees.

A summary of the pre-development BHL results is provided below and depicted in Figure 4:

- all Class B Woodland has been assigned a bushfire hazard level of Extreme
- all Class D Scrub has been assigned a bushfire hazard level of Extreme
- all Class C shrubland has been assigned a bushfire hazard level of Moderate
- all Class G Grassland has been assigned a bushfire hazard level of Moderate
- in accordance with the bushfire hazard level assessment methodology detailed in Appendix 2 of the Guidelines, vegetation that has a Low bushfire hazard level but is within 100 m of Extreme or Moderate bushfire hazard level vegetation has been assigned a Moderate bushfire hazard level
- all remaining areas have been assigned a bushfire hazard level of Low.

The pre-development BHL assessment (see Figure 4) shows that based on the existing vegetation, the project area contains land with Low, Moderate and Extreme BHLs.

Following development works, the project area will be largely cleared (see Figure 5). The post-development BHL assessment (see Figure 6) shows that following development works, the project area will contain land with predominantly Low and Moderate BHLs, with an area of Extreme BHL located in the southern portion of the site associated with vegetation retained within the CCW buffer.

4. Identification of bushfire hazard issues

Following development works, the project area will be predominantly cleared, with any remaining vegetation or trees configured in a way that can be excluded under a relevant Clause (2.2.3.2) of AS3959. Details of how each of these exclusions will be achieved will be provided at the subdivision and DA stages in detailed landscape drawings. A small area of vegetation will be retained in the southern portion of the site, associated with the CCW.

Strategen understands that the Western Power corridor traversing the eastern portion of the project area will be managed as POS by the City (following handover) to achieve an exclusion under Clause 2.2.3.2 (b), (c), (d), (e) and (f) of AS3959.

Given the above, the predominant bushfire hazard to the development is associated with Bush Forever site 270 to the west, south and south-east of the project area. The presence of this vegetation could result in fire travelling toward the project area from the west with a fire run of approximately 3 km through predominantly intact Class B woodland. There is also potential for bushfire occurrence through Class B woodland to the east within private landholdings. The vegetation adjacent to the project area is fragmented in areas, by agricultural land uses, major roads and tracks that would reduce the ability for fire spread and significant bushfire escalation at the development interface.

Sections 5 and 6 outline the bushfire protection criteria and management measures that will facilitate mitigating these bushfire hazards and ensuring compliance with the requirements of SPP3.7 and the Guidelines at future planning stages.

It is noted that the Mandogalup Fire Station is located approximately 1 km to the west along Anketell Road, providing the option of a direct suppression response and a two-minute response time at legal road speeds.

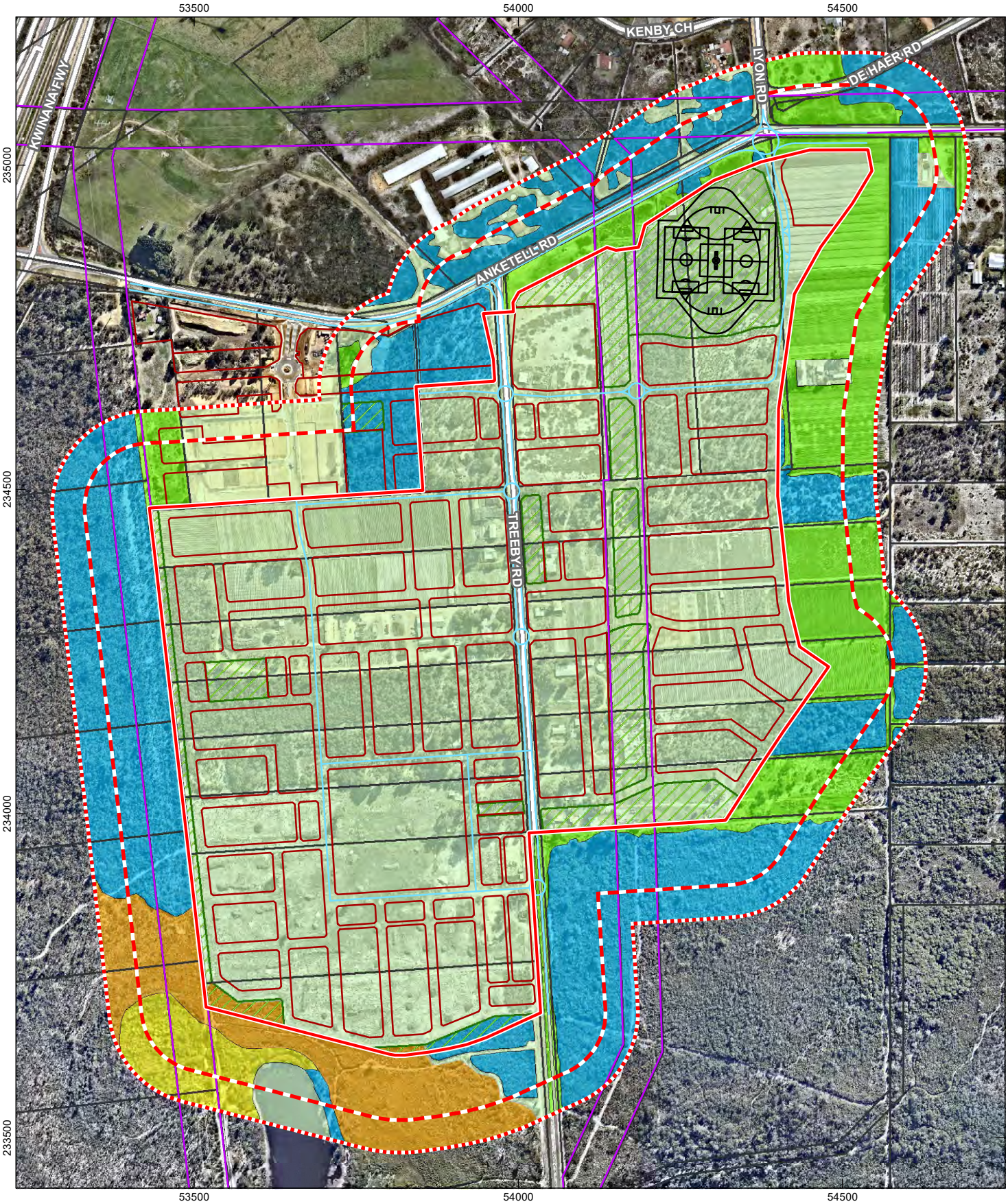

Figure 5: Post-development vegetation classification

N

Scale 1:8,000 at A4

0 100 200 m

Coordinate System:
GDA 1994 Perth Coastal Grid 1994

Date: 16/05/2019

Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastre
- Roads
- Carriageways
- Road reserve
- Sports field alternative
- Western Power easement
- Public open space

Vegetation classification

- Class B Woodland
- Class C Shrubland
- Class D Scrub
- Class G Grassland
- Excluded under Clauses 2.2.3.2. (e) and (f)

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Service Layer Credits: Nearmap: Aerial image, flown 01/2019. Client: Acumen Development Solutions. Site data 4/2019. Created by: h.sullivan

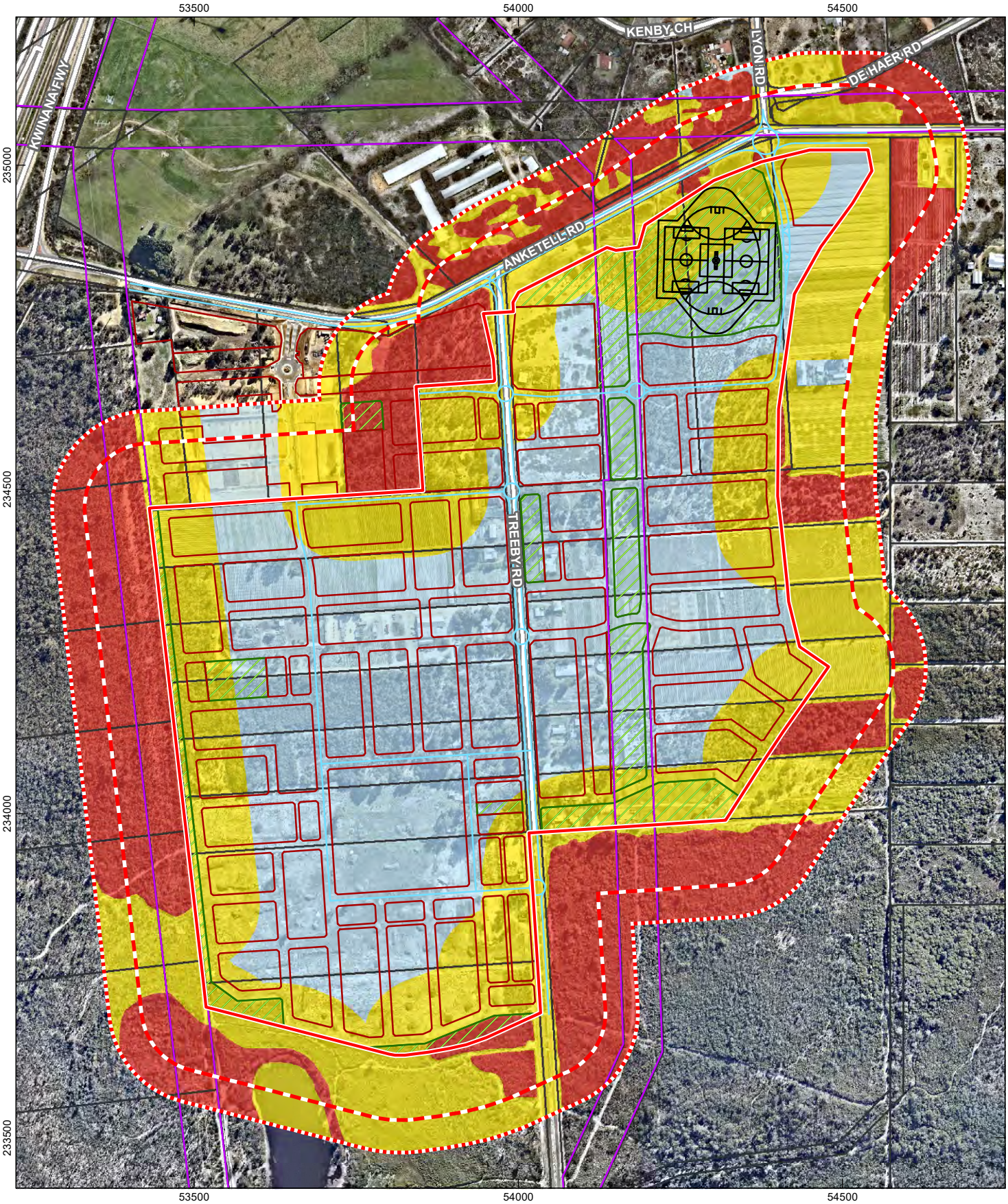

Figure 6: Post-development Bushfire Hazard Level assessment

N

Scale 1:8,000 at A4

0 100 200 m

Coordinate System:
GDA 1994 Perth Coastal Grid 1994

Date: 16/05/2019

Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastre
- Roads
- Carriageways
- Road reserve
- Sports field alternative
- Western Power easement
- Public open space

Bushfire hazard level

- Extreme
- Moderate
- Low

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Service Layer Credits: Nearmap: Aerial image, flown 01/2019. Client: Acumen Development Solutions. Site data 4/2019. Created by: h.sullivan

5. Assessment against the bushfire protection criteria

5.1 Compliance table

In response to the requirements of SPP 3.7 and the Guidelines, strategic level bushfire management measures have been devised to demonstrate how the bushfire protection criteria will be met at subsequent stages of the planning process, as outlined in Table 3.

Table 3: Bushfire protection criteria compliance table

Bushfire protection criteria	Method of compliance Acceptable solutions	Proposed bushfire management strategies
Element 1: Location	A1.1 Development location	Given the size of the project area and the proposed extent of clearing and vegetation modification required to facilitate future development, BHLs within the project area will be reduced to a moderate or low level (see Figure 6). The management measures specified in Section 6 will ensure that on completion of development, all developable land will comprise either a low or moderate BHL and a rating of BAL-29 or lower will be achieved through provision of appropriate setbacks to any post-development classified vegetation. The presence of perimeter roads and managed POS at the bushfire hazard interfaces will assist in achieving the required separation.
Element 2: Siting and design	A2.1 Asset Protection Zone	APZs sufficient to achieve BAL-29 or lower are to be implemented for all future lots subject to a BAL rating above BAL-LOW. As outlined above, the presence of perimeter roads and managed POS at the bushfire hazard interfaces will assist in achieving the required separation. The required APZs are to be identified at future planning stages based on future subdivision / development design and following a BAL contour assessment. APZs are to be implemented and maintained in accordance with Schedule 1 of the Guidelines (Appendix 3) and the City's firebreak notice (Appendix 2).
Element 3: Vehicular access	A3.1 Two access routes.	Future development will ensure at least two linkages to the existing public road network will be established. The proposed LSP identifies a through access by extension of Treeby Road from Anketell Road abutting the north of the project area to Thomas Road to the south of the project area. Two access routes are therefore readily achievable. In the event that the development of the project area is staged, the proponent will ensure two (temporary or permanent) access options to two different directions are provided to each stage of development.
	A3.2 Public road	Creation of new public roads will need to comply with technical requirements of the Guidelines (see Table 4).
	A3.3 Cul-de-sac (including a dead-end-road)	Future development will not result in creation of permanent cul-de-sacs or dead-end roads. Subdivision stage BMPs will ensure that any temporary cul-de-sacs or dead ends created during staging are compliant in accordance with Table 4. The development is proposed to connect to a separate development to the north-west of the project area (as shown in the SP; Figure 1) and provide thru access. In the event that development of the project area precedes the adjacent development, a temporary cul-de-sac will be required at the two 'dead-end' roads. The cul-de-sacs will be required to comply with the technical specifications in Table 4.
	A3.4 Battle-axe	N/A. Future development will not result in creation of battle-axes.

Bushfire protection criteria	Method of compliance Acceptable solutions	Proposed bushfire management strategies
	A3.5 Private driveway longer than 50 m	Should future development result in creation of private driveways longer than 50 m, then compliance for private driveways will need to be met as outlined in Table 4.
	A3.6 Emergency access way	No permanent emergency access ways will be proposed or required as part of development. Subdivision stage BMPs will ensure that any temporary EAWs created during staging are compliant in accordance with Table 4.
	A3.7 Fire service access routes (perimeter roads)	N/A. No fire service access routes will be proposed or required as part of development.
	A3.8 Firebreak width	Individual lot firebreaks will be compliant with the City of Kwinana firebreak notice (Appendix 2).
Element 4: Water	A4.1 Reticulated areas	Future development will be provided with a reticulated supply compliant with Water Corporation DS-63 requirements.
	A4.2 Non-reticulated areas	N/A. Proposed development will be reticulated.
	A4.3 Individual lots within non-reticulated areas (Only for use if creating 1 additional lot and cannot be applied cumulatively)	N/A. Proposed development will be reticulated.

Table 4: Vehicular access technical requirements

Technical requirement	Public road	Cul-de-sac	Battle-axe legs and private driveways longer than 50 m	Emergency access ways	Fire service access routes
Minimum trafficable surface (m)	6*	6	4	6*	6*
Horizontal distance (m)	6	6	6	6	6
Vertical clearance (m)	4.5	N/A	4.5	4.5	4.5
Maximum grade <50 m	1 in 10	1 in 10	1 in 10	1 in 10	1 in 10
Minimum weight capacity (t)	15	15	15	15	15
Maximum crossfall	1 in 33	1 in 33	1 in 33	1 in 33	1 in 33
Curves minimum inner radius	8.5	8.5	8.5	8.5	8.5

* Refer to E3.2 Public roads: Trafficable surface

Source: WAPC 2017

5.2 Discussion of management strategies

Strategen makes the following additional recommendations to inform ongoing planning stages of the development and increase the level of bushfire risk mitigation across the site:

1. On-site staging buffers: if development (and therefore clearing) is to occur on a staged basis, clearing in advance will need to occur to ensure building construction is not inhibited by a temporary vegetation extent located within adjacent development stages yet to be cleared. This can be achieved by ensuring that each approved stage subject to construction separated from classified vegetation by a 100 m wide (50 m for Class G grassland), on-site cleared or low threat buffer prior to development (not including vegetation proposed to be retained). Once the buffers are created, they will need to be maintained on a regular and ongoing basis at a fuel load less than 2 t/ha to achieve low-threat vegetation in minimal fuel condition, year-round, until such time that the buffer area is developed as part of the next development stage. This will assist in managing the current on-site temporary vegetation hazards.
2. Fuel management within cleared vacant lots: cleared lots will be managed on a regular and ongoing basis by the developer until sale of lots after which time landowners will be responsible for ongoing management. Management will involve slashing/mowing of grassland and weeds to height of less than 50 mm, which is driven through compliance with the City of Kwinana firebreak notice (refer to Appendix 2).
3. Road verge fuel management: road verges will need to be managed to ensure the understorey and surface fuels remain in a low threat, minimal fuel condition in accordance with Clause 2.2.3.2 (f) of AS 3959. Ongoing road verge management will be the responsibility of the City.

   POS fuel management: where exclusion Clause 2.2.3.2 (f) is applied, POS will be managed on a regular and ongoing basis by the developer after which time the City will be responsible for ongoing management. Management will involve slashing/mowing of grassland and weeds to height of less than 50 mm, and removal of leaf litter and other dead plant material.
4. Notification on title: notification is to be placed on the Title of all proposed lots subject to BAL-12.5 or higher (either through condition of subdivision or other head of power) to ensure landowners/proponents and prospective purchasers are aware that their lot is subject to an approved BMP and BAL assessment.
5. Landscaping plans: proposed landscaping plans for the project area (including POS, drainage basins, visual amenity buffers, streetscapes and any retained vegetation) will need to reflect the bushfire management measures required under this BMP and future subdivision and DA stage BMPs.
6. Building construction standards for commercial buildings: ember attack is likely to be the predominant risk to future development in a bushfire event, Strategen therefore recommends that buildings other than Class 1, 2, and 3 (and associated 10a) adopt a voluntary BAL-12.5 construction standard (where possible) for all future buildings to incorporate ember protection as a minimum. However, this is not a formal requirement of SPP3.7, the Guidelines or AS 3959.
7. Building setbacks: where APZs cannot be achieved solely within perimeter roads and low-threat landscaping, voluntary APZ building setbacks may be required within individual lots to ensure that no development will occur in BAL-40 or BAL FZ.
8. Consideration of BEEP/ BRMP provisions: if any vulnerable or high-risk land uses are being proposed, there will need to be consideration of Bushfire Emergency Evacuation Plan (BEEP) or Bushfire Risk Management Plan (BRMP) provisions at the DA stage.

6. Responsibilities for implementation and management of the bushfire measures

This BMP has been prepared as a strategic guide to demonstrate how development compliance will be delivered at future planning stages in accordance with the Guidelines. Aside from the preparation of future BMPs to accompany future subdivision and DAs where appropriate, there are no further items to implement, enforce or review at this strategic stage of the planning process.

Future BMPs prepared for subsequent subdivision and DAs are to meet the relevant commitments outlined in this strategic level BMP, address the relevant requirements of SPP 3.7 (i.e. Policy Measures 6.4 and 6.5 respectively) and demonstrate in detail how the proposed development will incorporate the relevant acceptable solutions to meet the performance requirements of the Guidelines. The proponent is to ensure that future BMPs include the following detailed information:

- proposed lot layout (subdivision stage)
- detailed landscaping design (subdivision stage)
- post development classified vegetation extent, effective slope and exclusions (subdivision stage)
- BAL contour map demonstrating that proposed development areas will achieve BAL–29 or lower (subdivision stage)
- width and alignment of compliant APZs (subdivision stage)
- confirmation of how bushfire management will be addressed during development staging (subdivision stage)
- proposed approach to fuel management or AS 3959 application in response to on-site POS or easements (subdivision stage)
- vehicular access provisions, including demonstration that a minimum of two access routes will be achieved for each stage of development in accordance with acceptable solution A3.1 (subdivision stage)
- water supply provisions with regards to reticulated water (subdivision stage)
- future requirements for any future vulnerable or high-risk land uses, such as provision of a Bushfire Emergency Evacuation Plan or Bushfire Risk Management Plan DA stage)
- provisions for notification on Title for any future lots with a rating of BAL–12.5 or greater as a condition of subdivision (subdivision stage)
- compliance requirements with the current City annual firebreak notice (subdivision stage)
- requirements for BAL compliance as a condition of subdivision (subdivision stage)
- acceptable solutions assessment against the bushfire protection criteria (subdivision stage)
- proposed implementation and audit program outlining all measures requiring implementation and the appropriate timing and responsibilities for implementation (subdivision stage).

On the basis of the information contained in this BMP, Strategen considers the bushfire hazards within and adjacent to the project area and the associated bushfire risk is readily manageable through standard management responses outlined in the Guidelines and AS 3959. Strategen considers that on implementation of the proposed management measures, the project area will be able to be developed with a manageable level of bushfire risk whilst maintaining full compliance with the Guidelines and AS 3959.

7. References

Bioscience 2018, *Local Water Management Strategy: Anketell North Local Structure Plan,* report prepared for Acumen Development Solutions.

Department of Fire and Emergency Services (DFES) 2018, *Map of Bush Fire Prone Areas*, [Online], Government of Western Australia, available from: *https://maps.slip.wa.gov.au/landgate/bushfireprone/*

Standards Australia (SA) 2009, *Australian Standard AS 3959–2009 Construction of Buildings in Bushfire-prone Areas*, Standards Australia, Sydney.

Strategen 2018, *Environmental Assessment Report: Anketell North Local Structure Plan*, report prepared for Acumen Development Solutions.

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

Western Australian Planning Commission (WAPC) 2017, *Guidelines for Planning in Bushfire-Prone Areas*, Western Australian Planning Commission, Perth.

Appendix 1
Landscape masterplan

POS & STREETSCAPES SUMMARY

1. District Open Space
   Multipurpose sport recreation facility.
   Large open turf areas for informal games & organized sport.

2. Linear Park
   North & south pedestrian & cycle network for residents & school students.
   Turf pockets interspersed with drainage treatment swales.
   Minor recreation features, ie. Gathering node with park furniture.

3. Pocket Park
   Small open space for local passive recreation use.
   Open turf, circulation pathways & gathering node.
   Intimate space with retained vegetation where available.

4. Nature Buffer
   Edge treatment to bush forever.
   Predominantly retained vegetation with circulation pathways.
   Landscaping for bush fire prevention.

5. Neighborhood Park
   Gathering space for informal active recreation.
   Areas of open turf, circulation pathways & drainage treatment basin.
   Public amenity such as picnic facilities.

6. Median Island Landscaping & Street Trees
   Native & endemic street tree planting to verges and median islands.
   Minimum of 1 street tree per lot frontage.
   Water wise low maintenance understorey planting allowing clear sight lines through the streetscapes.
   Minimum one footpath per street adjacent to the lot boundary.

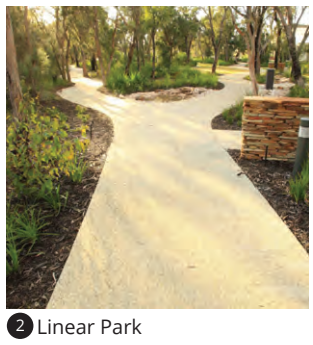
ANKETELL ROAD

TREEBY ROAD

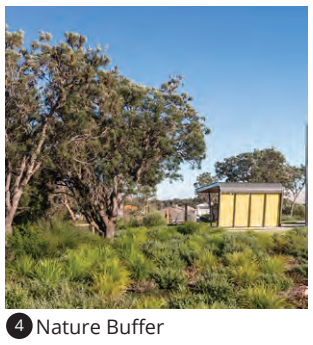
4.90 ha
0.29 ha
1.03 ha
0.54 ha
0.49 ha
0.40ha
0.77 ha
0.56 ha
1.38 ha
1.41 ha
1.09 ha
0.39 ha

LEGEND
- Extent of Works
- Drainage Basin
- Public Open Space Amenity Node
- Public Open Space
- Residential
- Primary School
- Community Facility
- Commercial
- Bush Forever
- Drainage Basin & Swale
- Existing trees to be retained if possible
- Proposed native & endemic trees


1 District Open Space


2 Linear Park


3 Pocket Park


4 Nature Buffer


5 Neighborhood Park


6 Median Island Landscaping & Street Trees

LD TOTAL
LEADERS IN LANDSCAPING

ANKETELL NORTH
LANDSCAPE MASTER PLAN

10.1636	C	17.05.19	1:5000
PROJECT NO	REVISION	DATE	SCALE

Appendix 2
City of Kwinana firebreak notice
2018/2019

Firebreak Variations

If the owner or occupier considers it **impractical to install a firebreak or comply with this notice for any reason**, you are required to apply to the City of Kwinana in writing by **30 October 2018 to obtain approval to install firebreaks in an alternative position.** If the variation is not approved, the owner or occupier must comply with this Notice in its entirety.

Previously approved firebreak variations do not need to be reapplied for unless circumstances have changed, or you have been advised in writing by the Local Government of any changes.

Additional Works

Regardless of land size and location, the City of Kwinana or its Bush Fire Control Officers may require owners and/or occupiers to undertake additional work on your property to improve access, and/or undertake further works to reduce a hazard that may be conducive to preventing the outbreak and/or the spread or extension of a fire.

Burning of Garden Refuse

PROHIBITED BURNING PERIODS ONLY

During the declared Prohibited Burning Period, owners and/or occupiers must not undertake any bush or garden refuse burning activities

RESTRICTED BURNING PERIODS ONLY

During the declared Restricted Burning Period only, owners and/or occupiers may:

- Apply for a permit to burn the bush for bush fire risk mitigation purposes, by following the conditions imposed on a permit to burn as issued by a Bush Fire Control Officer.
- In areas zoned rural by the Metropolitan Region Scheme you may undertake burning of leaves, tree branches, and other dry vegetation in piles no larger than 1.0m³ in size, without a permit to burn, subject to the following conditions:
  - No Flammable Matter (other than that being burned) is to be within five (5) metres of the fire at any time while the fire is burning;
  - The fire is lit between 6pm and 11pm and is completely extinguished before midnight on the same day;
  - At least one person is present at the site of the fire at all times until it is completely extinguished.
  - When the fire is no longer required, the person ensures that the fire is completely extinguished by the application of water or earth.

UNRESTRICTED BURN PERIODS ONLY

During the Unrestricted Burning Time, owners and/or occupiers in areas zoned rural under the Metropolitan Region Scheme may burn garden refuse and set fire to bush on their land without a permit. Burning of the bush must be undertaken in accordance with all relevant State legislation and Local Government Local Laws.

NO BURNING IN AREA DEFINED AS URBAN AREAS

Pursuant to section, 24G (2) of the *Bush Fires Act 1954*, no garden refuse burning is to be undertaken in areas defined as "Urban" under the Metropolitan Region Scheme without **written approval** of Local Government.

For information regarding dates for the Unrestricted, Restricted and Prohibited periods please contact the City of Kwinana City Assist office on 9439 0400 or view the City's website, **www.kwinana.wa.gov.au**.

PENALTIES

Failing to comply with this Fire Notice may result in a penalty of up to $5,000.

A person in default of the requirements of this Notice is also liable, whether prosecuted or not, to pay the costs of performing the work directed by the City of Kwinana or its Bush Fire Control Officer.

Any owner and/or occupier who engages a contractor to undertake works on their behalf is responsible to ensure that the works completed meet the requirements of this Notice.

Maria Cooke,
Acting Chief Executive Officer

City of Kwinana

BUSH FIRES ACT 1954

Fire Notice
City of Kwinana

Pursuant to the powers contained in section 33 of the *Bush Fires Act 1954* (as amended), all property owners and/or occupiers of land within the City of Kwinana are hereby served first and final notice and are required to comply with the requirements set out in this notice in its entirety.

All land and buildings shall be maintained for such duration and in such positions/dimensions and specifications as required by this notice or as approved in writing by the City of Kwinana or its Bush Fire Control Officers. The works outlined in this notice must be completed before the dates listed in this notice and must be maintained throughout as required by this notice.

Definitions

"ASSET PROTECTION ZONE" means an area with a radius of twenty (20) metres measured from the external perimeter of the building/s or as stated in your approved Bushfire Attack Level (BAL) assessment, within the boundaries of the lot on which the building/s is situated. Fuel loads in this zone shall be reduced and maintained to two (2) tonnes per hectare or less.

"BUSH FIRE CONTROL OFFICER" means an Officer appointed by the City of Kwinana to exercise the powers and duties of a Bush Fire Control Officer appointed under s38(1) of the Bush Fires Act 1954.

"BUSH FIRE" means a fire or potential fire, however caused, and includes a fire in a building.

"DEAD END" means a track, firebreak, road or access way that terminates without any means of escape or ability to turn around safely.

"EMERGENCY ACCESS WAYS" are for Emergency Services vehicles only and are not to be considered as an escape route unless declared as such by the Incident Controller during an emergency.

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

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

"TRAFFICABLE" means to be able to travel from one point to another in a fire vehicle on a firm and stable surface, unhindered without any obstruction that may endanger resources. The firebreak must not terminate without provision for egress to a safe place or a cleared turn around area of not less than a twenty one (21) metre radius (prior written approval may be required from the local government if trees are to be removed).

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

Land area – 3,001m² or greater

The works outlined in this section must be completed before 1 December 2018 and continually maintained until 30 April 2019.

Owners and/or occupiers of land that is 3,001m² or greater are required to:

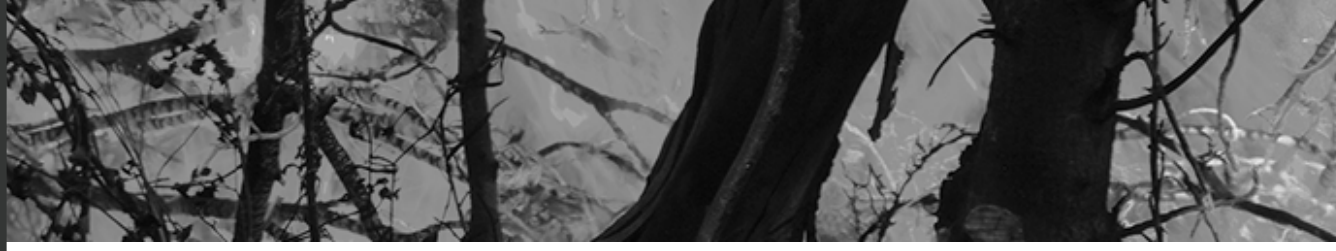
- Construct clear bare mineral earth firebreaks three (3) metres wide inside and along all boundaries of land in a continuous form, or within ten (10) metres of boundaries adjacent to roads, rail and drain reserves and all public open space reserves, with all overhanging branches, trees, limbs etc. to be trimmed back from over the firebreak area to a minimum width of four (4) metres and a vertical axis height of four (4) metres;
- Around all sides of the buildings on the property on the land construct clear bare mineral earth firebreaks three (3) metres wide around all buildings in a continuous form, or within twenty (20) metres of buildings, with all overhanging branches, trees, limbs etc. to be trimmed back from over the firebreak area to a minimum width of four (4) metres and a vertical axis height of four (4) metres;
- On all driveways and access ways to houses, sheds and buildings, maintain clear bare mineral earth surface to a trafficable standard three (3) metres wide in a continuous form, with all overhanging branches, trees, limbs etc. to be trimmed back from over all driveways and access ways to houses, sheds and buildings to a minimum width of four (4) metres and a vertical axis height of four (4) metres;
- On any land surrounding any place where, wood or timber piles, hay stacks, tyres, vehicles, flammable liquids, chemicals and gas products are kept on the land, construct clear bare mineral earth firebreaks three (3) metres wide in a continuous form, with all overhanging branches, trees, limbs etc. to be trimmed back from over the firebreak area to a minimum width of four (4) metres and a vertical axis height of four (4) metres;
- Construct these firebreaks in a manner so that there are no "Dead Ends," with all corners or change in directions wide enough for a heavy-duty fire or emergency services vehicle, to be able to turn the corner without the vehicle being obstructed in any way; and
- Maintain an asset protect zone around all buildings, infrastructure and fixed assets on the property.

Land area – 3,000m² or less

The works outlined in this section must be maintained all year round and owners and/or occupiers are required to;

- Have all matter such as long grass, weeds, etc. slashed, mowed or trimmed down by other means to a height no greater than 50mm across the entire property.
- All overhanging branches, trees, limbs etc. to be trimmed back from over any building area to a minimum width of two (2) metres from the walls and to a vertical axis height of four (4) metres surrounding any building.
- Maintain an asset protect zone around all buildings, infrastructure and fixed assets on the property.

Appendix 3
Asset Protection Zone Standards
(Schedule 1, the Guidelines)

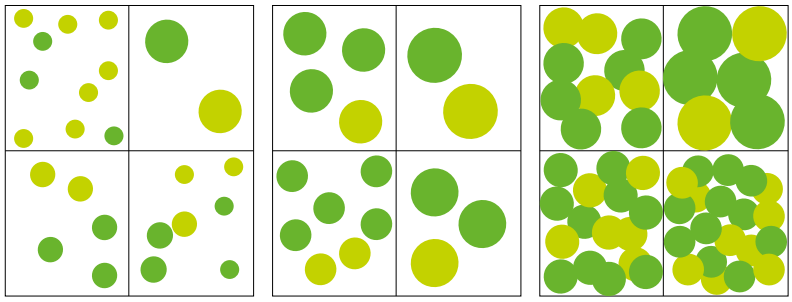


ELEMENT 2: SITING AND DESIGN OF DEVELOPMENT

SCHEDULE 1: STANDARDS FOR ASSET PROTECTION ZONES

- **Fences:** within the APZ are constructed from non-combustible materials (e.g. iron, brick, limestone, metal post and wire). It is recommended that solid or slatted non-combustible perimeter fences are used.
- **Objects:** within 10 metres of a building, combustible objects must not be located close to the vulnerable parts of the building i.e. windows and doors.
- **Fine Fuel load:** combustible dead vegetation matter less than 6 millimetres in thickness reduced to and maintained at an average of two tonnes per hectare.
- **Trees (> 5 metres in height):** trunks at maturity should be a minimum distance of 6 metres from all elevations of the building, branches at maturity should not touch or overhang the building, lower branches should be removed to a height of 2 metres above the ground and or surface vegetation, canopy cover should be less than 15% with tree canopies at maturity well spread to at least 5 metres apart as to not form a continuous canopy.

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



- **Shrubs (0.5 metres to 5 metres in height):** should not be located under trees or within 3 metres of buildings, should not be planted in clumps greater than 5m^2 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.

APPENDIX C
ACOUSTIC ASSESSMENT

ANKETELL NORTH DEVELOPMENT

ACOUSTIC ASSESSMENT

FOR

ACUMEN PROPERTY SOLUTIONS

MAY 2019

OUR REFERENCE: 24306-3-19086

Rochdale Holdings Pty Ltd A.B.N. 85 009 049 067 trading as:
HERRING STORER ACOUSTICS
P.O. Box 219, Como, W.A. 6952
(08) 9367 6200
hsa@hsacoustics.com.au

DOCUMENT CONTROL PAGE

ACOUSTIC ASSESSMENT

ANKETELL NORTH DEVELOPMENT

Job No: 19086
Document Reference: 24306-3-19086

FOR

ACUMEN PROPERTY SOLUTIONS

DOCUMENT INFORMATION			
Author:	Paul Daly	**Checked By:**	Tim Reynolds
Date of Issue :	7 May 2019		

REVISION HISTORY				
Revision	**Description**	**Date**	**Author**	**Checked**
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2	For council Comments	03/07/2019	TR	

DOCUMENT DISTRIBUTION				
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1	2	Acumen – Jarrod Rendell jarrod@acumends.com.au		✓
1	3	tbb – Rachel Chapman rachel@tbbplanning.com.au		✓

CONTENTS

APPENDICIES

EXECUTIVE SUMMARY

Herring Storer Acoustics was commissioned by Acumen Property Solutions, to undertake an acoustical assessment of noise that would be received at the proposed commercial and residential development located at the Anketell North Development from road traffic noise associated with the future Anketell Road.

Under the Western Australian Planning Commission (WAPC) Planning Policy 5.4 "Road and Rail Transport Noise and Freight Considerations in Land Use Planning" (SPP 5.4), the appropriate criteria for assessment for this development are:

EXTERNAL
$L_{Aeq(Day)}$ of 60 dB(A);
$L_{Aeq(Night)}$ of 55 dB(A).

INTERNAL
$L_{Aeq(Day)}$ of 40 dB(A) in living and work areas; and
$L_{Aeq(Night)}$ of 35 dB(A) in bedrooms.

Additional to the above, noise received at an outdoor area should also be reduced as far as practicable, with an aim of achieving an L_{Aeq} of 50 dB(A) during the night period.

From information provided, we understand that Anketell Road may, in the future, undergo a re-alignment, which would affect noise levels onto the development. Therefore, this report considers noise level associated with the proposed future road alignment.

The modification to Anketell Road would be considered as major upgrade and hence the infrastructure provided is obliged to achieve compliance with the "Noise Limits" at the ground floor. This normally requires the infrastructure provider to construct the barrier walls. However, in this case as, as outlined in the policy under Section 5.3.2 where a major road project is to be constructed in the vicinity of a future noise sensitive land use, the infrastructure provider and developer are both responsible for ensuring that the objectives of this policy are achieved. Similarly, for an upgrade to Anketell Road, the infrastructure provider would be responsible for achieving compliance with the "Noise Limits", which in this case would be the use of a dense graded asphalt road surface. However, once again, discussions should take place between the infrastructure provider and the developer to ensure that a mutually beneficial noise management plan is developed and implemented.

For this proposal, a Dry recreation centre, playing fields and a commercial lot have been proposed for the lots bordering Anketell Road. Depending on the final development/layout for the area, some of the residential lots located to the south of these would require noise amelioration in the form of quiet house design and/or Notification on Titles. These requirements would need to be determined once the lot layouts have been finalised.

Finally, it is noted that with the orientation of the closest residential lots to Anketell Road being such that they would face Anketell Road, the residences themselves would act as a barrier to the back yards (and the other residence behind). Hence compliance with the external criteria, for at least one outdoor area to comply with the "Noise Target" would be achieved.

1. INTRODUCTION

Herring Storer Acoustics was commissioned by Acumen Property Solutions, to undertake an acoustical assessment of noise that would be received at the proposed commercial and residential development located at the Anketell North Development from road traffic noise associated with the future Anketell Road.

This acoustic study has been undertaken to assess the commercial usage at the façade lots to Anketell Road, and if these areas contain any noise sensitive premises such as child care centres, then provide advice on the acoustic requirements.

As part of the study, the following was carried out:

- Determine by noise modelling the noise that would be received at proposed Lots within this stage of the LSP from vehicles travelling on the roadway (Anketell Road) for the future road alignment.
- Assess the predicted noise levels for compliance with the appropriate criteria.
- Provide detailed information as to noise control requirements such as quiet house design, noise walls and notification on titles.

For information, a site layout is attached as Figure A1 in Appendix A.

2. CRITERIA

The WAPC released on 22 September 2009 State Planning Policy 5.4 *"Road and Rail Transport Noise and Freight Considerations In Land Use Planning"*. Section 5.3 – Noise Criteria, which outlines the acoustic criteria, states:

> "5.3 - NOISE CRITERIA
>
> *Table 1 sets out the outdoor noise criteria that apply to proposals for new noise-sensitive development or new major roads and railways assessed under this policy.*
>
> *These criteria do not apply to—*
>
> - *proposals for redevelopment of existing major roads or railways, which are dealt with by a separate approach as described in section 5.4.1; and*
> - *proposals for new freight handling facilities, for which a separate approach is described in section 5.4.2.*
>
> *The outdoor noise criteria set out in Table 1 apply to the emission of road and rail transport noise as received at a noise-sensitive land use. These noise levels apply at the following locations —*
>
> - *for new road or rail infrastructure proposals, at 1 m from the most exposed, habitable façade of the building receiving the noise, at ground floor level only; and*
> - *for new noise-sensitive development proposals, at 1 m from the most exposed, habitable façade of the proposed building, at each floor level, and within at least one outdoor living area on each residential lot.*
>
> *Further information is provided in the guidelines.*

TABLE 1: OUTDOOR NOISE CRITERIA

Time of day	*Noise Target*	*Noise Limit*
Day (6 am–10 pm)	$L_{Aeq(Day)}$ *= 55 dB(A)*	$L_{Aeq(Day)}$ *= 60 dB(A)*
Night (10 pm–6 am)	$L_{Aeq(Night)}$ *= 50 dB(A)*	$L_{Aeq(Night)}$ *= 55 dB(A)*

The 5 dB difference between the outdoor noise target and the outdoor noise limit, as prescribed in Table 1, represents an acceptable margin for compliance. In most situations in which either the noise-sensitive land use or the major road or railway already exists, it should be practicable to achieve outdoor noise levels within this acceptable margin. In relation to the sites, however, there is an expectation that the design of the proposal will be consistent with the target ultimately being achieved.

Because the range of noise amelioration measures available for implementation is dependent upon the type of proposal being considered, the application of the noise criteria will vary slightly for each different type. Policy interpretation of the criteria for each type of proposal is outlined in sections 5.3.1 and 5.3.2.

The noise criteria were developed after consideration of road and rail transport noise criteria in Australia and overseas, and after a series of case studies to assess whether the levels were practicable. The noise criteria take into account the considerable body of research into the effects of noise on humans, particularly community annoyance, sleep disturbance, long-term effects on cardiovascular health, effects on children's learning performance, and impacts on vulnerable groups such as children and the elderly. Reference is made to the World Health Organization (WHO) recommendations for noise policies in their publications on community noise and the Night Noise Guidelines for Europe. See the policy guidelines for suggested further reading.

5.3.1 Interpretation and application for noise-sensitive development proposals

In the application of these outdoor noise criteria to new noise-sensitive developments, the objective of this policy is to achieve –

- *acceptable indoor noise levels in noise-sensitive areas (for example, bedrooms and living rooms of houses, and school classrooms); and*
- *a reasonable degree of acoustic amenity in at least one outdoor living area on each residential lot[1].*

If a noise-sensitive development takes place in an area where outdoor noise levels will meet the noise target, no further measures are required under this policy.

In areas where the noise target is likely to be exceeded, but noise levels are likely to be within the 5dB margin, mitigation measures should be implemented by the developer with a view to achieving the target levels in a least one outdoor living area on each residential lot[1]. Where indoor spaces are planned to be facing any outdoor area in the margin, noise mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces. In this case, compliance with this policy can be achieved for residential buildings through implementation of the deemed-to-comply measures detailed in the guidelines.

In areas where the outdoor noise limit is likely to be exceeded (i.e. above $L_{Aeq(Day)}$ of 60 dB(A) or $L_{Aeq(Night)}$ of 55 dB(A)), a detailed noise assessment in accordance

1 For non residential noise-sensitive developments, (e.g. schools and child care centres) consideration should be given to providing a suitable outdoor area that achieves the noise target, where this is appropriate to the type of use.

with the guidelines should be undertaken by the developer. Customised noise mitigation measures should be implemented with a view to achieving the noise target in at least one outdoor living or recreation area on each noise-sensitive lot or, if this is not practicable, within the margin. Where indoor spaces will face outdoor areas that are above the noise limit, mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces, as specified in the following paragraphs.

For residential buildings, acceptable indoor noise levels are $L_{Aeq(Day)}$ of 40 dB(A) in living and work areas and $L_{Aeq(Night)}$ of 35 dB(A) in bedrooms[2]. For all other noise-sensitive buildings, acceptable indoor noise levels under this policy comprise noise levels that meet the recommended design sound levels in Table 1 of Australian Standard AS 2107:2000 Acoustics—Recommended design sound levels and reverberation times for building interiors.

These requirements also apply in the case of new noise-sensitive developments in the vicinity of a major transport corridor where there is no existing railway or major road (bearing in mind the policy's 15-20 year planning horizon). In these instances, the developer should engage in dialogue with the relevant infrastructure provider to develop a noise management plan to ascertain individual responsibilities, cost sharing arrangements and construction time frame.

If the policy objectives for noise-sensitive developments are not achievable, best practicable measures should be implemented, having regard to section 5.8 and the guidelines."

The Policy, under Section 5.7, also provides the following information regarding "Notifications on Titles" :

"5.7 - NOTIFICATION ON TITLE

If the measures outlined previously cannot practicably achieve the target noise levels for new noise-sensitive developments, this should be notified on the certificate of title.

Notifications on certificates of title and/or advice to prospective purchasers advising of the potential for noise impacts from major road and rail corridors can be effective in warning people who are sensitive to the potential impacts of transport noise. Such advice can also bring to the attention of prospective developers the need to reduce the impact of noise through sensitive design and construction of buildings and the location of outdoor living areas.

The notification is to ensure that prospective purchasers are advised of –

- *the potential for transport noise impacts; and*
- *the potential for quiet house design requirements to minimise noise intrusion through house layout and noise insulation (see the guidelines).*

2 For residential buildings, indoor noise levels are not set for utility spaces such as bathrooms. This policy encourages effective "quiet house" design, which positions these non-sensitive spaces to shield the more sensitive spaces from transport noise (see guidelines for further information).

Notification should be provided to prospective purchasers and be required as a condition of subdivision (including strata subdivision) for the purposes of noise-sensitive development as well as planning approval involving noise-sensitive development, where noise levels are forecast or estimated to exceed the target outdoor noise criteria, regardless of proposed noise attenuation measures. The requirement for notification as a condition of subdivision and the land area over which the notification requirement applies, should be identified in the noise management plan in accordance with the guidelines.

An example of a standard form of wording for notifications is presented in the guidelines."

3. NOISE MONITORING

Previously, noise monitoring was undertaken at the boundary of the proposed LSP between the 27th June and the 4th July 2016. From these measurements, the noise received at the development from vehicles travelling along Anketell Road was determined.

The results of the noise data logging are summarised in Table 3.1 with the graphical data contained in Appendix C.

TABLE 3.1 – DETERMINATION OF TRANSPORTATION NOISE AT LOGGERS, dB(A)

Location	$L_{A10\ 18hr}$	$L_{Aeq(day)}$	$L_{Aeq(night)}$
Boundary of Development (7 metres from the road edge)	71.0	69.2	62.2

Based on the noise monitoring, the calculated difference between the $L_{A10,18hour}$ and $L_{Aeq,8hour}$, and the $L_{Aeq10,18hr}$ and $L_{Aeq,16\ hr}$ is -8.8 and -1.8 dB respectively. Also, as the difference between day and night L_{Aeq} noise levels is greater than 5 dB(A) (i.e. 7 dB(A)), the day period is the critical period for compliance.

4. MODELLING

To determine the requirements of any noise amelioration, acoustic modelling was carried out using the computer program 'SoundPlan'. Acoustic modelling was carried out for road traffic flows 20 years in the future.

TABLE 4.1 - NOISE MODELLING INPUT DATA

Parameter	Current Anketell Road	Future Anketell Road
Traffic flows	7,226 vpd	20,000 vpd
Heavy Vehicles (%)	19.6%	19.6%
Speed Limit (km/hr)	80/110	80/110
Road Surface	Chip Seal	Chip Seal
Façade Correction	+2.5 dB(A)	+2.5 dB(A)

Noise modelling was carried out for noise received within the development for current traffic volumes and road alignment to calibrate the noise model.

Advice has been provided by WAPC, MRWA and City of Kwinana that there is to be a major upgrade of Anketell Road in the future. This upgrade will likely align the road closer to the development boundary. Advice was also sought on the projected future traffic volumes, with the values shown in Table 4.1 above.

Based on the above information the following scenarios have been considered:

Scenario 1 – Future road alignment with future traffic volumes, no noise control (Appendix B Figure B1).

Design on the future alignment was provided by MRWA, hence has been used for the above scenarios.

Note : The noise modelling has included the built form of the commercial building on the lot in the north west corner of the proposed development, however, as the location and design of the dry recreation centre has not been finalised, this building has not been included in the noise model.

5. TRAFFIC NOISE ASSESSMENT

Under the WAPC State Planning Policy 5.4, for this development, the Noise Limits as listed in Table 1 are the appropriate noise levels to be achieved. Based on the noise monitoring, the difference between the $L_{Aeq(16hr)}$ and the $L_{Aeq(8hr)}$ would be greater than 5 dB(A). Therefore, if compliance with the day period noise limit is achieved, then compliance with the night period noise limits would also be achieved. The policy states that the outdoor criteria applies to the ground floor level only, however, it also states that noise mitigation measures should be implemented with a view to achieving the target levels in least one outdoor living area.

For residential premises, the Policy states that residence should be designed to meet the following acceptable internal noise levels:

Living and Work Areas	$L_{Aeq(Day)}$ of 40 dB(A)
Bedrooms	$L_{Aeq(Night)}$ of 35 dB(A)

The results of the noise modelling are shown in Figure 1 as an overall noise contour plot.

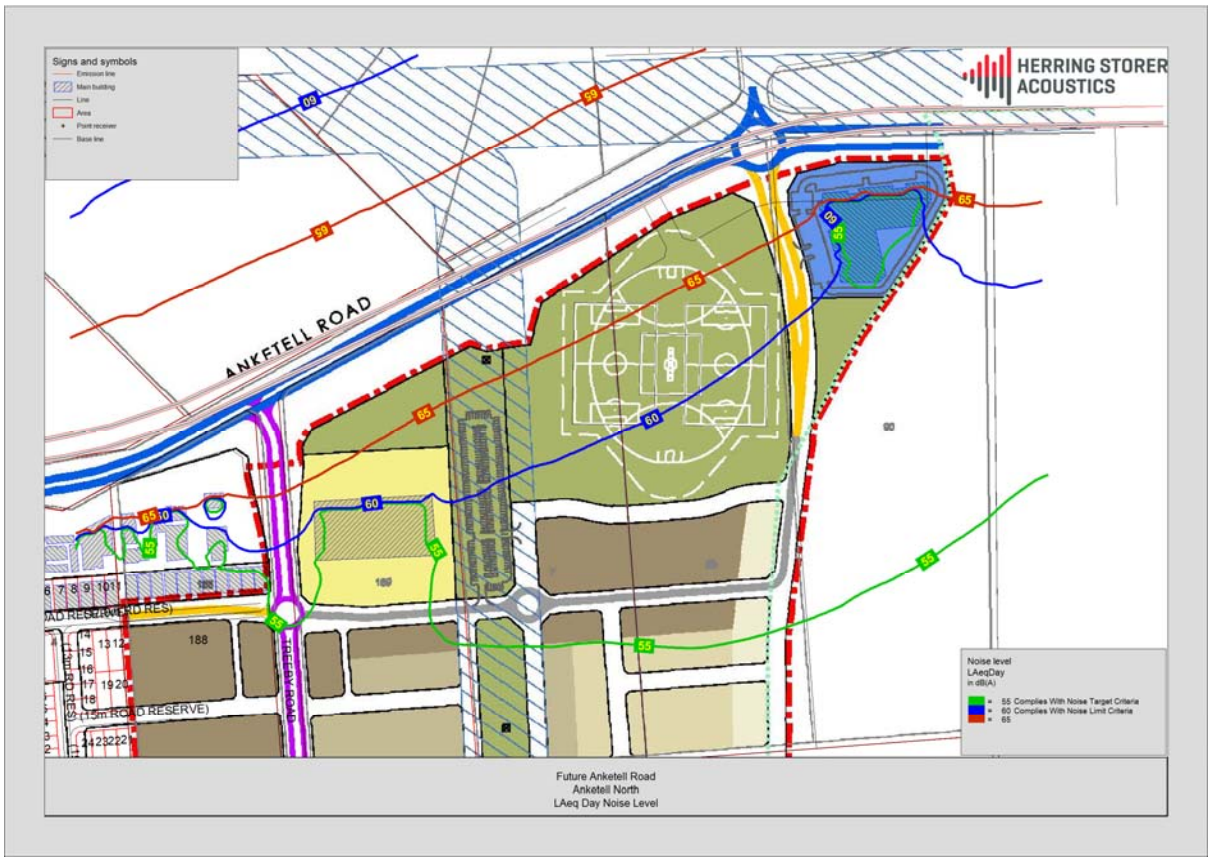


FIGURE 1 – FUTURE NOISE CONTOUR PLOT

The modification to Anketell Road would be considered as major upgrade and hence the infrastructure provided is obliged to achieve compliance with the "Noise Limits" at the ground floor. This normally requires the infrastructure provider to construct the barrier walls. However, in this case as, as outlined in the policy under Section 5.3.2 where a major road project is to be constructed in the vicinity of a future noise sensitive land use, the infrastructure provider and developer are both responsible for ensuring that the objectives of this policy are achieved. Similarly, for an upgrade to Anketell Road, the infrastructure provider would be responsible for achieving compliance with the "Noise Limits", which in this case would be the use of a dense graded asphalt road surface. However, once again, discussions should take place between the infrastructure provider and the developer to ensure that a mutually beneficial noise management plan is developed and implemented.

For reference, it is noted that noise received at some residential lots would exceed the "Noise Target". Hence, some lots would require noise amelioration in the form of "Quiet House" design and/or Notifications on Titles. These requirements would need to be determined once the Lot layout has been finalised.

Finally, it is noted that with the orientation of the closest residential lots to Anketell Road being such that they would face Anketell Road, the residences themselves would act as a barrier to the back yards (and the other residence behind). Hence compliance with the external criteria, for at least one outdoor area to comply with the "Noise Target" would be achieved.

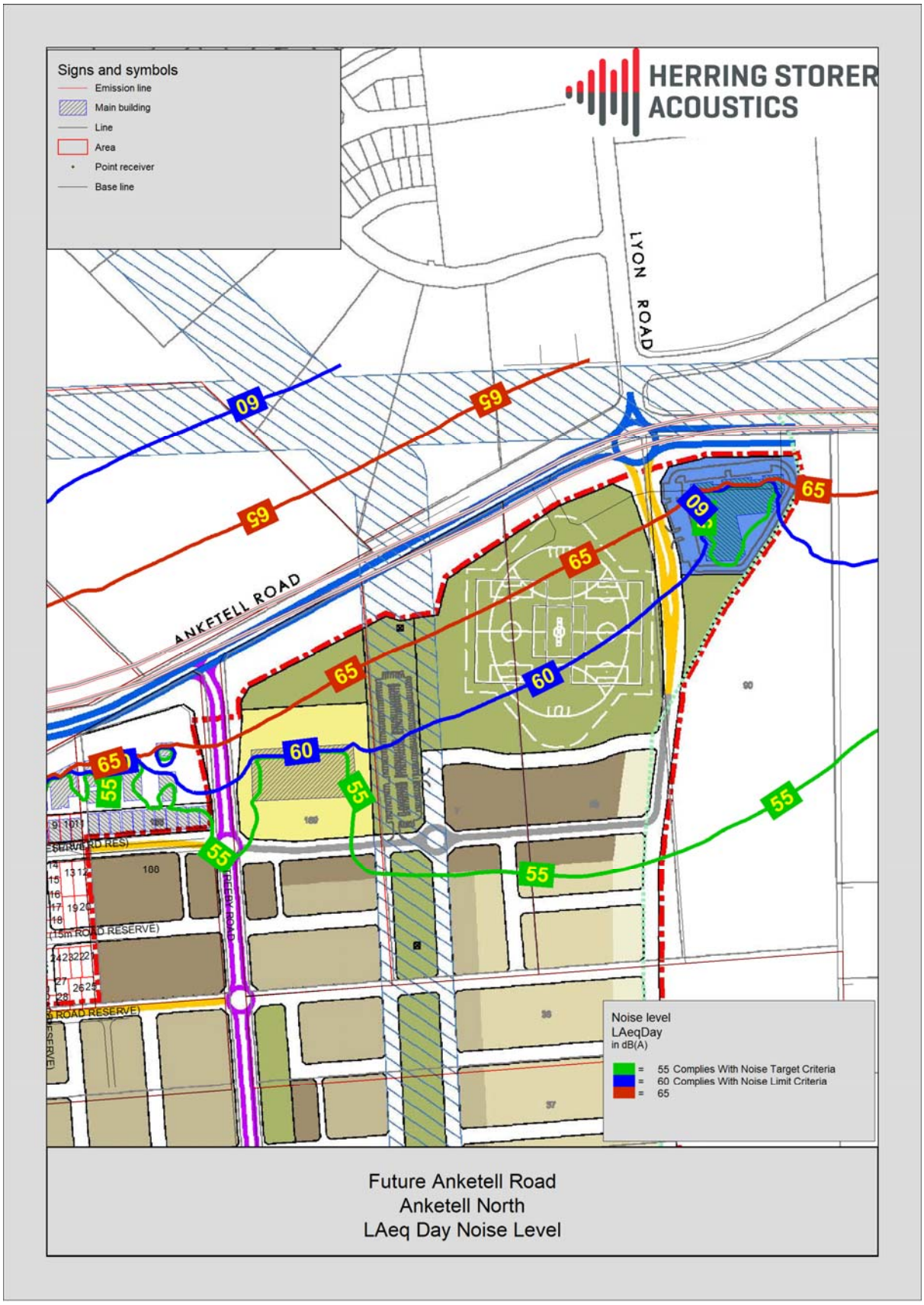
APPENDIX A

FIGURE A1 – SITE LAYOUT

FIGURE A1 – SITE LAYOUT

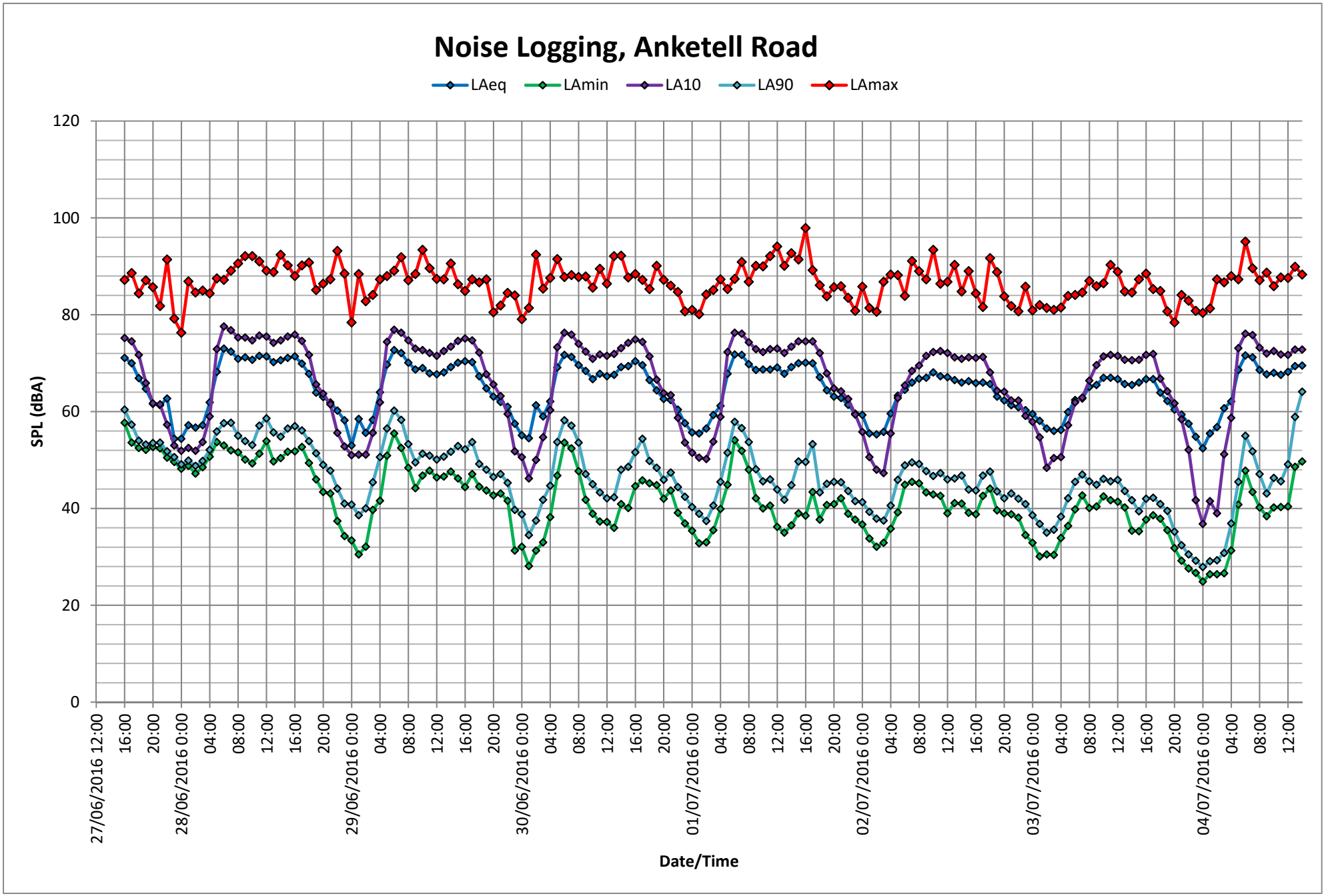
APPENDIX B

NOISE CONTOURS PLOT


Signs and symbols
Emission line
Main building
Line
Area
Point receiver
Base line
HERRING STORER ACOUSTICS
LYON ROAD
ANKETELL ROAD
65
60
55
Noise level
LAeqDay
in dB(A)
= 55 Complies With Noise Target Criteria
= 60 Complies With Noise Limit Criteria
= 65
Future Anketell Road
Anketell North
LAeq Day Noise Level

APPENDIX C

NOISE MONITORING RESULTS


Noise Logging, Anketell Road
LAeq
LAmin
LA10
LA90
LAmax
SPL (dBA)
120
100
80
60
40
20
0
27/06/2016 12:00
16:00
20:00
28/06/2016 0:00
04:00
08:00
12:00
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29/06/2016 0:00
04:00
08:00
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16:00
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30/06/2016 0:00
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04:00
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20:00
04/07/2016 0:00
04:00
08:00
12:00
Date/Time

APPENDIX D
SERVICE COMMERCIAL MARKET ADVICE

Information Paper

To:	**Jarrod Rendell**	jarrod@acumends.com.au	
Cc:	**Rachel Chapman**	rachel@tbbplanning.com.au	
From:	**Greg Davis**	g.davis@taktics4.com.au	
Date	**Thursday, 18 April 2019**	Pages	**3**
Subject	**Service Commercial Implications - Professional Opinion Anketell North LSP Amendment No. 4**		

Dear Jarrod

We understand that a Service Commercial zone is being considered along the frontage of Anketell Road in Wandi as part of an amendment to the Anketell North Local Structure Plan. You have requested Taktics4 to provide professional opinion on the suitability and sustainability of a Service Commercial zone in the area currently allocated within the LSP amendment.

Physical Capacity

The Service Commercial area is divided into two sites and are each approximately 1.5Ha in size. The combined area of both zoned sites is therefore approximately 3 Ha. Based on ground level development and an industry accepted plot ratio of between 33% and 50% of site, a land area of 3Ha (30,000sqm) would be physically able to accommodate up to 10,000 – 15,000sqm of built form. A 10,000 – 15,000sqm Service Commercial development would be consistent with similar large format retail/showroom retail developments around Perth.

Planning Logic

At face value the allocation of a Service Commercial zone along Anketell Road seems plausible. Anketell Road is ultimately designated to become a major freight route making residential development an inappropriate fronting land use to Anketell Road. Service Commercial would normally seem a logical buffer between freight traffic and residential development, as Service Commercial activity relies heavily on accessibility and exposure to significant traffic volumes. However, the limited origin and destination points to the east and west along Anketell Road would suggest that there would only be limited local or district (non-freight transport) traffic along Anketell Road, and exposure to freight transport traffic is less significant for Service Commercial businesses than resident-based vehicle traffic. I therefore have concerns about the sustainability of service commercial activity located on Anketell Road.

Wandi District Centre

Another major factor in considering Service Commercial along Anketell Road in this location could be its proximity less than 1km to the east of the planned Wandi District Centre (DC). It would normally make logical planning sense to accommodate Service Commercial adjacent to a District Centre. The Wandi DC is planned to accommodate 16,000sqm of retail floor space and 10,00sqm of Service Commercial activity. The overall size of the Wandi DC is physically capable of accommodating this floor space allocation. This sized centre typically comprises two full line supermarkets and a Discount Department Store such as Target, BigW or Kmart.

Retail development economics confirm that Wandi DC will not develop to its allocated size without securing each of these three major tenants. The Wandi DC is central to a very limited residential catchment. The residential areas planned to the east of the Kwinana Freeway from

45 Ventnor Avenue, WEST PERTH WA 6005 P + 61 8 9429 8813
Project Potential Pty Ltd (ACN 108 512 876) as trustee for DCG Trust (ABN 50 99 523 261 927) trading as Taktics4

Rowley Road to Mortimer Road is severely restricted by the Jandakot Water Management Plan. The potential residential development within The Wandi DC catchment is further impacted by the proximity of expansive regional open space areas including The Spectacles Reserve and Jandakot Regional Park. The main residential catchment for the Wandi DC was expected to come from Mandogalup to the north west of the Wandi – west of the freeway. However, there is doubt over the future potential for residential development in Mandogalup which may restrict the population in the Wandi DC catchment.

1.5km catchment - 8,500 residents instead of an initially planned 13,000 residents.

3km catchment – 15,300 residents instead of an initially planned 24,600 residents

I have concerns as to whether a major DDS will be attracted to Wandi DC even if future planning initiatives result in Mandogalup achieving a higher population base, meaning that I subsequently have concerns over the ability of the Wandi DC to attract the major retail anchor tenants necessary to reach its full retail planning potential.

Wandi DC may therefore initially (and potentially only) ever develop as a neighbourhood-based retail centre anchored by a single supermarket creating a total retail floor space of 5,000 sqm. This development model would limit the attractiveness of the surrounding areas for Service Commercial activity, as this activity relies heavily on the foot traffic and traffic exposure created by the major retail tenants. If this scenario does in fact unfold, the immediate Wandi DC zone will require every available commercial and community activity to be located together on the one site in order to create a vibrant hub of commercial activity where all businesses are able to trade from each other's exposure.

I also understand that there may be commercial initiatives afoot to attract a next level bulky goods warehouse retailer such as Costco to the Wandi DC site. Whilst I have concerns over the suitability and sustainability of this activity type in this location, it would not alter my position that all activity should, where possible be contained primarily within the Wandi DC site. I therefore have concerns over allowing significant Service Commercial activity to be developed along the major arterial of Anketell Road as this may inhibit the Wandi DC from reaching its full commercial potential.

Planning Implications

As discussed, the service commercial area is split in to two sites – east and west.

Western Site

With respect to other non-commercial planning considerations, I would recommend consideration be given to the removal of the Service Commercial zone (the 1.5Ha western site) along Anketell Road on the LSP. A possible alternative which achieves the current planning objectives of providing a buffer to residential activity long Anketell Road, may include the relocation of the District Open Space and Recreation activities further north to front Anketell Road. This solution would have the following consequences:

- It would provide stronger exposure and legibility for a district recreation facility rather than tucking it/hiding behind a service commercial facility
- It would allow for an increase in residential development to the south of a relocated open space area.

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- It would maintain the synergy between the Open space and community facility site as currently shown on the LSP.
- This would be a far better amenity outcome than having a valuable district open space and recreation facility fronting to a typically untidy low amenity rear servicing area of a service commercial area

Eastern Site

The above approach would satisfy the western site but would not resolve the Service Commercial area on the eastern site currently allocated for service commercial activity. This area is irregular in shape and remains unsuitable for residential activity as per previous discussions.

Given the planned nature of Anketell Road as a freight route this site may be best suited to a Freight Transport related Commercial Activity Hub. A freight transport related commercial activity hub may include a range of uses including (but not limited to) a petrol filling station and truck wash facilities as well as fast food and takeaway, geared solely (or at least predominantly) to large freight vehicles rather than cars. This activity in this location could benefit from significant exposure to freight transport by virtue of the road alignment, depth of the site and high visibility created by the recreation fields, and the sites access to two road frontages. This potential activity type on this eastern site forms no direct synergy with the broader Wandi District Centre and planned adjacent commercial activity as they will primarily cater to local and district residents shopping and commercial needs. The distance of the eastern site from the Wandi District Centre would ensure that freight transport movement into and out of a transport hub would not impede or conflict with private car movements entering and egressing from the Wandi District Centre.

This activity type together with the relocation of the district playing fields to Anketell Road provides a suitable buffer between planned residential uses and intensive and general rural land uses immediately to the east of the site. The size of the eastern site (1.5Ha) should be large enough to accommodate a combination of these activity types, without being large enough to create a facility too large for the intended purpose.

I would therefore consider exploring this activity type for the 1.5Ha eastern Service Commercial site. It should be noted that the opportunity for this activity type at this stage is predicated solely on the planned nature of Anketell Road as a freight route. Further market analysis would be required to determine whether such a transport hub would be feasible in this location.

I trust that these views assist you with your planning for the LSP amendment. I look forward to elaborating further should you wish to explore the suggested recommendations.

Regards

Greg Davis
Director
E g.davis@taktics4.com.au
M +61 439 959 762

APPENDIX E
LANDSCAPING PLAN

POS & STREETSCAPES SUMMARY

1. District Open Space
   Multipurpose sport recreation facility.
   Large open turf areas for informal games & organized sport.

2. Linear Park
   North & south pedestrian & cycle network for residents & school students.
   Turf pockets interspersed with drainage treatment swales.
   Minor recreation features, ie. Gathering node with park furniture.

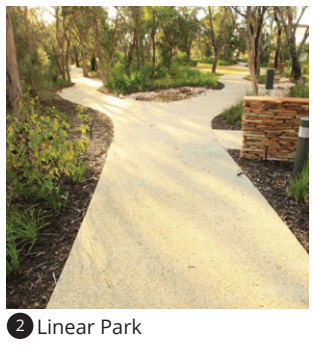
3. Pocket Park
   Small open space for local passive recreation use.
   Open turf, circulation pathways & gathering node.
   Intimate space with retained vegetation where available.

4. Nature Buffer
   Edge treatment to bush forever.
   Predominantly retained vegetation with circulation pathways.
   Landscaping for bush fire prevention.

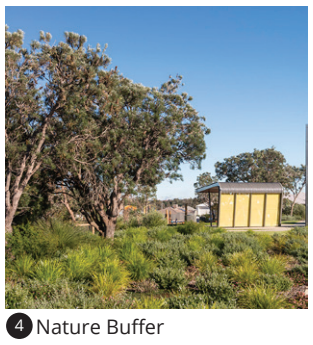
5. Neighborhood Park
   Gathering space for informal active recreation.
   Areas of open turf, circulation pathways & drainage treatment basin.
   Public amenity such as picnic facilities.

6. Median Island Landscaping & Street Trees
   Native & endemic street tree planting to verges and median islands.
   Minimum of 1 street tree per lot frontage.
   Water wise low maintenance understorey planting allowing clear sight lines through the streetscapes.
   Minimum one footpath per street adjacent to the lot boundary.


1 District Open Space


2 Linear Park


3 Pocket Park


4 Nature Buffer


5 Neighborhood Park


6 Median Island Landscaping & Street Trees

LD TOTAL
LEADERS IN LANDSCAPING

ANKETELL NORTH
LANDSCAPE MASTER PLAN

10.1636	C	17.05.19	1:5000
PROJECT NO	REVISION	DATE	SCALE

APPENDIX F
LOCAL WATER MANAGEMENT STRATEGY

Local Water Management Strategy

Lots 30-41, 100, 189 & Part of Lot 13 and 188 Treeby Road & Lots 89 and part of lot 90 Anketell Road, Anketell, WA, 6167

Issue No. 2

May 2019

Local Water Management Strategy (LWMS)

Anketell North Urban Cell

Lots 30-41, 100, 189 & Part of Lot 13 and 188 Treeby Road & Lots 89 and part of lot 90 Anketell Road, Anketell, WA, 6167

Prepared for:
Acumen/Taylor Burrell Barnett on behalf of the land owners of Lots 30-41, 100, 189 & Part of Lot 13 and 188 Treeby Road & Lots 89 and part of lot 90 Anketell Road.

Prepared By:
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www.biosciencewa.com

Document Control

Issue	Date	Author	Reviewer	Approved
1	28/11/2018	D. Alanoix	P. Keating	P. Keating
2	24/05/2019	D. Alanoix	P. Keating	P. Keating

Addendum to DWER RD8296 received March 8, 2019

Section	DWER Comments	Bioscience Reply
Section 4.4.1: Groundwater Levels	Please use maximum groundwater levels (MGL) rather than annual average maximum groundwater levels (AAMGL) when calculating distance from drainage basin inverts to groundwater. The use of MGL gives higher confidence with regards to drainage infrastructure that a range of groundwater levels, from different climate/weather scenarios and the likelihood of an increase in groundwater levels due to urbanization, are considered. There are instances within the City of Kwinana where groundwater levels have been rising over the last few years due to the change in land use from rural (or bushland) to urban.	Maximum groundwater levels (MGL) were determined. Calculation details are provided in Section 4.4.1. MGL values were used to design the infrastructure.
Section 6.1: Conceptual Management Strategy	1) Rain gardens along roads to infiltrate 1 year ARI events was proposed in the approved LWMS of March 2014. The current LWMS must justify why this water sensitive urban design feature has been removed from the revised LWMS. 2) Please provide written confirmation from Western Power that storage of stormwater in their service corridor is supported. 3) Section should describe how off-site discharges from Basins B7(2) and B7(4) connect to the Peel Sub R Drain to the north of the site.	1) Rain gardens are proposed to be located along roads. Figure 15, Table 15 and Appendix D provide details on the structures. Note that basins B2(5) takes all the POS space; rain-gardens will therefore located along the roads but near house frontage or side. This will be discussed in the future UWMP(s). Rain-gardens were sized to be at least 1% of the connected impervious area. 2) A written confirmation from Western Power will be provided. 3) This was addressed in Table 14.
Section 6.4.3: Detention Structure Configuration	Section notes that the drainage basin required volumes are included in Table 14 however they are missing. Please include these volumes in the table.	Volumes were included in Table 14.
Section 8:		1) Future UWMP(s) will provide updated data on

Subdivision and UWMP	1) Groundwater data used is derived from monitoring during 2006 and 2007 and is quite dated. This section should confirm future UWMP(s) will provide updated data on groundwater levels and quality. 2) Given that surface water discharges off-site are proposed this section should confirm future UWMP(s) will include pre-development surface water quality results.	groundwater level and quality. This comment was added to the content of the LWMS. 2) Likewise, future UWMP(s) will include pre-development surface water quality results.
Figure 15: Surface Water Runoff Post-Development and Basin Locations	This figure indicates that drainage basins in Catchment B public open space (POS) areas do not have rain-gardens or bio-infiltration basins to treat the minor rainfall events. Please indicate how the minor rainfall events undergo water quality treatment in Catchment B.	Rain gardens are provided in this catchment. They will be located along roads, at house frontage/side/POS entry.
Appendix	1) Please include conceptual drainage basin, rain garden and landscape designs including how stormwater infrastructure is integrated into the POS. For drainage basins please include top water levels (TWL) for all rainfall events, use of amended soils (depth and phosphorous retention index), depth to MGL from basin invert and slope gradients. POS areas should be configured to ensure a high proportion of useable open space, rather than large areas being dedicated to drainage. This can be achieved by landscaping/contouring these areas to drain 63% AEP events to bioretention areas, with stormwater overtopping the bioretention area into the larger POS area in greater rainfall events. 2) Figures 17 & 18 should indicate where any discharge off-site is to occur for any relevant rainfall event at the Anketell North Urban Cell site	1) Conceptual drainage basins were included into Appendix D of the LWMS. 2) Figures 17 and 18 were updated to reflect the comment. 3) A diagram including the CCW area and a 50m buffer (to Treeby Rd Lake) was included in the report as Figure 20. As seen on the Figure, part of the CCW has been cleared. It is also noted that the 50m buffer is outside the proposed development area. If still required, DBCA will be contacted to confirm the setting of the CCW area and buffer.

	and indicate pre and post discharge rates. 3) Conservation Category Wetlands (CCW) require a 50m buffer from development. Please include a diagram indicating CCW area and buffer. Also, include any written agreement with the Department of Biodiversity, Conservation and Attractions regarding the setting of the CCW area and buffer.	

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LWMS Better Urban Water Management Checklist

LWMS Item	Deliverable	Section
Executive Summary		
Summary of the development design strategy, outlining how the design objectives are proposed to be met	Design elements and requirements for best management practices and critical control points	Executive Summary
Introduction		
Total water-cycle management principles and objectives Planning background Previous studies		Section 1.1 Section 1.2 Section 1.3
Proposed Development		
Structure plan, zoning and land use Key landscape features Previous land use	Location plan Structure Plan Site context plan or a combination of above	Section 2.1 Figures 1 - 3
Landscape – proposed public open space areas	Landscape Plan	See basin cross sections for drainage areas
Design Criteria		
Agreed design objectives and source of objectives.		Section 3
Pre-Development Environment		
Existing information and more detailed assessments (monitoring) of site; explanation of how the site characteristics affect the design.		Section 4 Figures 4-13
Site conditions – existing topography/contours, aerial photo underlay, major physical features.	Site condition plan	Section 4
Geotechnical – topography, soils including acid sulphate soils and infiltration capacity, test pit locations.	Geotechnical plan	Section 4.1
Environmental – sensitive or significant vegetation areas, wetland areas and buffers, waterways and buffers, contaminated sites.	Environmental plan plus supporting detail where appropriate.	Section 4.2
Surface water – topography, 100 year floodway and flood fringe areas, 100 year proposed flow paths, water quality of flows entering and leaving site	Surface water plan	Section 4.3 Figure 7
Ground water – topography, test bore locations, ground water pre- and post development, water quality, ground water variation hydrograph.	Ground water plan plus details of ground water monitoring and testing.	Section 4.4 Appendix A

Water Sustainability Initiatives		
Water efficiency measures – private and public open spaces including method of enforcement		Section 5
Fit-for-purpose strategy and agreed actions and implementation		
Waste water management		Section 5.7
Stormwater Management Strategy		
Flood protection – peak flow rates, Volumes and top water levels at control points, 100- year flow paths – flood ways and flood fringe zones and/or along roads and reserves, 100-year detention areas.	100-year (1% AEP) flood plan Long section of critical points	Section 6 Figures 14 - 19
Manage serviceability – storage and retention required for the critical 5-year ARI storm events. Minor roads should be passable in the 5-years ARI event.	18% AEP event plan	
Protect ecology – detention areas for the 1-year 1-hour ARI event, areas for water quality treatment and types of agreed structural and non-structural best management practices and treatment trains (including indicative locations). Protection of waterways, wetlands (and their buffers), remnant vegetation and ecological linkages.	63% AEP event plan	
Groundwater Management Strategy		
Post development ground water levels, existing and likely final surface levels, outlet controls, and subsoil drain areas/exclusion zones.	Ground water plan	Section 7
Actions to address acid sulphate soils or contamination	Acid sulphate soil and dewatering management plans	Section 7
Subdivisions and UWMP		
Content and coverage of future urban water management plans to be completed at subdivision. Include areas where further investigations are required before detailed design		Section 8
Monitoring Program		
Recommended future monitoring plan including timing, frequency, locations and parameters, together with arrangements for ongoing actions.		Section 9
Implementation		
Developer commitments Roles, responsibilities, funding for implementation Assessment and review		Section 10

Executive Summary

On 18 March 2014, Bioscience submitted an LWMS for the Anketell North Cell. In the report, the Cell consisted of lots 30-41, 100, 188, 189 and part of Lot 13 Treeby Road & Lots 462-464, 467, 89, part of lot 90 and 652 Anketell Road.

Since then, one section of the Anketell North Cell, consisting of Lots 652, 2, 3 and part of lot 188 Anketell Road had its water management strategies and development approved. Accordingly this LWMS was prepared on behalf of Acumen/TBB for the remaining lots.

This LWMS has been developed to be consistent with the framework and process detailed in the Better Urban Water Management (WAPC, 2008a) guideline which sets the level of investigations, key principles and objectives, and documentation required at various decision points in the planning process.

The Local Structure Plan (LSP) seeks approval for the proposed development under the provisions of the City of Kwinana (CoK) Town Planning Scheme No.2 (TPS2). The LSP provides a framework for future development and establishes a context for subdivision. This LWMS, to support the LSP, will guide future subdivision to ensure that the land is developed in a sustainable manner, fulfil the objectives of the WAPC as described in Liveable Neighbourhoods Edition 3 (WAPC, 2009) and in accordance with the objectives of the Department of Water (DoW) and the CoK, and as such provides the necessary water management strategies to guide the subsequent Urban Water Management Plan (UWMP) required for subdivision.

The Anketell North Urban Cell has no natural rivers or creeks in the catchment. The Peel Sub P drain, a constructed open drain originates in close proximity to the south east of the development and ultimately drains the catchment through the Anketell South Urban Cell at the Thomas Road "Legal Point of Discharge" (LPD 3). Part of the north east area of the site drains north, ultimately to Peel Sub R Drain through LPD2. Surface water is also present in the surrounding wetlands during the wetter winter months. The Anketell South Urban Cell has also been hydraulically assessed to ensure predevelopment discharge rates are maintained. The Jandakot DWMP also highlighted the north west portion of the site as "soakage" where all of a 1% AEP event would infiltrate in predevelopment conditions.

Hydrological and hydraulic modelling has been undertaken for the pre-development scenario and calibrated to the values reported by the DoW in the Jandakot Drainage and Water Management Plan (DWMP), Peel main drain catchment (DoW, 2009). The results of this modelling indicate the peak discharges for the 100 year ARI event at the LPDs are:

- LPD 1: 103 l/s (to be infiltrated directly in the soakage area) Note that LPD1 is not applicable to the proposed LSP. No discharge from the LSP area will occur to this discharge point.
- LPD 2: 145 l/s (Discharge north towards the Peel Sub R Drain)
- LPD 3: 371 l/s (culverts under Thomas Road)

Development of the site will result in a significant increase in impervious surfaces and therefore runoff volumes leaving the site. To ensure the pre-development peak discharges are maintained drainage infrastructure will include bioretention areas, soakwells, overland flows and detention basins.

The effectiveness of the basins in maintaining the pre-development discharge flows for the 1% AEP event has been assessed. The post development basins are capable of maintaining the pre-development peak discharge for the critical storm duration for the design events with outflows regulated to those proposed in the DoW (former DWER) DWMP.

A treatment train has been devised for the development that employs industry standard Best Management Practices (BMPs) and will ensure the development does not result in any adverse impacts for the downstream receiving water bodies and ecosystems.The DoW *Jandakot DWMP* indicates that the department is currently developing water quality targets and in the interim, treatment trains should be based on the methodology established in the *Stormwater Management Manual for Western Australia*. Surface water quality should be managed through:

- On site retention of 63% AEP 1 hour event flows
- Bioretention systems sized as 2% of the connected impervious areas, and
- Non-structural measures to reduce applied nutrient loads.

1.0 Introduction

1.1 Integrated Water Cycle Management: Principles and Objectives

On 18 March 2014, Bioscience submitted an LWMS for the Anketell North Cell. In the report, the Cell consisted of lots 30-41, 100, 188, 189 and part of Lot 13 Treeby Road & Lots 462-464, 467, 89, part of lot 90 and 652 Anketell Road.

Since then, one section of the Anketell North Cell, consisting of Lots 652, 2, 3 and part of lot 188 Anketell Road had its water management strategies approved. To this end, a new LWMS was prepared on behalf of Acumen/TBB for the remaining lots (**Figure 1**).

Water management is paramount in all levels of planning to protect this valuable resource. Management endeavours to protect the environment, avoid flooding and meet the requirement of sustainable use of water. It is important to identify and clarify water management strategies and methodologies as they provide the framework for decision making at local structure and subdivision planning levels. This LWMS provides concept designs, guideline controls and management measures for:

- Water Quality: maintain or improve surface and ground water quality.
- Water Quantity: maintain the total water cycle balance within developments relative to the pre- development conditions.
- Water Conservation: maximise the efficient use of water resources.
- Ecosystem Health: retain natural drainage systems and protect ecosystem health.
- Economic Viability: implement long term economically viable stormwater management systems.
- Public Health: minimise public risk, including risk of injury or loss of life.
- Protection of Property: protect the built environment from flooding and water logging.
- Social Values: recognise and maintain social, aesthetic and cultural values.
- Development: deliver best practice stormwater management taking due cognisance of sustainability and precautionary principles.

This LWMS has been developed to be consistent with the framework and process detailed in the Better Urban Water Management (WAPC, 2008a) guideline which sets the level of investigations, key principles and objectives, and documentation required at various decision points in the planning process. A number of State Government Policies are relevant in addition to a number of published guidelines and standards which provide direction or guidance to achieve sustainable environmental and urban development and that define key principles and objectives. These include:

- State Water Strategy (Government of WA, 2003). State Water Plan (Government of WA, 2007).
- Statement of Planning Policy No 3 Urban Growth and Settlement (WAPC, 2006a).
- State Planning Policy 2.9 Water Resources (WAPC, 2006b).
- Planning Bulletin 92 Urban Water Management (WAPC, 2008b). Planning Bulletin 64/2009 Acid Sulphate Soils (WAPC, 2009). Liveable Neighbourhoods (WAPC, 2009).
- Better Urban Water Management (WAPC, 2008a).
- Developing a Local Water Management Strategy (DoW, 2008).
- Stormwater Management Manual for Western Australia (DoW, 2004-2007).
- Decision Process for Stormwater Management in Western Australia (DEC and SRT, 2005 and DoW, 2009).
- Stormwater Quality Management Manual for WA (DoE, 2004). National Water Quality Management Strategy (ANZECC, 2000).

This document takes due cognisance of and has been prepared and compiled consistent with these polices and their requirements.

1.2 Planning Background

The Local Structure Plan (LSP) seeks approval for the proposed development under the provisions of the City of Kwinana Town Planning Scheme No.2 (TPS2). The LSP (**Figure2**) provides a framework for future development and establishes a context for subdivision. This LWMS, to support the LSP, will guide future subdivision to ensure that the land is developed in a sustainable manner, fulfil the objectives of the WAPC as described in Liveable Neighbourhoods (WAPC, 2009) and in accordance with the objectives of the Department of Water and Environmental Regulation (DWER) and the City of Kwinana (CoK) and as such provides the necessary water management strategies to guide the subsequent Urban Water Management Plan (UWMP) required for subdivision.

1.3 Local Studies

Regional and local studies related to subject site are:

- Jandakot drainage and water management plan. Peel main drain catchment (DoW, 2009).

Site-specific studies include:

- Jandakot Structure Plan. Anketell South Cell. Thomas Road, Anketell (360 Environmental Pty Ltd,2009).
- Lots 1, 2, 3 and 17 Thomas Road, Anketell: Pre-Development Hydrological Monitoring (JDA,2009)
- Lots 13 and 100 Treeby Road: Pre-Development Hydrological Monitoring (JDA, 2008)
- Wandi/Anketell South Pre-Development Hydrological Monitoring (JDA, 2008)

- Anketell North – District Water Management Strategy (JDA, 2009)
- Anketell South Urban Cell -LWMS Issue No. 1. (VDM, 2010)
- LWMS for the Anketell North Cell (Bioscience 2014)

2.0 Proposed Development

2.1 Structure Plan, Zoning and Land Use

The Anketell North Urban Cell site is located approximately 32km south of Perth and covers an area of approximately 100ha of which 86 ha is assessed within this LWMS. Historically much of the site has been cleared to provide rural residential and agricultural activities. The site is bounded by the Anketell Road to the north, the Jandakot Regional Park to the west, the Jandakot Groundwater Protection Area to the east and the Bush Forever Reserve site 270 to the south.

The proposed Local Structure Plan (LSP) shown in **Figure 2** has been designed to be sensitive to the site constrictions and is to incorporate the following development categories:

- Residential of R20, R25, R30 and R40 densities
- Service Commercial
- Primary school
- Community Facility
- Public Open Spaces (POS)
- Drainage reserves
- Western power line easement

2.1.1 Metropolitan Region Scheme Zoning

Under the Metropolitan Region Scheme (MRS), maps 24 & 28, the Anketell North Urban Cell is currently zoned "Urban", as detailed in **Figure 3**, except for a 100m wide strip of "Urban Deferred" directly abutting Anketell Road. The area labelled urban deferred has potential to be required for the widening of Anketell Road in future freight routes.

Part of the site (near the eastern boundary) retains a "Rural Water Protection" zoning reflecting the Jandakot Underground Water Protection Area. Whilst this area is not zoned for urban uses, it does form part of the landholdings and as such consideration has been given to the treatment of these areas within the LSP.

The Kwinana Freeway, to the west of the site, is classified as a "Primary Regional Road". Land to the immediate north and south of the subject site is zoned "Urban".

2.1.2 City of Kwinana Town Planning Scheme No. 2 Zoning

The site is currently zoned "Development" under the provisions of the City of Kwinana Town Planning Scheme No.2 (TPS 2). TPS 2 applies to all land within the Local Authority area, and contemplates both zoning and development control for land.

The purpose of the Development zone is to provide a flexible planning mechanism for the development of larger areas. The Development zone requires the preparation of comprehensive structure planning in order coordinate development and to provide adequate planning control within the specified area. Subdivision, use and development of the subject site is to be generally in accordance with the adopted Structure Plan.

The objectives of the Development Zone as stated under TPS 2 are as follows:

- Designate land for future development
- Provide a planning mechanism for the identification and protection of areas of conservation value whilst facilitating the growth of the Town
- Provide for the orderly planning of large areas of land for residential, commercial, industrial and associated purposes through a comprehensive structure planning process
- Enable planning to be flexible and responsive to changing circumstances throughout the developmental stages of the area
- Provide sufficient certainty for demand forecasting by service providers

The proposed Structure Plan is consistent with the above objectives and allocates land uses, conservation reserves, provides a flexible mechanism of planning, and identifies the provision of service infrastructure within the subject site.

In order to ensure integration with the balance of the Anketell Cell Development zone, Scheme Amendment No.100 was initiated by Council on the 23 July 2008 which proposes the inclusion of Development Contribution Areas and Plans relevant to each of the future urban cells within the JSP / Eastern Residential Intensification Concept (ERIC) area under Schedule 5 of TPS 2. The contributions amendment provides a framework for cost sharing of those key infrastructure items (road upgrades, public open space, etc) identified within ERIC for each urban cell. The CoK are completing their assessment of community infrastructure needs such as community sites.

2.1.3 Eastern Residential Intensification Concept (ERIC)

ERIC was prepared by the CoK in 2005, to provide strategic direction and refinement of the future urban areas identified within the JSP. ERIC comprises the Cells of Mandogalup, Wandi, Anketell, Casuarina and Wellard (east) and defines a framework by which urban subdivision and development is able to occur in an orderly and co-ordinated manner. ERIC is intended to be used as a guide in the preparation of a more detailed Local Structure Plans.

ERIC predominantly deals with district level issues which are not dealt with by the JSP such as:

- The co-ordination of development;
- Provision of community infrastructure;

- District and local open space distribution; Treatment of the district and local road network; Pedestrian cyclist movement;
- Hierarchy of centres;
- Remnant vegetation protection;
- Adverse landscape impact minimisation; and
- The framework for development contributions to district and local infrastructure and facilities, the need for which will be generated by subdivision and development within the structure plan area

ERIC was advertised for public comment in 2006, and is being revised by the CoK having regard to submissions received on the draft plan and subsequent events including the relocation of the station site to Rowley Road south, the requirements of the JDWMP and the need to resolve inconsistencies with the JWSP.

3.0 Design Principles and Criteria

The primary objective of this LWMS is to design a development that manages the total water cycle in a sustainable, well integrated manner, whilst adhering to the principles of Water Sensitive Urban Design (WSUD) as outlined in the State Planning Policy 2.9 Water Resources (WAPC, 2006), Liveable Neighbourhoods (WAPC, 2007) and Stormwater Management Manual for WA (DoW, 2007). The LWMS should tie in with regional and local principles and objectives of total water cycle management including the CoK Town Planning Scheme No.2.

This report is drafted to:

- Identify existing site conditions including land use, geotechnical parameters, ecological habitats, groundwater and surface water characteristics
- Apply relevant regulations and guidelines governing water management
- Incorporate total water cycle management and water-sensitive urban design principles and ensure that development is consistent with current best management practices and best planning practices for the sustainable use of water resources
- Identify possible impacts on local groundwater quality and quantity to ensure post-development conditions are equal to or better than pre-development conditions
- Promote management of the urban water cycle as a single system in which all urban water flows are recognised as a potential resource and where the interconnectedness of water supply, stormwater, wastewater, flooding, water quality, waterways, estuaries and coastal waters is recognised
- Maximise compliance with best practice stormwater management including stormwater retention
- Promote use of water conservation mechanisms to increase efficiency and identify site constraints and opportunities for the re-use and recycling of water, particularly stormwater, consistent with state water strategy recycling objectives
- Conserve and/or re-vegetate local native vegetation in developments to minimise water use and maximise infiltration, particularly where landscaping is proposed provided fire protection is not put in jeopardy

The foundation for stormwater management within urban areas is the Stormwater Management Manual for Western Australia (DoW, 2004-2007) and coupled with the Decision Process for Stormwater Management in WA (DoE and SRT, 2005 and DoW, 2009) provides guidance as to how urban development can achieve compliance with the principle, objective and delivery approach. The objectives and design criteria identified for total water cycle management at the subject site are based upon the *Jandakot Drainage and Water Management Plan Peel Main Drain Catchment* (DoW, 2009), as summarised in **Table 1.**

Table 1: Objectives and Design Criteria

Principle	Key LWMS Element
Water Conservation Restrict the use of potable scheme water throughout the development	• Target consumption rates for scheme water both internally and externally of buildings • Integration of water and landuse management into all planning stages • Manage vegetation in drainage areas to minimise irrigation dependency • Use of rainwater harvesting systems
Water Quality Maintain surface and ground water quality at pre-development winter concentration levels and if possible, improve the quality	• Monitor pollutant and nutrient outputs of the development to not exceed ambient conditions to establish ambient conditions and trigger values. If catchment ambient conditions have not been determined, relevant Healthy Rivers Action Plan and/or ANZECC water quality guidelines shall apply. • Pollutant source controls to be implemented including reduced nutrient application, WSUDs, collection pots, education schemes • All run-off from catchment to receive treatment prior to discharge to a receiving environment • Manage contaminated areas and acid sulfate soils in accordance with Department of Environment and Conservation and Department of Water Plans • Implement end-of-pipe measures to mitigate any contaminants remaining in the stormwater prior to discharging to receiving environments.
Water Quantity A relative comparison between pre and post-development for annual discharge volume and peak flow should be maintained	• Management of run-off up to 1% AEP events throughout the development • Maintenance of existing flow regimes at or below current discharge levels • Implement plan to maximise infiltration where possible • Sub-soils drains to be installed where required at above current AAMGL • Groundwater level to be maintained relative to predevelopment levels • Manage groundwater levels by providing free-draining drainage and a minimum separation of 1.2m between finished floor levels • Invert levels of basins and other drainage structure to be set appropriate to the AAMGL
Ecosystem Health Determine of ecological requirements to maintain and improve sensitive areas	• 63% AEP events post development kept relative to pre development discharge levels by retention and offering of primary treatment • Identification of impacts affecting significant environments and maintenance of desirable hydrological flow regimes
Economic Viability To implement stormwater systems that are economically viable in the long term	• Implement a proven technology • Minimise pollutant and sediment entering the drainage infrastructure requiring further maintenance
Public Health To minimise the public risk, including risk of injury or loss of life	• Design in accordance with relevant design standards, best management practices, council regulations and government agency requirements

to the community	• All drainage infrastructure to infiltrate retained water within 96 hours to minimise disease vectors and nuisance insect growth
Protection of Property To protect the built environment from flooding	• Developments designed to offer protection against storm events up to the 1% AEP
Social Values To ensure that social aesthetic and cultural values are recognised and maintained when managing stormwater	• Integration of drainage and POS functions to enhance and improve the local residential community • Minimise the impacts of construction activities

4.0 Pre Development Environment

4.1 Geotechnical Aspects

4.1.1 Soils

The geology at the site and surrounding area as per the Geological Survey of Western Australia 1:50000 Environmental Geological Series Armadale Map part of sheets 2033 I and 2133 IV (1986) (**Figure 4**) is:

- S8 – SAND – white to pale grey at surface, yellow at depth, fine to medium grained, moderately sorted, sub-angular to rounded, frequent heavy mineral, rare feldspar, of alluvial origin over SANDY CLAY to CLAYEY SAND of the Guildford Formation, of eolian origin
- S10 - SAND - as S8 over sandy clay to clayey sand of Guildford Formation, of eolian origin
- S7 - SAND - pale yellowish brown, medium to coarse grained sub-angular quartz, trace of feldspar, moderately sorted, of residual origin
- MS5 - SANDY SILT - dark, brownish grey silt, with disseminated fine grained quartz sand, firm, variable clay content, of Lacustrine origin

The 360 Environmental *Phase 1 Environmental Assessment* identified the soils on the site as being divided into 3 main sub-groups of the Bassendean Sand group, as summarised in **Table 2**.

Table 2: Soil Profiles

Soil Sub Grade Name	Soil Description	Main Landform Unit and Location
Spearwood S2a Phase (211Sp_S2a)	Lower slopes (1-5%) of dune ridge with minor limestone outcrops. Moderately deep to deep siliceous yellow-brown sands or pale sands with yellow-brown subsoils.	Gentle slopes of coloured and earthy sands. Low risk of salinity, water logging, erosion and phosphorus loss. Majority of the site. North western and central site
Spearwood S1b Phase (211Sp_S1b).	Dune ridges with slopes up to 15%. Deep siliceous yellow brown sands or pale sands with yellow-brown subsoil.	Gentle slopes of coloured and earthy sands. Low risk of salinity, water logging, and phosphorus loss. Moderate risk or erosion. Central Western boundary. (Lots 30-35)
Bassendean B1 Phase (212Bs_B1)	Extremely low to very low relief dunes, undulating sand plain and discrete sand rises. Deep bleached grey sands sometimes with a pale yellow B horizon or a weak iron organic hardpan at depths generally greater than 2 m. Banksia dominant.	Gentle slopes and flats of Pale sands. Low risk of salinity and water logging. Moderate risk of water erosion, low to moderate risk of phosphorus loss. North eastern corner (Lot 90)

Bassendean B2 Phase (212Bs_B2)	Flat to very gently undulating well drained sand plain. Deep bleached grey sands with a pale yellow B horizon or a weak iron-organic hardpan 1.2m.	Gentle slopes and flats of pale sands. Low risk of salinity and water logging. Moderate risk of water erosion, lot to moderate risk of phosphorous loss. Well drained and flat Lots 7 and 89
Bassendean B3 Phase (212Bs_B3)	Closed depressions and poorly defined stream channels. Poorly to very poorly drained. Moderately deep, bleached sands with an iron-organic pan, or clay subsoil. Surfaces are dark grey sand or sandy loam.	Swamp and wet soils. Low risk of salinity and wind erosion. High risk of Water logging and phosphorous loss. Model rate risk of water erosion. Poorly drained. Isolated pockets in southwest corner and southwest (Lots 13, 41, 40 and 39).
Bassendean B6 Phase (212Bs_B6)	Imperfectly drained sand plain and broad extremely low rises. Deep or very deep grey siliceous sands.	Gentle slopes and flats of pale sands. Low risk salinity and water logging and water erosion. Moderate to high risk of phosphorous loss and moderate risk of wind erosion. Well drained and flat. South and southeast. (Lots 41, 35 and 100)

Hand augering around and in Treeby Road Lake conducted by Endemic Environments in February 2010 revealed a 1.2m thick layer of highly plastic clay near the lake, indicating the lake is perched and not in direct hydraulic contact with the regional aquifer.

4.1.2 Acid Sulphate Soils

The DEC acid sulphate soils (ASS) risk map indicates a large portion of the north west of the site is classified as Class 3 and has low to no risk of ASS occurring within 3m of the surface. There are two locations within the site classified as high risk ASS (Class 1), and these are located adjacent to Treeby Road Lake and along the eastern boundary (north of the Peel Sub P Drain). The remainder of the site has a moderate to low risk of ASS occurring within 3m of the natural surface (Class 2).(**Figure 5**).

4.2 Environmental Assets

The following paragraphs summarise the findings of the *Anketell North Cell Local Structure Plan Environmental Assessment* prepared by 360 Environmental and the *Flora and Vegetation of Anketell Urban Deferred Cell*, prepared by Bennett Environmental Consulting.

4.2.1 Significant Flora and Fauna and Bush Forever

Given the current use of the land is largely for rural residential/agricultural purposes, a large portion of the site has been predominantly cleared. However, patches of native vegetation remain

in the northern portions. The existing vegetation is typical of that related to the Bassendean Central and South Complex- Banksia/Eucalypt Woodland (360 Environmental, 2009). A Bush Forever reserve and Regional Park lie adjacent the site indicating that much of the vegetation in this area is protected. Bush Forever site 270 borders directly to the south and west of the site and incorporates a portion of Lot 13. Bush Forever site 270 has previously been realigned as part of this planning process. Bush Forever 269 occurs further west and contains the Beeliar Regional Park. An Environmentally Sensitive Area (ESA) occurs along a section of the southern boundary of the site, acting as a buffer for the neighbouring Bush Forever site 270.

Flora

A botanical survey of Lots 2-4, 7, 30-41, 89, 90, 100,188,189 and 652 (360 Environmental) identified a number of flora species within the study area. The vegetation condition ranged from *very good* to *completely degraded*. The Commonwealth listed Banksia Woodlands on the Swan Coastal Plain TEC is present within the site.

In addition, there are two Priority Ecological Community (PEC) located to the south of the site. Priority 2 *Banksia illicifolia* woodlands (SCP22) and Priority 3 *Low lying Banksia attenuate woodlands or shrublands* (SCP21c). A site survey undertaken by 360 Environmental in spring 2009 confirmed the Priority 3 PEC occurring on site through PATN analysis of collected flora and vegetation data.

The DECs Declared Rare Flora (DRF) and Priority Flora Databases were accessed to determine the potential for DRF or priority species to be present on the site. No DRF were documented as occurring on site. However the search indicated there is evidence of one Priority Flora species occurring on site:

- *Jacksonia gracillima*

These findings are supported by the results of the 360 Environmental Spring 2009 Flora and Vegetation Survey. No DRF species were recorded as occurring on site. *Jacksonia gracillima*, a Priority 3 Flora, was recorded from two quadrants, one within the site and one to the south of the site. Although the databases indicate there are no DRF listed species occurring on the site, the following protected species are known to occur in the Anketell region:

- *Aotus codifolia*
- *Aponogeton hexatepalus*
- *Caladenia huegelii*
- *Cyathochataeta teretifolia*
- *Diuris micrantha*
- *Diuris purdiei*
- *Dodonaea hackettiana*

- *Drakaea elastica*
- *Eremaea asterocarpa subsp. Brachyclada*
- *Styldium longitubum* (360 Environmental, 2009)

Three significant species that were identified as having the potential to occur on the site are listed on the DEWHA's *Environment Protection and Biodiversity Conservation* (EPBC) Act 1999 Protected Matters Search Tool (2009). These were:

- *Caladenia heugelii*
- *Drakaea elastic*
- *Lepidosperma rostratum*

Fauna

A search of the DEC's Threatened and Priority Fauna database has indicated that the following fauna have been recorded within a five kilometer radius of the site, and have the potential to occur on the site:

- Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*)
- Chuditch (*Dasyurus geoffroii*)
- Lined Skink (*lerista lineate*)
- Western Brush Wallaby (*Macropus Irma*)
- Quenda (*Isoodon obesulus fusciventer*)

A search of DEWHA's (2009b) Protected Matters Search Tool was undertaken and identified three vulnerable and three endangered species listed under the EPBC Act as potentially occurring on the site:

- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*)
- Baudin's Black Cockatoo (*Calyptorhynchus baudinii*)
- Graceful Sun Moth (*Synemon gratiosa*)
- Chuditch or Western Quoll (*Dasyurus geoffroii*)
- Red-tailed Phascogale (*Phascogale calura*)
- Quokka (*Setonix brachyurus*)

For more information regarding the sites Flora and Fauna, please refer to the *Anketell North Cell Local Structure Plan Environmental Assessment*, prepared by 360 Environmental.

4.2.2 Wetlands

The DEC maintains a Geomorphic Wetland Dataset which classifies all recorded wetlands into specific management categories based on their ecological attributes and functions. These classes consist of Conservation Category (CC), Resource Enhancement (RE) and Multiple Use (MU) wetlands.

The following wetlands are identified either within or directly adjacent to the site on the DEC's Geomorphic Database of Wetlands of the Swan Coastal Plain maps:

- UFI 14148 – a Conservation Category Wetland located over much of Lot 13 and extending south where it continues to Thomas Road
- UFI 15290 – a Conservation Category Sumpland (Treeby Road Lake) which is located on the westernmost margin of Lot 100 and portions of which extend onto Bush Forever Site 270A to the west
- UFI 6666 – a Conservation Category Sumpland centred around the Peel Sub P drain on Lot 13.

In addition, five Conservation Category Wetlands occur within the adjacent area to the south (sumpland UFI 6721 (Sandy Lake (SWC EPP Lake)), sumpland UFI 13082, sumpland UFI 13079, dryland UFI 13506 and sumpland UFI 13080). An additional three geomorphic wetlands (MU sumpland UFI 6668, MU sumpland UFI 6669 and RE dampland UFI 6667) occur to the immediate south. To the west of the study area lies the most important Bush forever and Environmental Protection Policy lake in the Jandakot area, being The Spectacles wetlands, consisting of Spectacles north (Sumpland CC UFI 6639) and Spectacles south (Sumpland CC UFI 6637). These wetlands are part of the Beeliar Regional Park and lie within Bush forever site 269.

Aerial processed contours of the site and a detailed survey of the Peel Sub P Drain identify an outlet from Treeby Road Lake (UFI 15290) into the Peel Sub Drain at an invert level of 16.002m AHD. The peak water level in Treeby Road Lake is likely to be controlled by the drain during wetter than average rainfall years. The combination of a drying climate and declining groundwater levels have likely reduced the frequency of any outflows from the Treeby Road Lake to the Peel Drain (Endemic, 2010). Significant surface water storage in Treeby Road Lake has been identified in the *Jandakot Drainage and Water Management Plan (DWMP)* (DoW, 2009) Ultimate Drainage Plan (Appendix C). For the 10 and 100 year ARI events, 23,600m^3 and 31,500m^3 respectively. These volumes are to be targeted in the post development scenario.

In 2005 a wetland reclassification and boundary assessment was completed for the wetlands on Lots 13 and 100 and submitted to the Waters and Rivers Commission. The Assessment was undertaken based on the questionnaire set out in EPA Bulletin 686: Guide to Wetland Management in the Perth and near Perth Swan Coastal Plain Area (Environmental Protection Authority, 1993). The investigation, undertaken by RPS Bowman Bishaw Gorham in September 2004 found that Lots 100 and 13 had been disturbed in the past and that Lot 100 still had an active horticulture usage, consisting of hydroponic vegetables being grown in an old nursery. This assessment indicated the wetland management category for wetlands on the site should be reduced to Multiple Use. After initial inspection and agreement to the reclassification, the Waters and Rivers Commission withdrew its agreement and stated that the wetlands would remain mapped as Conservation Category (Endemic, 2010).

During the planning process for both the Anketell North and Anketell South Urban Cells, the Department of Planning and the Department of Environment and Conservation have been involved in the project and developed a Negotiated Planning Solution (NPS). The NPS is a compromised balance between development and conservation and coincides with the realignment of the Bush Forever boundaries for site 270 and permits the use of the CCW in this development. The area is zoned "urban deferred" under the Metropolitan Regional Scheme. Some of the communications relating to the NPS have been included as an Appendix to this LWMS report.

All wetlands within the study area are classified as sumplands or damplands, which are basin type wetlands. Sumplands are subject to seasonal inundation, while damplands are subject to seasonal water logging for part of the year. However, the wetland located over much of Lot 13 (Sumpland CC UFI 14148) has been described as exhibiting 'dampland' characteristics by Endemic, as the habitat is unlikely to show signs of waterlogging except under extreme rainfall conditions.

The City of Kwinana's proposed target for the protection of all Conservation Category Wetlands (CCW) requires an appropriate setback for future urban developments within the subject site. A Wetland Management Plan for all CCW's that are retained as part of a subdivision is also required. A wetland management strategy for the Anketell precinct has been provided by Endemic (March, 2010) and outlines the necessary management strategies for Treeby Road Lake. Recommended management strategies include:

- Delineation of a suitable buffer according to Guidance statement 33 (EPA, 2005) for a minimum 50 m buffer distance around Treeby Road Lake (**Figure 20**)
- Maintenance of an appropriate cycle of seasonal inundation within the Treeby Road Lake
- Prevention of uncontrolled access to sensitive wetland and bush habitats
- Rehabilitation of the buffer and degraded portions of the Treeby Road Lake with local native species. Protection mechanisms between the buffer and proposed development to ensure the wetland and buffer area are not damaged during or post construction
- Weed treatment of bushland areas using suitable bio-safe herbicides

For more information, please refer to *Wetland Management Strategy, Anketell Central Precinct (Lots 13 & 100 Treeby Road)*, prepared by Endemic (March 2010).

4.2.3 Contaminated Sites

The nearest contaminated site as shown on the DEC contaminated sites database is located at 80 Anketell Road, over 3.5km north west of the site (**Figure 6**). The hydraulic gradient of the ground water in the area means that there is no possibility this contaminated site will impact upon the development site in any way.

4.3 Surface Water

This LWMS has been produced to better understand surface runoff generation in 1, 5 and 100 year ARI events and guide future planning.

4.3.1 Surface Water Quantity

Regional surface water and drainage was assessed in the Jandakot District Water Management Plan (DWMP) (DoW, 2009). The Jandakot DWMP split the region into sub-catchments in order to calculate surface water flow into regional drains. In the DWMP the Anketell North Urban Cell was shown to be split into three sub catchments based on topographical information (**Figure A3.1 Appendix C**) with runoff either flowing to northern (CATR1B) or southern (CATP4A) discharge points and also an area of soakage in the north west. VDM identified the predevelopment flow paths and sub-catchments in **Figure 7**.

The peak elevation of 41mAHD occurs on Treeby Road approximately 250m south of Anketell Road. From here, the site falls towards Anketell Road at grades between 2.5% and 5%, while to the south the site falls to an elevation of approximately 16mAHD at a grades of approximately 2.0%.

The Peel Sub P drain is a Water Corporation tributary open drain to the Peel Main Drain. It originates to the east of the study area and runs parallel to the southern boundary before heading south into the Peel Main Drain. The southern catchments of the study area drain via the Peel Sub P drain. Overflow discharge from the Treeby Lake also contributes to the open drain flow. There are no natural water courses within the development area. The predevelopment flow from the study area into the Peel Sub P drain was identified in the Jandakot DWMP (**Figure 4.3a Appendix C**) as being 0.030 m^3/s and 0.060 m^3/s for the 10 (10% AEP) and 100 year (1% AEP) events respectively. The values are calculated from the Longitudinal Sections and the increase in flow within the channel.

The Peel Sub R drain is located north of the study area and was identified in the Jandakot DWMP as the ultimate discharge point for the north sub-catchment of the site. The Peel Sub R Drain will also be the discharge point for the proposed Wandi Urban Development north of Anketell Road. The predevelopment flow into the Peel Sub R drain was identified in the Jandakot DWMP longitudinal sections (**Figure 4.2b Appendix C**) as being 0.13 m^3/s and 0.17 m^3/s for the 10 (10% AEP) and 100 year (1% AEP) events respectively (Anketell North Urban Cell contributes approximately 50% of the contributing catchment area and flow rates were halved). Total discharge rates north (LPD 2) are 0.065 m^3/s and 0.085 m^3/s for 10 (10% AEP) and 100 year (1% AEP) ARI events respectively.

The north eastern sub-catchments are fully infiltrated in the sandy soil with no discharge into bushland i.e. infiltrated within basins and swales in the post development scenario.

The above stated discharge flow rates are to be maintained in the post development my mitigating flows in compensation basins as per the Jandakot DWMP.

4.3.2 Pre Development Surface Water Flows

The pre-development flows for the site were estimated by VDM using the ARR Regional WA South West Rational Method (EA, 2001) coupled with a hydrological/hydraulic model XP-Storm. The following information was abstracted from the VDM report. Note that although LPD1 is mentioned in this section, no discharge from the LSP area will occur to LPD1 at post-development. We assumed that the north-western section of Anketell North Cell meets the pre-development requirements.

This was used to simulate runoff from design storm events in the catchment assuming runoff is proportional to slope, area, infiltration rates and a percentage impervious. Design rainfall for the hydrologic model has been determined based on Australia Rainfall and Runoff Intensity Frequency Duration (IFD) data for Jandakot. Hydrologic and hydraulic analysis has been undertaken with 1 (63% AEP), 5 (18% AEP) and 100 year (1% AEP) ARI storm events for durations between 15 minutes and 72 hours.

Sub-catchments and slopes were determined from Landgate contours and the detailed topographical survey of the Peel Sub P Drain. Based on this data, VDM identified 3 points at which surface water runoff will ultimately collect for either infiltration or discharge into regional drains. This supports the work undertaken by the Department of Water in the Jandakot DWMP. The points were termed; Legal Points of Discharge (LPD) in the VDM report:

- LPD 1: North western site boundary (total infiltration or "soakage")
- LPD 2: Anketell Road, approximately 190m south west of Treeby Road
- LPD 3: 3 x 600mm diameter culverts under Thomas Road

LPD 3 is located within the Anketell South Urban Cell (to be developed as part of a separate application), these properties are owned by the same parties and the drainage strategy for both Anketell North and South Cells are reliant upon each other due to the complex nature of flows with the catchment. Therefore, it is considered appropriate that LPD 3 be chosen as a comparison point for the pre-and post-development flow regimes.

The catchments considered as part of the VDM assessment are summarised below and illustrated in **Figure 7**:

- Catchment 1: A largely external catchment to the west of the site, draining to Sandy Lake. Overflow from Sandy Lake enters the Peel Sub P drain at the culverts under Thomas Road.

- Catchment 2: Extending from the north of the site to the topographic highs to the north west, north and north east. The catchment drains to Treeby Road Lake, with overflow discharging into the Peel Sub P drain.
- Catchments 3 and 4: Covering the topographic highs to the north east of the site and discharge into the Peel Sub P drain at its origin.
- Catchment 5: Extending across the north and centre of the site and includes the external eastern catchment of the Peel Sub P drain. Catchment 5 discharges into the culverts under Thomas Road, which is the legal point of discharge for the Peel Sub P drain catchment.
- Catchment 6: Includes the eastern portion of the site and is the largely flat external catchment to the east. Catchment 6 also discharges into Peel Sub P drain at the culverts under Thomas Road.
- Catchment 7: Incorporates the north eastern portion of the site and discharges to the north across Anketell Road under the Western Power easement.
- Catchment 8: The north western portion of the site and all runoff will be fully infiltrated

Catchment areas, time of concentration (tc) and pre-development flows were estimated and are summarised in **Table 3**. **Table 4** summarises the peak flow rate at each of the LPDs.

Table 3: Pre Development Catchment Runoff Calculations

Catch. ID	Area (ha)	t_c (min)	ARI Flows (l/s)					
			1 Year		5 Year		100 Year	
			Rational	XP-Storm	Rational	XP-Storm	Rational	XP-Storm
1	40.238	84.8	54	55	121	123	358	361
2	121.364	153.9	130	133	290	302	837	839
3	53.693	99.1	69	74	157	165	460	466
4	83.521	125.8	96	102	216	227	627	622
5	44.715	89.7	58	60	131	136	386	388
6	68.569	113.1	78	84	175	186	511	517
7	33.265	76.5	49	51	112	114	333	330
8	18.798	56.2	38	39	86	87	258	261

Table4: Summary of Predevelopment Legal Points of Discharge

Legal Points of Discharge	1-yr ARI Peak Discharge (l/s)	5-yr ARI Peak Discharge (l/s)	100-yr ARI Peak Discharge (l/s)
LPD 1	39	87	261
LPD2	51	114	330
LPD3	183	517	1,092

The Jandakot DWMP identified the predevelopment discharge rates in 10 and 100 year events (Section 4.3.1):

- LPD 1 - Discharge: All events fully infiltrated
- LPD 2 - Discharge: 10 year: 0.065m³/s
  100 year: 0.085m³/s
- LPD 3 - Discharge: 10 year: 0.180m³/s
  100 year: 0.360m³/s

Comparison of the Rational Method calculations and the XP-Storm generated flow rates indicates the hydrologic model is producing peak flow rates very similar to those obtained through application of the recommended ARR procedures. However, comparison of the flow rate observed downstream of Thomas Road (the Legal Point of Discharge (LPD)) indicates the peak discharge from the hydrologic model is considerably higher than the 360l/s reported by the DoW in the *Jandakot DWMP*. As the modelling undertaken by the DoW has been calibrated against gauged stream flow data, it is considered appropriate that the loss parameters applied to the XP-Storm model be adjusted to achieve calibration with the peak discharge reported by the DoW. To achieve calibration to the DoW model, the proportional loss values of the hydrologic model were amended, as summarised in **Table 5.**

Table 5: ARR *vs* DoW Proportional Loss Parameters

Catch. ID	1-yr ARI Proportional Loss		5-yr ARI Proportional Loss		100-yr ARI Proportional Loss	
	ARR	DoW	ARR	DoW	ARR	DoW
1	0.037	0.01	0.053	0.015	0.087	0.020
2	0.043	0.01	0.062	0.015	0.102	0.020
3	0.040	0.01	0.057	0.015	0.093	0.020
4	0.041	0.01	0.059	0.015	0.097	0.020
5	0.037	0.03	0.053	0.035	0.088	0.040
6	0.038	0.03	0.054	0.035	0.089	0.040
7	0.039	0.03	0.055	0.035	0.091	0.040
8	0.043	0.03	0.061	0.035	0.101	0.040

NOTE: ARR weighted coefficient values refer to those obtained using Australian Rainfall and Runoff Regional WA South West Method. DoW values refer to those required to achieve calibration to the peak flow rates reported in the *Jandakot Drainage and Water Management Plan* for the Peel Sub P Drain

The XP-Storm model was subsequently run for the 1-yr, 5-yr and 100-yr ARI events. Results of these simulations indicate the model is well calibrated to the DoW model, with a variation in pre-development peak discharge for the 100 year ARI event of only 2.3% (**Table 6**).

Table 6: Summary of Pre-Development Legal Point of Discharge

Legal Points of Discharge	1-yr ARI Peak Discharge (l/s)	5-yr ARI Peak Discharge (l/s)	100-yr ARI Peak Discharge (l/s)
LPD 1 Soakage Area	**27**	**50**	**103**
LPD 2	39	72	145
LPD 3	80	168	371

NOTES: LPD 3 is calibrated to the values reported in the *Jandakot DWMP.* No recorded data is available for LPD 1 and LPD 2, however the runoff coefficients adopted for these catchments are consistent with those applied for the calibrated LPD 3. LPD1 is a soakage area and flows to it will be infiltrated.

4.3.3 Surface Water Quality

Surface water monitoring was to be undertaken by JDA, however during the period of their engagement, there was no rainfall events resulting in the generation of surface water flows.

4.4 Groundwater

4.4.1 Groundwater Levels

JDA undertook predevelopment groundwater monitoring with several bores located throughout the local area and continued by VDM Consulting (**Table 7**). Groundwater flow direction is east to west with a gradient of approximately 0.003. **Figure 8** shows minimum groundwater levels across the study area in the autumn to early winter months (April-July). Typically, bores located near wetland features show groundwater to be within 0.7m of the surface in wetter periods.

Groundwater levels do not express great seasonal variability indicating there is an interconnection between localised perched water bodies and the underlying shallow aquifer. Localised perched water systems appear trapped between confined fine grained sand bodies and some lenses of clay. JDA investigations noted that during bore installation no clearly defined underlying confined layers were observed. Groundwater behaviour indicates that a combination of a drying climate (Endemic, 2010), recharge frequency, abstraction of groundwater in or near site investigated and declining regional groundwater levels are likely to control the replenishment and outflow patterns of the wetland systems located adjacent to the site.

The *Wetland Management Strategy, Anketell Central Precinct (Lots 13 & 100 Treeby Road)*, by Endemic (March 2010) discusses the peak water levels and outflows from Treeby Road Lake and concludes that the combination of a drying climate and declining groundwater levels have likely reduced the frequency of any outflows from the Treeby Road lake to the Peel Drain (Endemic, 2010).

The Department of Water and Environmental Regulation (DWER) monitor and maintain long term water monitoring bores across the area. The closest DoW bores are Sites 11812632 and 61419711 (JE22C) located approximately 1.5km north east and on the eastern boundary of the site respectively.

Table 7: Groundwater Bore Data

Monitoring Bore	Location (GDA Coordinates)		Top of Casing (mAHD)	Total Depth (mBNS)
	Easting	Northing		
WAM5s	392819	6436201	29.26	12.00
WAM5d	392819	6436200	29.25	15.00
WAM6s	392948	6435906	29.14	12.00
WAM6d	392946	6435906	29.10	15.00
WAM7s	392498	6435094	34.57	18.00
WAM7d	392498	6435095	34.57	21.00
WAM8s	392718	6434838	21.51	5.00
WAM8d	392718	6434838	21.48	8.00
WAM9s	392002	6434770	18.58	5.00
WAM9d	392001	6434769	18.79	9.50
WAM10s	392545	6433942	19.37	5.00
WAM10d	392546	6433942	19.32	9.50
WAM11	392144	6435637	30.88	22.0
WAM12(s)	391937	6436182	14.79	4.00
WAM12(d)	391938	6436181	14.81	10.00
WAM13(s)	392021	6436000	15.60	4.00
WAM13(d)	392022	6436000	15.51	9.00
WAM14	392597	6433559	18.61	5.30
WAM15s	392571	6433790	18.19	4.30
WAM15d	392570	6433791	18.18	10.30
WAM16s	392117	6433764	16.66	4.30
WAM16d	392117	6433763	16.71	12.80
JE22C	392520	6434584	20.33	6.15
11812632	392887	6435694	24.44	9.00

From long term DoW data (1994-2014) the annual average maximum groundwater level (AAMGL) for the bore JE22C was calculated to be 17.965mAHD while the historical maximum was recorded on 16/10/1996 and reached an elevation of 21.399 mAHD.

In order to provide higher confidence with regards to drainage infrastructure a maximum groundwater level (MGL) has to be calculated. To this end, DWER's JE22C bore and JDA WAM

bores dataset must be used to determine the MGL to occur within the site. This is achieved by adding the difference between JE22C historical level and JE22C level recorded at "t" time to the JDA WAM bore levels recorded at "t" time (with "t" time being a date of +/- one month).

JDA WAM bores 5 to 13 were recorded between 2005 and 2007, while JDA WAM bores 14 to 16 were recorded between 2007 and 2009. To his end, one JE22C water level in each time period recorded within a month of the JDA bore's records is required to calculate the MGL.

Table 8 details the calculation while **Figure 9** provides a visual representation of the calculated MGL.

The infrastructure will be designed to provide enough clearance from the MGL.

Table 8: Calculated MGL (mAHD) for the JDA Monitored Data

Bore	Historical level recorded date	Level (mAHD)		
JE22C	16-10-96	21.399		
Bore	**Recorded date for 2005-2007 time period**	**Level (mAHD)**	**Difference between JE22C historical level and "t" time level**	**Calculated MGL (mAHD)**
JE22C	30-09-05	20.99	0.409	
WAM5	27-09-05	20.06		20.469
WAM6	27-09-05	21.08		21.489
WAM7	27-09-05	18.97		19.379
WAM8	20-09-05	20.06		20.469
WAM9	26-09-05	15.8		16.209
WAM10	26-09-05	17.37		17.779
WAM11	27-09-05	13.72		14.129
WAM12	27-09-05	14.15		14.559
WAM13	27-09-05	14.13		14.539
Bore	**Recorded date for 2007-2009 time period**	**Level (mAHD)**	**Difference between JE22C historical level and "t" time level**	**Calculated MGL (mAHD)**
JE22C	05-09-09	20.509	0.89	
WAM14	11-09-08	16.81		17.7
WAM15	11-09-08	16.71		17.6
WAM16	11-09-08	15.19		16.08

4.4.2 Groundwater Quality

Groundwater quality testing was completed by JDA Consultant Hydrologists (JDA). Results indicate that waters are mildly acidic to acidic with pH ranging from 3.5 (WAM15 (s)) to 6.5 (WAM6 (s)).

The pH tends to fluctuate seasonally and with groundwater levels. pH affects the amount of nutrients that are soluble in soil water i.e. nutrients for plant growth. Seasonal variation in pH was from 0.67 to 1.37 units at each bore. pH of waters from deep bores were closely related to those of the shallow bores. Many wetlands have near-neutral pH (approximately 7), but considerable variation in either direction occurs naturally and in diurnal cycles. Rainwater is naturally slightly acidic (as low as pH 5.5), due to dissolved atmospheric carbon dioxide, but the pH may be rapidly modified by chemical and biological processes once the water enters the wetland (e.g. carbonate buffering, photosynthesis) (DEC, 2013). In wetlands with little biological activity and few reactive minerals, the pH may remain mildly acidic.

Very low pH in wetlands is a cause for concern, as it may cause the mobilisation of toxic metals or other contaminants (DEC, 2013). Wetlands can also be acidified by acid sulfate soils. These soils contain acidity stored as sulfide minerals in permanently waterlogged sediments that, if exposed to the air by falling water levels, can result in generation of strongly acidic soils and waters that can potentially flow into receiving waters. In areas expressing highly acid groundwater values further acid sulfate soil investigation should be implemented if excavation is proposed. Future planning and engineering design across the study shall also pay careful attention to the groundwater levels and make efforts to maintain the predevelopment levels not discharging/ exporting groundwater into receiving waters.

Salinity, or electrical conductivity (EC) (mS/cm) in all bores assessed generally increases with time to reach a maximum of 2.81mS/cm in WAM16 (d) bore. This latter bore is located at about 100m east from the Sandy Lake and is subject to study in the Anketell South Urban Cell Report. EC values estimate soluble salt content and can be elevated by fertilisers that can flow to low lying areas during rainfall events before percolating into soils and groundwater. The availability and concentration of salt in a wetland helps to shape its ecological character (DEC, 2013). The type and concentration of salts in a wetland has a very strong bearing on the wetland, and particularly on the life forms which will inhabit it. Wetland species are adapted to particular ranges and types of salts in their environment; some saline wetland species may rely on a high level of salinity to function. Wetland species are physiologically adapted to particular ranges or concentrations of salinity meaning that if these concentrations change too much or too rapidly, this can cause a decline in health and even result in mortality. Seasonally dry areas increase the concentration of salts in the soil and hence groundwater by evaporative processes and decreasing water volumes. This is a natural process but should be monitored. Excessive drying by future drainage shall be avoided.

Nutrients in groundwater are any substances that provide nourishment for the promotion of life. Generally, in regards to wetlands, the two main nutrients of interest are phosphorus and nitrogen. These nutrients influence the type and abundance of living things contained within the study area.

Nutrients are carried into the study area by water movements i.e. rainwater generated surface water flows and groundwater flows. The concentration of dissolved nutrients is elevated in groundwater due to uptake from soils and rocks. The greater the input of water then the greater the potential increase in nutrient levels. This leads to the requirement of a treatment train approach to promote a higher quality water reaching receiving waters. Export of nutrients can be regulated by implementing structural control systems to reduce discharge flow rates and hence reduce water level fluctuations.

The median of total Phosphorous was also reported to be relatively high as compared to the EPA targets (0.1 mg/L) for the Peel Main Drain and Serpentine River sites (0.135 mg/L). High phosphorus levels can be indications of past human or animal activity i.e. surface water runoff from developed areas, application of nutrients in agricultural management systems and animal grazing. The median filterable of Reactive Phosphorous were reported to be low. Ammonium as NH4-N concentrations across most of the bores is relatively low, normally below 1.0 mg/L. However bores WAM5 (s) and WAM7 (d) presented high concentrations to reach a maximum peak of 3.50 mg/L for the WAM5 (s) bore.

Nutrients assessed presented various trends with time. Nitrate occurs naturally in plants but levels can become elevated if the plants are affected by drought before decomposing and leaching with runoff. Often higher levels are expected with application of fertilisers (ammonia based) and animal grazing. Nitrite and Nitrate were generally low across all assessed bores. However, Nitrate concentrations for bores WAM 5, 6 and 7 are very high but with a decreasing trend over time. WAM6 (s) bore, which shows the highest concentrations, show a decreasing trend over time with the highest peak of about 86 mg/L during the early period of the monitoring program. Subsequent concentrations decreased to a low of about 20 mg/L to then increase with time to an approximate of 60 mg/L.

In general, nutrient concentrations present various trends with an overall decreasing value with time and substantial variability with depth. In Section 4.4.1 it was stated that there is evidence of localised perched water and shallow aquifer interaction. This appears to be the solute transport path from the localised perched to the shallow aquifer.

4.4.3 Groundwater Licences

According to a search of the Department of Water the Water Register website there are 8 licenses within the proposed LSP area (see Section 7.3 for details). This allows the extraction of 326,700kL of water from 13 draw points in the superficial aquifer. Groundwater licences will be transferred prior to the commencement of the UWMP.

4.5 Summary of Opportunities and Constraints

The geology within the investigated area mainly comprises sandy to clayey layers and groundwater levels are mainly found at about 4.0m deep below natural ground surface. This gives the opportunity for infiltration of stormwater at local (soakwell) and regional (basin) scale and minimizing/limiting fill required to provide sufficient clearance between finished lot levels and groundwater.

Groundwater quality assessment has shown that there is substantial variability in water quality with time and depth. Overall pH readings indicate that the waters are mildly acidic to acidic. Three bores WAM 5, 6 and 7 were detected to contain substantial concentrations of nutrients, particularly Nitrite-Nitrate and Ammonium.

Subsoil drainage will not be required as adequate separation between MGL and finished lot levels is provided naturally.

5.0 Water Sustainability Initiatives

Developments generally increase stress levels on the water resources available for that area. Better Urban Water Planning (WAPC) guidelines indicate that a development should sustainably manage and utilise the supply and usage of water within it. This LWMS includes strategies aimed at achieving a better management of water resources to reduce the impact that the development has on resources and the surrounding environment.

Water is an essential requirement and valuable resource for all developments and practical water conservation methods should be considered to maintain an appropriate efficiency of water consumption. Conservation methods should incorporate both the use of potable and non-potable water sources. There are several methods utilised in planning to achieve the Better Urban Water Management (WAPC, 2008) target consumption reductions discussed within this section. These techniques are adopted to have a similar reduction when used in industrial and school environments.

The Water Corporation promotes urban development criteria aimed at an overall reduction in scheme water use by the use of "Waterwise" devices and practices. These management systems are used internally or externally to the property and operate much the same as traditional methods but have a lower percentage of water use.

5.1 Water Conservation

A large proportion of the total water used within a development is in the home. The State Water Plan 2007 (Government of Western Australia, 2007) has set a target for domestic use of scheme water of 100 kL/year per person. The Water Use in House Code (5 Star Plus: Dept of Housing and

Works, 2007) requires the use of water efficient appliances and fixtures in new homes and will be adopted throughout the development. Council requirements for efficiency will also be adhered to in conjunction with Australian Codes and Standards. Water conservation will be encouraged by providing educational material by means of advertising and information at the point of sale.

5.1.1 Fixtures and Fittings

As part of the BCA 5 Star Plus initiative water efficient fixtures and fittings will be mandatorily incorporated into the development from the design stage to Australian Standard Codes. Water sensitive urban design (WSUD) techniques implemented throughout the development will create an environment that encourages interest in water saving measures such as the use of water saving shower heads, taps and toilets, AAA rated appliances (washing machines, toilets, dishwashers), pressure reduction, drip reticulation, gardening practices.

The BCA 5 star Plus initiative implemented by the Government of Western Australia 1 Sep 2007 requires:

- All tap fittings other than bath outlets and garden taps must be 4 star WELS rated
- All showerheads must be 3 star WELS rated
- All sanitary flushing system must be a minimum 4 star WELS rated
- Outdoor pools & spas for class 1 dwelling must be provided with a cover to reduce evaporation
- The pipe from the hot water system or recirculating hot water system to the furthest hot water outlet must not exceed 20m or 2L of internal volume

The water use within a four member residence and the quantity of water that can be saved by using water efficient devices (based on *Domestic Water Use Study* (Water Corporation, 2003)) is given in **Table 9**.

Table 9: Domestic Water Consumption Rates

No	Appliances	Type of Appliances	Assumption	Water Consumption (kL/year)	Water Saving (kL/year)
1	Shower Head	Conventional shower head	One 7.5 minute shower per person per day	99	-
		AAA rated shower head		77	22
2	Flushing	Conventional single flush toilet	Three flushes per person per day	48	-
		Duel flush toilet		31	18
3	Washing Machine	Conventional top loader	One load per household per day	53	-
		AAAA rated front loader		15	38
		Conventional	16% of all water used in	32	-

4	Taps	Water saving	the home is used via taps	16	16
Total		Conventional Devices		232	-
		Water Saving Devices		138	94

(Data Source: Domestic Water Use Study, Water Corporation, 2003, and Household Water Use Calculator).

5.1.2 Rainwater Harvesting

As large percentages of potable scheme water are used externally for irrigating gardens, it is possibly the greatest opportunity to reduce total usage. Rainwater tanks retain runoff onsite to be used in dry periods. They also, in effect, work as a peak water retention device as the resident will release the flow gradually whilst reducing owner dependence on potable scheme water. Rainwater from roofs and other impermeable areas can be collected in rainwater tanks for future use. The water can also be utilised internally for toilet flushing etc provided suitable plumbing is provided. Rainwater tanks can be supplied upon request by the purchaser as an optional addition for the property but cannot be sufficiently relied on to effectively reduce run-off flow rates however, the developer should encourage the installation of such devices.

5.1.3 Water Landscaping

Water landscaping forms a large portion of water conservation strategy as successful approaches reduce the quantity of water required for irrigation and also reduce the total runoff. Landscaped drainage is located in lots, road reserves, rain gardens, drainage basins and any open space where possible and designed to meet the requirements of Liveable Neighbourhoods (WAPC, 2009a) and the council planning department. Any irrigation required should be from an appropriate source i.e. treated wastewater, licensed bore, rainwater harvesting.

The development will achieve water conservation through landscaping by planting drought tolerant indigenous species, reducing the area of lawn, increasing pervious areas, improving soil water holding capacity and, where irrigation is required, the installation of water efficient systems. Infiltration systems should also be incorporated to maximise use of high soil permeability onsite.

Indigenous vegetation has minimal or no irrigation requirements and should be planted throughout the development including within the road reserves and basins (provided fire protection is not jeopardised). Such plants also help to promote a natural ecological environment and minimise the introduction of alien species whilst offering a habitat for native species. Where irrigation of vegetated areas cannot be avoided, it should be restricted during the day as evaporation rates are at their greatest.

Road reserve vegetation shall be protected from vehicular damage by a kerb stone perimeter. The road gradient should also act to convey surface water directly into the entry points in an efficient manner to achieve rapid entry into infiltration drainage systems. Appropriate ground surfaces should also be chosen where possible to achieve higher infiltration and lower the evaporation rate

i.e. mulch, porous paving, gravel. Maintenance of landscaped areas should be easily achieved by incorporating access points. The plant species should also facilitate this with low requirements for irrigation and upkeep.

5.2 Lot Water Consumption

A typical four person family house without water saving measures uses 492kL/year: 232kL in-house and 260kL outside. This equates to approximately 123kL/year per person which is greater than the State Water Plan target.

A four person family home that employs water saving measures uses only 225kL/year: 120kL in-house and 115kL outside. This equates to approximately 56kL/year per person well below the State Water Plan target and below the upper limit of the target.

Using the Water Corporation's Water Balance Tool, per person potable water consumption was calculated at 86kl/year. This is 14kl/year less than the target of 100kL/year per person potable water use set out in the State Water Plan 2007 (Government of Western Australia, 2007).

5.3 Water Supply Management

The Water Corporation has made provision for water supply to the Anketell (North) Cell in its planning for servicing the south-east corridor. The site is located within the Water Corporation's Thomson's Gravity Scheme. Preliminary investigations with the Water Corporation have resulted in a review of the current Water Corporation scheme planning. To service Anketell (North) a water supply will have to ultimately extend from the distribution mains required for the Wandi Cells north of the Anketell (North) cell. In addition to this an injection via an additional distribution main (diameter 700mm) from the west side of the Kwinana Freeway is required. Preliminary investigations suggest this distribution main would cross under the Kwinana Freeway near to the existing Peel Main Drain Crossing. Main Roads WA has confirmed that a crossing at Rowley Road is not feasible and Water Corporations preference is for a crossing south of Rowley Road. Ultimately the actual crossing location is to be determined by Water Corporation.

The internal water reticulation will be designed and constructed in accordance with normal Water Corporation standards. For more information regarding the reticulated water supply for the site, please refer to the *Cell 3 Anketell (South) Local Structural Plan Servicing Report*, prepared by Ewing VDM (dated January 2010).

5.7 Waste Water Management

The Water Corporation made provision for a reticulated sewerage scheme for the Anketell (North) Cell in its planning for servicing the south-west corridor. The site is located within the Water Corporation's "Thompsons Lake" sewerage catchment which is connected to the Bibra Lake Main

sewer that discharges into the Woodman Point Wastewater Treatment Plant. The Water Corporation advised servicing of Anketell (north) Cell would occur from the north.

Preliminary investigations with the Water Corporation have confirmed the establishment of 'four' prefunded pump stations as follows:

(A) – Type 90 Pump Station East of Kwinana Freeway
(B) – Type 90 Pump Station West of Kwinana Freeway
(C) – Type 10 Pump Station West of Kwinana Freeway, Southern area
(D) – Type 40 Pump Station East of Kwinana Freeway adjacent to Thomas Road

The entire Anketell (North) and (South) cells are proposed to be serviced from pump stations 'A' and 'D'. The northern half of the Anketell (North) cell will be serviced through a gravity sewerage system to pump station 'A'. The southern half of Anketell (North) and Anketell (South) will be serviced through a gravity sewerage system to pump station 'D' which will be pumped via a pressure main back up into the Anketell (North) gravity system which ultimately discharges into pump Station 'A'.

The preferred sewer pressure main route option from pump station 'A' is along Darling Chase up the main spine road and across into Mandogalup south of Rowley Road and then up along Barfield Road to Macquarie Boulevard via Jackadder Avenue.

All lots will be developed with a conventional gravity sewerage system of reticulation sewers located within road reserves. In some cases lot levels will need to be adjusted to service appropriately.

For more details regarding the servicing of the proposed development, please refer to *Cell 3 Anketell (North) Local Structure Plan Servicing Report* prepared by Ewing VDM (dated January 2010).

6.0 Stormwater Management Strategy

This LWMS addresses how urban surface and stormwater quantity and quality should be managed to protect ecological, socio-economic and cultural values. It will assist decision making ensuring structural and non-structural remedial measures in developments are undertaken in a cost-effective, integrated and coordinated manner within a close proximity to the guidance given in the Stormwater Management Manual for WA (DoW). The approach will also be consistent with the key design objectives of water sensitive urban design practices detailed in the previous sections.

6.1 Conceptual Management Strategy

Surface runoff water flows over the catchment and can potentially inundate a development by exceeding the water holding capacity and drainage infrastructure. This becomes a greater problem in and around Perth where shallow superficial aquifers can reduce the infiltration rate of soils that intercept surface water flow. Suspended particles and pollutants in carrier water often cause long term damage to drainage systems, groundwater and ecosystems. Developments decrease the effective permeability of the overall site, and hence, increase peak runoff rates, flooding and erosion potential. Efforts will be made to manage risk by disconnecting constructed impervious areas from receiving water bodies (preventing direct discharge) and by reducing the amount of constructed impervious areas (DoW, 2009). This will be achieved using basins and infiltration systems.

Surface water flows are to be managed at both lot level and development scale to maintain predevelopment hydrology by retaining or detaining surface water, and to infiltrate runoff close to source. Drainage is split into two categories, minor and major, based on capacity requirements of varying AEP events;

- Minor Drainage- rooftop guttering, underground pipes, rain gardens and swales
- Major drainage- specific road arrangements for overland flows, drainage basin reserves, overland swale systems, attenuation and infiltration areas

Minor drainage systems are designed to accommodate AEP events of a frequency up to 18% whilst major drainage is designed to convey stormwater from events up to, and including, magnitudes of 1% AEP events. Drainage systems are designed to attenuate the peak volume safely allowing time for slow release into the downstream network whilst offering water quality treatment prior to discharge. The release of water into receiving bodies should be at predevelopment rates and controlled by invert levels, orifice plates, riser pipes, weirs or similar infrastructure.

The design concepts for managing stormwater across the Anketell North Urban Cell are:

- Employ soakwells in lots to retain and infiltrate the 63% AEP event and avoid direct runoff to the street conveyance system; this will increase infiltration and detention periods whilst reducing peak flow rates
- Rain gardens long roads to infiltrate 63% AEP events
- Provide pipe systems within the road reserve to convey runoff for storm events up to the 18% AEP event to the basins and legal discharge points (when possible) (LPDs)
- Provide safe overland flow paths for the 1% AEP events to the basins and discharge points
- Retention/Detention: Provide adequate storage to attenuate post-development flows to predevelopment conditions and maintain the required free-board to finished lot levels
- Discharge to receiving environment: Provide an outlet to the nearest regional drainage line and ensure that flow rates and water qualities are within the design limits

6.2 Structural and Non-Structural BMPs

To maintain and improve water quality this development will use the treatment train approach to 'source control' pollutants using best management practices (BMPs) as detailed in the DoW report Stormwater Management Manual for WA (DoW, 2009). BMPs can be a cost effective means of reducing operation and maintenance expenditure post-development especially when utilising non-structural methods. BMPs are used in two forms; structural and non-structural.

The proposed development should employ a combination of the following BMPs at each level to achieve the required stormwater treatment;

Table 10: WSUD Elements, Scale and Ownership

Scale	Ownership	Best Management Practice: Water Quantity and Quality
Lot	Lot owner	Soakwells Rainwater tanks and porous pavement where appropriate. Gardens and amended soils
Street	Local Authority	Infiltration/vegetated roadside swales when possible. Rain gardens, Sediment traps
Catchment		Compensating, storage and infiltration basins.

The City of Kwinana offers advice on an extensive selection of Water and Energy Initiative BMPs that their residents can adopt throughout the household. The advice is made available through the council website and can be supplied to the new residents during handover.

6.2.1 Lot Level BMPs

- Soakwells are widely used for direct infiltration of the relatively clean runoff from roofs generated in frequently occurring events (up to the 18% AEP) especially in the free draining sand soils. Soakwells will be to CoK specifications
- Soil sampling is required to ascertain the phosphorus retention capacities and particularly that of any fill to be used
- Reducing areas of lawns that may require fertiliser and irrigation
- Minimise connected impervious areas to no more than 70% of the lot. Applications where impervious surfaces exceed 70% of the lot should only be considered where compensation measures are taken to reduce the amount of stormwater runoff generated
- Rainwater harvesting tanks shall be made available during planning and construction stages
- Education campaigns to increase residential awareness of pollutant control i.e. by using fertilisers correctly and using techniques for minimising stormwater runoff pollutants. Information is to be provided to new homeowners by developers and builders
- Inclusion of native planting suitable to Perth soil conditions in garden design and landscaping strategies

6.2.2 Street Levels BMPs

Treatment of storm runoff from road surfaces that potentially contain nutrients, heavy metals, hydrocarbons and other pollutants is paramount in WSUD. Grassed swales and bioretention measures will be used to promote settlement of suspended particulate matter and offer a degree of nutrient removal from carrier water and reduce eutrophication in the receiving bodies of water whilst improving the aesthetics of the development.

Infiltration/bioretention systems, such as rain gardens along roads, vegetated swales and leaky manholes, will be incorporated into road design across the development to assist in providing attenuation and temporary storage, critical to water quality treatment. Street sweeping will reduce particulate contaminants entering stormwater networks to improve the overall effectiveness of bioretention systems and reduce costs associated with maintenance.

6.2.3 Catchment Level BMPs

Catchment level BMPs are predominantly storage basins to improve water quality prior to any discharge into regional drains or infiltration. Detention basins are most effective when the contaminants are primarily particulate but removal of soluble (bio-available) contaminants, such as phosphorous and nitrogen, may also be achieved when retention times are sufficient and basins are vegetated. Rainfall events less than the 1% AEP will be conveyed to basins through rain gardens.

In general, bioretention areas in storage basins are required to constitute a minimum of 2% of the impervious connected area. The basins will also utilise high PRI materials in their design to

improve nutrient stripping. Source controls compliment basin and swale use by limiting the use of nutrient application through appropriate landscape design and plant species selection. The basins provide visual/landscape amenity and ecological diversity. In the case of linear storage basins, consideration should be given to vegetation to reduce aesthetic intrusiveness.

The LWMS assumes that drainage for the LSP can be accommodated in part while some runoff will exit the proposed LSP area to maintain the predevelopment peak flow rates at LPD2 and LPD3.

Some water from large storm events will be directed to Treeby Lake as per the predevelopment flow conditions. This will also improve the hydrologic regime of the lake by ensuring a continued water supply to the lake in a time of declining rainfall and groundwater. The *Jandakot Drainage and Water Management Plan* (DoW, 2009) identified the requirement for 31,500m³ of storage for the 1% AEP event to be provided across the development. The structures required to direct the water to the lake will be defined at the UWMP stage, however current planning identifies overland flow or pipe system as the likely method.

Note however, overland flow will most likely be facilitated by the basin overflow system i.e. weir or riser pipe/ orifice plate structures to allow flows once a set invert level is reached in low frequency events. Overland flow paths will require some protection from erosion i.e. rock lined swales. The road surfaces will also be used to channel surface water flows towards basins in the 1% AEP events.

6.2.4 Site Constraints and Structural BMP Selection

The primary requirement of stormwater management is to maximise infiltration through the use of structural source control BMPs. To identify the most appropriate source control BMPs, the following is required:

- Investigations to determine baseline water quantity and quality
- Site specific geotechnical and hydro-geological assessments to ascertain whether the site is capable of infiltrating the runoff generated primarily based on local soil types and conditions and ground water levels
- Subdivision layouts detailing streetscapes

The site conditions and constraints that must be considered (in addition to the efficiency of BMPs to reduce nutrient loads) prior to the selection of appropriate BMPs is summarised in **Table 11**.

Table 11: BMPs and Site Constraints

Structural BMP	Consideration
Infiltration (soakwells, porous pavements)	Ground water level and quality Soil types (i.e. permeability, phosphorous retention capacity, acid sulfate and contaminated zones)
Bio-retention	Groundwater level and quality Soil types (i.e. permeability, phosphorous retention capacity, acid sulfate and contaminated zones) Subdivision layout

6.3 Hydrological Modelling

To develop a relevant stormwater management strategy for the proposed development, hydrologic and hydraulic modelling have been undertaken for the catchment with existing and post-development scenarios. A computer simulated model was produced by Bioscience using XP SWMM software package to calculate runoff rates for different average recurrence interval (ARI) rainfall events. XP is a comprehensive package for dynamic modeling of stormwater by developing link-node (1D) and spatially distributed hydraulic models (2D) for analysis and design to aid in water resource management.

The XP model setup utilises topographical data to create an elevation base map or digital terrain map (DTM). The DTM is split into post development catchment boundaries based on topography and the local structure plan (LSP) as shown in **Figure 14**. The link and node details for the site are input manually to represent the real world (and proposed) drainage network onsite from information collected during site investigations and provided by the developer/ engineer. The runoff sub-catchments are each designated a landuse runoff coefficient and drainage node based on surface covering and geotechnical information i.e. sand, sandy clay, clay, grass, road. All links and nodes are joined together in a continuously branched drainage system with outfall points to match the proposed legal discharge points (LPDs) onsite. The software is capable of comprehensively modelling the hydrologic and hydraulic components of stormwater management systems to determine sub-catchments peak discharge flows and detention basin volumes required to manage surface water flows. The XP model was calibrated against the DoW and VDM predevelopment flow conditions.

Preliminary analysis of the development and its constraints are summarised in this LWMS and further detailed analysis will be undertaken as a part of the cell structure and UWMP. Data used as input into the hydrologic module of the XP model to generate runoff hydrographs for the sub-catchments can be found in **Appendix B**.

6.3.1 Rainfall

Design rainfall for the hydrologic model has been determined based on Australia Rainfall and Runoff (ARR, IE 2000) Intensity Frequency Duration (IFD) data for Jandakot. Hydrologic and

hydraulic analysis has been undertaken with 63%, 18%, and 1% AEP events for duration between 30 minutes and 72 hours. The IFD data used in the modelling are tabulated in **Appendix B**.

6.3.2 Post Development Land Use Assumptions and Loss Models

Different soil types and land uses have different infiltration characteristics and runoff rates that have been factored into the model and calculations. Land uses for the post-development scenario have been extracted from the Local Structure Plan (**Figure 2**). The aerial images show the existing catchments are comprised of rural and bush land with predominantly sandy soils and have very little impervious surfaces. The proposed land uses in the post-development scenario include single and group housing residences, commercial and retail areas, a community purposes site, public open spaces (POS) and road reserves and result in increased runoff.

Catchments 7.1, 3.4, 4, 2.1, 5.1, 5.2, 1 and 6 are external to the North Anketell development and are not to be developed and runoff will remain the same as predevelopment rates except for catchment 3.1 (size of the pre-development catchment 3 being smaller at post-development).

Table 12 presents the initial (IL) and continuing (CL) loss values use in the modelling for post development.

Type	IL	CL	CAT	Comments
Impervious urban	15.85	0.15 (proportional)	2.2, 2.3, 2.4, 2.5, 2.6, 3.1, 3.2, 3.3, 7.2, 7.3, 7.4, and 7.5	Takes in consideration the 63% infiltration by raingardens
Pervious urban	15.86	6 (absolute)	2.2, 2.3, 2.4, 2.5, 2.6, 3.1, 3.2, 3.3, 7.2, 7.3, 7.4, and 7.5	Takes in consideration the 63% infiltration by soakwells for the initial loss. ARR value was used for the absolute loss

6.4 Hydraulic Modelling

The sub-catchment hydrographs generated during the hydrologic modelling were routed through a hydraulic network representing the development in the hydraulic mode of XP-SWMM to ascertain the peak flow rates, flood levels and required peak storage volumes.

6.4.1 Drainage Flow Paths

In predevelopment conditions surface water flows overland either towards the soakage area (LPD1) and the northern discharge point (LPD2) or south to Treeby Road Lake and the Peel Sub P Drain (LPD3). The sandy nature of the soil across the study area resulted in high infiltration rates that, in frequent rainfall events, can have little or no notable runoff.

Note that we assumed that the northern western section of Anketell North Cell (located outside this LSP area) meets the pre-development requirement at LPD1. As such, no flow path to this discharge point was modelled in this LWMS.
Significant storage of 31,500m³ exists in Treeby Road Lake (see DoW Ultimate Drainage Plan 100 year events **Appendix C**). Results of predevelopment modelling indicate (**Figure 7**) that for all storms up to and including the 1% AEP event, no runoff is discharged from Treeby Road Lake. We maintained the same outcome at post-development. Some discharge will occur from Catchments 2.4 and 2.5. Note that catchment 2.7 will discharge into basin B2(4) As discussed previously, the structures required to direct the water to the lake will be defined at the UWMP stage.

Former pre-development catchment 3 is smaller at post-development (i.e. catchment 3.1) and therefore provide some mitigation of peak discharges and lowers slightly peak discharges at LPD3 (from 371 l/s to 363 l/s) (**Appendix B**). This slight difference in peak flow rate will provide some leeway to the Anketell South Cell development.

Catchments 7.4 and 7.2 consisting respectively of the community facility and the commercial area will discharge into basins that will discharge into LPD2 to maintain pre-development peak flow rate. The structures required to direct the water to the lake will be defined at the UWMP stage.

The remaining catchments will retain and infiltrate all runoff.

Development of the study area requires modifications to the existing surface elevations and land uses resulting in changes to the existing flow patterns. Increased post development surface water will be managed through the drainage network as described in Section 6.2. All devices are sized to maintain pre-development peak discharges. The alignment of the Peel Sub P Drain is to remain the same ensuring the flow within it supports the hydrologic regimes and maintains ecological habitats. Surface water flow paths, catchment names and basin locations for post development events are shown in **Figure 15**. Event plans for 63%, 18% and 1% AEP events within the LSP area are presented in **Figures 16-18**.

6.4.2 Soak Wells

Soak wells have been sized to capture and retain (at a minimum) the 63% AEP runoff from roof areas to promote at source infiltration within individual lots. A permeability of 2 x 10^{-4}m/s was used for sizing of the soak wells and based on a proposed development density for the site of R20, an average roof area for each lot of 200m² was used for each residence.

A summary of the possible configurations for the site is shown in **Table 13**

Table 13: R20 Soakwell Calculations for the Subject Site

Nominal Diameter (mm)		**1500**	**1500**	**1500**	**1800**	**1800**	**1800**	**1800**	**1800**
Internal Diameter (m) Liner		**1.5**	**1.5**	**1.5**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**
Depth (m)		**0.9**	**1.2**	**1.5**	**0.6**	**0.9**	**1.2**	**1.5**	**1.8**
Allowable Roof Area (m^2)		**107**	**127**	**147**	**117**	**154**	**183**	**212**	**237**
Storm Duration (min)	Rain-Fall (mm/hr)	LOCALITY OF JANDAKOT ROOF/PAVEMENT AREA ABLE TO BE DRAINED BY VARIOUS SIZE SOAKWELLS							
10	44.4	222	294	365	217	320	423	526	629
15	36.2	184	243	301	181	265	350	434	518
20	31.0	164	215	266	162	236	310	384	458
30	24.6	142	185	228	143	205	267	329	391
45	19.3	126	163	200	129	182	235	288	340
60	16.1	118	151	184	123	170	218	265	312
90	12.5	110	139	167	118	159	200	240	281
120	10.4	107	133	158	117	154	191	228	264
240	6.7	107	127	147	126	154	183	212	240
360	5.2	113	130	147	138	163	188	212	237
480	4.3	120	136	151	151	173	196	218	240
600	3.7	128	142	157	164	184	205	225	246
720	3.3	136	149	163	177	196	215	234	253
1080	2.6	159	171	182	213	229	246	262	279
1440	2.1	182	192	203	247	262	277	292	307
1800	1.8	204	214	223	280	294	308	322	336
Soakwells Required		2	2	2	2	2	2	1	1

6.4.3 Detention Structure Configuration

Detention basins are proposed across the Anketell Urban Cell (North and South). A summary of the basin volumes required is included as **Table 14**. The locations of the basins are shown in **Figure 15**.

Detention basins have been designed to have a maximum depth of 1.2m during the major 1% AEP event and to provide adequate freeboard to ensure the integrity of the top of bund (TOB) during a major storm event. Several of the basins have riser type structures to control discharge to predevelopment rates. Swales are to have a maximum depth of 0.5m.

Table 14: Detention Basin Summaries

Basin ID	Ground Level (mAHD)	Basin Surface Area (m2)	Invert Level (mAHD)	Basin Bottom Area (m2)	Max. Groundwater Level (mAHD)	Basin Total Depth (m) (inc. any freeboard)	Storage Depth (m)	Storage Volume (m3) (exc. freeboard)	Infiltration Rate (mm/s)	1% AEP Level (mAHD)	1% AEP Surface Area (m2)	Discharge Details	Freeboard to 1% AEP Level (m)	18% AEP Level (mAHD)	18% AEP Surface Area (m2)	Discharge Details	Freeboard to 18% AEP Level (m)
B2(2/3)	27	2,476	25.8	1,250	16.25	1.2	0.88	1,478	200	26.68	2,108	No discharge	0.32	26.34	1,750	No discharge	0.66
B2(4)	17.8	2,686	17.3	2,100	16.75	0.5	0.47	1,116	200	17.77	2,649	To Treeby Lake, 0.3m diameter pipe,	0.03	17.367	2,174	0 L/s	0.433
B2(5)	20	2,959	18.8	1,600	17 - 18.5	1.2	1.11	2,466	200	19.91	2,843	To Treeby Lake, 0.5m pipe, 383 L/s	0.09	19.44	2,273	0 L/s	0.56
B2(6)	23.5	1,183	22.3	400	19	1.2	0.86	567	200	23.16	919	No discharge	0.34	22.59	551	No discharge	0.91
B3(1)	22	2,581	21.1	1,600	20.5	0.9	0.83	1,700	200	21.93	2,496	To Treeby Lake, 0.3m diameter pipe,	0.07	21.31	1,808	0 L/s	0.69
B3(2)	30.8	1,592	29.6	650	20.25	1.2	0.83	791	200	30.43	1,257	No discharge	0.37	29.83	798	No discharge	0.97
B3(3)	22.5	1,351	21.3	500	20.5	1.2	1.02	865	200	22.32	1,197	To Treeby Lake, 0.3m diameter pipe,	0.18	21.66	712	0 L/s	0.84
B7(4)	28.5	1,509	28.15	1,200	18.5	0.35	0.32	429	200	28.47	1,481	To LPD 2 0.3m diameter pipe 181L/s	0.03	28.3	1,328	41 L/s	0.2
B7(5)	29.4	1,669	28.2	700	19.5	1.2	0.71	707	200	28.99	1,292	No discharge	0.41	28.42	847	No discharge	0.98
B7(6)	26.5	2,300	24.9	1,400	21	1.6	0.54	916	200	25.5	1,991	No discharge	0.2	25.22	1,702	No discharge	0.48

Rain gardens, swale (when applicable) and soakwells will infiltrate rainfall from the 63.2% AEP at source

6.4.4 Detention Basin Outlet Structures and Rain Gardens

Basins and outlet structures have been designed and modelled to achieve a comparable LPD outlet flow with the predevelopment conditions. Surface water volumes and storage requirements were calculated to provide adequate attenuation within the basins. The outlet type, invert and outflow rate for each basin and LPD are given in **Table 14**.

Basins are to be grassed or vegetated with nutrient stripping plants and utilise soil improvement to offer an efficient treatment to surface water flows throughout the development.

Rain gardens will be located at POS entry and be at least 1% of the connected impervious area. Note that basins B2((5) takes most of the POS space; rain-gardens will therefore located along the roads at POS entry but also near house frontage or side to reach the 1% area. This will be discussed in the future UWMP(s). Rain gardens calculations are provided in **Table 15** and details in **Appendix D**.

Table 15: Rain Garden Calculations

Catchment	Catchment Area (m²)	Road Reserve Area (m²)	Inflow Volume (m³)	Inflow Rate (m³/s)	Infiltrated Volume (m³)	Stored Volume (m³)	Garden Area (m²)	2% Area	1% Area	Provided rain-garden area
B2(2)	146,000	47,300	605	0.168	215	391	1562	946	473	473 m2 (i.e. 1% connected impervious area). If 2% required, rain gardens at house frontage and sides (along roads) should be installed
B2(3)	20,000	5,800	74	0.021	26	48	192	116	58	58 m2 (i.e. 1% connected impervious area). There is still POS space if 2% required
B2(4)	93,100	29,600	379	0.105	135	244	978	592	296	373 m2 (>1% connected impervious area). If 2% required, rain gardens at house frontage and sides (along roads) should be installed
B2(5)	156,000	80,900	1036	0.288	368	668	2672	1618	809	404 m2 (<1% connected impervious area). Rain gardens at house frontage and sides (along roads) should be installed to at least the 1%.
B2(6)	29,000	10,200	131	0.036	46	84	337	204	102	143 m2 (>1% connected impervious area). If 2% required, rain gardens at house frontage and sides (along roads) should be installed
B3(1)	106,000	32,800	420	0.117	149	271	1083	656	328	457 m2 (>1% connected impervious area). If 2% required, rain gardens at house frontage and sides (along roads) should be installed
B3(2)	42,600	12,800	164	0.046	58	106	423	256	128	256 m2 (i.e 2% connected impervious area)
B3(3)	48,400	11,100	142	0.039	50	92	367	222	111	127 m2 (>1% connected impervious area). If 2% required, rain gardens at house frontage and sides (along roads) should be installed
B7(2)	46,126	2,882	37	0.010	13	24	95	58	29	Provided in CAT7.6
B7(3)	48,053	15,185	194	0.054	69	125	501	304	152	Provided in CAT7.6
B7(4)	45,600	29,800	381	0.106	135	246	984	596	298	343 m2 (>1% connected impervious area). If 2% required, rain gardens at house frontage and sides (along roads) should be installed
B7(5)	42,000	15,500	198	0.055	70	128	512	310	155	310 m2 (i.e 2% connected impervious area)
B7(6)	17,922	15,065	193	0.054	68	124	498	301	151	428 m2

CONCLUSION OF THE MODELLING: The Jandakot DWMP figures 4.2b & 4.3a (Appendix C) identified the predevelopment discharge rates for each LPD. All post development flows (except for the 63% AEP event at LDP 2) closely meet the predevelopment flows identified in the Jandakot DWMP and will ensure protection of infrastructure downstream of the development and will not inundate the Anketell South proposed development drainage system (**Appendix B**).

6.5 Flood Management

Managing storm runoff aims at preventing and/or minimising the risk of flooding. Road pipe drainage systems typically manage stormwater up to the 18% AEP event while the road reserves are designed to cater for overland flow up to the 1% AEP. The UWMP will further develop these concepts to an engineered design.

6.5.1 Local 63% AEP and 18% AEP Events

- Soakwells will collect and infiltrate roof runoff at source up to the minimum 63% AEP event
- Rain gardens will collect and treat rain fall from 63% AEP from roads
- A road pipe drainage system with leaky manholes will collect and convey flows up to the 18% AEP event, discharging into bioretention pockets and infiltration systems incorporated into the median of the collector roads and within the designated drainage reserves
- Flush kerbing will be implemented to allow sheet flow and reduce pipe lengths and the need for side entry pits where possible
- Bubble-up pits are proposed at the entrance of the bioretention systems where runoff cannot enter as overland flow. These bioretention pockets have been sized to infiltrate/retain up to the 1 year 1 hour AEP event from all connected impervious areas on the site
- The 63% and 18% AEP event plans are included as **Figures 16** and **17** respectively

6.5.2 Local 1% AEP Events

- The road kerb system will convey flows that exceed the capacity of the pipe drainage system in the 1% AEP event, discharging into the proposed detention basins. Detailed design of the drainage system will be undertaken during the UWMP to ensure that adequate freeboard is achieved from the local 1% AEP year event
- The road network provides flood storage as well as conveyance in the 1% AEP storm events
- Minimum habitable floor level to be a minimum 0.5m above 1% AEP flood levels to ensure public safety
- The 1% AEP event plan is included as **Figure 18**

Analysis at UWMP stage of flow velocities will determine scouring protection measures in the development and determine final floor levels to ensure they are minimum 0.5m above flood level. Surface flow velocity and depth checks will also be undertaken to ensure public safety during critical 1% AEP storm events.

6.6 Surface Water Quality Management

The DoW *Jandakot Drainage and Water Management Plan* indicates that the department is currently developing water quality targets and in the interim, treatment trains should be based on the methodology established in the *Stormwater Management Manual for Western Australia*. Surface water quality should be managed through:

- On site retention of 63% AEP event flows in soakwells and rain gardens
- Bioretention systems sized as 2% of the connected impervious areas
- Non-structural measures to reduce applied nutrient loads

6.6.1 Lot Drainage Systems

Whilst lot runoff may contain some gross pollutants, organic matter, sediments, nutrients and other contaminants, these are to be contained and removed by the lot drainage system. Contaminant loads are most effectively reduced by facilitating infiltration by;

- Soakwells to infiltrate clean roof runoff which would otherwise be discharged and come into contact with contaminants
- Lot levels are generally flat which reduces runoff rates and allows more time for the water to infiltrate and inhibits re-suspension of contaminants

The above measures assist in containing pollutants within lots and prevent the contamination of downstream receiving waters. Furthermore, nutrients may be reduced by appropriate use of fertilizers and using plants with a high nutrient uptake. These measures are to be promoted by providing educational material at the point of sale.

6.6.2 Development Drainage System

Surface runoff from roads will be directed through the development via the swale, rain garden, pipe and basin drainage network. The pipe network will convey water up to the 18% AEP event. Recent policies promote stormwater treatment measures that are designed to treat the peak flow from the 63% AEP 1hour event. This would capture most minor and first flush events and will result in treatment of over 98% of the average annual stormwater runoff (DoE, 2004). Where practical, median infiltration/bioretention systems will be incorporated into the road reserve to promote at source infiltration.

To satisfy this requirement all flow from the 63% AEP 1hour event will be retained within the vegetated core of the infiltration basins. Bubble-up pits and side entry pits will be used to direct piped runoff into the vegetated area which efficiently remove sediments and thus aid in further nutrient reductions. In addition, the swales and entry grates will collect gross pollutants.

The swales and detention/infiltration basins are to be vegetated with local native species selected for their ability to take up nutrients as well as contain high PRI materials to aid in phosphorus removal. The landscape design and list of vegetation species will be provided in the UWMP.

In addition to structural controls, maintenance practices are equally important for maintaining the effectiveness of the stormwater quality system. Excessive vegetation should be trimmed and/or removed routinely to promote growth and continual take up of nutrients, including routine removal of sediments and vegetative material (e.g. turf clippings) from the drainage network and road surfaces that would otherwise ultimately end up in the basins. A detailed maintenance plan will be included in the UWMP however the developer is likely to undertake this work until an agreed handover date (or survival rate is achieved) with the local authority is reached.

6.7 Ecological Protection

As the urban landscape changes, increased peak surface water flows rates are generated that potentially impact receiving environments by causing erosion and increasing the period of inundation of vegetation. Management of this risk is essential in maintaining and improving current hydrological regimes and supporting biodiversity across the development. Protection shall be offered to ensure wetlands do not suffer negative impacts from drying out due to diverted surface flows and localised lowering of groundwater table.

As previously identified, predevelopment surface water flows generated in the northern portion of the study area drain to Treeby Road Lake prior to ultimate discharge at the southern LPD. Changes to the urban fabric will essentially increase flows to Treeby Road Lake and alter the current hydrological regime. Consultation with the authors of the *Wetland Management Strategy*, Anketell Central Precinct (Lots 13 & 100 Treeby Road) assisted in developing a flow management strategy that did not adversely affect the hydrology and ecology of Treeby Road Lake. The objectives of this management strategy consisted of:

- Ensuring the maximum depth of the lake does not increase by more than 10%
- Maximising infiltration of runoff to ensure the lake continues to be fed by groundwater
- Allowing the large ARI events to continue to enter the lake

Outlet structures of the detention basins have been designed such that the low flow culverts will discharge to either the pipe drainage network, or as overland flow into the Peel Sub P Drain. This satisfies the requirements that the small ARI events (<5 year) do not enter the lake.

Whilst it is acknowledged that directing water to the lake will change its current hydrology, the lake being replenished with water from large storm events will improve its inundation periods that have reduced due to the drying climate. Peak water levels in the lake will be controlled through its connectivity with the Peel Sub P Drain at Thomas road by the outlet structures.

As discussed in Section 4.2.2, a wetland management strategy has been developed for the Treeby Road Lake. For more details, please refer to *Wetland Management Strategy, Anketell Central Precinct (Lots 13 & 100 Treeby Road)*, prepared by Endemic (March 2010).

6.8 Disease Water Vector and Nuisance Insects Management

Mosquitoes breed in standing water in natural and man-made wetlands, as well as a range of water bodies and storage containers in urban environments. They can breed in fresh, brackish and saline water conditions and different mosquito species have different habitat requirements. To reduce health risks from mosquitoes, retention and detention systems are designed to ensure that between the month of November and May, detained stormwater is fully infiltrated in a time period not exceeding 96 hours.

The most effective mosquito management programs are integrated programs, involving more than just the application of chemicals to kill larval or adult mosquitoes. Appropriate land use planning is crucial for achieving adequate buffers between wetlands and residential and recreational land uses.

Direct methods, including physical control (such as source reduction by filling, draining or removing breeding sites, screening rainwater tanks, wearing protective clothing), biological control (such as adding fish to ponds), chemical control (the use of pesticides to kill mosquitoes and the use of personal repellents) and cultural control (such as planning outdoor activities to avoid mosquito activity times, or building screened outdoor living areas) are also important components of an integrated mosquito management program. Application of pesticides for mosquito control must be in accordance with the product label. Environmental approval may be required if mosquito management actions are to be undertaken in conservation areas.

7.0 Groundwater Management Strategy

Groundwater, much like surface water, must be assessed to show compatibility with planning policies for Western Australia and the City. The key groundwater strategy objectives are;

- Protection of infrastructure and assets from flooding and inundation by high seasonal groundwater levels, perching and soil moisture rise
- Management and minimisation of changes in groundwater levels during and following development
- Maintain and, if possible, improve groundwater quality during and post development
- Protection of groundwater dependent ecosystems from the impacts of urban runoff

7.1 Groundwater Levels

The groundwater levels are to be maintained at predevelopment levels by ensuring that runoff is infiltrated close to source for frequently occurring rainfall events. Discharge into receiving water bodies is to be restricted to predevelopment flows to ensure that potential groundwater recharge is maximised. A combination of WSUD techniques such as soakwells, rain gardens, swales and infiltration basins will offset declining ground water levels in the region and supplement any irrigation requirements.

Perched groundwater was identified in localised areas and shows interconnectedness within the shallow aquifer. Depth to perched groundwater is generally 1.5m and possibly recharges Treeby Road and Sandy Lakes. The average depth of groundwater at the site is adequate for the efficient application of soakwells. Imported and local free draining fill material will be used to ensure adequate separation between surface levels and groundwater to ensure effective infiltration in drainage areas.

Groundwater levels across the site are generally greater than 1.5m and sub soil drainage is not required. Bulk earthworks across the site will also increase the separation to groundwater. Applying a subsoil drains can affect the local groundwater dependent ecosystems and alter the hydrological regimes of receiving water bodies and will be avoided.

Infiltration structures will not intersect ground water and invert levels must be minimum 0.5m above AAMGL and will empty within the required 96hrs between May and November.

7.1.1 Groundwater During Construction

Groundwater levels are impacted on by construction activities i.e. localised drawdown from dewatering activities. With current depth to groundwater, the import of fill material and staged project works, there will not be equirement for deep excavation requiring dewatering.

7.1.2 Other Effects on Groundwater Level

Vegetation in the study area transpires water from both surface and ground resources and can be relied on as an efficient way of locally managing the groundwater levels. Leaves intercept rainfall and release water vapor whilst providing a large surface area for evaporation. Therefore the leaf area index (LAI) is an important feature when selecting plantings i.e. plants with large leaf surface areas. The root system is also fundamental to water uptake. The depth of water usually predicts how far the roots will "reach" to find water. Shallow rooted grasses thrive on shallow water tables and deep rooted vegetation have a further reach to deep groundwater. Owing to the high seasonal fluctuations of groundwater level on the development, a variety of root depth plants should be selected (20% deep rooted) i.e. grasses and native deep rooted perennial species.

7.2 Groundwater Quality

Downstream water regimes will receive surface water runoff and ground water that originate at the development. It is important that the quality of the water entering downstream receiving waters is comparable to the pre-development environment, including upstream ground water, and where possible improved such that the development does not trigger assessment levels and does not contribute to a decline in water quality.

Groundwater quality characteristics will be assessed against the Guideline Values from ANZECC ARMCANZ (former Ministerial Councils Australian and New Zealand Environment and Conservation Council & Agriculture and Resources Management Council of Australia and New Zealand) and The Department of Health. The Guideline Values represent the target values for groundwater quality for both short and long term in healthy environments.

Groundwater quality will be improved by the use of structural and non structural control BMPs to achieve target outcomes. This document aims to encourage infiltration at source where possible. This infiltrated water will enter underlying ground waters and may ultimately emerge and/or discharge further downstream in surface waters, such Sandy Lake. Whilst the soil profile may treat the infiltrated water and remove some nutrients through natural process, the use of PRI amended soils should be investigated in the UWMP. The locations of possible sources of nutrients are the swales and basins, POS areas, gardens and lot soakwells. The following measures can be implemented to ensure that the infiltrating water is treated to an acceptable water quality.

7.2.1 Basins

The vegetation species should be native, have a high nutrient uptake and should be able to survive in dry conditions. Vegetation should be trimmed and/or harvested routinely to encourage growth and nutrient uptake. Storage chambers and bubble-up pits, road medians and basins should be cleaned routinely to remove gross pollutants and sediments as they may contain

nutrients and other contaminants. Basins lso to have high PRI material incorporated to aid in uptake of phosphorus.

7.2.2 POS

The POS areas will enhance the local environment by utilising native vegetation consistent with the local setting and minimum turf requirements (subject to fire management). Whilst natural vegetation will not require fertilisers, turf areas will. The amount of fertilisers can be reduced by using soils with high phosphorus retention capacities and using species with low water and nutrient requirements such as *Cynodon dactylon*, *Cynodon x, Cynodon transvaalensis, Paspalum vaginatum, Stenotaphrum secundatum* or *Pennisetum clandestinum* (Water Corporation, 2008).

7.2.3 Gardens

Owing to relatively dense development (range between R20 and R60) coupled with the latest trends in contemporary house designs, there is generally a decrease in the availability of gardens areas reducing the potential uptake of nutrients by vegetation. Where possible, the use of native vegetation and nutrient retaining soils in gardens, coupled with the responsible use of fertilisers should be encouraged. Information on garden fertiliser management shall be offered to residents by developers as a non-structural BMP to improve groundwater quality.

7.2.4 Lot Soak Wells

Soak wells receive direct clean high quality runoff from roofs with potential for storage and later use in and around the building. Roof runoff will be infiltrated by soakwells for frequently occurring events and recharge local groundwater (see Section 6 for soakwell requirements)

7.3 Groundwater Allocation

Increasing development and climate change have increased demand pressures on water resources. It is particularly relevant to Perth where a substantial portion of the potable water supply is derived from groundwater which, as a result of development and declining rainfall has experienced decreased replenishment. There is continual pressure on development to consider reductions in potable water consumption by replacing scheme water with non-potable water.

As per the Department of Water's Water Register there are currently 8 licences with 13 draw points registered across the Anketell North Urban Cell (**Table 16**). Total water allocation per annum is 326,700kL (see Figure 19). All allocation is from the Jandakot Mound 1. Irrigation is required over portions of the POS and school zones totalling 8ha and requiring approximately 60000kL based on a groundwater used for POS irrigation being restricted to no more than 7500kl/ha/year as per DoW requirements. This figure is likely to be a lot less as deductions of POS areas for basins have not been made.

Table 16: Groundwater Licences for the LSP Area

GWL Licence	Lot	Aquifer	Subarea	Allocation (kl/yr)	Drawpoint number	Expiry
GWL180329	Lot 30	Superficial	Jandakot Mound 1	68,000	2	19-12-24
GWL101078	Lot 32	Superficial	Jandakot Mound 1	10,350	2	06-06-26
GWL48228	Lot 34	Superficial	Jandakot Mound 1	19,950	1	05-05-26
GWL160839	Lot 100	Superficial	Jandakot Mound 1	8,000	1	27-11-26
GWL160331	Lot 38	Superficial	Jandakot Mound 1	30,000	1	01-03-26
GWL179454	Lot 39	Superficial	Jandakot Mound 1	61,150	2	10-12-24
GWL58529	Lot 41	Superficial	Jandakot Mound 1	9,200	2	19-02-27
GWL 48225	Lot 90	Superficial	Jandakot Mound 1	120,050	2	23-02-24

8.0 Subdivision and UWMP

This report aims to manage the study area following guidance from the Better Urban Water Management framework. To progress the application for subdivision an Urban Water Management Plan (UWMP) will be prepared. The main areas which require further investigation at UWMP stage include, but are not limited to:

- Continued compliance with the CoK and DoW design objectives and criteria
- Geotechnical investigation including an ASS soil exclusion assessment and management plan (if required)
- Determine the Phosphorus Retention Index (PRI) of the soils where swales and/or basins are to be constructed
- Detailed earthworks and stormwater management design including the size, location and design of public open space areas and integrated flood management capability
- The above investigations shall be used to refine the XP-Storm model to determine specifications of water storage, basin capacity, road drainage networks, roadside swales, off site discharge and associated scour protection
- Development of proposed WSUD elements to detail implementation
- Ascertain final non-structural water quality improvement measures and treatment trains to be implemented at a minimum of 1% of the connected impervious surface area
- The landscape management plan is to be developed to include aspects of water conservation strategies and stormwater management including the retention of existing vegetation
- Applications for a groundwater abstraction license should be lodged to secure irrigation water for the POS and well as for dust suppression and construction requirements as soon as possible to ensure water requirements are met
- Detailed monitoring and evaluation programs, targets for surface water quality, flows and levels that are to be maintained post development
- Construction management and management of subdivisional works (to ensure no impact on regional conservation areas, management of soil treatment, dewatering, dust, hazardous materials and waste)
- Ongoing management and maintenance requirements including the roles and responsibilities of each stakeholder including funding and maintenance arrangements
- Monitoring to provide updated data on groundwater level and quality. This will start upon approval of the LWMS.
- Sampling at discharge points to provide surface water quality results. This will start upon approval of the LWMS.

9.0 Monitoring Program

A pre and post development monitoring programme and contingency plan is designed to allow a qualitative assessment of water in the drainage catchment in line with the requirements set out regionally. The developer is to negotiate the monitoring programme with a suitably qualified and experienced provider of water sampling and analysis.

9.1 Pre Development Monitoring

JDA Consultant Hydrologists undertook initial groundwater and surface water predevelopment monitoring in May 2005- August 2007 (Appendix A). VDM Consulting continued the investigation with the installation of 9 monitoring bores and subsequent monitoring from October 2009-January 2010. Surface water across the study area and within the Peel Sub P Drain was not available for analysis during any of the monitoring periods. As discussed previously, in the absence of water quality data, surface water quality should be managed through:

- On site retention of 63% AEPI event flows
- Bioretention systems sized as 2% of the connected impervious areas, and
- Non-structural measures to reduce applied nutrient loads

9.2 Post Development Ground and Surface Water Monitoring

The objectives of post development monitoring centre on the potential impacts of the storm water management measures, such as infiltration and treatment of runoff water in soakwells, swales and detention basins, on ground water levels and surface and ground water quality within the development as well as on the downstream receiving environments. As such it is a specific objective that nutrient levels should not be increased as a result of urban development, and ideally should decrease after development.

9.2.1 Groundwater

Ground water levels are to be measured by means of a electronic ground water level dipper prior to purging for sampling quarterly, as well as in the months of September, October and November to capture peak groundwater levels. Parameters and trigger values are given in Tables 18 and 19. Triggers are to be set at median background value determined from pre development monitoring with the annual median parameter value determined from 4 sampling events per year to compare to the trigger value. Long term targets are set to ANZECC & ARMCANZ (2000) guidelines.

9.2.3 Surface Water

Surface water monitoring is to occur at the LPD at Thomas road, the entry of the PSPD into the site, and the drainage outlet from Sandy Lake. Monitoring is to occur on a quarterly basis and after first flush rains in May or June. Data loggers will be used at the LPD and Sandy lake to monitor flows and a gauge board is to be installed at Sandy Lake. Samples are to be taken if water is available. Parameters and trigger values are given in **Tables 17** and **18**.

9.2.4 Water Quality

Ground water samples, following purging at least five borehole volumes, are to be obtained by means of submersible pump for detailed laboratory analysis. An accredited laboratory is to be consulted to ensure that ground and surface water samples are taken, handled, packaged, stored, transported and delivered with an appropriately completed chain of custody, using the correct labels, container type with sufficient volume, preserved (if required), and to facilitate scheduling of laboratory analysis within stipulated holding times. Equipment used in the sampling process is to be decontaminated using Decon 90, a phosphate free detergent, followed by rinsing with laboratory grade distilled water on arrival at site and between sampling locations to reduce the risk of cross contamination.

Table 17: Monitoring Requirements

<table>
<tr><th>Monitoring</th><th>Locations/Sampling Sites</th><th>Sampling Frequency</th><th>Field Parameter</th><th>Laboratory Parameter</th></tr>
<tr><td>Ground Water</td><td>Existing monitoring bores: refer Figure 8</td><td>Quarterly: Jan, Apr, Jul and Oct
In addition: Sep, Oct and Nov: peak ground water level</td><td rowspan="2">Ground Water Levels Surface flows (record estimate)
In situ water quality: pH, EC, DO, Turbidity</td><td rowspan="2">Nutrients: TP, FRP, TN, TKN, NH4, NO_3 and NO_2.</td></tr>
<tr><td>Surface Water</td><td>Legal point of discharge (Thomas Road culverts) and at the entry point of the Peel Sub P Drain into the site.
Drainage controls: Outlets at Sandy Lake</td><td>Quarterly: Jan, Apr, Jul and Oct
In addition: May or Jun first flush</td></tr>
<tr><td colspan="5">a1: water column nutrient concentrations and chlorophyll a shall be included for laboratory testing as an indication of the effectiveness of the drainage design to manage water quality impacts and off-site losses, and diffuse nutrient sources from catchment land use and runoff.</td></tr>
<tr><td colspan="5">Monitoring of the Acid Sulfate Soils Management Plan and Section 5C Dewatering Licence.</td></tr>
<tr><td colspan="5">Additional parameters to be monitored during surface and storm water management include:
visual inspection (at end of summer before first flush and after winter) of stormwater management system and controls for erosion and debris and sediment built-up;
vegetation and erosion in POS; and
availability of water wise information and materials (water efficient fittings and appliances and gardens) to prospective buyers.</td></tr>
<tr><td colspan="5">Review (and reporting to the CoK): six monthly (summer and winter) for 5 years immediately following development to ensure baseline conditions are not worsened by the development.</td></tr>
<tr><td colspan="5">Laboratory analyses are to be undertaken by a certified National Association of Testing Authorities (NATA) accredited laboratory. Sampling is to be undertaken in accordance with Australian Standard AS/NZS 5667 series of water-quality-sampling guidance. Ground water sampling is to be undertaken in accordance with Australian Standard AS/NZS 5667.11:1998.</td></tr>
</table>

Table 18: Trigger Values

Parameter	Trigger Value
Nutrients	Surface Water Total Suspended Solids: measured as Turbidity: <5NTU. Total Phosphorous: 0.1mg/L. Total Nitrogen: 1.0mg/L. Ground Water (Monitoring locations to be established in UWMP) Total Phosphorous: No deterioration in median bore value; Total Nitrogen: No deterioration in median bore value;
Trigger values have been set, taking due cognizance of the ambient concentrations reported thus far, in accordance with the Healthy Rivers Action Plan (SRT, 2008), the Australian Drinking Water Guidelines (ANZECC, 2000), the Assessment Levels for Soil, Sediment and Water (DEC, 2003) and the Department of Health Reporting on Contaminated Sites Reporting Guideline for Chemicals in Ground Water.	

9.3 Reporting

Reporting in a structure and format, to be agreed with the CoK and DWER, will be the responsibility of the developer. Reports for review by the CoK and DoW will compare monitoring results with target design and performance criteria to ascertain what, if any, further actions may be required, and will provide ongoing assessment of the suitability of monitoring and reporting plans and frequencies. Where a trigger value for contingency action has been reached, a more detailed report on the occurrence, its impact and proposed action to prevent recurrence is to be compiled.

Six monthly reviews of ground water levels and surface and ground water quality (summer and winter) are required post development. In addition, monitoring and reporting outcomes will be used to continually improve the proposed WSUD and amend, if necessary, the design for subsequent stages of development.

9.4 Contingency Plan

If in the assessment of performance compliance observational or analytical deviations are observed, an iterative approach shall be taken to ascertain the most appropriate contingency and/or remedial action to be taken. Where monitoring parameters reach and/or exceed trigger values, appropriate contingency actions as required will be initiated by further investigation such as additional sampling and analyses, or other as appropriate, to determine whether the breach:

- Is genuine, outside the natural variability of the parameter and signifies a real decline or is simply an isolated occurrence.
- May have been caused by external events.
- Was caused by failure of structural BMPs provided during sub-division works.

- Caused an impact on the local and downstream receiving environment together with an assessment of the impact.

The following contingency measures, in consultation with relevant authority, will address the majority of physical deteriorations that may occur:

- Identify/locate the source of water quality deterioration and remove/replace as appropriate. Prevent continuing deterioration with temporary controls.
- Remove/replace/repair existing structural control, provide/construct additional controls or modify/alter controls/procedures to prevent further and/or future deterioration in water quality.
- If, subsequent to the above deterioration in water quality continues, construction/operation management and maintenance plans and practices are to be revised and altered/modified if required.

The final monitoring program and actions to assess the hydrological impacts of developing the site, water quality triggers, reporting structures and formats and contingency plans are to be agreed with the CoK and DWER during the UWMP

10.0 Implementation Plan

10.1 Developer Commitments

The developer is committed to deliver the UWMP, in consultation with the CoK and DWER, and to subsequently develop detailed engineering designs for subdivision application.

10.2 Roles/Responsibilities and Funding

The key stakeholders are:

- Developer: Mammoth Nominees Pty Ltd and Well Holdings Pty Ltd and other land owners
- Department of Water
- City of Kwinana
- Water Corporation

Their roles, responsibilities and funding are summarised below:

Table 19: Key Stakeholders and Responsibilities

Organisation	Role/Responsibility	Funding
City of Kwinana	Assumes future long term responsibility for roads and storm water infrastructure including the ongoing operation and maintenance thereof subsequent to agreed handover by the developer.	Rates
Water Corporation	Assumes future responsibility for the potable water supply and sewerage infrastructure including the ongoing operations and maintenance thereof.	Rates
Developer: Mammoth Nominees Pty Ltd and Well Holdings Pty Ltd and other land owners.	Obtain approval of the UWMP over subject site Implement approved Acid Sulphate Soils and Dewatering Management Plans, and Taking Water and Disposal Licences during construction of subdivision works. Demonstrate that the proposed subdivision designs supportive of the UWMP can achieve the water quantity and quality objectives and criteria set by this document. Undertake post development monitoring, including the provision of appropriate monitoring locations, for a period of 2 years following sale of the last lot within the development. Utilise monitoring data to amend or provide BMPs to ensure that water quality objectives are achieved. Construct and subsequently maintain stormwater control measures until handover to the CoK.	Developer

10.3 Review

Subdivision approvals require a UWMP (largely an extension of the LWMS) to provide the detail to concepts included in this document, and implemented in the detailed engineering design and construction of the proposed development.

In addition to the above and in the event of non-completion of construction activities within 10 years of approval being granted then the local water management strategy will require review ensuring the contents remains relevant allowing updates to be made. The design objectives shall be revised to ensure that targets are consistently met. Similar boundaries shall be maintained to ensure the proposed development meets the specific drainage plan and that calculations achieve their intended targets and arising problems can be easily identified. The review shall be undertaken by competent persons and cover, but not be limited to, the following:

- Impacts of the development
- Design objectives
- Water management strategies
- Receiving water body management including the health of dependent ecosystems

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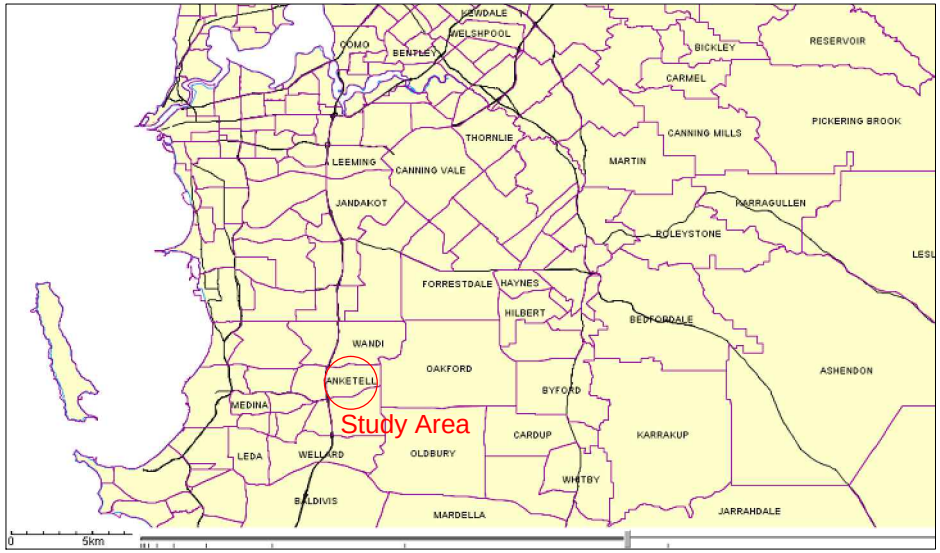
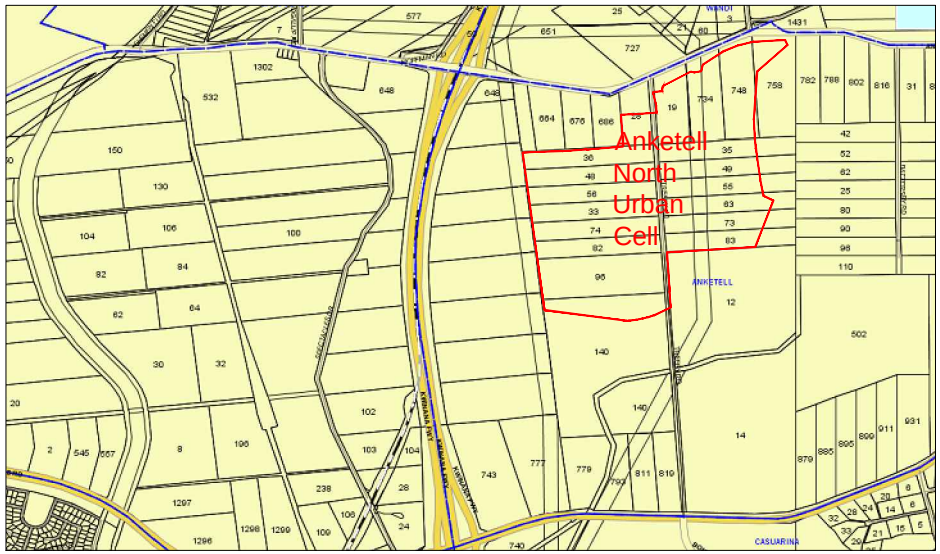
Figures





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Data Source: WA Atlas, Perth Groundwater Atlas & Nearmaps

Bioscience Pty Ltd

Anketell North Urban Cell, City of Kwinana,Perth, WA

Local Water Management Strategy
30/11/2018

Figure 1: Location Plan

FIGURE 2. LSP

LEGEND

LOCAL SCHEME

LOCAL SCHEME RESERVES

- Parks And Recreation / Drainage

PUBLIC PURPOSES

- Community Facility
- Primary School

ZONES

- Residential R20
- Residential R25
- Residential R30
- Residential R40
- Service Commercial

OTHER

- Primary Distributor
- Integrator B
- Neighbourhood Connector B
- Major Access Street
- Structure Plan Amendment Boundary
- Western Power Easement
- Mrs Rural Water Protection Zone Boundary

0m 50 100 150m

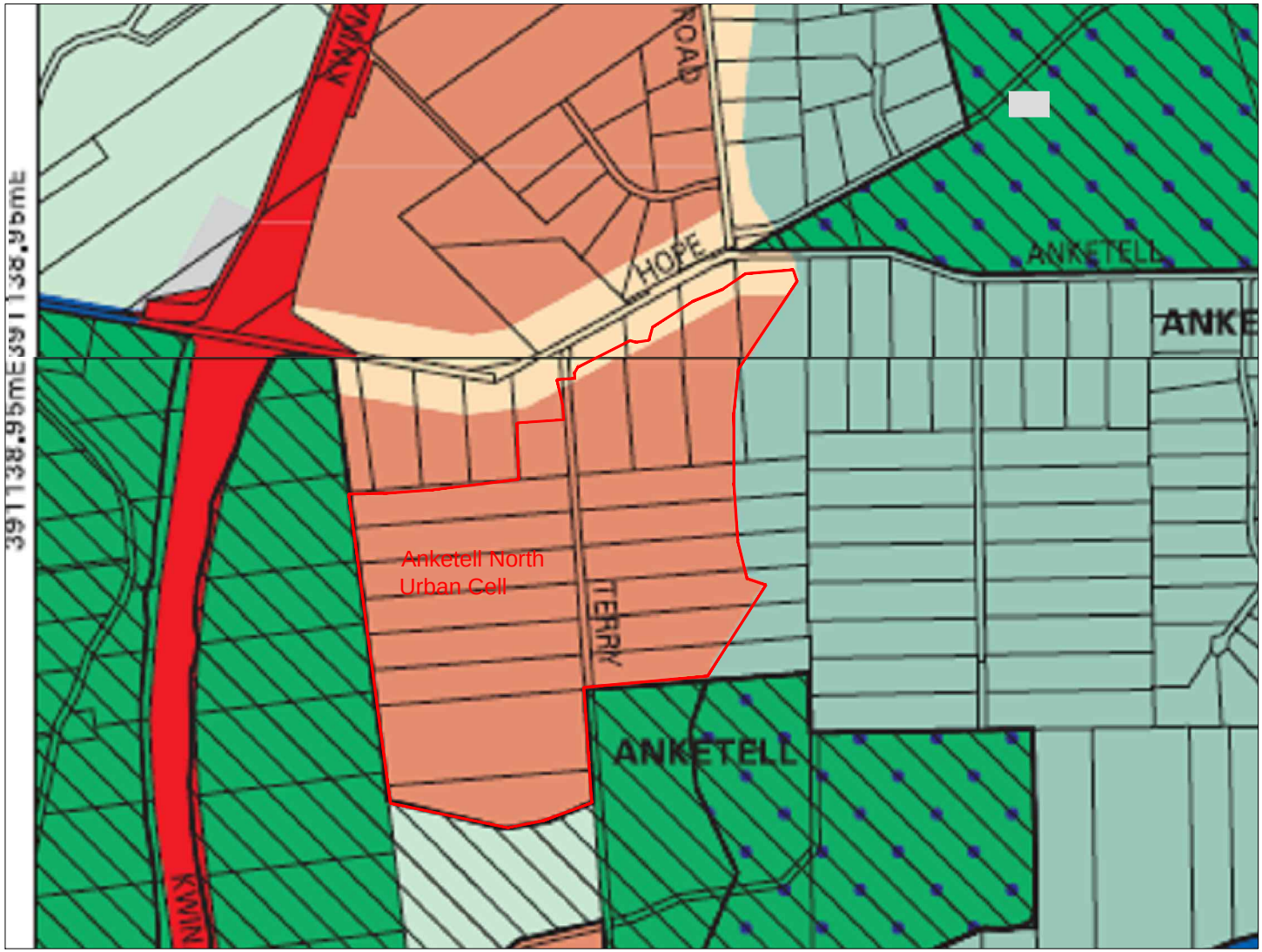
LYON ROAD

ANKETELL ROAD

AREA SUBJECT TO SEPARATE STRUCTURE PLAN APPROVALS

TREEBY ROAD

9002 9002 9003 9002 652 188 189 4 7 89 90 30 31 32 33 34 35 36 37 38 39 40 41 12 9000



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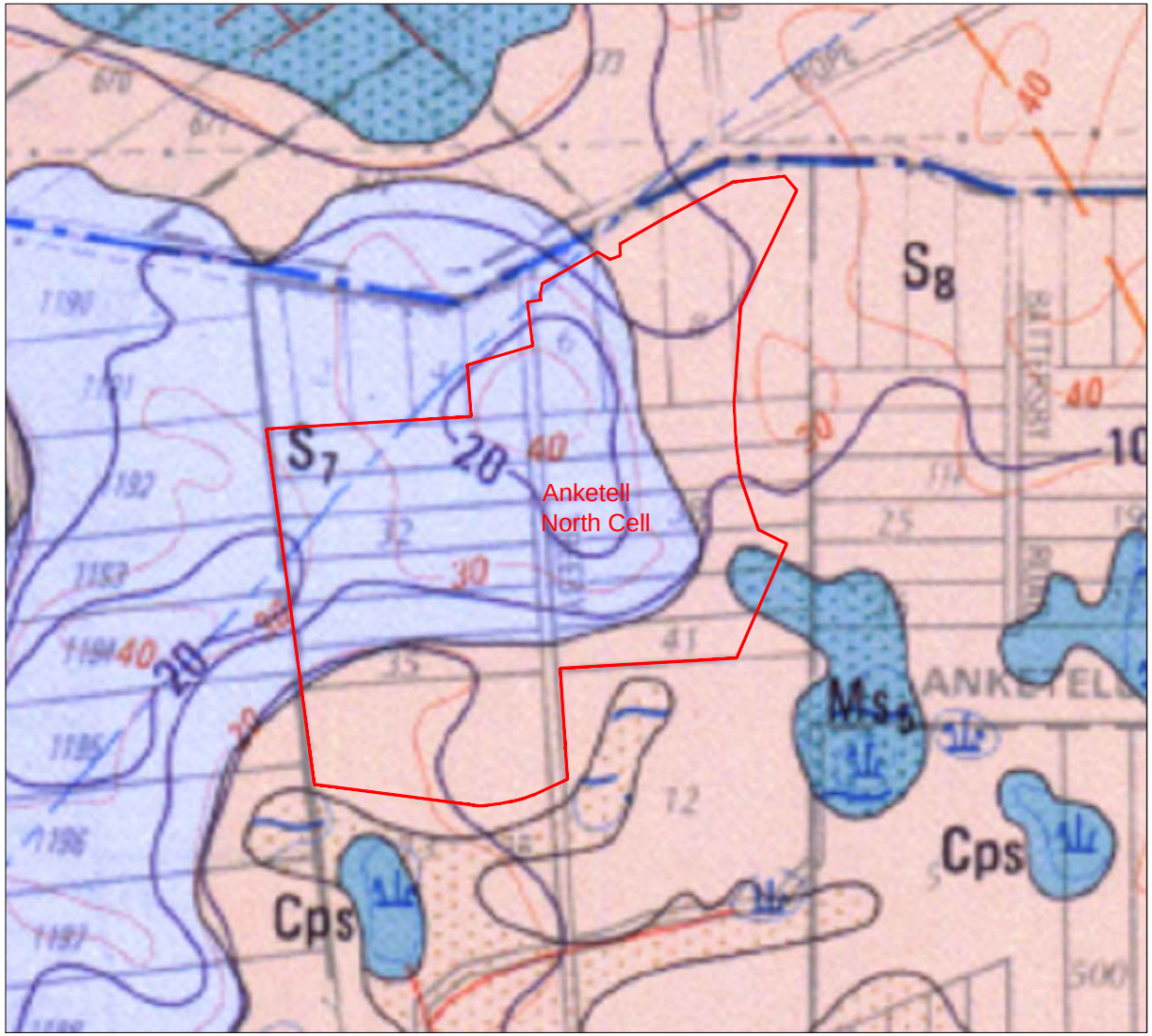
Local Water Management Strategy
30/11/2018

Figure 3: Metropolitan Region Scheme Maps 24 & 28



ARMADALE
GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

S8 - SAND - white to pale grey, yellow at depth, fine to medium grained, moderately sorted, subangular to rounded, frequent heavy minerals, of eolian origin

S10 - SAND - as S8 over sandy clay to clayey sand of Guildford Formation, of eolian origin

S7 - SAND - pale yellowish brown, medium to coarse grained sub-angular quartz, trace of feldspar, moderately sorted, of residual origin

MS5 - SANDY SILT - dark, brownish grey silt, with disseminated fine grained quartz sand, firm, variable clay content, of Lacustrine origin

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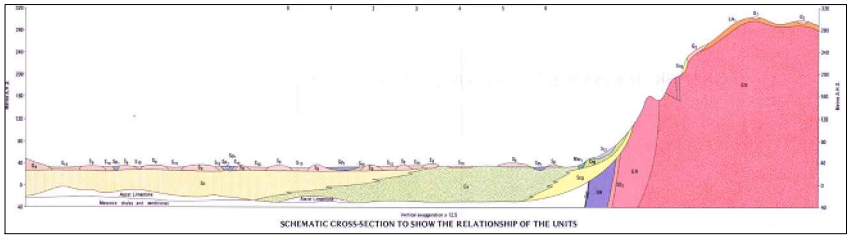
SCHEMATIC CROSS-SECTION TO SHOW THE RELATIONSHIP OF THE UNITS

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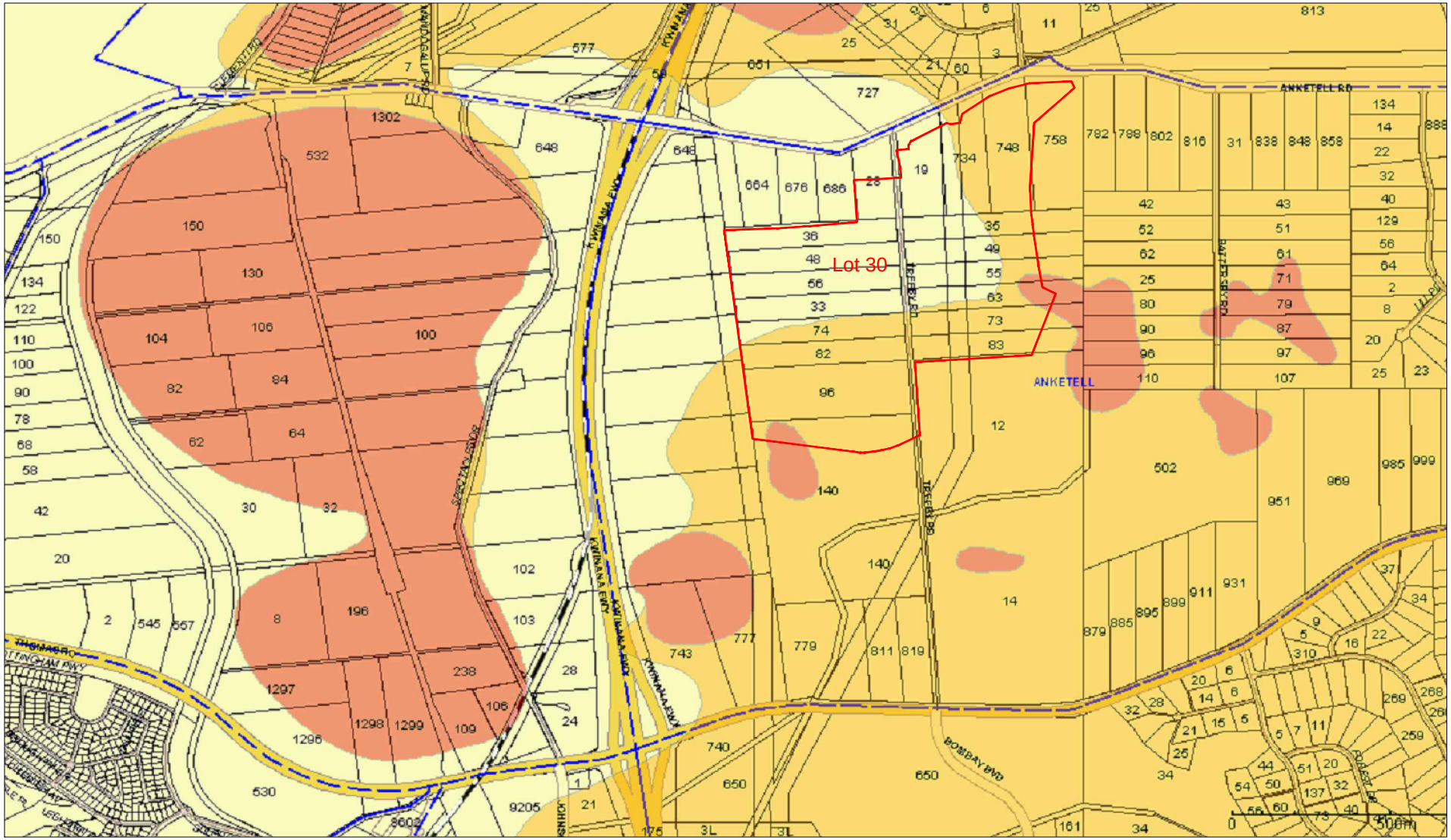
Figure 4: Fremantle & Armadale Geological Survey Maps



High risk of ASS

Moderate to low risk of ASS

Low risk of ASS

Data Source: WA Atlas

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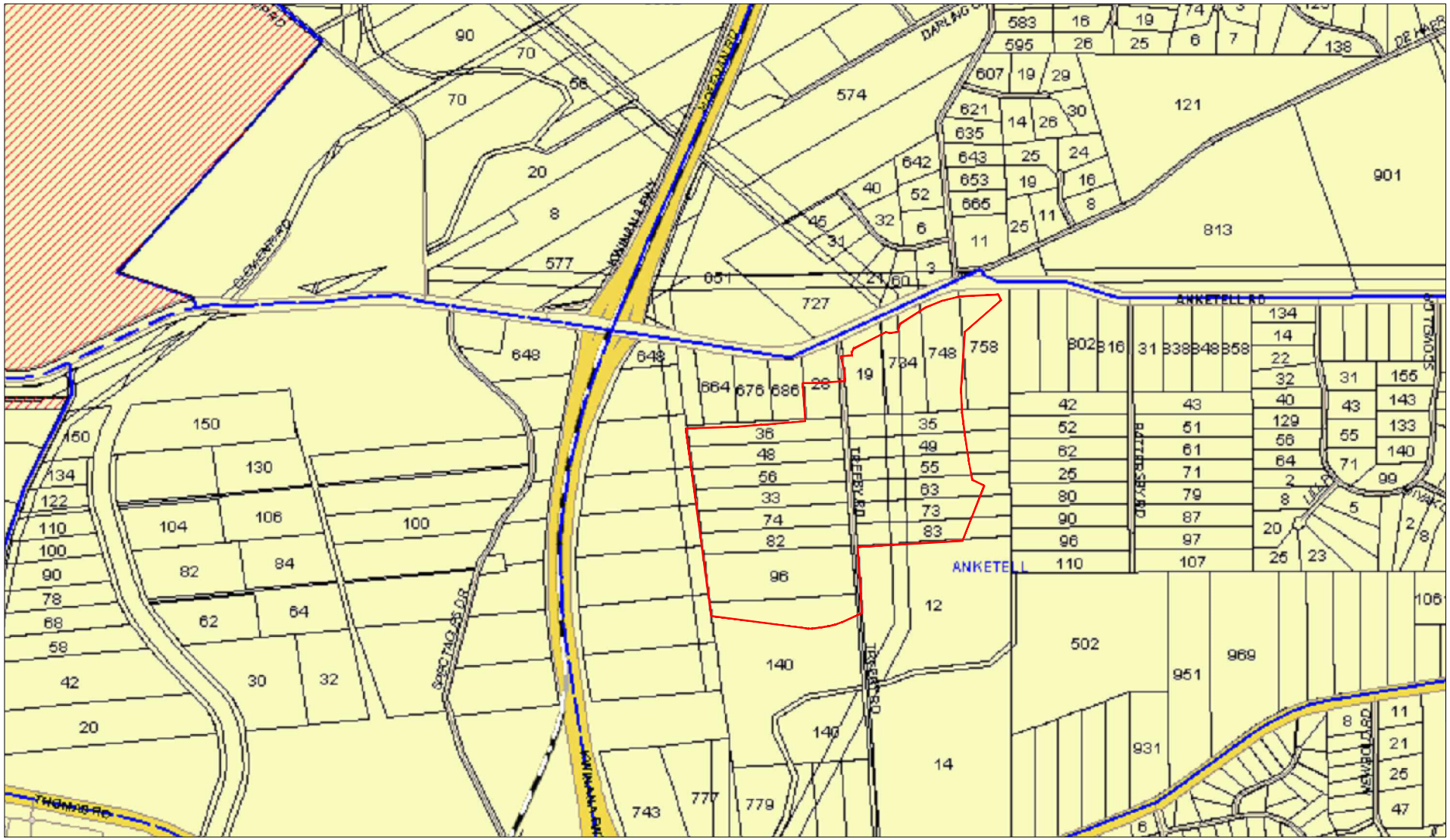
Figure 5: Acid Sulfate Soil Risk Map



Contaminated Site

Data Source: WA Atlas

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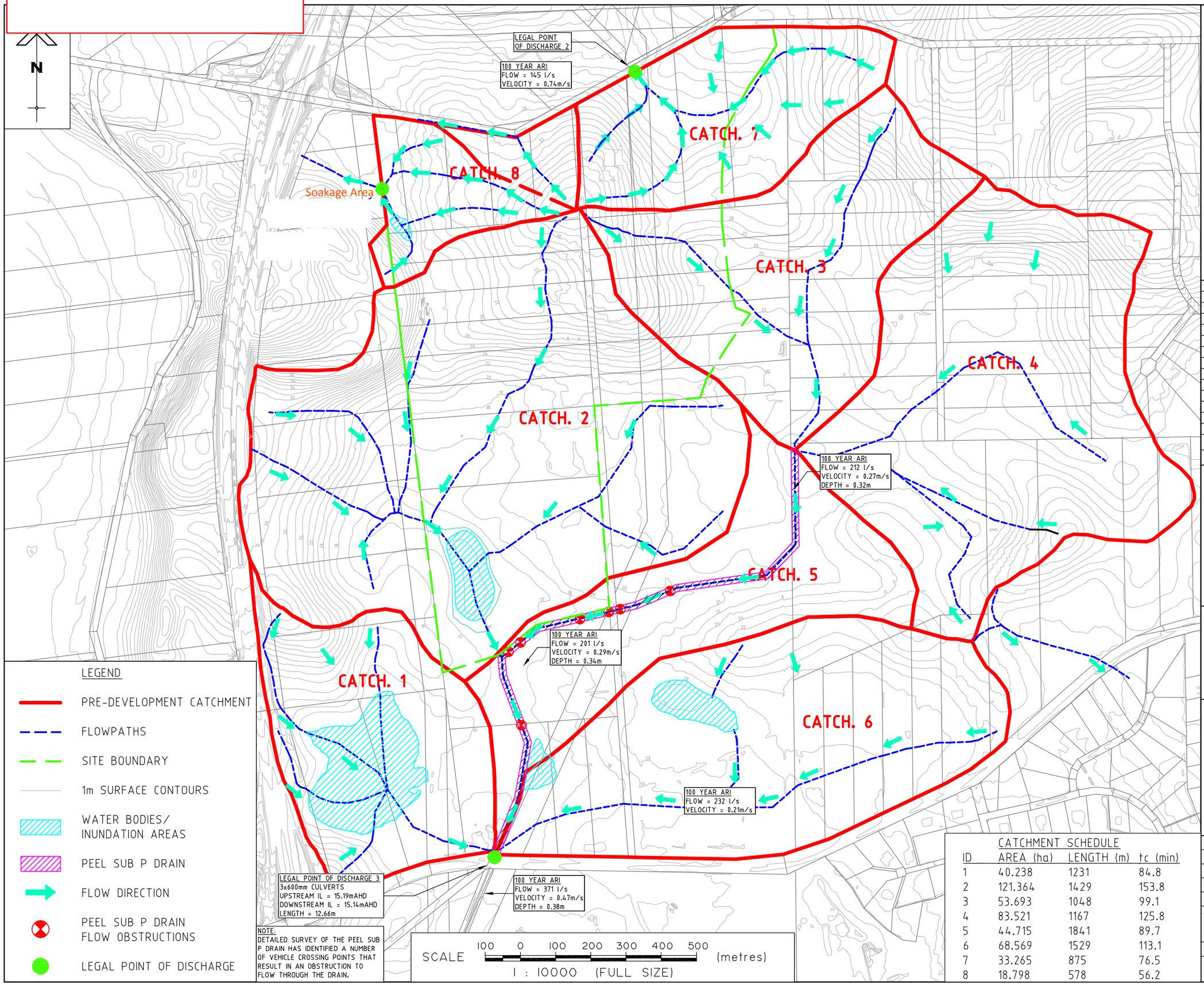
Local Water Management Strategy
30/11/2018

Figure 6: Contaminated Sites

FIGURE 7.



ANKETELL NORTH CELL

LOTS 30-41, 100, 188, 189
& PART LOT 13 TREEBY RD
& LOTS 2-4, 7, 89, 90 & 652
THOMAS ROAD, ANKETELL

FOR

MAMMOTH NOMINEES PTY LTD
& WELL HOLDINGS PTY LTD

REV.	DESCRIPTION	APPR.	DATE
A	FOR APPROVAL	MC	14.04.10

REVISIONS

CATCHMENT SCHEDULE

ID	AREA (ha)	LENGTH (m)	tc (min)
1	40.238	1231	84.8
2	121.364	1429	153.8
3	53.693	1048	99.1
4	83.521	1167	125.8
5	44.715	1841	89.7
6	68.569	1529	113.1
7	33.265	875	76.5
8	18.798	578	56.2

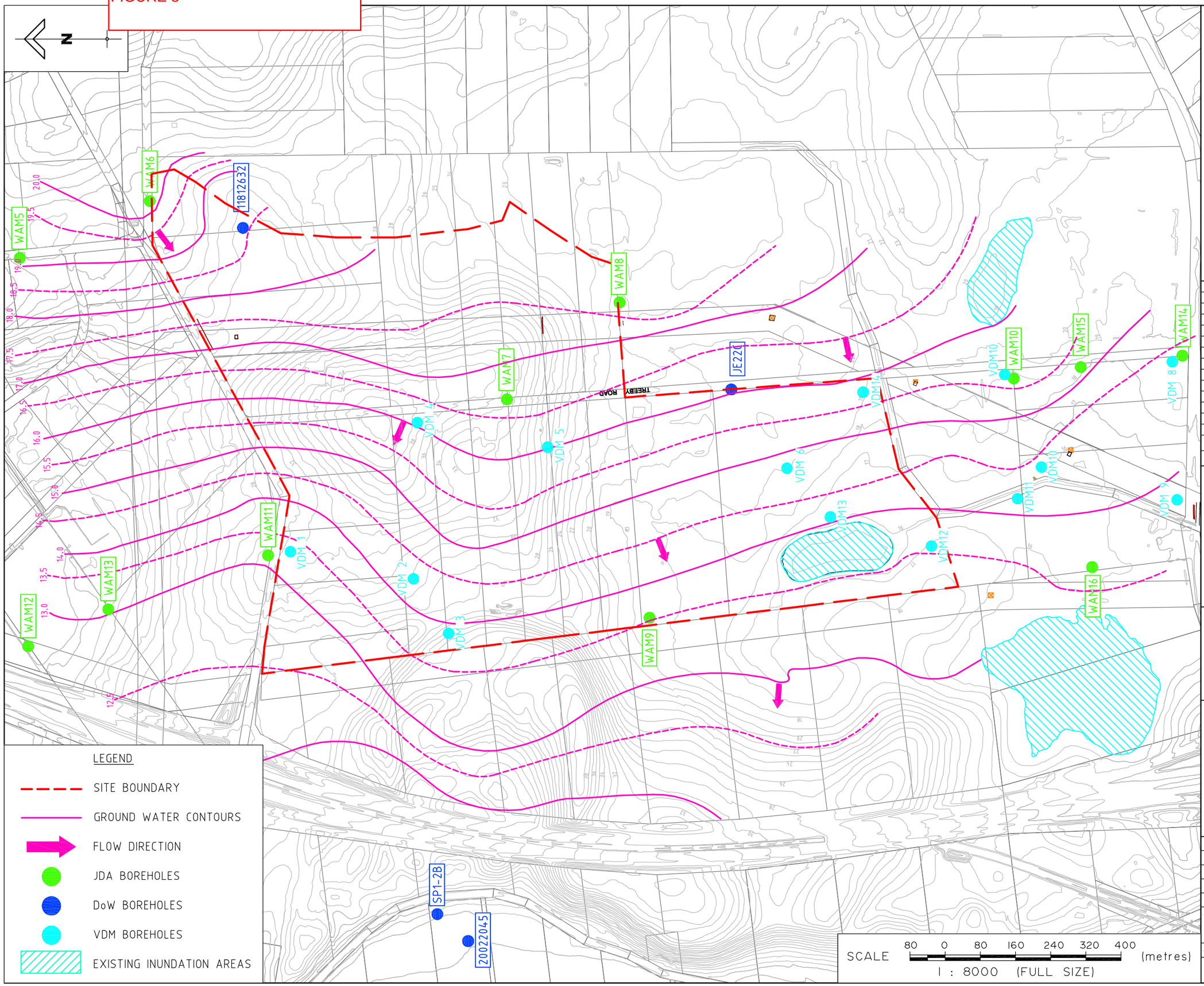
VDM CONSULTING
310 Selby Street North
Osborne Park WA 6017
Phone +61 8 9241 1800
Fax +61 8 9241 1999
Email environmental@vdmgroup.com.au

DRAWING TITLE :

FIGURE 7
PRE-DEVELOPMENT CATCHMENT
& SURFACE WATER PLAN

DEVEL. APPLIC. No. :	DATE : 14.04.10
PROJECT LEADER : MATT CURTIS	
DESIGNER : AJAY SINGH	
DRAFTSPERSON : AJAY SINGH	
CHECKED : STEVEN CHAMBERLAIN	
APPROVED FOR AND ON BEHALF OF VDM CONSULTING PVT.LTD.	
R.P.E.Q. No. :	
SCALE : 1:10000	DATUM : / FULL SIZE : A3
PROJECT No.: 09-0435	DRAWING No. : N240 / REVISION : A

FIGURE 8



ANKETELL NORTH CELL

LOTS 30-41, 100, 188, 189
& PART LOT 13 TREEBY RD
& LOTS 2-4, 7, 89, 90 & 652
THOMAS ROAD, ANKETELL

FOR

MAMMOTH NOMINEES PTY LTD
& WELL HOLDINGS PTY LTD

REV.	DESCRIPTION	APPR.	DATE
A	FOR APPROVAL	SC	19.04.10

REVISIONS

VDM CONSULTING

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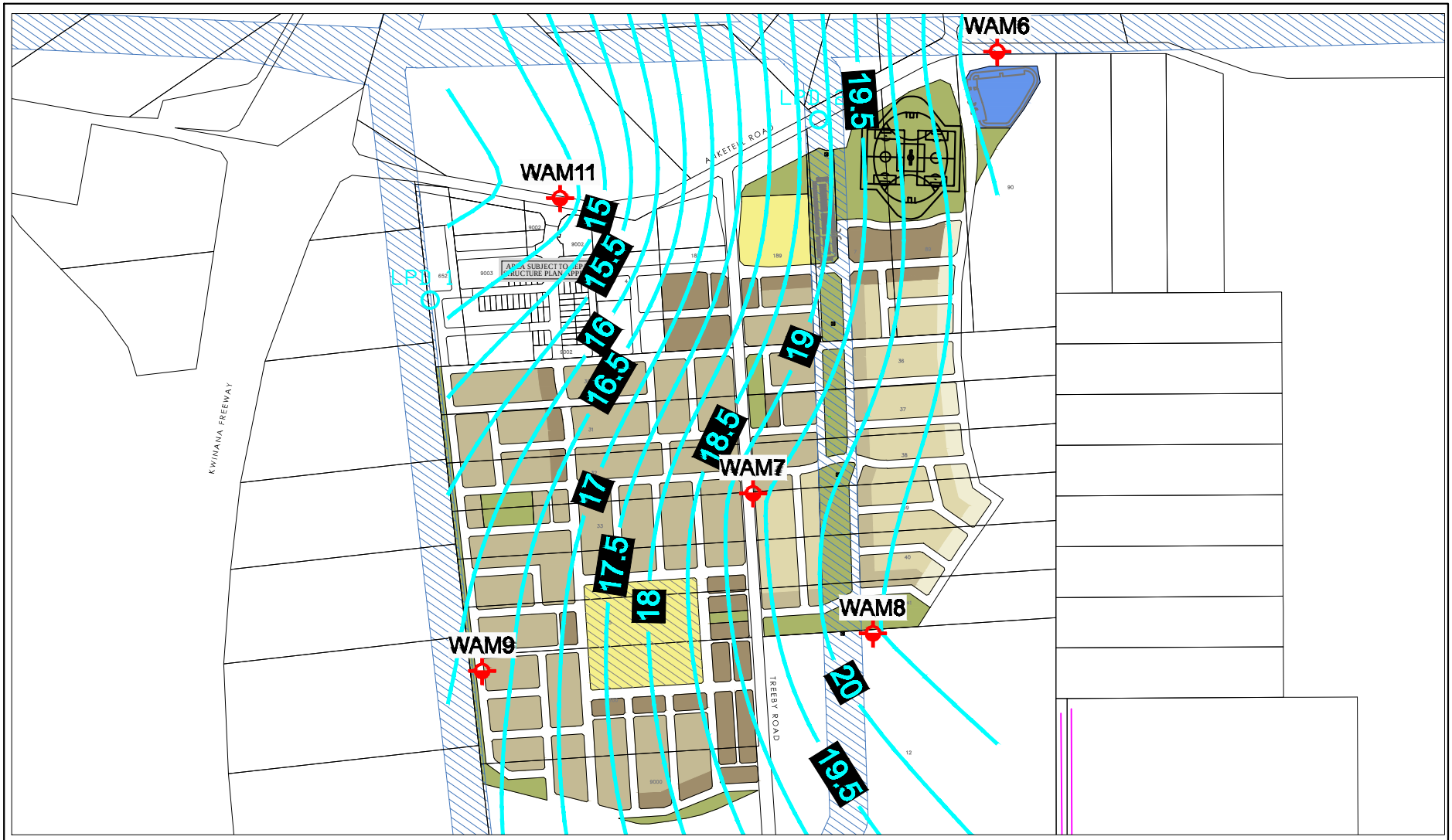
Osborne Park WA 6017
Phone +61 8 9241 1800
Fax +61 8 9241 1999
Email environmental@vdmgroup.com.au

DRAWING TITLE :

FIGURE 8
ESTIMATED MINIMUM GROUNDWATER LEVELS

DEVEL. APPLIC. No. :	DATE : 19.04.10
PROJECT LEADER : MATT CURTIS	
DESIGNER : EDGARDO ALARCON LEON	
DRAFTSPERSON : STEVEN CHAMBERLAIN	
CHECKED : EDGARDO ALARCON LEON	
APPROVED FOR AND ON BEHALF OF VDM CONSULTING	
CPEng. No. :	

SCALE : 1:8000	DATUM :	FULL SIZE : A3
PROJECT No.: 09-0435	DRAWING No. : N900	REVISION : A



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WEBSITE: www.biosciencewa.com

Data Source: Client supplied drawings and calculations

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24/05/2019

Figure 9: Calculated MGL Contours (0.5 mAHD interval)

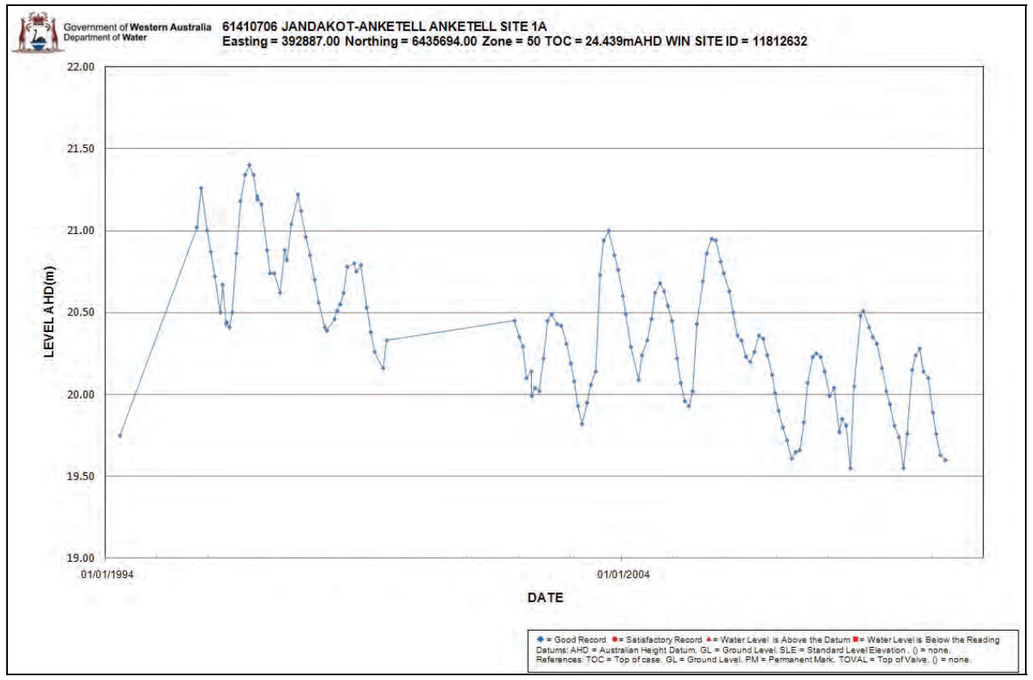


Figure 10 Groundwater Level Monitoring Plot – DoW Bore 11812632

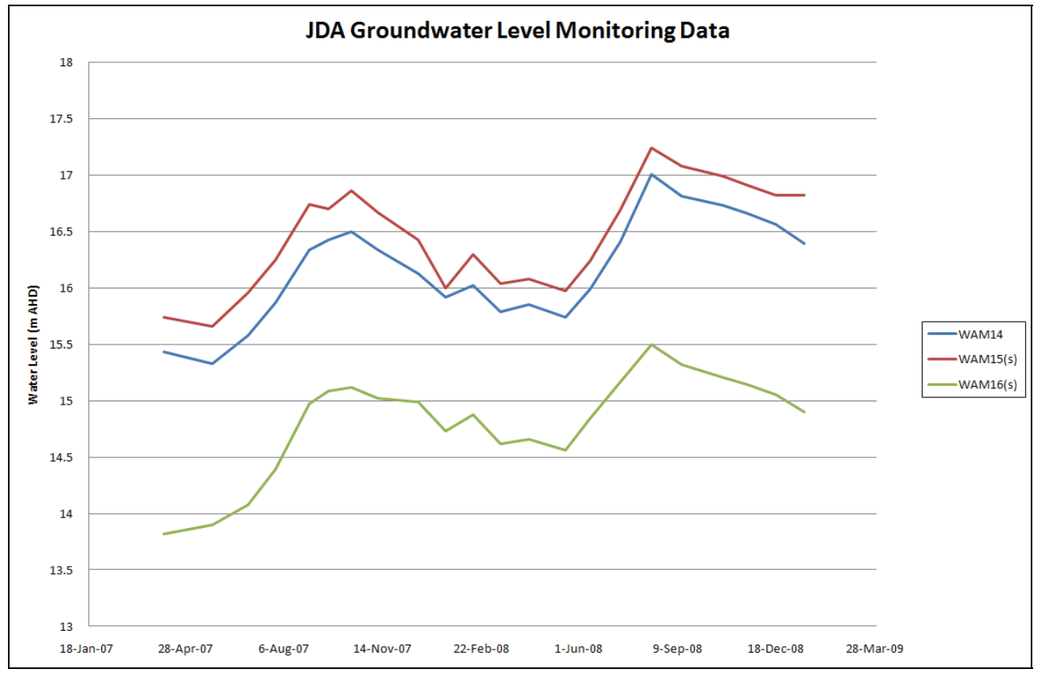


Figure 11 Groundwater Level Monitoring Plot – JDA Bore WAM14-16

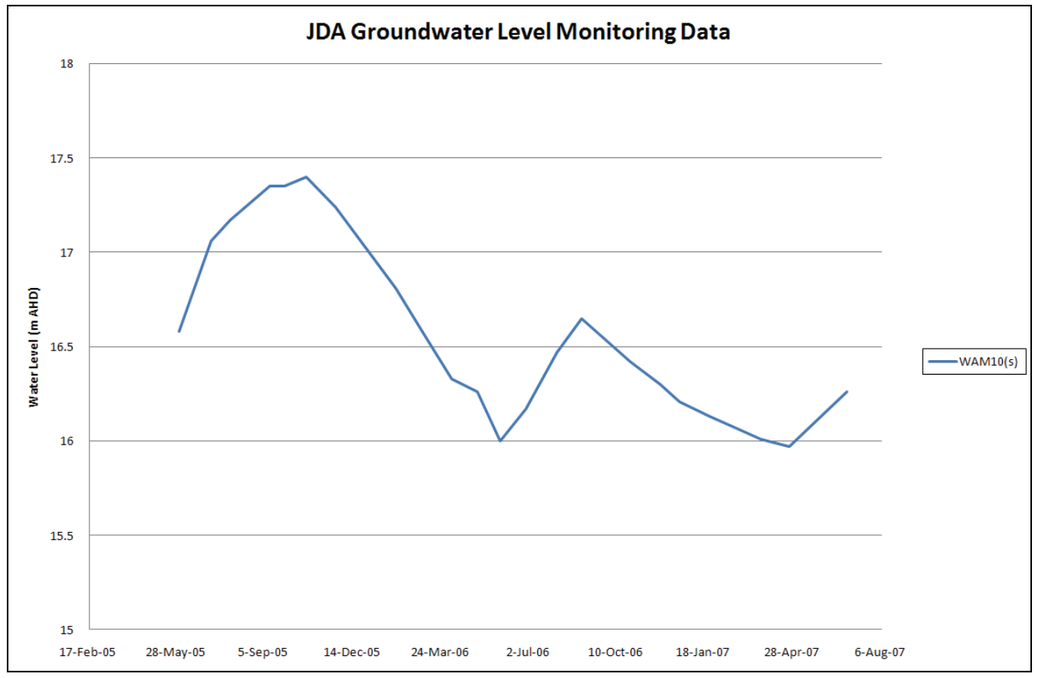


Figure 12 Groundwater Level Monitoring Plot – JDA Bore WAM10

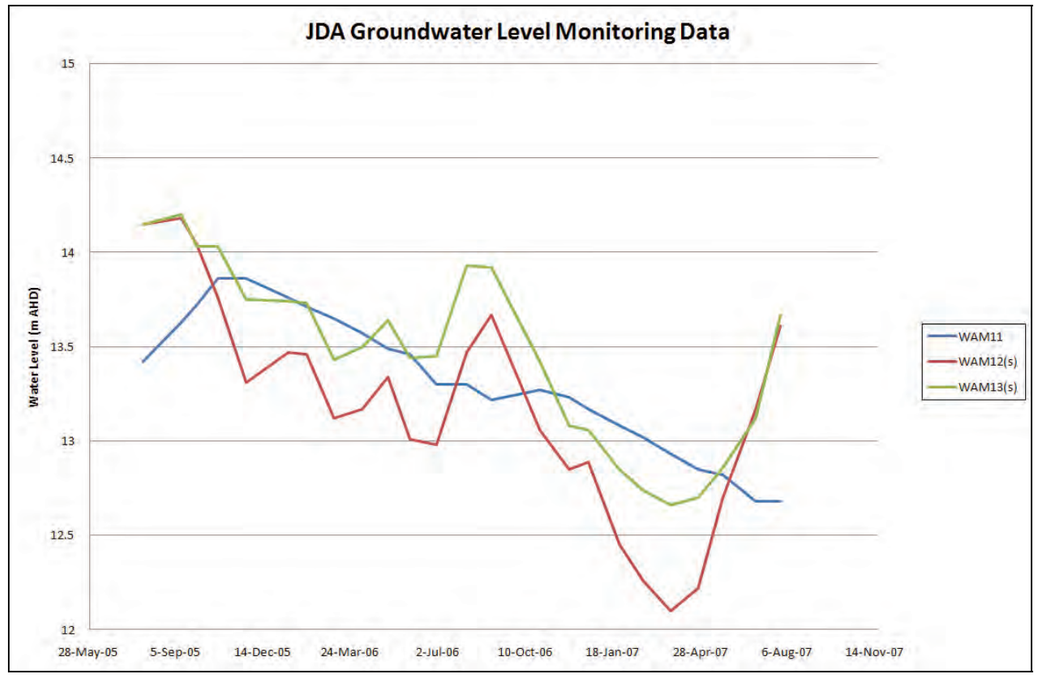
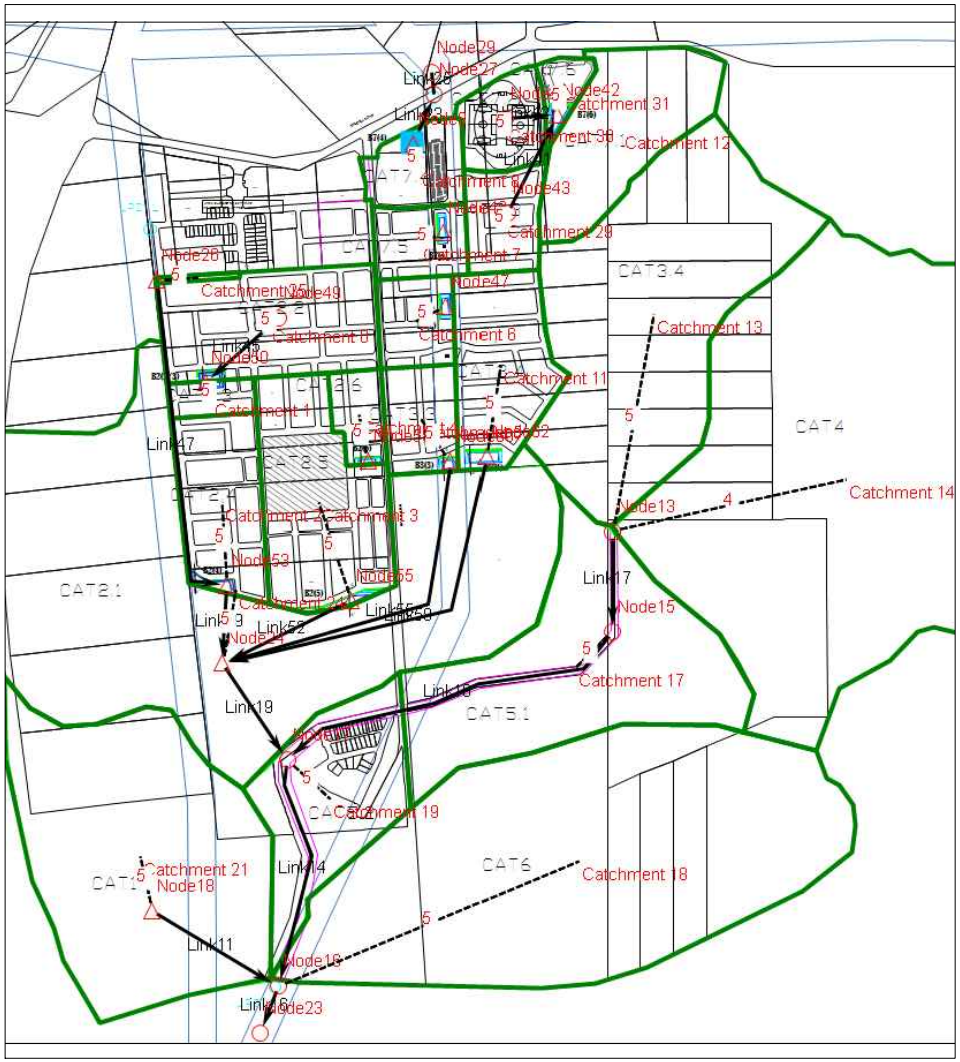
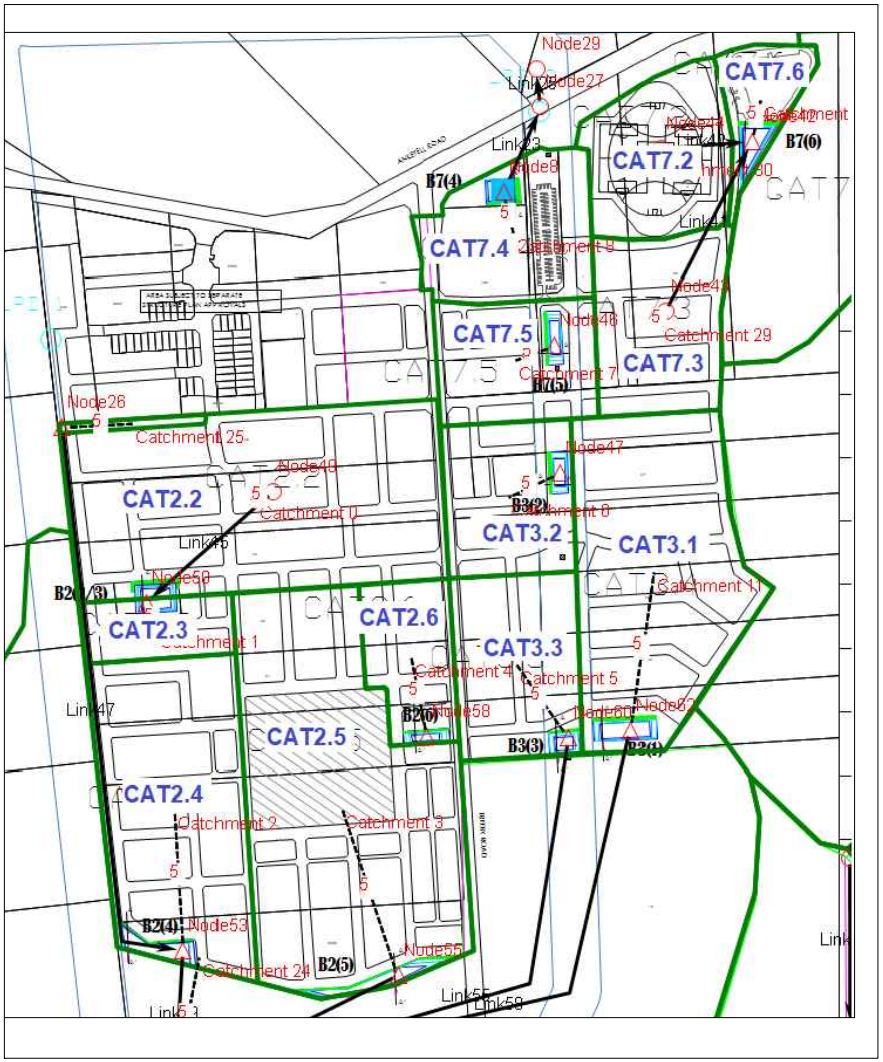


Figure 13 Groundwater Level Monitoring Plot – JDA Bore WAM11-13





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Catchment Boundary & Number

Modelled Water Flow Direction

Modelled Storage Basin

Modelled Node

Data Source: Bioscience XP Model

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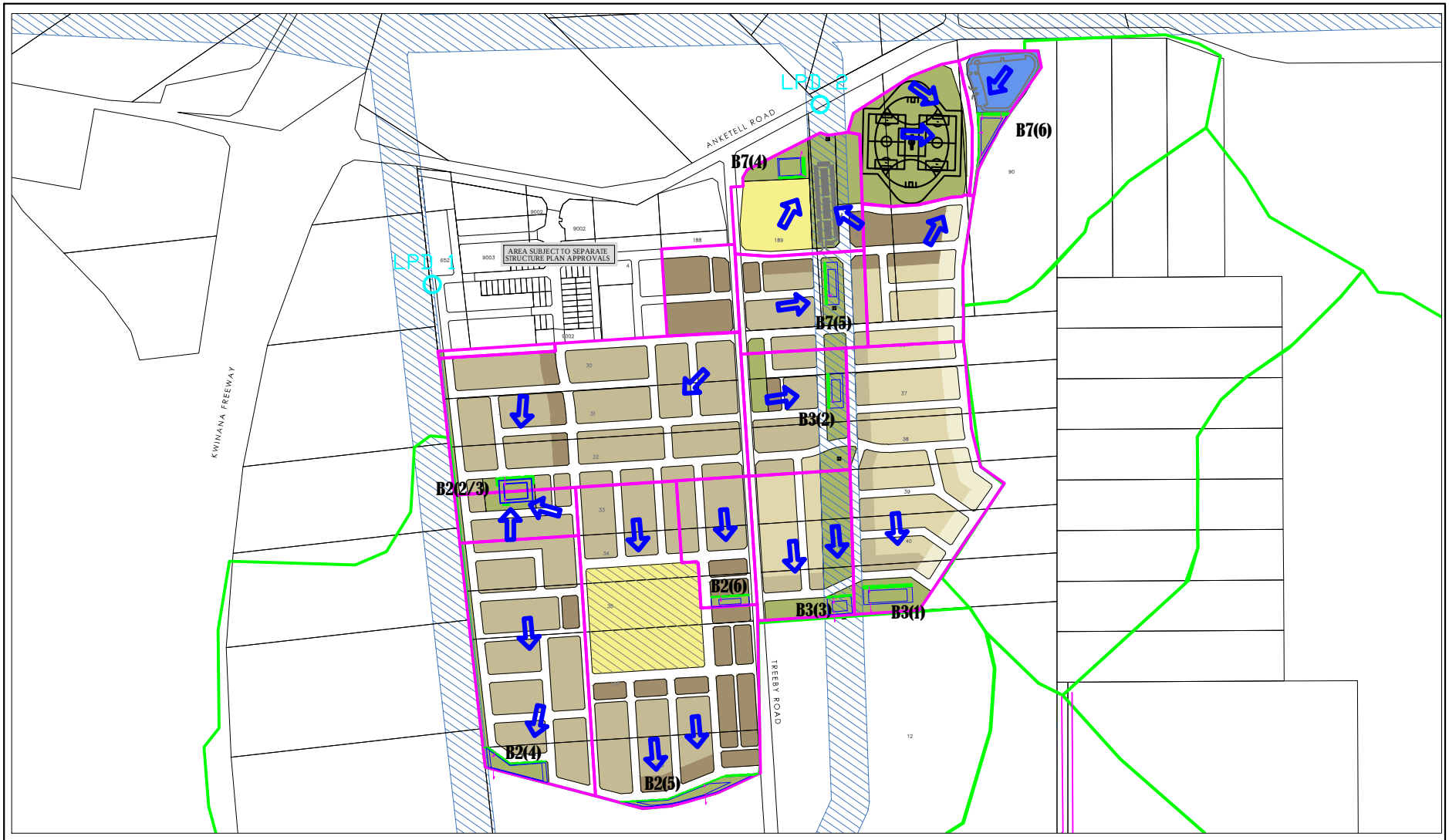
29/05/2019

Figure 14: Sub-Catchments in XP Model



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WEBSITE: www.biosciencewa.com

Catchment Boundary & Number

Surface Water Flow Direction

Storage Basins (e.g. B2(5) means BAsin NAme)

POS (also include swale, western boundary strip)

Rain gardens at POS entry

Data Source: Client supplied drawings

Bioscience Pty Ltd

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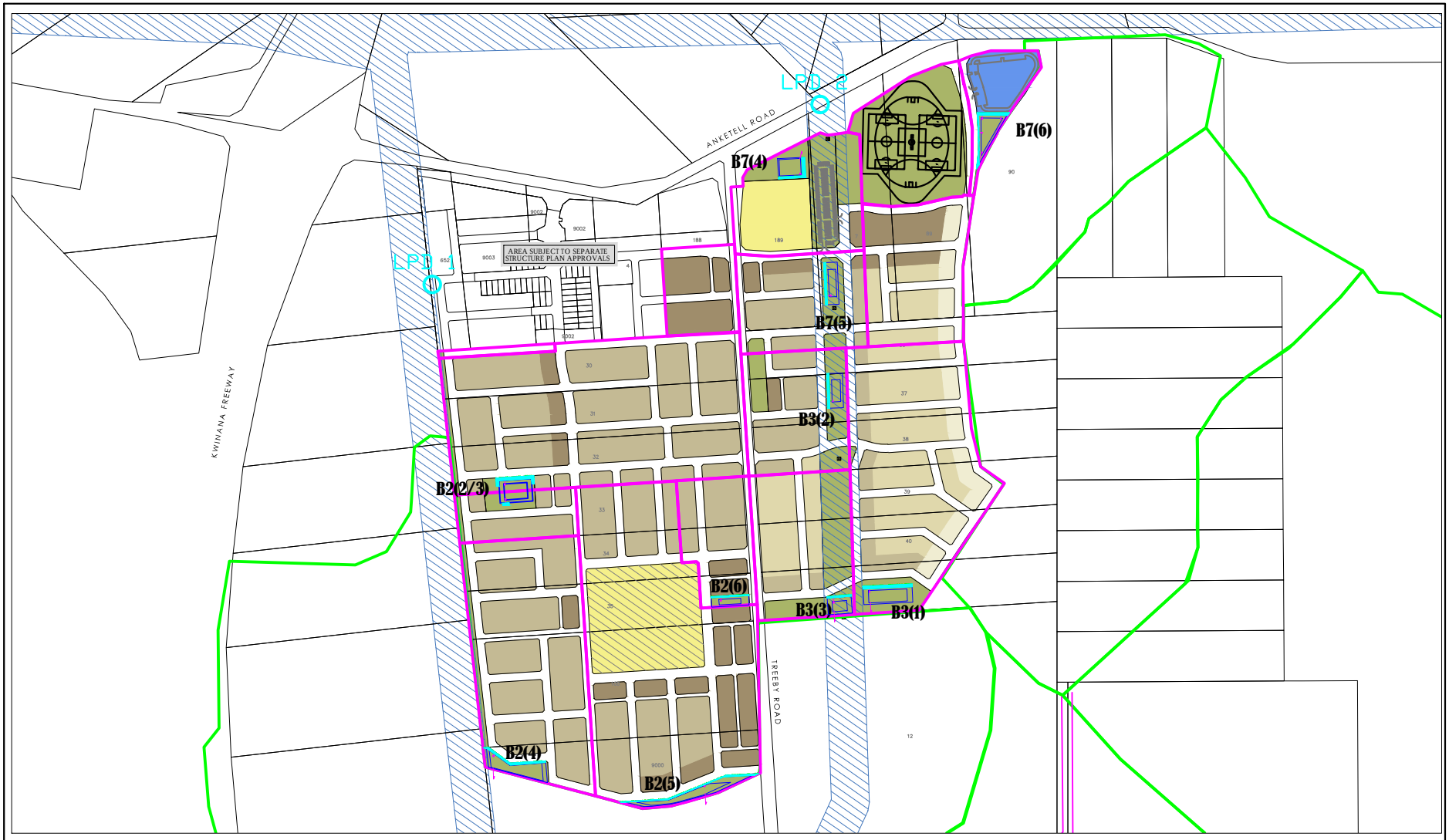
Local Water Management Strategy
24/05/2019

Figure 15: Surface Water Runoff Post-Development and Basin Locations



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WEBSITE: www.biosciencewa.com

Catchment Boundary & Number

Surface Water Flow Direction

Storage Basins (e.g. B2(5) means BAsin NAme)

Inundated Area

Rain gardens at POS entry

Data Source: Client supplied drawings

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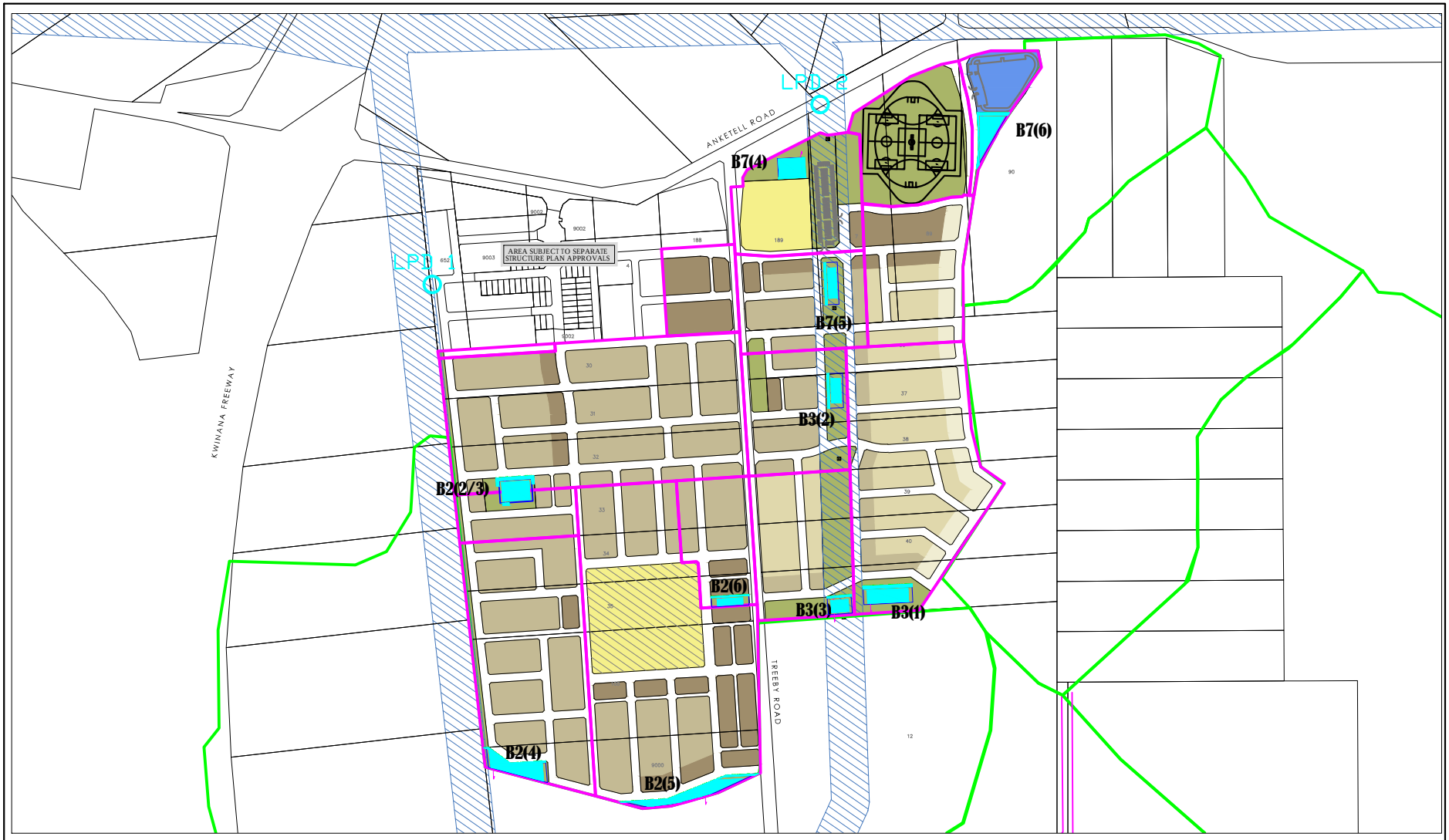
Local Water Management Strategy
24/05/2019

Figure 16: 63% AEP Event Plan



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WEBSITE: www.biosciencewa.com

Catchment Boundary & Number

Surface Water Flow Direction

Storage Basins (e.g. B2(5) means BAsin NAme)

Inundated Area

Rain gardens at POS entry

Data Source: Client supplied drawings

Bioscience Pty Ltd

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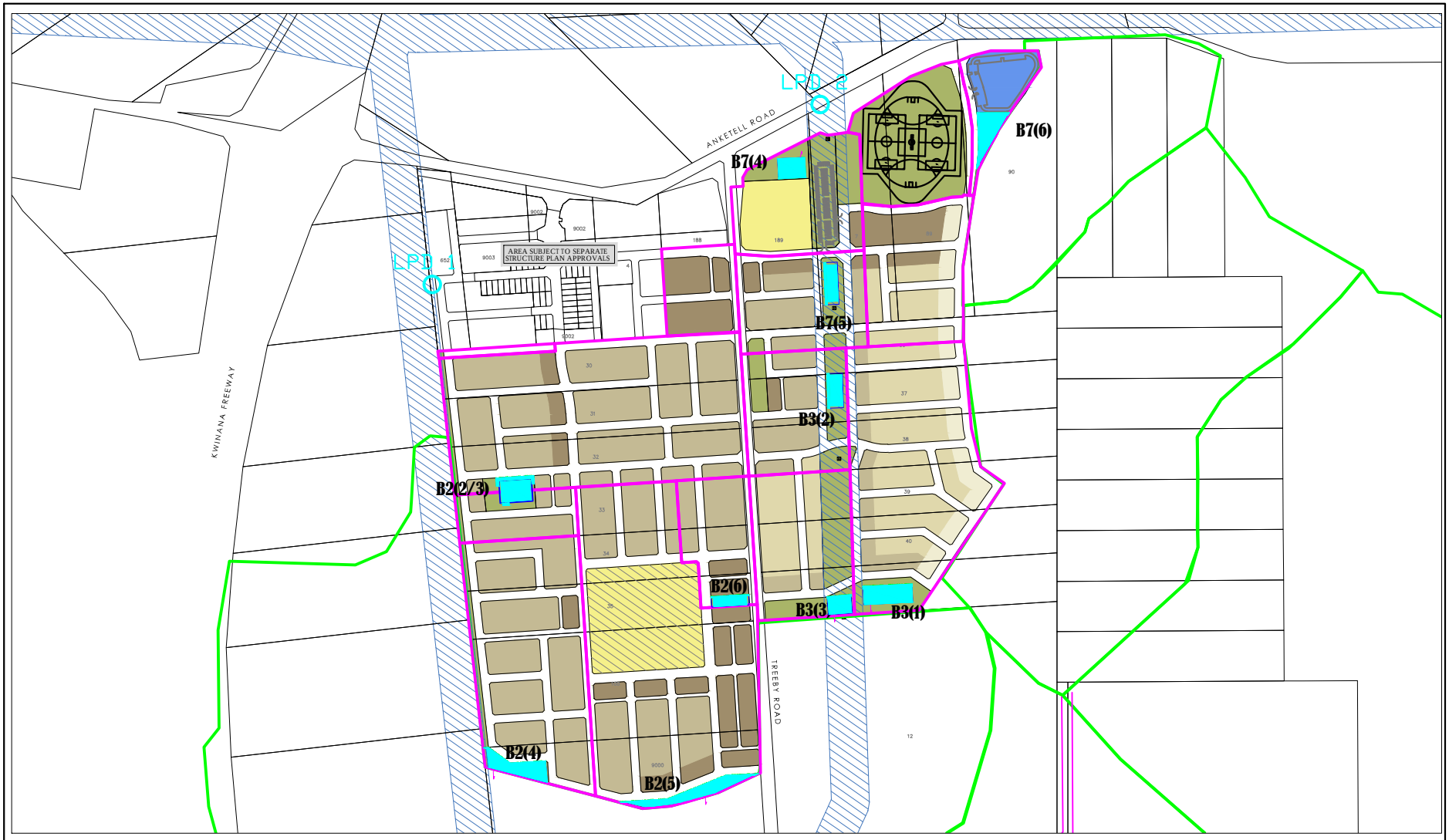
Local Water Management Strategy
24/05/2019

Figure 17: 18% AEP Event Plan



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WEBSITE: www.biosciencewa.com

Catchment Boundary & Number

Surface Water Flow Direction

Storage Basins (e.g. B2(5) means BAsin NAme)

Inundated Area

Rain gardens at POS entry

Data Source: Client supplied drawings

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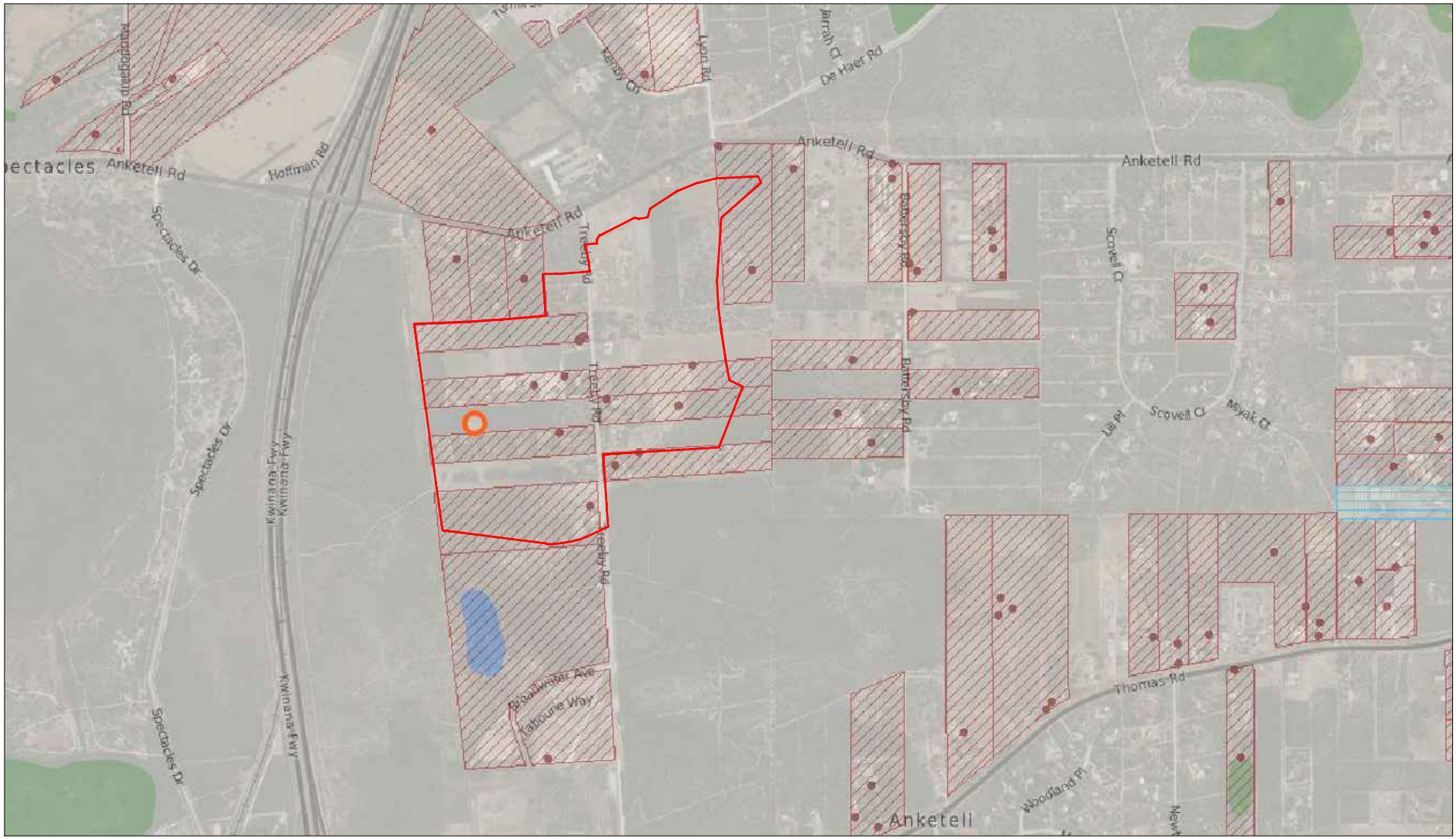
Local Water Management Strategy
24/05/2019

Figure 18: 1% AEP Event Plan



Groundwater Draw Point

Data Source: Department of Water

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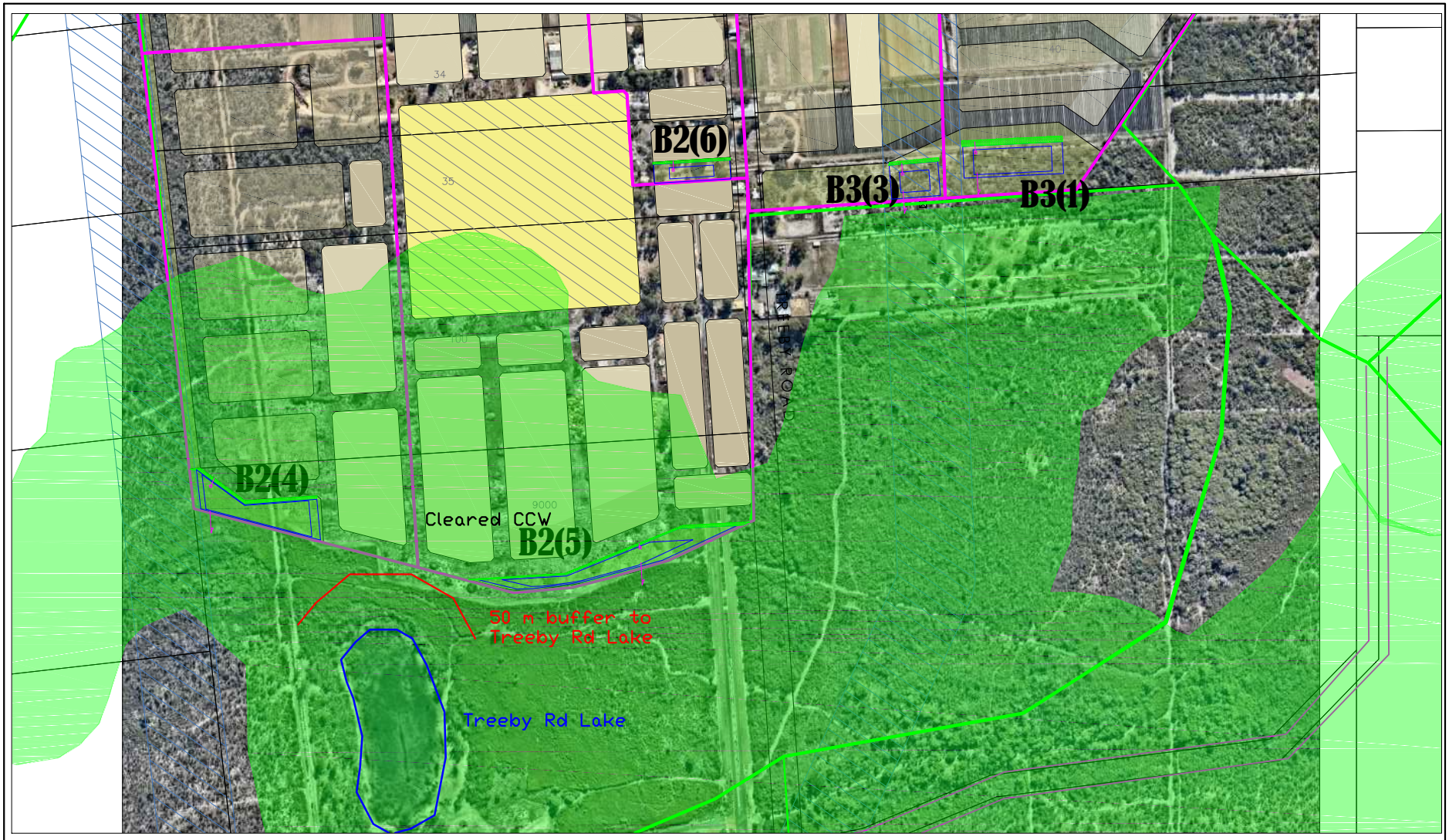
30/11/2018

Figure 19: Groundwater Allocation



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CCW

Data Source: Client supplied drawings

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Figure 20: CCW and 50 m Buffer to Treeby Rd Lake

Appendix A: Monitoring Data

Appendix A: Water Monitoring Data

Groundwater Bore Data

Monitoring Bore	Location (GDA Coordinates)		Top of Casing (mAHD)	Total Depth (mBNS)
	Easting	Northing		
WAM5s	392819	6436201	29.26	12.00
WAM5d	392819	6436200	29.25	15.00
WAM6s	392948	6435906	29.14	12.00
WAM6d	392946	6435906	29.10	15.00
WAM7s	392498	6435094	34.57	18.00
WAM7d	392498	6435095	34.57	21.00
WAM8s	392718	6434838	21.51	5.00
WAM8d	392718	6434838	21.48	8.00
WAM9s	392002	6434770	18.58	5.00
WAM9d	392001	6434769	18.79	9.50
WAM10s	392545	6433942	19.37	5.00
WAM10d	392546	6433942	19.32	9.50
WAM11	392144	6435637	30.88	22.0
WAM12(s)	391937	6436182	14.79	4.00
WAM12(d)	391938	6436181	14.81	10.00
WAM13(s)	392021	6436000	15.60	4.00
WAM13(d)	392022	6436000	15.51	9.00
WAM14	392597	6433559	18.61	5.30
WAM15s	392571	6433790	18.19	4.30
WAM15d	392570	6433791	18.18	10.30
WAM16s	392117	6433764	16.66	4.30
WAM16d	392117	6433763	16.71	12.80
SP1-2B	391329	6435252	14.90	17.50
JE22C	392520	6434584	20.33	6.15
JM42	393325	6437618	25.80	16.70
11812632	392887	6435694	24.44	9.00

JDA Lot 13 & 100 Treeby Road (April 2008)

Bore ID	Water Level (m AHD)														
	30-May-05	5-Jul-05	27-Jul-05	9-Sep-05	26-Sep-05	21-Oct-05	23-Nov-05	10-Jan-06	31-Jan-06	3-Mar-06	4-Apr-06	4-May-06	Min.	Max.	Difference
WAM9(s)	14.43	14.96	15.12	15.4	15.46	15.51	15.34	15.01	14.85	14.62	14.44	14.3	14.3	15.51	1.21
WAM9(d)	14.76	15.33	15.47	15.75	15.8	15.86	15.66	15.36	15.19	14.97	14.78	14.65	14.65	15.86	1.21
WAM10(s)	16.58	17.06	17.17	17.35	17.35	17.4	17.24	16.94	16.81	16.57	16.33	16.26	16.26	17.4	1.14
WAM10(d)	16.56	17.05	17.16	17.34	17.37	17.4	17.23	16.94	16.79	16.58	16.39	16.26	16.26	17.4	1.14
SP1-2B	-	-	-	-	-	11.9	11.8	11.66	11.6	11.48	11.39	11.37	11.37	11.9	0.53
JE22C	-	17.84	17.98	18.18	18.24	18.2	18.03	17.65	17.4	17.11	16.95	16.81	16.81	18.24	1.43

Bore ID	Water Level (m AHD)														
	29-May-06	28-Jun-06	2-Aug-06	30-Aug-06	24-Oct-06	27-Nov-06	19-Dec-06	23-Jan-07	20-Feb-07	22-Mar-07	23-Apr-07	28-Jun-07	Min.	Max.	Difference
WAM9(s)	14.27	14.15	14.35	14.54	14.46	14.37	14.32	14.13	14.06	13.98	13.9	14.04	13.9	14.54	0.64
WAM9(d)	14.59	14.53	14.69	14.86	14.88	14.72	14.62	14.53	14.41	14.33	14.27	14.39	14.27	14.88	0.61
WAM10(s)	16	16.17	16.47	16.65	16.42	16.3	16.21	16.13	16.07	16.01	15.97	16.26	15.97	16.65	0.68
WAM10(d)	16.23	16.21	16.4	16.62	16.46	16.29	16.22	16.15	16.07	16.01	15.97	16.26	15.97	16.62	0.65
SP1-2B	11.36	11.32	11.5	11.52	11.44	11.32	11.26	11.28	11.06	11	10.98	11.07	10.98	11.52	0.54
JE22C	16.8	16.77	-	17.37	17.27	16.86	16.83	16.56	16.61	16.53	16.68	16.7	16.53	17.37	0.84

JDA Wandi/Anketell South (April 2008)

Bore ID	Water Level (m AHD)														
	27-Sep-05	21-Oct-05	23-Nov-06	10-Jan-06	31-Jan-06	3-Mar-06	4-Apr-06	4-May-06	29-May-06	28-Jun-06	2-Aug-06	30-Aug-06	Min.	Max.	Difference
WAM5(s)	20.07	20.08	19.99	19.85	19.82	19.65	19.54	19.53	19.47	19.46	19.62	19.58	19.46	20.08	0.62
WAM5(d)	20.06	20.08	20.01	19.83	19.77	19.64	19.55	19.51	19.45	19.46	19.59	19.57	19.45	20.08	0.63
WAM6(s)	20.97	21	20.98	20.87	20.69	20.59	20.46	20.36	20.5	20.67	20.32	20.4	20.32	21	0.68
WAM6(d)	21.08	21.15	21.12	20.97	20.88	20.72	20.6	20.52	20.27	20.37	20.45	20.45	20.27	21.15	0.88
WAM7(s)	19.52	19.62	19.54	19.09	18.89	18.66	18.63	18.51	18.4	18.09	18.23	18.12	18.09	19.62	1.53
WAM7(d)	18.97	19.04	18.64	18.07	18.82	17.49	17.35	17.55	17.7	17.82	18.01	18.01	17.35	19.04	1.69
WAM8(s)	20.15	20.15	19.96	19.6	19.44	19.23	19.13	19.05	18.99	19.11	19.2	19.35	18.99	20.15	1.16
WAM8(d)	20.06	20.05	19.87	19.53	19.4	19.21	19.09	19	18.97	18.93	19.2	19.26	18.93	20.06	1.13
SP1-2B	-	11.9	11.8	11.66	11.6	11.48	11.39	11.37	11.36	-	11.5	11.52	11.36	11.9	0.54
JE22C	-	18.2	18.03	17.65	17.4	17.11	16.95	16.81	16.8	-	17.04	17.37	16.8	18.2	1.4
JM42	22.09	22.22	22.17	22.01	21.95	21.82	21.67	21.62	21.58	21.48	-	21.07	21.07	22.22	1.15

Bore ID	Water Level (m AHD)														
	6-Oct-06	24-Oct-06	27-Nov-06	19-Dec-06	23-Jan-07	20-Feb-07	23-Mar-07	23-Apr-07	22-May-07	28-Jun-07	26-Jul-07	30-Aug-07	Min.	Max.	Difference
WAM5(s)	19.55	19.52	19.42	19.28	19.18	19.09	19.02	18.98	19.04	19.07	19.17	19.38	18.98	19.55	0.57
WAM5(d)	19.52	19.52	19.42	19.31	19.18	19.09	19.03	18.99	19.02	19.08	19.18	19.4	18.99	19.52	0.53
WAM6(s)	20.34	20.32	20.31	20.1	19.97	19.87	19.79	19.76	19.74	19.74	19.87	20.16	19.74	20.34	0.6
WAM6(d)	20.47	20.37	20.15	20.23	20.07	20	19.9	19.82	19.84	19.85	19.96	20.22	19.82	20.47	0.65
WAM7(s)	17.98	17.84	17.55	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	18.35	17.55	18.35	0.8
WAM7(d)	17.7	17.7	17.36	17.16	16.94	16.79	16.64	16.81	17.04	17.27	17.48	17.73	16.64	17.73	1.09
WAM8(s)	19.5	19.19	19.08	18.92	18.84	18.72	18.68	18.55	18.58	18.79	-	19.31	18.55	19.5	0.95
WAM8(d)	19.3	19.11	19	18.89	18.85	18.74	18.69	18.61	18.59	18.73	-	19.25	18.59	19.3	0.71
SP1-2B	-	11.44	11.32	11.26	11.3	11.06	-	10.98	-	-	11.26	-	10.98	11.44	0.46
JE22C	17.24	16.27	16.86	16.83	16.56	16.61	-	16.68	16.47	16.7	17	17.57	16.27	17.57	1.3
JM42	21.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-

JDA Lots 1, 2, 3 & 17 Thomas Road

Bore ID	Water Level (m AHD)														
	4-Apr-07	23-May-07	28-Jun-07	26-Jul-07	30-Aug-07	18-Sep-07	11-Oct-07	7-Nov-07	18-Dec-07	15-Jan-08	12-Feb-08	11-Mar-08	Min.	Max.	Difference
WAM14	15.43	15.33	15.58	15.87	16.34	16.43	16.5	16.34	16.13	15.92	16.02	15.79	15.33	16.5	1.17
WAM15(s)	15.74	15.66	15.96	16.25	16.74	16.7	16.86	16.67	16.43	16	16.3	16.04	15.66	16.86	1.2
WAM15(d)	15.24	15.22	15.44	15.75	16.25	16.34	16.43	16.24	16.02	15.75	15.81	15.61	15.22	16.43	1.21
WAM16(s)	13.82	13.9	14.08	14.39	14.97	15.09	15.12	15.02	14.99	14.73	14.88	14.62	13.82	15.12	1.3
WAM16(d)	13.64	13.7	13.93	14.28	14.8	14.91	14.94	14.84	14.74	14.48	14.67	14.41	13.64	14.94	1.3
SP1-2B	10.97	10.99	11.07	11.26	11.39	11.46	11.46	11.38	11.26	11.15	11.19	11.09	10.97	11.46	0.49
JE22C	-	16.47	16.7	17	17.57	17.85	17.92	20.33	17.76	20.33	17.36	16.74	16.47	20.33	3.86

Bore ID	Water Level (m AHD)														
	9-Apr-08	16-May-08	10-Jun-08	11-Jul-08	11-Aug-08	11-Sep-08	23-Oct-08	17-Nov-08	16-Dec-08	13-Jan-09			Min.	Max.	Difference
WAM14	15.85	15.74	15.99	16.41	17.01	16.81	16.73	16.66	16.56	16.39			15.74	17.01	1.27
WAM15(s)	16.08	15.97	16.24	16.69	17.24	17.08	16.99	16.91	16.82	16.82			15.97	17.24	1.27
WAM15(d)	15.7	15.65	15.87	16.29	16.88	16.71	16.58	16.5	16.4	16.69			15.65	16.88	1.23
WAM16(s)	14.66	14.56	14.84	15.17	15.5	15.32	15.21	15.14	15.05	14.9			14.56	15.5	0.94
WAM16(d)	14.42	14.42	14.72	15.01	15.3	15.19	15.11	15.01	14.94	14.8			14.42	15.3	0.88
SP1-2B	11.13	11.12	11.08	11.4	11.69	11.58	11.58	11.56	11.53	11.43			11.08	11.69	0.61
JE22C	-	-	16.87	17.2	18.02	17.82	17.7	17.7	17.49	17.2			16.87	18.02	1.15

Anketell North DWMS

Bore ID	Water Level (m AHD)														
	27-Jul-05	9-Sep-05	27-Sep-05	21-Oct-05	23-Nov-05	10-Jan-06	31-Jan-06	3-Mar-06	4-Apr-06	4-May-06	29-May-06	28-Jun-06	Min.	Max.	Difference
WAM11	13.42	13.63	13.72	13.86	13.86	13.76	13.71	13.65	13.57	13.49	13.46	13.3	13.3	13.86	0.56
WAM12(s)	14.15	14.18	14.04	13.76	13.31	13.47	13.46	13.12	13.17	13.34	13.01	12.98	12.98	14.18	1.2
WAM12(d)	14.12	14.15	14.08	13.91	13.55	13.49	13.47	13.01	13.12	13.26	13.14	13.12	13.01	14.15	1.14
WAM13(s)	14.15	14.2	14.03	14.03	13.75	13.74	13.73	13.43	13.5	13.64	13.44	13.45	13.43	14.2	0.77
WAM13(d)	14.08	14.13	14.08	13.91	13.68	13.64	13.62	13.31	13.36	13.47	13.33	13.33	13.31	14.13	0.82
SP1-2B	-	-	-	11.9	11.8	11.66	11.6	11.48	11.39	11.37	11.36	11.32	11.32	11.9	0.58
JE22C	17.98	18.18	18.24	18.2	18.03	17.65	17.4	17.11	16.95	16.81	16.8	16.77	16.77	18.24	1.47

Bore ID	Water Level (m AHD)														
	2-Aug-06	30-Aug-06	24-Oct-06	27-Nov-06	19-Dec-06	23-Jan-07	20-Feb-07	23-Mar-07	23-Apr-07	22-May-07	28-Jun-07	26-Jul-07	Min.	Max.	Difference
WAM11	13.3	13.22	13.27	13.23	13.17	13.08	13.02	12.93	12.85	12.82	12.68	12.68	12.68	13.3	0.62
WAM12(s)	13.47	13.67	13.06	12.85	12.89	12.45	12.26	12.1	12.22	12.7	13.17	13.61	12.1	13.67	1.57
WAM12(d)	13.5	13.7	13.23	12.82	12.89	12.5	12.33	12.23	12.39	12.62	13.08	13.52	12.23	13.7	1.47
WAM13(s)	13.93	13.92	13.42	13.08	13.06	12.85	12.74	12.66	12.7	12.86	13.12	13.67	12.66	13.93	1.27
WAM13(d)	13.75	13.76	13.31	13	12.89	12.77	12.66	12.57	12.61	12.76	13.05	13.5	12.57	13.76	1.19
SP1-2B	11.5	11.52	11.44	11.32	11.26	11.3	11.06	11	10.98	10.99	11.07	11.26	10.98	11.52	0.54
JE22C	17.04	17.34	16.27	16.86	16.83	16.56	16.61	16.53	16.68	16.47	16.7	17	16.27	17.34	1.07

Adjusted AAMGL Calculations

Department of Water long-term bore JE22C MGL: 1994 = 18.768mAHD
Department of Water long-term bore JE22C AAMGL: = 17.965mAHD

Bores across Anketell North Site:
JDA WAM11, WAM6, WAM7, WAM9, WAM8
DoW 11812632, JE22C
VDM VDM 1-6, 12, 13, 14

Closest bore to JE22C is WAM8
Highest recorded groundwater level in WAM8: 20.06mHDD in September 2005
JE22C groundwater level in September 2005: 18.258mAHD which is above the AAMGL by 293mm

2005 recorded groundwater levels adjusted to AAMGL

WAM11	=	13.72	-	0.293	= 13.427 mAHD
WAM6	=	21.15	-	0.293	= 20.857 mAHD
WAM7	=	19.04	-	0.293	= 18.747 mAHD
WAM9	=	15.86	-	0.293	= 15.567 mAHD
WAM8	=	20.06	-	0.293	= 19.767 mAHD
WAM5	=	20.08	-	0.293	= 19.787 mAHD
WAM10	=	17.40	-	0.293	= 17.107 mAHD
WAM12	=	14.15	-	0.293	= 13.857 mAHD
WAM13	=	14.13	-	0.293	= 13.855 mAHD
WAM14	=	No 2005 recorded			
WAM15	=	No 2005 recorded			

To 2007 recorded levels
2007 MGL in JE22C: 17.78
17.965 - 17.78 = 0.185m

WAM14	=	16.5	+	0.185	= 16.685 mAHD
WAM15	=	16.43	+	0.185	= 16.615 mAHD

Appendix B: Modeling Data

Appendix B: Modeling Data

VDM Modeling Data

Rainfall

Design rainfall for the hydrologic model has been determined based on Australia Rainfall and Runoff (ARR, IE 2000) Intensity Frequency Duration (IFD) data for Jandakot. Hydrologic and hydraulic analysis has been undertaken with 1, 5, and 100-year ARI storms for duration between 15 minutes and 72 hours. The IFD data used in the modelling are tabulated below;

IFD Rainfall Intensities (mm/hr)

Duration (min)	1-yr ARI	5-yr ARI	100-yr ARI
15	9.1	15.2	29.9
20	10.3	17.2	33.1
25	12.3	20.1	37.9
30	14.5	23.3	43.1
45	16.1	25.8	47.0
60	18.7	29.7	53.1
90	20.8	32.7	57.8
120	24.1	37.5	65.3
180	30.9	47.5	81.1
360	35.8	54.8	93.0
720	39.8	60.8	103.1
1080	46.0	70.6	120.3
1440	50.7	78.6	134.8
1800	54.6	84.8	147.4
2160	57.8	90.4	158.5
2880	62.9	99.3	176.8
4320	69.6	111.2	201.7

Roughness Coefficient

Manning's roughness coefficients (n) used in the hydraulic model were:

- 0.014 for concrete pipes, and
- 0.030 for vegetated channels.

Additional sensitivity analysis was undertaken for vegetated channels with the Manning's n=0.055 to represent a situation where the channel becomes overgrown.

Tail Water and Boundary Conditions

The model extends 20m downstream of the site's LPD (i.e. the culverts under Thomas Road). As the Thomas Road culverts represent the control point for flows leaving the site, a free outflow tail water condition with normal depth of flow was employed.

Bioscience Modeling Data

Peak flow rates and hydrographs at both Pre- and Post-Development were generated with XP-SWMM using Laurenson as routing method.

Bioscience developed their own pre-development modelling to ascertain peak flow rates in the local point discharge (LPDs) at post-development level.

Rainfall intensities for the Perth area were downloaded from the Innovize website (former XP Solutions). Intensities are overall similar to the ones used in VDM modeling.

Similarly we used the same roughness coefficient and the same boundary conditions.

Note that VDM mentioned runoff coefficients in their modeling report; parameter which Laurenson doesn't used in its formula. We assumed that VDM used another routing method. Our calibration method therefore differs from them.

Pre-Development Model

Table A: Pre-Development Catchment Details

Catchments	Impervious areas (ha)	Pervious areas (ha)	Slope
1	0.5	39.17	0.025
2	1	120	0.025
3	0.01	39	0.01
4	0.24	84.18	0.01
5.1	0.04	30.06	0.0085
5.2	0.25	15.05	0.0098
6	0.5	66.1	0.008
7	0.5	32.5	0.015

Note that invert and spill crest levels, along with the bottom and surface areas of Treeby Road Lake and Sandy Lake were abstracted from the Jandakot UWMP written by DWER (former DoW).

Initial loss (IL) and continuing loss (CL)

Pervious Area

Initial loss and continuing loss at pre-development were the first parameters to be calibrated. Initial loss value (20 mm) was abstracted from the ARR while continuing loss was calibrated by assessing inflow from catchment 2 into Treeby Road Lake. We were looking at reaching a water level of 16mAHD (as calculated by DWER) under the critical 1% AEP event. An absolute loss of 6 mm/hr was determined.

Impervious Area

An Initial loss of 15.85 (63%AEP 1hr) for the impervious areas (roofs) was selected. It assumes that the impervious areas are connected to the pervious areas and as such the 63%AEP 1hr from these areas will infiltrate the pervious via existing soakwells for instance.

Table B: Modelling Run Results with determined IL and CL

Discharge Point	Peak Flow Rate at critical 1% AEP
LPD2	252 L/s (DWER: 145 L/s)
LPD3	751 L/s (DWER: 371 L/s)

As seen on Table B, peak flow rates for the LPDs were significantly above the ones found in the Jandakot UWMP. VDM also had the same issue. To this end, we decided to calibrate the B value of both pervious and impervious areas to obtain the adequate peak flow rates.

Table C provide the calibrate B values while peak flow rate results are provide in Table D.

Table C: B values

CAT	Impervious B calculated	Impervious B calibrated	Pervious B calculated	Pervious B calibrated
1	0.004420	CNR	0.167218	CNR
2	0.006338	CNR	0.299311	CNR
3	0.000605	0.021970	0.176262	0.415000
4	0.003159	0.021969	0.260587	0.370000
5.1	0.001254	0.010771	0.153790	0.153800
5.2	0.003230	CNR	0.106562	0.050000
6	0.004679	0.022216	0.232378	0.700000
7	0.004534	0.018537	0.150372	0.190000

CAT: Calibration not required

Table D: Peak flow rates at 1% AEP after Calibration

Discharge Point	Peak Flow Rate at critical 1% AEP
LPD2	144 L/s (DWER: 145 L/s)
LPD3	371 L/s (DWER: 371 L/s)

Results are as per DWER's predicted peak flow rates. However, when running the model for the 63% and 18% AEP, resulting peak flow rates were lower than DWER's (Table E).

Table E: Peak flow rates at 63% and 18%

Discharge Point	63% AEP	18% AEP
LPD2	16 L/s (DWER: 39 L/s)	37 L/s (DWER: 72 L/s)
LPD3	20 L/s (DWER: 80 L/s)	66 L/s (DWER: 168 L/s)

To solve this issue, we decided to calibrate the continuing loss for the lower events. After several runs, a value of 1.25 mm/hr (absolute) was selected for the 63% AEP runs and 3.4 mm/hr was selected for the 18% AEP runs. Results are provided in Table F.

Table F: Peak flow rates at 63% and 18% after Calibration

Discharge Point	63% AEP	18% AEP
LPD2	27 L/s (DWER: 39 L/s)	75 L/s (DWER: 72 L/s)
LPD3	80 L/s (DWER: 80 L/s)	165 L/s (DWER: 168 L/s)

The peak flow rate for the 63% AEP at LDP2 is still low, however, this had no impact for the post-development as we will try to target the 39 L/s. Not however that this peak flow rate at LPD2 is unlikely to be reached at post-development due to rain gardens and soakwells infiltrating the event.

Post-Development Model

This was extensively discussed in the content of the LWMS. As such, this section summarizes the most important point of the modeling. Note that parameters determined at pre-development modeling are used at post-development modeling.

Table G: Pre-Development Catchment Details

CAT	Area (ha)	Impervious areas (ha)	Pervious (ha)	Slope Impervious	Slope Pervious
1	39.7	0.53	39.17	0.025	0.025
2.1	78.7	1	71.7	0.025	0.025

2.2	14.6	4.73	9.87	0.005	0.055
2.3	2	0.58	1.42	0.005	0.055
2.4	9.31	2.96	6.35	0.005	0.055
2.5	15.6	8.09	7.51	0.005	0.055
2.6	2.9	1.02	1.88	0.005	0.055
3.1	10.6	3.28	7.32	0.005	0.055
3.2	4.26	1.28	2.98	0.005	0.055
3.3	4.84	1.11	3.73	0.005	0.055
3.4	39.7	0.01	39.69	0.01	0.01
4	84.7	0.24	84.46	0.01	0.01
5.1	30.1	0.04	30.06	0.0085	0.0085
5.2	15.3	0.25	15.05	0.0098	0.0098
6	66.6	0.5	66.1	0.008	0.008
7.1	13.3	1	12.3	0.0288	0.0288
7.2	5.26	3.54	1.72	0.005	0.055
7.3	5.93	1.5	4.43	0.005	0.055
7.4	4.56	2.98	1.58	0.005	0.055
7.5	4.2	1.55	2.65	0.005	0.055
	Urban catchments, please see Loss Parameters in Table H				

Table H: Loss Parameters

Type	IL	CL	CAT	Comments
Impervious urban	15.85	0.15 (proportional)	2.2, 2.3, 2.4, 2.5, 2.6, 3.1, 3.2, 3.3, 7.2, 7.3, 7.4, and 7.5	Takes in consideration the 63% infiltration by raingardens
Pervious urban	15.86	6 (absolute)	2.2, 2.3, 2.4, 2.5, 2.6, 3.1, 3.2, 3.3, 7.2, 7.3, 7.4, and 7.5	Takes in consideration the 63% infiltration by soakwells for the initial loss. ARR value was used for the absolute loss

We maintained these losses across all rainfall events.

Final results are presented below.

Table I: Peak Flow Rates at Post Dev.

Discharge Point	63% AEP	18% AEP	1% AEP
LPD2	0 L/s (DWER: 39 L/s)[1]	44 L/s (DWER: 72 L/s)	181L/s (DWER: 145 L/s)
LPD3	78 L/s (DWER: 80 L/s)	161 L/s (DWER: 168 L/s)	362L/s (DWER: 371 L/s)

[1] Significant drop in flow rate due to raingarden and soakwell infiltration of the 63% AEP. If required, runoff from Catchment 7.1 will be directed to LPD2 to maintain peak flow rate under a 63% AEP event. This can be discussed at UWMP stage upon DWER's advice.

Appendix C: Subcatchments and Ultimate Drainage Strategy System from DWER

THE INFORMATION CONTAINED HEREIN IS SUBJECT TO ONGOING REVIEW AND AMENDMENTS AND SHOULD BE READ IN CONJUNCTION WITH THE ASSOCIATED REPORT.

SUBCATCHMENTS

N

GIBBS ROAD
ROWLEY ROAD
LYON ROAD
ANKETELL ROAD
THOMAS ROAD
ORTON ROAD
MORTIMER ROAD
KING ROAD
JACKSON ROAD
MCLARTY ROAD
FREEWAY
KWINANA

LEGEND

- Scheme Boundary
- InfoWorks SubCatchment
- CAT23 InfoWorks SubCatchment Number
- Soakage

0 500 1000 1500 2000
SCALE OF METRES

AUTHOR: SLee DESIGN FILE: Figure_A3.1_PreDev_SubCatch.dgn

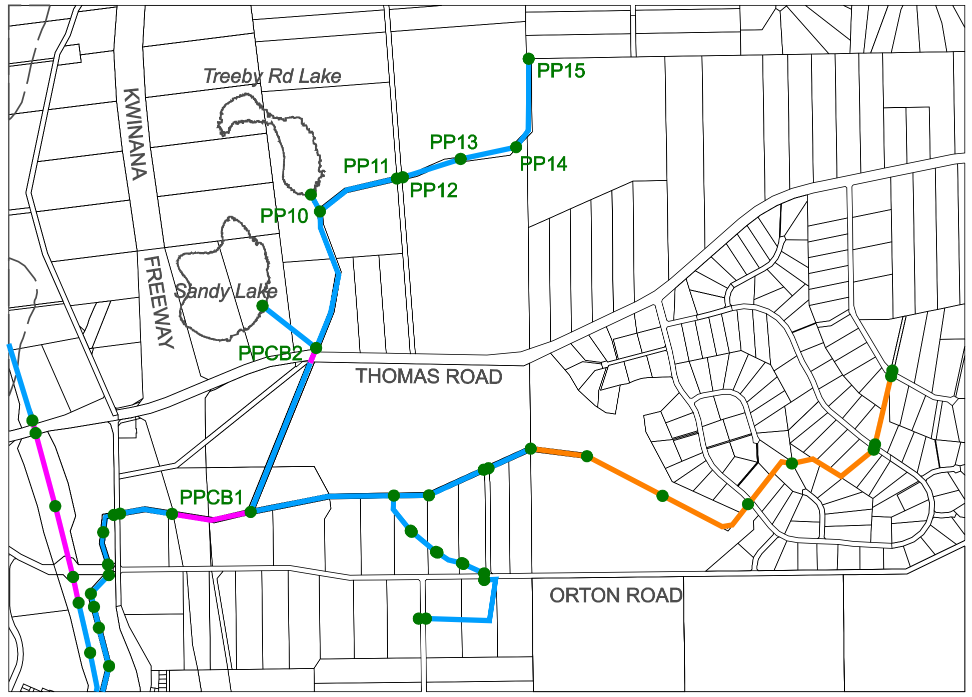
WATER CORPORATION

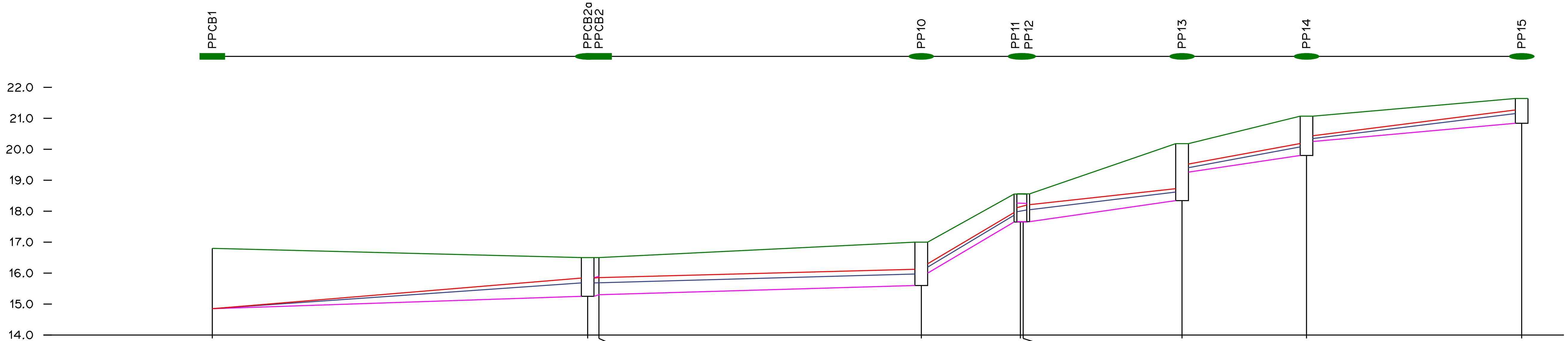
PROJECT N°: 6116977 DATE: 27/06/2008 COORDINATE SYSTEM: MGA94 - Zone 50

Figure A3.1

THE INFORMATION CONTAINED HEREIN IS SUBJECT TO ONGOING REVIEW AND AMENDMENTS AND SHOULD BE READ IN CONJUNCTION WITH THE ASSOCIATED REPORT.

N





Chainage (m), Ground level (m AHD), 10 year ARI HGL level (m AHD), 100 year ARI HGL level (m AHD), Invert level (m AHD):

Chainage (m)	Ground level (m AHD)	10 year ARI HGL level (m AHD)	100 year ARI HGL level (m AHD)	Invert level (m AHD)	Invert level (m AHD)
0	16.80	15.19	15.29	-	14.85
666	16.50	15.66	15.81	15.25	15.25
686	16.50	15.67	15.82	15.30	15.30
1258	17.00	15.95	16.08	15.60	16.00
1434	18.55	17.85	17.93	17.65	17.65
1439	18.56	18.01	18.16	17.66	17.66
1721	20.18	19.39	19.45	18.34	19.26
1942	21.07	20.38	20.44	19.80	20.25
2324	21.64	21.12	21.23	20.84	-

Reach (chainage)	Size (mm)	Max 10 year ARI flow (m3/s)	Max 100 year ARI flow (m3/s)
0 – 666	3000x1000	0.19	0.35
666 – 686	3X 600	3X0.06	3X0.12
686 – 1258	3000x1000	0.13	0.24
1258 – 1434	2400x900	0.13	0.24
1434 – 1439	600	0.13	0.24
1439 – 1721	2400x900	0.10	0.18
1721 – 1942	2200x800	0.10	0.18
1942 – 2324	2200x800	0.10	0.18

DESIGN FILE: Figure 4.3a SubDrain P Pt 1of4

AUTHOR: SLee

WATER CORPORATION

Peel Sub P Drain

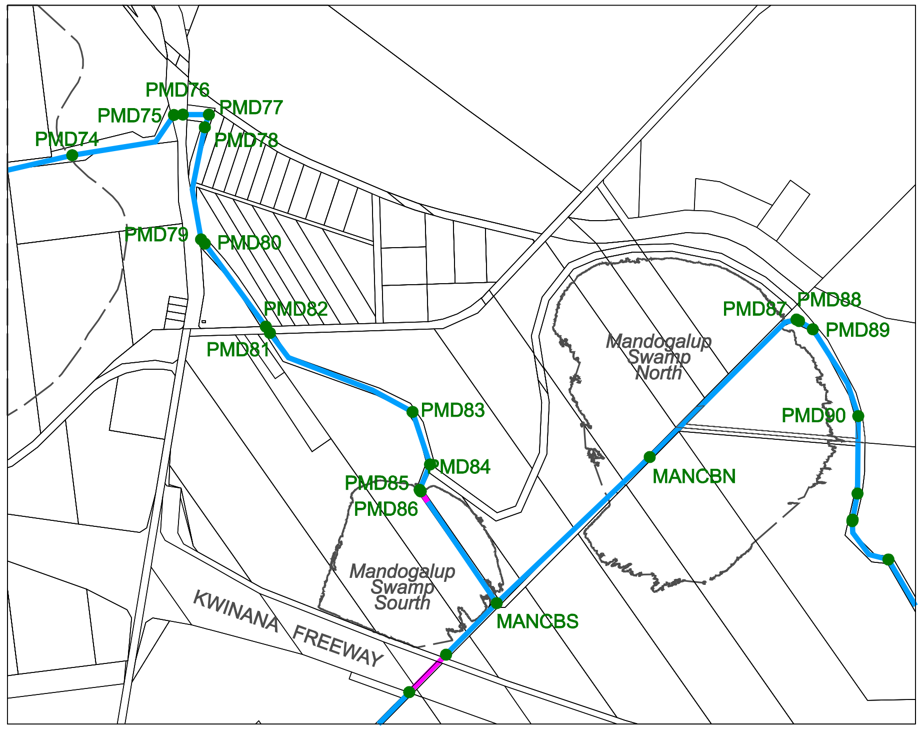
LONGITUDINAL SECTION

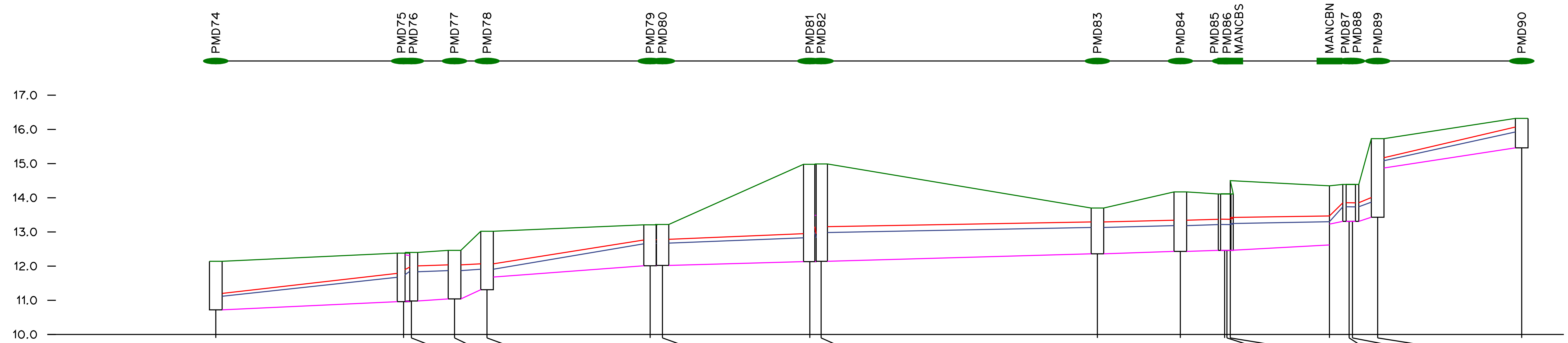
Existing System HGLs & Flows

Figure 4.3a

PROJECT N°: DP2 DATE: 24/04/2009

N





Chainage (m)	Ground level (m AHD)	10 year ARI HGL level (m AHD)	100 year ARI HGL level (m AHD)	Invert level (m AHD)	Invert level (m AHD)
0	12.14	11.09	11.16	-	10.72
335	12.38	11.70	11.81	10.96	10.96
349	12.40	11.88	12.05	10.98	10.98
426	12.46	11.91	12.07	11.04	11.04
484	13.02	11.95	12.10	11.31	11.68
775	13.21	12.68	12.79	12.01	12.01
797	13.22	12.70	12.81	12.02	12.02
1060	14.98	12.86	12.98	12.13	12.13
1080	14.99	13.03	13.19	12.14	12.14
1573	13.70	13.18	13.33	12.36	12.36
1721	14.17	13.23	13.38	12.43	12.43
1800	14.11	13.26	13.41	12.46	12.46
1804	14.11	13.26	13.41	12.46	12.46
1810	14.50	13.29	13.46	12.46	12.46
1987	14.35	13.34	13.51	12.62	13.23
2022	14.39	13.80	13.93	13.31	13.31
2028	14.39	13.80	13.93	13.31	13.31
2073	15.73	15.21	15.32	13.43	14.87
2330	16.32	16.01	16.16	15.46	-

Segment (chainage)	Size (mm)	Max 10 year ARI flow (m3/s)	Max 100 year ARI flow (m3/s)
0–335	6900x1420	1.15	1.59
335–349	1350	1.15	1.59
349–426	6900 x1420	1.15	1.59
426–484	6900 x1420	1.10	1.52
484–775	6020x1200	1.10	1.52
775–797	6325 x1200	1.10	1.52
797–1060	6630x1200	1.10	1.52
1060–1080	1350	1.10	1.52
1080–1573	7030x1300	1.10	1.52
1573–1721	7030x1300	1.10	1.52
1721–1800	7030 x1300	1.10	1.52
1800–1804	7030 x1300	1.07	1.47
1804–1810	2X 900	2X0.53	2X0.73
1810–1987	7030 x1300	0.94	1.30
1987–2022	5300 x1020	0.98	1.66
2022–2028	5300 x1020	0.98	1.66
2028–2073	5300 x1020	0.98	1.66
2073–2330	4660x860	0.98	1.66

AUTHOR: PHaywood DESIGN FILE: Figure 4.2b Peel MD Pt 2 of 4

WATER CORPORATION

Peel Main Drain Part 2 of 4

LONGITUDINAL SECTION

Existing System HGLs & Flows

Figure 4.2b

PROJECT N°: DP2 DATE: 24/04/2009

AUTHOR: SLee DESIGN FILE: Figure_5.1_PostDevelopmentSystemDetails.dgn

PROJECT N°: 6116977 DATE: 26/06/2008 COORDINATE SYSTEM: MGA94 - Zone 50

WATER CORPORATION

N

LEGEND

- Catchment Boundary
- Water Corporation Open Drain
- Water Corporation Piped Drain
- Local Authority Open and Piped Drains
- ▲ Gauging Station
- ② Flow Station locations in Table 5.1

GIBBS ROAD
LYON ROAD
ROWLEY ROAD
ANKETELL ROAD
THOMAS ROAD
ORTON ROAD
MORTIMER ROAD
KWINANA FREEWAY
KING ROAD
JACKSON ROAD
MILLAR ROAD

Peel Main Drain
Peel Sub Q Drain
Peel Sub R Drain
Peel Sub P Drain
Peel Sub P1 Drain
Peel Sub P1A Drain
Peel Sub O Drain
Peel Sub N2 Drain
Peel Sub N Drain
Peel Sub N1 Drain

Banjup Swamp
Mandogalup Swamp North
Mandogalup Swamp South
Spectacles Wetland North
Spectacles Wetland South
Treeby Rd Lake
Sandy Lake
Johnson Rd Wetland
Mortimer Rd Wetland
Bollard Bulrush

Banjup Swamp		
CGL	=	23.9 mAHD
TWL_{10}	=	24.3 mAHD
S_{10}	=	900 m³
TWL_{100}	=	24.5 mAHD
S_{100}	=	2,700 m³

Mandogalup Swamp North		
CGL	=	12.8 mAHD
TWL_{10}	=	13.5 mAHD
S_{10}	=	31,700 m³
TWL_{100}	=	13.7 mAHD
S_{100}	=	68,500 m³

Mandogalup Swamp South		
CGL	=	12.7 mAHD
TWL_{10}	=	13.4 mAHD
S_{10}	=	1,500 m³
TWL_{100}	=	13.7 mAHD
S_{100}	=	2,000 m³

Spectacles Wetland North		
CGL	=	9.3 mAHD
TWL_{10}	=	9.4 mAHD
S_{10}	=	368,000 m³
TWL_{100}	=	9.6 mAHD
S_{100}	=	502,800 m³

Spectacles Wetland South		
CGL	=	9.3 mAHD
TWL_{10}	=	9.3 mAHD
S_{10}	=	98,900 m³
TWL_{100}	=	9.5 mAHD
S_{100}	=	153,400 m³

Treeby Rd Lake		
CGL	=	15.5 mAHD
TWL_{10}	=	15.8 mAHD
S_{10}	=	23,600 m³
TWL_{100}	=	16.0 mAHD
S_{100}	=	31,500 m³

Sandy Lake		
CGL	=	14.5 mAHD
TWL_{10}	=	14.6 mAHD
S_{10}	=	3,000 m³
TWL_{100}	=	14.6 mAHD
S_{100}	=	5,500 m³

Johnson Road Wetland		
CGL	=	11 mAHD
TWL_{10}	=	11 mAHD
S_{10}	=	3,700 m³
TWL_{100}	=	11 mAHD
S_{100}	=	4,100 m³

Bollard Bulrush Swamp		
CGL	=	5.5 mAHD
TWL_{10}	=	4.8 mAHD
S_{10}	=	705,900 m³
TWL_{100}	=	5.6 mAHD
S_{100}	=	1,826,800 m³

Mortimer Road Wetland		
CGL	=	10 mAHD
TWL_{10}	=	10 mAHD
S_{10}	=	31,100 m³
TWL_{100}	=	10.1 mAHD
S_{100}	=	34,900 m³

0 500 1000 1500 2000
SCALE OF METRES

Figure 5.1

POST DEVELOPMENT SYSTEM

AUTHOR: SLee DESIGN FILE: Figure 7.1 Local Arterial Design North.dgn

PROJECT N°: 6116977 DATE: 30/06/2008 COORDINATE SYSTEM: MGA94 - Zone 50

WATER CORPORATION

N

LEGEND

- Scheme Boundary
- Water Corporation Open Drain
- Water Corporation Piped Drain
- Local Authority Open and Piped Drain
- Sub-catchment Boundary
- Local Authority Compensating Basin
- 20m Drainage Reserve

ROWLEY ROAD

KWINANA FREEWAY

Peel Main Drain

Peel R Sub Drain

Peel Main Drain

Spectacles North Wetland

20m

15m

20m

15m

20m

15m

Norkett Rd CB

CGL	=	17 mAHD
LWL	=	17.3 mAHD
TWL_{10}	=	17.9 mAHD
S_{10}	=	26100 m^3
TWL_{100}	=	18.3 mAHD
S_{100}	=	43500 m^3
Existing GL	=	18.3 mAHD

Lyon Rd CB

CGL	=	20.4 mAHD
LWL	=	20.7 mAHD
TWL_{10}	=	21.3 mAHD
S_{10}	=	14500 m^3
TWL_{100}	=	21.7 mAHD
S_{100}	=	23800 m^3
Existing GL	=	21.7 mAHD

Mandogalup West CB

CGL	=	12.8 mAHD
LWL	=	13.1 mAHD
TWL_{10}	=	13.7 mAHD
S_{10}	=	14400 m^3
TWL_{100}	=	14.1 mAHD
S_{100}	=	24300 m^3
Existing GL	=	14.1 mAHD

Mandogalup East CB

CGL	=	12.8 mAHD
LWL	=	13.1 mAHD
TWL_{10}	=	13.6 mAHD
S_{10}	=	9400 m^3
TWL_{100}	=	14.1 mAHD
S_{100}	=	18200 m^3
Existing GL	=	14.1 mAHD

Clementi Rd CB

CGL	=	11.5 mAHD
LWL	=	12.1 mAHD
TWL_{10}	=	12.7 mAHD
S_{10}	=	18700 m^3
TWL_{100}	=	13.1 mAHD
S_{100}	=	32700 m^3
Existing GL	=	13.1 mAHD

Darling Chase CB

CGL	=	14 mAHD
LWL	=	14.3 mAHD
TWL_{10}	=	14.9 mAHD
S_{10}	=	36000 m^3
TWL_{100}	=	15.3 mAHD
S_{100}	=	58900 m^3
Existing GL	=	15.3 mAHD

Hoffman Rd CB

CGL	=	12.8 mAHD
LWL	=	13.1 mAHD
TWL_{10}	=	13.6 mAHD
S_{10}	=	6300 m^3
TWL_{100}	=	14.0 mAHD
S_{100}	=	10700 m^3
Existing GL	=	14.1 mAHD

Antketell Rd CB

CGL	=	14 mAHD
LWL	=	14.3 mAHD
TWL_{10}	=	14.8 mAHD
S_{10}	=	21500 m^3
TWL_{100}	=	15.3 mAHD
S_{100}	=	39800 m^3
Existing GL	=	15.3 mAHD

0 200 400 600 800

SCALE OF METRES

LOCAL ARTERIAL DRAINAGE CONCEPTUAL DESIGN MANDOGULUP

Figure 7.1

AUTHOR: SLee DESIGN FILE: Figure 7.2 Local Arterial Design.dgn

PROJECT N°: 6116977 DATE: 16/06/2008 COORDINATE SYSTEM: MGA94 - Zone 50

WATER CORPORATION

N

LEGEND

- Scheme Boundary
- Water Corporation Open Drain
- Water Corporation Piped Drain
- Local Authority Open and Piped Drain
- Sub-catchment Boundary
- Local Authority Compensating Basin
- 20m Drainage Reserve

ANKETELL ROAD

Treeby Rd CB

CGL	=	17 mAHD
LWL	=	18 mAHD
TWL_{10}	=	18.4 mAHD
S_{10}	=	16700 m^3
TWL_{100}	=	18.8 mAHD
S_{100}	=	30300 m^3
Existing GL	=	19 mAHD

Treeby Rd Lake

Sandy Lake

Thomas Rd CB

CGL	=	14 mAHD
LWL	=	15.7 mAHD
TWL_{10}	=	16.2 mAHD
S_{10}	=	8000 m^3
TWL_{100}	=	16.5 mAHD
S_{100}	=	14100 m^3
Existing GL	=	16.7 mAHD

KWINANA FREEWAY

THOMAS ROAD

Orton Rd CB

CGL	=	13.2 mAHD
LWL	=	14.9 mAHD
TWL_{10}	=	15.4 mAHD
S_{10}	=	26000 m^3
TWL_{100}	=	15.6 mAHD
S_{100}	=	42600 m^3
Existing GL	=	15.9 mAHD

20m

Peel Main Drain

Peel Sub P Drain

Peel Sub P1 Drain

Peel Sub P1A Drain

ORTON ROAD

Holden Close CB

CGL	=	11.8 mAHD
LWL	=	14.4 mAHD
TWL_{10}	=	15.0 mAHD
S_{10}	=	6000 m^3
TWL_{100}	=	15.4 mAHD
S_{100}	=	11100 m^3
Existing GL	=	15.4 mAHD

LandgrenRd Nth CB

CGL	=	15.2 mAHD
LWL	=	16.4 mAHD
TWL_{10}	=	16.9 mAHD
S_{10}	=	14800 m^3
TWL_{100}	=	17.1 mAHD
S_{100}	=	24300 m^3
Existing GL	=	17.4 mAHD

LandgrenRd Sth CB

CGL	=	15.4 mAHD
LWL	=	16.4 mAHD
TWL_{10}	=	17.0 mAHD
S_{10}	=	5200 m^3
TWL_{100}	=	17.4 mAHD
S_{100}	=	8800 m^3
Existing GL	=	17.4 mAHD

0 200 400 600 800
SCALE OF METRES

Figure 7.2

LOCAL ARTERIAL DRAINAGE CONCEPTUAL DESIGN ANKETELL

AUTHOR: SLee DESIGN FILE: Figure_ES1_UltimateDrainageSystem.dgn

PROJECT N°: 6116977 DATE: 30/06/2008 COORDINATE SYSTEM: MGA94 - Zone 50

WATER CORPORATION

N

LEGEND

- Catchment Boundary
- Water Corporation Open Drain
- Water Corporation Piped Drain
- Local Authority Open and Piped Drains
- Drains to be transferred to Local Auth.
- (1) Flow Station locations in Table 5.1
- Gauging Station

GIBBS ROAD
LYON RD
ROWLEY ROAD
Banjup Swamp
Peel Main Drain
Mandogalup Swamp North
Mandogalup Swamp South
Incorporate drainage requirements into ERIC DSP
Peel Sub Q Drain
Peel Sub R Drain
ANKETELL ROAD
Spectacles Wetland North
Spectacles Wetland South
KWINANA
Treeby Rd Lake
Sandy Lake
THOMAS ROAD
Peel Sub P Drain
Peel Sub P1 Drain
Transfer Sub Drains to Town of Kwinana
ORTON ROAD
Peel Sub P1A Drain
FREEWAY
Johnson Rd Wetland
Peel Sub O Drain
Peel Sub N2 Drain
MORTIMER ROAD
Mortimer Rd Wetland
KING ROAD
Develop Operating Regimes for Wetlands with Environmental Regulators
Bollard Bulrush
Peel Sub N Drain
Peel Sub N1 Drain
JACKSON ROAD
MILLAR ROAD

Banjup Swamp		
CGL	=	23.9 mAHD
TWL_{10}	=	24.3 mAHD
S_{10}	=	900 m^3
TWL_{100}	=	24.5 mAHD
S_{100}	=	2,700 m^3

Mandogalup Swamp North		
CGL	=	12.8 mAHD
TWL_{10}	=	13.5 mAHD
S_{10}	=	31,700 m^3
TWL_{100}	=	13.7 mAHD
S_{100}	=	68,500 m^3

Mandogalup Swamp South		
CGL	=	12.7 mAHD
TWL_{10}	=	13.4 mAHD
S_{10}	=	1,500 m^3
TWL_{100}	=	13.7 mAHD
S_{100}	=	2,000 m^3

Spectacles Wetland North		
CGL	=	9.3 mAHD
TWL_{10}	=	9.4 mAHD
S_{10}	=	368,000 m^3
TWL_{100}	=	9.6 mAHD
S_{100}	=	502,800 m^3

Treeby Rd Lake		
CGL	=	15.5 mAHD
TWL_{10}	=	15.8 mAHD
S_{10}	=	23,600 m^3
TWL_{100}	=	16.0 mAHD
S_{100}	=	31,500 m^3

Sandy Lake		
CGL	=	14.5 mAHD
TWL_{10}	=	14.6 mAHD
S_{10}	=	3,000 m^3
TWL_{100}	=	14.6 mAHD
S_{100}	=	5,500 m^3

Spectacles Wetland South		
CGL	=	9.3 mAHD
TWL_{10}	=	9.3 mAHD
S_{10}	=	98,900 m^3
TWL_{100}	=	9.5 mAHD
S_{100}	=	153,400 m^3

Johnson Road Wetland		
CGL	=	11 mAHD
TWL_{10}	=	11 mAHD
S_{10}	=	3,700 m^3
TWL_{100}	=	11 mAHD
S_{100}	=	4,100 m^3

Bollard Bulrush Swamp		
CGL	=	5.5 mAHD
TWL_{10}	=	4.8 mAHD
S_{10}	=	705,900 m^3
TWL_{100}	=	5.6 mAHD
S_{100}	=	1,826,800 m^3

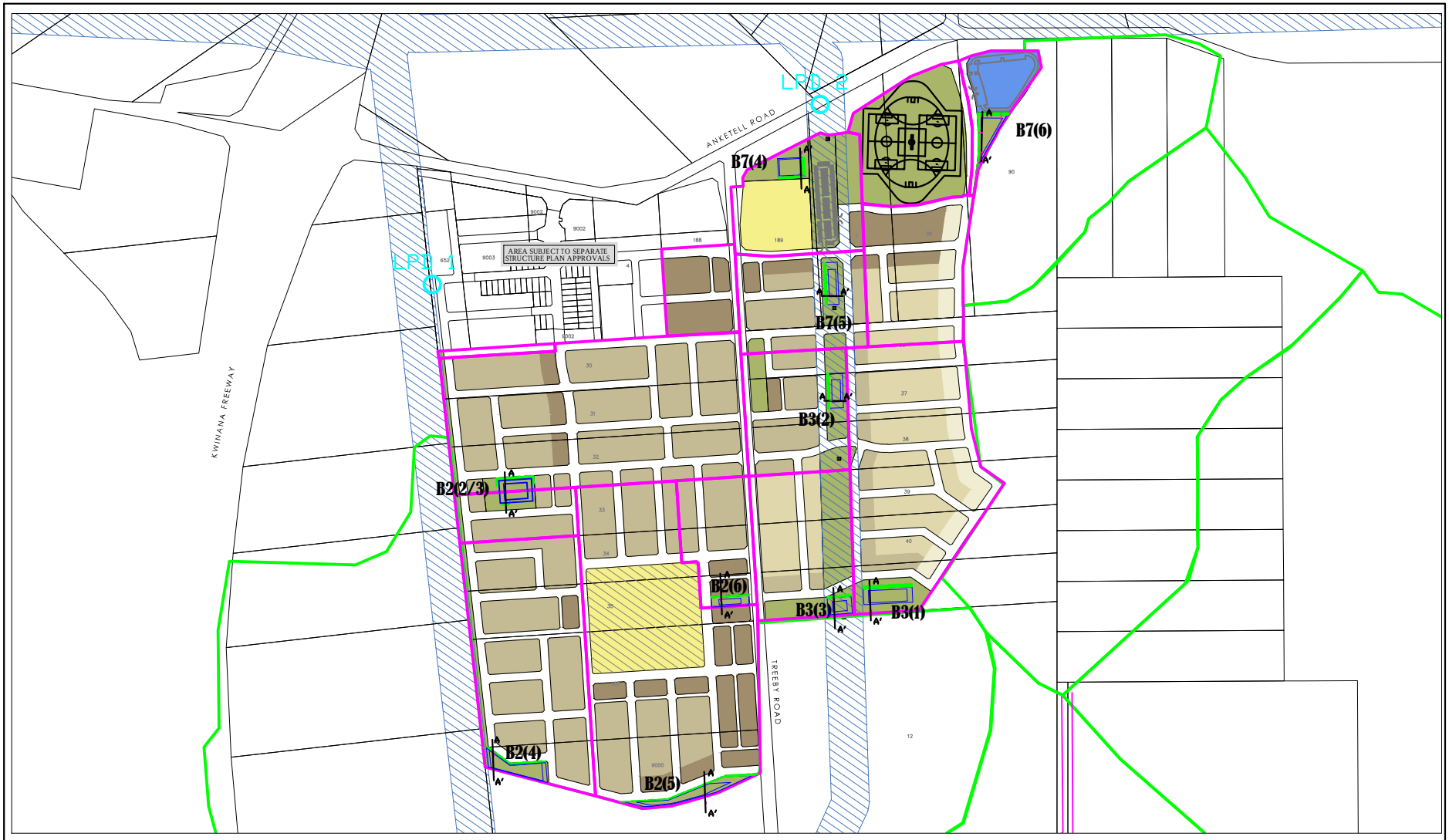
Mortimer Road Wetland		
CGL	=	10 mAHD
TWL_{10}	=	10 mAHD
S_{10}	=	31,100 m^3
TWL_{100}	=	10.1 mAHD
S_{100}	=	34,900 m^3

0 500 1000 1500 2000
SCALE OF METRES

Figure ES1

ULTIMATE DRAINAGE SYSTEM

Appendix D: Basin Cross-Sections and Rain Garden Details



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Catchment Boundary & Number

Surface Water Flow Direction

Storage Basins (e.g. B2(5) means BAsin NAme)

POS (also include swale, western boundary strip)

Rain gardens at POS entry

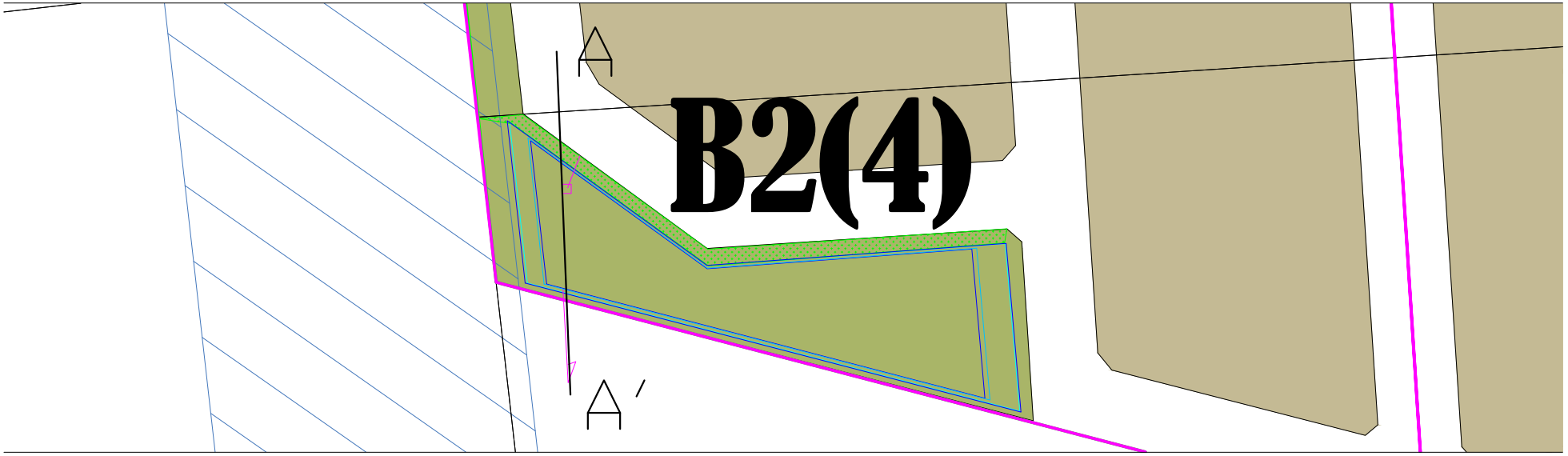
Data Source: Client supplied drawings

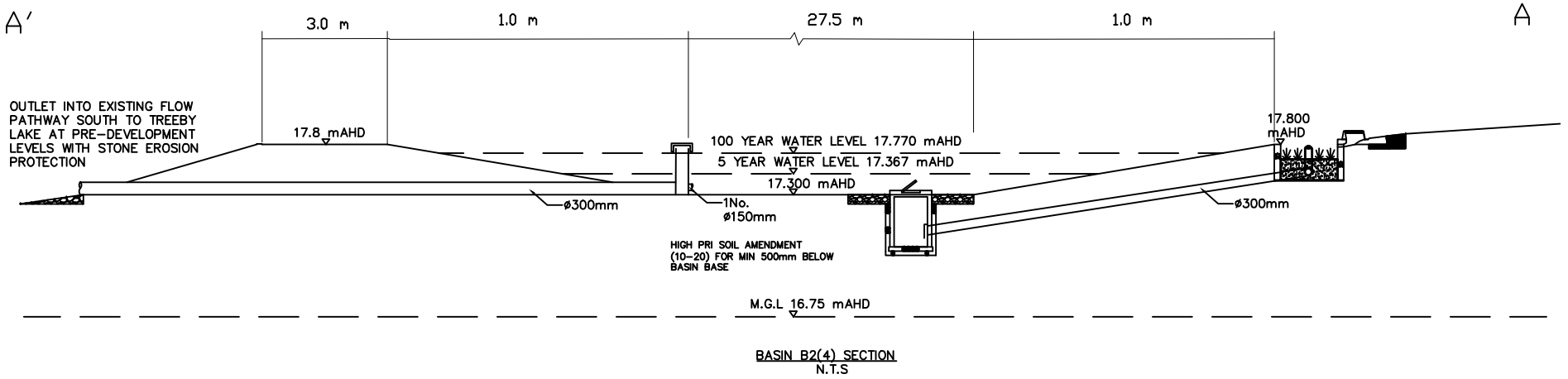
Bioscience Pty Ltd

Anketell North Urban Cell, City of Kwinana,Perth, WA

Local Water Management Strategy
24/05/2019

Appendix D: Basins and Rain Gardens AA' Cross Section Lines





BASIN B2(4) SECTION
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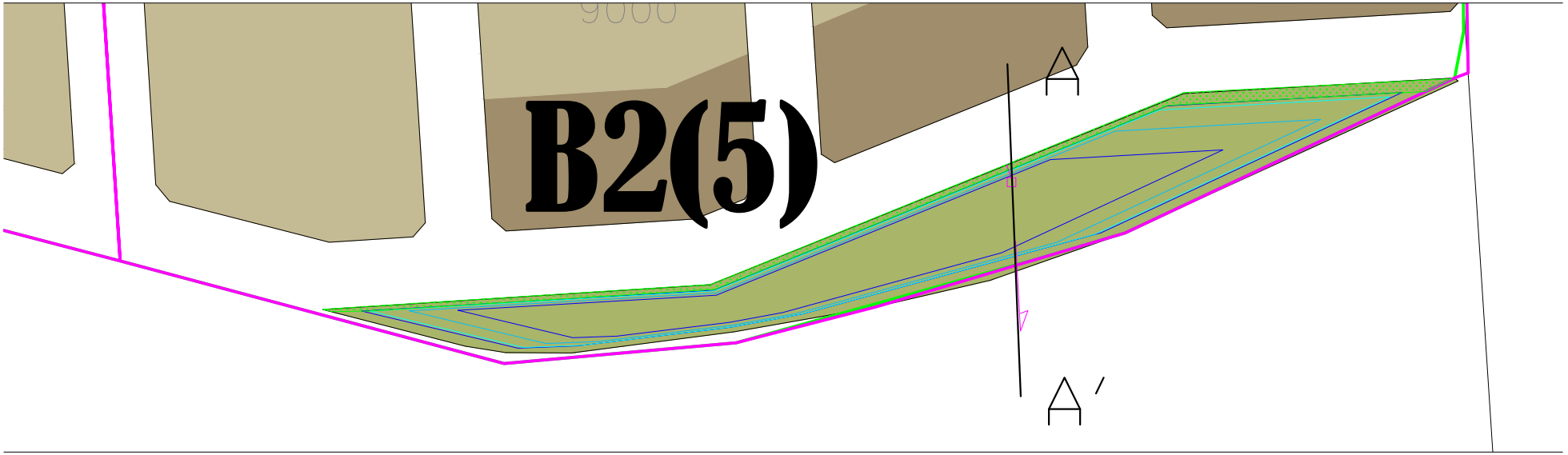

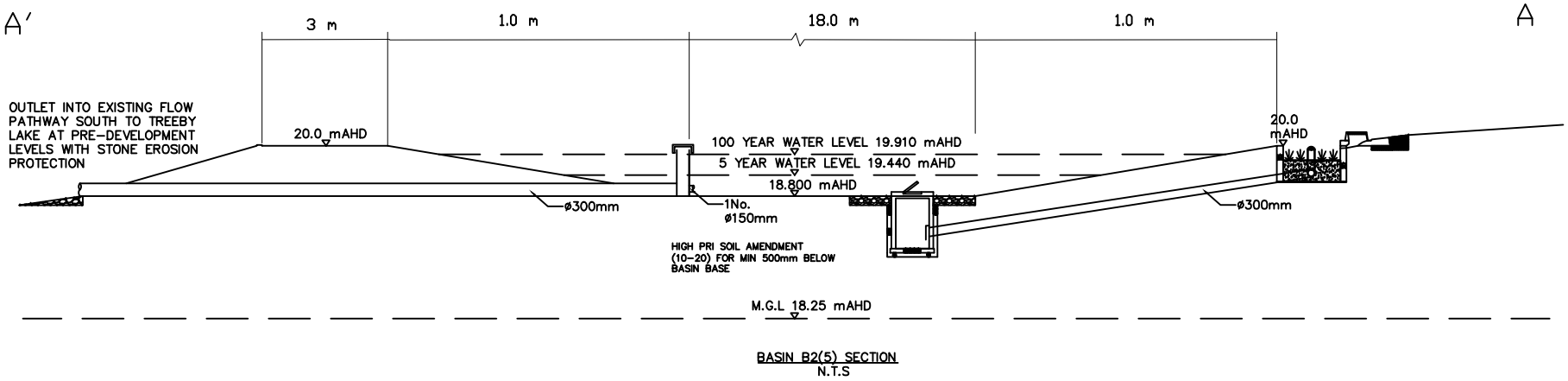

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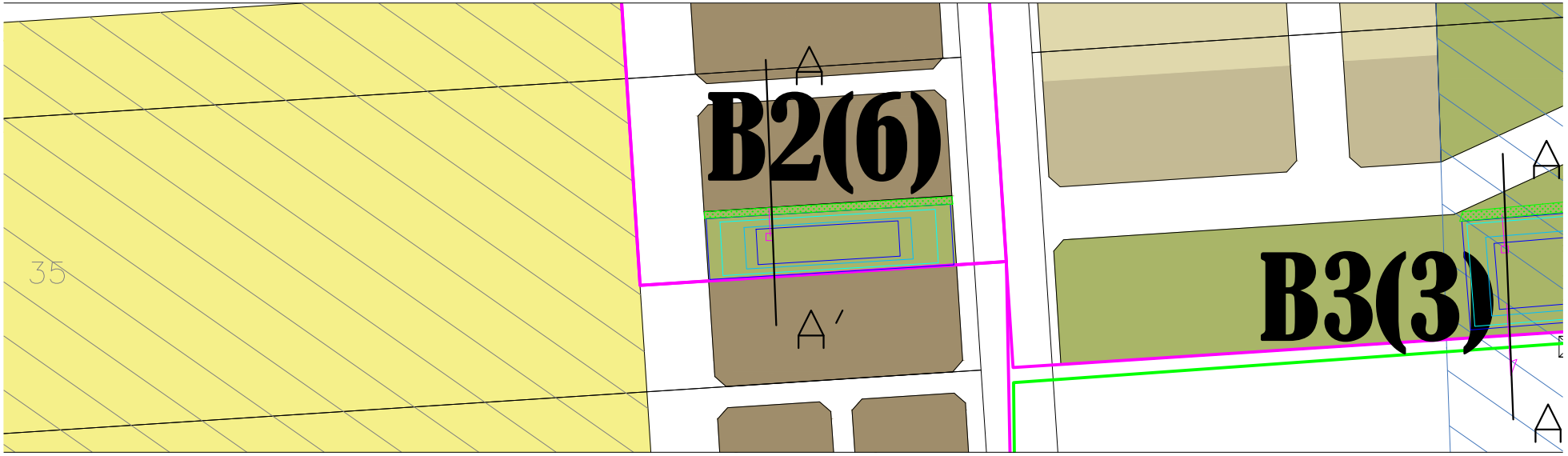

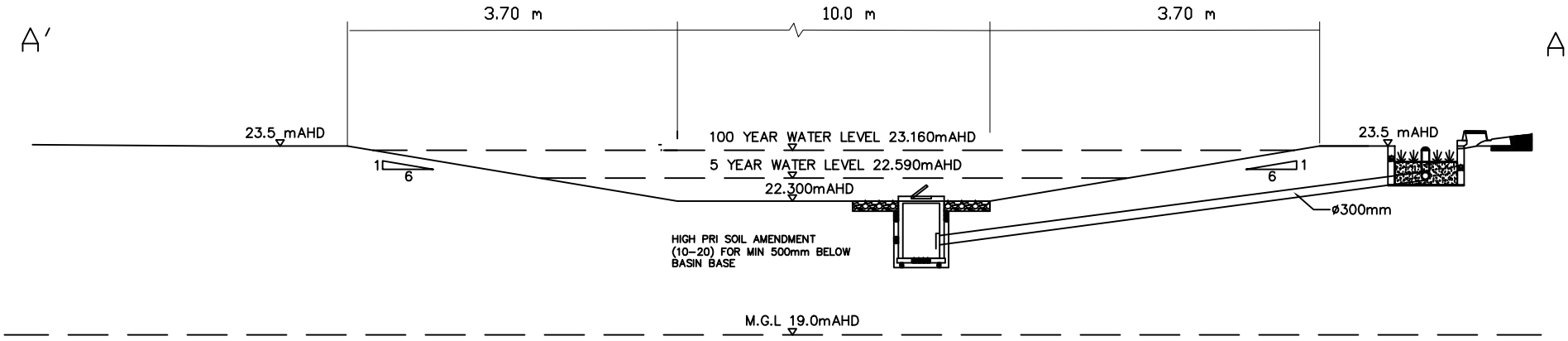

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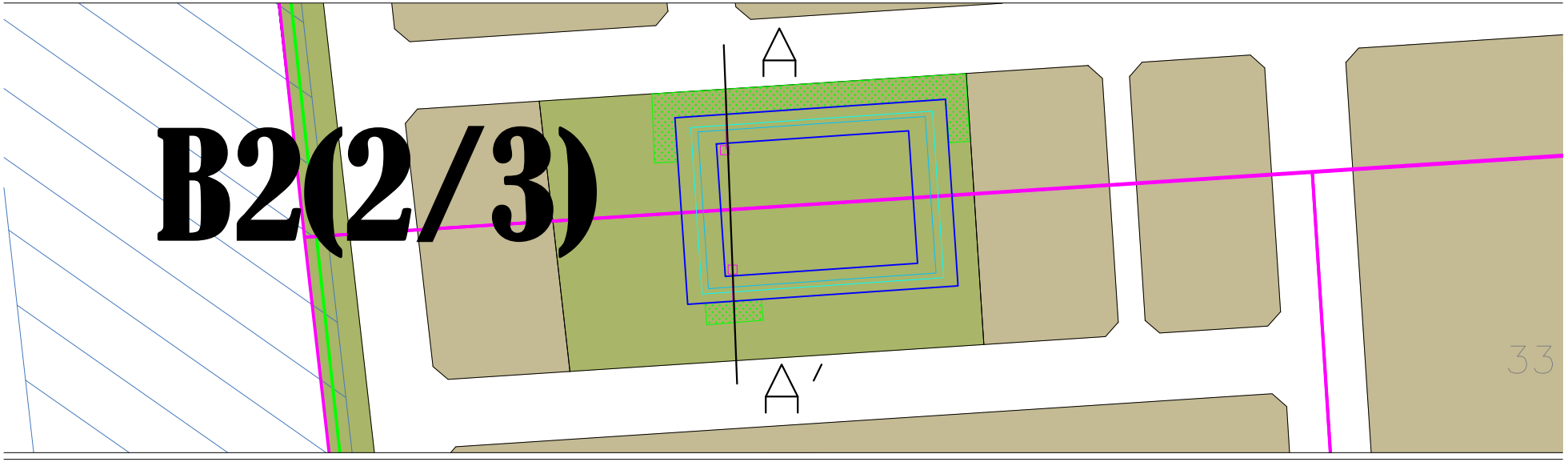

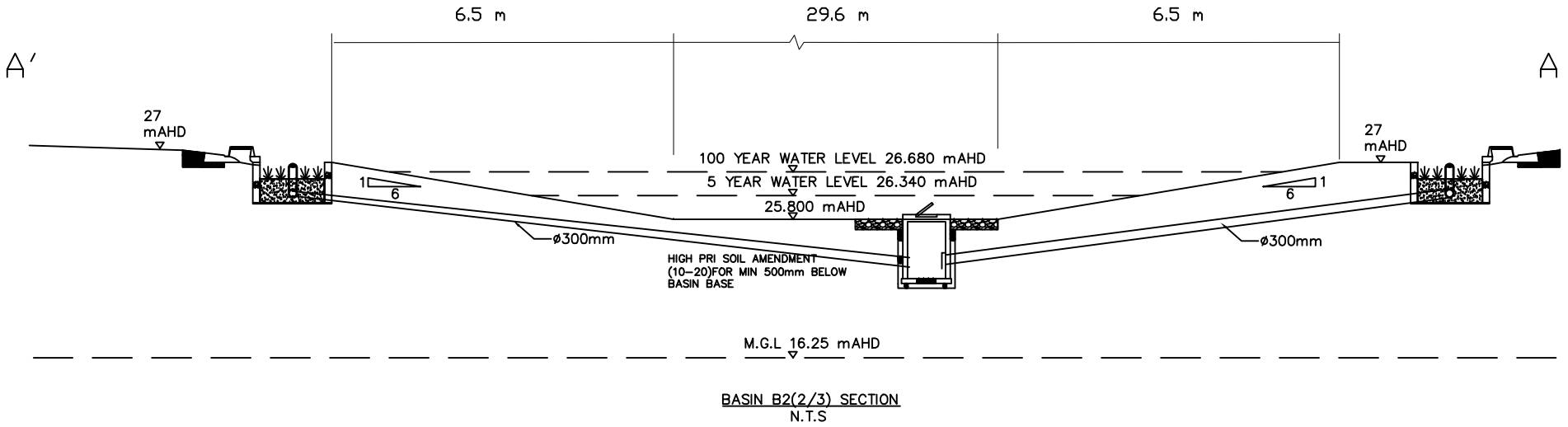

BASIN B2(2/3) SECTION
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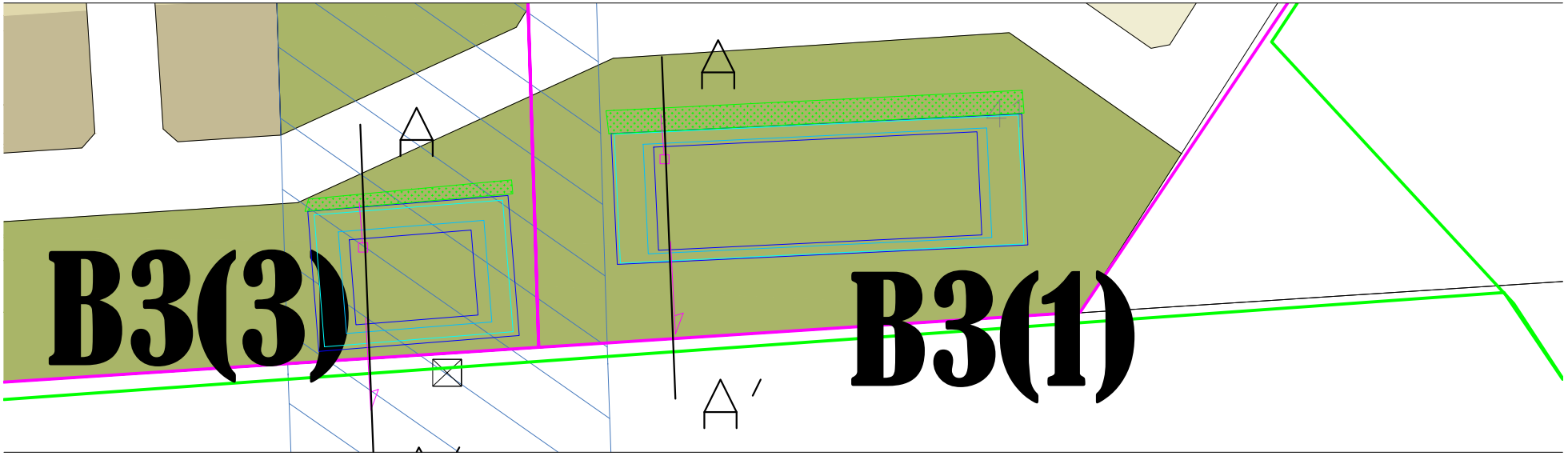

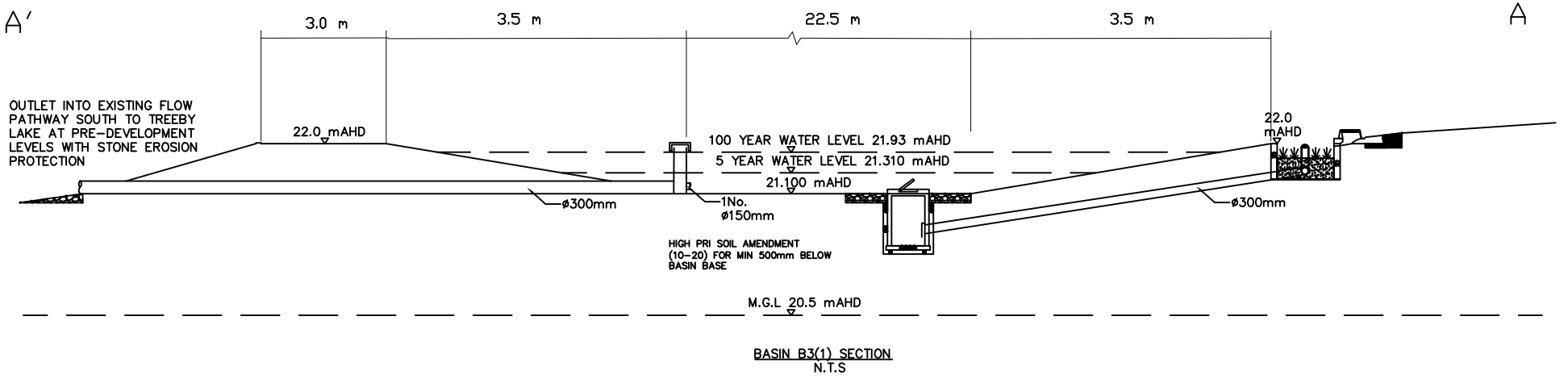

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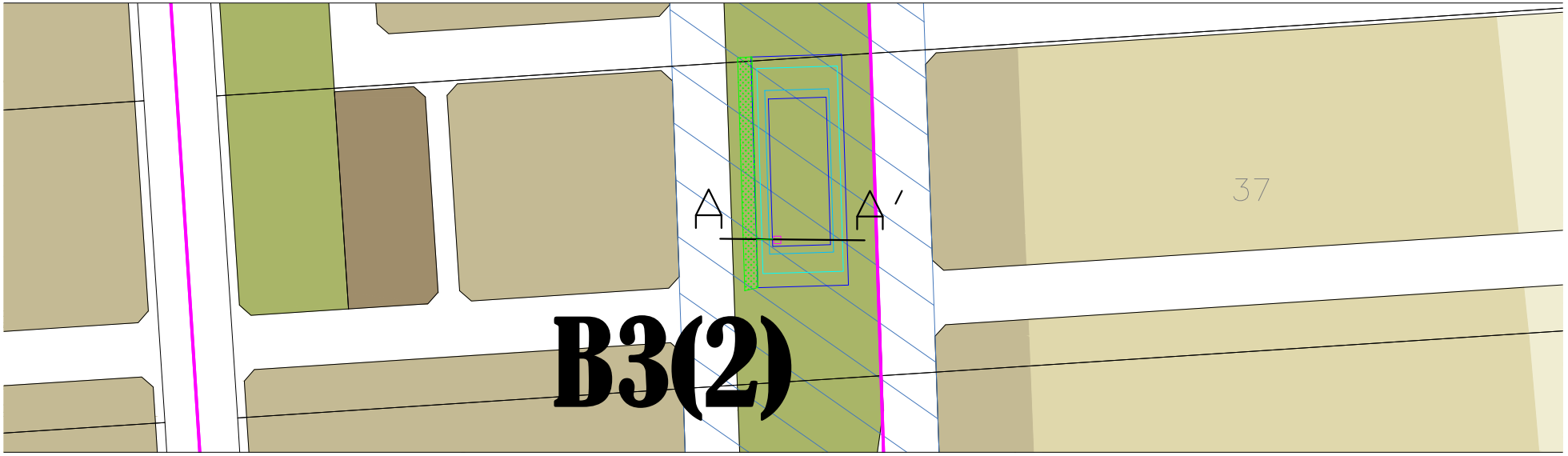

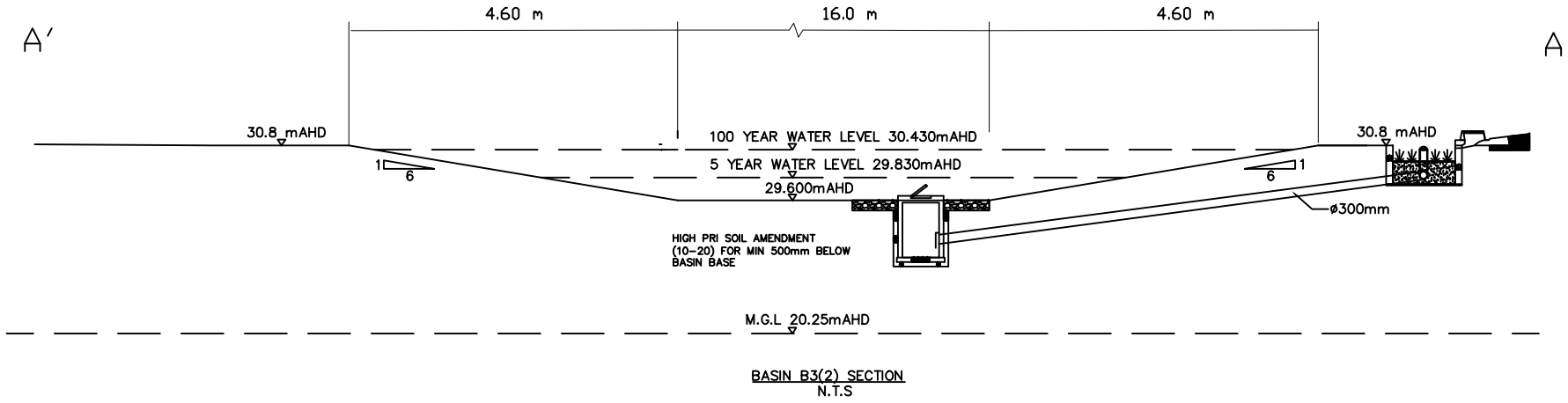

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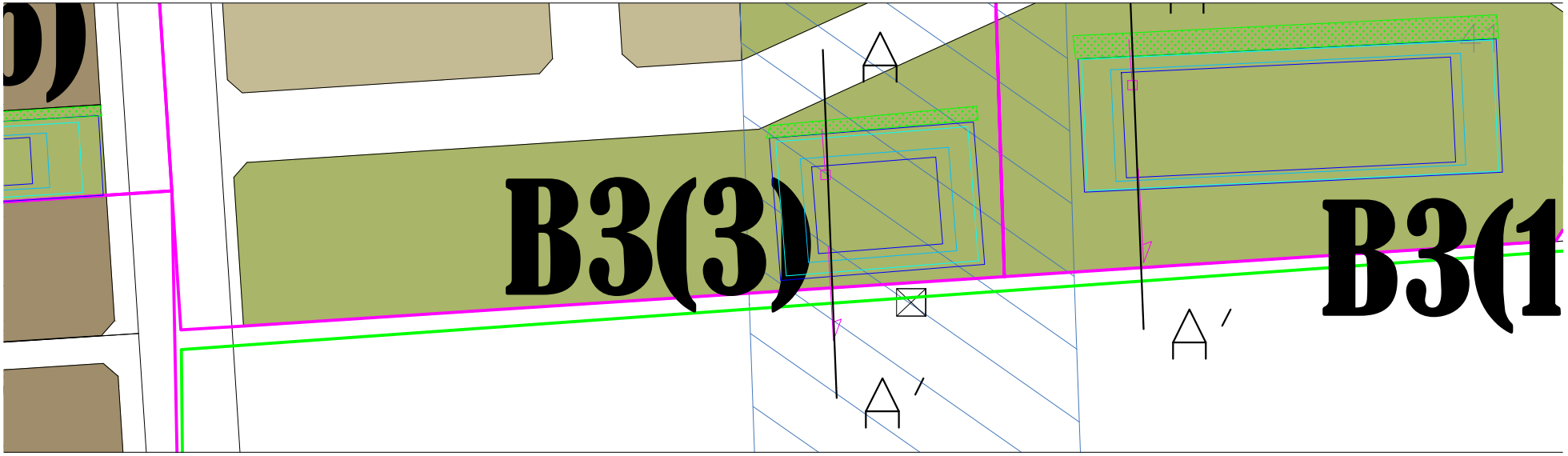

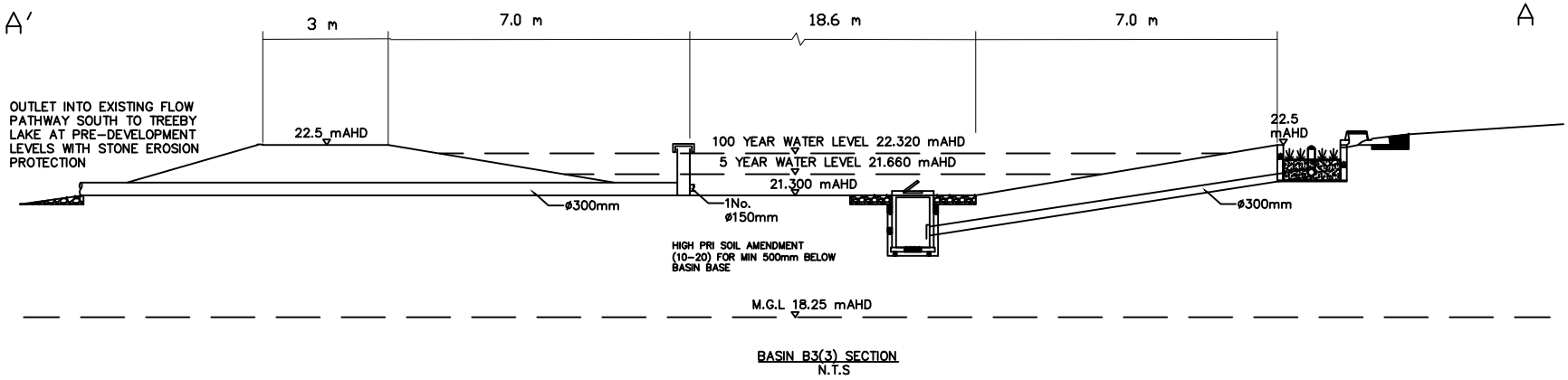

BASIN B3(3) SECTION
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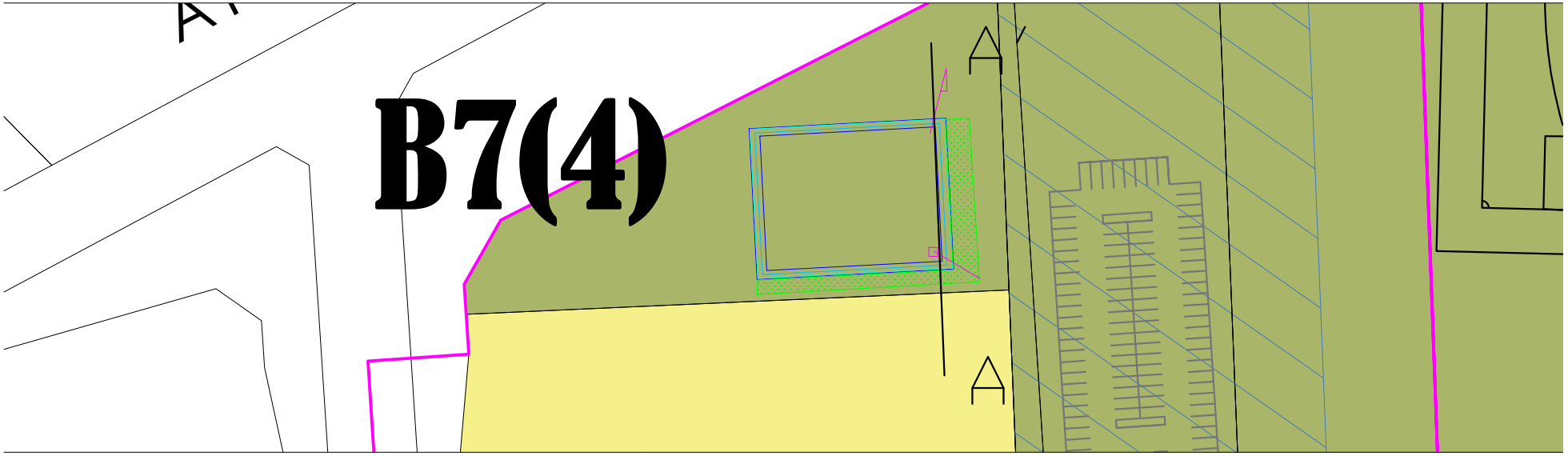
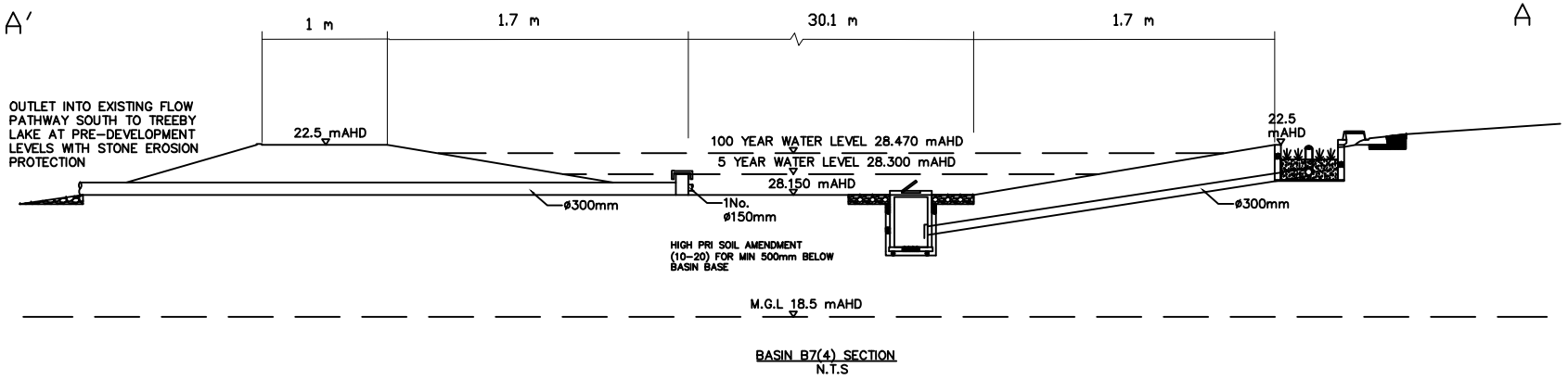
TITLE: ANKETELL NORTH URBAN CELL – BASIN B3(3) DETAILS

DATE: 23 / 05 /2019

DWG NO.: ANK007

REV.: A





BASIN B7(4) SECTION
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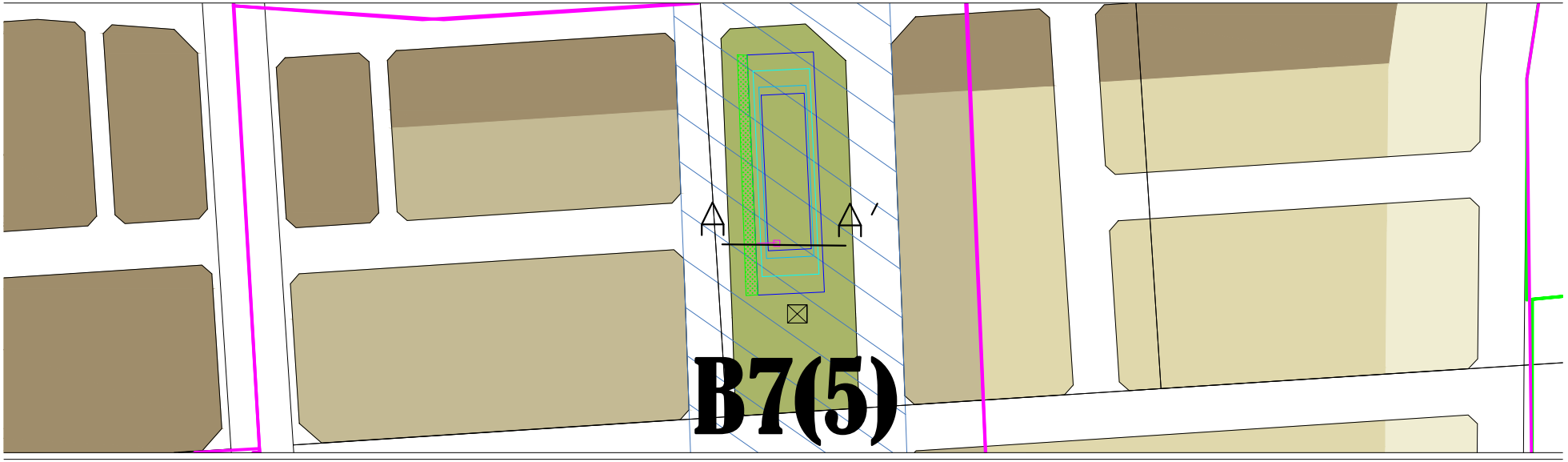
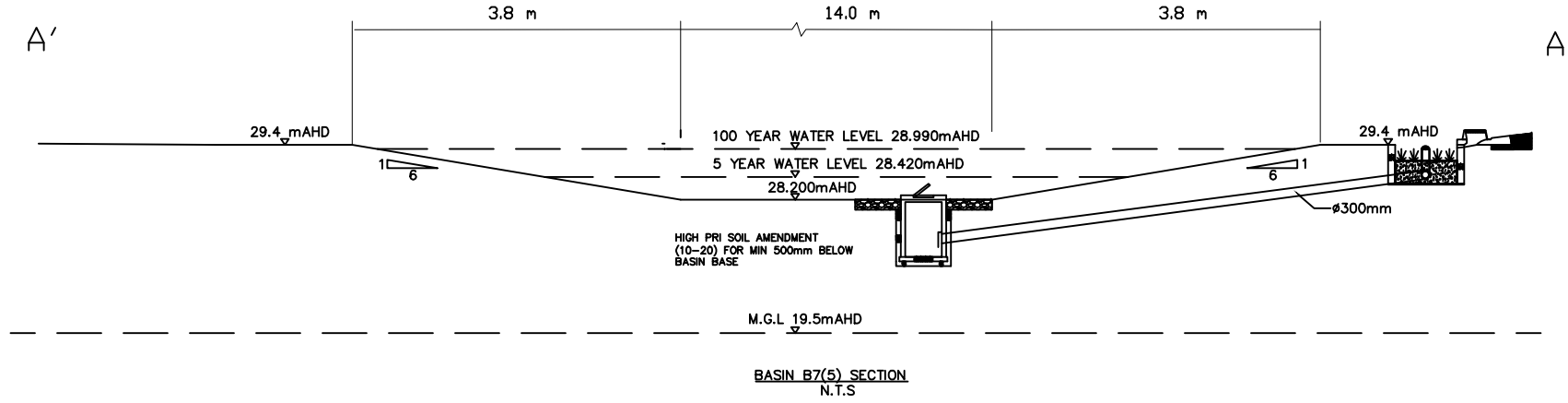
DATE: 23 / 05 /2019

DWG NO.: ANK008

REV.: A





BASIN B7(5) SECTION
N.T.S

Bioscience

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A	23/05/2019	FOR COMMENT	DA	PK
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SCALE:

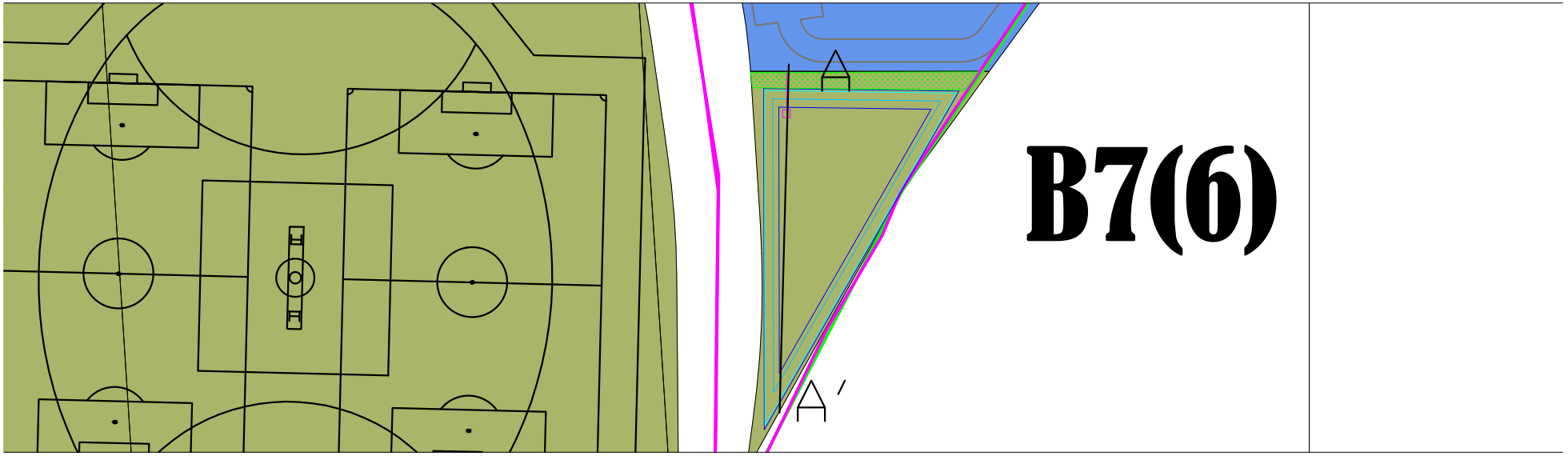
CLIENT: Acumen, TBB

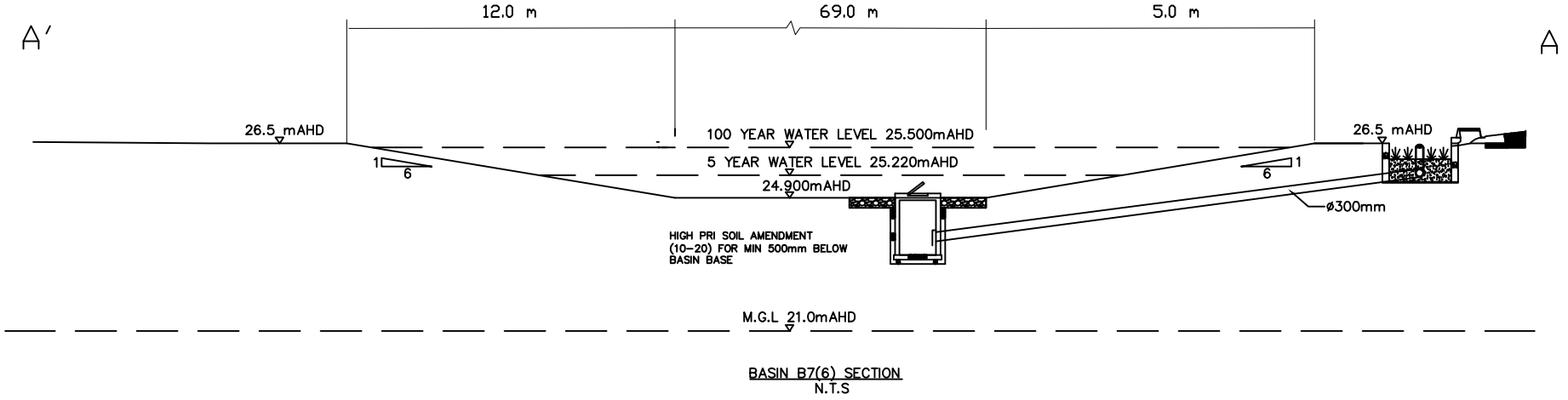
TITLE: ANKETELL NORTH URBAN CELL – BASIN B7(5) DETAILS

DATE: 23 / 05 /2019

DWG NO.: ANK009

REV.: A





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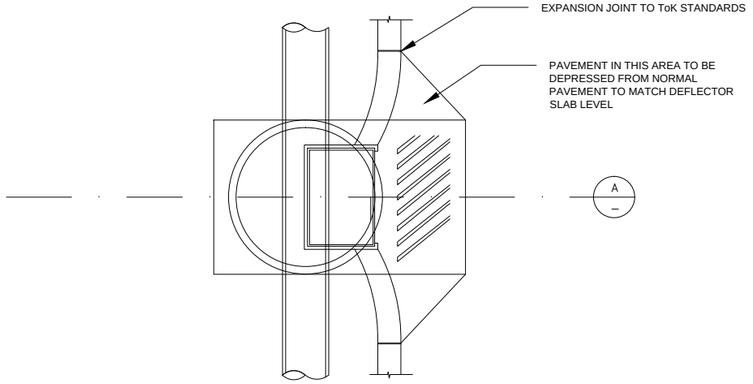
CLIENT: Acumen, TBB

TITLE: ANKETELL NORTH URBAN CELL – BASIN B7(6) DETAILS

DATE: 23 / 05 /2019

DWG NO.: ANK010

REV.: A



SIDE ENTRY PIT PLAN
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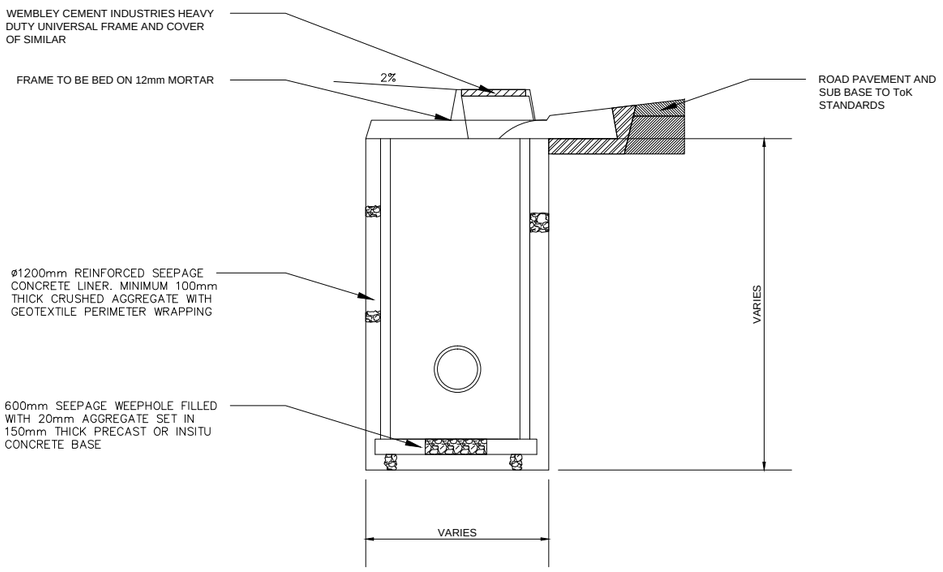

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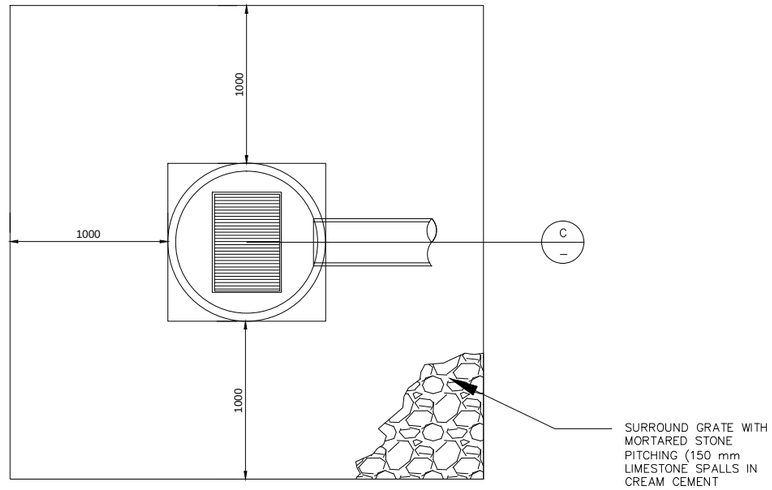

BUBBLE–UP PLAN
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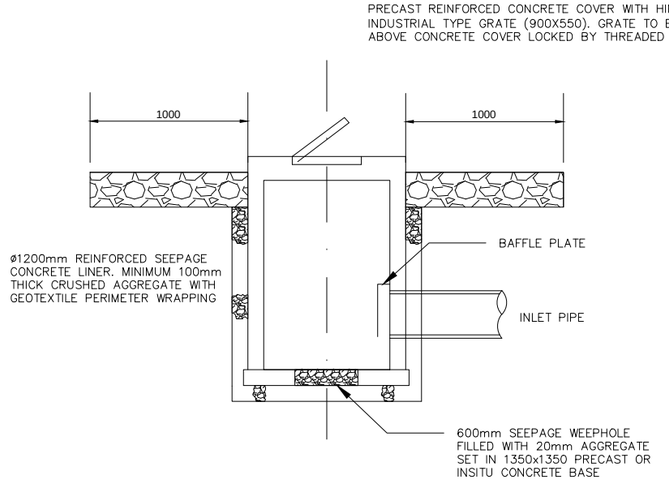

BUBBLE–UP SECTION (C)
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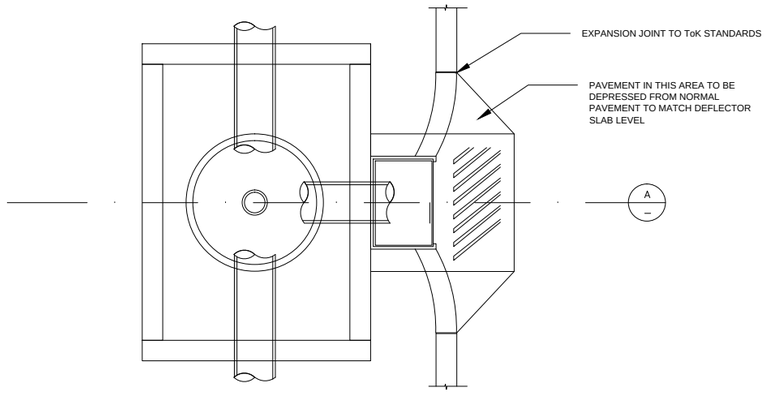
TITLE: ANKETELL NORTH URBAN CELL – SIDE ENTRY & BUBBLE UP PIT DETAILS

DATE: 20/11/2013

DWG NO.: BIO 001

REV.: A



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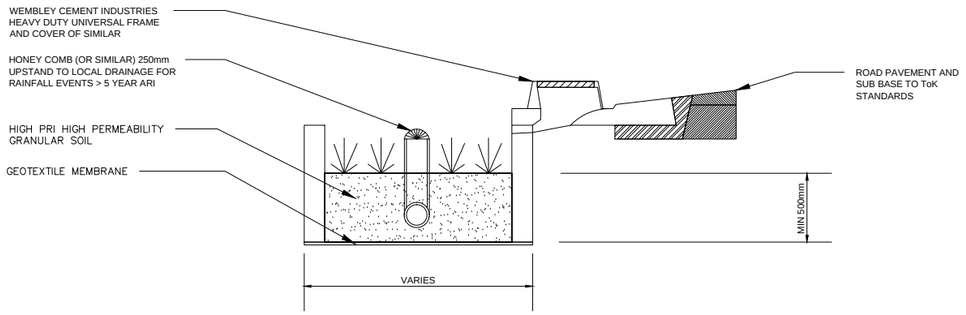

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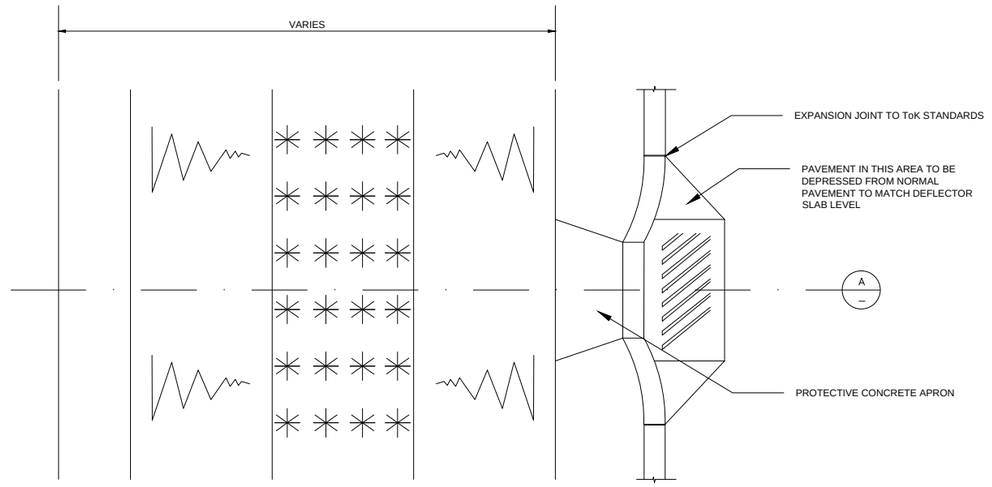

TYPICAL SWALE PLAN
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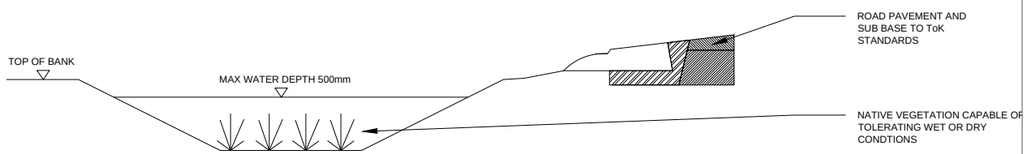

TYPICAL SWALE SECTION A
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SCALE: N.T.S

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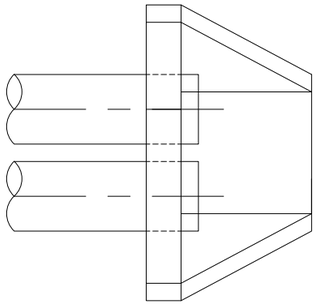
CLIENT: BIOSCIENCE

TITLE: ANKETELL NORTH URBAN CELL – TYPICAL RAIN GARDEN & SWALE DETAILS

DATE: 20/11/2013

DWG NO.: BIO 001B

REV.: A



DOUBLE HEADWALL PLAN
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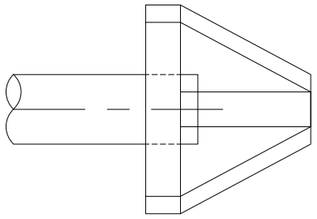

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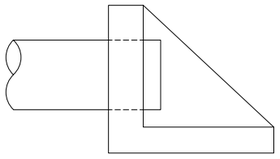

HEADWALL SIDE ELEVATION
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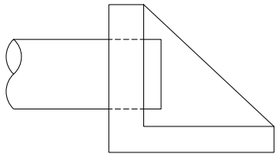

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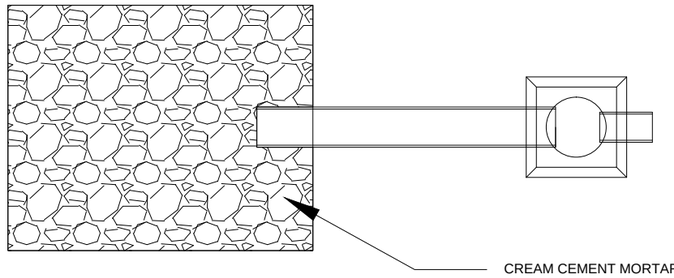

OUTFALL & RISER PLAN
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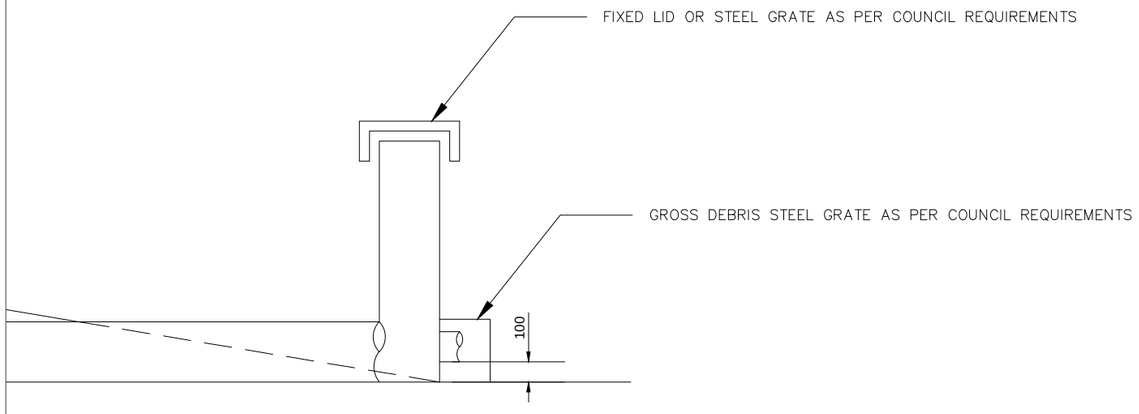

RISER SIDE ELEVATION
N.T.S

Bioscience

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SCALE: N.T.S

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CLIENT: BIOSCIENCE

TITLE: ANKETELL NORTH URBAN CELL – HEADWALL & RISER DETAILS

DATE: 20/11/2013

DWG NO.: BIO 002

REV.: A

APPENDIX G
LOCAL WATER MANAGEMENT STRATEGY ADDENDUM

27 February 2020

Your Ref:
Our Ref: H19062Av2

City of Kwinana
Cnr Gilmore Ave & Sulphur Road,
Kwinana WA 6167
ATTENTION: Nino Scidone

Dear Nino,

RE: ANKETELL NORTH, LOCAL WATER MANAGEMENT STRATEGY ADDENDUM

This Local Water Management Strategy (LWMS) addendum has been prepared by Hyd2o on behalf of Acumen Development Solutions in support of the revised Anketell North Local Structure Plan (LSP). The addendum report has been initiated through amendments made to the Anketell North LSP and has been prepared to review and refine the overall stormwater management strategy and stormwater modelling across the LSP area. This modelling will later be used to guide subdivision planning and the development of Urban Water Management Plans (UWMPs) within the site.

This report does not intend to reproduce all elements of the approved LWMS. It is intended to be read in conjunction with the previously approved LWMS (Bioscience, 2014) and to supersede post development stormwater modelling outcomes detailed in that report for the LSP area (herein referred to as the site). It should be noted that the key principles and objectives of the approved LWMS remain current.

This document provides a total water cycle management approach to development and has been prepared consistent with the previously approved LWMS for the site and Better Urban Water Management (Western Australian Planning Commission, 2008).

Note that recent updates to Australian Rainfall and Runoff (Ball et al, 2016) have resulted in changes in terminology to describe design rainfalls. Generally, Exceedance per Year (EY) terminology is recommended to be used for very frequent design rainfalls, Annual Exceedance Probability (AEP, %) used for frequent and infrequent design rainfalls, and AEP (1 in x) used for rare design rainfalls. These terms replace previous ARI terminology as follows in this report:

- 1 Year Average Rainfall Interval (ARI) – replaced with 1 EY
- 5 Year ARI – replaced with 0.2 EY
- 100 Year ARI – replaced with 1% AEP

1. SITE CHARACTERISTICS

The site is generally described as having the following predevelopment characteristics:

- The site is approximately 84 ha in area and located within the City of Kwinana. The site contains land adjacent to both sides of Treeby Rd immediately south of Anketell Rd (Figure 1), on the eastern side of the Kwinana Freeway.
- The existing land uses are predominantly rural including rural-residential, livestock grazing, rural business, and bushland.

- The topography is remnant of undulating coastal sand dunes and ranges from around a minimum of 17 mAHD near Treeby Road Lake to a maximum of 41 mAHD in the elevated central area adjacent to Treeby Rd.
- The Fremantle 1: 50,000 geology sheet (Gozzard, 1983) indicates that the site is underlain predominately by Sand (S7/S8) and Sand over Guildford Formation (S10), with some minor areas of Peaty Clay (Cps) and Sandy Silt (MS5) in low lying areas. Acid sulphate soil (ASS) mapping from Planning Bulletin no 64 (WAPC, 2003) indicates the majority of the site mapped as a moderate to low risk of ASS occurring within 3m of natural soil surface. The low lying areas have a high to moderate risk of ASS occurring within 3 m of natural surface.
- Key surface water features and topographic catchment are shown in Figure 1. The majority of the drains are to the south and are located in the catchments of Treeby Road Lake and the Peel Sub P Drain. Parts of the site also drain to the north and northwest. Bioscience (2014) defined allowable discharges from the site at key locations are also shown in Figure 1. It is important to note that the majority of rainfall would infiltrate through the subsurface profile and the topographic catchment shown in Figure 1 are likely to generate flows in major events only,
- The Jandakot Drainage and Water Management Plan (Department of Water DoW, 2009) indicates that there is no contribution to the Peel Sub P drain from Treeby Rd Lake in a 1% AEP event. The estimated 1% AEP event level for Treeby Road Lake is 16.0 mAHD (DoW, 2009). Treeby Road Lake does however have a 300mm diameter overflow connection to the drain at 17.0 mAHD should this ever be required.
- According to the Department of Biodiversity Conservation and Attraction (DBCA) Geomorphic Wetlands of the Swan Coastal Plain dataset, the site contains conservation category and multiple use wetlands (Figure 1). With respect to the wetlands located in Lot 13, the Department of Planning agreed to a Bush Forever Negotiated Planning Solution (NPS), whereby the development of an ecological linkage between Anketell North and South urban cells has been accepted as an appropriate measure for offsetting any loss of biodiversity that may incur as a result of development within Lot 13 (Rowe Group, 2011).
- Endemic & Associates prepared a Wetland Management Plan (2010) and a Wetland and Rehabilitation Management Plan: Lot 13 Treeby Road, Anketell (2017) for the site in accordance with the agreed boundaries. The WRMP provides an approach for clean-up, vegetation protection, rehabilitation and weed management for the site.

2. GROUNDWATER MAPPING

The original LWMS (Bioscience, 2014) utilised monitored bore data previously installed and collected by JDA Consultant Hydrologists. Further monitoring was then carried out VDM Consulting, and at least one winter peak reading for each site bore was collected between May 2005 and January 2009. This Addendum report has re-interpreted this data in the context of long term DWER groundwater bores near the site to refine groundwater mapping of both the average annual maximum groundwater level (AAMGL) and maximum groundwater level (MGL) for use in stormwater modelling.

Monitored data at each site bore was used for analysis and correlated to long term historical DWER bore data to calculate AAMGL and MGL for each bore on site. September groundwater levels (representative of winter maximum levels) recorded at each bore specific to the period they were monitored are shown in Table 1. The AAMGL and MGL for the DWER bores (JE22C and Anketell Site A) for the full extent of their records (including more recent data to 2019) are presented in Table 2 and Table 3 respectively. Hydrographs for JE22C and Anketell Site are shown in Attachment 1. Differences between the relevant September reading at JE22C and Anketell Site A and the calculated AAMGL and MGL for their full records are also shown in Table 2 and Table 3 and are used as correction values for site bores to calculate the AAMGL and MGL at these locations (Table 4).

Figure 2 shows MGL and AAMGL contour mapping based on the calculated values across the site. The lowest groundwater levels were recorded at WAM11 while the highest levels were recorded at WAM6d. At bore locations the AAMGL ranged from 13.24 to 20.20 mAHD and the MGL ranged from 14.21 to 21.57 mAHD. Groundwater can be seen to generally flow west towards the coast consistent with the Perth Groundwater Map (Department of Water and Environmental Regulation, DWER, 2019). Groundwater levels have a considerable gradient across the site with a fall of 7 meters in groundwater elevation from east to west.

Note that while the sites groundwater data is relatively old, it is still considered valid for use in determining AAMGL and MGL as there has been no significant land use change within the site since the original readings, and more recent DWER data has been used in these calculations in order to consider any recent groundwater variations.

Individual UWMP's will however be required to provide updated data for on-site groundwater levels and quality to refined estimates locally, particularly for areas were groundwater is considered close to natural surface.

Table 1: Groundwater Level Monitoring Results

Bore	Easting	Northing	Top of Casing mAHD	Peak Reading Date	Peak Reading mAHD
WAM5d	392819	6436200	29.25	27-09-05	20.06
WAM6d	392948	6435906	29.10	27-09-05	21.08
WAM7d	392498	6435095	34.57	27-09-05	18.97
WAM8d	392718	6434838	21.48	27-09-05	20.06
WAM9d	392002	6434769	18.79	26-09-05	15.8
WAM10d	392545	6433942	19.32	26-0-05	17.37
WAM11	392144	6435637	30.88	27-09-05	13.72
WAM13d	392021	6436000	15.51	27-09-05	14.13
WAM14	392597	6433559	18.61	11-09-08	16.81
WAM16d	392117	6433763	16.71	11-09-08	15.19

Table 2: DWER Bore AAMGL

Long Term DWER Bore	Period of Record	AAMGL (1994-2019) (m AHD)	GW Level (mAHD) Sep 2005	Correction Factor for Site Bores to AAMGL Sep 2005 (m)	GW Level (m AHD) Sep 2008	Correction Factor for Site Bores to AAMGL Sep 2008 (m)
JE22C	1994-2019	17.87	18.25	-0.38	17.86	0.01
Anketell Site A	1994-2019	20.37	20.94	-0.57	20.49	-0.12

Table 3: DWER Bore MGL

Long Term DWER Bore	Period of Record	MGL (1994-2019) (m AHD)	GW Level (m AHD) Sep 2005	Correction Factor for Site Bores to MGL Sep 2005 (m)	GW Level (m AHD) Sep 2008	Correction Factor for Site Bores to MGL Sep 2008 (m)
JE22C	1994-2019	18.77	18.25	0.52	17.86	0.91
Anketell Site A	1994-2019	21.40	20.94	0.46	20.49	0.90

Table 4: Estimated Site Bores AAMGL and MGL

Bore	GW Level (m AHD) Sep Reading	Correction (m)	AAMGL (m AHD)	Correction (m)	MGL (m AHD)
WAM5d	20.06	-0.48	19.58	+0.49	20.55
WAM6d	21.08	-0.48	20.60	+0.49	21.57
WAM7d	18.97	-0.48	18.49	+0.49	19.46
WAM8d	20.06	-0.48	19.58	+0.49	20.55
WAM9d	15.80	-0.48	15.32	+0.49	16.29
WAM10d	17.37	-0.48	16.89	+0.49	17.86
WAM11	13.72	-0.48	13.24	+0.49	14.21
WAM13d	14.13	-0.48	13.65	+0.49	14.62
WAM14	16.81	-0.06	16.75	+0.91	17.72
WAM16d	15.19	-0.06	15.13	+0.91	16.10

3. MODIFIED STRUCTURE PLAN

A copy of the revised structure plan for the site is included as Attachment 2.

Proposed land use within the site is generally consistent with that shown in the original LSP and LWMS (Bioscience 2014), albeit with the relocation of the main POS sports facility to Anketell Rd and the associated realignment of roads and lots across the site as a result.

These changes have resulted in modifications to the post development drainage routes and local catchment boundaries which are detailed in this report.

4. POS IRRIGATION

There are a number of distributed POS areas located within the site. Some of these areas will be used for drainage and will consist of integrated and landscaped stormwater storage areas. Landscape planning and architecture for the site is currently underway and all documentation will be provided as a separate process to this report. Landscape plans will include a description of the proposed POS landscaping including plant species and identification of areas required for stormwater for both minor (water quality) and major (flood management) events.

Details of calculations for stormwater volumes which will be used to inform landscape planning are contained in Section 5.

POS irrigation is proposed through the use of a groundwater bore. The site is located within the Serpentine groundwater area and Jandakot Mound 1 groundwater subarea for which there is water allocation available in the superficial aquifer. Ten existing licences within the site are shown in Figure 3 and total an existing groundwater allocation of 357,300 kl/yr.

Based on the total POS area (including powerline corridor) of approximately 13.2 ha and an irrigation rate of 6,750 kL/ha/yr, it is estimated approximately 89,100 k/L per annum will be required. More than sufficient water therefore exists within the site via transfer of existing licences for long term POS irrigation.

All groundwater licences will be ultimately transferred to the City of Kwinana on the handover of POS area.

5. STORMWATER MANAGEMENT

Stormwater management is proposed to be undertaken consistent with DWER water sensitive design practices. The system will consist of a series of lot soakwells, piped road drainage system, bioretention areas for water quality treatment and infiltration areas for water quantity management within POS areas.

The system will also include measures such as raingardens and roadside swales, with these opportunities to be identified at UWMP stage within suitable roads to ultimately reduce the 15mm biofiltration areas shown in this LWMS Addendum.

Based on the revised structure plan, updated post-development drainage catchments are shown in Figure 4. The revised LSP has been split into 10 separate post-development drainage catchments, with a further two areas being managed external to the site.

Catchments I and G are proposed to discharge to the Treeby Road Lake during major events while all other catchments are proposed to be infiltrated and retained on site.

Various runoff coefficients applied to different land uses for each of the events modelled are shown in Table 5. These have been determined using Hyd2o's CUURV runoff rate calculator shown in Attachment 3. These rates assume all residential lots greater than 300 m^2 will have soakwells sized to retain a 15 mm event on site, and the commercial area and school site will be required to manage all events up to the 1% AEP within their sites.

Stormwater modelling for the POS/drainage reserves was undertaken by Hyd2o using the PONDS groundwater infiltration model to determine flood storage requirements and provide an assessment of areas required for distributed stormwater infiltration. PONDS is a program specifically designed for modelling groundwater/surface water interactions for the design of stormwater infiltration areas, based on the finite difference computer program MODFLOW, development by the U.S. Geological Survey.

The design storms modelled by PONDS were calculated with reference to the methodology in Australian Rainfall and Runoff (AR&R) and the Bureau of Meteorology Computerised Design IFD Rainfall System (CDIRS). The rainfall temporal pattern was assumed to be spatially uniform across the catchment. Storm durations modelled ranged from 10 minutes to 72 hours.

For modelling purposes, a permeability rate of 5 m/day was adopted. This rate is considered likely to be conservative given the sites sandy soils. Further site specific soil infiltration testing will be required in due course to inform detailed design during the UWMP stages for individual development areas.

A stormwater event plan for the site is contained as Figure 5 with a table of modelling results contained as Table 5. Modelling outputs are also shown in Attachment 4 and reflected through indicative stormwater storage sections provided in Attachment 5.

Total storage volume and area across the site for the 15mm event are estimated as approximately 2731 m^3 and 0.91 ha, increasing to 13,306 m^3 and 2.21 ha, for the 1% AEP event. This equates to 1.09 % and 2.65 % of the total contributing catchment areas for 15mm and 1% AEP events respectively.

Note that storage shapes shown in Figure 5 are indicative only for determination of area requirements and representation of the storage area required.

The final flood attenuation area configuration (side slopes etc.), locations, and elevations will be documented in future UWMPs and will be dependent on final earthworks, drainage, landscaping and road design levels for the development. Volumes and area requirements will also be refined at UWMP stage based the adoption where practical of other upstream stormwater management measures such as raingardens and roadside swales.

With respect to stormwater biofiltration areas adjacent to Treeby Road Lake these areas will be required to demonstrate at UWMP stage the design of suitable spillways and use of diffuse overland flow methods to reduce discharge velocities and avoid erosion and scouring. This will be undertaken in consultation with relevant agencies.

Table 5: Stormwater Management

Catchment	A	B	C	D	E	F	G	H	I	J	K
Lots R20 (ha)	1.40	-	-	0.44	-	-	-	-	-	-	-
Lots R25 (ha)	6.76	-	-	0.79	-	-	-	-	-	-	-
Lots R30 (ha)	2.03	1.59	0.62	0.25	-	1.71	2.07	8.46	8.79	-	0.47
Lots R40 (ha)	-	0.15	0.41	1.37	-	0.42	2.47	0.45	0.36	-	0.09
School (ha)	-	-	-	-	-	-	3.99	-	-	-	-
POS (ha)	2.81	1.16	0.49	0.33	1.55	0.14	0.29	0.83	0.71	4.88	0.09
Commercial (ha)	-	-	-	1.20	-	-	-	-	-	-	-
Community (ha)	-	-	-	-	1.64	-	-	-	-	-	-
Road Reserve (ha)	5.02	1.20	0.91	2.31	0.16	0.99	2.31	4.35	4.52	-	0.39
Total Area (ha)	18.02	4.01	2.43	6.69	3.36	3.26	11.10	14.10	14.40	4.88	1.05
Equiv Imp Area (15mm event) (ha)	3.47	0.90	0.83	2.30	0.11	0.90	2.86	3.23	3.30	-	0.32
Equiv Imp Area (20% &1% AEP) (ha)	8.90	1.94	1.33	3.36	1.17	1.81	4.22	7.59	7.80	-	0.59
Storage Characteristics											
MGL (mAHD)	20.5	20.5	19.7	21.5	18.5	18.5	16.9	16.7	16.5	No Storage	15.0
Side Slopes (v:h)											
Biofilter	0	0	0	0	0	0	0	0	0		0
Flood Storage	6	6	6	6	6	6	6	6	6		6
K (m/day)	5	5	5	5	5	5	5	5	5		5
Water Quality : 15 mm Event											
Invert (mAHD)	22.4	29.4	27.4	25.9	27.9	20.9	18.2	25.4	17.2	On Site Infiltration	27.9
Base Area (m²)	1733	450	413	1150	53	450	1430	1613	1650		160
Flood Rise (m)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30		0.30
TWL (mAHD)	22.7	29.7	27.7	26.2	28.2	21.2	18.5	25.7	17.5		28.2
Volume (m³)	520	135	124	345	16	135	429	484	495		48
TWL Area (m²)	1733	450	413	1150	53	450	1430	1613	1650		160
Flood Management : 20% AEP (separate area to 15mm storage area)											
Invert (mAHD)	21.5	28.5	26.5	25.0	27.0	20.0	To wetland	24.5	To wetland	On Site Infiltration	27.0
Base Area (m²)	3040	285	150	525	208	204		1625			36
Flood Rise (m)	0.34	0.68	0.64	0.58	0.62	0.68		0.60			0.64
TWL (mAHD)	21.84	29.18	27.14	25.58	27.62	20.68		25.10			27.64
Volume (m³)	1112	302	170	411	218	264		1182			72
TWL Area (m²)	3538	629	401	921	516	597		2325			210
Critical storm (hr)	3	6	6	3	6	6		3			6
Flood Management : 1% AEP (separate area to 15mm storage area)											
Flood Rise (m)	1.14	1.15	1.09	1.11	1.03	1.13	To wetland	1.19	To wetland	On Site Infiltration	1.02
TWL (mAHD)	22.64	29.65	27.59	26.11	28.03	21.13		25.69			28.02
Volume (m³)	4428	669	405	1026	473	602		2796			176
TWL Area (m²)	4841	945	648	1368	781	903		3114			369
Critical Storm (hr)	24	12	12	24	12	12		12			12

Minor refinements to catchment areas shown in this report are considered likely to occur as detailed design proceeds, and stormwater modelling will be updated accordingly during the UWMP process.

As several catchments propose utilisation of the powerline corridor for infiltration of stormwater, an application was submitted to Western Power for their advice/consideration. Western Power has provided advice indicating this approach as acceptable subject to specific conditions as detailed in Attachment 6. These conditions include no excavation works being located 20 m of tower foundations, and that detailed design drawings are to be submitted to Western Power for review at later stages of planning and detailed design.

6. CONCLUSIONS/RECOMMENDATIONS

This addendum provides revised groundwater mapping and stormwater modelling for the site to address proposed LSP changes since the approval of the original Anketell North Local Water Management Strategy (Bioscience, 2014).

The updated stormwater management modelling in this report takes into consideration revised LSP changes and associated catchment and earthworks modifications to revise post development stormwater requirements for the site. It is recommended that modelling contained in this addendum be used as the basis for guiding future subdivision development within the site and the development of future UWMPs.

Aside from the revised groundwater mapping and stormwater modelling detailed in this report, all principles and objectives of the approved LWMS (Bioscience, 2014) remain valid for implementation.

7. REFERENCES

Bioscience (2014) Anketell North Urban Cell Local Water Management Strategy.

Department of Environment and Water Regulation (2019). Perth Groundwater Map (online)

Department of Water (2007). Stormwater Management Manual for Western Australia

Department of Water (2009) Jandakot Drainage and Water Management Plan: Peel Main Drain Catchment. 2009

Endemic & Associates (2010) Wetland Management Strategy, Anketell Central Cell (Lots 13 and 100 Treeby Road, Anketell).

Endemic & Associates (2017) Wetland and Rehabilitation Management Plan Lot 13 Treeby Road, Anketell

Gozzard, J. R. (1983) Fremantle Part Sheets 2033 I and 2033 IV, Perth Metropolitan Region Environmental Geology Series. Geological Survey of Western Australia, Department of Minerals and Energy, Perth.

Western Australian Planning Commission (2008). Better Urban Water Management. Government of Australia, October 2008.

Should you have any queries regarding this report, please do not hesitate to contact Sasha Martens or Suzanne Smart of this office.

Yours sincerely,

Sasha Martens, Principal Engineering Hydrologist

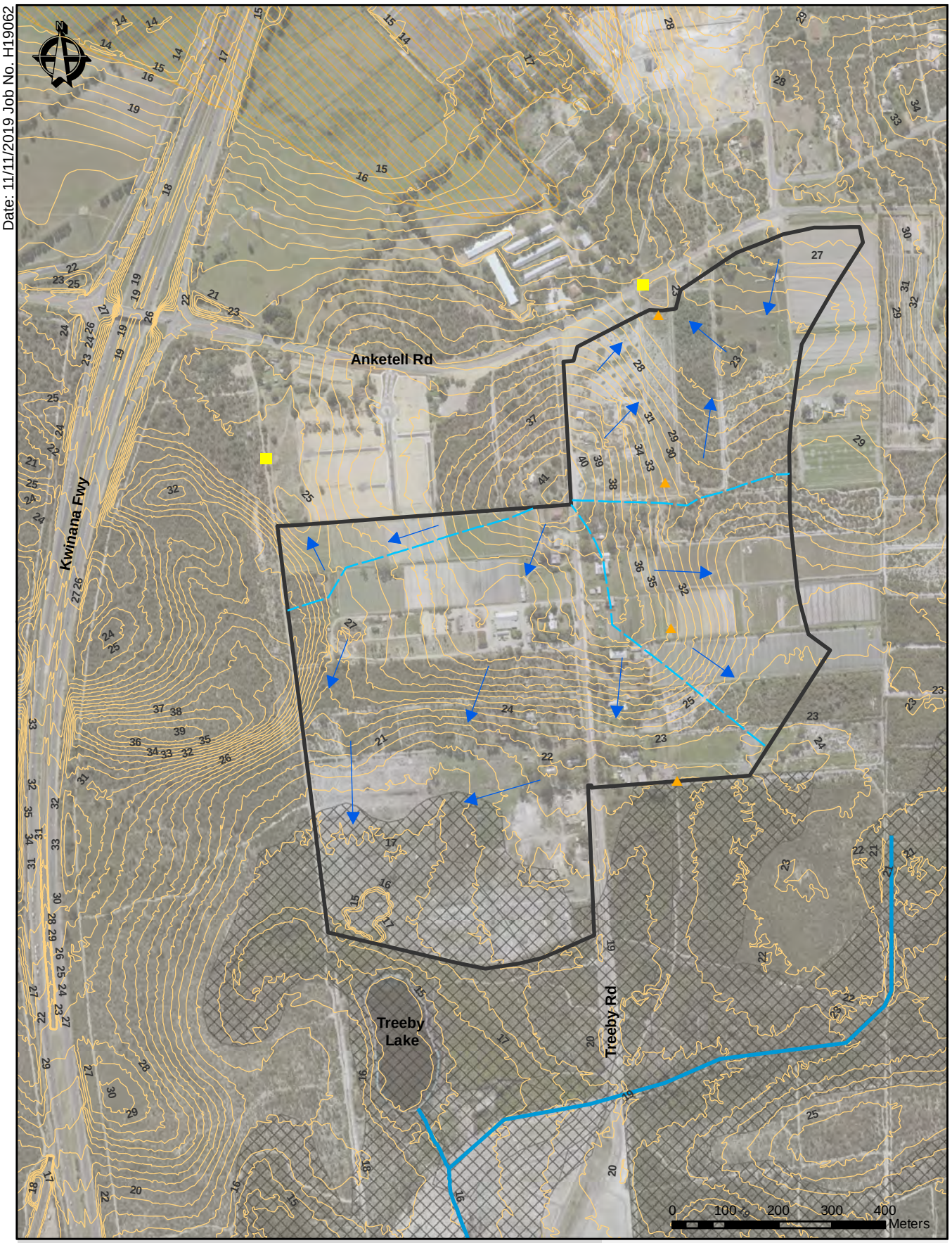
Attached

Figure 1: Site Conditions Plan
Figure 2: Groundwater Mapping
Figure 3: Existing DWER Groundwater Licencing
Figure 4: Land Use & Catchment Plan
Figure 5: Stormwater Management Plan

Attachment 1: DWER Bore Hydrographs & Groundwater Data
Attachment 2: Revised Structure Plan
Attachment 3: CURRV Runoff Rate Calculator
Attachment 4: Modelling Outputs
Attachment 5: Indicative Stormwater Storage Sections
Attachment 6: Western Power Advice

FIGURES

Date: 11/11/2019 Job No. H19062



Site
LiDAR Contours 1m (mAHD)
Catchment Boundaries
Peel Sub P Drain
Surface Water
Conservation Wetland
Multiple Use Wetland
Resource Enhancement
Legal Point of Discharge (Bioscience, 2014)
Western Power Transmission Tower

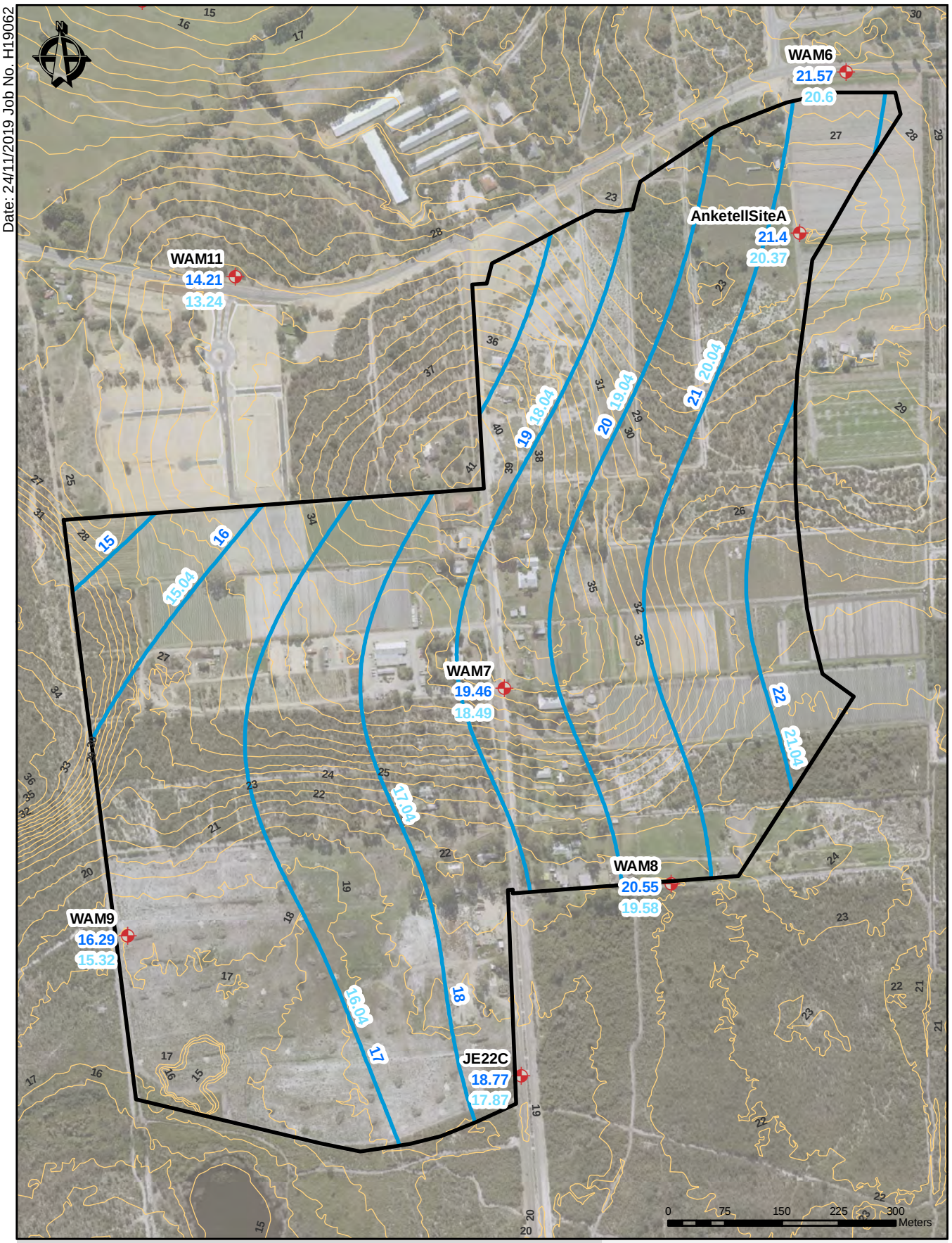
hyd2o

Anketell North LWMS Addendum

Site Conditions Plan

Figure 1

Date: 24/11/2019 Job No. H19062



Site

Topography (mAHD)

Groundwater Bores

MGL mAHD

AAMGL mAHD

Groundwater Level Contour

MGL mAHD

AAMGL mAHD

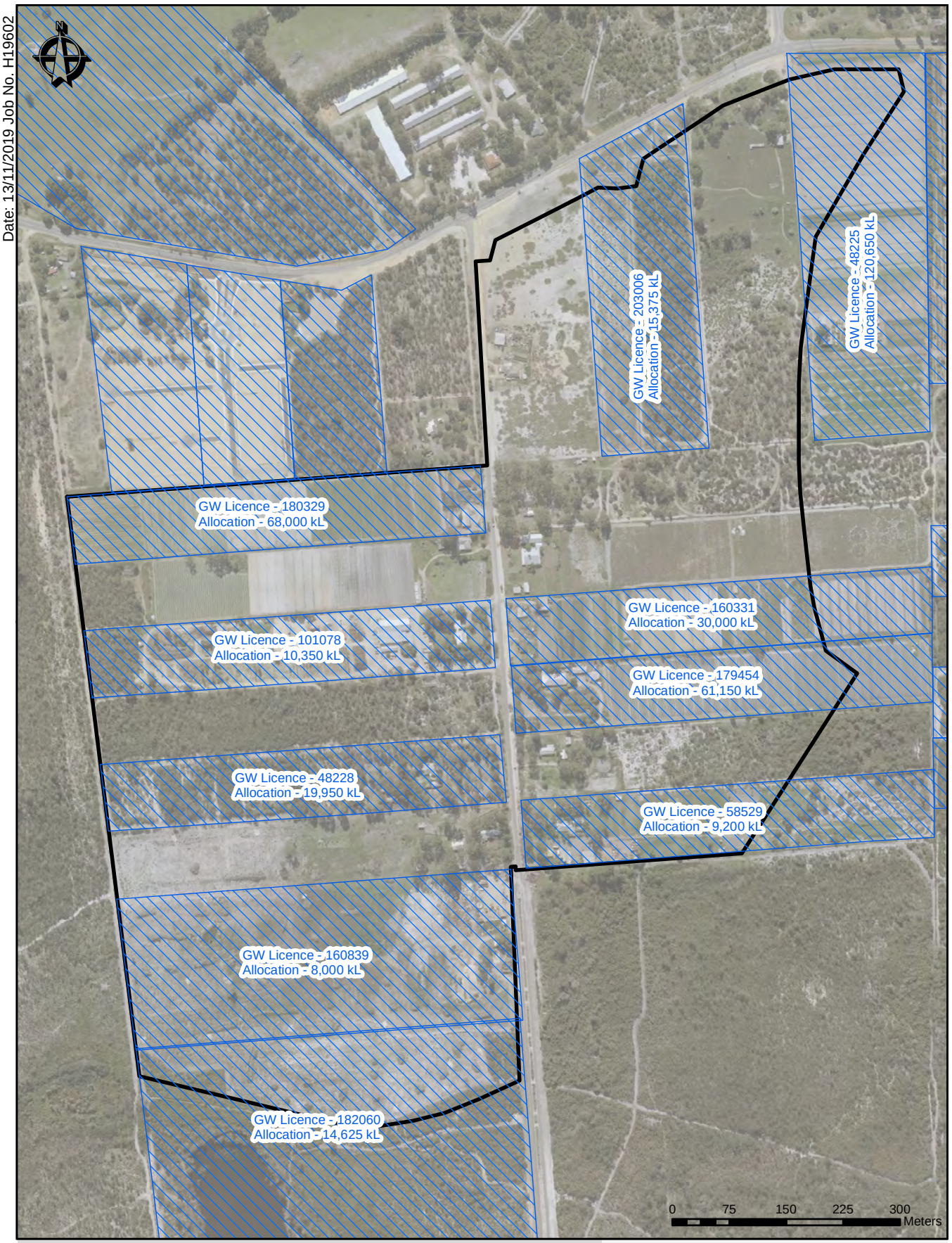
hyd2o

Anketell North LWMS Addendum

Groundwater Plan

Figure 2

Date: 13/11/2019 Job No. H19602



Site

Existing GW Licences

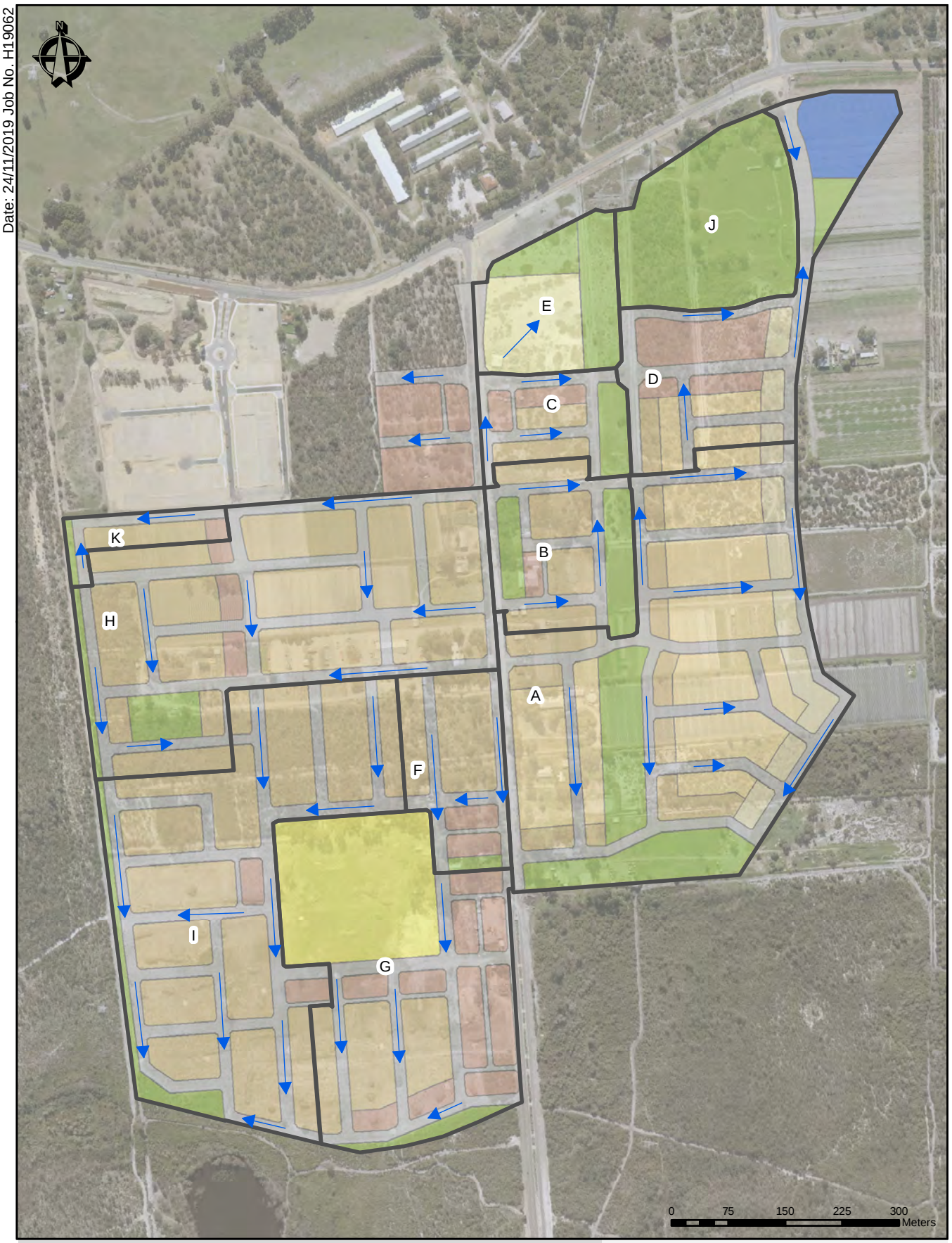
hyd2o

Anketell North LWMS Addendum

Groundwater Licence Allocations

Figure 3

Date: 24/11/2019 Job No. H19062



Catchments

Flow Direction

Land Use

Res. R20		Res. R40		Commercial	
Res. R25		POS		Community	
Res. R30		Road		School	

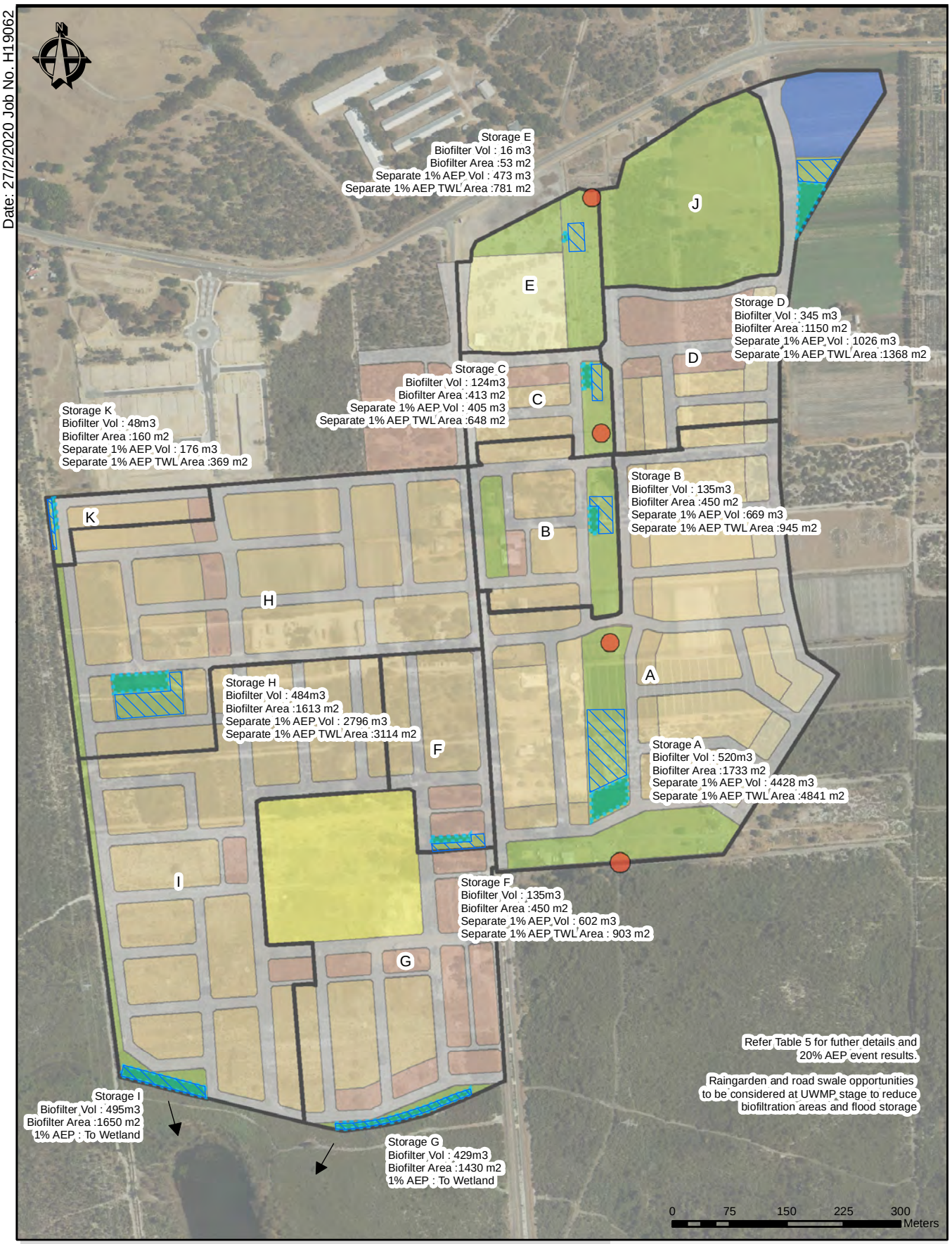
hyd2o

Anketell North LWMS Addendum

Land Use & Catchment Plan

Figure 4

Date: 27/2/2020 Job No. H19062



1% AEP Area
Catchments
Western Power Towers
Biofiltration Area

Res. R20		Res. R40		Commercial	
Res. R25		POS		Community	
Res. R30		Road		School	

hyd2o

Anketell North LWMS Addendum

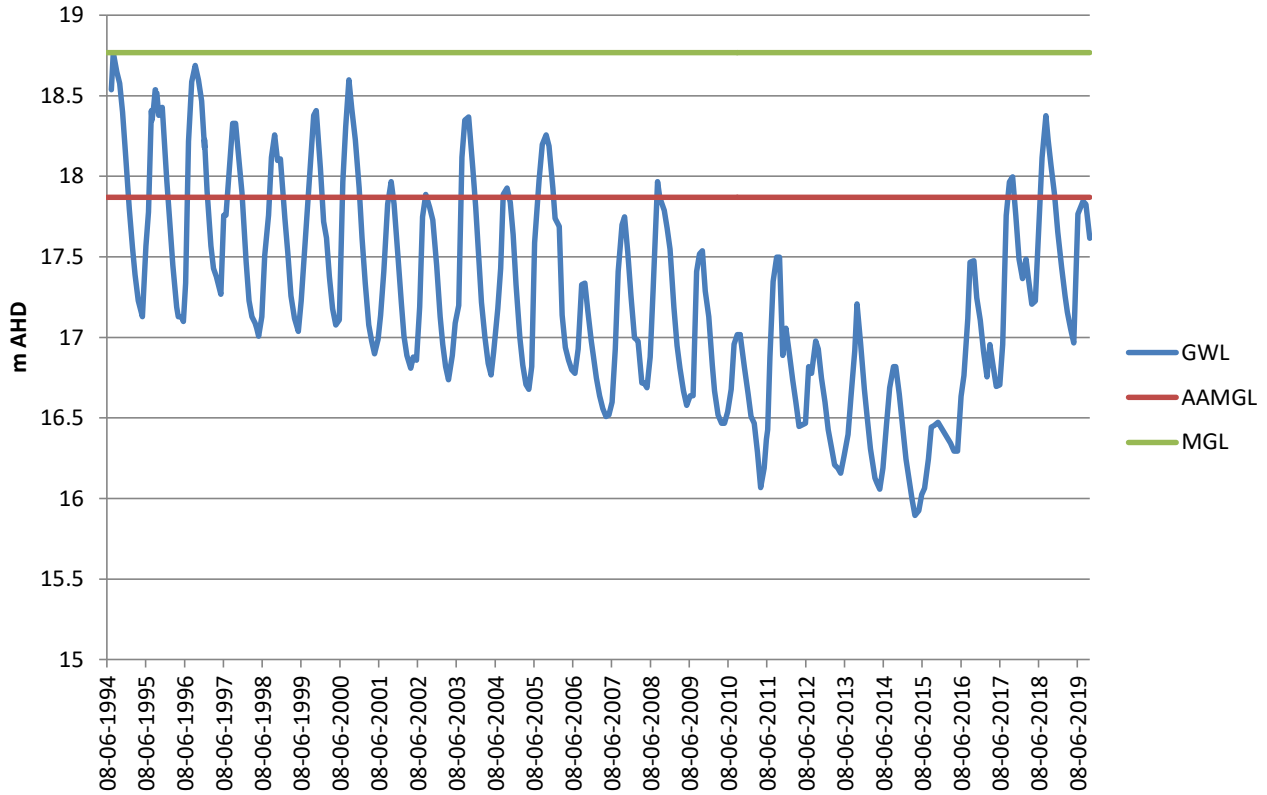
Stormwater Management Plan

Figure 5

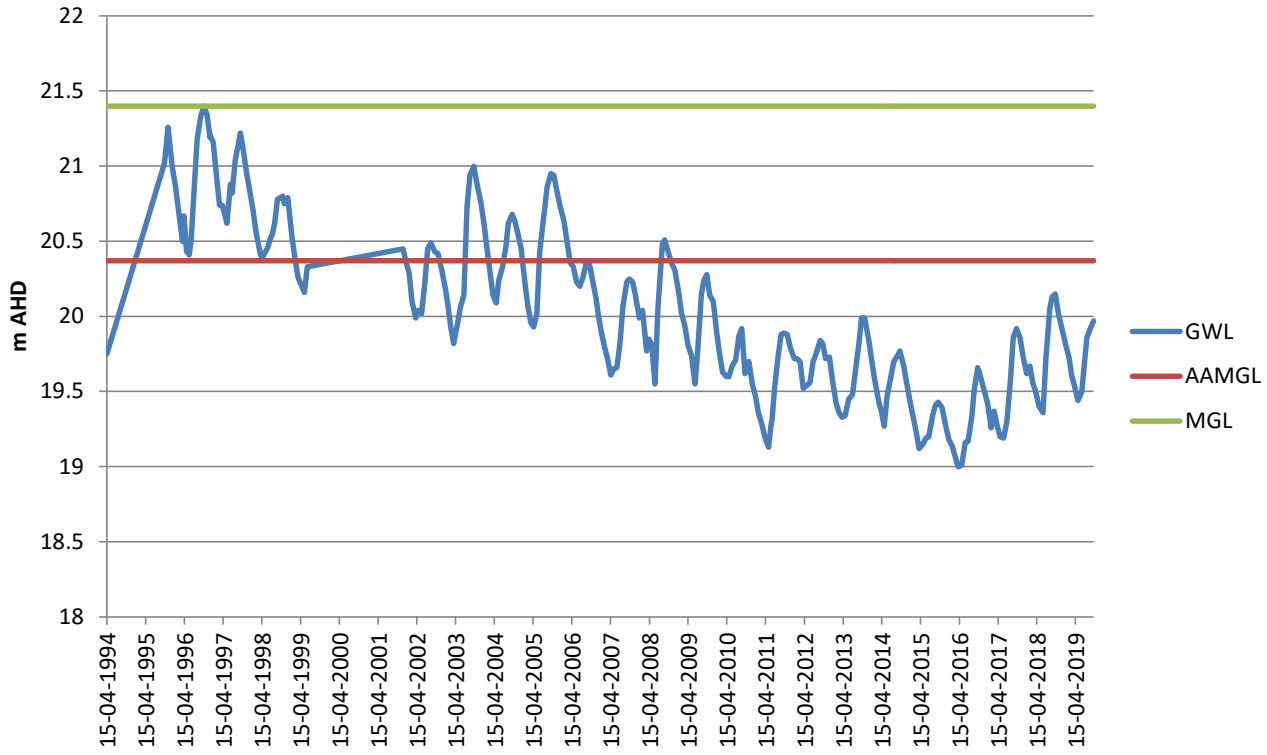
ATTACHMENT 1
DWER Bore Hydrographs & Groundwater Data

Date: 14/11/2019 Job No. H19062

JE22C Bore Hydrograph



Anketell Site A Bore Hydrograph



Source : DWER Water Information Reporting

JDA Lot 13 & 100 Treeby Road (April 2008)

Bore ID	Water Level (m AHD)														
	30-May-05	5-Jul-05	27-Jul-05	9-Sep-05	26-Sep-05	21-Oct-05	23-Nov-05	10-Jan-06	31-Jan-06	3-Mar-06	4-Apr-06	4-May-06	Min.	Max.	Difference
WAM9(s)	14.43	14.96	15.12	15.4	15.46	15.51	15.34	15.01	14.85	14.62	14.44	14.3	14.3	15.51	1.21
WAM9(d)	14.76	15.33	15.47	15.75	15.8	15.86	15.66	15.36	15.19	14.97	14.78	14.65	14.65	15.86	1.21
WAM10(s)	16.58	17.06	17.17	17.35	17.35	17.4	17.24	16.94	16.81	16.57	16.33	16.26	16.26	17.4	1.14
WAM10(d)	16.56	17.05	17.16	17.34	17.37	17.4	17.23	16.94	16.79	16.58	16.39	16.26	16.26	17.4	1.14
SP1-2B	-	-	-	-	-	11.9	11.8	11.66	11.6	11.48	11.39	11.37	11.37	11.9	0.53
JE22C	-	17.84	17.98	18.18	18.24	18.2	18.03	17.65	17.4	17.11	16.95	16.81	16.81	18.24	1.43

Bore ID	Water Level (m AHD)														
	29-May-06	28-Jun-06	2-Aug-06	30-Aug-06	24-Oct-06	27-Nov-06	19-Dec-06	23-Jan-07	20-Feb-07	22-Mar-07	23-Apr-07	28-Jun-07	Min.	Max.	Difference
WAM9(s)	14.27	14.15	14.35	14.54	14.46	14.37	14.32	14.13	14.06	13.98	13.9	14.04	13.9	14.54	0.64
WAM9(d)	14.59	14.53	14.69	14.86	14.88	14.72	14.62	14.53	14.41	14.33	14.27	14.39	14.27	14.88	0.61
WAM10(s)	16	16.17	16.47	16.65	16.42	16.3	16.21	16.13	16.07	16.01	15.97	16.26	15.97	16.65	0.68
WAM10(d)	16.23	16.21	16.4	16.62	16.46	16.29	16.22	16.15	16.07	16.01	15.97	16.26	15.97	16.62	0.65
SP1-2B	11.36	11.32	11.5	11.52	11.44	11.32	11.26	11.28	11.06	11	10.98	11.07	10.98	11.52	0.54
JE22C	16.8	16.77	-	17.37	17.27	16.86	16.83	16.56	16.61	16.53	16.68	16.7	16.53	17.37	0.84

JDA Wandi/Anketell South (April 2008)

Bore ID	Water Level (m AHD)														
	27-Sep-05	21-Oct-05	23-Nov-06	10-Jan-06	31-Jan-06	3-Mar-06	4-Apr-06	4-May-06	29-May-06	28-Jun-06	2-Aug-06	30-Aug-06	Min.	Max.	Difference
WAM5(s)	20.07	20.08	19.99	19.85	19.82	19.65	19.54	19.53	19.47	19.46	19.62	19.58	19.46	20.08	0.62
WAM5(d)	20.06	20.08	20.01	19.83	19.77	19.64	19.55	19.51	19.45	19.46	19.59	19.57	19.45	20.08	0.63
WAM6(s)	20.97	21	20.98	20.87	20.69	20.59	20.46	20.36	20.5	20.67	20.32	20.4	20.32	21	0.68
WAM6(d)	21.08	21.15	21.12	20.97	20.88	20.72	20.6	20.52	20.27	20.37	20.45	20.45	20.27	21.15	0.88
WAM7(s)	19.52	19.62	19.54	19.09	18.89	18.66	18.63	18.51	18.4	18.09	18.23	18.12	18.09	19.62	1.53
WAM7(d)	18.97	19.04	18.64	18.07	18.82	17.49	17.35	17.55	17.7	17.82	18.01	18.01	17.35	19.04	1.69
WAM8(s)	20.15	20.15	19.96	19.6	19.44	19.23	19.13	19.05	18.99	19.11	19.2	19.35	18.99	20.15	1.16
WAM8(d)	20.06	20.05	19.87	19.53	19.4	19.21	19.09	19	18.97	18.93	19.2	19.26	18.93	20.06	1.13
SP1-2B	-	11.9	11.8	11.66	11.6	11.48	11.39	11.37	11.36	-	11.5	11.52	11.36	11.9	0.54
JE22C	-	18.2	18.03	17.65	17.4	17.11	16.95	16.81	16.8	-	17.04	17.37	16.8	18.2	1.4
JM42	22.09	22.22	22.17	22.01	21.95	21.82	21.67	21.62	21.58	21.48	-	21.07	21.07	22.22	1.15

Bore ID	Water Level (m AHD)														
	6-Oct-06	24-Oct-06	27-Nov-06	19-Dec-06	23-Jan-07	20-Feb-07	23-Mar-07	23-Apr-07	22-May-07	28-Jun-07	26-Jul-07	30-Aug-07	Min.	Max.	Difference
WAM5(s)	19.55	19.52	19.42	19.28	19.18	19.09	19.02	18.98	19.04	19.07	19.17	19.38	18.98	19.55	0.57
WAM5(d)	19.52	19.52	19.42	19.31	19.18	19.09	19.03	18.99	19.02	19.08	19.18	19.4	18.99	19.52	0.53
WAM6(s)	20.34	20.32	20.31	20.1	19.97	19.87	19.79	19.76	19.74	19.74	19.87	20.16	19.74	20.34	0.6
WAM6(d)	20.47	20.37	20.15	20.23	20.07	20	19.9	19.82	19.84	19.85	19.96	20.22	19.82	20.47	0.65
WAM7(s)	17.98	17.84	17.55	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	18.35	17.55	18.35	0.8
WAM7(d)	17.7	17.7	17.36	17.16	16.94	16.79	16.64	16.81	17.04	17.27	17.48	17.73	16.64	17.73	1.09
WAM8(s)	19.5	19.19	19.08	18.92	18.84	18.72	18.68	18.55	18.58	18.79	-	19.31	18.55	19.5	0.95
WAM8(d)	19.3	19.11	19	18.89	18.85	18.74	18.69	18.61	18.59	18.73	-	19.25	18.59	19.3	0.71
SP1-2B	-	11.44	11.32	11.26	11.3	11.06	-	10.98	-	-	11.26	-	10.98	11.44	0.46
JE22C	17.24	16.27	16.86	16.83	16.56	16.61	-	16.68	16.47	16.7	17	17.57	16.27	17.57	1.3
JM42	21.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-

JDA Lots 1, 2, 3 & 17 Thomas Road

Bore ID	Water Level (m AHD)														
	4-Apr-07	23-May-07	28-Jun-07	26-Jul-07	30-Aug-07	18-Sep-07	11-Oct-07	7-Nov-07	18-Dec-07	15-Jan-08	12-Feb-08	11-Mar-08	Min.	Max.	Difference
WAM14	15.43	15.33	15.58	15.87	16.34	16.43	16.5	16.34	16.13	15.92	16.02	15.79	15.33	16.5	1.17
WAM15(s)	15.74	15.66	15.96	16.25	16.74	16.7	16.86	16.67	16.43	16	16.3	16.04	15.66	16.86	1.2
WAM15(d)	15.24	15.22	15.44	15.75	16.25	16.34	16.43	16.24	16.02	15.75	15.81	15.61	15.22	16.43	1.21
WAM16(s)	13.82	13.9	14.08	14.39	14.97	15.09	15.12	15.02	14.99	14.73	14.88	14.62	13.82	15.12	1.3
WAM16(d)	13.64	13.7	13.93	14.28	14.8	14.91	14.94	14.84	14.74	14.48	14.67	14.41	13.64	14.94	1.3
SP1-2B	10.97	10.99	11.07	11.26	11.39	11.46	11.46	11.38	11.26	11.15	11.19	11.09	10.97	11.46	0.49
JE22C	-	16.47	16.7	17	17.57	17.85	17.92	20.33	17.76	20.33	17.36	16.74	16.47	20.33	3.86

Bore ID	Water Level (m AHD)														
	9-Apr-08	16-May-08	10-Jun-08	11-Jul-08	11-Aug-08	11-Sep-08	23-Oct-08	17-Nov-08	16-Dec-08	13-Jan-09			Min.	Max.	Difference
WAM14	15.85	15.74	15.99	16.41	17.01	16.81	16.73	16.66	16.56	16.39			15.74	17.01	1.27
WAM15(s)	16.08	15.97	16.24	16.69	17.24	17.08	16.99	16.91	16.82	16.82			15.97	17.24	1.27
WAM15(d)	15.7	15.65	15.87	16.29	16.88	16.71	16.58	16.5	16.4	16.69			15.65	16.88	1.23
WAM16(s)	14.66	14.56	14.84	15.17	15.5	15.32	15.21	15.14	15.05	14.9			14.56	15.5	0.94
WAM16(d)	14.42	14.42	14.72	15.01	15.3	15.19	15.11	15.01	14.94	14.8			14.42	15.3	0.88
SP1-2B	11.13	11.12	11.08	11.4	11.69	11.58	11.58	11.56	11.53	11.43			11.08	11.69	0.61
JE22C	-	-	16.87	17.2	18.02	17.82	17.7	17.7	17.49	17.2			16.87	18.02	1.15

Anketell North DWMS

Bore ID	Water Level (m AHD)														
	27-Jul-05	9-Sep-05	27-Sep-05	21-Oct-05	23-Nov-05	10-Jan-06	31-Jan-06	3-Mar-06	4-Apr-06	4-May-06	29-May-06	28-Jun-06	Min.	Max.	Difference
WAM11	13.42	13.63	13.72	13.86	13.86	13.76	13.71	13.65	13.57	13.49	13.46	13.3	13.3	13.86	0.56
WAM12(s)	14.15	14.18	14.04	13.76	13.31	13.47	13.46	13.12	13.17	13.34	13.01	12.98	12.98	14.18	1.2
WAM12(d)	14.12	14.15	14.08	13.91	13.55	13.49	13.47	13.01	13.12	13.26	13.14	13.12	13.01	14.15	1.14
WAM13(s)	14.15	14.2	14.03	14.03	13.75	13.74	13.73	13.43	13.5	13.64	13.44	13.45	13.43	14.2	0.77
WAM13(d)	14.08	14.13	14.08	13.91	13.68	13.64	13.62	13.31	13.36	13.47	13.33	13.33	13.31	14.13	0.82
SP1-2B	-	-	-	11.9	11.8	11.66	11.6	11.48	11.39	11.37	11.36	11.32	11.32	11.9	0.58
JE22C	17.98	18.18	18.24	18.2	18.03	17.65	17.4	17.11	16.95	16.81	16.8	16.77	16.77	18.24	1.47

Bore ID	Water Level (m AHD)														
	2-Aug-06	30-Aug-06	24-Oct-06	27-Nov-06	19-Dec-06	23-Jan-07	20-Feb-07	23-Mar-07	23-Apr-07	22-May-07	28-Jun-07	26-Jul-07	Min.	Max.	Difference
WAM11	13.3	13.22	13.27	13.23	13.17	13.08	13.02	12.93	12.85	12.82	12.68	12.68	12.68	13.3	0.62
WAM12(s)	13.47	13.67	13.06	12.85	12.89	12.45	12.26	12.1	12.22	12.7	13.17	13.61	12.1	13.67	1.57
WAM12(d)	13.5	13.7	13.23	12.82	12.89	12.5	12.33	12.23	12.39	12.62	13.08	13.52	12.23	13.7	1.47
WAM13(s)	13.93	13.92	13.42	13.08	13.06	12.85	12.74	12.66	12.7	12.86	13.12	13.67	12.66	13.93	1.27
WAM13(d)	13.75	13.76	13.31	13	12.89	12.77	12.66	12.57	12.61	12.76	13.05	13.5	12.57	13.76	1.19
SP1-2B	11.5	11.52	11.44	11.32	11.26	11.3	11.06	11	10.98	10.99	11.07	11.26	10.98	11.52	0.54
JE22C	17.04	17.34	16.27	16.86	16.83	16.56	16.61	16.53	16.68	16.47	16.7	17	16.27	17.34	1.07

ATTACHMENT 2
Revised Structure Plan

LEGEND

LOCAL SCHEME

LOCAL SCHEME RESERVES

- Parks And Recreation / Drainage

PUBLIC PURPOSES

- Community Facility
- Primary School

ZONES

- Residential R20
- Residential R25
- Residential R30
- Residential R40
- Service Commercial

OTHER

- Primary Distributor
- Integrator B
- Neighbourhood Connector B
- Major Access Street
- Structure Plan Amendment Boundary
- Western Power Easement
- Mrs Rural Water Protection Zone Boundary

0m 50 100 150m

LYON ROAD

ANKETELL ROAD

AREA SUBJECT TO SEPARATE STRUCTURE PLAN APPROVALS

TREEBY ROAD

9002 9002 9002 9003 652 188 189 4 7 89 90 30 31 32 33 34 35 36 37 38 39 40 41 12 9000

ATTACHMENT 3
CURRV Runoff Rate Calculator

CURRV

Calculator for Urban Runoff Rates & Volumes

24/11/2019

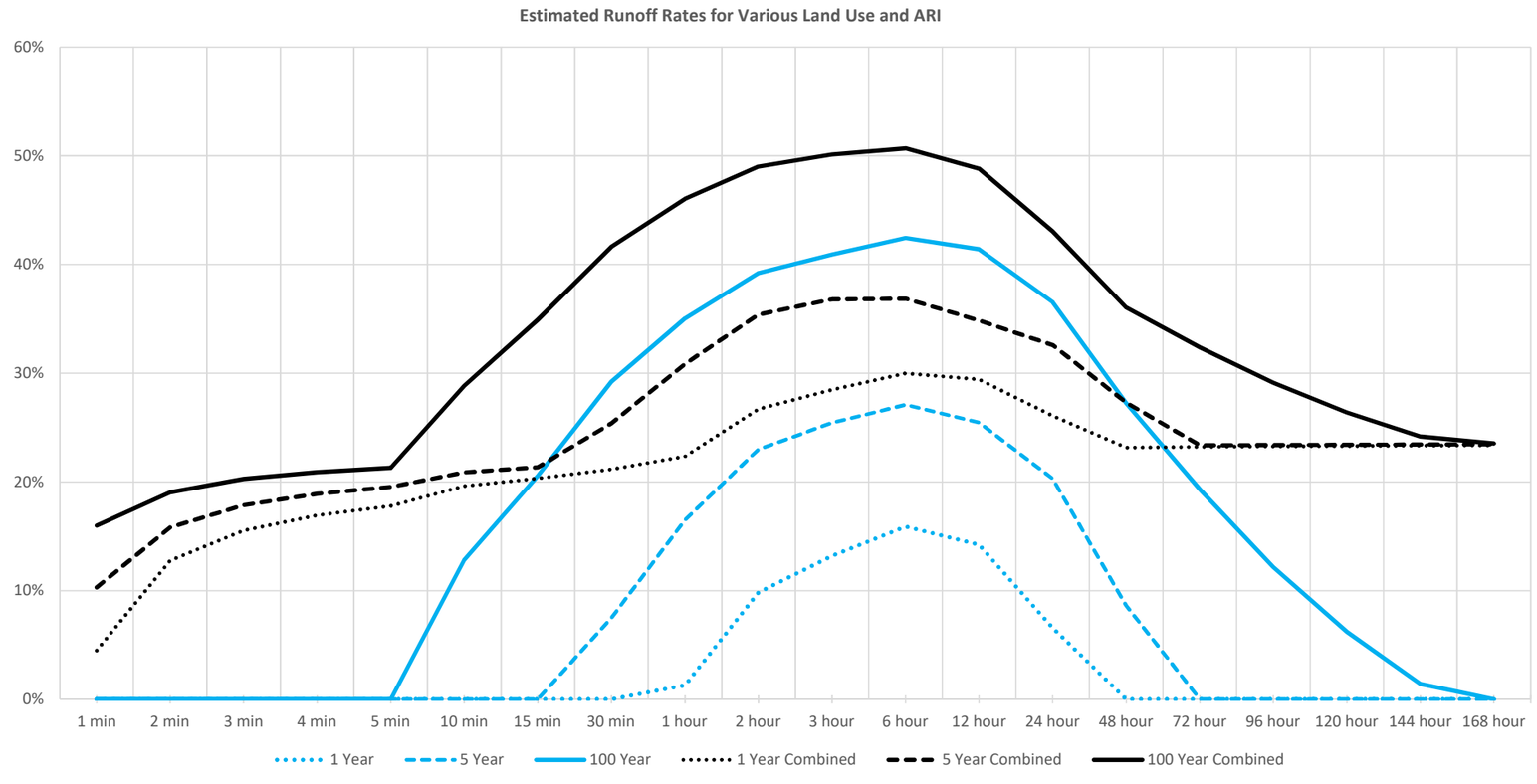
	Land Use Description	Area (ha)	Use in Calc	Imperv Initial Loss mm	Perv Initial Loss mm	Perv Continue Loss mm/hr	On Site Soak (mm)	Empty (days)	AR&R EIA/TIA System Connect Ratio	Roof %	Ext Imp %	Ext Perv %	Comment
1	Residential R40	5.72	Yes	1.5	20.0	4.0	0.0	0.50	60%	65	22	13	Lot connection for small lots
2	Residential R30	25.98	Yes	1.5	20.0	4.0	15.0	0.50	60%	65	22	13	Soakwells
3	Residential R25	7.55	Yes	1.5	20.0	4.0	15.0	0.50	60%	62	18	20	Soakwells
4	Residential R20	1.83	Yes	1.5	20.0	4.0	15.0	0.50	60%	47	13	40	Soakwells
5	Road	22.19	Yes	1.5	20.0	4.0	0.0	0.50	100%	0	70	30	
6	POS	13.20	Yes	1.5	20.0	4.0	0.0	0.50	30%	0	0	100	
7	Community	1.64	Yes	1.5	20.0	4.0	15.0	0.50	70%	60	20	20	Building, carpark & garden assumed
8	School	3.99	No					0.50	0%				Assumed to retain and infiltrate all events on site
9	Commercial	1.20	No					0.50	0%				Assumed to retain and infiltrate all events on site
10								0.50					

EIA : Effective Impervious Area, TIA : Total Impervious Area

Land Use Graph Selector **2**

(11 - combined total)

Residential R30



Project **Treeby Rd Anketell**

Rainfall IFD Data

Annual Exceedence Probability

	Duration	63.2% 1.00	50% 1.44	20% 4.48	10% 10	5% 20	2% 50	1% 100
1	1 min	1.9	2.0	2.7	3.1	3.5	4.1	4.6
2	2 min	3.3	3.6	4.5	5.2	5.9	6.9	7.6
3	3 min	4.4	4.8	6.1	7.0	8.0	9.3	10.4
4	4 min	5.3	5.8	7.4	8.6	9.8	11.4	12.7
5	5 min	6.0	6.6	8.5	9.9	11.3	13.3	14.8
6	10 min	8.7	9.6	12.5	14.6	16.7	19.6	21.9
7	15 min	10.5	11.6	15.1	17.6	20.2	23.6	26.4
8	30 min	14.0	15.4	20.0	23.2	26.5	31.0	34.6
9	1 hour	18.2	19.9	25.6	29.8	34.0	39.9	44.6
10	2 hour	23.4	25.6	32.7	38.0	43.6	51.6	58.2
11	3 hour	27.1	29.5	37.8	44.1	50.7	60.4	68.5
12	6 hour	34.5	37.6	48.5	56.9	65.9	79.4	90.9
13	12 hour	43.3	47.3	61.5	72.5	84.3	102.0	117.0
14	24 hour	53.2	58.4	76.1	89.4	104.0	124.0	142.0
15	48 hour	64.6	70.9	91.6	106.0	121.0	143.0	160.0
16	72 hour	72.9	79.9	102.0	117.0	132.0	153.0	169.0
17	96 hour	80.3	87.8	111.0	127.0	142.0	162.0	178.0
18	120 hour	87.5	95.6	120.0	136.0	152.0	173.0	189.0
19	144 hour	94.9	103.0	130.0	146.0	162.0	185.0	202.0
20	168 hour	103.0	112.0	139.0	158.0	175.0	199.0	218.0

Estimated Runoff Rates

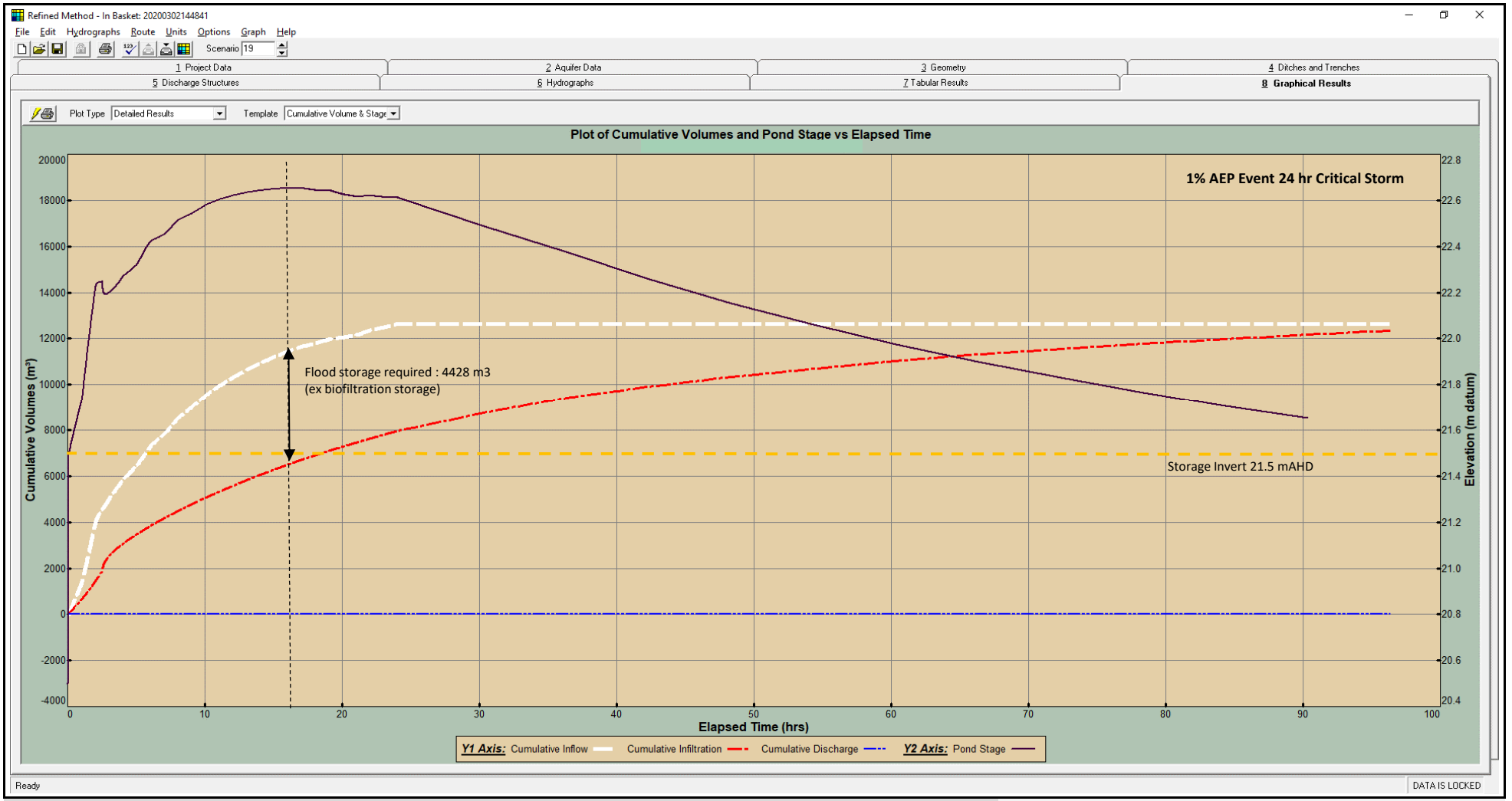
Annual Exceedence Probability

	63.2% 1.00	50% 1.44	20% 4.48	10% 10	5% 20	2% 50	1% 100
Maximum of All Events	1.00	1.44	4.48	10	20	50	100
Residential R40	**51%**	52%	**52%**	**53%**	54%	55%	**55%**
Residential R30	**16%**	19%	**27%**	**32%**	36%	40%	**42%**
Residential R25	**15%**	17%	**25%**	**30%**	35%	39%	**42%**
Residential R20	**11%**	13%	**20%**	**26%**	31%	36%	**39%**
Road	**69%**	69%	**72%**	**76%**	79%	82%	**84%**
POS	**0%**	0%	**5%**	**8%**	11%	14%	**16%**
Community	**17%**	20%	**30%**	**36%**	40%	45%	**48%**
School	**0%**	0%	**0%**	**0%**	0%	0%	**0%**
Commercial	**0%**	0%	**0%**	**0%**	0%	0%	**0%**
0	**0%**	0%	**0%**	**0%**	0%	0%	**0%**
combined total	**30%**	31%	**37%**	**41%**	45%	48%	**51%**

Event Selector	**16**	**72 hour**					
Residential R40	**51%**	51%	**51%**	**52%**	52%	52%	**52%**
Residential R30	**0%**	0%	**0%**	**5%**	10%	16%	**19%**
Residential R25	**0%**	0%	**0%**	**4%**	9%	15%	**18%**
Residential R20	**0%**	0%	**0%**	**3%**	7%	11%	**13%**
Road	**69%**	69%	**69%**	**69%**	69%	69%	**69%**
POS	**0%**	0%	**0%**	**0%**	0%	0%	**0%**
Community	**0%**	0%	**0%**	**5%**	11%	17%	**21%**
School	**0%**	0%	**0%**	**0%**	0%	0%	**0%**
Commercial	**0%**	0%	**0%**	**0%**	0%	0%	**0%**
0	**0%**	0%	**0%**	**0%**	0%	0%	**0%**
combined total	**23%**	23%	**23%**	**26%**	28%	31%	**32%**

ATTACHMENT 4
Modelling Outputs

Date : 27/2/2020 Job No: H19062



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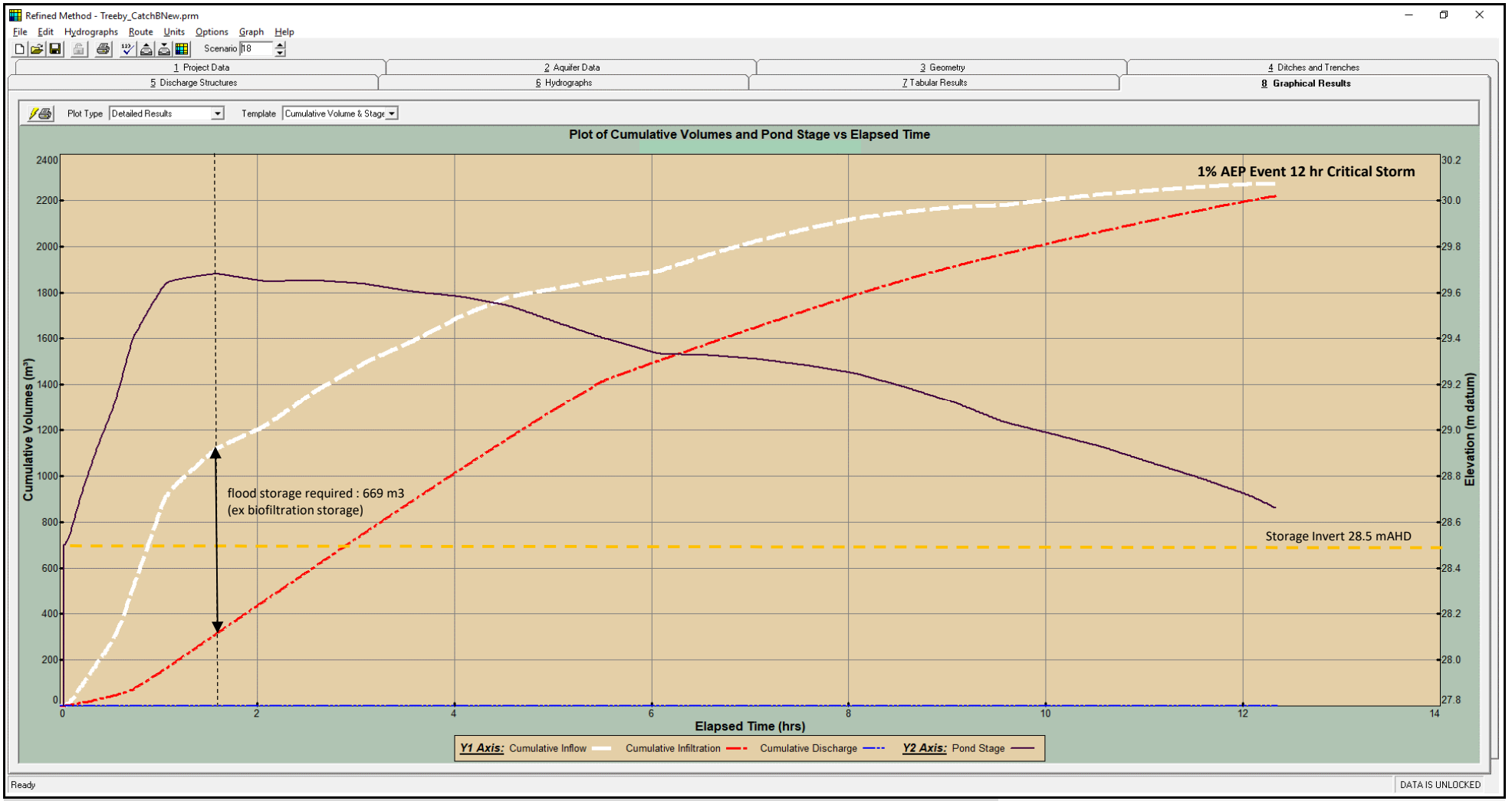
Anketell North LWMS Addendum

1% AEP Event PONDS Modelling: Catchment A

Attachment 4A

Date : 27/2/2020 Job No: H19062



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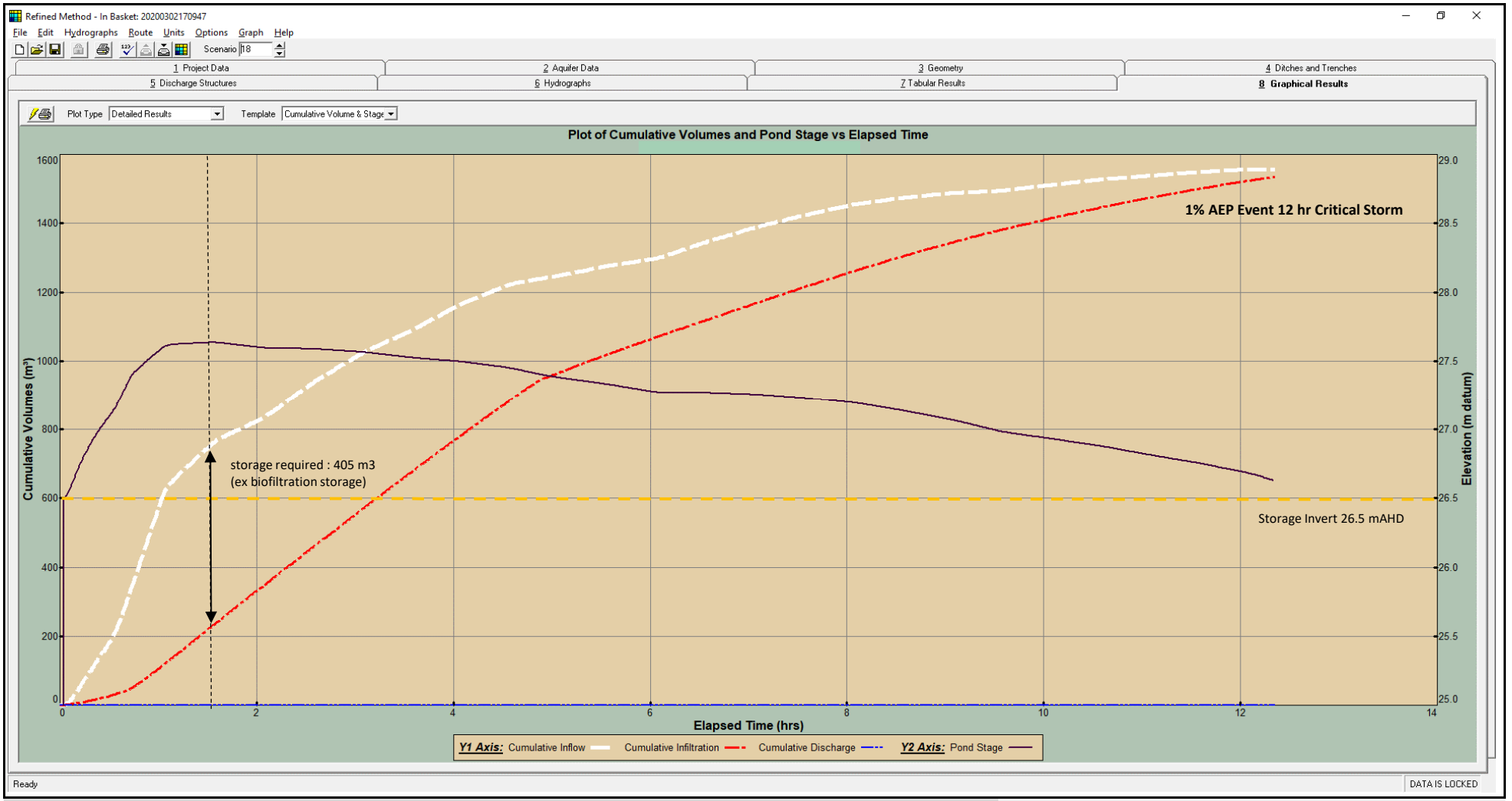
Anketell North LWMS Addendum

1% AEP Event PONDS Modelling: Catchment B

Attachment 4B

Date : 27/2/2020 Job No: H19062



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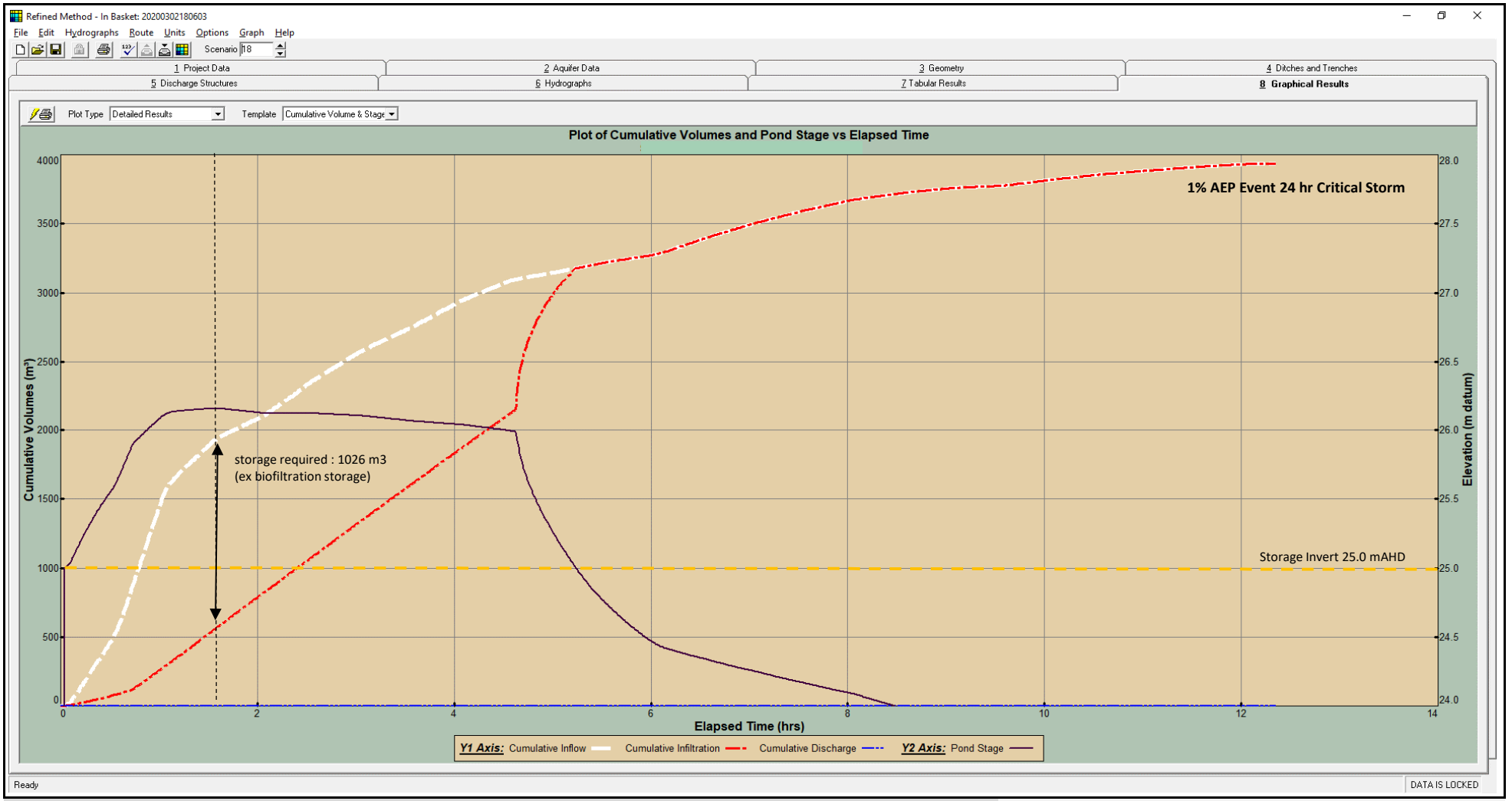
Anketell North LWMS Addendum

1% AEP Event PONDS Modelling: Catchment C

Attachment 4C

Date : 27/2/2020 Job No: H19062



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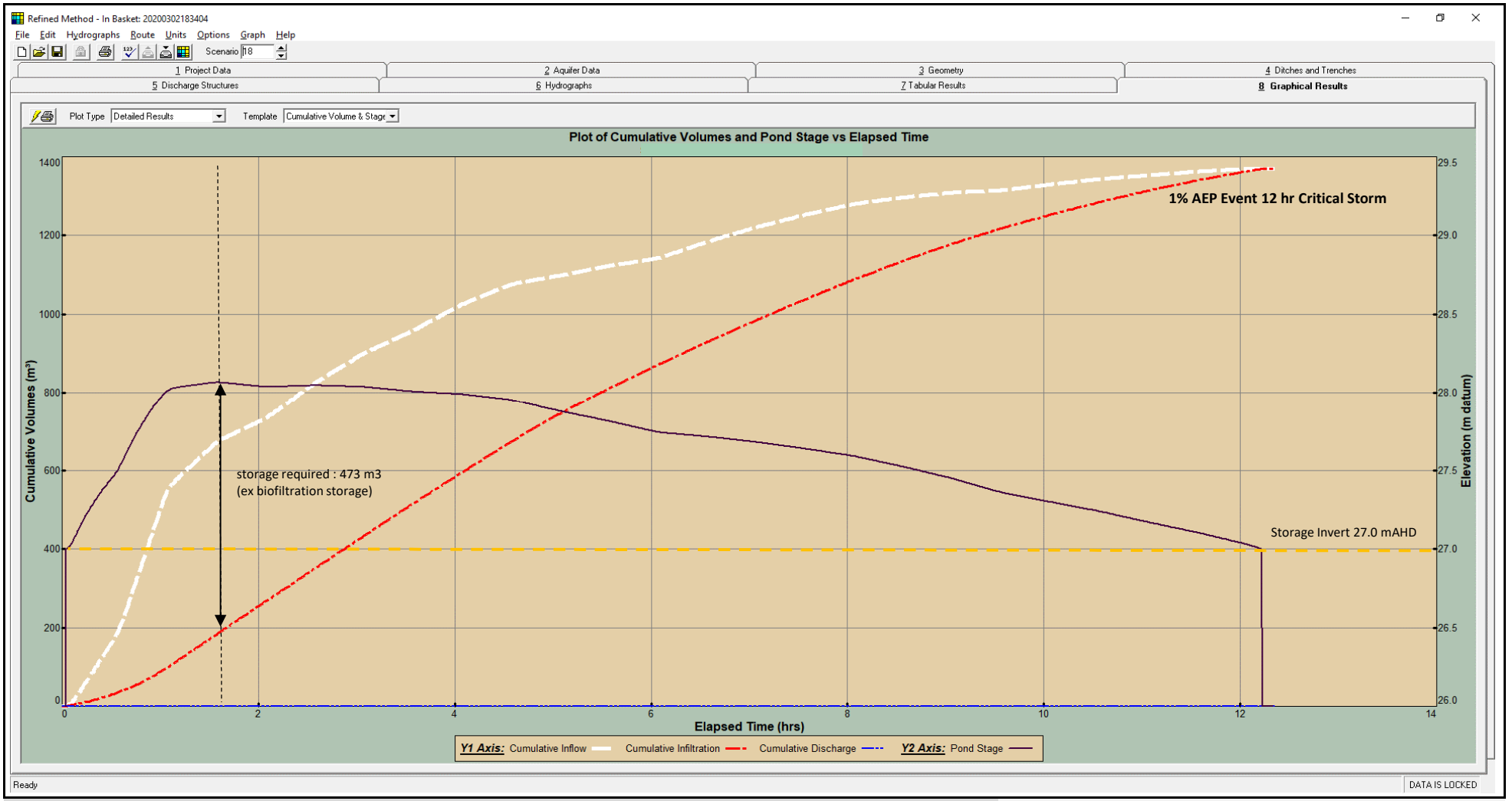
Anketell North LWMS Addendum

1% AEP Event PONDS Modelling: Catchment D

Attachment 4D

Date : 27/2/2020 Job No: H19062



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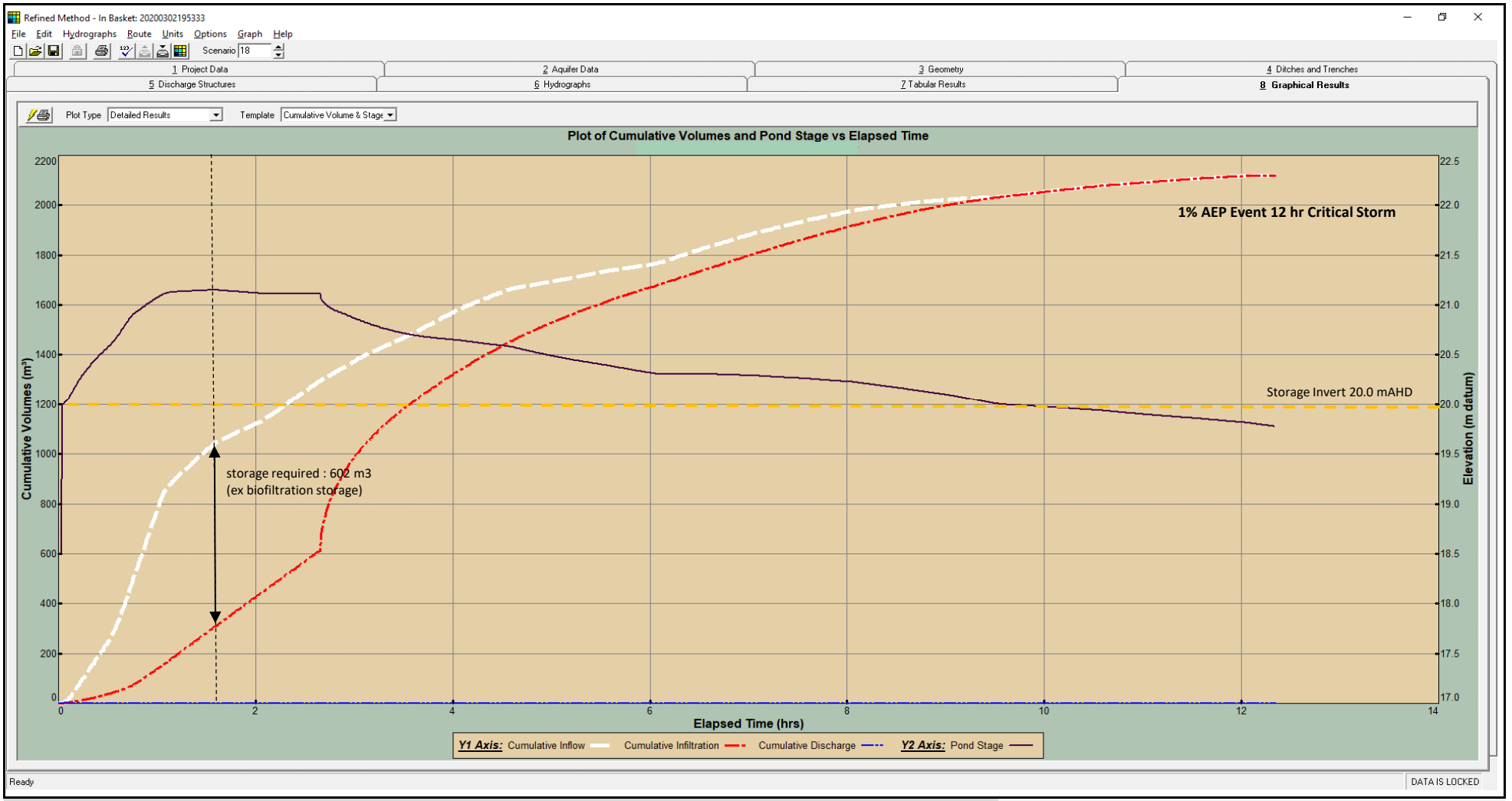
Anketell North LWMS Addendum

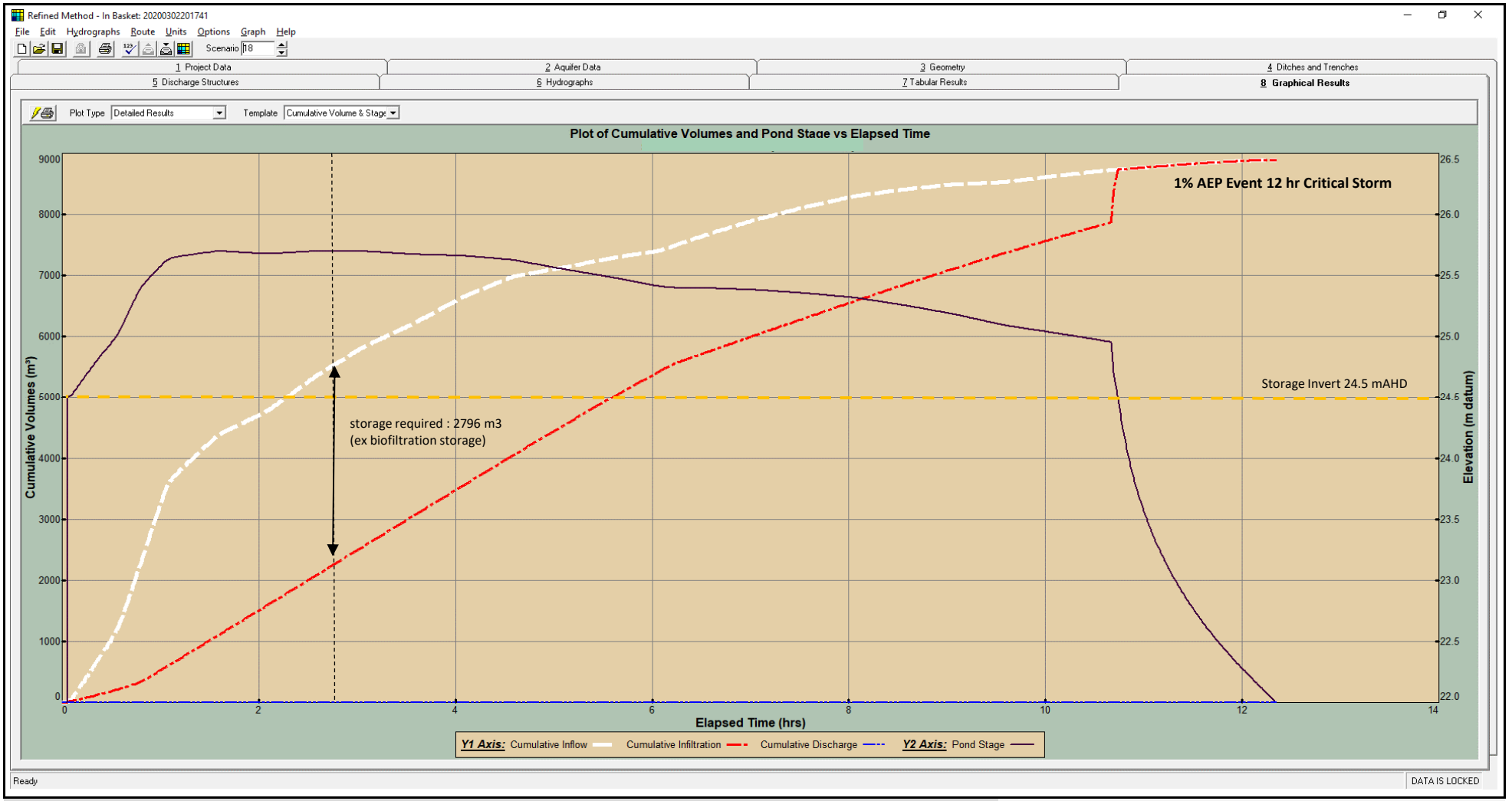
1% AEP Event PONDS Modelling: Catchment E

Attachment 4E

Date : 27/2/2020 Job No: H19062



Date : 27/2/2020 Job No: H19062



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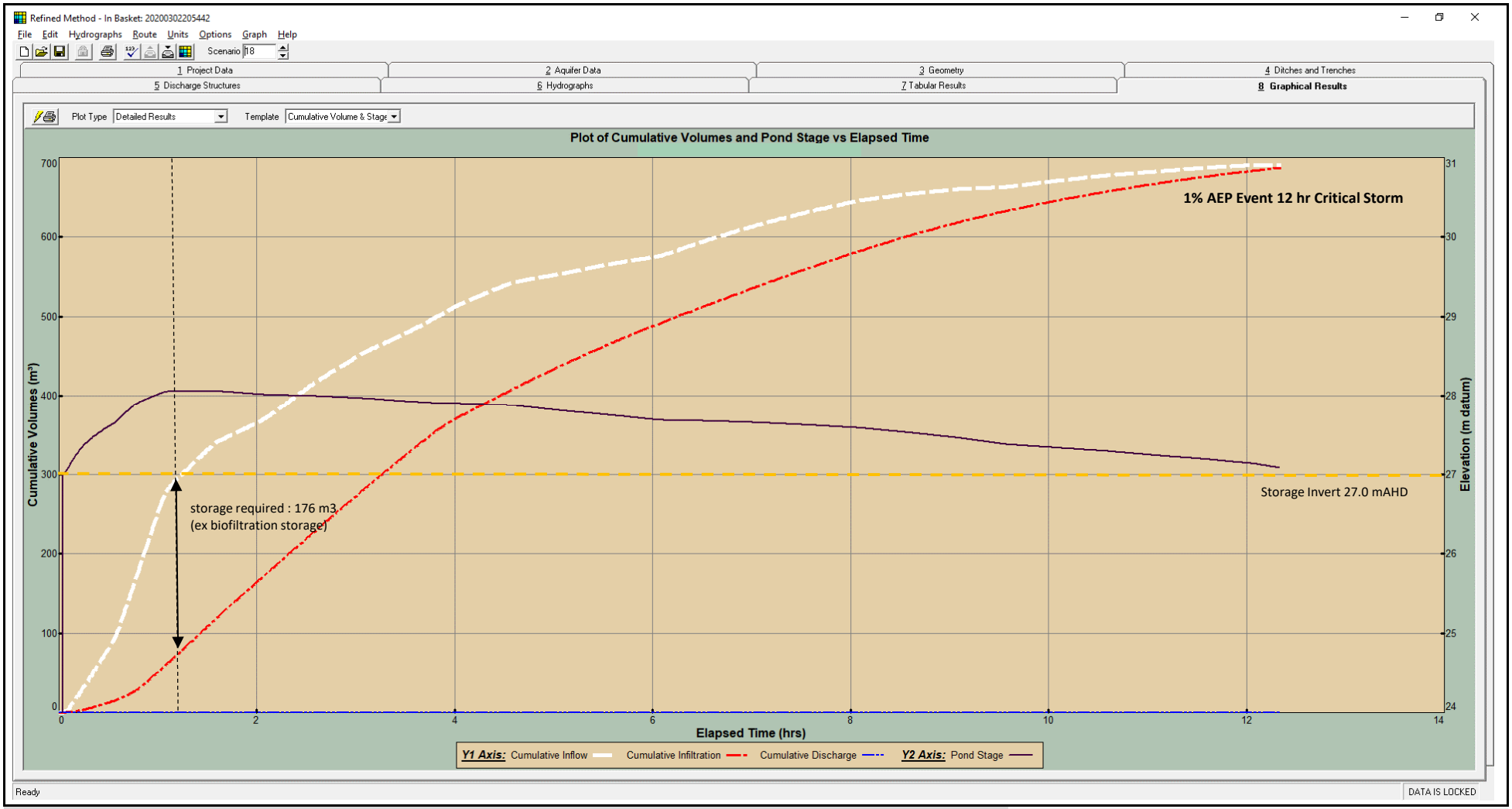
Anketell North LWMS Addendum

1% AEP Event PONDS Modelling: Catchment H

Attachment 4G

Date : 27/2/2020 Job No: H19062



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Anketell North LWMS Addendum

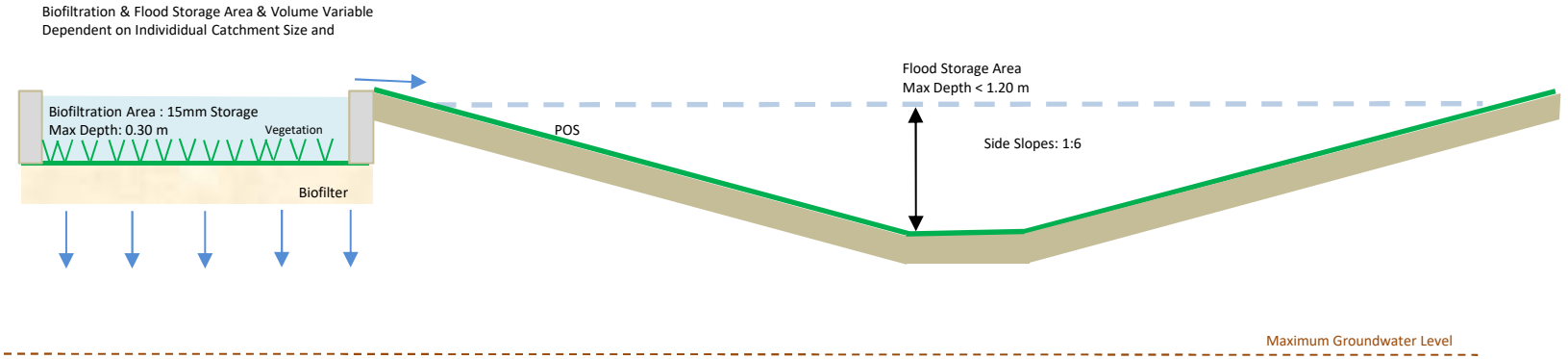
1% AEP Event PONDS Modelling: Catchment K

Attachment 4H

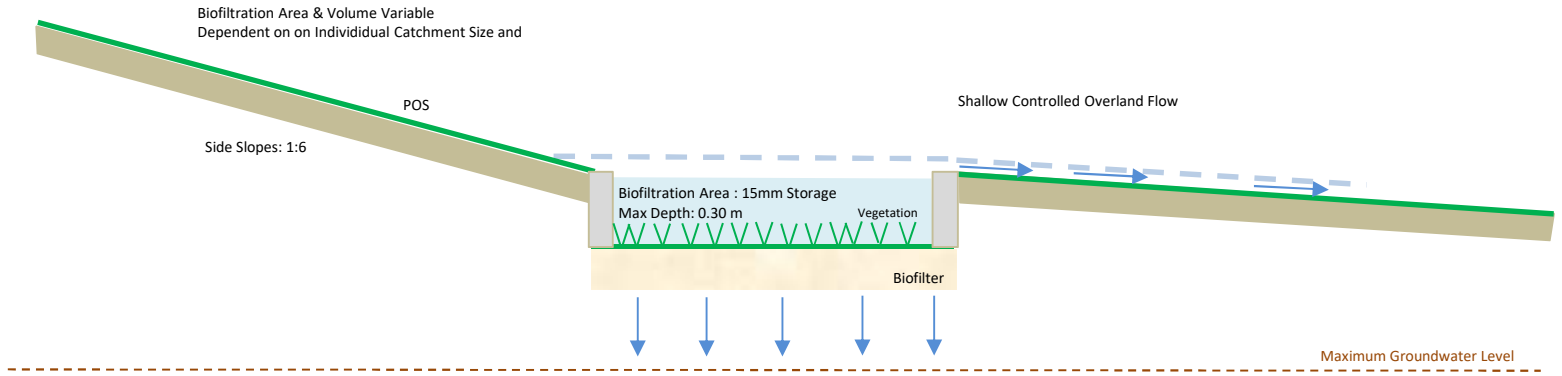
ATTACHMENT 5
Indicative Stormwater Storage Sections

Date: 27/2/2020 Job No. H19062

Storages A-F, H, and K Typical Design Configuration



Storages G & I Typical Design Configuration



Note: Cross-sections are not to scale

hyd$_2$o

Anketell North LWMS Addendum

Indicative Stormwater Storage Sections

Attachment 5

ATTACHMENT 6
Western Power Advice

From: Leanne Cooper [mailto:Leanne.Cooper@westernpower.com.au]
Sent: Wednesday, 12 February 2020 9:39 AM
To: Sean <sean@hyd2o.com.au>
Subject: RE: Work near Transmission and Communication Assets (WTC) Application - Reference Code: GM8L4H

Hi Sean

Due to limited information provided the response was general. As such it is relevant to all. However, the final design proposals should be submitted for all sites for Western Power to review and comment.

I hope that helps to answer your query.

Let me know if you require anything further.

Kind regards
Leanne Cooper
Coordinator – Working near Transmission & Communication Assets
Access Solutions

363 Wellington Street, Perth WA 6000
t (08) 9326 6626
e leanne.cooper@westernpower.com.au

westernpower.com.au

From: Sean <sean@hyd2o.com.au>
Sent: Tuesday, 11 February 2020 5:07 PM
To: Leanne Cooper <Leanne.Cooper@westernpower.com.au>
Subject: RE: Work near Transmission and Communication Assets (WTC) Application - Reference Code: GM8L4H

Hi Leanne,

Just following up on our talk yesterday.

I just wanted to confirm that you may be able to get some advice in writing about being able to assume the conditions in our application advice would be somewhat similar for the rest of the powerline corridor?

Again anything basic would be greatly appreciated.

Kind regards,

Sean O'Sullivan

Engineering Hydrologist

(Mon-Fri)

hyd2o hydrology

Suite 6B, 103 Rokeby Rd Subiaco WA 6008
PO Box 1055, Subiaco WA 6904
p +61 8 9382 8683 | f +61 8 6380 1910 | m 0406 931 194

Our Ref: CS011265 EDM# 51602878
Enquiries: Leanne Cooper (08) 9326 6626

6 February 2020

COMMERCIAL-IN-CONFIDENCE

Sean O'Sullivan
Hyd2o Hydrology
PO Box 1055
SUBIACO WA 6008

Dear Sean

Work near Transmission & Communication Assets (WTC) – Works Response
Stormwater Basins – Lot 37 Treeby Rd

Further to your WTC Application lodged with Western Power, we are pleased to advise you that we have now completed the works relating to the following application & areas of work:

WTC Application Reference	Application Submission Date	Area of Works
GM8L4H	5 December 2019	Lot 37 Treeby Rd

Please find attached the following information:-

1. Civil Structural Assessment

Should you wish to clarify any of the above information or discuss this matter with us, please do not hesitate to contact your Consultant, Leanne Cooper on (08) 9326 6626 and/or at leanne.cooper@westernpower.com.au.

Yours sincerely

ROB CHANDLER
LINE RELOCATIONS TEAM LEADER
CUSTOMER SERVICE
WESTERN POWER

Attachments
1. Civil Structural Assessment

westernpower
It's ON
363 Wellington Street Perth 6000
GPO Box L921 Perth WA 6842
e enquiry@westernpower.com.au
westernpower.com.au
t 13 10 87
f (08) 9225 2660
TTY 1800 13 13 51
TIS 13 14 50
Electricity Networks Corporation
ABN: 18 540 492 861

ANNEXURE 2 – CIVIL STRUCTURAL ASSESSMENT

Western Power Scope

The scope of Western Power work is to assess WTC Ref# GM8L4H for the civil works, excavation and backfilling of the proposed Anketell North residential development stormwater detention basin in close proximity to the following towers:

- Single circuit 330kV line SHO-ST/OLY 91 Tower 455 and 456

Scope of works is for (L37) 39 Treeby Rd, Anketell only. Scope boundary shown in red on Figure 1.

Customer Provided Information

This civil and structural assessment is based on the stormwater management plan drawing submitted by Hydro2o titled "3-Western Power Subdivision Figure 5" dated 3/12/2019.

Western Power Assessment

This Assessment is based on Hydro2o Job no. H19062, Drawing title "Anketell North LWMS Addendum Stormwater Management Plan Figure 5", dated 3/12/19. The Assessment has found the proposed works located at (L37) 39 Treeby Rd, Anketell can proceed subject to the following conditions;

1. Any excavation works within 20m of tower foundations shall not be carried out without Western Power review.
2. Stock piles and storage are not permitted within 20m of tower footprint.
3. Any permanent fencing to be installed within the easement is to be submitted to Western Power for review.
4. Use of conductive pipes and uninsulated metallic fencing within the easement must be assessed for earth potential rise and induction voltages with the report submitted to Western Power for review.
5. Detailed design drawings including design depth, drain cross section and 100-year ARI water level to be submitted for review.
6. Vehicle access plan including slope ratios to be submitted to Western Power for review.
7. Street lights should be placed outside the easement where possible. Street lights installed within the easement shall be placed offset in the plan and meet standard clearance requirements.
8. The contractor shall comply with section 3.64 of the Western Australia Occupational Safety and Health Regulations.

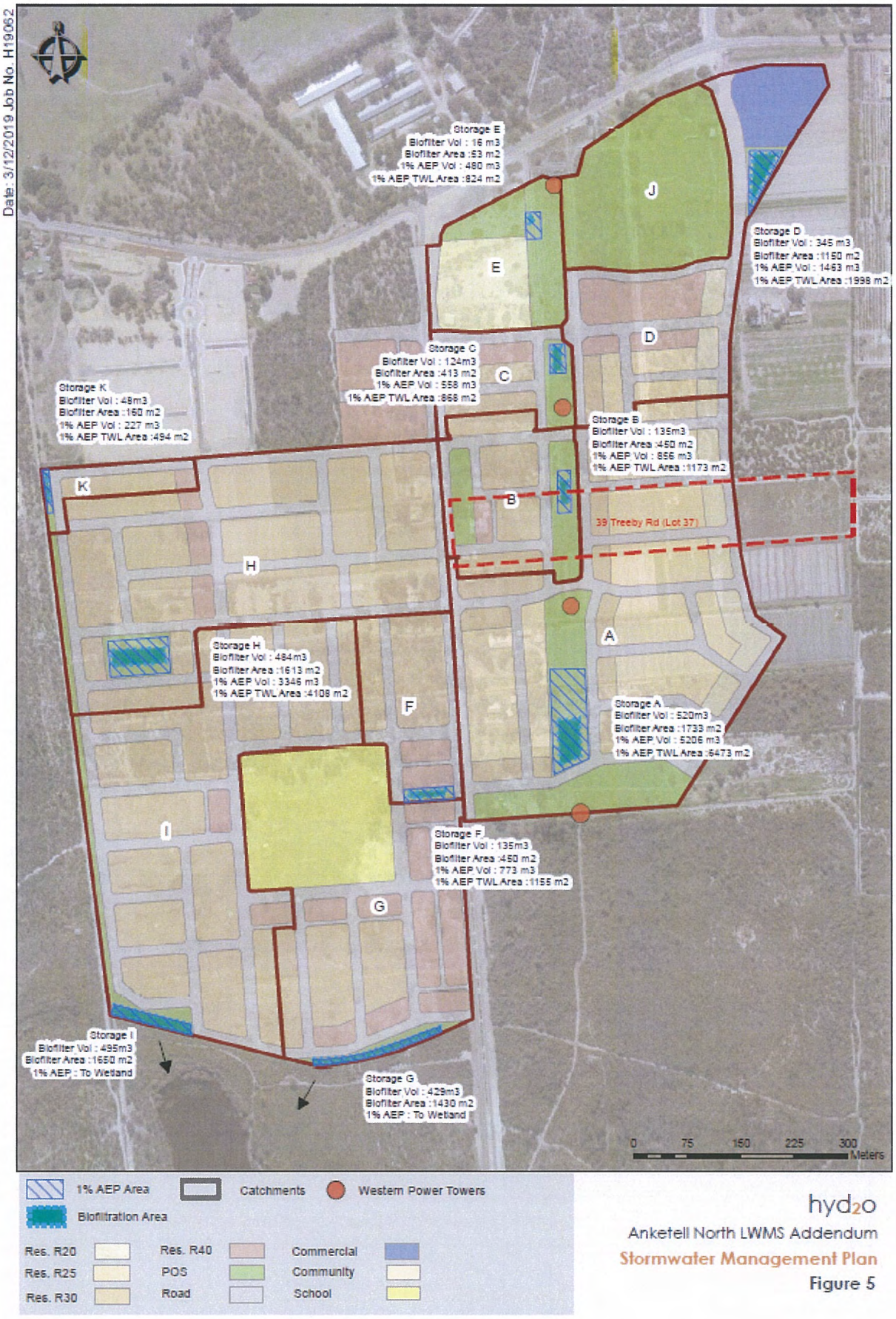
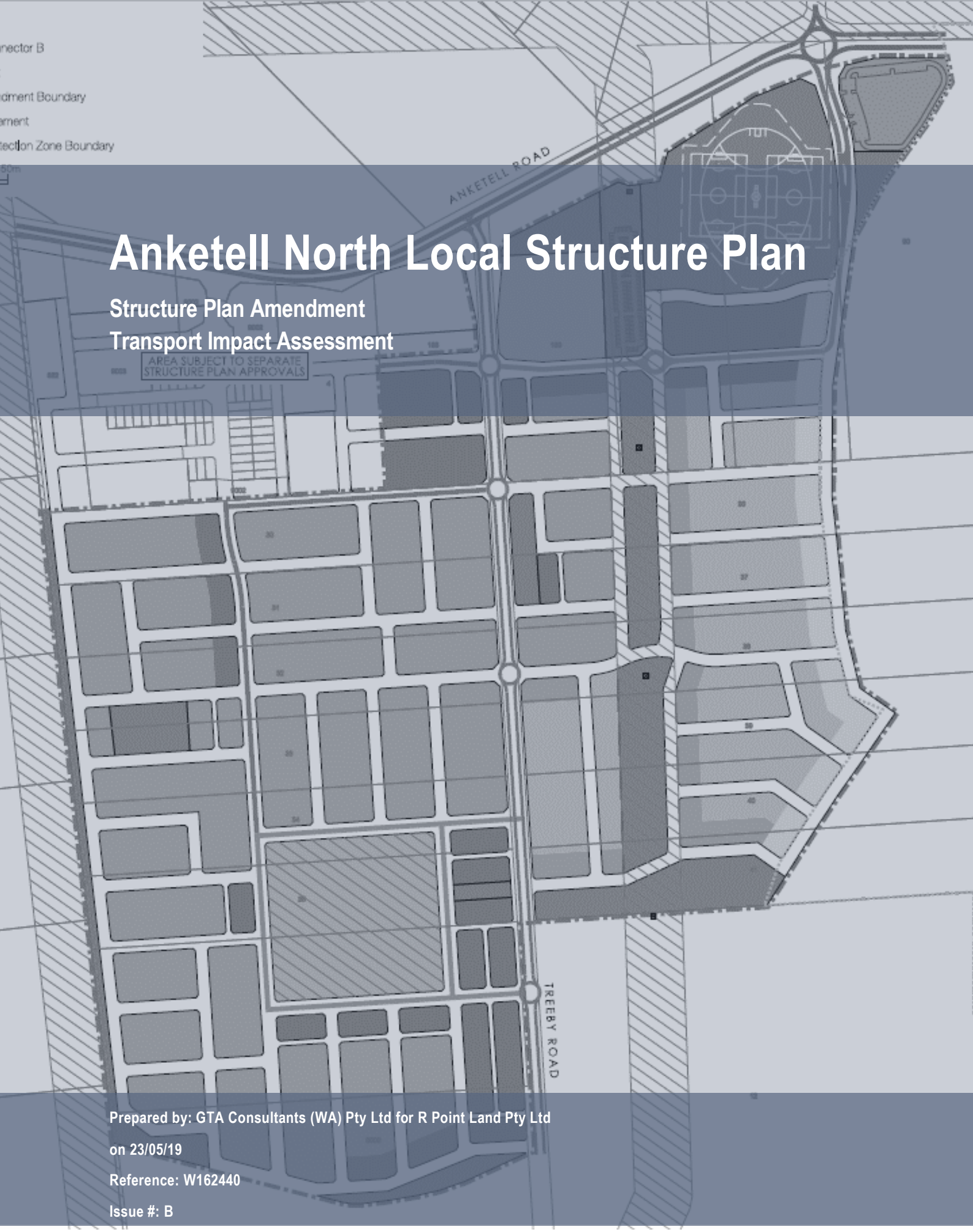


Figure 1: Scope of Works

APPENDIX H
TRANSPORT IMPACT ASSESSMENT



Anketell North Local Structure Plan

Structure Plan Amendment
Transport Impact Assessment

Prepared by: GTA Consultants (WA) Pty Ltd for R Point Land Pty Ltd

on 23/05/19

Reference: W162440

Issue #: B

GTAconsultants

Anketell North Local Structure Plan

Structure Plan Amendment
Transport Impact Assessment

Client: R Point Land Pty Ltd

on 23/05/19

Reference: W162440

Issue #: B

Quality Record

Issue	Date	Description	Prepared By	Checked By	Approved By	Signed
A	04/12/18	Final – A	AZ / AQ	AQ / TM	TM	TM
B	23/05/19	–Revised Yields – reduced service commercial	AZ	TM	TM	

GTAconsultants

Melbourne | Sydney | Brisbane
Adelaide | Perth

SUMMARY

GTAconsultants

SUMMARY

An amendment to the Anketell North Local Structure Plan (ANLSP) is currently being proposed. The structure plan (SP) amendment proposes to slightly amend the internal road network, as well as altering the lot yield and residential density code. A roundabout has also been planned for and designed at the Anketell Road / Lyon Road intersection by Main Roads WA which was not previously included in the existing SP and is further discussed in this report.

Overall, the lot yields are proposed to slightly increase from 1,066 to 1,397 dwellings in the amendment area and there are some 6,000m^2 of service commercial development area proposed to the south of the Anketell Road / Lyon Road intersection. The traffic volumes expected to be generated by the amendment area is approximately 15,150 vehicle trips per day (vpd). Most of these vehicle trips are expected to access the SP via the Anketell Road / Treeby Road future signalised intersection, followed by the Anketell Road / Lyon Road future roundabout.

An internal footpath network will be provided as part of this development and will connect to a future 2.5m wide dual use path along Anketell Road, as per the *City of Kwinana Development Contribution Plan Report 4 – Anketell (DCA4)*.

Cycling links will also be provided across the SP area, linking the proposed primary school in the west of the structure plan, to the proposed district playing fields in the north-east, via the land that is available over the SP's north-south easement.

Anketell Road is currently classified as a District Distributor A road and is constructed to a rural standard at present. It is proposed to be upgraded to a four-lane divided carriageway and function as a Primary Distributor Freight Route as part of the State Government led Westport project. Anketell Road will be upgraded, not as part of this proposed structure plan, but as part of the development contribution plan. This key future freight route will connect the SP area to Naval Base and Kwinana Beach Industrial Areas.

Assessment of the proposed traffic and transport network for the SP amendment has shown that the proposed connectivity will function adequately when the area is fully developed, assumed and estimated to be by 2031.

Further to the details provided in the Conclusion Section 7 of this Transport Impact Assessment (TIA) prepared by GTA Consultants, the high-level determination is that the SP amendment, under the assumed traffic generation and distributions noted does not critically compromise the external transport network. The location of future intersections and network of links are adequate to support the overall amendment.

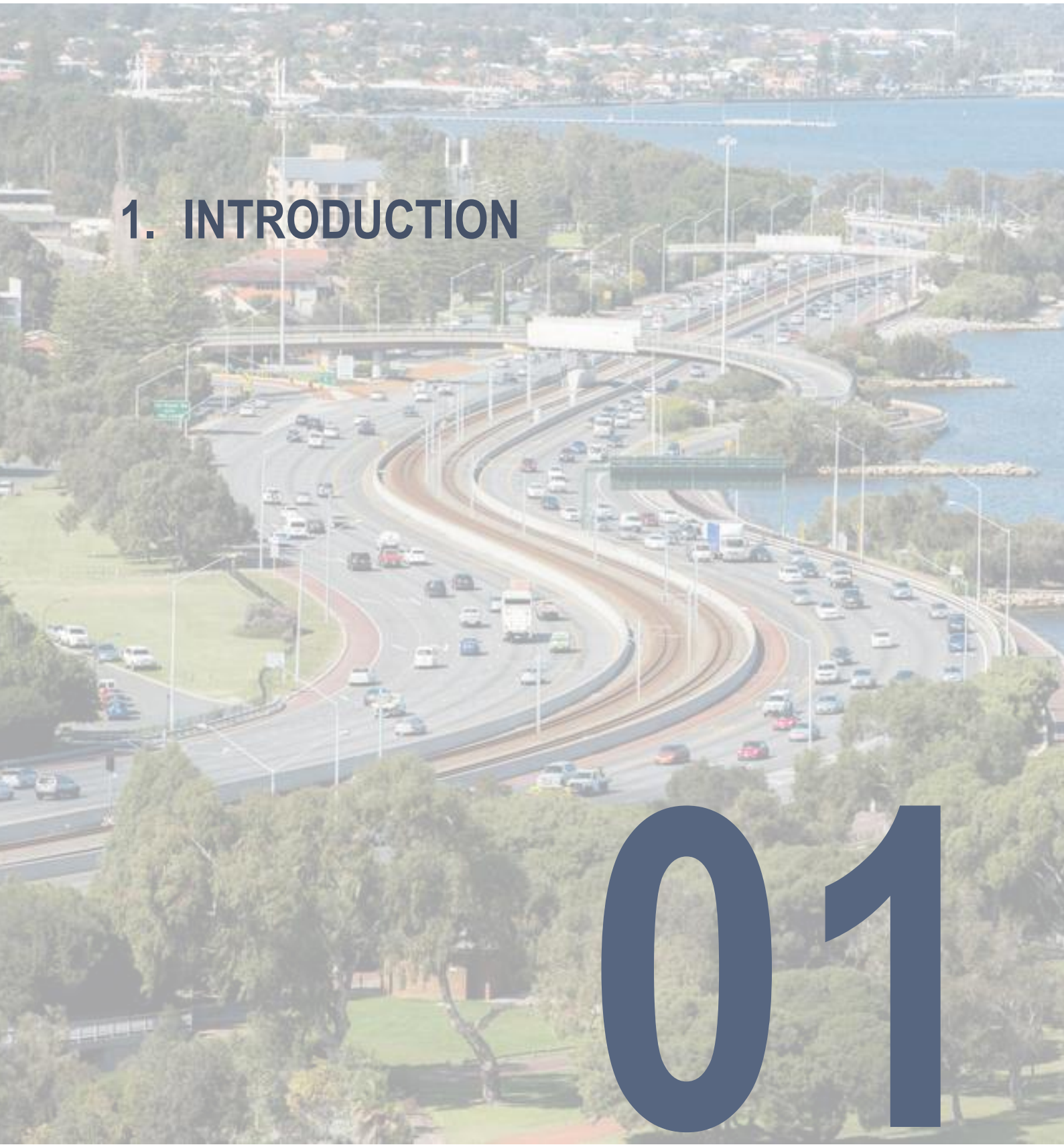
It can be concluded from the information presented in this TIA that the proposed amendments to the SP can be supported by the future traffic network. Accordingly, the transport characteristics of the proposed SP amendment are considered acceptable.

CONTENTS

Appendices

Figures

Tables



1. INTRODUCTION

01

1.1. Background & Proposal

The Anketell North Local Structure Plan (ANLSP) was previously approved in December 2015. Amendment No. 1 to ANLSP was recently endorsed by the Western Australian Planning Commission (WAPC) in April 2019. It is understood that two other smaller Structure Plan (SP) amendments are also current (as of 29 October 2018) and with the City for their assessment.

Amendment No. 1 (October 2017) proposed to reconfigure the westernmost left in / left out entry into the SP to include a right turn in from Anketell Road. Advice received from the City in October 2018 was that this additional right turn movement was not supported by the City, and the recently endorsed Amendment No. 1 confirms this access remains as a left-in/left-out .

The two other SP amendments mentioned above relate to the predominantly Service Commercial zoned area in the north of the SP and just south of Anketell Road. These amendments are understood to reconfigure the land use types slightly.

A subsequent amendment, and the subject of this report, is now being proposed to the ANLSP area, which proposes to:

- move the large Public Open Space (POS) (District Playing Fields) previously located in the centre of the ANLSP to the north-east corner of the new SP
- include an additional development area in the north-east corner of the new SP
- recode of several residential lots
- introduce a Service Commercial area.

GTA Consultants (GTA) has been engaged by Acumen Development Solutions on behalf of the landowner RPoint Land Pty Ltd, in October 2018 to undertake a transport impact assessment of the proposed Amendment. The Structure Plan has been slightly revised in May 2019, which removes a significant portion of the Service Commercial area, shifts the POS further north adjacent Anketell Road and introduces a small additional residential area

1.2. Purpose of this Report

Volume 2 of the Western Australian Planning Commission Transport Assessment Guidelines (WAPC Guidelines) provide direction on the preparation of a Transport Impact Assessment (TIA) for Planning Schemes and Structure Plans. The WAPC Guidelines identify that a TIA for a Structure Plan is to provide a broad-brush assessment.

The current WAPC policy identifies the need to prepare a transport assessment for a structure plan amendment to be discussed with the assessing authority. GTA contacted the City and discussed the key preliminary transport issues of the ANLSP area.

In accordance with the WAPC Guidelines, this TIA outlines only the proposed amendments.

1.3. Previous Studies

The following studies were previously prepared and are relevant to the subject sites due to their proximity:

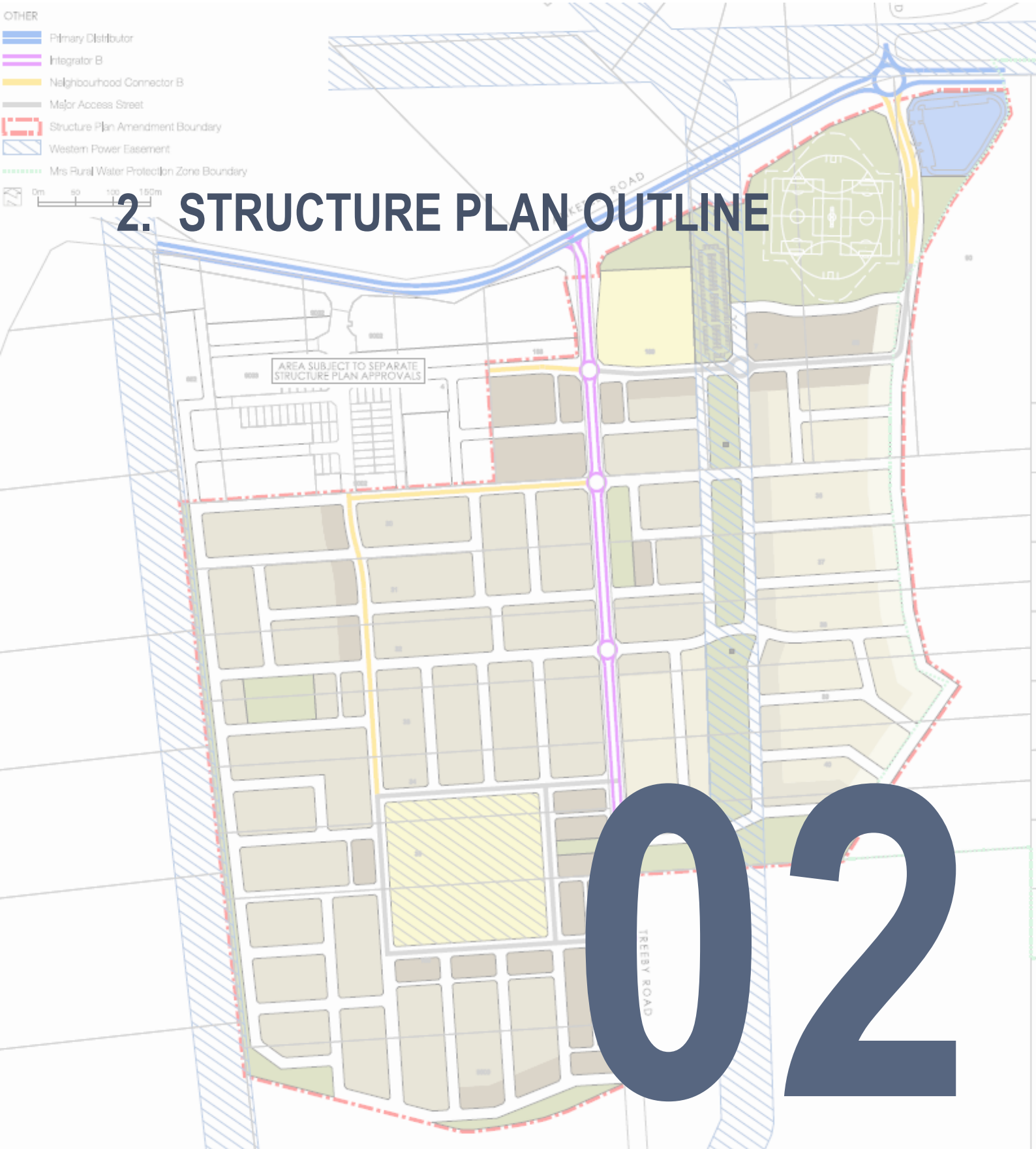
- Lots 2 & 3 Anketell Road, Anketell North LSP Amendment (Transcore, February 2017)
- Anketell North Local Structure Plan Transport Impact Assessment Report (Transcore, October 2015).

1.4. References

In preparing this report, reference has been made to the following:

- City of Kwinana's Town Planning Scheme No.2 (TPS 2)
- Liveable Neighbourhoods Guidelines

- WAPC Transport Assessment Guidelines for Development
- plans for the proposed structure plan provided on 14 May 2019 prepared by Taylor Burrell Barnett Town Planning and Design (TBB)
- consultation undertaken with the City regarding status of the various SP Amendments and their consultation with Main Roads WA on access to Anketell Road
- various technical data as referenced in this report
- other documents as nominated.



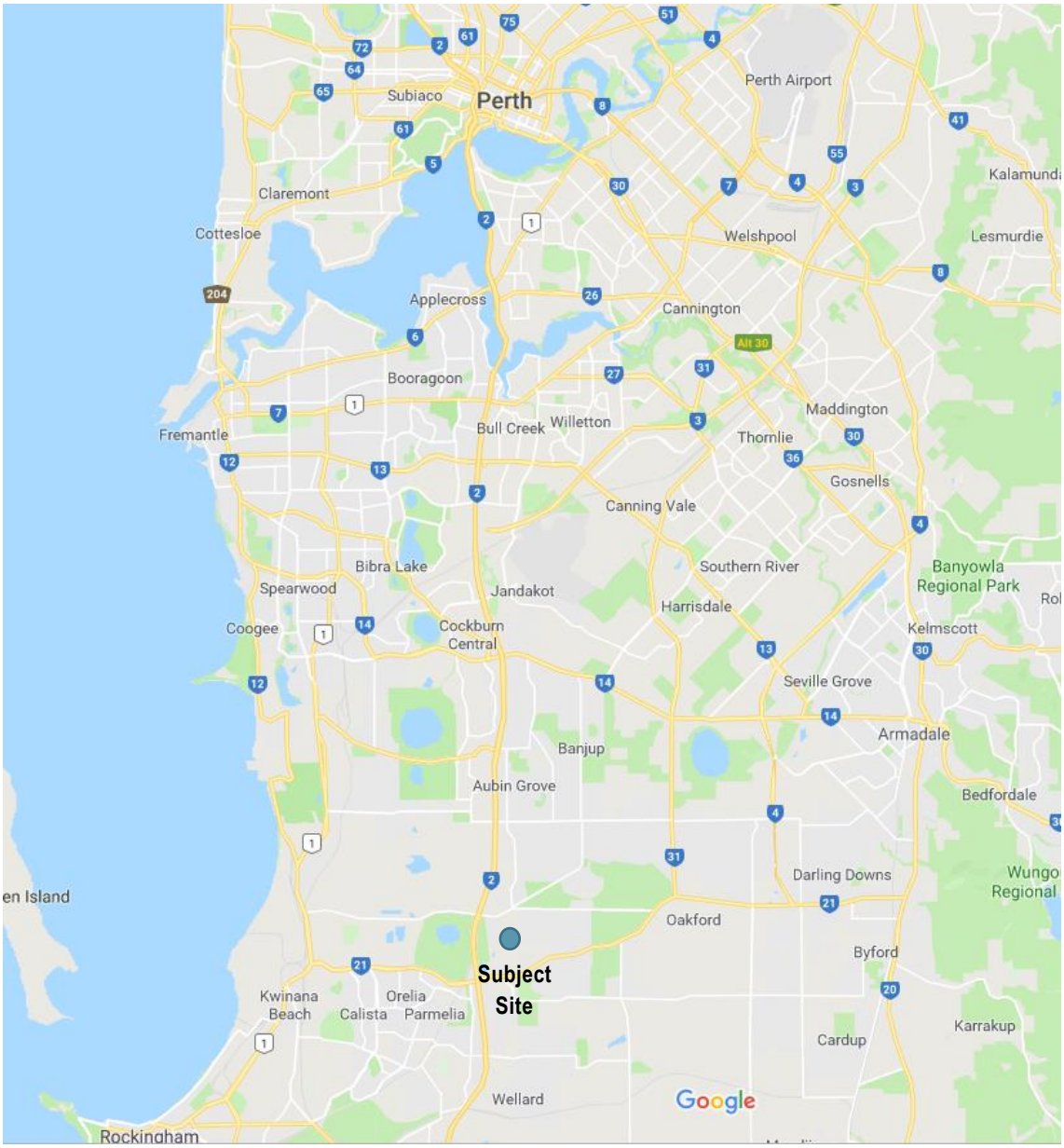
2. STRUCTURE PLAN OUTLINE

02

2.1. Regional Context

The subject site is in the suburb of Anketell, within the City of Kwinana. The site is approximately 31km south of the Perth CBD, approximately 200m east of the Kwinana Freeway and approximately 11km north-east of the Kwinana Town Centre.

Figure 2.1: Location Map



(PhotoMap courtesy of GoogleMaps)

2.2. Proposed Land Uses

The Amendment to ANLSP proposes a slight increase in density, modified road layout and an additional Service Commercial zoned area. The change in land uses relevant to the amendment area is summarised in Table 2.1.

Table 2.1: Land Uses – SP amendment area only

Land Use	Previously Approved Yield	Proposed Amendment Yield
Residential R10	21 lots	N/A
Residential R20	N/A	33 lots
Residential R25	164 lots	209 lots
Residential R30	607 lots	837 lots
Residential R40	202 lots	318 lots
Residential R60	72 lots	N/A
Community Facility	1.67ha	1.65ha
Primary School	4ha	4ha
Service Commercial	N/A	6,072m² NDA
Parks and Recreation / Drainage	12.4ha	13.4ha
Total	**1,066 lots**	**1,397 lots**

It is important to note that the Transport Assessment for the current ANLSP outlines a greater number of residential (1,544 lots), as this includes the SP area outside of the amendment.

For clarity, the ANLSP area outside of the amendment outlines a Mixed Use Residential of 34 lots, Retail use of 2,431sq.m. and Commercial use of 15,624sq.m which is presumed to be within the northern located lots, just south of Anketell Road.

The Service Commercial net developable area (NDA) proposed as part of the new SP is based on 50% of the estimated GFA, as advised by Taylor Burrell Barnett.

2.3. Attractors or Generators of Traffic (non-residential)

There are numerous supporting facilities within the structure plan areas which would be attractors or generators of traffic, such as:

- Primary School (already approved)
- Service Commercial (newly proposed as part of this amendment)
- Community Facility (already approved)
- Public Open Space and wetlands.

2.4. Specific Access Considerations

Since the approval of the original SP in December 2015, a subsequent Amendment No. 1 proposed a right turn into the SP area from the westernmost access road which was previously a left-in left-out intersection. This Amendment has since been determined, and the endorsed Amendment No. 1 retains a left-in left-out intersection. This has been acknowledged as part of the traffic modelling undertaken for this report.

It is also noted that a roundabout is now being proposed at the intersection of Lyon Road and Anketell Road by Main Roads WA. This replaces the previously proposed left-in left-out intersection just east of the Treeby Road / Anketell Road future signalised intersection.

Whilst these are not specific transport issues, these new traffic conditions will impact the distribution of the generated trips and is therefore considered in this assessment.

3. EXISTING SITUATION

03

3.1. Subject Site

The subject site comprises of numerous lots to the south of Anketell Road, Anketell. The ANLSP area has changed slightly to include additional land adjacent to the Lyon Road / Anketell Road intersection. The site area is bound by Anketell Road to the north, the Kwinana Freeway and Park/Recreation/Drainage to the west, and other land currently zoned Development under the City's TPS 2.

TPS 2 states that the Development Zone requires a structure plan to further guide development, and as such the ANLSP was prepared.

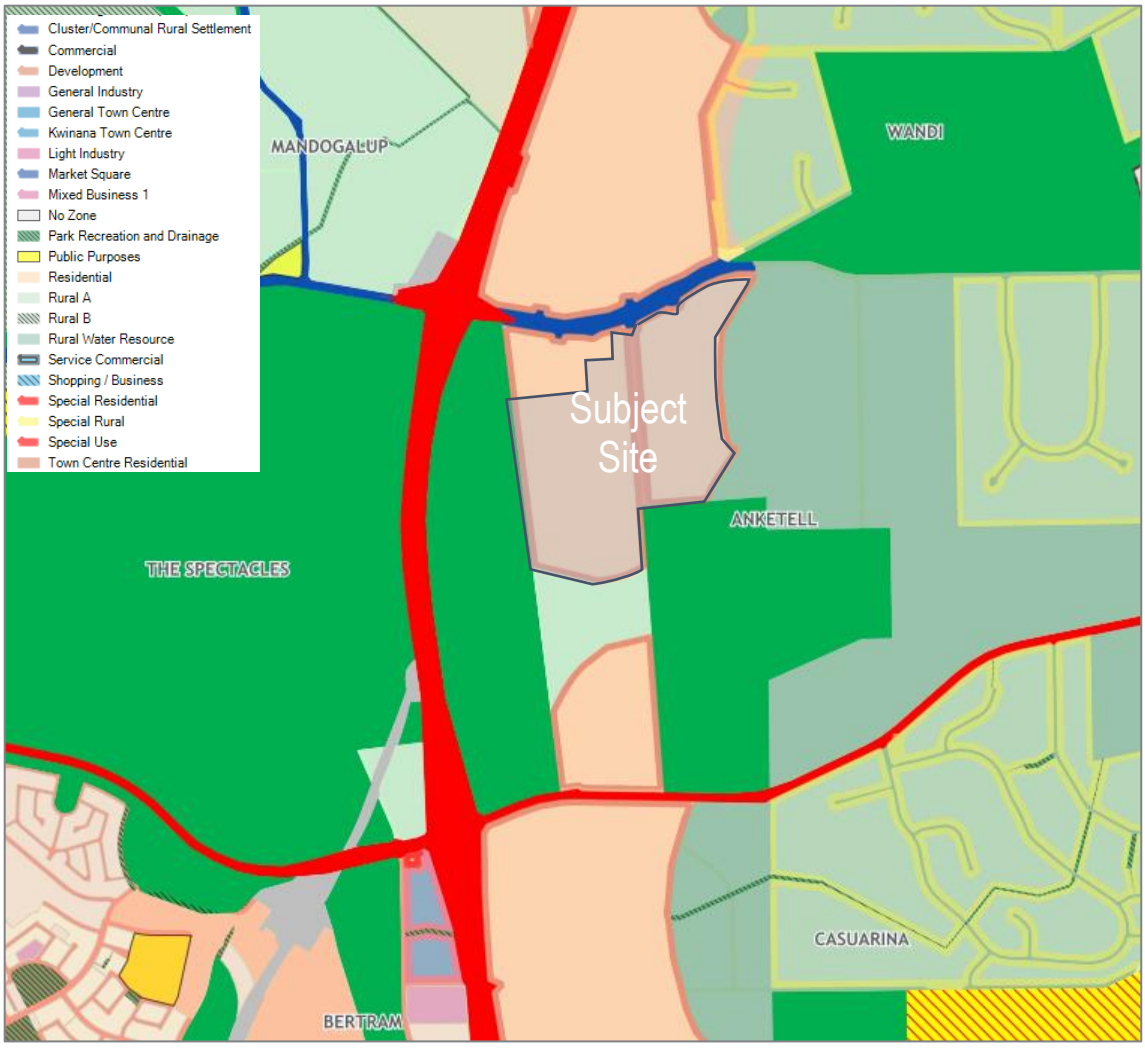
The surrounding properties include a mix of zones including the Rural Water Resource, Parks and Recreation and Rural A Zones.

The location of the subject site and the surrounding environs is shown in Figure 3.1, and the land zoning is shown in Figure 3.2.

Figure 3.1: Subject Site and its Environs

(PhotoMap courtesy of NearMap Pty Ltd)

Figure 3.2: Land Zoning Map



(Reproduced from City of Kwinana Intramaps)

3.2. Existing Movement Network

3.2.1. Roads (including RAV Networks)

The urban development of the Anketell area is limited, and the land is currently largely of rural nature. The site is bound by Anketell Road to the north, with the Kwinana Freeway within proximity on the western boundary and Treeby Road through the centre.

Anketell Road

Anketell runs north of the subject area and is identified as an "Other Regional Road" under the Metropolitan Region Scheme (MRS). It is identified as a District Distributor A Road with a posted speed limit of 80km/h west of Tuart Road and 90km/h east of Tuart Road as per the Main Roads Western Australia (MRWA) Functional Road Hierarchy and Road Information Mapping System. It is carrying 6,155 vpd (M-F avg) with 14.2% truck traffic in the site's vicinity (2017/18 data).

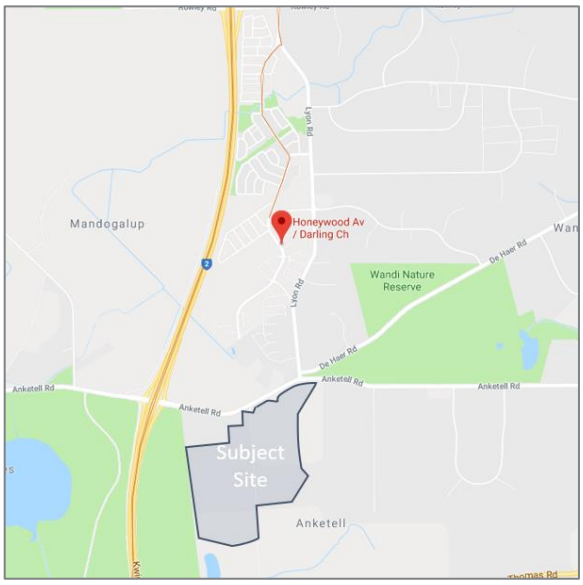
Anketell Road has been identified as an alternative freight route to the Naval Base and Kwinana Beach industrial areas and will ultimately be a dual divided carriageway.

Treeby Road

Treeby Road runs north-south through the centre of the ANLSP area and is identified as a local road with a posted speed limit of 50km/h by the MRWA Road Information Mapping System. The northernmost point of Treeby Road currently intersects Anketell Road at a priority-controlled T-Junction. The southern portion is not constructed yet, and as such does not connect to Thomas Road, however is planned to connect to Thomas Road in the future.

3.2.2. Pedestrian and Cyclist Network

Access to the structure plan area is currently quite limited or incomplete as the surrounding area is still currently being developed. There are currently no footpaths or cycle lanes or paths along Anketell Road.



3.2.3. Public Transport

The bus services in the area are currently limited given the rural nature of the land. There are no bus routes servicing the subject site currently. The closest existing bus stop is approximately 1.5km north of the site, within the developments north of Anketell Road and terminates at Honeywood Avenue/Darling Chase.

In addition to road based public transport, the Kwinana Train Station on the Mandurah railway line is located approximately 2km from the site (measured in a straight-line distance).

3.3. Existing Road Network (Within 2km)

In addition to Anketell Road and Treeby Road discussed above, there are a few other roads within a 2km radius of the subject site including Kwinana Freeway and Lyon Street.

Kwinana Freeway runs north-south near the westernmost part of the site. It is classified as a Primary Distributor and reserved as a Primary Regional Road under the MRS. It has a posted speed limit of 100km/h and is constructed as a four -lane divided carriageway. The closest Kwinana Freeway interchange to the ANLSP area is at Anketell Road.

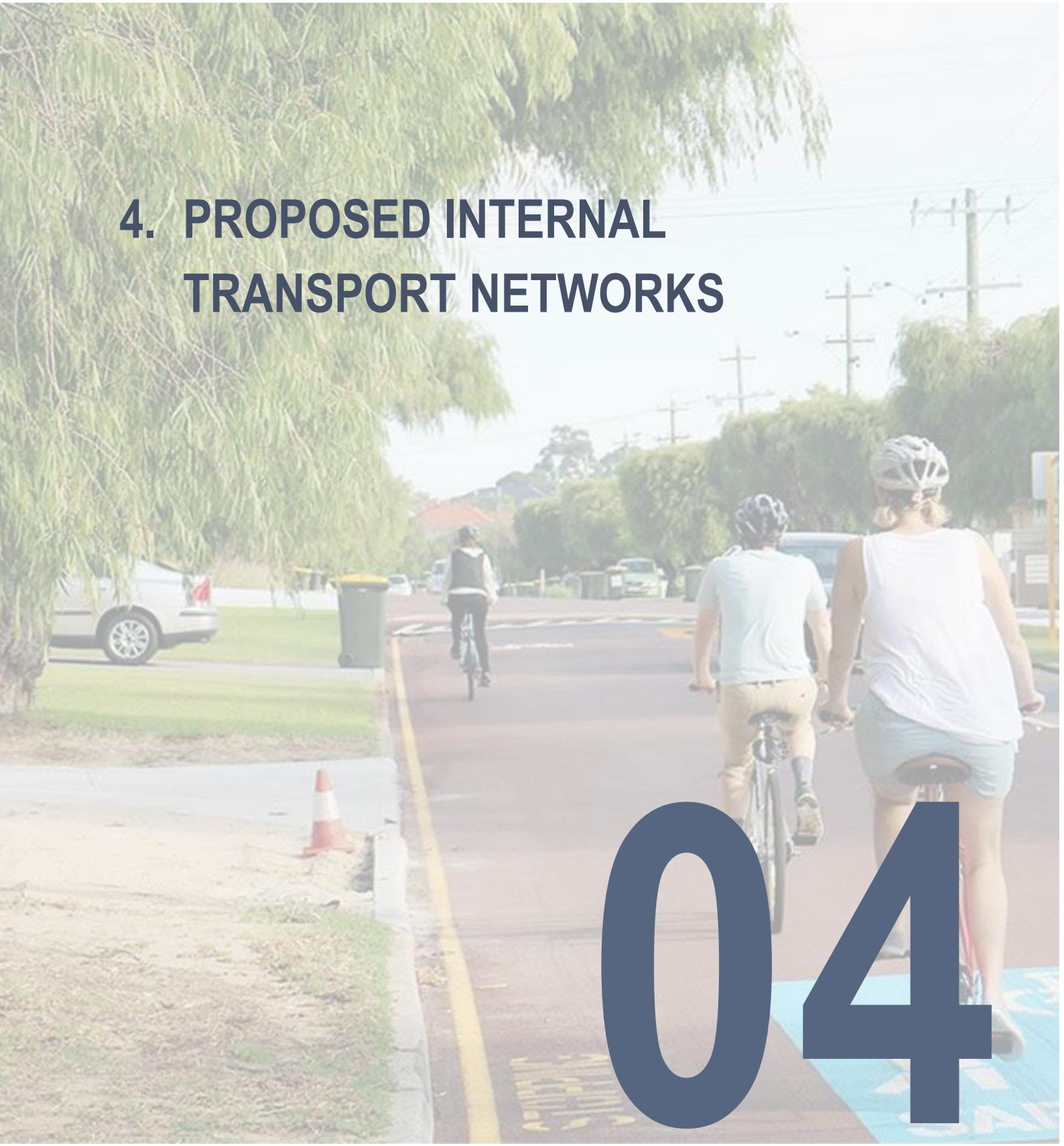
Lyon Street is a Local Distributor road with which runs north-south between Anketell Road, north of the subject site, to Rowley Road and beyond to Atwell. It has a posted speed limit of 80km/h to Rowley Road, then 60km/h through Aubin Grove and 50km/h in Atwell.

3.4. Traffic Counts (within 2km)

Figure 3.3: Location of Counters

Table 3.1: Traffic Count Information

	Location	2017/18 Monday to Friday Average	% Cars	% Trucks
1	Anketell Road (West of Kwinana Freeway)	14,324	80.2%	19.8%
2	Kwinana Freeway (NB at Anketell Road)	37,107	91.5%	8.5%
3	Kwinana Freeway (SB at Anketell Road)	39,028	92.5%	7.5%
4	Anketell Road (East of Kwinana Freeway)	6,155	85.8%	14.2%
5	Kwinana Freeway (SB N of Thomas Road)	42,575	90.3%	9.7%
6	Kwinana Freeway (NB N of Thomas Road)	40,068	86.3%	13.7%
7	Kwinana Freeway (NB at Thomas Road)	32,843	90.3%	9.7%
8	Kwinana Freeway (SB at Thomas Road)	34,139	92.1%	7.9%
9	Thomas Road (East of Kwinana Freeway)	13,622	88.2%	11.8%
10	Thomas Road (West of Newbold Road)	16,116	88.7%	11.3%



4. PROPOSED INTERNAL TRANSPORT NETWORKS

04

4.1. Changes to Existing Road Network

A number of changes to the existing road network are planned. Anketell Road is to be upgraded from two to four lanes divided.

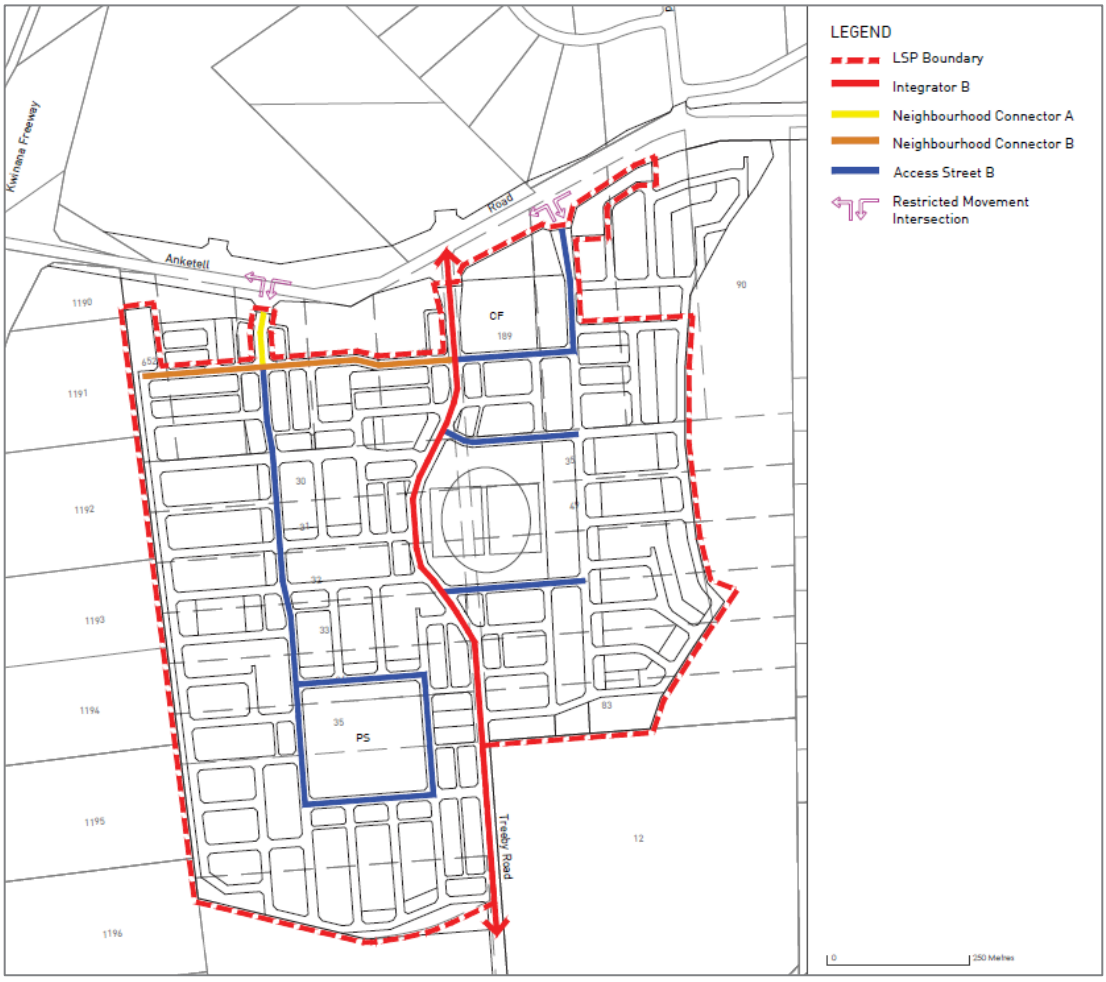
Anketell Road is currently approved for a left in / left out intersection at Road 1 (the westernmost intersection to the ANLSP area between Kwinana Freeway and Treeby Road). An amendment to introduce a right turn into Road 1 from Anketell Road was submitted, however the City has indicated that it did not support this access, although the outcome will be determined by the WAPC. The City has requested GTA to assume that it will remain as a left in / left out intersection.

Based on information provided at officer level from a Development Engineer from the City of Kwinana via email on 19 November 2018, Anketell Road is proposed to be upgraded to a Primary Distributor Freight Route road as part of the Westport project, led by the State Government. As part of this, MRWA have prepared a design for a roundabout at the Lyon Road / Anketell Road intersection. It was noted that the only full movement intersections would be Lyon Road / Anketell Road and Treeby Road / Anketell Road. All other access points would remain as left-in / left-out, unless otherwise approved. However, it was noted by the officer that it would be unlikely for MRWA to support any changes to this network described above.

4.2. Proposed Road Hierarchy, Road Reserve Widths and Speed Limits

The road hierarchy for the ANLSP area was established in the original structure plan document, as per Figure 4.1.

Figure 4.1: Current Road Hierarchy (ANLSP 2015)



The lot layout has now changed, and the updated road hierarchy is shown in Figure 4.2, and has been determined based on the modelling undertaken by GTA for this amendment.

Figure 4.2: Proposed Road Hierarchy - Amendment

(Base map sourced from Taylor Burrell Barnett, May 2019)

Further discussion on the proposed road hierarchy, including internal cycle links is provided in Chapter 6 – Analysis of Internal Transport Networks.

5. INTEGRATION WITH SURROUNDING AREA

05

INTEGRATION WITH SURROUNDING AREA

5.1. Surrounding Attractors

Most of the land surrounding the subject area is currently still rural and has not been developed. Given this, there are limited attractors surrounding the structure plan area. The surrounding attractors could include The Spectacles and Wandi Nature Reserve.

5.2. Trip Attractors/Generators within 800m

The area within 800m is predominantly rural, including Special Rural and Rural Water Resource, as well as urban residential land to the north of Anketell Road and therefore predominantly urban residential. Within the Wandi South Structure Plan area, which lies to the north of the ANLSP area, there will be a future high school and public open space to complement the SP amendment's residential area.

The Anketell South Structure Plan, which lies south of the ANLSP, identifies land zoned as commercial, service commercial and public purpose / community facility, in addition to the residential land and associated public open space.

More locally, the ANLSP is predominantly residential with a future primary school, public open space and community facility.

5.3. Proposed Changes to Land Uses within 800m

The Anketell South Local Structure Plan and the Local Development Plan is within 800m of the SP amendment, on the southern end of Treeby Road. The Local Development Plan was endorsed by the City of Kwinana on 10 August 2017. A small neighbourhood centre has been allocated to the Anketell South SP area despite the area ultimately accommodating only 1,200 residents. This planned centre will ultimately trade to the community to the south of Thomas Road.

Wandi District Centre is planned to be the predominant retail centre in the area immediately to the north of Anketell Road.

5.4. Travel Desire Lines from Structure Plan to these Attractors/Generators

Travel desire lines to local attractors such as the school, community facility and commercial areas will be well catered for when developed as they all lie on direct road routes which will cater for motor vehicles, pedestrians and cyclists. There are no other trip attractors/generators within 800m of the structure plan areas as the surrounding land is predominantly Rural and/or Residential.

5.5. Adequacy and Deficiencies in External Transport Networks

It is understood that Anketell Road will be upgraded to a dual carriageway in the future which is expected to accommodate up to 20,000vpd, consistent with an Integrator B.

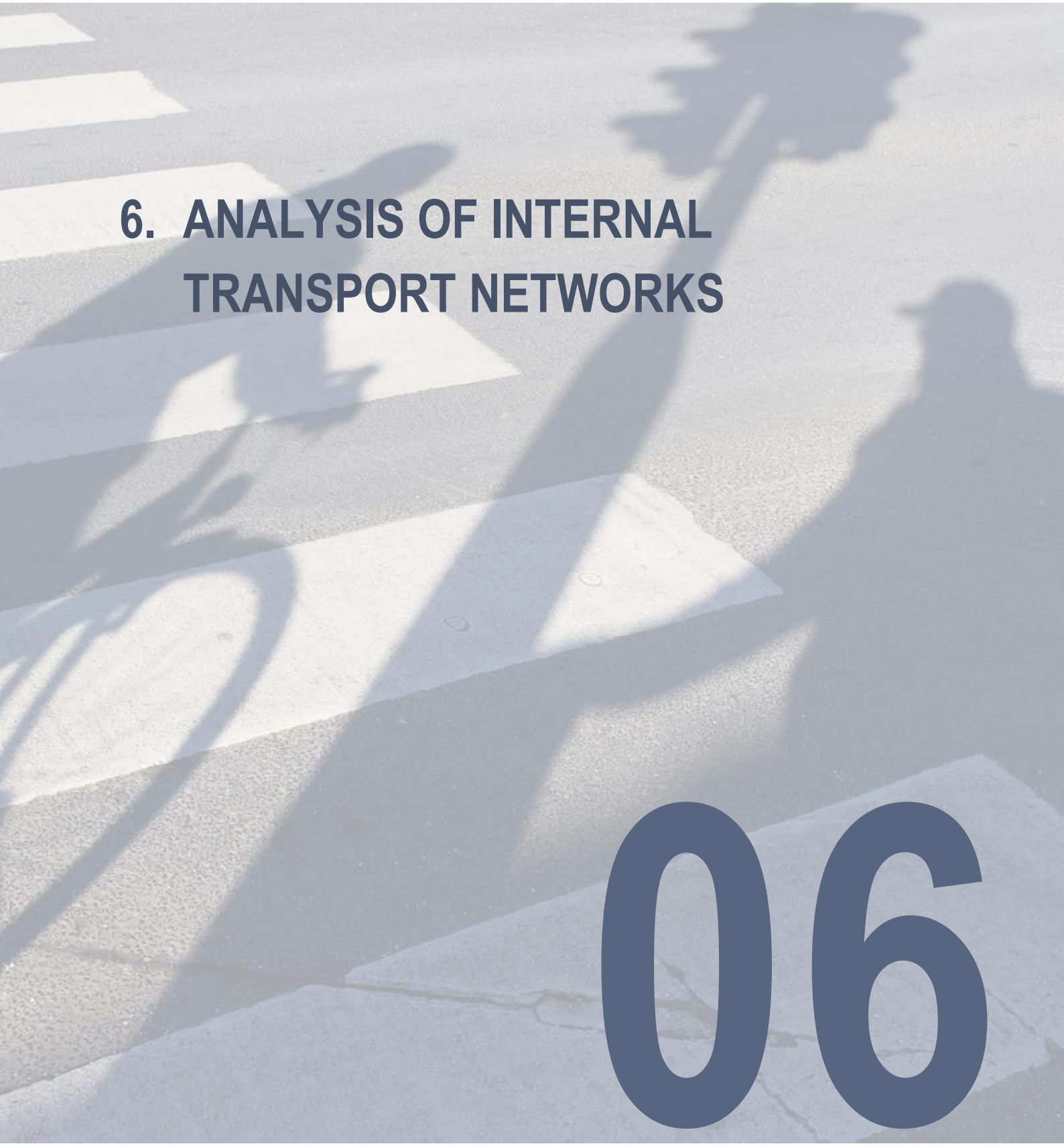
Treeby Road between Anketell Road and Thomas Road is either not constructed or constructed to a rural standard. Therefore, Treeby Road will also need to be upgraded or constructed to an urban standard, as per the road hierarchy discussed in Chapter 6.

The construction and upgrading of these roads are required to support the development in the structure plan area and are identified in DCA4. Footpaths and cycling facilities are required to connect the development areas with the wider network, which include the 2.5m dual use path identified in DCA4.

5.6. Remedial Measures to Address Deficiencies

Most of the internal roads will be developed as part of the ANLSP area. The subject area is also subject to DCA4. This includes provisions for contributions to support the upgrading of intersections along Anketell Road, as well as the upgrading of Anketell Road to a single carriageway urban standard westwards of Treeby Road (including reconstruction and alignment, treatment of intersections, kerbing, undergrounding of power, lighting, construction of a 2.5m wide dual use path, drainage and lighting).

Treeby Road is required to be upgraded to a Neighbourhood Connector standard, as per DCA4, and most of the upgrades will be captured by the subdivision of adjacent land. The portion of Treeby Road between Anketell North LSP and Anketell South LSP will be subject to developer contribution fees for the upgrading and construction which is not captured by the land subject to DCA4.



6. ANALYSIS OF INTERNAL TRANSPORT NETWORKS

06

6.1. Assessment Year(s) and Time Period(s)

The development has been assumed to be fully developed by 2031, or approximately in 12 years.

6.2. Access Strategy

The access arrangements to/from the SP amendment includes:

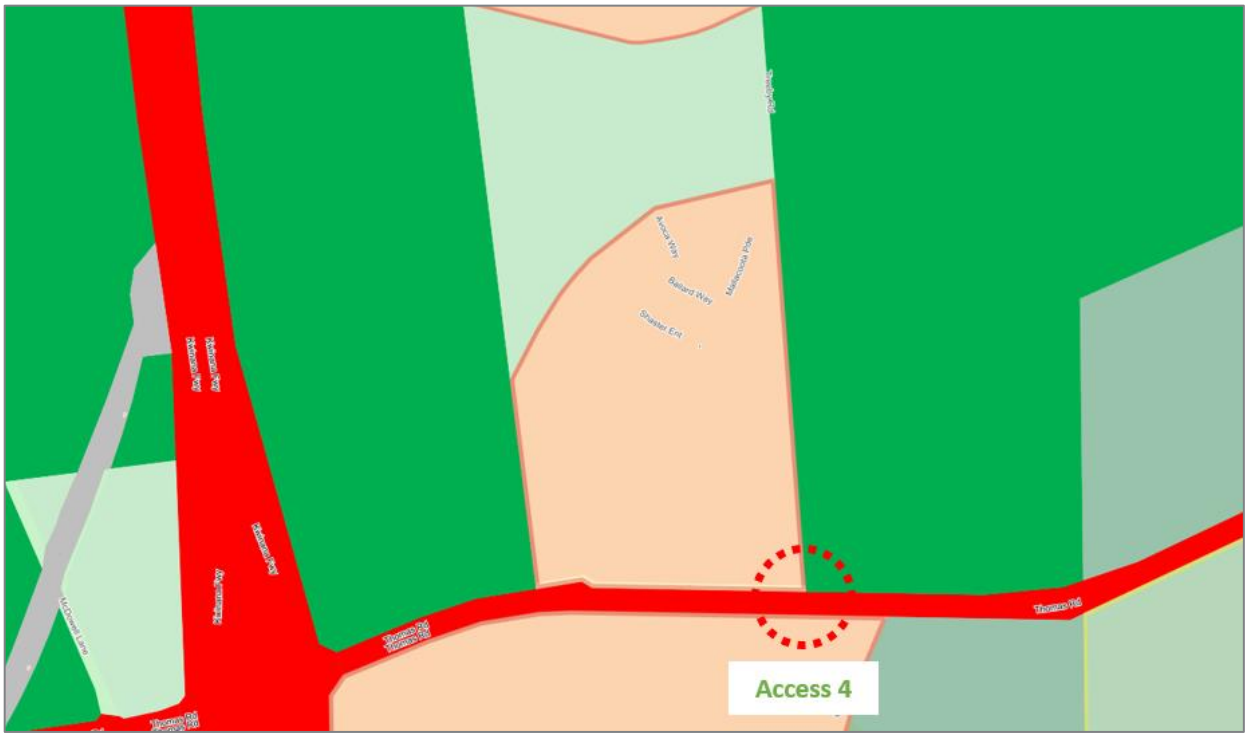
- Access 1 – a Left in/Left out (LILO) on Anketell Road to the north-west of the site (already approved).
- Access 2 – a full movement signalised intersection at Anketell Road / Treeby Road to the north of the site (already approved). This intersection is currently configured as a priority-controlled T-intersection and will connect to the City's planned extension of Cordata Avenue to Anketell Road in the future.
- Access 3 – a 4-way roundabout access at the Lyon Road Anketell Road intersection to the north-east of the SP. Consultation for the southern leg to connect into the Main Roads WA roundabout has been through the City to date.
- Access 4 – a full movement T-intersection at Treeby Road / Thomas Road further south of the site. The City's online Intramaps website map as shown in Figure 6.2 confirms that Treeby Road will ultimately be extended to form a T-intersection with Thomas Road.

The locations of the proposed access intersections and road connections are shown in Figure 6.1.

Figure 6.1: Proposed Access Points

(Base map sourced from Taylor Burrell Barnett, May 2019)

Figure 6.2: SP Amendment Access 4 – Ultimate Treeby Road / Thomas Road T-intersection



(Reproduced from City of Kwinana Intramaps)

6.3. Future Year Baseline Traffic

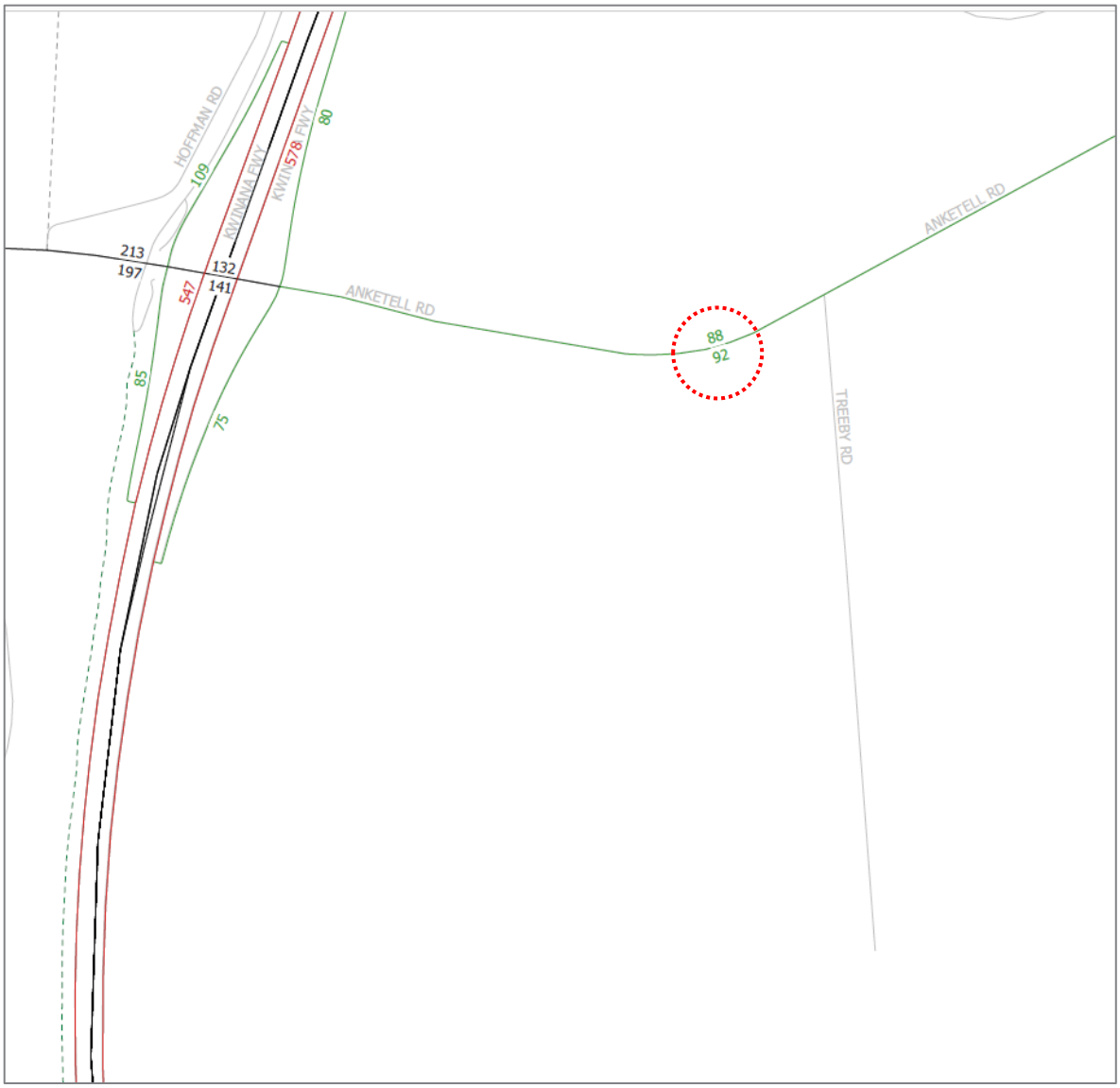
Reference has been made to the most up-to-date[1] strategic modelling outputs from the Main Roads WA Regional Operations Model (ROM 24) to establish the level of background growth to be applied to existing traffic volumes on Anketell Road and Treeby Road.

According to the information sourced from the Main Roads WA ROM model, the projected two-way daily flows on Anketell Road in the vicinity of the ANLSP area is about 18,000vpd in 2031 (including ANLSP traffic as shown in Figure 6.3). It is noted however that the ROM 24 model does not include flows along Treeby Road.

ROM 24 as a strategic model normally incorporates the local links for connection purposes only, in which the turning estimates are either unavailable or they don't represent the true network alignment. As such, reference has been made to Figure 7 in the approved ANLSP Transport Assessment report produced (October 2015) which indicates that the projected background traffic in 2031 (excluding ANLSP traffic) along Treeby Road is expected to be in the order of 1,500 (north of Thomas Road) to 2,500 (South of Anketell Road).

[1] Confirmed by Main Roads WA in an email on 12 November 2018.

Figure 6.3: ROM 24 Link Volume Diagram in the vicinity of ANLSP (x100)



(Source: Main Roads WA ROM 24 model in 2031)

6.4. Structure Plan Generated Traffic

6.4.1. Vehicle Trip Generation

In order to establish an estimate of the potential maximum vehicle trip generation for the SP amendment, reference was made to the proposed land uses and expected activity profiles. GTA also referred to the previous outcomes derived from the approved ANLSP Transport Assessment report produced by Transcore in October 2015. GTA estimated traffic generation impacts using conventional methods and standard trip generation rates extracted primarily from the WAPC Guidelines. Reference has also been made to the *Trip Generation 7th edition, 2003 - Institute of Transportation Engineers (ITE)* and the *RMS NWS Guide to Traffic Generating Developments*.

It is noted that the proposed SP amendment falls within neighbouring SP areas to the north and south which are expected to mainly facilitate residential and commercial development near the proposed ANLSP development. In this

respect, it is important to consider the impact of any traffic travelling through the SP amendment from these external generators. These include:

- External Zone 1 (EZ1); "Anketell South" development to the south of the SP area and it includes Lots 1, 2, 3 & 17 Thomas Road and Portion of lot 100 Treeby Road, Anketell. This area is expected to include a mixture of low to medium residential codes in addition to a commercial use.
- External Zone 2 (EZ2); "Wandi South" development to the north of ANLSP, which accommodates a mixture of low to high residential codes, primary and secondary school sites.

GTA's trip generation methodology is discussed in further detail below.

6.4.2. Structure Plan Generated Traffic

Assessed traffic generation is shown in Table 6.1. Please note the assumed areas relate to the whole of the ANLSP, not just the amendment area, as the trips for the land to the south of Anketell Road also impacts the traffic impact assessment.

Table 6.1: Adopted Trip Generation Rates

Zone	Proposed Land Use	Assumed Area/Number of Lots/Students	Daily Trip Generation Rate	Daily Trips (VPD)
ANLSP amendment	Residential	1,397 (lots)	8 trips per lot per day	11,176
	School	4ha = 600 (students)	2 trips per student (c)	1,200
	Service Commercial*	21,696 (m2)	12 trips per 100 sqm of GFA	2,604
	Community Facility**	12.68ha = 16,514 (m2)	0.58 trips per patron (assuming 300 patrons)	174
Total				**15,154**

* Trip generation rate for "Office" has been sourced from the NSW RTA Guidelines and was assumed for the service commercial lots.

** Trip generation rate for "Function Centre" has been sourced from the ITE Guidelines and was assumed for community facility lot.

ANLSP will include around 1,397 residential dwellings, with an assumed average trip generation of 8 trips per dwelling per day, resulting in a total of around 11,176 vehicle trips per day.

The 'Primary School' is assumed to cater for up to 600 students, and the modelling assumes 2 trips per student per day (assuming all car mode which is a very conservative estimate) resulting in 1,200 vehicle trips per day.

For the purpose of the modelling, the 'Service Commercial' lots has been assumed as offices with a trip generation rate of 12 trips per 100 sqm of GFA. This is considered as a moderate trip rate for the various types of service commercial uses that could later be developed under the City's permitted uses and therefore a reasonable assumption. This assumption is also consistent with the approved ANLSP. As advised by Taylor Burrell Barnett, a 30% reduction has been applied to the total area indicated in Table 6.1 for GFA conversion which results in 2,604 trips per day.

The 'Community Facility' has been assumed in the modelling as a function centre with a maximum capacity of 300 patrons. The community facility lot is expected to generate in the order of 174 vehicles per day.

In total, the entire ANLSP is expected to generate some **15,150 trips per day**.

6.4.3. Vehicle Trip Distribution and Assignment

The trips calculated in the trip generation exercise above were distributed onto the road network using the following method and assumptions:

- The assessment year that has been adopted is 2031, with full development of ANLSP amendment, Anketell South, and Wandi South assumed.
- ANLSP was broken down into smaller internal sub-zones in addition to two External Zones (EZ1 and EZ2) to capture the through traffic demand from/to Anketell South, and Wandi South. This zone structure divided the project area into key traffic sub-areas within the development and by land-use to provide an appropriate traffic model. The modelled network is shown in Figure 6.4.
- The major attraction patterns surrounding the ANLSP were analysed in accordance with various traffic counts sourced from the Main Road WA online traffic database. These external distribution percentages are outlined in Table 6.2.

Table 6.2: Adopted External Traffic Distributions

To/From	Distribution Percentage (%)	
	Inbound	Outbound
Kwinana Freeway (North), Anketell Road (West)	46.7%	44.3%
Kwinana Freeway (South), Thomas Road (West, East)	52.4%	54.3%
Anketell Road (East)	1.0%	1.4%
Total	**100%**	**100%**

- The inbound/outbound distribution percentage assumed to/from Anketell Road East (1.0 – 1.4%) has been further validated by reviewing future planning to the east of Anketell Road. Reference has been made to the *Jandakot Structure Plan Report* (DoPLH, August 2007), which identifies a large portion of this land as Rural (see Figure 6.5). It is also noted that a significant portion of land to the east of the ANLSP area is zoned as Rural – Water Protection under the Metropolitan Region Scheme (See *State Planning Policy 2.3: Jandakot Groundwater Protection* also applies to this area and identifies that the minimum lot size for subdivision is 2ha. and it shows that areas to the east of Anketell Road are identified predominantly as rural. An extract from the *Final Jandakot Structure Plan* is provided in Figure 6.5.
- As outlined in Table 6.3 below, the majority (75%) of the ANLSP's 'Primary School' trips were apportioned internally to the residential lots within the SP area. Given that Anketell South development (EZ1) to the south of ANLSP does not propose a school, the remaining 25% has been allocated to Anketell South (EZ1) to the south of ANLSP given the proximity to the school site. It is noted that Wandi South (EZ2) has access to other primary and secondary school choices within its vicinity.

Table 6.3: Assumed "Primary School" Trip Distribution

Zone	School Trip Proportions	Daily School Trips (VPD)
ANLSP	75%	900
Anketell South (EZ1)	25%	300
Total	**100%**	**1,200**

- For the "Service Commercial" and "Community facility" lots, the percentages outlined in Table 6.4 have been applied for the traffic distribution these lots. It is noted that the inbound/outbound external trips for these uses have been assigned to the external network using the same percentages highlighted in Table 6.2.

Table 6.4: Assumed "Service Commercial" and "Community Facility" Trip Distribution

	Trip Proportions	Service Commercial Trips (VPD)
Service Commercial Lots		
ANLSP (internal)	15%	552
External	85%	3,128
Total	**100%**	**3,680**
Community Facility Lot		
ANLSP (internal)	40%	70
External	60%	104
Total	**100%**	**174**

- Apart from primary school, service commercial, and community facility related trips, zero internal trips are assumed for the internal residential zones travelling within ANLSP.
- For each internal zone within ANLSP travelling to/from another zone, it was assumed that the vehicle making the trip would be following the shortest path to get to their destination.

Figure 6.4: Excerpt of ANLSP Amendment Traffic Demand Model

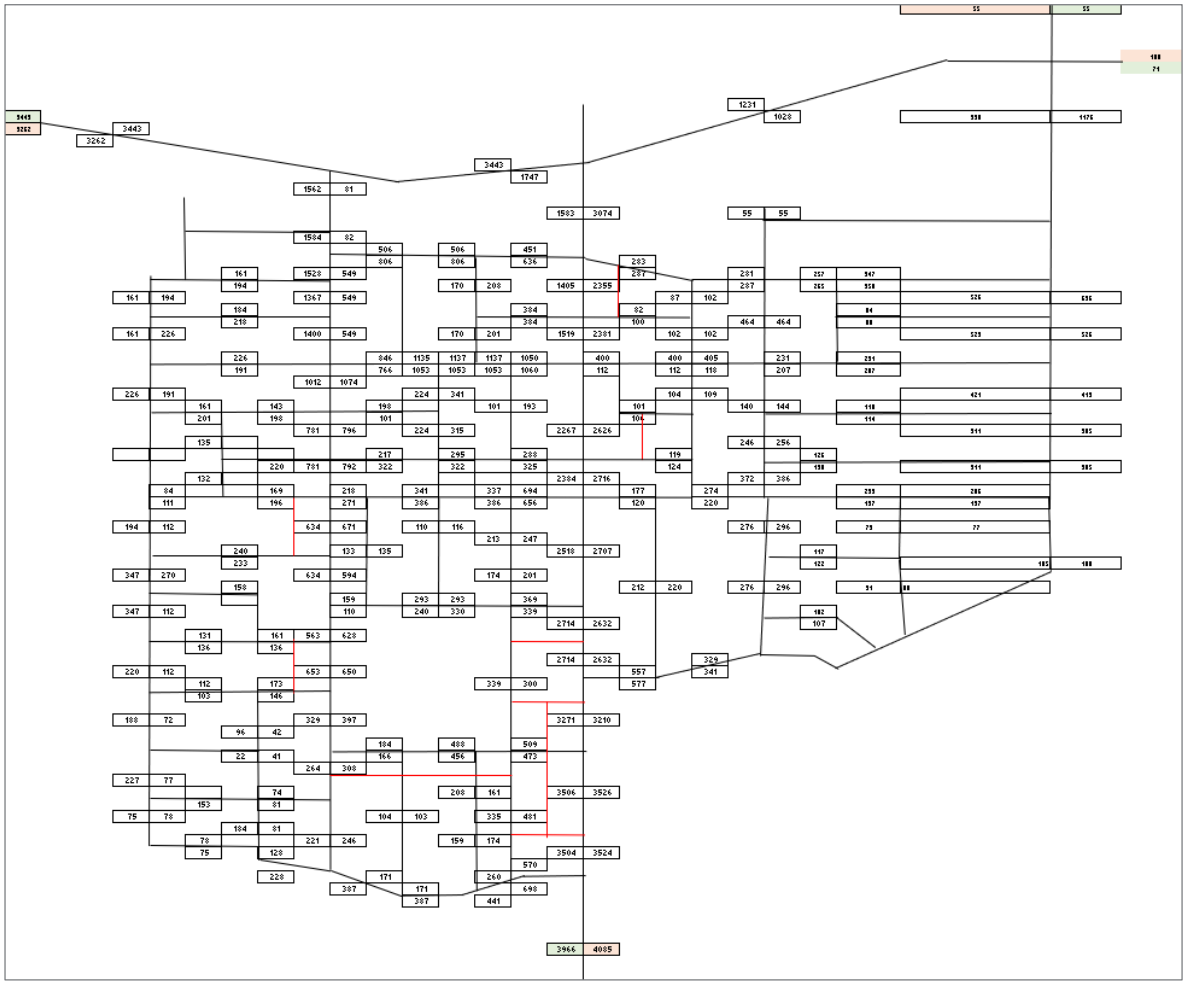
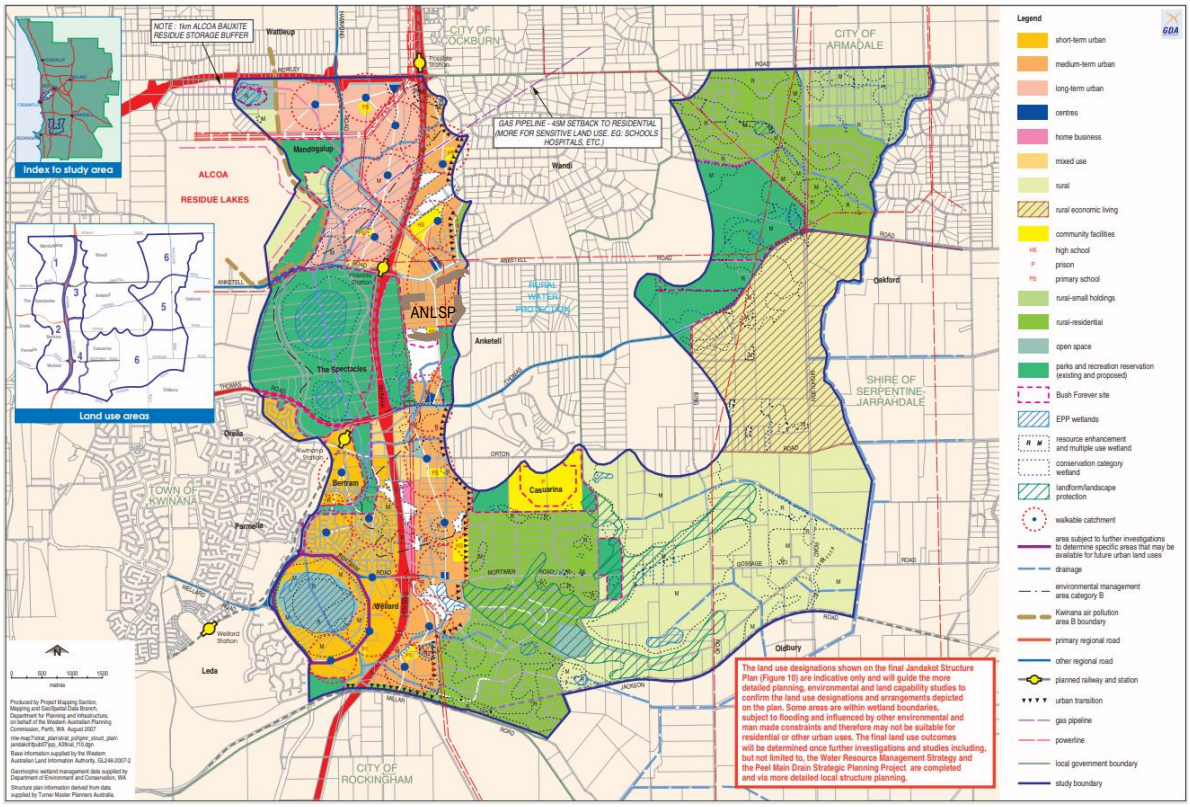
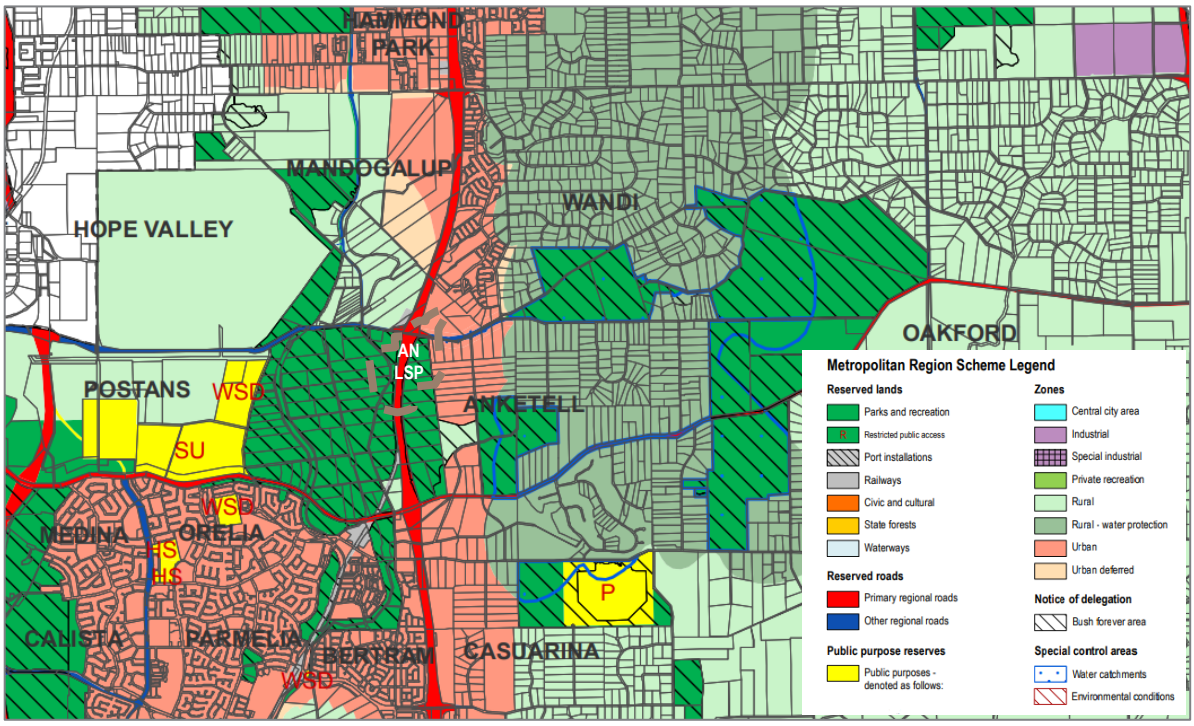


Figure 6.5: Final Jandakot Structure Plan Map



(Source: Extract of Jandakot Structure Plan, Department of Planning, Lands and Heritage Online Website - reviewed in November 2018)

Figure 6.6: Metropolitan Region Scheme Zoning



(Source: MRS Maps, Department of Planning, Lands and Heritage - reviewed in November 2018)

6.4.4. Traffic Flows and Road Hierarchy

The traffic generated within the study area was assigned onto the road network using the methods and assumptions noted above. Future demands for each internal and external zone in addition to background traffic on Anketell Road and Treeby Road were then added together resulting in the daily demands set out in Figure 6.7.

Figure 6.7: Estimated Daily Vehicle Demands in 2031 (Total traffic)

(Base map sourced from Taylor Burrell Barnett, May 2019)

On this basis, the proposed internal road hierarchy for the SP amendment was developed, as shown in Figure 6.9. This road hierarchy has been developed using the guidelines and indicative daily traffic volume limits set out in *Liveable Neighbourhoods*, together with the overall design principles and aims for the ANLSP amendment.

Of note is that Treeby Road is proposed as an Integrator B. The existing width of Treeby Road is 20m – 22m (varies along sections). This key north-south road is being proposed as a boulevard design within the already approved 25.2m indicative road reservation width. To avoid the unnecessary CAP roads previously identified along Treeby Road, a road cross section similar to that of Honeywood Avenue, Honeywood (north of Anketell Road in the City of Kwinana) is appropriate with 4m wide carriageway widths, 6m wide median island restricting driveway movements to left-in / left out, shared use pathways on both sides of verge and roundabouts supplemented by occasional median breaks designed for u-tuns where roundabouts are distanced apart. This is an excellent design outcome for Treeby Road in lieu of undesirable CAP roads. Drainage swale in the central median will be limited to areas where the Treeby Road grades are flatter; however, this does not prohibit this boulevard concept being used.

Figure 6.8: Honeywood Avenue cross-section example in Honeywood

(Photomap courtesy of Google Maps)

Figure 6.9: Proposed Road Hierarchy

(Base map sourced from Taylor Burrell Barnett, May 2019)

The road reserve widths proposed for each class of road are in line with the *Liveable Neighbourhoods* guidance (indicative), as set out below:

- Integrator B = 29.2m, 2x7.5m including on-street parking, plus an off-street shared path.
- Neighbourhood Connector B = 19.4m. Additionally, streets abutting the western service commercial lots (outside of the amendment area) where the westernmost left in / left out to Anketell Road is located, are recommended to be constructed to this standard to allow for on-street parking plus shared path on one verge. The verge width for

Neighbourhood Connector B streets can be reduced from 6.2m to 5.5m to reduce the overall reserve width from 19.4m to 18.0m which represents the minimum.

The remainder of the local road network is classified as Access Street A, B, C, and D or laneways with 16.5m – 14.2m road reserve width as follows:

- Access Street A = 20m – 24m. The portion of the north-south connection which provides access to the eastern Service Commercial lots and Public Open Space (District Playing Fields) is recommended to be constructed to this standard.
- Access Street B = 16.5m – 18m. Streets surrounding the Public Open Space (District Playing Fields) are recommended to be constructed to this standard. The access streets adjoining the primary school are also recommended to be configured as Access Street B standard in order to allow for on-street parking on both sides of the street.
- Access Street C = 15.4m – 16m.
- Access Street D = 14.2m (narrower access streets (5.5 to 6m pavement width) may be appropriate in locations further away from centres and activity where traffic flows are less than 1,000vpd and a low on-street parking demand exists).

6.5. Intersection Types

Given the predominantly residential land use within the ANLSP amendment area, and their weighted one-directional peak hour flows within the internal road network, it is not expected any capacity issues will occur at junctions and that uncontrolled priority and roundabout intersections will be sufficient to accommodate the expected demand.

Roundabouts are suggested along the now 'straighter' north-south alignment of Treeby Road to maintain safe speeds and facilitate traffic movements. This also applies to the intersections adjacent to the community facility and the commercial areas to provide effective circulation for traffic accessing these lots.

A few of the intersections adjacent to the primary school are suggested to operate as roundabouts to assist school peak traffic movements, with priority-controlled intersections for the remaining. These should be further confirmed at the time that the school is planned in detail to ensure appropriate treatments are provided at convenient locations for safe pedestrian, cyclists movement and school drop of pick-up / set down.

A full movement signalised intersection at Anketell Road / Treeby Road to the north of the SP amendment is approved and will remain so. Other intersections on Anketell Road are proposed to operate as a left in / left out and a roundabout. Assessing the expected traffic volumes in the Structure Plan area, intersection controls were reviewed against Table 2.4 from the Austroads publication, *Guide to Traffic Management Part 6 – Intersections, Interchanges and Crossings* which provides advice as to intersection performance in peak flow conditions with regards to possible further analysis. This is summarised in Table 6.5.

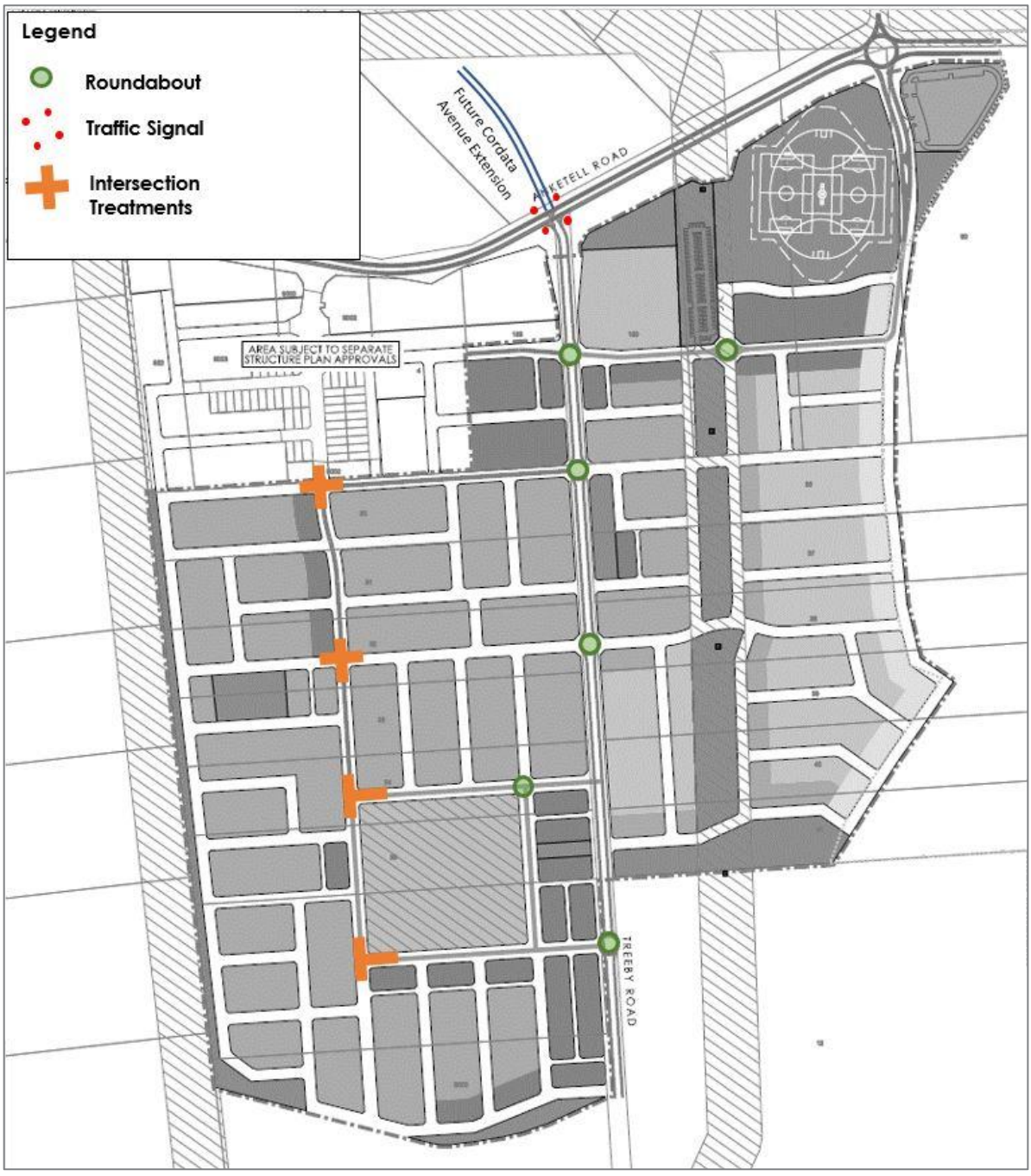
Table 6.5: Austroads Guidelines

Major Road Type	Major Road Flow (two-way, vph)	Minor Road Flow (two-way, vph)
Two-lane	400	250
	500	200
	650	100
Four-lane	1,000	100
	1,500	50
	2,000	25

The peak volume per hour (vph) would be approximately 10% in the PM peak. The traffic volumes are low enough on the internal network of Access Street so as not to warrant further assessment for the structure plan internal roads. It is expected that all internal intersections should operate at a high level of service (LOS) with minimal delays and queues.

The proposed SP amendment internal traffic management for the control of local intersections is shown in Figure 6.10.

Figure 6.10: Internal Traffic Management



(Base map sourced from Taylor Burrell Barnett, May 2019)

6.6. Future Public Transport and Pedestrian and Cycle Infrastructure

As noted previously in Section 3.2.3, there are no bus routes servicing the subject site currently. The closest bus service to the site is route 537 which runs 1.5km north of the site. The SP area is also well outside of the 800m walkable catchment to/from the nearest train station.

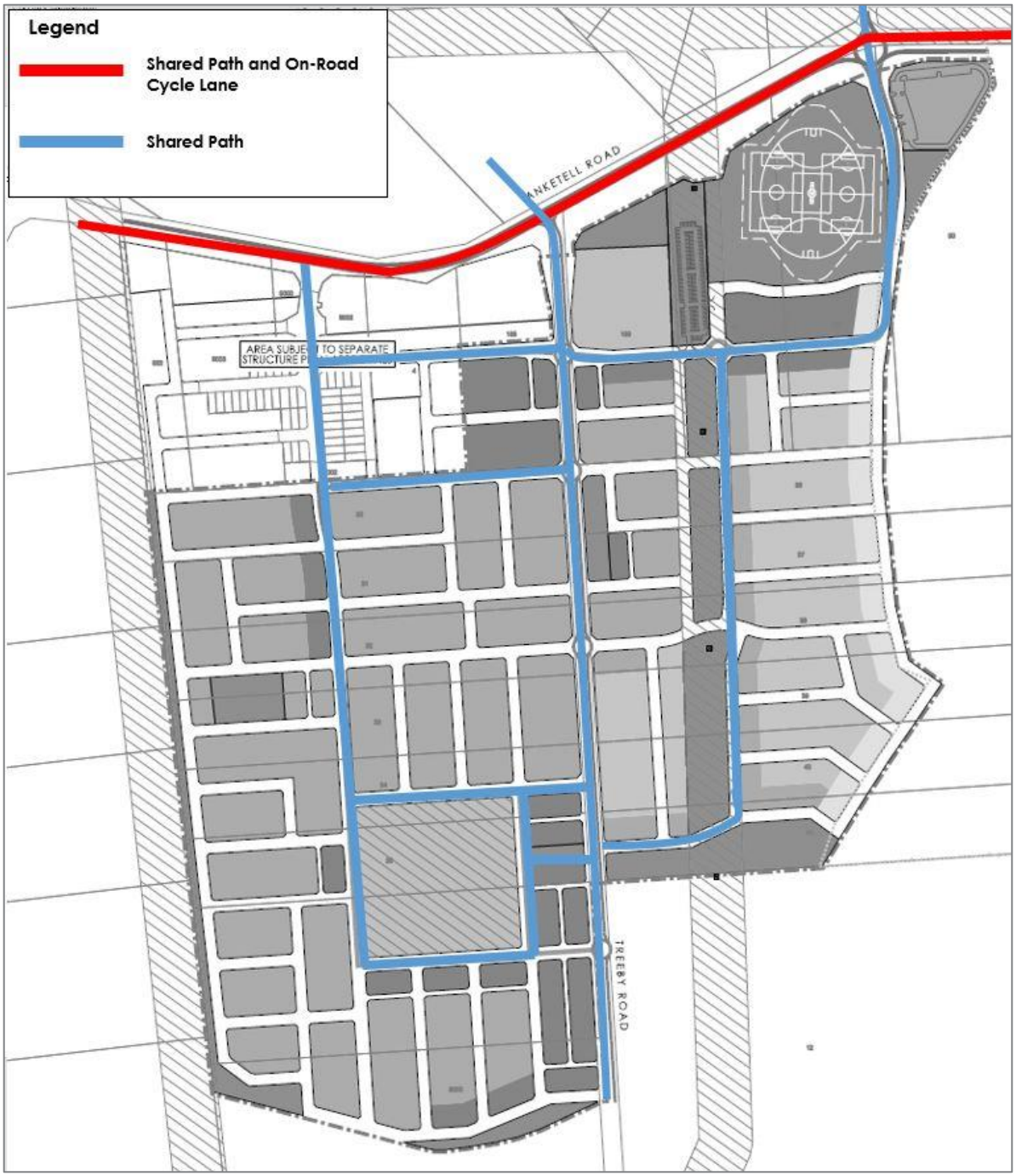
According to information sourced from the approved ANLSP Transport Assessment, bus route 537 will run along the Treeby Road north-south connection and serve Wandi and Anketell cells and provide a good connection between Aubin Grove station and Kwinana station. Another service (Bus Route 545) is planned in the future to service the SP areas to the south of Thomas Road, and provide connection to the Kwinana train station and bus interchange facility.

The SP amendment has been designed in accordance with *Liveable Neighbourhoods* and is cognisant of achieving walkable catchments and a high pedestrian amenity. All streets are recommended to be provided with a footpath on at least one side and a wider footpath is appropriate adjacent to the primary school to enhance the safety of the access to the school. The recommended cycle network is shown in Figure 6.11. Shared paths are recommended along the Integrator B and Neighbourhood Connector roads, as well as along the Western Power Easement on the eastern side of the ANLSP area, providing a cycling connection between the Primary School and the District Playing Fields.

Local access streets with daily traffic flows lower than 3,000 vehicles per day will provide ample opportunity for pedestrians to cross without experiencing delay. The Neighbourhood Connectors which are designed as boulevards also provide greater opportunity for pedestrians to cross safely.

The Neighbourhood Connector roads are suited to on-street cycling as per the (physically separated from cars/trucks), and/or with a shared path on the verge. On April 27 2016, WA's laws were changed to allow cyclists of all ages to use footpaths, unless otherwise signed. The amendment to the *Road Traffic Code 2000* brought WA's bicycle laws into line with the rest of Australia, making it legal for parents to cycle alongside their children on footpaths, improving safety.

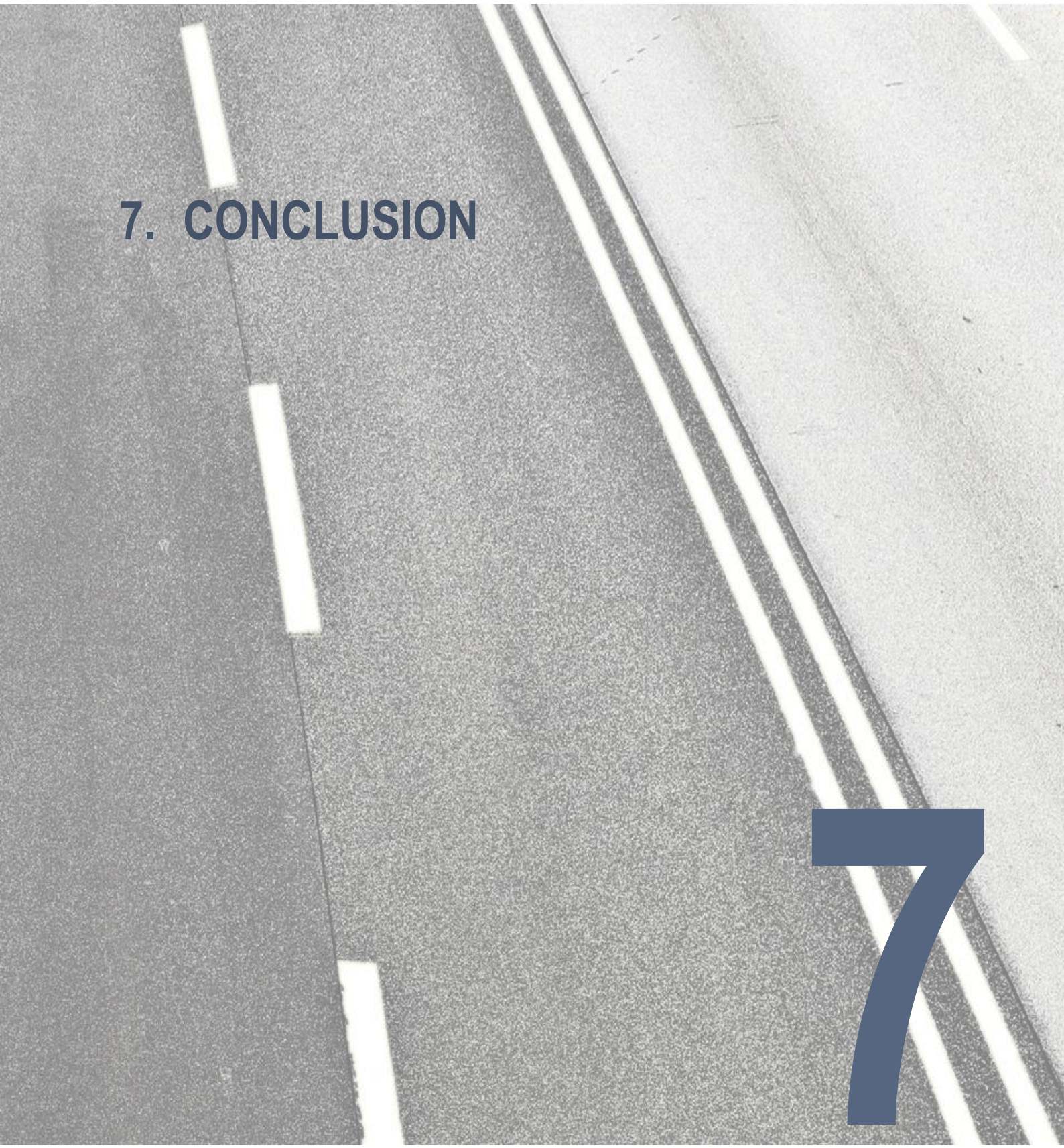
Figure 6.11: Proposed Cycle Network



(Base map sourced from Taylor Burrell Barnett, May 2019)

6.7. Traffic Impact of Development on Local Area

Based on the above assessment it is concluded that the development will have an acceptable impact on the surrounding roads and intersections with no major network changes required to the external transport network over and above what is proposed as part of the amendment.



7. CONCLUSION

7

CONCLUSION

This Transport Impact Assessment Report has been prepared in support of the amendment to the Anketell North Local Structure Plan ANLSP (The 'SP amendment'). The SP amendment proposes to:

- Relocate the Public Open Space (District Playing Fields) from the centre of the SP to the north-east corner, adjacent to a new roundabout proposed by Main Roads WA at the Lyon Road / Anketell Road intersection, which also results in the realignment of Treeby Road;
- Extend the SP amendment boundary to include the land in the north east corner and designate this land as 'Service Commercial'; and
- Amend the residential density codes slightly which results a change from the approved 1,066 dwellings to 1,397 dwellings.

The ANLSP entire site area covers approximately 86ha identified as 'development zone' immediately east of the Kwinana Freeway reserve. Based on the analysis and discussions presented within this report, the following conclusions are made:

- This site has an approved SP layout for which the future transport networks have been largely mapped out. The site layout for the amendment has been developed in this regard and intends to enhance the movement networks in the area.
- The relocation of the Public Open Space (District Playing Fields) from the centre of the SP to the north-east corner, effectively enables Treeby Road to remain in its 'straighter' alignment with traffic calming measures via roundabouts and landscaped median in an aesthetically pleasing boulevard style that removes the previously proposed undesirable CAP roads.
- It is proposed to provide footpaths alongside all Neighbourhood Connectors and a minimum of one side of all roads (with key access roads provided with a footpath on both sides).
- Shared use paths and/or on-road cycle lanes are to be provided on key links, including integrator and neighbourhood connectors, as well as roads adjacent to the primary school and district open space. A connection is also recommended along the Western Power Easement, connecting the primary school to the district playing fields.
- Vehicular access to/from the SP amendment has regard to the adjacent structure plan layouts. In total four access points are provided, with three of these expected to be key on Anketell Road.
- The ANLSP in its entirety, including the amendment proposed, is expected to generate some 15,150 vehicle trips per day. Most of the vehicle trips accessing the site are expected to do so via the future Anketell Road / Treeby Road signalised intersection, followed by the future Lyon Road / Anketell Road roundabout.
- The road network within the SP amendment has been determined based on daily flows and in accordance with *Liveable Neighbourhoods*.
- The extension of the SP to include additional Service Commercial area will not compromise the traffic network as the daily traffic volumes are supported by an additional Lyon Road / Anketell Road roundabout in addition to the Treeby Road / Anketell Road signalised intersection that was previously assessed for the potential traffic generation. As such, no daily adverse traffic impacts on external roads is expected in terms of overall traffic volume when compared with the current ANLSP.
- It is expected the external traffic generation associated with the SP amendment can be accommodated on the future planned external road network.

The high-level determination of this TIA is that the SP amendment, under the assumed traffic generation and distributions noted in this TIA does not critically compromise the transport network. The location of future intersections and network of links are adequate to support the overall amendment.

CONCLUSION

It can be concluded from the information presented in this TIA that the proposed modifications to the SP can be supported by the future traffic network. Accordingly, the transport characteristics of the SP amendment are considered acceptable.

The WAPC checklist is included at Appendix B.

A. PROPOSED STRUCTURE PLAN

A

LEGEND

LOCAL SCHEME

LOCAL SCHEME RESERVES

- Parks And Recreation / Drainage

PUBLIC PURPOSES

- Community Facility
- Primary School

ZONES

- Residential R20
- Residential R25
- Residential R30
- Residential R40
- Service Commercial

OTHER

- Primary Distributor
- Integrator B
- Neighbourhood Connector B
- Major Access Street
- Structure Plan Amendment Boundary
- Western Power Easement
- Mrs Rural Water Protection Zone Boundary

0m 50 100 150m

LYON ROAD

ANKETELL ROAD

AREA SUBJECT TO SEPARATE STRUCTURE PLAN APPROVALS

TREEBY ROAD

9002 9002 9002 9003 652 188 189 4 7 89 90 30 31 32 33 34 35 36 37 38 39 40 41 12 9000

B. WAPC GUIDELINES CHECKLIST

B

APPENDIX: WAPC GUIDELINES CHECKLIST

Item	Provided	Comments/Proposals
Summary	Yes	Provided on page (ii)
Introduction/Background	Yes	Provided as Chapter 1
Structure plan proposal		
regional context	Yes	Provided as Chapter 2.1
proposed land uses	Yes	Provided as Chapter 2.2
table of land uses and quantities	Yes	Provided in Chapter 2.2
major attractors/generators	Yes	Provided as Chapter 2.3
specific issues	Yes	Provided as Chapter 2.4
Existing situation		
existing land uses within structure plan	Yes	Provided as Chapter 3.1
existing land uses within 800 metres of structure plan area	Yes	Provided as Chapter 3.1
existing road network within structure plan area	Yes	Provided as Chapter 3.2
existing pedestrian/cycle networks within structure plan area	Yes	Provided as Chapter 3.2
existing public transport services within structure plan area	Yes	Provided as Chapter 3.2
existing road network within 2 (or 5) km of structure plan area	Yes	Provided as Chapter 3.3
traffic flows on roads within structure plan area (PM and/or AM peak hours)	N/A	No existing traffic flows
traffic flows on roads within 2 (or 5) km of structure plan area (AM and/ or PM peak hours)	Yes	Provided as Chapter 3.4
existing pedestrian/cycle networks within 800m of structure plan area	Yes	Provided as Chapter 3.2
existing public transport services within 800m of structure plan area	Yes	Provided as Chapter 3.2
Proposed internal transport networks		
changes/additions to existing road network or proposed new road network	Yes	Provided as Chapter 4.1
road reservation widths	Yes	Provided as Chapter 4.2
road cross-sections & speed limits	Yes	Provided as Chapter 4.2
intersection controls	Yes	Provided in Chapter 6
pedestrian/cycle networks and crossing facilities	Yes	Provided in Chapter 6
public transport routes	N/A	Current proposal will not change the public transport network
Changes to external transport networks		
road network	Yes	Provided as Chapter 6.4
intersection controls	Yes	Provided as Chapter 6.5
pedestrian/cycle networks and crossing facilities	Yes	Provided as Chapter 6.6
public transport services	Yes	Provided as Chapter 6.6

APPENDIX: WAPC GUIDELINES CHECKLIST

Item	Provided	Comments/Proposals
Integration with surrounding area		
trip attractors/generators within 800 metres	Yes	Provided as Chapter 5.2
proposed changes to land uses within 800 metres	Yes	Provided as Chapter 5.3
travel desire lines from structure plan to these attractors/generators	Yes	Provided as Chapter 5.4
adequacy of external transport networks	Yes	Provided as Chapter 5.5
deficiencies in external transport networks	Yes	Provided as Chapter 5.5
remedial measures to address deficiencies	Yes	Provided as Chapter 5.6
Analysis of internal transport networks		
assessment year(s) and time period(s)	Yes	Provided as Chapter 6.1
structure plan generated traffic	Yes	Provided as Chapter 6.4
extraneous (through) traffic	Yes	Provided as Chapter 6.4
design traffic flows (that is, total traffic)	Yes	Provided as Chapter 6.4
road cross-sections	Yes	Provided as Chapter 6.4
intersection controls	Yes	Provided as Chapter 6.5
access strategy	Yes	Provided as Chapter 6.2
pedestrian/cycle networks	Yes	Provided as Chapter 6.6
safe routes to schools	Yes	Provided as Chapter 6.6
pedestrian permeability & efficiency	Yes	Provided as Chapter 6.6
access to public transport	Yes	Provided as Chapter 6.6
Analysis of external transport networks		
extent of analysis	Yes	Provided as Chapter 6.4
base flows for assessment year(s)	Yes	Provided as Chapter 6.4
total traffic flows	Yes	Provided as Chapter 6.4
road cross-sections	Yes	Provided as Chapter 6.5
intersection layouts & controls	Yes	Provided as Chapter 6.5
pedestrian/cycle networks	Yes	Provided as Chapter 6.6
Conclusions		

Transport Assessor's Name: Tanya Moran / Ahmad Qader / Angela Zhang

Company: GTA Consultants Date: 23/05/19

GTAconsultants

www.gta.com.au

APPENDIX I
ENGINEERING SERVICING REPORT

TABEC
Civil Engineering Consultants

ANKETELL NORTH LOCAL STRUCTURE PLAN AMENDMENT
ENGINEERING INFRASTRUCTURE REPORT

TABEC Pty Ltd

May 2019 (Revised)

CLIENT: Rpoint Properties Pty Ltd

PROJECT: Anketell North Local Structure Plan Amendment

TITLE: Engineering Infrastructure Report

DOCUMENT REVIEW				
Revision	Date Issued	Written By	Reviewed By	Approved By
1 (DRAFT)	28/10/2018	CBITMEAD		
2	3/12/2018	C BITMEAD		
3	15/5/2019	C BITMEAD		

TABLE OF CONTENTS

1 INTRODUCTION

TABEC Pty Ltd has prepared this report to support a proposed amendment to the Anketell North Local Structure Plan (ANLSP). Engineering matters were discussed in the Anketell North Local Structure Plan Report prepared by Rowe Group in 2015, therefore this report will focus on engineering related items that have changed in the period from January 2015 until October 2018 and the impact of the changes contemplated by the subject amendment.

It is understood that the proposed amendment to ANLSP has arisen out of a review of the requirement to realign a section of Treeby Road in order to accommodate a district open space (DOS) in an area constrained by the alignment of Western Power overhead transmission lines. Although the DOS is located within the central portion of ANLSP, the topography at the location and the requirement to realign an existing road are considered to be less than ideal. In light of this R-Point Property engaged a consultant team to investigate alternative options for the location of the DOS, the result of which is the subject of this submission.

The investigation and preparation of the report is based on a review of the existing approved Local Structure Plan, preliminary advice from the various service authorities, desktop reviews and site investigations where appropriate. The information is current as of May 2019 and is subject to changes and timing as development proceeds around the subject land. Figure 1 illustrates the proposed amendment area with an aerial image.

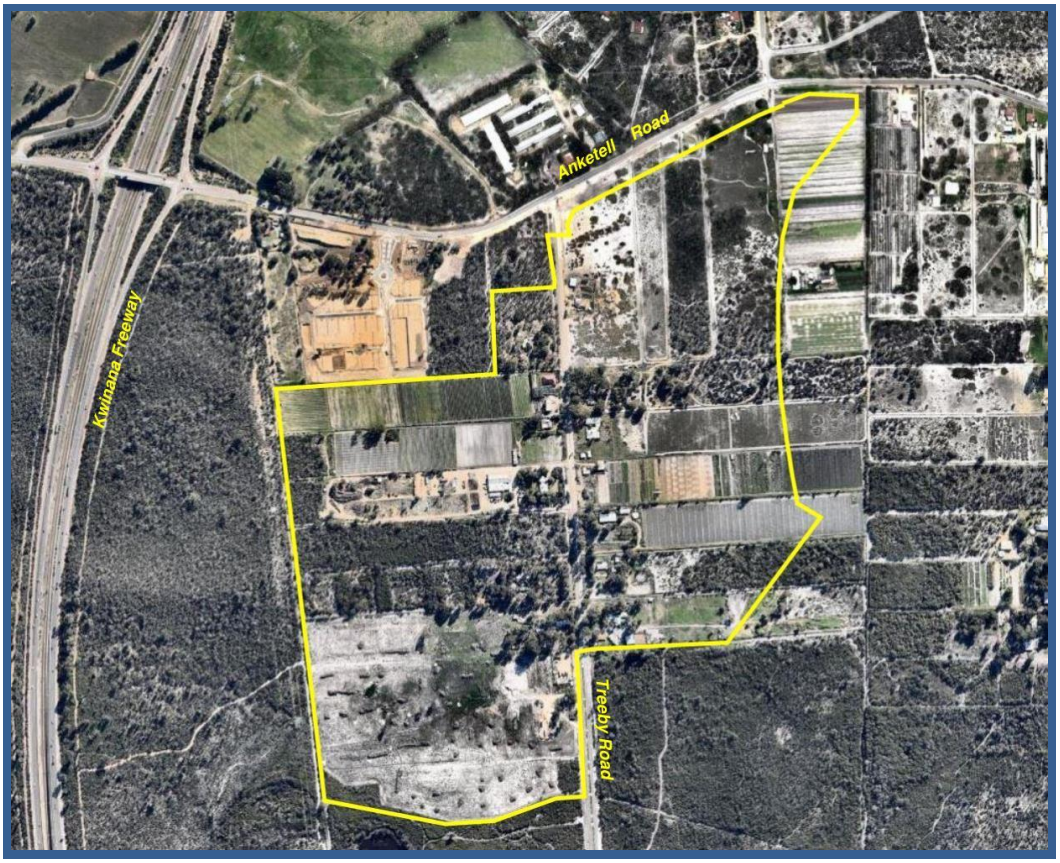


Figure 1 – Site location and aerial image (Nearmap)

The footprint of the proposed amendment area sits within the 2015 ANLSP area, with the significant changes to the plan being the section east of Treeby Road associated with the re-located DOS to a location adjacent to Anketell Road in an area that was partly excluded from the 2015 ANLSP. Within the context of servicing, overall dwelling yield within the amendment area is therefore similar to the 2015 ANLSP. Lots 35, 100 and 9000 Treeby road, occupying the south-west portion of the ANLSP area has an existing conditional subdivision approval issued by Western Australian Planning Commission. As part of this amendment, there are no changes proposed within lots 35, 100 and 9000.

1.1 Landform / Topography

The ANLSP area has undulating topography with site gradients as steep as around 8% (1 in 12). Levels across the site range from a low of around 19.0mAHD up to 41.0mAHD, a difference of over 22 metres.

The central area of the site where the DOS is shown in the current ANLSP has gradients of up to 6% (1 in 16) and a level difference across the proposed DOS site of 12m which would require significant re-contouring across a number of existing properties in order to provide viable gradients for the DOS playing fields.

The proposed relocated DOS is in an area where the natural surface level difference is in the order of 3m, requiring comparatively little earthworks to create a useable space for recreational playing fields.

Within the broader ANLSP area, existing landform gradients above about 5.5% would need to be re-contoured to ensure that proposed retaining walls constructed as part of subdivision development works are less than 3m high for rear of lot retaining or about 0.75m high for side boundary retaining. Due to the fragmented land ownership across the LSP area, the most optimal development outcomes in terms of landform are often not achieved due to differences in development timing across various landowners requiring tie-ins to existing boundary levels, retention of existing structures and the like. For this reason, the proposed development landform is likely to follow to a degree, the existing landform. Notwithstanding, the most desirable development outcome would minimize site gradients and therefore also minimize the occurrence of high retaining walls which would otherwise need to be contemplated through following the existing site gradients.

To achieve the most optimal development landform across the LSP area adjacent landowners / developers should be encouraged to work together to co-ordinate boundary levels for the benefit of both. This benefit would include a more desirable development landform along with an associated reduction in siteworks and retaining costs.

Given the earthworks required to achieve reasonable development grades , the opportunities to retain vegetation will be somewhat constrained across the LSP area. However an initial review of earthworks across the LSP area indicates an ability to retain some vegetation within some of the POS areas, notwithstanding the requirement to also accommodate stormwater drainage within POS.

1.2 Ground Conditions

Geology mapping for the area indicates the entire area consists of Bassendean (quartz) sands. Although this has not been tested with any specific on ground investigations recent subdivision works undertaken at the northern end of the structure plan area highlight that the site geology is consistent with the mapping.

Typically, Bassendean Sands provide for good permeability of water into the soil profile, provided that there is sufficient freeboard above groundwater level.

Some of the properties within the area have historically or are currently operating as market gardens. As part of any future development, appropriate testing would need to be undertaken to ensure there are no residual contaminants resulting from the pre-development land uses.

Acid sulfate soil (ASS) mapping published by Department of Water shows the majority of the LSP area as having no risk of ASS, with only the eastern and southern margins as having moderate to low risk of ASS. The areas shown as having low risk will require future site investigations to ascertain whether or not potential ASS exists within the area. Despite the moderate to low risk, if potential ASS is found, appropriate management plans to deal with soils disturbed during development construction works will need to be implemented.

2 STORMWATER DRAINAGE

Together with the preliminary earthworks plan, drainage catchments have been determined which has been utilised in the preparation of the amended Local Water Management Strategy (LWMS) by hydrology consultant Bioscience. The report details the stormwater management strategy and how the key design elements in the proposed urban environment include the maintenance of predevelopment flow paths and catchments. While there will be some modification to the natural surface gradients, generally, the post development landform with follow the pre-development landform in relation to high and low points therefore the current drainage catchment will remain, notwithstanding the urban development form.

West of Treeby Road, drainage infiltration basins remain the same as the 2015 Structure Plan. East of Treeby Road, the drainage catchment areas remain similar to the 2015 plan however some of the basins have changed size due to different land use within some of the sub-catchments. In order to optimise land use, there will be a focus to utilise the power transmission line easement for infiltration of stormwater within shallow depth, unfenced basins that would minimise length of time of standing water as far as practical.

Conveyance from source to the swales / basins would be via a pit and pipe system constructed to the requirements of City of Kwinana. Future lots within the LSP area will be responsible for containing stormwater on-site for events up to 18% Annual Exceedance Probability (AEP).

In preparation of this LSP amendment, modelling of the stormwater system has been undertaken by Bioscience within the framework of Better Urban Water Management Guideline (WAPC, 2008a). This modelling will be assessed in further detail during the future detailed subdivision design phase of the developments which will provide full details of water levels, basin volumes for critical storm events and also the details of the underground detention facilities and piped network. This information will be detailed in the Urban Water Management Plans (UWMP), which will be a Western Australian Planning Commission (WAPC) condition of subdivision as stages are developed.

3 WASTEWATER

The proposed LSP amendment area sits within two Water Corporation catchments that have somewhat of an overlap, therefore providing some flexibility with respect to wastewater planning.

The existing lots that front Anketell Road all fall within a catchment for which there is a gravity outfall consisting of a 225mm diameter PVC pipe in Anketell Road that discharges to Thompsons Lake Pump Station 902-63 located east of Kwinana Freeway about 700m north of Anketell Road. The initial stage of development within the Anketell North Local Structure Plan area has dictated the requirement for the sewer in Anketell Road which is shown red in figure 2 below. Water Corporation have advised that this sewer catchment can be extended to the south as far as practical and based on our review, this could encompass areas up to around 500m south of Anketell Road with an elevation generally above about 28.0mAHD at the southern extremity of the catchment.

The balance of the LSP amendment area has a planned gravity sewer discharge through to the recently completed sewer pumping station (Anketell PS174-04) located within the Anketell South Local Structure Plan area. However, proposed sewer servicing of the southern portion of the LSP area is dependent on an outfall sewer constructed between the southern end of ANLSP and PS174-04 adjacent to the wetland that separates Anketell North from Anketell South. This outfall is required to be funded by a developer, or developers within the catchment.

The 250mm diameter pressure main that transfers effluent from PS174-04 runs through ANLSP within Treeby Road reserve. If there are any changes in level and alignment of Treeby Road, the pressure main will need to be modified in some form to suit the Treeby Road changes.

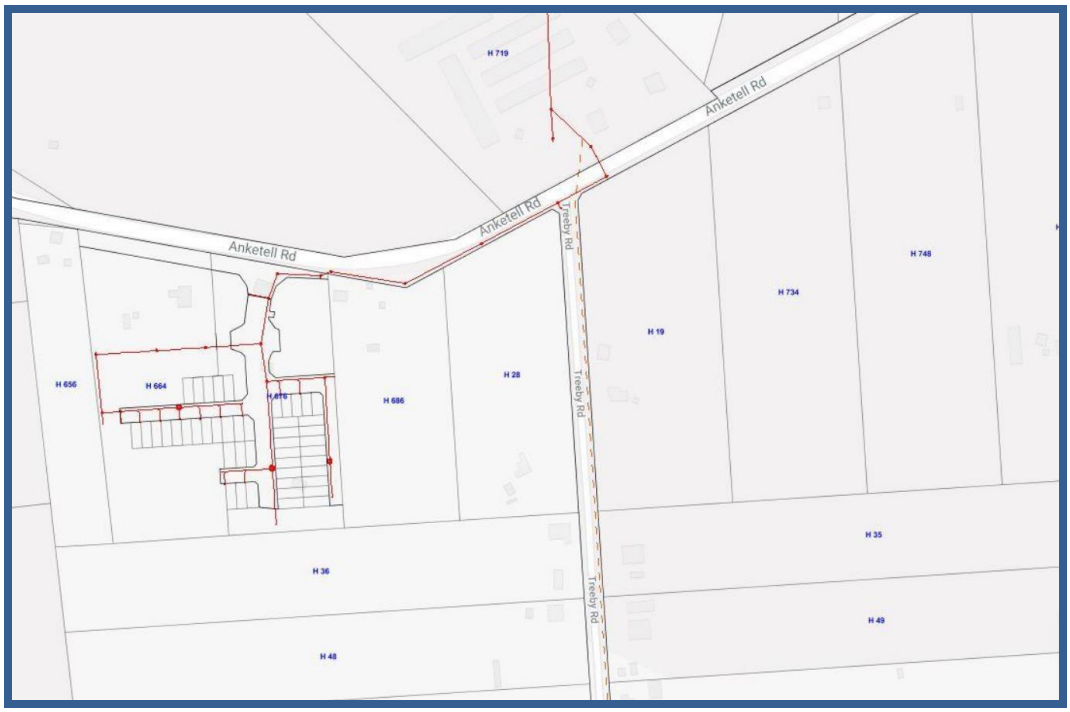


Figure 2 – Existing gravity sewer infrastructure (source: Water Corporation November 2018)

4 WATER SUPPLY

The Structure plan amendment area is located within the Thompsons Lake Gravity Zone which is serviced from north of the site.

With the recent development of the northern portion of the structure plan area, water mains that will ultimately service the whole Anketell North Structure Plan area have already been built within Anketell Road and Albina Avenue. This comprises 250mm diameter mains in Lyon Road and Anketell Road.

Within the structure plan area, a 200mm diameter water main is proposed within Treeby Road. There are also two north-south directional 150mm diameter mains proposed, one either side of Treeby Road. There rest of the mains within the area will consist of 100mm diameter pipework.

All of the water supply network within the structure plan area will be developer funded.

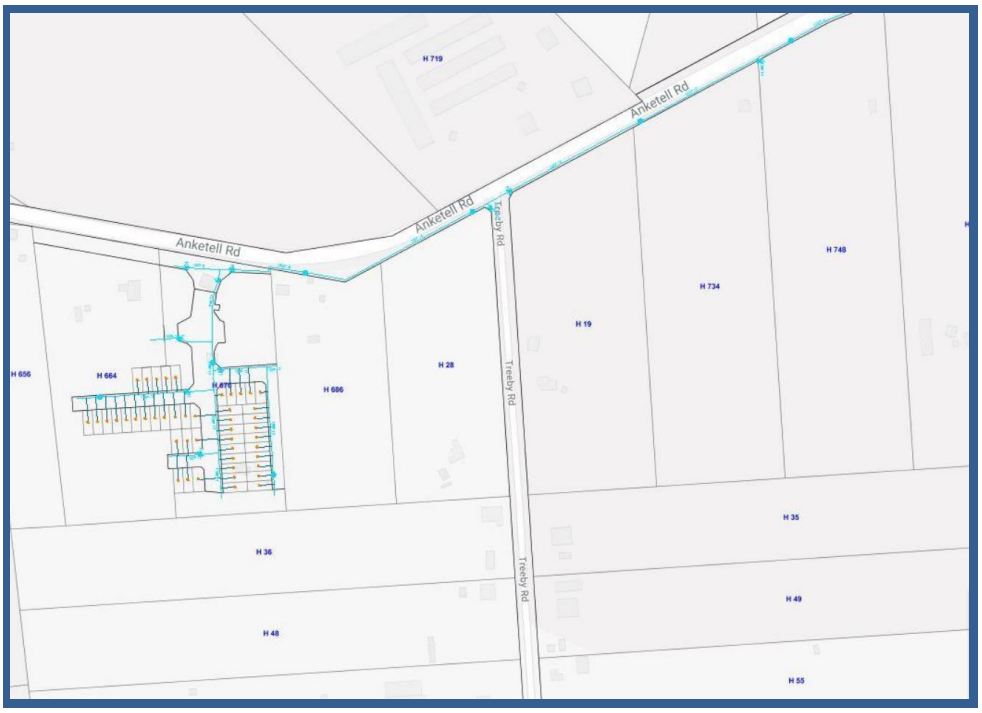


Figure 3 – Existing water supply infrastructure (source: Water Corporation November 2018)

5 POWER SUPPLY

There is currently capacity within Western Power's network to service the development.

Although there are transmission lines that traverse the site parallel to and east of Treeby Road, there is no direct connection to these lines. Instead, power to the proposed area will be sourced from the existing High Voltage power lines in Treeby Road. These power lines in Treeby Road will be converted to underground supply as part of the roll out of development.

In accordance with normal development requirements, the power system will consist of high voltage cable and infrastructure including ground mounted cabinet transformers and switchgear, connected to a

network of low voltage cables connecting end users to the transformers. All HV cabinet infrastructure needs to be installed a level that achieves clearance above proposed stormwater levels.

Other than accommodating the power transmission line easements and physical clearance to towers etc. power supply does not represent an impediment to development within the area.

All roads constructed within the structure plan area will need to have lighting installed to the satisfaction of City of Kwinana, Western Power and relevant Australian Standards. This can include Western Power standard lighting or decorative lighting from Western Powers Streetvision range. Recently introduced by Western Power is an option for LED street lighting.

6 GAS SUPPLY

Recent subdivision works at Albina Avenue, off Anketell Road has bought a gas supply pipe network to the immediate area. It is therefore expected that developers within the LSP area will work with Atco to allow for the gas network to be extended into proposed development areas.

Under current arrangements, the developer will provide a trench in which Atco will install their pipe network. This is considered to be standard practice for subdivision works.

7 COMMUNICATIONS

Recent subdivision works at Albina Avenue, off Anketell Road is included in the NBNCo rollout map therefore expansion of the NBNCo rollout to the immediate surrounding area is considered to be a logical extension that would not require any extraordinary charges (other than the current $600 per lot fee) to be levied on the developer. However, under this arrangement, the developer is responsible for the design and construction of a pipe and pit network in accordance with NBNCo requirements.

8 ROADWORKS

All roads within the LSP area are required to be constructed in accordance with City of Kwinana requirements. It is expected that all roads will have an asphalt wearing surface with concrete kerb edge restraints. Road reserve and carriageway widths will be in accordance with Liveable Neighbourhoods and City of Kwinana requirements.

Subject to developer discretion, roads and on-street parking areas may include feature such as brick paving or coloured asphalt.

Proposed intersection treatments within the LSP will be in accordance with traffic engineering requirements.