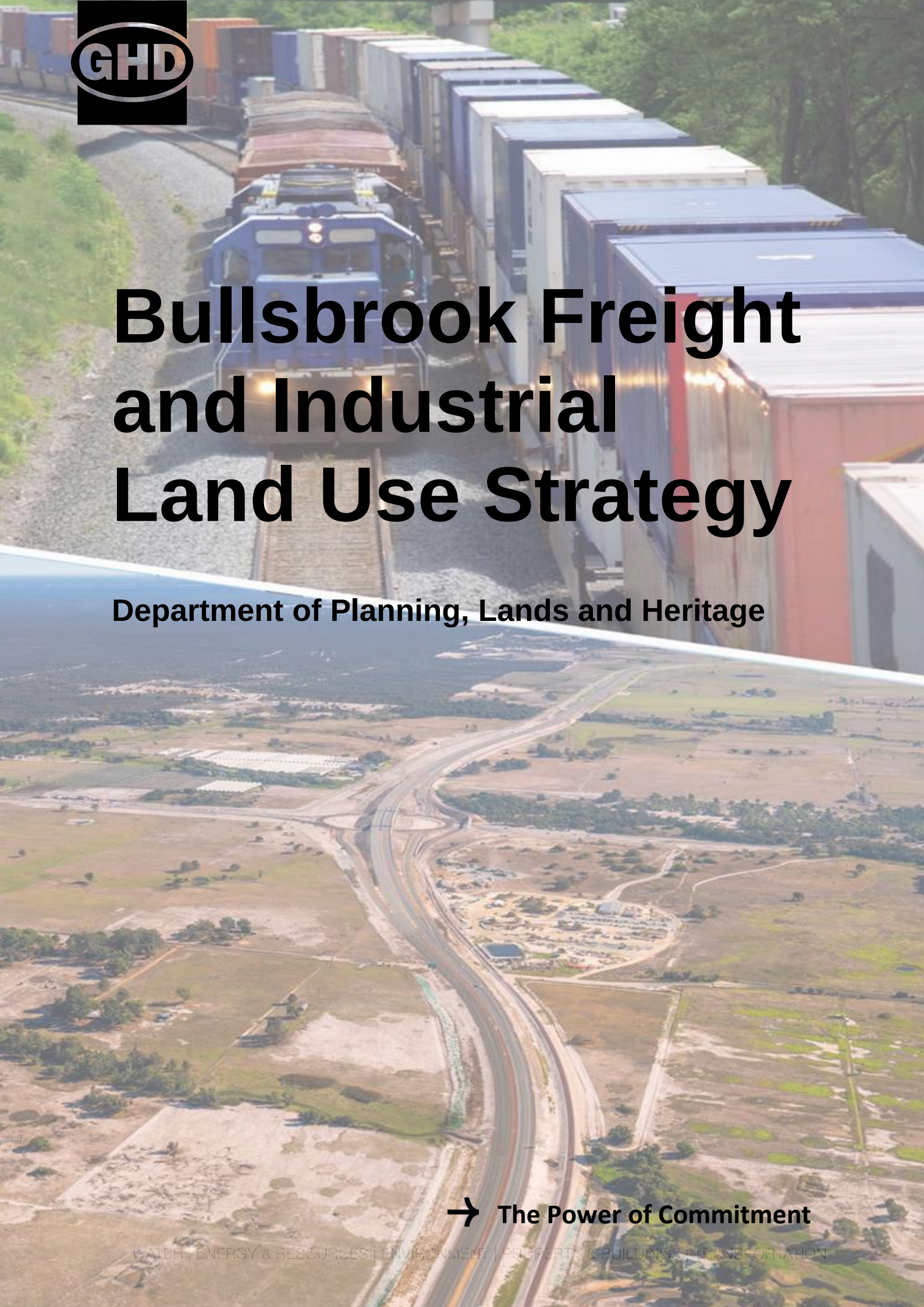


Bullsbrook Freight and Industrial Land Use Strategy

Department of Planning, Lands and Heritage

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GHD

Level 10, 999 Hay Street

Perth, WA 6000, Australia

T 6222 8222 | **F** 9463 6012 | **E** permail@ghd.com | **ghd.com**

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Executive summary

Located in the northeast fringe of the metropolitan area approximately 35 km from the Perth CBD, Bullsbrook consists of mainly rural and rural residential land. Significant growth is expected within the Bullsbrook Townsite within the next 15 to 20 years, with the population expected to more than triple from approximately 6,048 to 20,506 people. Additionally, a significant portion of land, north of Ellenbrook, has been identified for urban expansion over the next 30 years.

As the population continues to grow in the Perth and Peel regions, there will be corresponding demand for employment opportunities both within and across sub-regions. Highly efficient freight services will also be required to maintain the supply chains necessary to service this population. There is a need to identify existing and future freight corridors and strategic sites to avoid land use and transport conflicts and to manage the interface between communities, freight corridors and industrial development.

The North East Sub-Regional Planning Framework (NESRPF), identifies significant industrial expansion and investigation areas within the Bullsbrook locality and the need for an intermodal terminal (IMT) in the northeast sub-region. This was supported by the Westport Port and Environs Strategy 2020 which recognised the importance of the establishment of logistics hubs in the outer metropolitan areas, including Bullsbrook, for the effective movement of freight. It is anticipated that approximately 1.2 million shipping containers will need to be distributed via rail and 2.6 million by road by 2068. This will require a network of IMTs able to process trains, trucks and containers efficiently.

Muchea located approximately 20 km north of the Bullsbrook freight and industrial area, is well positioned with strategic location factors very similar to Bullsbrook, including access to Great Northern Highway (GNH), the future Perth-Darwin National Highway (PDNH), freight rail, road linkages to the northwest sub-region as well as a sustainable employment base. Bullsbrook and Muchea industrial areas will ideally form an employment corridor.

The Bullsbrook freight and industrial area is well located to benefit from the anticipated population growth in surrounding urban expansion and investigation areas as identified in the NESRPF. The significant increase in residential population will provide the population driven demand and the workforce to support industrial development activity within the area, which will also provide an employment base for the adjoining northwest sub-region.

The development of the Bullsbrook freight and industrial area presents a number of unique challenges including several environmental/conservation constraints, overall low-lying conditions with high groundwater, high connectivity of surface water and groundwater, limited potable water supplies and insufficient capacity of existing reticulated sewerage services. Additionally, the timing of proposed upgrades to the movement network will need careful consideration to ensure coordinated delivery of access that supports safe and efficient movement for all users.

The Bullsbrook freight and industrial area Land Strategy (the Strategy) is a high-level strategic response to the opportunities, issues and constraints within the Bullsbrook freight and industrial area and provides an implementation framework to guide the preparation of the more detailed planning studies and structure plans that will inform future amendments to the Metropolitan Region Scheme and local planning scheme. In recognition of the identified constraints to industrial development, the Strategy aims to provide guidance to what considerations or further investigations are likely to be required, to achieve such development.

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1. Introduction

1.1 Background

The identification of significant industrial expansion and investigation areas within the Bullsbrook locality (NESRPF) and the demand for employment opportunities deriving from the predicted increase in population will necessitate an efficient freight service. Subsequently the need for a future IMT in the northeast sub-region was identified in the Western Australian Planning Commission's (WAPC) *Directions 2031 and Beyond*. The document acknowledged the need for an IMT in the north metropolitan area to achieve a better balance between intra-metropolitan road and rail freight.

Over the next few years, several studies were undertaken by the State Government to identify appropriate options for an IMT within the northeast sub-region, including a site assessment by Department of Transport (DoT) in June 2012 (prepared by Worley Parsons Consulting). A high-level study prepared by GHD in 2016, identified the preferred location for an IMT within the South Bullsbrook area, to the west of the narrow-gauge freight railway and north of Stock Road.

The study emphasised the preferred location's proximity to existing and proposed transport links including the Millendon-Narngulu narrow gauge freight line, GNH and the PDNH as a strategic opportunity. Under the advice of the Industrial Land Strategy Taskforce, the DoT submitted a report to the WAPC requesting the declaration of a Planning Control Area (PCA) over the preferred site. The WAPC declared a PCA (PCA 150) over the preferred site on 21 July 2015, to protect the site while further detailed investigations were undertaken. This PCA has recently been renewed to the year 2025.

The IMT will be a key facility serving the proposed Bullsbrook industrial area, as well as providing a transport hub for the distribution of commodities from Fremantle and Kwinana, and to concentrate commodities going to those ports.

The presence of an IMT within the Bullsbrook freight and industrial area contributes to the rationalisation of freight transport within the Perth metropolitan region, by using rail to transport goods and commodities to and from the ports at Fremantle and Kwinana. This would assist in managing many of the externalities and issues associated with the movement of containerised freight through Perth, particularly as the Fremantle inner-harbour and its major servicing roads approach their practical capacity limits. Perth's existing container movement routes pass through highly constrained residential areas, conflicting with increasing volumes of commuter and service vehicle traffic. This situation is highly undesirable for both industry and the broader public.

In establishing a new IMT, or inland port, it will be critical that the issues associated with existing freight corridors in Perth (such as close residential populations, poor design characteristics and co-location of freight and commuter traffic) are not repeated. Ultimately, provision of an IMT at this location will support the government's desire to increase the use of rail rather than road as the preferred freight transport mode.

This was supported by the Westport Port and Environs Strategy Outcomes Report 2020 which identifies the Bullsbrook IMT in a ring of current and future IMTs located on the perimeter of the Perth metropolitan area that will provide critical supply chain linkages to the Fremantle and Kwinana ports. Whilst the Bullsbrook IMT does not form part of the preferred design for the project business case for Westport, it was identified as a long-term IMT site or as an alternative (contingency) to the preferred IMT sites at Kenwick, Kewdale and Forrestfield.

The NESRPF, identifies significant land for industrial expansion and investigation adjacent to the proposed IMT location and anticipates that demand for industrial land in the northeast sub-region will reach 2810 ha by 2050. Land supply to meet this demand will be distributed across several existing industrial areas, in addition to the Bullsbrook freight and industrial area. The Bullsbrook freight and industrial area has a long-term horizon to provide employment and industrial land beyond 2050.

In considering potential options for industrial development in this area, which is a relatively undeveloped "greenfield" location, there is considerable opportunity to strategically plan for new freight and industrial activity, and to identify and "future proof" the transport infrastructure that will be required for the successful operation of an industrial area.

The development of an industrial area at Bullsbrook is likely to serve as a major employment centre for Perth's rapidly growing north-east sub-region and will likely attract workers from the north-west sub-region. It will also serve as a logistical hub for consumer products bound for Perth's northern coastal sub-region. Consequently, excellent transport links will be required, not only within the area but also between Bullsbrook and a wide range of origins and destinations.

The Bullsbrook freight and industrial area is well located to benefit from the anticipated population growth in surrounding urban expansion and investigation areas as identified in the NESRPF. The significant increase in residential population will provide population driven industrial demand and the workforce to support industrial development activity within the area.

The introduction of residential populations within proximity to the Bullsbrook freight and industrial area does, however, introduce potential land use conflicts. This includes impacts associated with off-site emissions arising from industrial development (including noise, light, odour, visual amenity and dust) as well as the impact of increased residential and commuter activity on the future road network.

1.2 Role and purpose

This Strategy provides a vision for future development of the Bullsbrook freight and industrial area, including infrastructure and transport requirements to support the proposed intermodal terminal and to provide for long-term employment opportunities. Due to the high-level nature of the document, the Strategy is not intended to address detailed planning and design matters, rather it is intended to provide strategic context for appropriately addressing these matters as part of further planning and design. The key purposes of the Strategy are to:

- assess existing and likely demand for industrial land and the opportunities and constraints of industrial land use within the strategy area.
- consider potential land use conflicts and the interface between communities, freight corridors and industrial development.
- ensure successful integration of the proposed intermodal terminal site and surrounding industrial and employment lands with transport infrastructure, to support a safe and efficient strategic freight transport network.
- identify broad land use precincts to guide further detailed structure planning for the area.
- identify planning objectives and provide appropriate strategies and actions to resolve the key issues that influence these objectives.

- provide a strategic framework for use by State, local government, and other stakeholders to inform the next stages of the planning process and to guide future amendments to the Metropolitan Region Scheme and local planning scheme.

1.3 Consultation

Prior to GHD being engaged to undertake the Bullsbrook Freight and Industrial Land Use Planning Strategy, limited consultation for the project had occurred. Consultation undertaken was mainly around the establishment of the Stakeholder Reference Group and the provision of project information to identified organisations that were asked to nominate representatives.

Agencies represented on the Stakeholder Reference Group included:

- Department of Planning Lands and Heritage
- Department of Transport
- City of Swan
- Development WA
- Department of Defence
- Arc Infrastructure
- Water Corporation
- Western Power
- Main Roads Western Australia
- Department of Biodiversity, Conservation and Attractions
- Public Transport Authority
- Department of Water and Environmental Regulation and
- Freight Logistics Council

GHD developed a Stakeholder Engagement Strategy (SES) for the Bullsbrook Freight and Industrial Land Use Planning Strategy. SES focused on ensuring relevant stakeholders were informed about the project and were given the opportunity to provide feedback, ask questions and identify areas of concern.

Stakeholders were informed, consulted, and engaged throughout the project in a variety of ways that included:

- four briefings and workshops with the Stakeholder Reference Group
- consultation with community groups and community members
- consultation with council staff, State Government agencies and servicing authorities
- provision of information about the project to stakeholders on the Department of Planning, Lands and Heritage website

Table 1 below, summarises the stakeholder groups that were engaged with as part of the project and the themes of discussion.

Further detail including date and type of engagement undertaken with stakeholders is provided in Appendix A.

Table 1 - Stakeholder groups and Themes of Discussion

Stakeholder group	Themes of Discussion
Department of Planning, Lands and Heritage	Opportunities and Constraints Planning considerations/issues Movement and access considerations/issues Review Stakeholder Reference Group Comments District Structure Plan Water Management
City of Swan	District Structure Plan Urban/industrial interface Proposed concept, land uses and yields within City of Swan Review Stakeholder Reference Group Comments Surrounding Development
MRWA	Connectivity Movement and interfacing road projects
Stakeholder Reference Group	Project risks District Structure Plan Emerging Issues Concept Plan
RAAF Base Pearce	Base operational requirements Future Base Planning District Structure Plan Defence Aviation Areas Regulations Aircraft Noise Public Safety Extraneous Lighting Bird and Flying Fox Strike
Department of Water and Environment Regulation	DWER requirements for DWMS Groundwater Monitoring Water Management Issues MRS Amendments Local Structure Plan, Local Scheme Amendments and Subdivision Environmental Investigations
Sirona (now Harvis)	Future Planning
Donald Veal Consultants	District Structure Plan Industrial land yields
Lendlease	District Structure Plan

Stakeholder group	Themes of Discussion
	Urban Investigation Area - South of the District Structure Plan area.
WAPC	District Structure Plan
Water Corporation	District Structure Plan Urban Investigation Area - South of the District Structure Plan area.
Parcel Property	Proposed transport network Planning for proposed future developments
Rowe Group	District Structure Plan Urban Investigation Area - South of the District Structure Plan area.

1.4 Background Studies

The preparation of this Strategy has been informed by the following supporting desktop studies:

- Environmental Study
- Regional Water Management Strategy
- Bushfire Hazard Level Assessment
- Transport Strategy
- Service Infrastructure Study
- Industrial Demand and Market Analysis

1.5 Scope and limitations

This report has been prepared by GHD for Department of Planning, Lands and Heritage and may only be used and relied on by Department of Planning, Lands and Heritage for the purpose agreed between GHD and the Department of Planning, Lands and Heritage as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Department of Planning, Lands and Heritage arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

GHD has prepared this report on the basis of information provided by Department of Planning, Lands and Heritage and others (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Strategy area

2.1 Locational context

The Strategy area comprises approximately 3,339hectares of land situated 35 km from the Perth CBD and 22 km north of the Midland Strategic Regional Centre (refer Figure 2). The Strategy area is bounded by the Royal Australian Air Force Base Pearce (RAAF Base Pearce) and GNH to the east, the southern boundary of the Shire of Chittering to the north, the PDNH to the west and Warbrook Road to the south. The Perth-Geraldton regional freight railway line bisects the Strategy area.

This Strategy applies to that land contained within the inner edge of the broken line denoting the Strategy boundary as shown on Figure 3.

2.2 Development of the Strategy Area

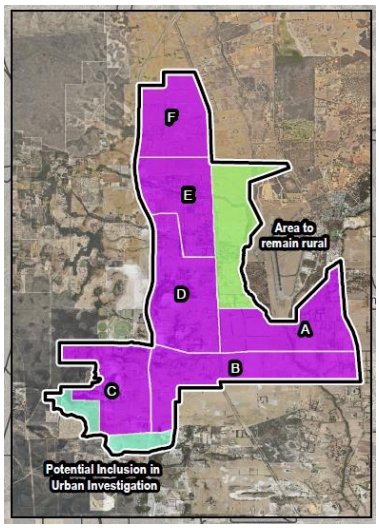
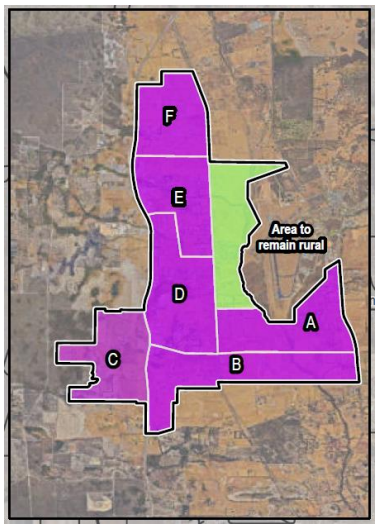
The Bullsbrook Freight and Industrial Land Use Strategy project was initiated in 2018, commencing with several technical studies to investigate the strengths, weaknesses, and broader characteristics of the Bullsbrook locality. The technical studies were completed in 2021, with their findings used to define the project area and inform the content of the Strategy document (refer Appendices B – G).

The Bullsbrook Freight and Industrial Land Use Strategy was released for public consultation in February 2022. In response to comments received during consultation, the following changes were made to the Strategy area:

- A portion of land to the southwest Precinct of C, identified in the technical appendices for '*Potential Inclusion in Urban Investigation*' was removed due to an overlap with the substantially commenced *North Ellenbrook East District Structure Plan* and *North Ellenbrook West District Structure Plan*. While the proposed zoning and reservation of this land generally aligned with the Strategy, the area was removed to avoid overlap and potential conflicts in the documents.
- A parcel of land to the north of Cooper Road and south of Robinson Road was added to Precinct C. Comprising 5 lots and totaling 117 hectares, the area was identified for Inclusion in Industrial Investigation in the Strategy document after the technical appendices were completed. The land was included due to it's potential to take advantage of access to Tonkin Highway via the Stock Road intersection. As this area was added after completion of the technical studies, proponents in this location will need to undertake additional work to understand how the addition of that area may impact environmental, water, bushfire, traffic outcomes.

Development of the Strategy area at each major project stage is summarised in Table 2 below:

Table 2 - Development of the Strategy area

	
Technical Appendices, completed 2021	**Final Bullsbrook Freight and Industrial Land Use Strategy, October 2022**

2.3 Precincts

The Strategy identifies six precincts which have been determined based on a range of pertinent matters which become apparent in the latter sections of this Strategy. The precincts and their intended development objectives and form are further discussed in detail under Section 10 of this Strategy. However, a brief overview of each precinct is provided below and illustrated in Figure 1 below:

2.3.1 Precinct A

Precinct A is approximately 508 hectares in area and is bounded by Stock Road to the south, GNH to the east, RAAF Base Pearce to the north and the rail line to the west.

2.3.2 Precinct B

Precinct B has an area of approximately 590 hectares and abuts Stock Road to the north, GNH to the east, the Strategy area boundary to the south and Precinct C to the west. The precinct is characterised by its proximity to major arterial roads / transport linkages as well as its proximity to sensitive environmental areas.

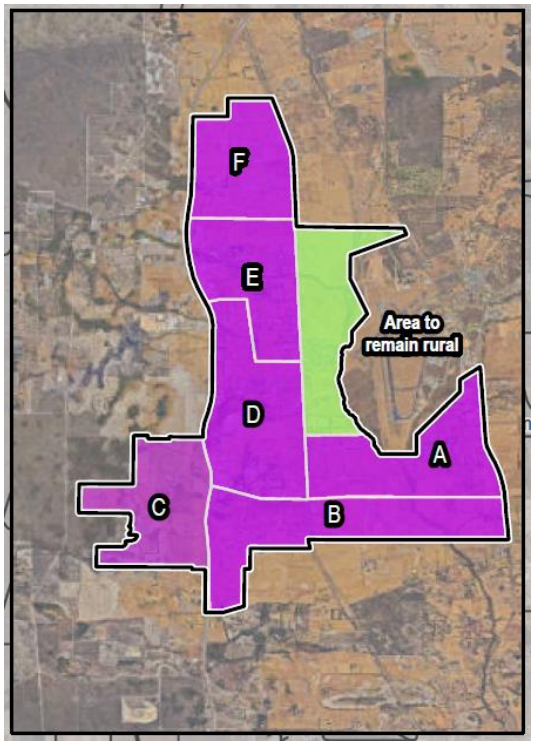


Figure 1 - Strategy area Precincts

2.3.3 Precinct C

Precinct C is approximately 559 hectares and bounded by Robinson Road to the north, Precinct B to the east, Warbrook Road extension to the south and Gnangara-Moore River State Forest to the west.

2.3.4 Precinct D

Precinct D is approximately 560 hectares and is bounded by Precinct E to the north, the railway line to the east, Stock Road to the south and PDNH to the west.

2.3.5 Precinct E

Precinct E is approximately 422 hectares and is bordered by Precinct F to the north, the rail line to the east, Precinct D to the south and PDNH to the west. This precinct presents opportunities due to the east-west road connectivity which will be further discussed within this Strategy. It also presents opportunities to support the development of Muchea.

2.3.6 Precinct F

Precinct F is approximately 401 hectares and is bounded by PDNH to the north and west, the railway line to the east and Precinct E to the south.

2.4 Land ownership

The Strategy area comprises a mix of private landholdings and Commonwealth land, totaling 502 lots. Table 3 below describes the breakdown of lots, based on a desktop review of cadastral information.

Table 3 - Lot analysis

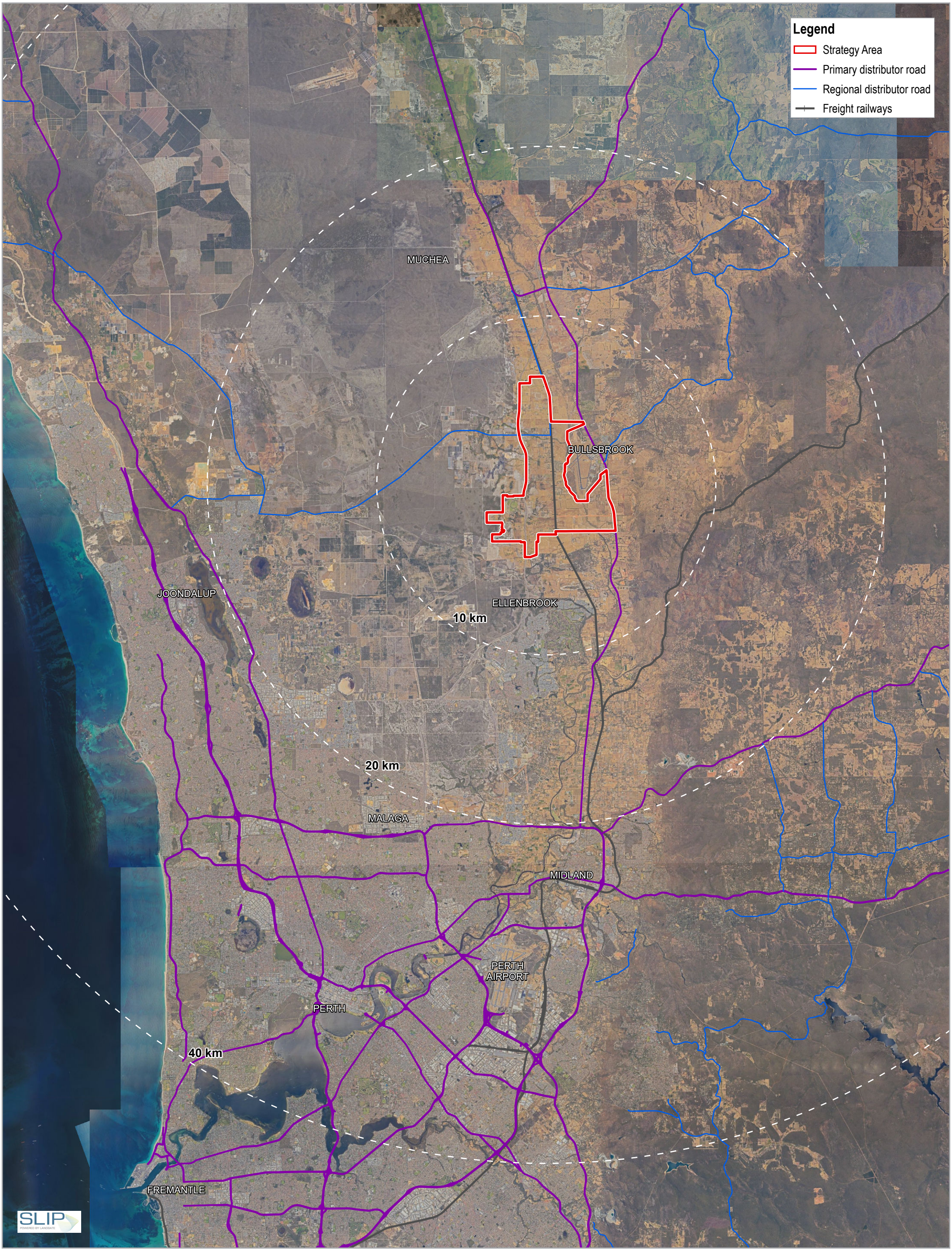
	Small (0-1 ha)	Medium (1-5 ha)	Large (5-20 ha)	X-large (>20 ha)	Total
Crown Allotment	9	2	3	15	29
Freehold	199	29	61	37	326
Reserve	5	1	0	0	6
Road	51	35	16	0	102
Other	18	14	7	0	39
Total	282	81	87	52	502

Landgate provided the following explanation regarding land parcels identified as 'Crown Allotments':

"A crown allotment parcel describes a piece of land that is still recognised (by shape and size) as the original land parcel issued following alienation of that parcel from the crown."

Land parcels identified as a 'Crown Allotment' in Figure 4 can be held in freehold ownership. As per the explanation from Landgate above, Freehold lots are identified as Crown Allotments where a resurvey has not occurred since its creation.

The land within the Strategy area is fragmented with private landowners accounting for 78 percent of the landholdings. The majority of the private landholdings are held in lots of one hectare or less (refer Figure 4).



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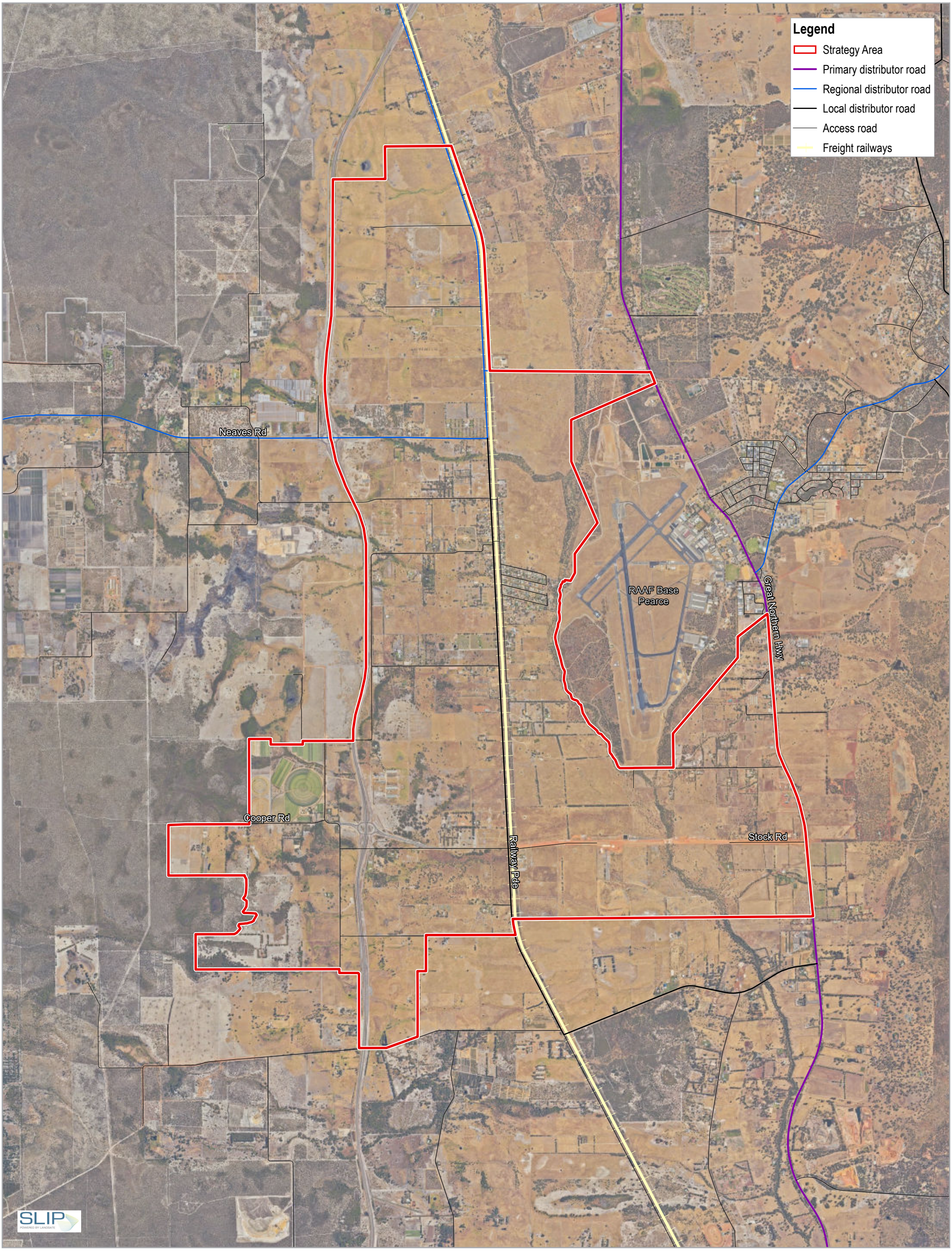
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Study Area in Context

FIGURE 2

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Data source: Landgate: Railways - 20150305, locality boundaries - 20180319 WA Now Aerial Imagery - accessed 20180702; MRWA: Road hierarchy - 20170906; GHD: Master plan boundary - inset 100m from supplied masterplan boundary (DPLH - 201805), Buffer lines - 20180702, Geoscience Australia: National Geodata Topo 250k Series 3 - 2006. WANow: Landgate / SLIP. Created by: wwang3



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BULLSBROOK MASTER PLAN
KEY SUMMARY FINDINGS REPORT

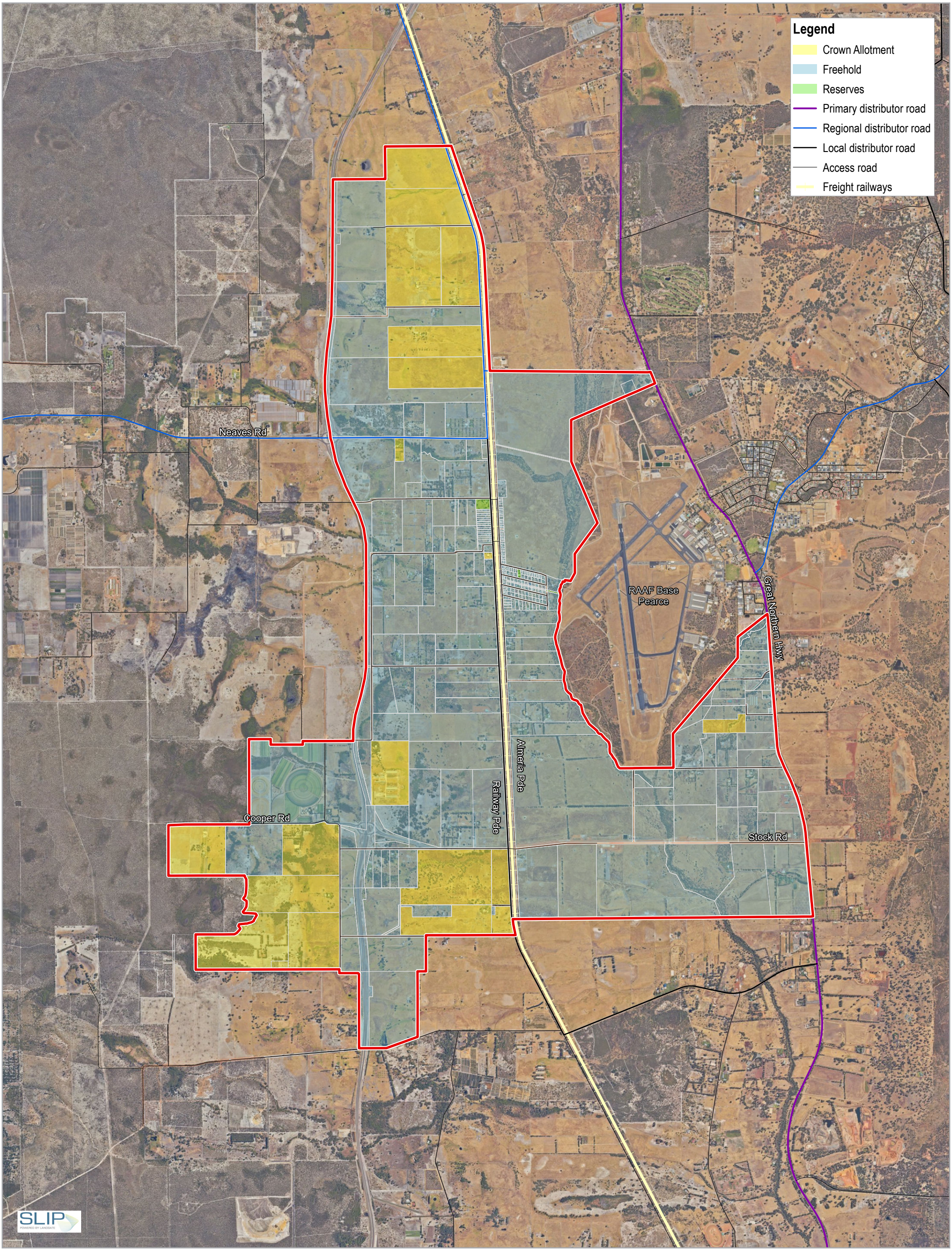
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Revision No. **0**
Date **8/09/2022**

Bullsbrook Master Plan Location

FIGURE 3

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BULLSBROOK MASTER PLAN
KEY SUMMARY FINDINGS REPORT

Land Ownership in Study Area

Project No. **61-37134**
Revision No. **2**
Date **19/09/2022**

FIGURE 4

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Data source: Landgate: Railways - 20150305, WA Now Aerial Imagery - accessed 20180703. DPLH: Cadastre and ownership - 201805; Main Roads WA: Road hierarchy: 20170906; GHD: Master plan boundary - inset 100m from supplied masterplan boundary (DPLH - 201805); Geoscience Australia: National Geodata Topo 250k Series 3 - 2006. WANow: Landgate / SLIP Landgate_Subscription_Imagery_WANow: . Created by: wwang3

2.5 Land use

The Strategy area consists predominantly of rural land uses, with some industrial and public purpose land uses. The following describes generally the land use activities within and surrounding the Strategy area.

2.5.1 Rural

Rural land use activities currently undertaken within the Strategy area include horse agistment, cleared grazing land, catteries, kennels, and rural-residential housing.

There is, however, a pocket of residential development located between the rail line and the RAAF Base Pearce, between Turner Road and Deanhead Street. This residential enclave consists of approximately 160 residential lots. It is not intended that this enclave be developed for industrial purposes. The inclusion of this land within the Strategy seeks to ensure that consideration is given to the interface between these residences and any industrial activity.

There is rural land north-west of Cooper Road and Tonkin Highway intersection comprising 5 lots totaling approximately 117ha. The land is bound by Cooper Road to the south, Tonkin Highway to the east, Commonwealth (Defence) owned land to the north and Bush Forever to the west. The land is well located to take advantage of access to Tonkin Highway via the Stock Road intersection and as such has been identified as being suitable for inclusion as an industrial area.

2.5.2 Industrial

The land that is currently zoned Industrial is cleared with some subdivision and development approvals determined. Development of the land has commenced in some areas, particularly on parcels close to the Bullsbrook Townsite. As this land is appropriately zoned and the planning framework already established, it is anticipated that this land will be the first stage of development within the Strategy area. This would provide an early catalyst to attract and promote the development of freight and logistics land uses to this area as well as provide for some local industry to service the Bullsbrook South urban expansion catchment.

2.5.3 Urban

The Bullsbrook townsite is located to the east of GNH. The endorsed Bullsbrook Townsite Structure Plan proposes significant future residential development expanding predominantly to the south of the existing townsite. It is noted that Bullsbrook Townsite Structure Plan also contemplates northward expansion of the Bullsbrook Townsite. This urban expansion area is currently zoned 'Urban Deferred' and 'Rural' under the Metropolitan Region Scheme (MRS). It is estimated that the urbanisation of this area will more than triple the residential population from 6,048 people to 20,506 people by 2036.

The north-east sub-regional planning framework identifies land for urban investigation (generally referred to as North Ellenbrook) immediately to the south of the Strategy area. This urban investigation area is proposed to develop in the medium to long term and constitutes a significant potential employment base for the Bullsbrook freight and industrial area.

2.5.4 Commonwealth Government Purposes

The RAAF Base Pearce abuts the eastern boundary of the Strategy area. RAAF Base Pearce is the main air force base in Western Australia and one of the busiest in the country with high-frequency aircraft movements. RAAF Base Pearce occupies an area of approximately 688 ha and is likely to expand operations in the future as its role increases in importance.

The impact of base operations on development within the Strategy area will include, inter alia, height restrictions, separation distances and land use restrictions surrounding telecommunications and radar sites, matters relating to bird strike, lighting restrictions and restrictions associated with safeguarding of explosive ordnances. Additionally, there are plans to extend the runways at RAAF Base Pearce, which may further affect clearance/height requirements.

3. Planning framework

3.1 Zoning and reservations

The majority of land within the Strategy area is zoned 'Rural' under the MRS, with a portion of land to the east of Railway Parade and north of Stock Road zoned 'Industrial' (Figure 5). Various areas of land are reserved for Primary Regional Road, Other Regional Road, Public Purpose, and Railway purposes.

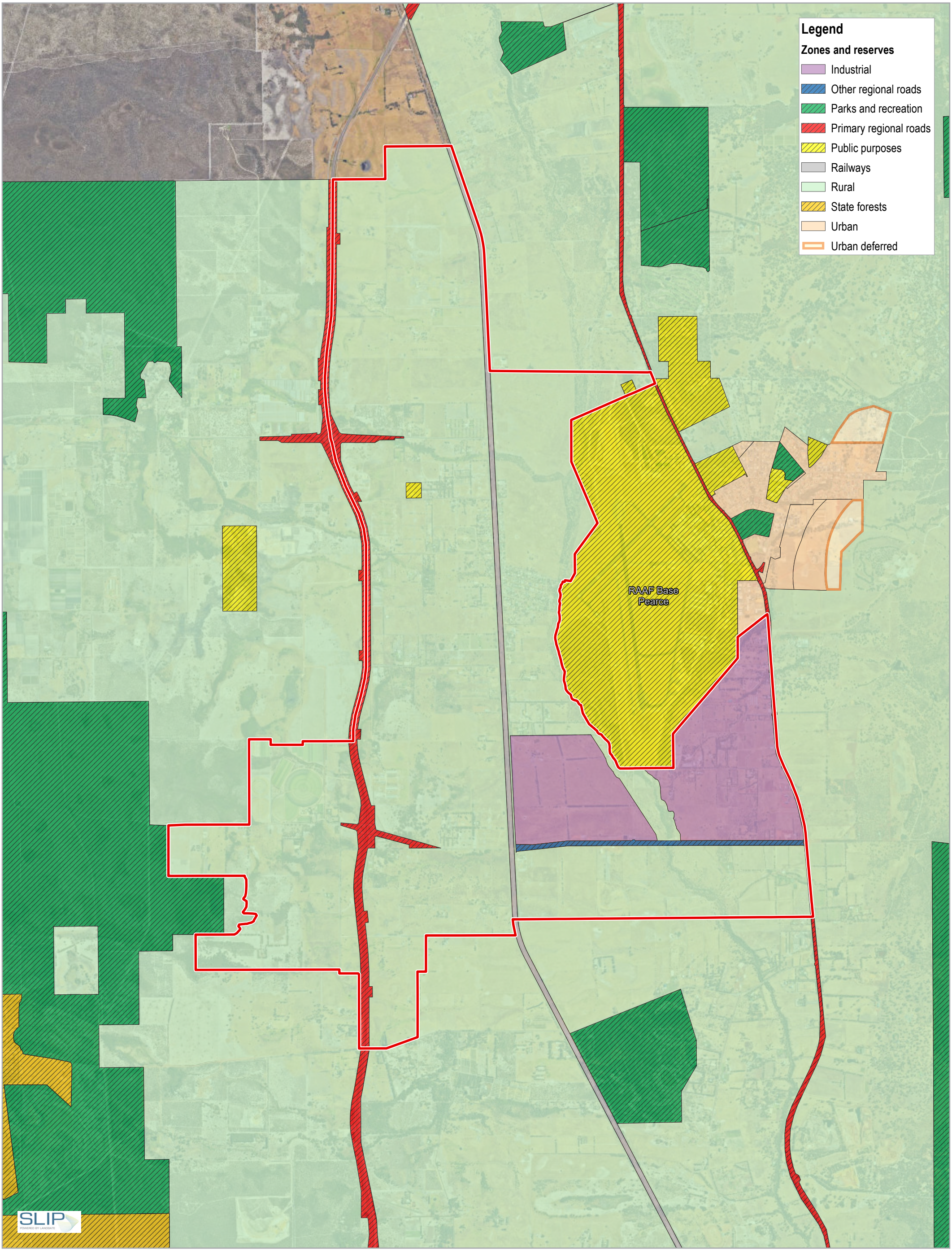
A PCA was declared on 21 July 2015 over the land to the northwest of the Railway Parade/Stock Road intersection for the purpose of identifying the land required for the proposed IMT (Figure 6). This PCA (PCA 150), has recently been renewed and will remain in effect until July 2025.

A further PCA (PCA 154) was declared on 22 July 2020 to protect land required for the upgrading and widening of Stock Road at existing and future intersections between GNH and the PDNH (Figure 7).

MRS Amendment 1219/41 rezoned two sites east of Railway Parade and north of Stock Road from 'Rural' to 'Industry'. These sites were subsequently rezoned 'Special Use' under The City of Swan Local Planning Scheme No. 17 (LPS 17). The remaining land within the Strategy area, that is not reserved in accordance with the MRS, is zoned 'General Rural' under LPS 17 (Figure 8).

The rezoning of any additional land to 'Industrial' under the MRS will require such land to be similarly rezoned under the local planning scheme. LPS17 contains the following industrial zones:

- light industrial (generally small-scale industrial development)
- general industrial (manufacturing, servicing, storage, and distribution)
- industrial development (requires structure plan)



Paper Size ISO A3

0 300 600 900 1,200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

DEPARTMENT OF PLANNING, LANDS & HERITAGE

BULLSBROOK MASTER PLAN
KEY SUMMARY FINDINGS REPORT

Metropolitan Region Scheme

Project No. **61-37134**
Revision No. **0**
Date **8/09/2022**

FIGURE 5

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Print date: 08 Sep 2022 - 17:18

Data source: Landgate: Metropolitan Region Scheme - 20180123, WA Now Aerial Imagery - accessed 20180703. GHD: Master plan boundary - inset 100m from supplied masterplan boundary (DPLH - 201805); Geoscience Australia: National Geodata Topo 250k Series 3 - 2006. Landgate_Subscription_Imagery_WANow: . Created by: wwang3

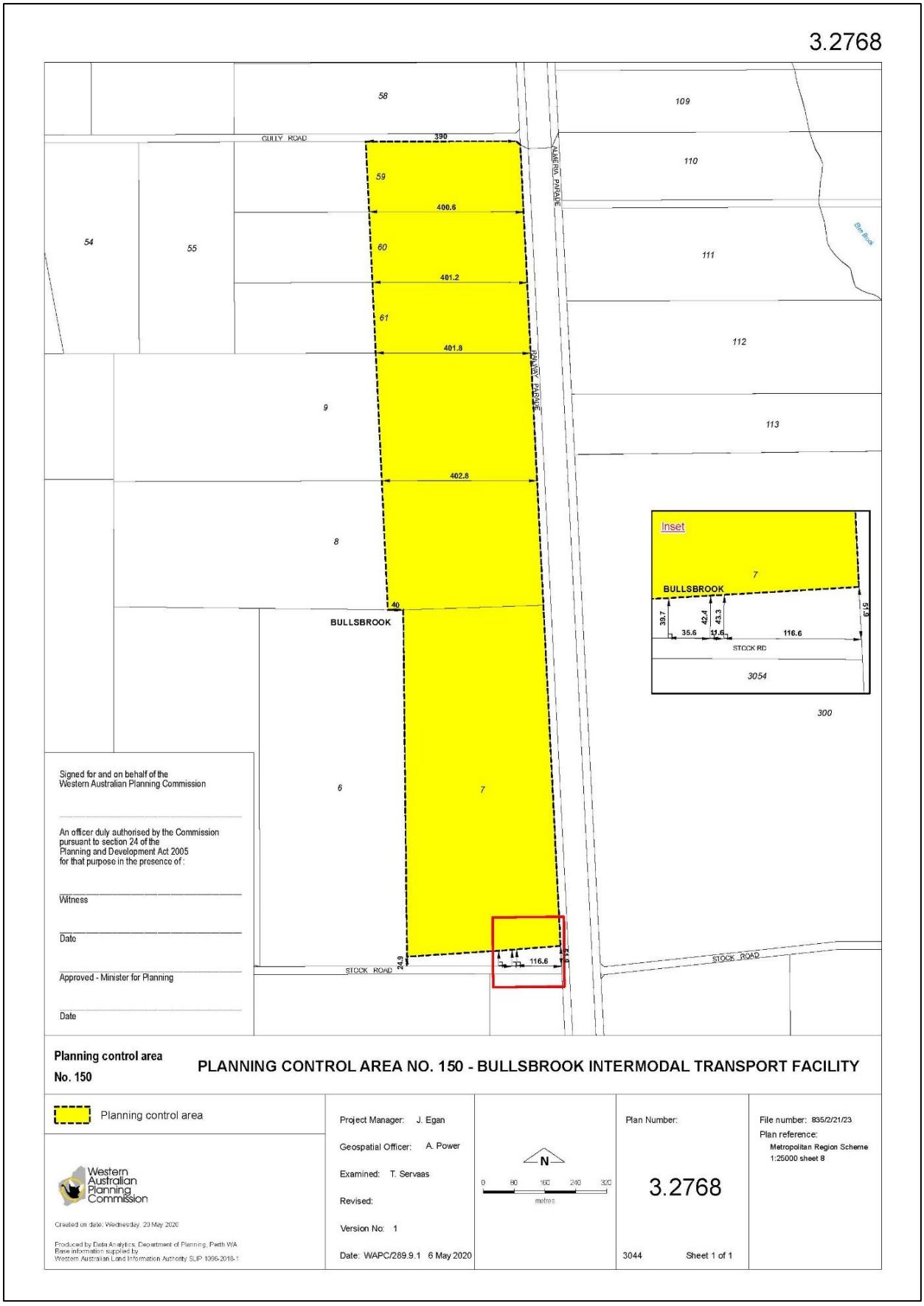
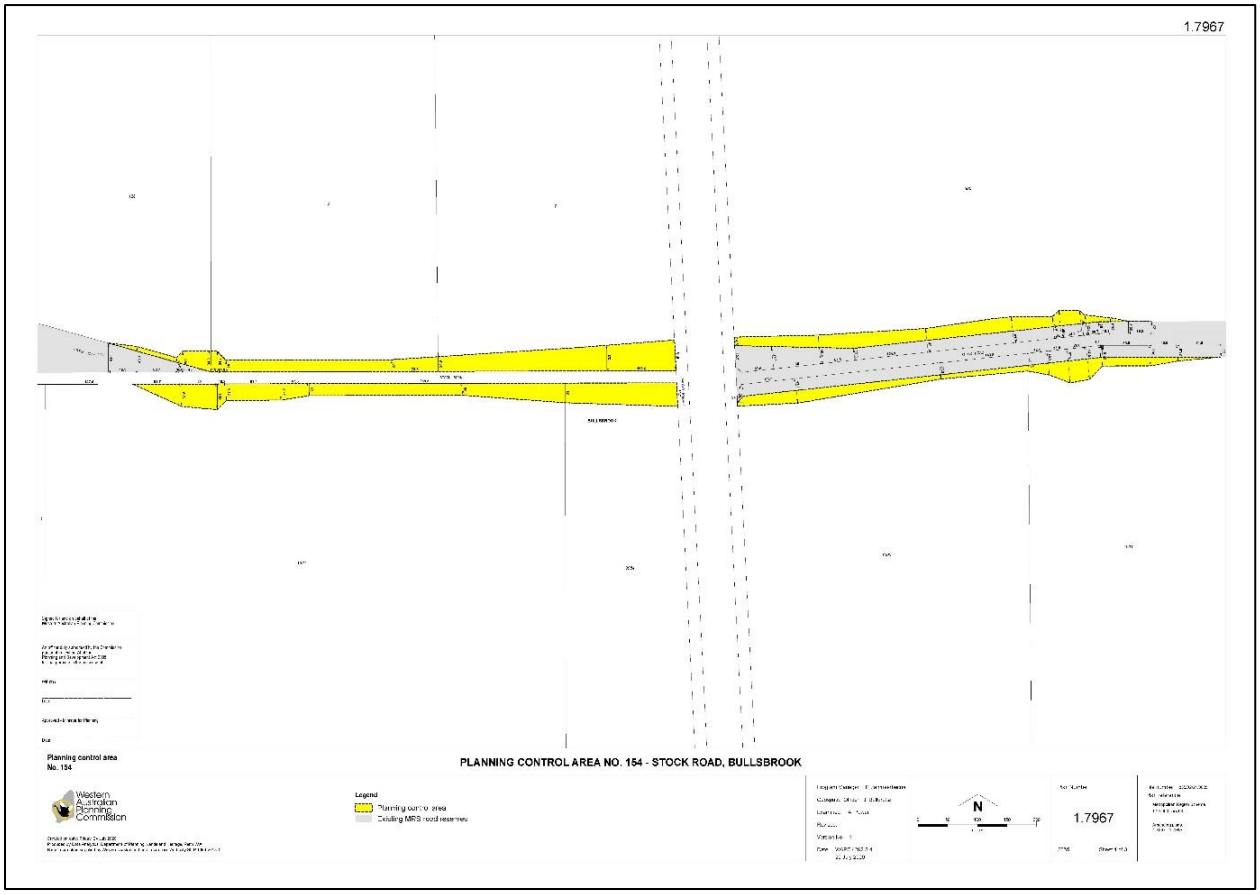
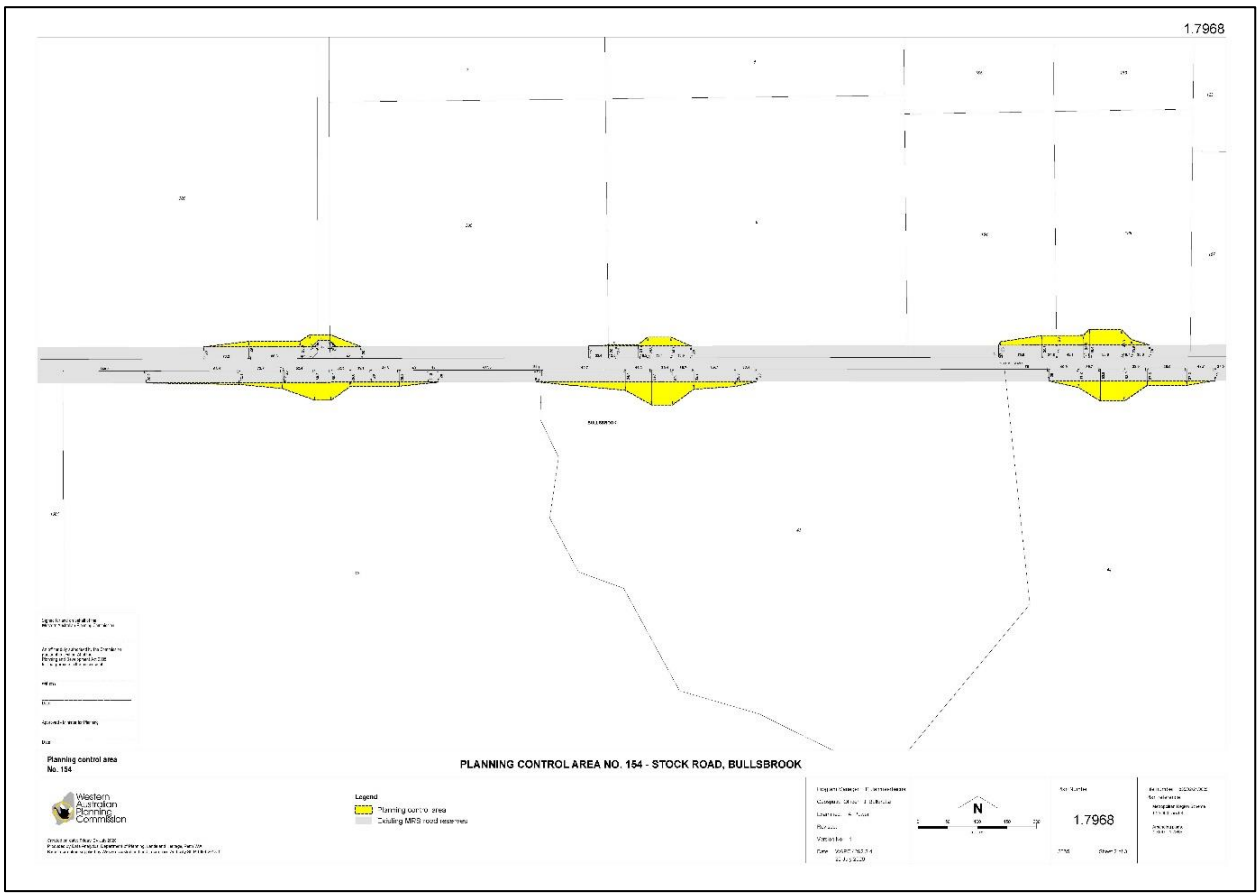


Figure 6 - PCA 150 (Source: DPLH)


1.7967
PLANNING CONTROL AREA NO. 154 - STOCK ROAD, BULLSBROOK
Planning control area
No. 154
Western Australian Planning Commission
Legend
Planning control area
Excluding MRS road reserves
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1.7967


1.7968
PLANNING CONTROL AREA NO. 154 - STOCK ROAD, BULLSBROOK
Planning control area
No. 154
Western Australian Planning Commission
Legend
Planning control area
Excluding MRS road reserves
N
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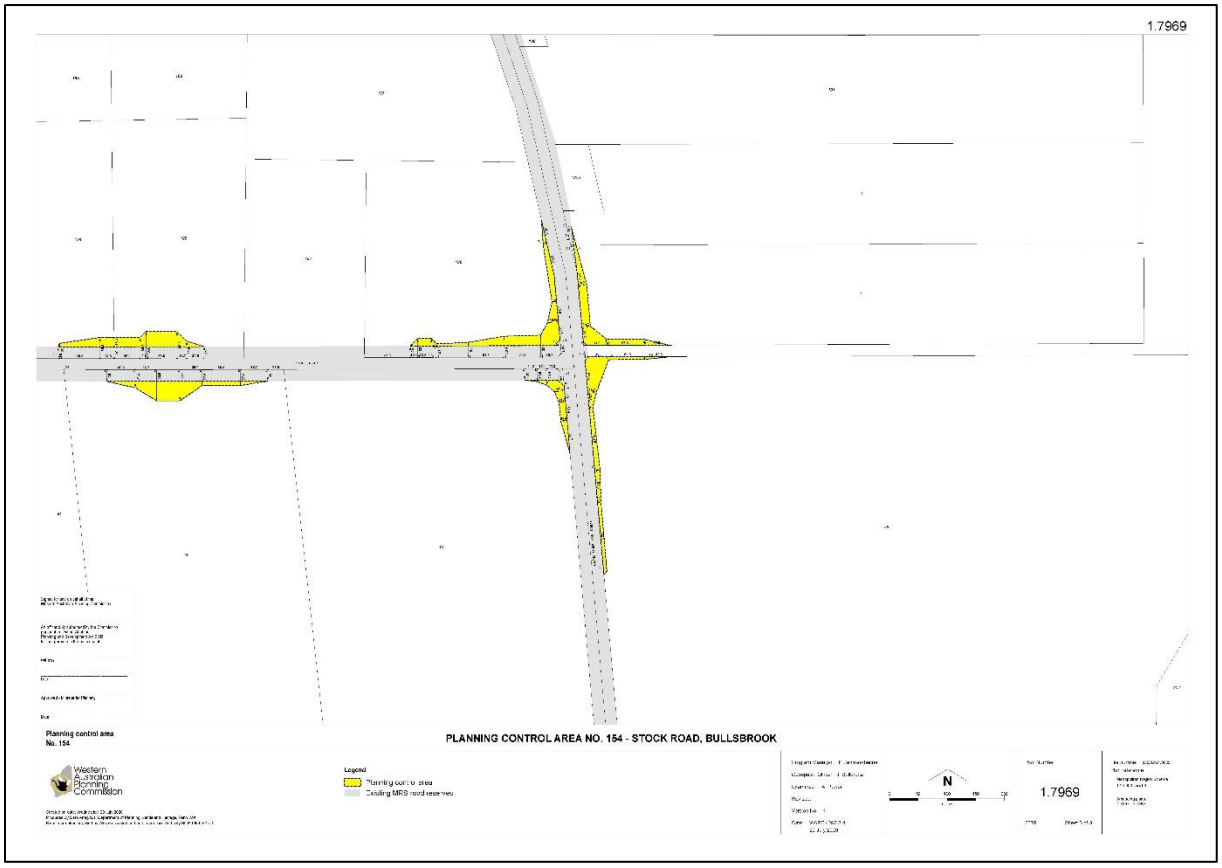
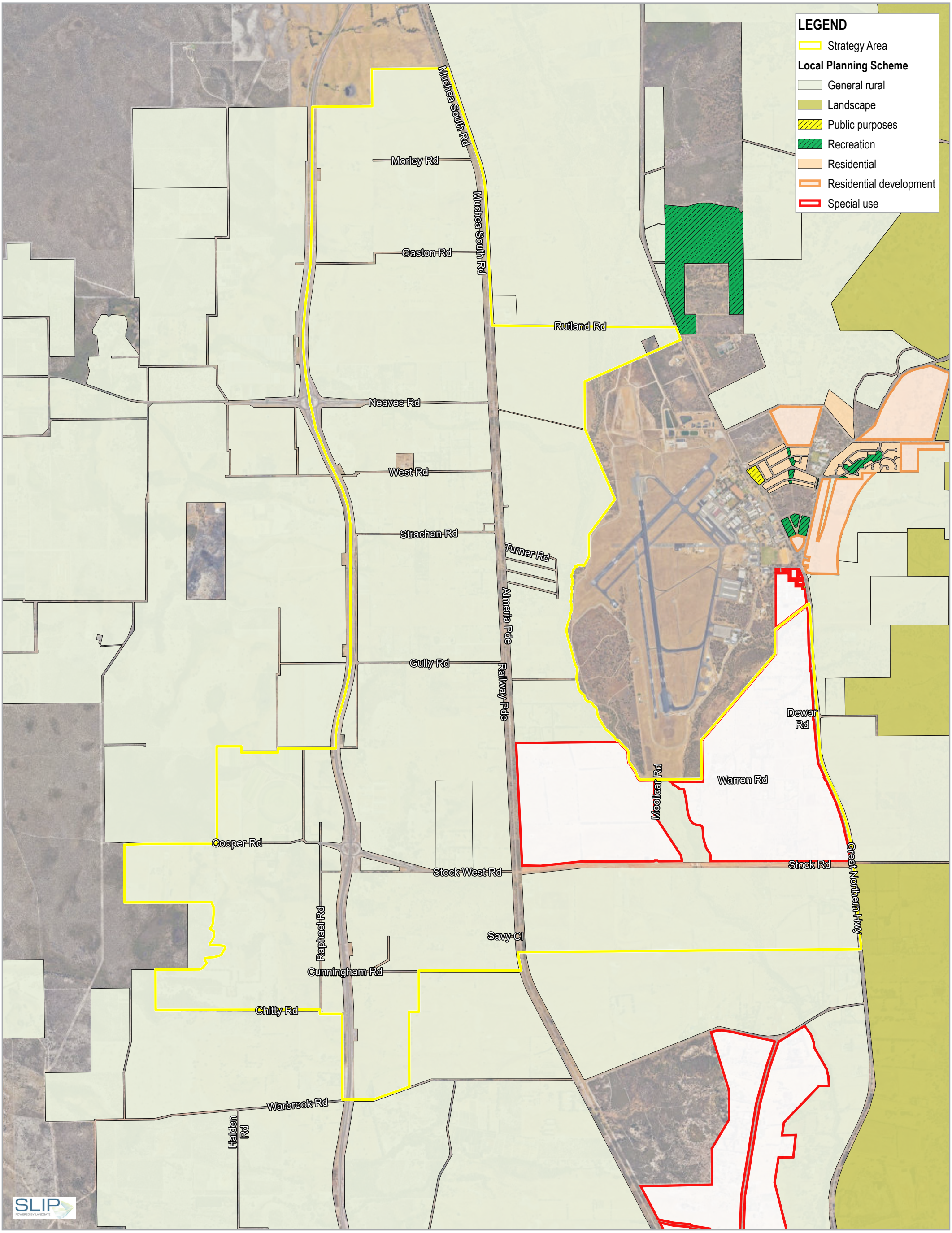


Figure 7 - PCA 154 (Source: DPLH)



Paper Size ISO A3

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Kilometres

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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DEPARTMENT OF PLANNING, LANDS & HERITAGE
BULLSBROOK MASTER PLAN

Local Planning Scheme

Project No. **61-37134**
Revision No. **0**
Date **19 Sep 2022**

FIGURE 8

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Data source: Landgate: Imagery, Roads - 20160617; DPLH: Local Planning Scheme - 20180709. Created by: wwang3

3.2 Planning frameworks and strategies

3.2.1 State Planning Strategy

The State Planning Strategy 2050 is Western Australia's principal planning document for strategic integrated land use across State, regional and local jurisdictions. The State Planning Strategy recognises the need to plan for the State's economic development to ensure the release of land for infrastructure and industry to meet the needs of enterprise. It promotes structure planning of industrial areas to ensure optimal output with minimal waste and the development of industrial sites that encourage eco-efficiency and co-location of similar enterprises. Intermodal transportation and coordinated efficient freight logistics systems are identified as supporting improved efficiency of the freight distribution network. Aspirations relevant to this Strategy include:

- suitable land is allocated and zoned for enterprises, business and industry, including project ready industrial lands, buffers and infrastructure.
- land is zoned or reserved for economic activity including strategic industrial sites and supporting infrastructure and buffers.
- WA consistently attracts global investment that enables emerging enterprise to develop and raise productivity.
- clusters of industry drive productivity and stimulate new ancillary businesses.
- industrial areas are structure planned to produce optimal output with minimal waste.
- all strategic industrial areas are developed to an approved structure plan.

3.2.2 Economic and Employment Land Strategy: non-heavy industrial: Perth Metropolitan and Peel Regions

The Economic and Employment Lands Strategy (EELS) (WAPC 2012) recognises that a key constraint for industrial development in the northern sub-regions is the current lack of east-west connectivity linking the workforce in the northwest sub-region with the employment opportunities in the northeast sub-region.

The EELS further recognised the need for additional IMTs to optimise supply-chain efficiencies as a result of increased containerisation trends, noting the northeast sub-region as having potential to incorporate an inland IMT facility.

Relevantly, the EELS identifies Bullsbrook (South) as the potential location for the development of an IMT, as a key driver to strengthen industrial and employment activity in the region and recommended a heavy industrial site of approximately 471 ha, generally in the south-east portion of the Strategy area be developed to support this in the medium term (4-10 years).

3.2.3 Perth and Peel @3.5 Million

Perth and Peel @ 3.5 Million is the State Government's overarching strategic plan for the Perth and Peel regions over the next 30 years. This plan, which includes a suite of documents, provides a spatial vision for the metropolitan area through land use planning and infrastructure frameworks. A

key strategic focus of these frameworks is the facilitation of increased employment self-sufficiency though the provision of employment opportunities close to where people live.

The northwest sub-region does not have any major freight, intermodal facilities or transport hubs that would act as a catalyst and support major industrial activities and employment. This combined with significant environmental constraints has resulted in the identification of limited industrial zoned land within the northwest sub-region.

Accordingly, increased accessibility to employment opportunities in the northeast sub-region, is required to support its workforce. A key objective of this Strategy is the provision of more direct linkages between the two northern sub-regions, delivering opportunities for additional employment within proximity of the northwest sub-region. This will in turn afford greater employment self-sufficiency in the northern sub-regions and decrease the commuter pressure on the regional transport network.

Bullsbrook is identified in Perth and Peel @ 3.5 Million as a potential location for the provision of a future intermodal freight terminal and industrial centre. Strategic development of the Bullsbrook freight and industrial area will both complement the existing worker profiles of the northern sub-regions as well as provide greater employment opportunities. The land uses proposed within this Strategy facilitate this through understanding the existing and future workforce profiles of the northern sub-regions, as outlined in the findings of the Industrial Land Demand and Market Analysis (see Appendix G).

3.2.4 Northeast Sub-Regional Planning Framework

The Strategy area sits within the northeast sub-region, the development and planning of which is guided by the NESRPF. The NESRPF identifies a significant area of land for industrial expansion and industrial investigation within the Bullsbrook locality (Figure 9).

Overall, the land proposed for industrial expansion and investigation within the Bullsbrook freight and industrial area is 2,542 ha (excluding the land within the Strategy area identified as remaining rural or subject of further urban investigation) which accounts for more than three quarters of proposed industrial land supply in the sub-region. The framework anticipates 31,800 additional jobs will be provided within the Bullsbrook and Ellenbrook areas.

The Muchea Industrial Park is located approximately 20 km north of the Bullsbrook freight and industrial area. The NESRPF identifies the Muchea employment node to the north of the sub-region and notes its development for land uses such as transport, livestock, fabrication, warehousing, wholesaling, and general commercial use. However, the road to rail infrastructure proposed for the Bullsbrook freight and industrial area is not available at Muchea. The Strategy has considered the broader regional development and supply of industrial land in defining preferred land uses and precincts. In doing so, it is anticipated the Bullsbrook freight and industrial area will complement other industrial areas, including Muchea.

The NESRPF reiterates the proposed IMT at Bullsbrook as a medium to long-term development facilitating strategic employment and optimising transport infrastructure use, noting that it is unlikely to be required prior to 2031.

The NESRPF recognises the potential long-term opportunity to provide additional east-west linkages and enhance the future freight network (Figure 10) and identifies the following regional road functions within and surrounding the Bullsbrook freight and industrial area:

- PDNH, a primary distributor that will improve freight transport and general traffic capacity through the northern part of the sub-region.
- Neaves Road, upgraded to primary distributor and extended east of the PDNH as an integrator arterial road will be an important east-west link road forming part of the freight network.
- Cooper Road, a potential linkage to connect directly to the Stock Road extension to provide a more direct east-west connection. The NESRPF notes that future investigations would need to determine the feasibility due to environmental constraints including the Gnangara Priority 1 Water Protection Area and adjacent bushland.

The Strategy reflects the NESRPF in promoting the PDNH and Neaves Road as major arterial roads.

3.2.5 Westport Port and Environs Strategy 2020

The Westport Port and Environs Strategy seeks to deliver an integrated plan to meet the freight and logistics needs for Perth and the South West for the next 50 to 100 years. The Westport Port and Environs Strategy identifies the importance of the Restricted Access Vehicle (RAV) network between the future Kwinana port and industrial areas in ensuring efficient containerised road freight supply chains. It is anticipated that the port will be connected to Tonkin Highway by an east-west link at Anketell Road, providing a major freight route from Kwinana through to Muchea. Tonkin Highway would then efficiently connect through to a network of existing and proposed intermodal sites ringing the metropolitan area, including the IMT at Bullsbrook (east and west).

The Westport Port and Environs Strategy confirms the location of an IMT at Bullsbrook as part of a broader strategy to develop a ring of IMTs in outer metropolitan areas to support port and supply chains for Perth and surrounding regions.

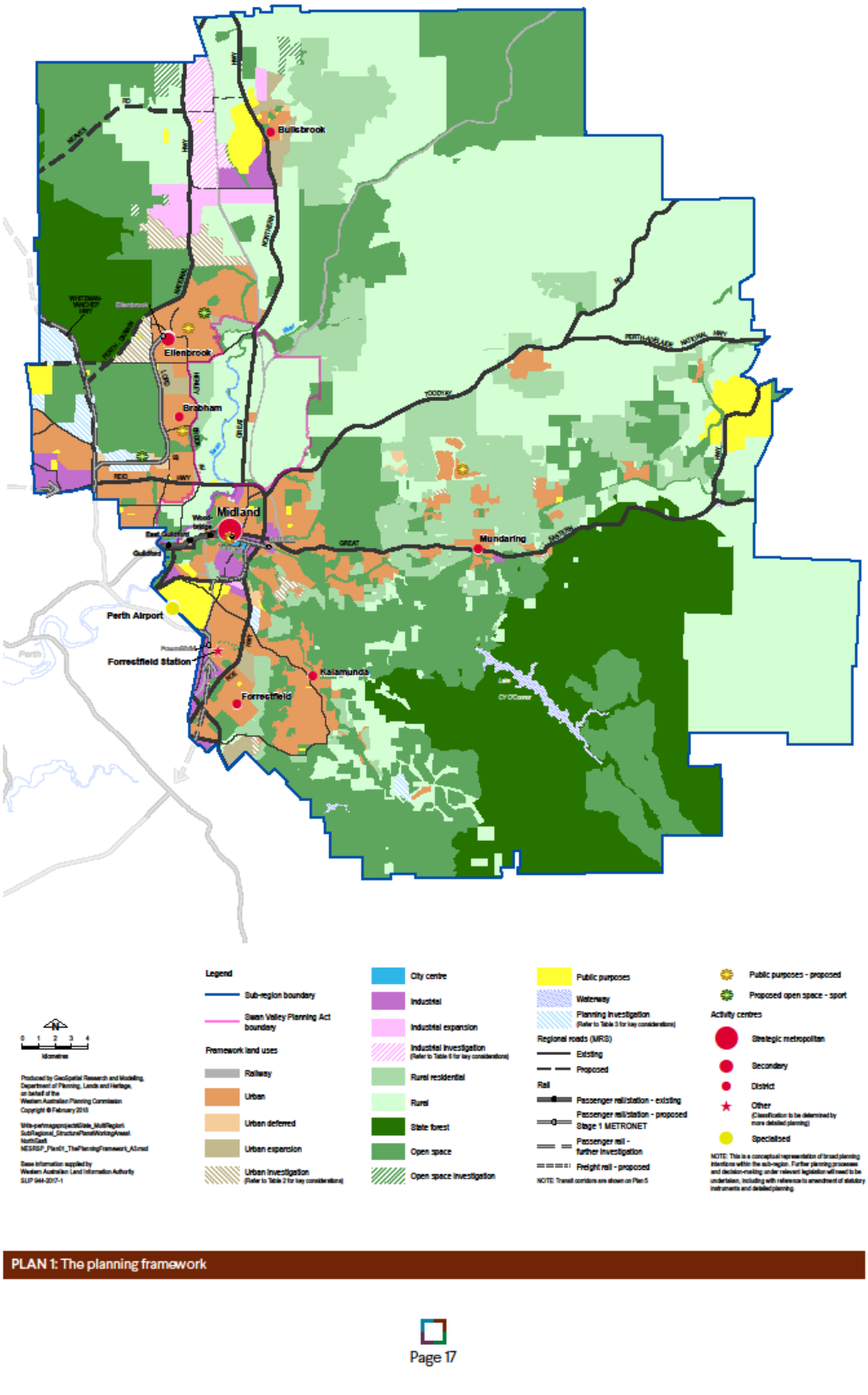
3.2.6 Westport's Preferred Design

In November 2023, the Government announced the preferred Westport port and supply chain design for the project business case. The design has been prepared to a planning horizon to 2074, which has included consideration of a potential Bullsbrook IMT as a part of this work.

The preferred design was informed by the outcomes of the Supply Chain Integrated Design (2024) project and the Landside Logistics Opportunities Study (2023) which both identified how to optimise freight network for Westport.

Westport's preferred supply chain design does not identify Bullsbrook as part of the preferred freight network for the project business case, however it does identify Bullsbrook as a long-term IMT site in the event that additional capacity is required for the north-east and north-west corridor, or as an alternative (contingency) to the preferred IMT sites, being Kenwick, Kewdale and Forrestfield. Furthermore, the development of an IMT facility at Bullsbrook is not precluded if local demand arises or the private sector seek to fund and develop these facilities.

The Bullsbrook IMT site (within Precinct D) has been secured via an existing Planning Control Area and the conclusions of Westport's preferred supply chain are consistent with the staging and timing proposed by the Strategy, which highlights the development of other adjacent precincts in the short-medium term.



PLAN 1: The planning framework

Figure 9 - NESRPF (Source DPLH)

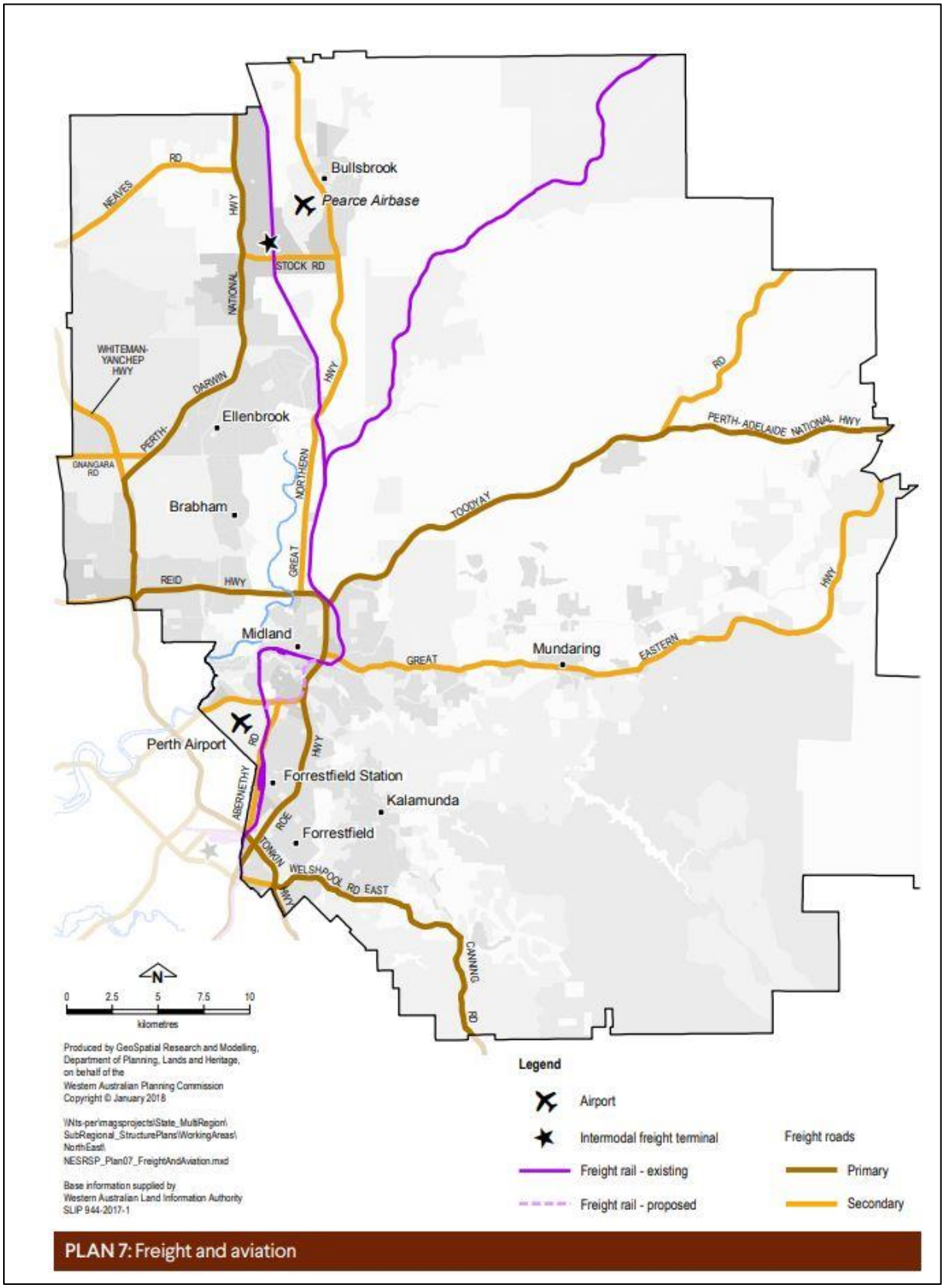


Figure 10 - NESRPF Plan 7: Freight and Aviation Network

3.2.6 City of Swan Local Planning Strategy 2020

A key economy and employment objective of the City of Swan Local Planning Strategy is:

"*Facilitate the creation of a sustainable economy and provide opportunities for growth in a wide range of employment areas.*"

The Local Planning Strategy outlines several key issues under this objective which include the need to preserve existing industrial land, identifying future industrial land for employment and economic development and, the need for an intermodal terminal hub.

Bullsbrook South is mentioned as one of the strategic industrial areas with the smaller industrial area of Bullsbrook Central identified as existing industrial land needing preservation and future expansion. Furthermore, Bullsbrook South, Bullsbrook North, and Hazelmere South have been identified as potential medium-term non-heavy industrial sites with a zoning timeframe of 4 to 10 years. The Bullsbrook Townsite precinct (north) has been identified for non-heavy industrial use in the long term (more than 10 years). There is no intermodal terminal in the North-West or North-East sub-regions of Perth at present, however, Bullsbrook South is identified as having the potential to accommodate an intermodal terminal.

This Strategy will support the Local Planning Strategy's objective and evidently aligns with the key issues identified by providing a range of industrial development opportunities to meet the needs of the City and surrounding areas.

3.2.7 City of Swan Local Rural Strategy

The City's Local Rural Strategy complements the local planning strategy by establishing strategies and actions for development of all land not zoned 'urban' in the local government area. The strategy identifies the strategy area as an industrial investigation area with the objective to facilitate opportunities for development of additional industrial land. The strategy notes that structure planning will dictate the function and form of industrial development and land use within the structure plan location.

3.2.8 City of Swan Local Transport Strategy

The City's Local Transport Strategy confirms that future road freight is primarily expected to follow the major highways within the City of Swan, with the most noticeable change being the construction of the PDNH. The PDNH will see a sizeable volume of freight vehicle use in preference to GNH, although some freight vehicles are likely to remain on GNH as this is the only major regional north-south freight route that allows for oversize overmass (OSOM) vehicles (i.e., up to 10 metres high and 10 metres wide).

It is further noted that changes to Neaves/Rutland Roads may require duplication works and realignment of the eastern portion (east of Railway Parade) to provide better connectivity with GNH. While the pre-eminence of the PDNH may serve to reduce traffic along this section of Neaves Road in the longer term, the overall function and usage of the eastern portion of Neaves Road will be greatly affected by the decision and timing of any realignment.

The City's Local Transport Strategy further notes that Stock Road will ultimately form a major link between the PDNH and GNH, in addition to being the primary access to the South Bullsbrook Industrial Estate (Northern Gateway) and the Bullsbrook residential development. This additional

traffic is likely to necessitate an upgrade of the GNH/Stock Road intersection, as well as grade separation of the existing Stock Road rail crossing.

The City's Local Transport Strategy makes the following recommendations in relation to Bullsbrook:

- the timing of Stock Road intersection treatments as a result of regional road upgrades and development, should be investigated.
- a rail crossing upgrade study for the Stock Road rail crossing should be undertaken.
- an evaluation of Neaves Road including grade separation at PDNH should be undertaken.

3.3 State Planning Policies

3.3.1 SPP 1.0 – State Planning Framework

SPP 1.0 provides a central State Planning Framework and sets the context for decision-making on land use and development in Western Australia. The policy reiterates the primary aim of planning as described in the State Planning Strategy, which is to provide for the sustainable use and development of land. Specific to the Strategy, a key principle of the framework is to facilitate trade, investment, innovation, employment, and community betterment.

3.3.2 SPP 2.0 – Environment and Natural Resources

SPP 2.0 is the overarching policy relating to the natural environment in broader land use planning and decision-making. The policy set outs principles to support sustainability in planning through integrating ecological, environmental, and social considerations.

Future planning will need to consider and integrate environment and natural resource management in the development and implementation of detailed land use plans.

3.3.3 SPP 2.8 – Bushland Policy for the Perth Metropolitan Area

SPP2.8 applies to Bush Forever areas within the Perth Metropolitan Region. The policy aims to ensure the protection and management of regionally significant bushland is addressed and integrated with broader land use planning decision-making.

Seven Bush Forever sites intersect the study area (Bush Forever sites 6, 100, 97, 294, 296, 298 and 399). Impacts of industrial development on the reserves will need to be managed through the structure planning process and subsequent detailed planning.

3.3.4 SPP 2.9 – Water Resources

SPP2.9 recognises the importance of water resources in maintaining the wellbeing of the environment, community, and existing and future development. The policy provides additional guidance for the consideration of water resources in land use planning. SPP2.9 objectives seek to protect, conserve, and enhance significant water resources, assist in ensuring availability of suitable water resources and promote their sustainable use.

3.3.5 Draft SPP 2.9 – Planning for Water

Draft SPP2.9 – Planning for Water seeks to ensure that planning and development considers water resource management and includes appropriate water management measures to achieve optimal water resource outcomes. The policy provides guidance for decision making around provision of reticulated and on-site sewerage.

3.3.6 SPP 3.4 – Natural Hazards and Disasters

SPP3.4 objectives are to include planning for natural disasters (including flooding and bushfire) as a fundamental element in preparation of all planning documents to minimise adverse impacts of natural disasters.

Planning for the area should have regard to the potential natural hazards in the area including flooding and bushfire.

3.3.7 SPP 3.5 – Historic Heritage Conservation

SPP3.5 sets out the process by which areas of historic heritage significance are identified, conserved, and protected through planning decision making.

3.3.8 SPP 3.7 – Planning in Bushfire Prone Areas

SPP3.7 guides implementation of effective risk-based land use planning and development to reduce the impact of bushfire on property and infrastructure. The policy applies to strategic planning documents located in designated bushfire prone areas.

3.3.9 SPP 4.1 – Industrial Interface

The purpose of SPP4.1 is to protect industry and infrastructure facilities from the encroachment of incompatible land uses and ensure that planning decisions consider the locational constraints of these land uses, the significant investments they represent and their current and future benefits and costs to the community when considering the most appropriate land uses for the surrounding land. SPP4.1 also seeks to prevent land use conflict between industry/infrastructure facilities and sensitive land uses.

3.3.10 SPP 5.4 – Road and Rail Transport Noise and Freight Considerations in Land Use Transport

SPP5.4 provides measures to minimise adverse impacts of transport noise while balancing the effect on noise-sensitive development and cost of transport infrastructure. The objectives of the policy seek to facilitate development and operation of an efficient freight network and the strategic co-location of freight handling facilities.

3.4 Structure plans

3.4.1 Bullsbrook Townsite District Structure Plan

The Bullsbrook Townsite District Structure Plan (Bullsbrook Townsite DSP), approved by the WAPC in April 2018, sets out the strategy for future development of the Bullsbrook townsite to meet State Government objectives to provide for anticipated population growth. The Bullsbrook Townsite DSP encompasses land directly to the east of the Strategy area and comprises a variety of land uses including the land zoned 'Industrial Development' in the south-east of the Bullsbrook freight and industrial area (Figure 11). The Bullsbrook Townsite DSP estimates the area to generate at least 11,000 jobs at full build out, focusing on transport related industries complementary to the IMT. The plan provides strategic guidance for future land use planning and growth of the townsite aimed at:

- allowing for a diversity of land uses, which generates local employment opportunities to contribute to self-sufficiency.
- facilitating essential industrial growth within the existing 'Industrial Development' and 'Light Industrial' zones with an appropriate land use and built form interface along the GNH.
- providing appropriate land use interfaces between residential and non-residential development by the inclusion of an area of 'Transitional Land Uses' along the western boundary of GNH.

3.4.2 South Bullsbrook Industrial Precinct Local Structure Plan No. 1

The South Bullsbrook Industrial Precinct Local Structure Plan No. 1 encompasses 130 hectares of land and is bounded by the RAAF Base Pearce to the north, GNH to the east, Stock Road to the south and the Ellen Brook to the west. The structure plan provides for a wide range of industrial uses and includes a Highway Service zone adjacent to the intersection of Stock Road and GNH to provide for commercial opportunities that are able to capitalise on the increased exposure (Figure 12).

3.4.3 South Bullsbrook Local Structure Plan No. 2

The South Bullsbrook Local Structure Plan No. 2 encompasses 176.5 hectares and is bounded by the rail line to the west, the existing rural land to the north, Stock Road to the south, RAAF Base Pearce and Ellen Brook to the east. It is envisaged that the South Bullsbrook Local Structure Plan 2 will primarily service the resource sector. However, there are also opportunities to integrate large freight and logistics operations with the future IMT which is to be located immediately west of the precinct (Figure 13).

3.4.4 North Ellenbrook (West) District Structure Plan

The North Ellenbrook (West) District Structure Plan encompasses 611 hectares and is bounded by reserve land to the west, and south, Chitty Road to the north, and the PDH to the east. It is envisaged that the North Ellenbrook (West) DSP will accommodate future population growth and demand for housing in proximity to major transport and employment areas in the North-East Corridor (Figure 14).

3.4.5 North Ellenbrook (East) District Structure Plan

The North Ellenbrook (East) District Structure Plan encompasses 449 hectares and is bounded by PDH to the west, Warbrook Road to the north, Maralla Road to the south, and the PDH to the east. Like the North Ellenbrook (West) DSP, it is envisaged that the North Ellenbrook (East) DSP will accommodate population growth in proximity to major transport and employment areas (Figure 15).

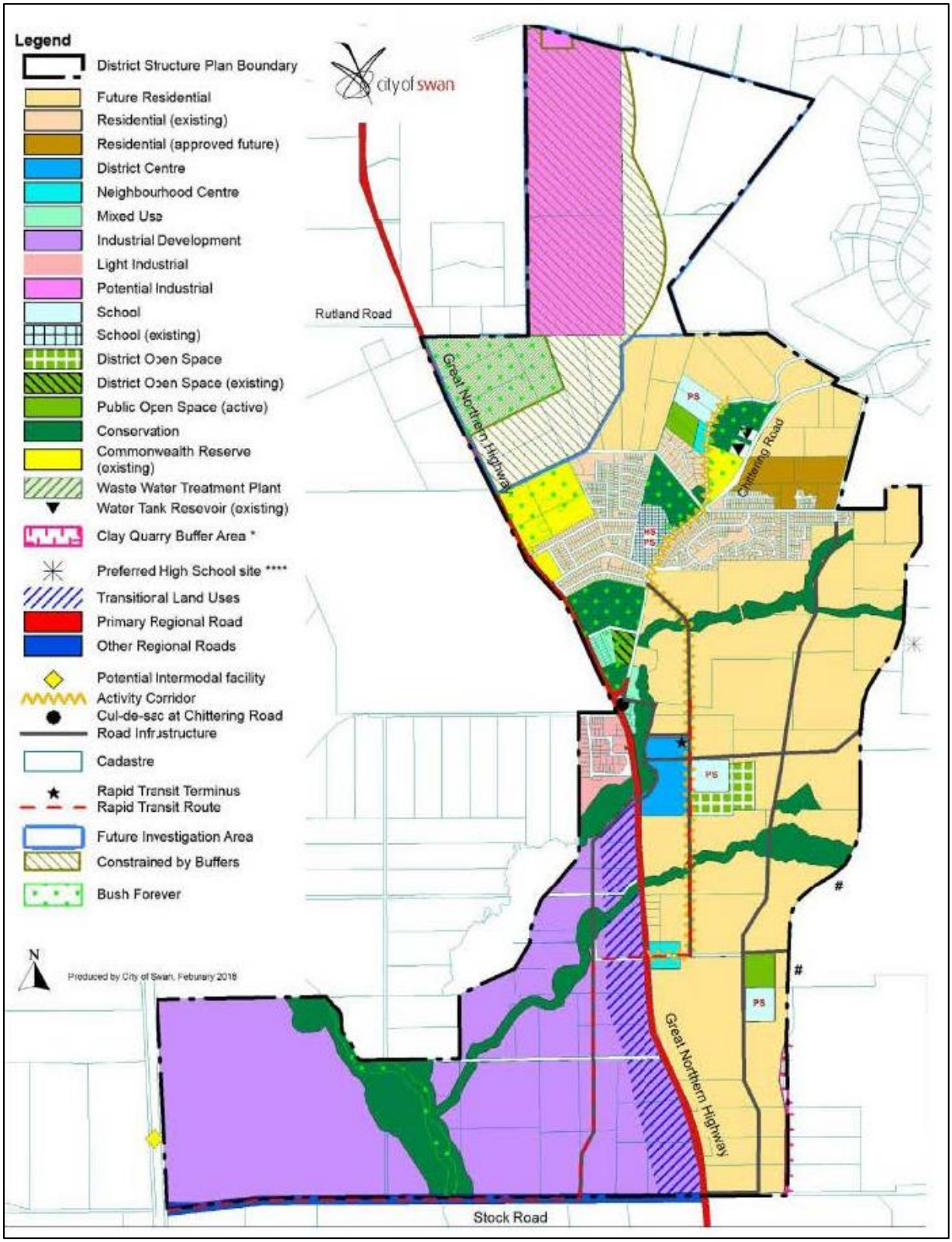


Figure 11 - Bullsbrook Townsite District Structure Plan

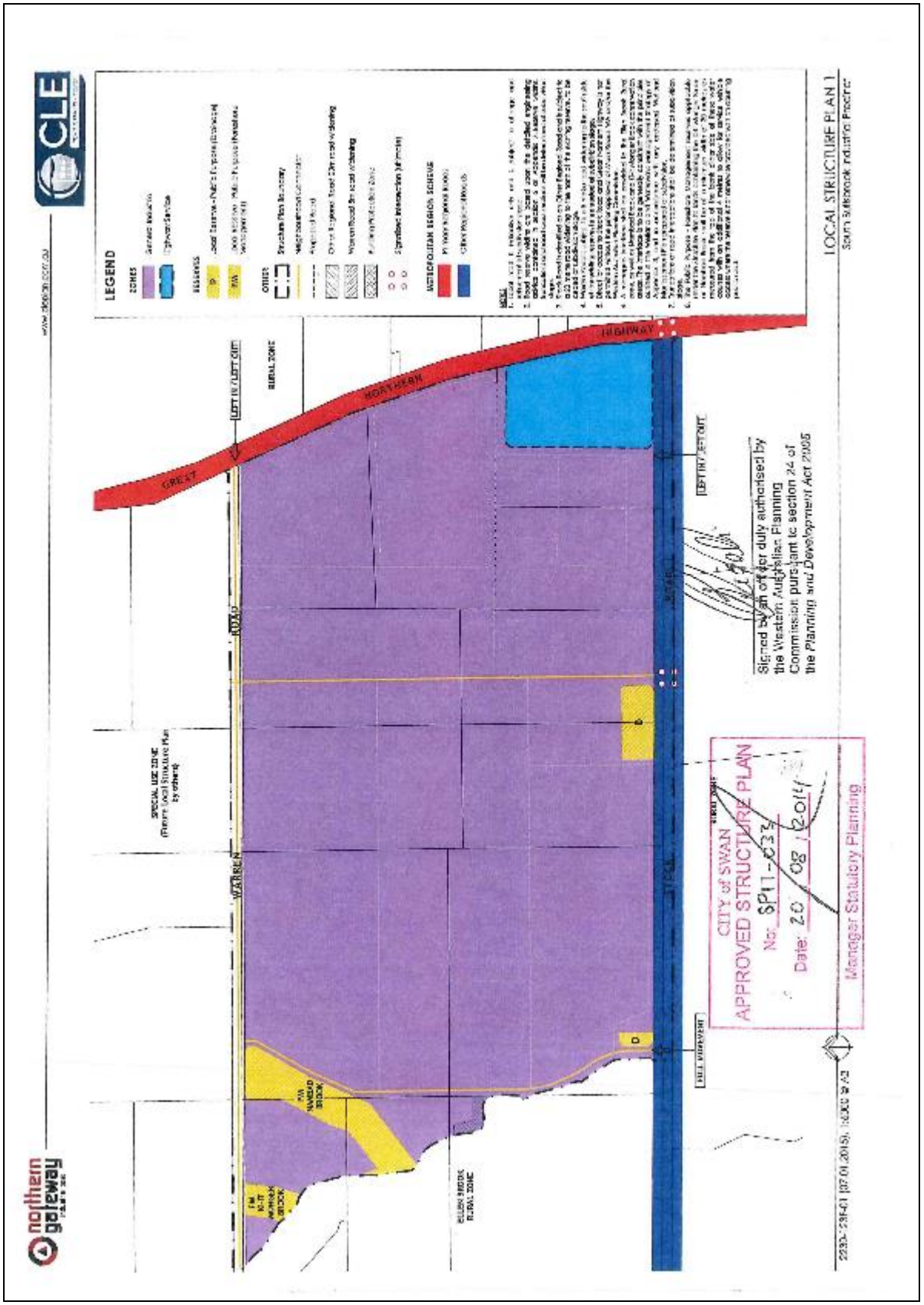


Figure 12 - South Bullsbrook Industrial Precinct LSP 1 Map

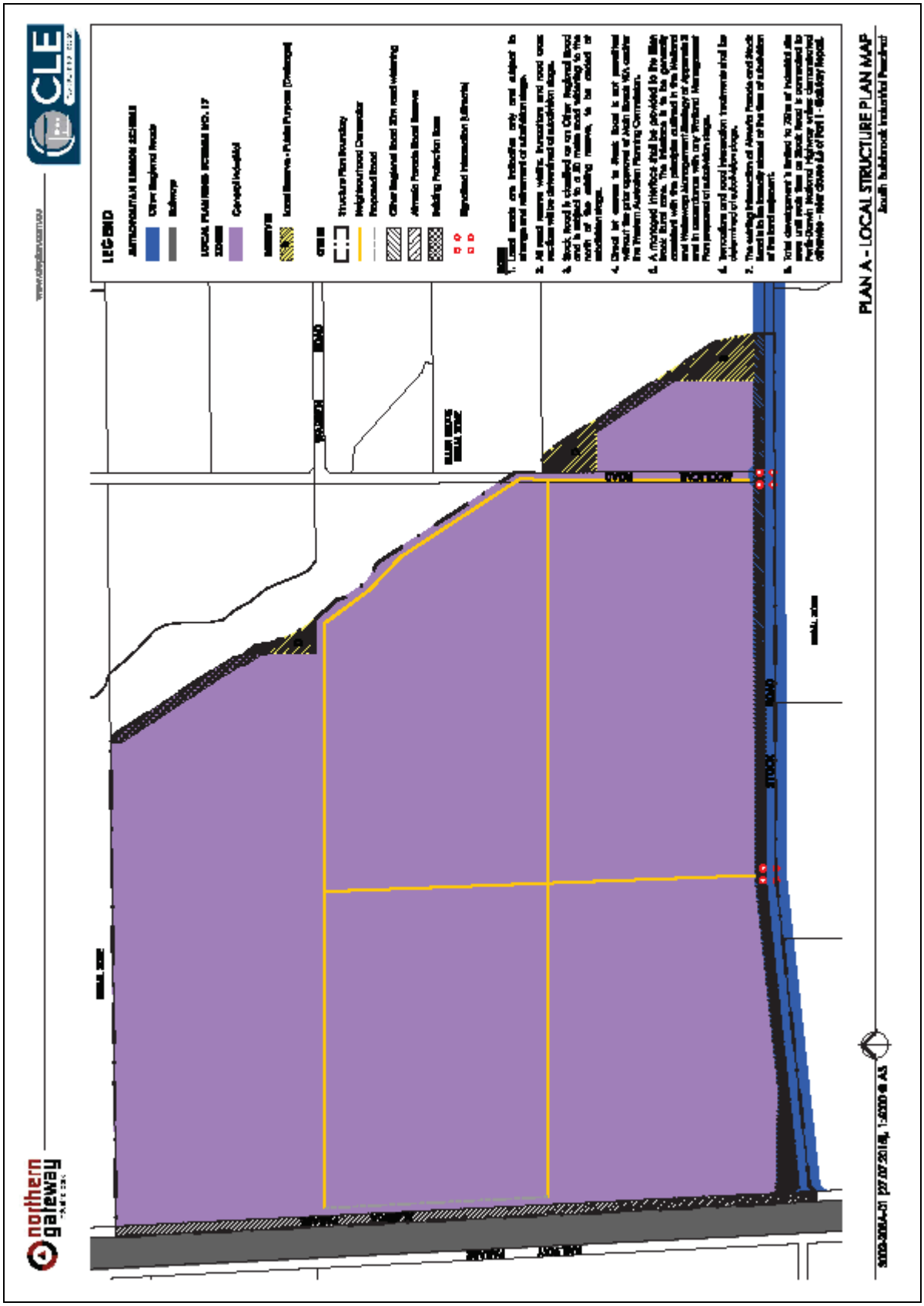


Figure 13 - South Bullsbrook Industrial Precinct Plan LSP 2 Map

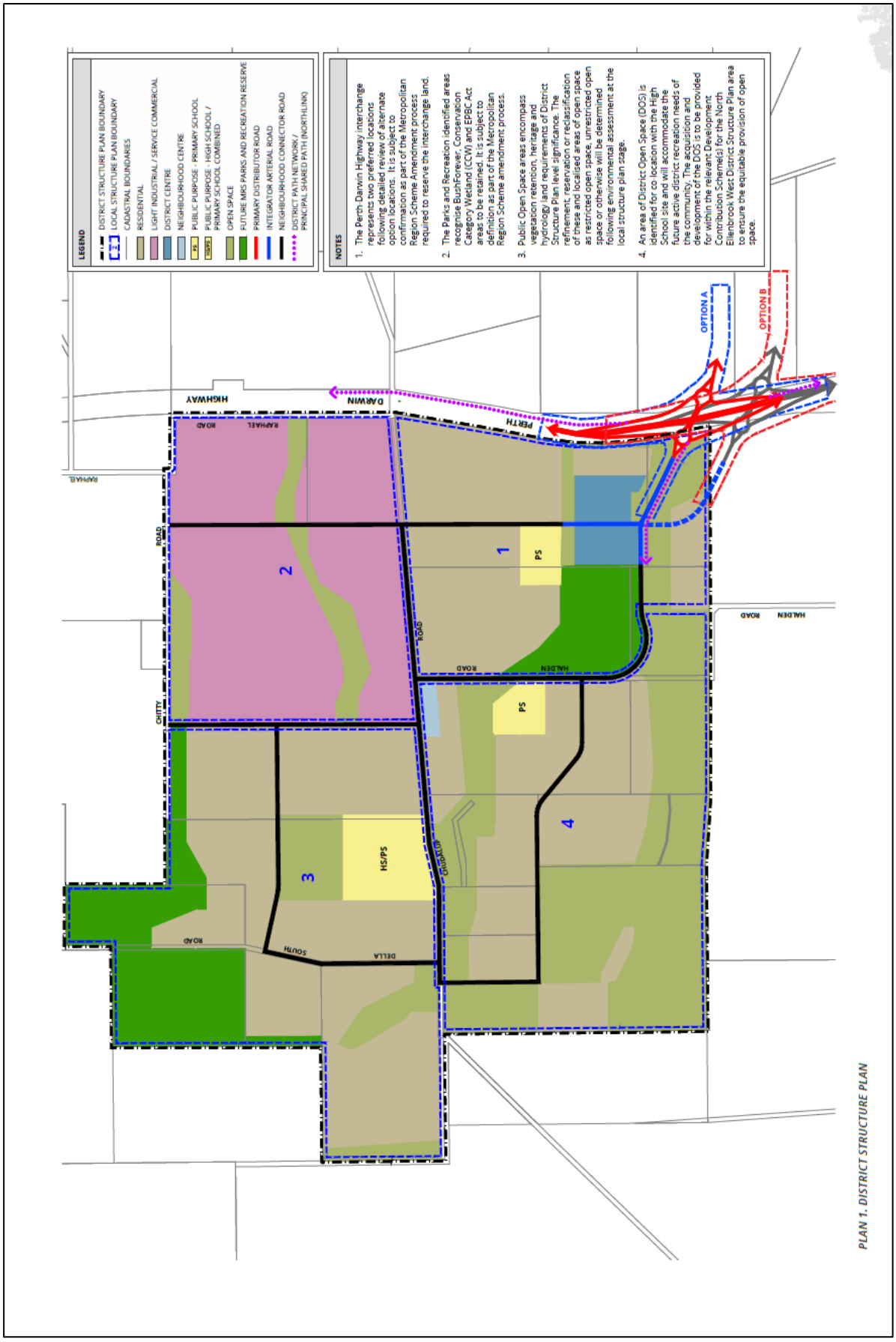


Figure 14 - North Ellenbrook (West) DSP Map

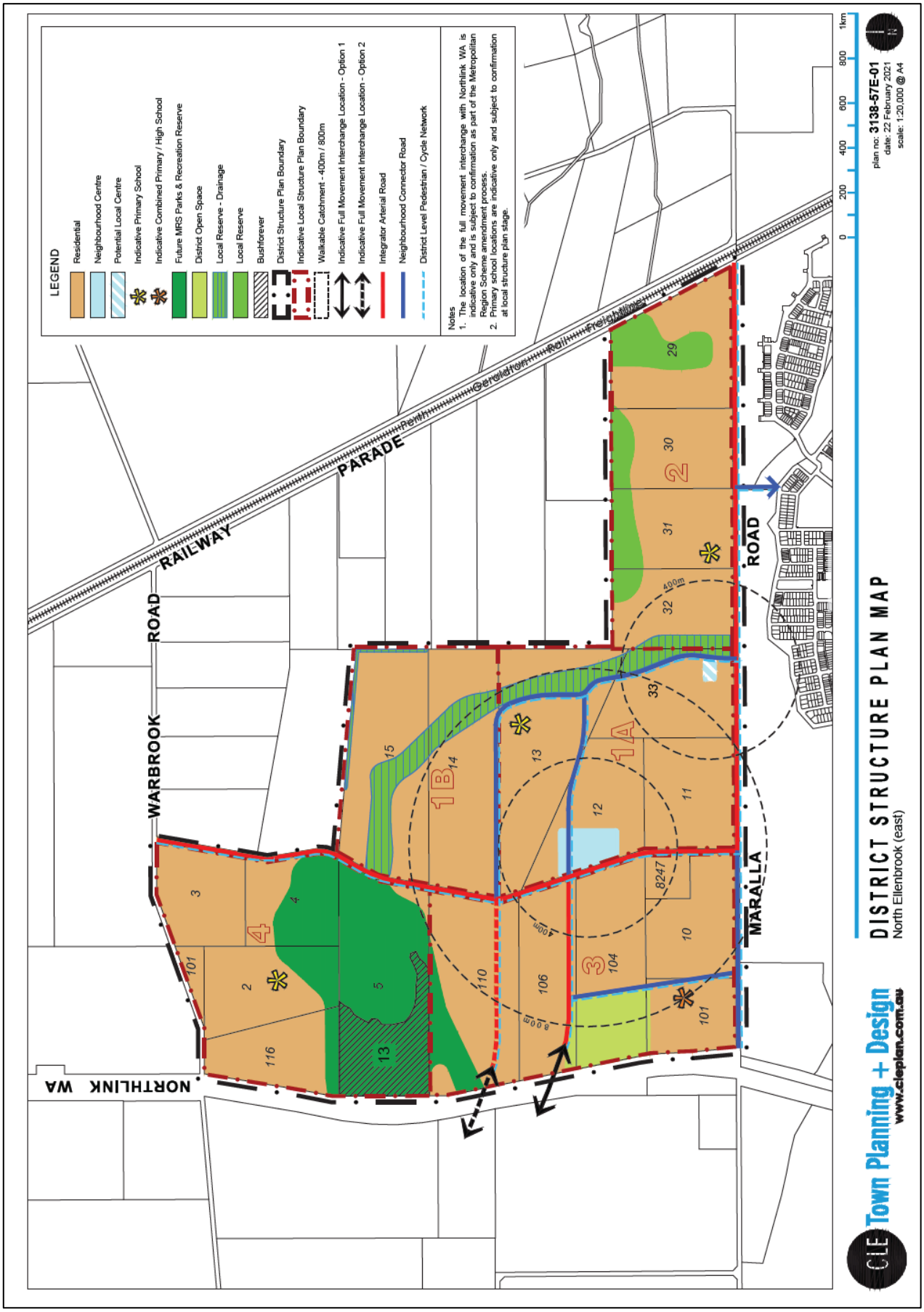


Figure 15 - North Ellenbrook (East) DSP Map

4. Site conditions and constraints

4.1 Biodiversity and conservation

A desktop Environmental Study was prepared to support the Strategy and is contained in Appendix B – Environmental Study. The outcomes of this assessment are summarised below.

4.1.1 Vegetation

The Strategy area is situated within the Swan Coastal Plain which is a low-lying coastal plain covered with woodland. The following four main vegetation complexes are identified within the site:

- Yangah Complex (generally Melaleuca sp)
- Beermullah Complex (Casuarina, Marri, and Eucalyptus Wandoo sp)
- Bassendean Complex (Banksia, Eucalyptus and Melaleuca sp)
- Guildford Complex (Eucalyptus and Melaleuca sp)

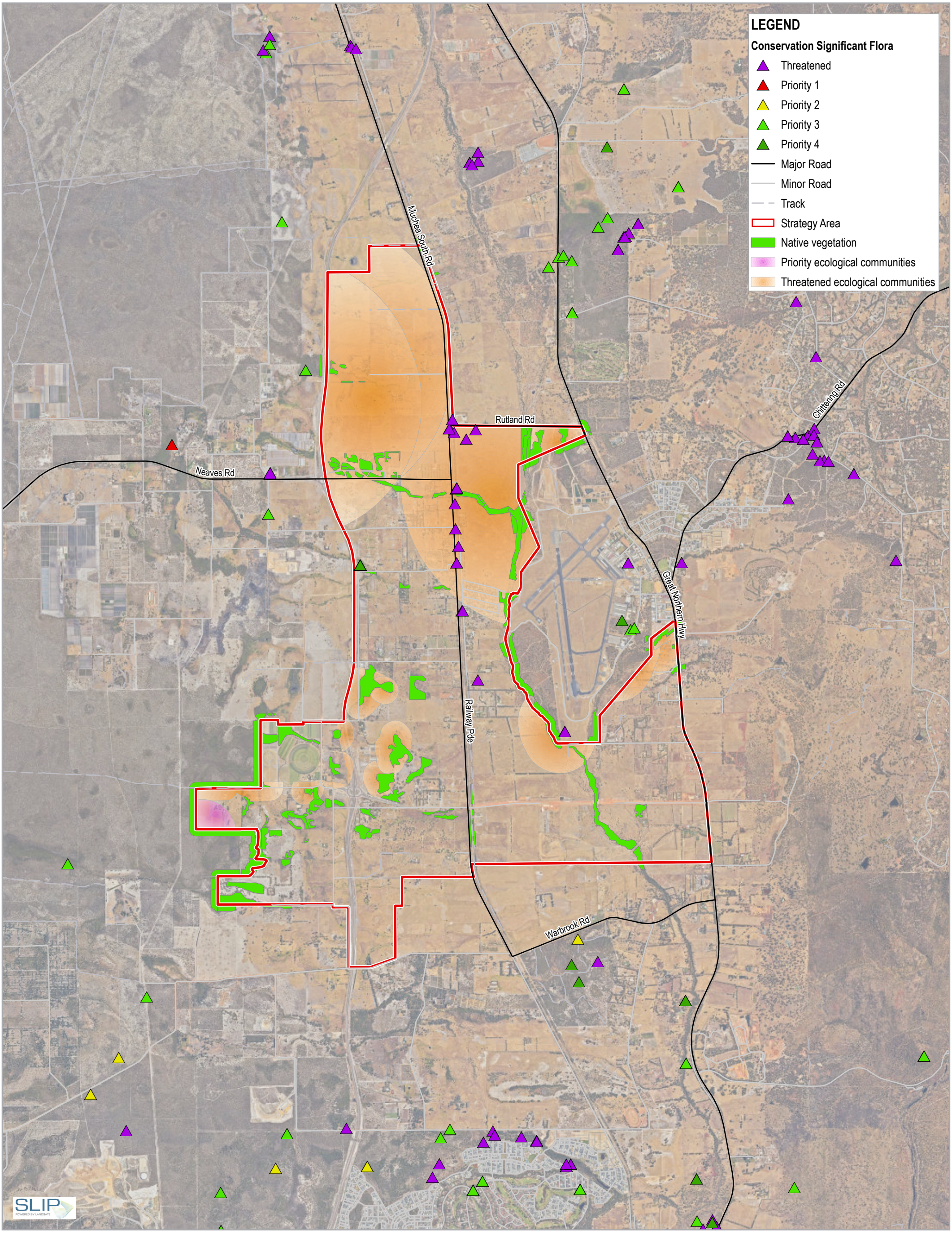
The native vegetation has been extensively cleared, with less than 10 percent of pre-European extent remaining. Remnant vegetation is generally retained within the Bush Forever sites and adjacent to water courses.

4.1.2 Flora

There are 905 flora taxa representing 100 families and 351 genera within five kilometres, with a number of conservation significant flora within and adjacent to the Strategy area (Figure 16). Five Threatened Ecological Communities (TECs), listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act), have been identified as occurring or likely to occur within the Strategy area, namely:

- assemblages of plants and invertebrate animals of tumulus (organic mound) springs of the Swan Coastal Plain. This community is known to occur within the Strategy area.
- Banksia Woodland of the Swan Coastal Plain. This community, which is also listed as a Priority 3 – Priority Ecological Community by the Department of Biodiversity, Conservation and Attractions (DBCA) is likely to occur within the Strategy area.
- Clay Pans of the Swan Coastal Plain. This community is known to occur within the Strategy area.
- Corymbia calophylla – Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain. This community is known to occur within the strategy area.
- Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain. This community is known to occur within the area.

Fauna and flora surveys, confirming the occurrence of any TECs, priority ecological communities or declared rare fauna, will be required to support any rezoning proposals.



Paper Size ISO A3

0 0.5 1 1.5 2

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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Department of Planning, Lands and Heritage
Bullsbrook Freight and Industrial Land Use Planning Strategy

Native vegetation and conservation significant ecological communities and flora

Project No. **61-37134**
Revision No. **0**
Date **30 Sep 2022**

FIGURE 16

\\ghdnet.internal\ghd\AU\Perth\Projects\61\37134\GIS\Maps\Working\137134\61\Data source: DPLH: Site Boundary - 20180702; Landgate: Imagery (August 2018), Roads - 20180820; DBCA: Conservation Significant Flora, Conservation Significant Fauna, TEC/PEC; DPIRD: Native Vegetation - 20171026. Created by: wwang3
Print date: 30 Sep 2022 - 16:25

4.1.3 Fauna

There are 425 species of fauna within the Strategy area and within a radius of five kilometres of the Strategy area. The fauna includes amphibians, birds, fish, invertebrates, mammals, and reptiles. There are nine species of migratory birds and 37 listed threatened species, as well as several introduced and/or invasive species.

There are 13 conservation significant species within a five-kilometre buffer of the Bullsbrook freight and industrial area, including the Forest Red tailed Black Cockatoo, Carnaby's Cockatoo, Peregrine Falcon, Chuditch, Quenda, Western Brush Wallaby, Black Striped Snake and Western Swamp Tortoise (Figure 17).

Fauna surveys to confirm the occurrence of any threatened, conservation significant or declared rare species, will be required to support any rezoning proposals. However, surveys and other Fauna management considerations will be addressed at subsequent planning stages.

4.1.4 Conservation areas

A number of environmentally sensitive areas occur or intersect with the Strategy area, likely aligned with TECs, DBCA managed lands, Bush Forever sites and geomorphic wetlands.

High quality conservation areas should be protected through appropriate measures which could include:

- inclusion within appropriate scheme reserves where required for protection
- implementation of buffer areas
- identification of appropriate land uses adjacent to these areas
- application of environmentally sustainable design
- implementation of drainage and water management systems that protect environmental assets

Further detailed studies and structure plans should identify appropriate measures to protect identified conservation areas.

4.1.4.1 State forest

The Strategy area intersects with a portion of the Gnangara-Moore River State Forest along its western boundary which is also included in Bush Forever Sites No 6 and 399. The Gnangara-Moore River State Forest extends from Pinjar to Whiteman Park and covers an area of approximately 66,000 hectares. The land is managed by the DBCA. There are nine other DBCA managed conservation areas within five kilometres of the Strategy area. The State Forest is proposed to be retained in the Rural zone.

4.1.4.2 Bush Forever

The Strategy area intersects with seven Bush Forever sites, with an additional nine sites within five kilometres. The majority of the Bush Forever sites are located within the Rural zone or along existing water courses. Where Bush Forever sites are within areas designated for future industrial use, they should be identified and set aside for conservation purposes.

4.1.4.3 Western Swamp Tortoise

The Western Swamp Tortoise is listed as Critically Endangered under the EPBC Act. The tortoise is found in two remnant habitats (Ellen Brook and Twin Swamps Nature Reserves) and two translocated habitats (Moore River National Park and Lake Wanamal Nature Reserve at Mogumber).

The Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011 is in place to protect habitat suitable for the long-term survival of wild populations of the Western Swamp Tortoise. The policy defines an area which includes Ellen Brook and Twin Swamps Nature Reserves. The southern boundary of the Strategy area is located approximately 0.8 km north of the Twin Swamps Nature Reserve and 4.7 km north of the Ellen Brook Nature Reserve and intersects the northern extent of the policy area.

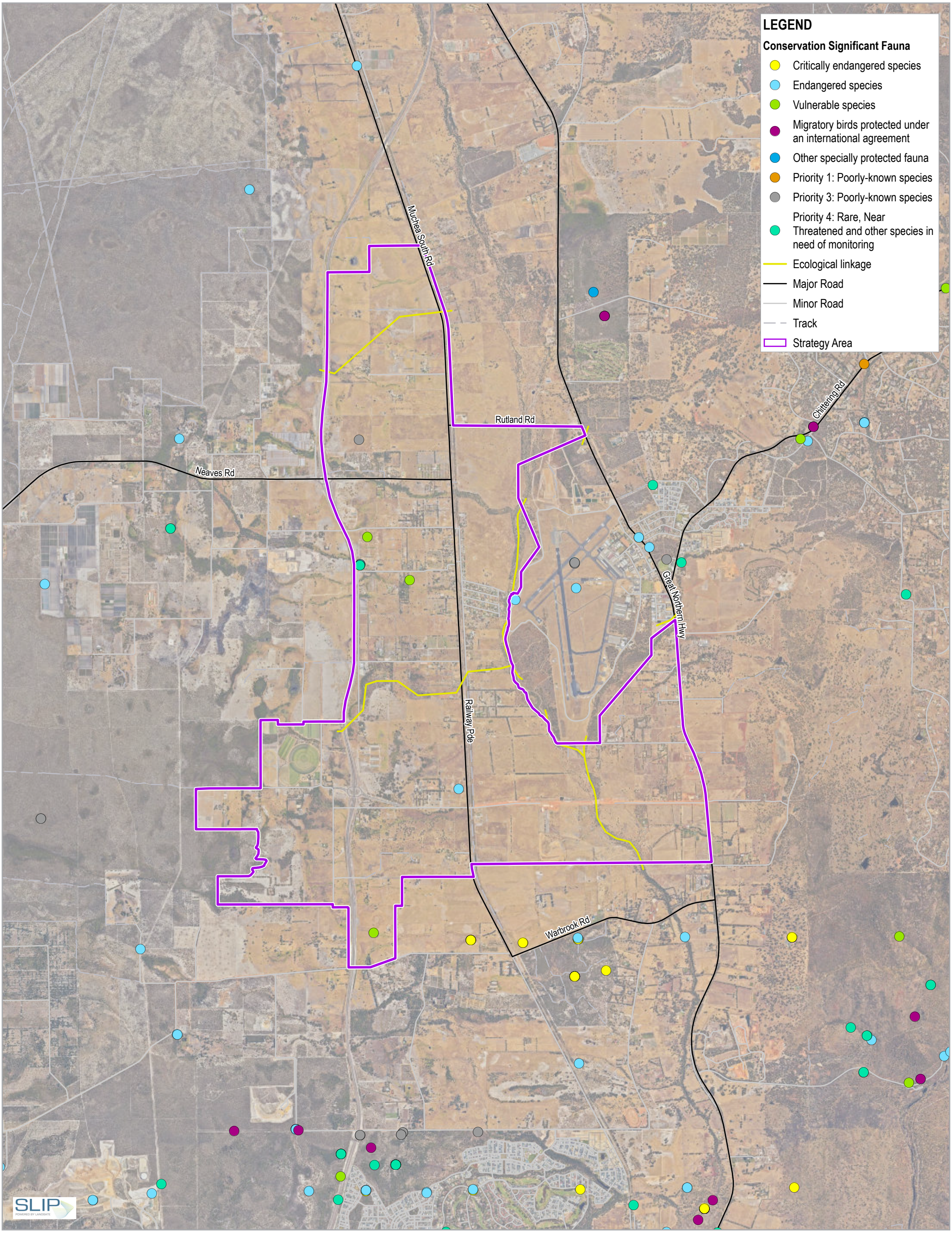
Development within the site is to comply with the provisions of the policy by minimising and avoiding impact from activities that might degrade the Western Swamp Tortoise habitat. This includes management of environmental, pollution control and drainage systems designed to maintain water quality and quantity. The Regional Water Management Strategy (RWMS) prepared as part of this Strategy provides management strategies to maintain water quality and quantity. These strategies should guide district and local water management strategies and development within specific precincts to mitigate impacts on the Western Swamp Tortoise habitat.

Local structure plans prepared for areas adjoining the Western Swamp Tortoise habitat should ensure that the allocation of future land use is cognisant of and consistent with the objectives of the policy. Additionally, management plans mitigating any adverse impacts on the Western Swamp Tortoise habitat will be required.

4.1.4.4 Ecological linkages

Five ecological linkages intersect the Strategy area (Link ID 27, 28, 29, 30 and 31).

Ecological linkages are to be maintained and protected where possible through local structure planning. The potential for their use as green corridors to provide amenity and protection for flora and fauna should be investigated during these subsequent planning stages.



Paper Size ISO A3

0 0.5 1 1.5 2

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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Ecological linkages and Conservation Significant Fauna

Project No. **61-37134**
Revision No. **0**
Date **30 Sep 2022**

FIGURE 17

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Print date: 30 Sep 2022 - 16:31

Data source: Landgate: Imagery (August 2018), Roads - 20180820; GHD: Site Boundary - 20180702; DPLH: Ecological Linkages; DBCA: Conservation Significant Fauna. Created by: wwang3

4.2 Heritage

4.2.1 Aboriginal heritage

Four registered Aboriginal sites are present within the Strategy area as listed in Table 4. Any future development within the heritage site boundaries is required to have due regard to and comply with the requirements of the *Aboriginal Heritage Act 1972*.

Table 4 - Registered Aboriginal sites

ID	Name	Restriction	Status	Type
3525	Ellen Brook	No gender restrictions	Registered Site	Mythological
3583	Ki-It Monger Brook 2	No gender restrictions	Registered Site	Ceremonial, Modified Tree, Mythological
25735	Bingham Road Creek Artefact Scatter	No gender restrictions	Registered Site	Artefacts/Scatter
4362	South Bullsbrook	No gender restrictions	Registered Site	Artefacts/Scatter
21994	Neaves Creek Field Site 01	No gender restrictions	Registered Site	Artefacts/Scatter

There may be a need for future Aboriginal heritage surveys to be carried out as part of implementation of the strategy. In addition, further places/sites such as artefact scatters may exist within the area proposed for development and may be disturbed during works. Ongoing consultation with Traditional Owners will need to occur throughout implementation of the strategy.

4.2.2 Other heritage

There are two sites with historic heritage significance within the Strategy area:

1. West Bullsbrook Hall (25869) – heritage listed site of significant historic value to the local community. Adopted under the City of Swan Heritage List
2. Old shop (25963) – listed in the municipal inventory, the old shop has some historic value having served the community as a corner store. Adopted under the City of Swan Municipal Inventory

It is unlikely that future industrial development will affect the historic heritage sites as they are within the existing residential area which is to remain 'Rural'.

4.3 Landform and soils

4.3.1 Topography

The Strategy area lies immediately east of the Darling Escarpment and is generally flat in profile with topographic elevation ranging from 57 metres AHD to 40 metres AHD on the western edge of the area, and from 40 metres AHD to 30 metres AHD on the eastern edge of the area. The highest point is 64 metres AHD in the south-west corner and the lowest elevation is 24 metres AHD where Ellen Brook crosses the southeastern boundary.

4.3.2 Soils

The main geological units in the Strategy area are the Guildford Formation comprising alluvium and the Bassendean Sand comprising aeolian sand. The soils across much of the study area are classified as Pinjarra Landscape Zone, comprising seasonally waterlogged flats (palusplains). The Pinjarra Landscape Zone features numerous ephemeral waterways, natural or constructed, which intersect the palusplain. The Pinjarra Landscape Zone coincides with and is predominantly underlain by the fluvial deposits of the Guildford Formation (Low 1971).

The Bassendean Dune System occurs along the western boundary of the Strategy area. Along the eastern margin of the Bassendean Dunes relatively thin layers of sand are interspersed with silts and clays of riverine origin. A small portion in the southwest corner of the Strategy area and at the end of Strachan Road is Bassendean sands, non-calcerous sands and podsolised soils with low-lying wet areas. A section at the eastern end of Rutland Road is part of the Dandaragan Plateau soils, gently undulating plateau with areas of sandplain and laterite on cretaceous sediments (refer Figure 18).

The flat profile of the land together with soil profile results in poor drainage capacity. Detailed site-specific geotechnical investigations will be required to support future local structure plans and associated Local Water Management Strategy (LWMS). Some geotechnical investigation may be required to support a District Water Management Strategy to inform modelling. This should be confirmed with the Department of Water and Environmental Regulation (DWER) at that stage.

4.3.3 Acid sulfate soils

The majority of the Strategy area contains soils with a 'Moderate to low risk of Acid Sulfate Soils (ASS) occurring within 3m of natural soil surface but high to moderate risk of ASS beyond 3m of natural soil surface'. There are also small portions to the south-west identified as having 'High to moderate risk of ASS occurring within 3m of natural soil surface'(refer Figure 19).

Acid sulphate soils are naturally occurring and generally pose no risk to surrounding areas when they are submerged under the water table. However, should this substance become dry, there is a risk that it will react with the air, producing airborne sulphuric acid.

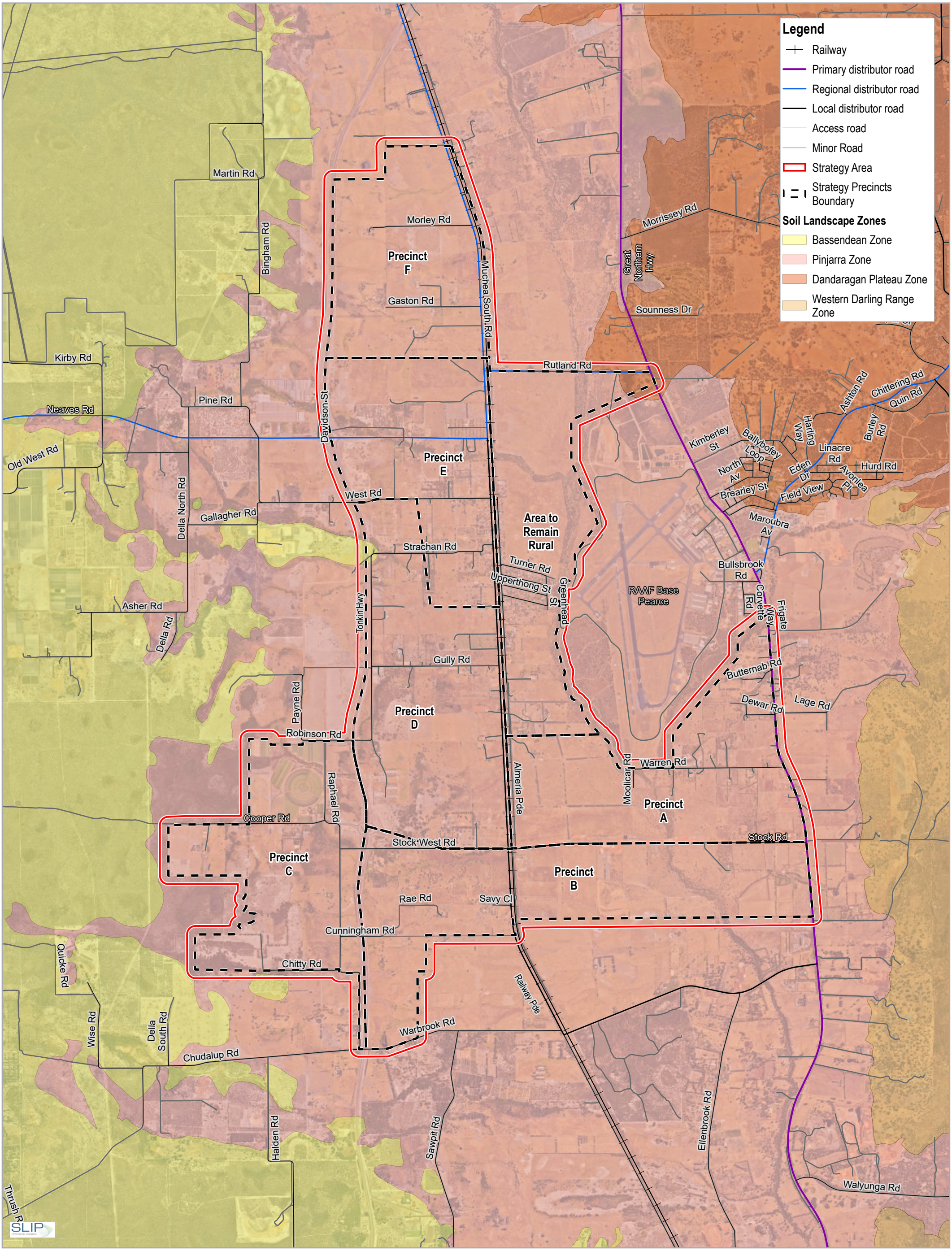
It is recommended that further detailed investigation be carried out prior to development to assess the location, extent, and severity of potential acid sulfate soils. Where the site is found to contain Acid Sulfate Soils, this may require an Acid Sulfate Soils and Dewatering Management Plan.

4.3.4 Contaminated sites

There are no contaminated sites listed on the DWER Contaminated Sites Database within the Strategy area. In this regard, previous studies have however indicated that existing and previous land uses in the area have the potential to contaminate soils. This includes activities such as poultry farms and deep soil irrigation farms. It is recommended that further investigations be undertaken at the time when a development application is being prepared on a lot that previously contained these sorts of uses to confirm whether remediation works are required.

Where a parcel of land has historically been used for intensive agricultural activities, it is recommended that these sites be investigated further to assess if there is any evidence of potentially contaminating activities.

Per- and poly-fluoroalkyl substances (PFAS) contamination has been identified within the soil and water around RAAF Base Pearce, with contamination reported to have spread to groundwater within West Bullsbrook due to surface water overflow from the Ellen Brook to land, and interaction between the Ellen Brook and superficial groundwater (GHD 2018). Appropriate use of groundwater within the contaminated areas should be considered in consultation with the Department of Health primarily, and the DWER.



Paper Size ISO A3

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Kilometres

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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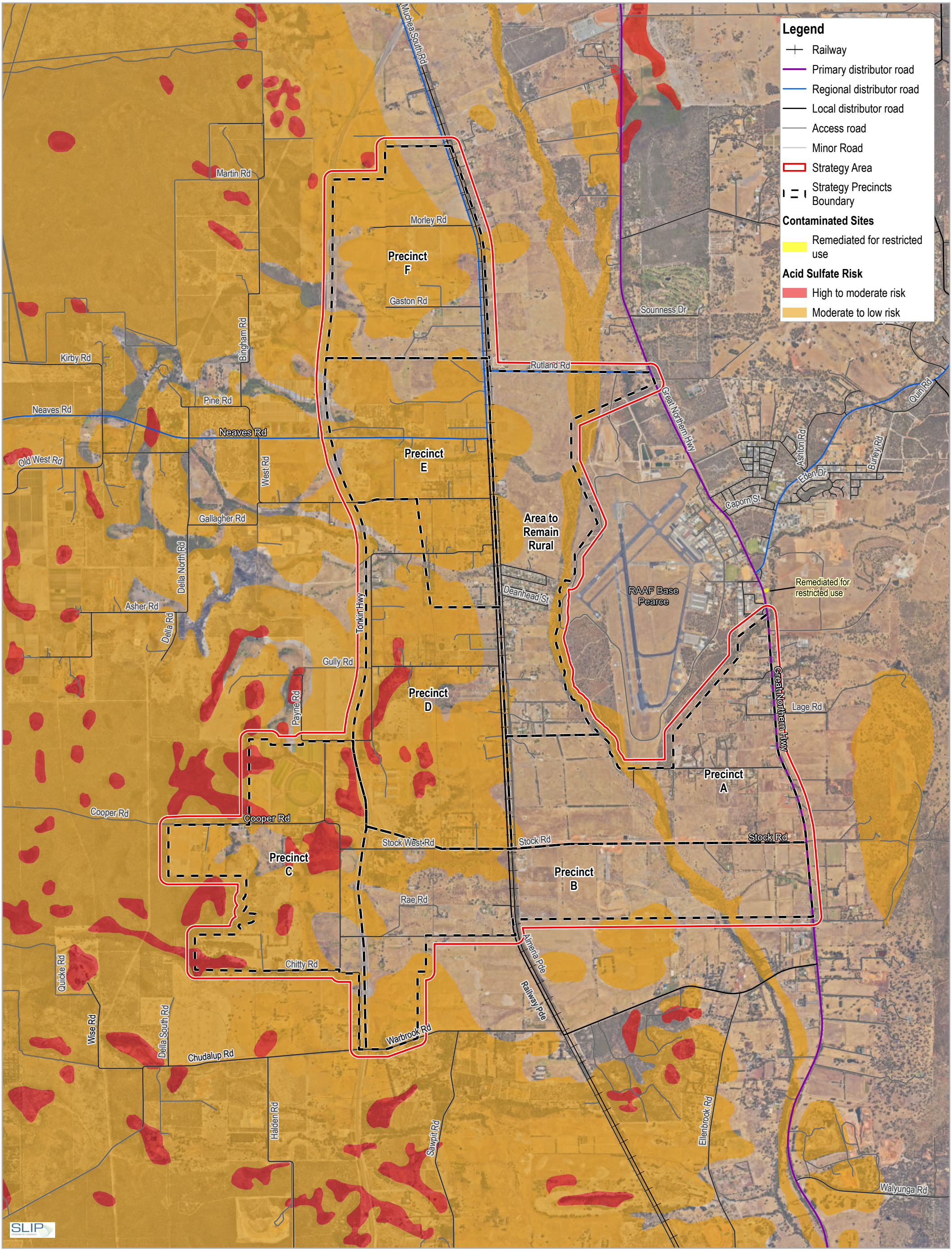
Soil Landscape Zones

Project No. **61-37134**
Revision No. **G**
Date **3/10/2022**

FIGURE 18

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Data source: GHD: Masterplan Boundary, Transport Network - 20180702, Concept Plan - 20181102; Landgate: Roads, Railway - 20180820, Imagery - accessed 20200424. Created by: wwang3



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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

GHD

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Acid Sulfate Soil and Contaminated Land

Project No.	**61-37134**
Revision No.	**G**
Date	**3/10/2022**

FIGURE 19

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Print date: 03 Oct 2022 - 15:01

Data source: GHD: Masterplan Boundary, Transport Network - 20180702, Concept Plan - 20181102; DWER: Acid Sulphate Risk - 20171219; Landgate: Roads, Railway - 20180820, Imagery - accessed 20200424. Created by: wwang3

4.4 Groundwater and surface water

A Regional Water Management Strategy has been prepared to support this Strategy and is included in Appendix C. The outcomes of the pre-development assessment are summarised below.

4.4.1 Surface water

The Ellen Brook, located along the eastern boundary of the Strategy area, is the major water body and runs for a length of approximately 65km from north to south discharging into the upper Swan River and is part of the Swan River Surface Water Area. Several ephemeral unnamed tributaries, as well as the Ki-It Monger Brook and Nambab Brook join the Ellen Brook. Ki-It Monger Brook and Nambab Brook both flow from east to west crossing GNH, meeting the Ellen Brook just south of Warren Road. Sawpit Gully is just outside the Strategy area, to the south of Warbrook Road.

Due to being relatively flat and on the western side of the Darling Escarpment, several drainage lines occur within the Strategy area. There are 63 Geomorphic Wetlands that intersect the Strategy area (Figure 20). Due to the regional topography and geology found within the Swan Coastal Plain, the wetland networks typically operate as 'through flow' lakes. Under these operating conditions wetlands are hydraulically connected to the local groundwater system, being both an expression of the superficial aquifer and an opportunity for surface water recharge to groundwater based on the season. Due to the extensive interconnection between surface water and groundwater systems, any development within the Strategy area will be required to maintain both surface and groundwater flows as well as water quality, to protect these ecosystems.

Wetland buffers are recommended to protect conservation category wetlands from potential adverse impacts resulting from human activities, this can be appropriately managed through the appropriate reservation and/or zoning of conservation category wetlands (and their buffers) in local scheme reserves.

4.4.2 Groundwater

The Strategy area is located within the Swan Groundwater Area and approximately 200 metres east of the Gnangara Underground Water Pollution Control Area (Priority 1). Large portions of the Strategy area are subject to a moderate to high risk of seasonal inundation or waterlogging (Figure 21). Some decline in groundwater levels has occurred due to abstraction for agricultural purposes.

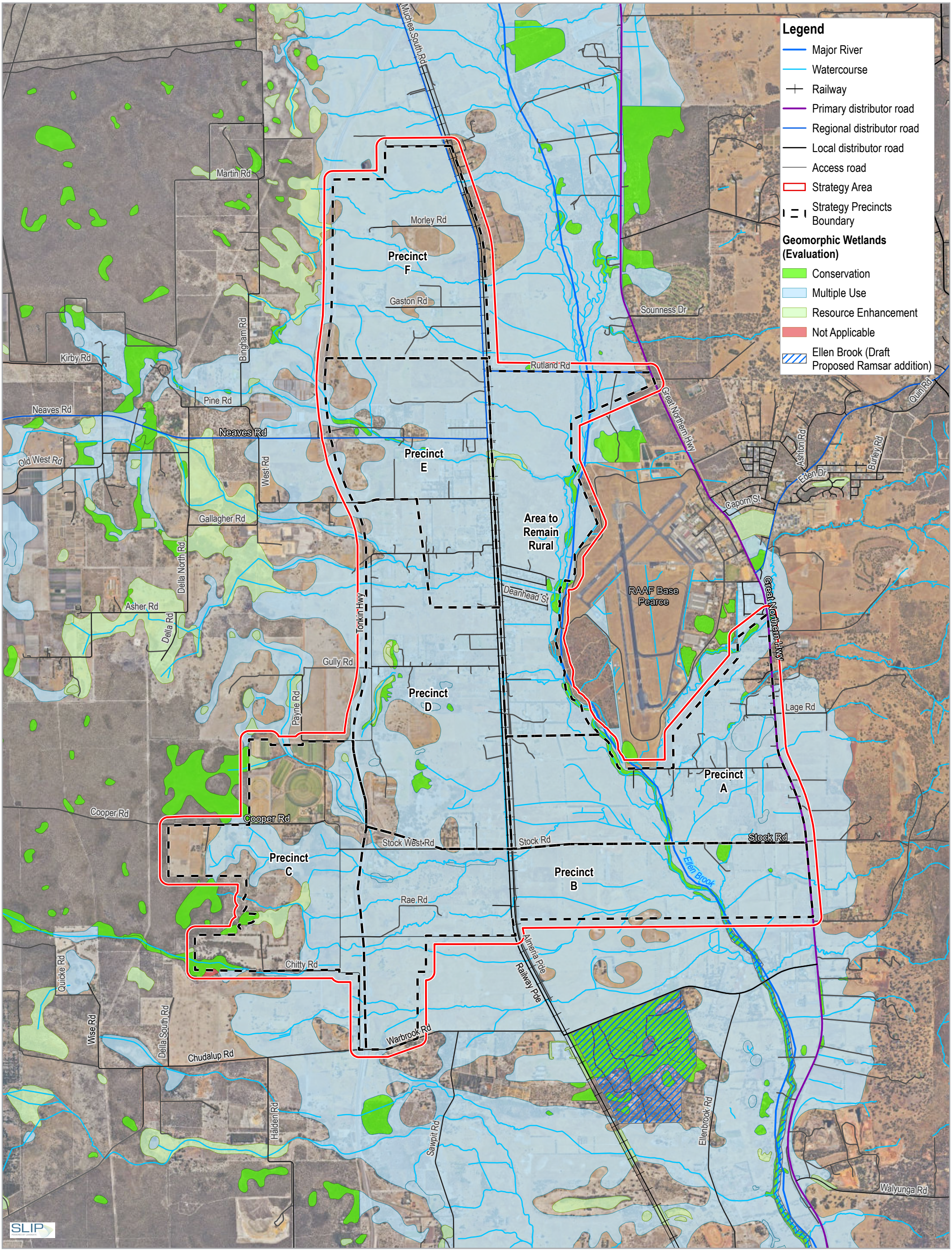
For allocation purposes, aquifers are divided into specific groundwater areas and subareas. The Strategy area is predominately located within the Radar groundwater subarea. A small region of the southwest of the Strategy area lies within the Neaves groundwater subarea, and small area of the southeast of the Strategy area lies within the Bandy Springs groundwater subarea. Advice from the DWER indicates that all aquifers are over allocated within the region and water demand requirements for any further development will need to be met through investigation of existing groundwater allocation and alternative water sources in the short-term.

Groundwater will significantly contribute to the transport of nutrients to Ellen Brook and the Swan-Canning estuary, largely due to the proximity to the natural ground surface during periods of inundation, causing mobilisation of nutrients. Within the Strategy area the superficial aquifer has been drained to reduce seasonal inundation and enable agricultural and other land use. The superficial aquifer also supports a mix of remnant ephemeral, seasonal and permanent wetlands. Several geomorphic wetlands and drainage systems within the area are recognised as Type 2 and

Type 3 Groundwater Dependent Ecosystems, requiring certain elements of the quantity and quality of groundwater to remain consistent in order to persist.

Groundwater abstraction is one of the easiest and most cost-effective alternatives to scheme water for industry feedwater and irrigation purposes. Due to the long-term nature of the proposed development of the Strategy area, the status of the groundwater allocations may change as land use changes. As development progresses the current availability of groundwater for open space irrigation and industry specific use should be reassessed.

The quality of the groundwater (salinity, alkalinity, heavy metal concentrations etc.) could affect industrial processes, therefore filtration or treatment of the groundwater may be required depending on the desired end use. Given the emerging risk of PFAS contamination within the Bullsbrook area, groundwater quality testing should be considered prior to consideration of superficial groundwater within potentially affected areas.



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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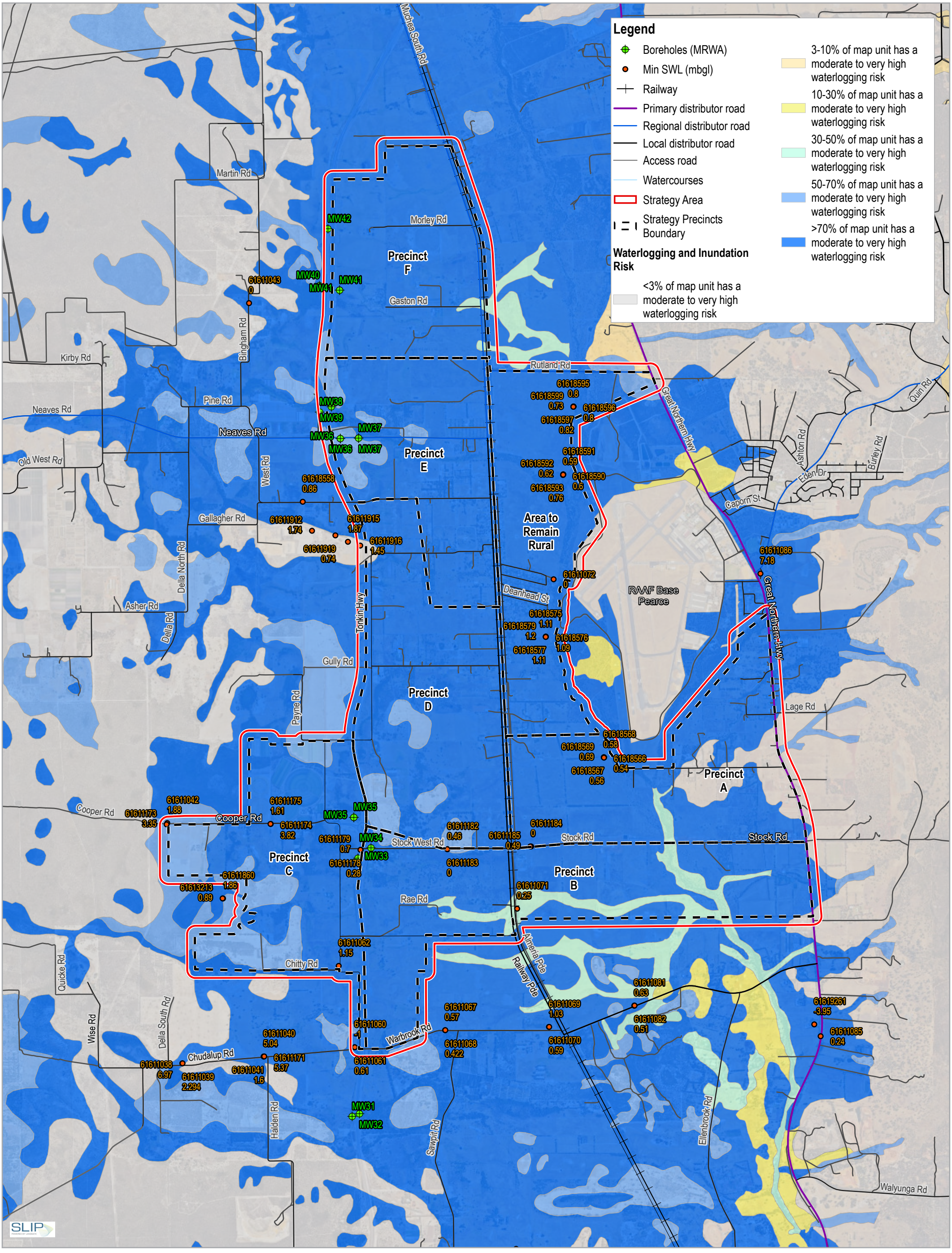
Geomorphic Wetlands and Draft Proposed RAMSR Additions

Project No.	**61-37134**
Revision No.	**G**
Date	**3/10/2022**

FIGURE 20

G:\61\37134\GIS\Maps\Working\6137134\6137134.aprx
Print date: 03 Oct 2022 - 15:05

Data source: GHD: Masterplan Boundary, Transport Network - 20180702, Concept Plan - 20181102; Landgate: Roads, Railway - 20180820, Imagery accessed 20200424. Created by: wwang3



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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Department of Planning, Lands & Heritage
Bullsbrook Freight and Industrial Regional Water Management Strategy

Waterlogging Risk and Groundwater Wells

Project No. **61-37134**
Revision No. **G**
Date **3/10/2022**

FIGURE 21

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Print date: 03 Oct 2022 - 15:07

Data source: GHD: Masterplan Boundary, Transport Network - 20180702, Concept Plan, Waterlogging and Inundation Risk - 20181102; DPIRD: Waterlogging and Inundation Risk - 20200212; Landgate: Roads, Railway - 20180820, Imagery accessed 20200424. Created by: wwang3

4.4.3 Wetlands

There are no wetlands listed under *Ramsar Convention on Wetlands of International Importance 1971* (RAMSAR) within the Strategy area. However, the *Ellen Brook Draft Proposed RAMSAR Addition* is located on the southern boundary of the Strategy area, immediately to the south of Warbrook Road (refer Figure 20). There are numerous wetlands of conservation significance within the Strategy area of which 37 are classified as Conservation Category Wetlands (CCW) and a further 12 are classified as Resource Enhancement Wetlands (REW). The majority of the Strategy area is designated as Multiple Use Wetland (MUW)

The Ellenbrook, its banks and foreshore are identified as a CCW with several other CCWs and REWs occurring along or in proximity to the Ellen Brook and its minor tributaries.

4.4.4 Water management and development

The Strategy area comprises a series of water dependent ecosystems, environmentally sensitive areas and land which is seasonally inundated. This presents complex challenges for the integrated management of surface and groundwater to maintain water quality and ecological functions as well as protect development from risk of flood and inundation. This is further compounded by the lack of planned water and wastewater servicing for the area.

Traditional development across the Swan Coastal Plain has typically relied on a combination of between 1.0 to 2.0 metres of imported sand fill and subsoil drainage where groundwater is within 1.5 metres of the finished surface level. The availability and cost of fill could present a significant cost constraint to traditional development approaches across the Strategy area, which experiences shallow groundwater conditions and seasonal inundation. The required level of fill will be determined by several factors including ecological water requirements for water dependent ecosystems, building and infrastructure design, and subsoil drain spacing.

Key considerations and water management issues to be addressed within the Strategy area at the next stage of planning include:

- the area is dominated by broad low-lying floodplains, intersected by a network of minor and major surface drainage channels with high connection to the superficial aquifer. Conditions are variable across the Strategy area including near surface groundwater, seasonally perched groundwater, and slightly confined groundwater with upward vertical gradients.
- due to the shallow nature of groundwater across the Strategy area, and the high connectivity between surface and groundwater systems, the water resources and water dependent ecosystems are vulnerable to impacts from changes in water quantity and water quality.
- the Strategy area is large and remote from established and serviced urban fronts. The Water Corporation has indicated there is limited capacity to provide scheme water servicing to parts of the Strategy area, however wastewater servicing is limited to urban development. The Government Sewage Policy requires provision of wastewater reticulation to all new industrial development and specifies minimum lot sizes for on-site disposal. Extensive parts of the Strategy area are constrained by sewage sensitive areas.
- due to significant water resource, water supply and environmental constraints, any proposed change in land use to accommodate industrial activities will likely require a site-

specific investigation to determine the feasibility and practicalities of on-site versus reticulated sewer and water supply.

4.5 Bushfire hazard

The Department of Fire and Emergency Services (DFES) Map of Bushfire Prone Areas (DFES 2018) identifies several sites within the Strategy area as bushfire prone (Figure 22). The majority of these sites are located around remnant vegetation and existing natural assets. A pre-development bushfire hazard level assessment has been prepared to support the Strategy (Appendix D).

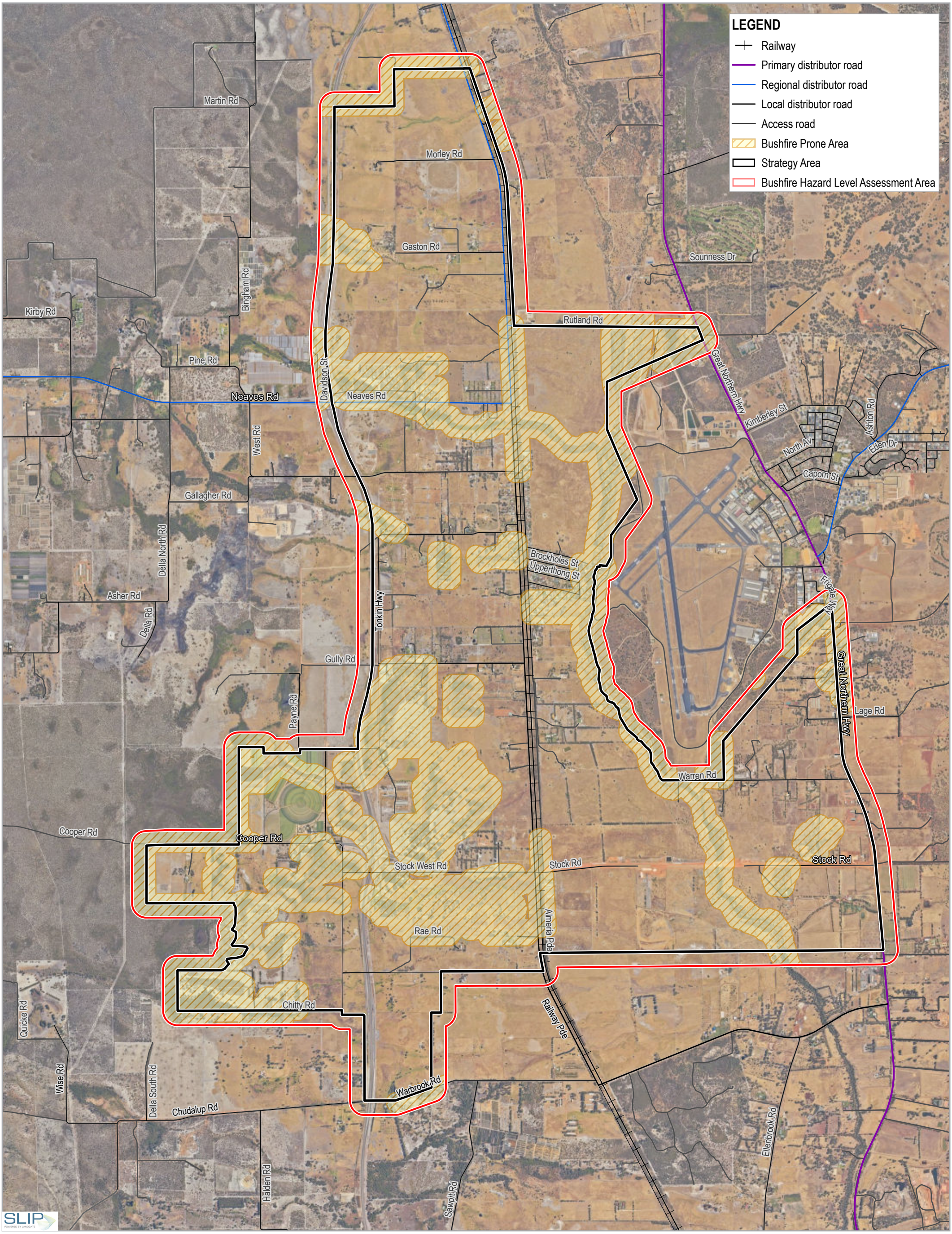
Vegetation within the bushfire hazard level assessment area reflects Class B Woodland (at varied heights and density based on level of disturbance resulting in the three subclasses of Low Woodland (07), Open Woodland (06) and Woodland (05)), Class G Grassland, Class C Shrubland and Class D Scrub. These relate to the original vegetation types across the overall strategy area at varying levels of clearing and degradation from the agricultural use of the locality.

This assessment indicates that the area is largely located within a 'Moderate' bushfire hazard area with some small areas of 'Extreme' hazard. The assessment demonstrates that future development will largely occur within areas of low to moderate bushfire hazards. Any development within patches of extreme hazard will result in the removal of that vegetation, and therefore the removal of that hazard.

Those areas of extreme bushfire hazard with environmental values that require protection (for example Bush Forever) should be reserved and protected from development. Other areas of hazard can be cleared to enable industrial development, dependent on existing groundwater levels. Where vegetation is to be retained, further structure plans will be required to demonstrate how the bushfire risk can achieve a low to moderate bushfire hazard.

The assessment demonstrates that bushfire hazards can be managed subject to implementation of appropriate bushfire protection criteria at future planning stages. Spatial demonstration of bushfire protection criteria and strategies for compliance should be assessed at the local structure planning stage through the preparation of a bushfire management plan. The bushfire management plan should accompany a local structure plan and provide recommendations and strategies to ensure all development will be limited to areas of low to moderate bushfire hazard.

Bushfire Attack Level (BAL) assessments and contour mapping that implement local structure plan recommendations and strategies to comply with bushfire protection criteria must accompany subdivision applications.



Paper Size ISO A3

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Kilometres

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

GHD

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Bullsbrook Freight and Industrial Landuse Planning Strategy

Bushfire Prone Areas

Project No. **61-37134**
Revision No. **0**
Date **13/09/2022**

FIGURE 22

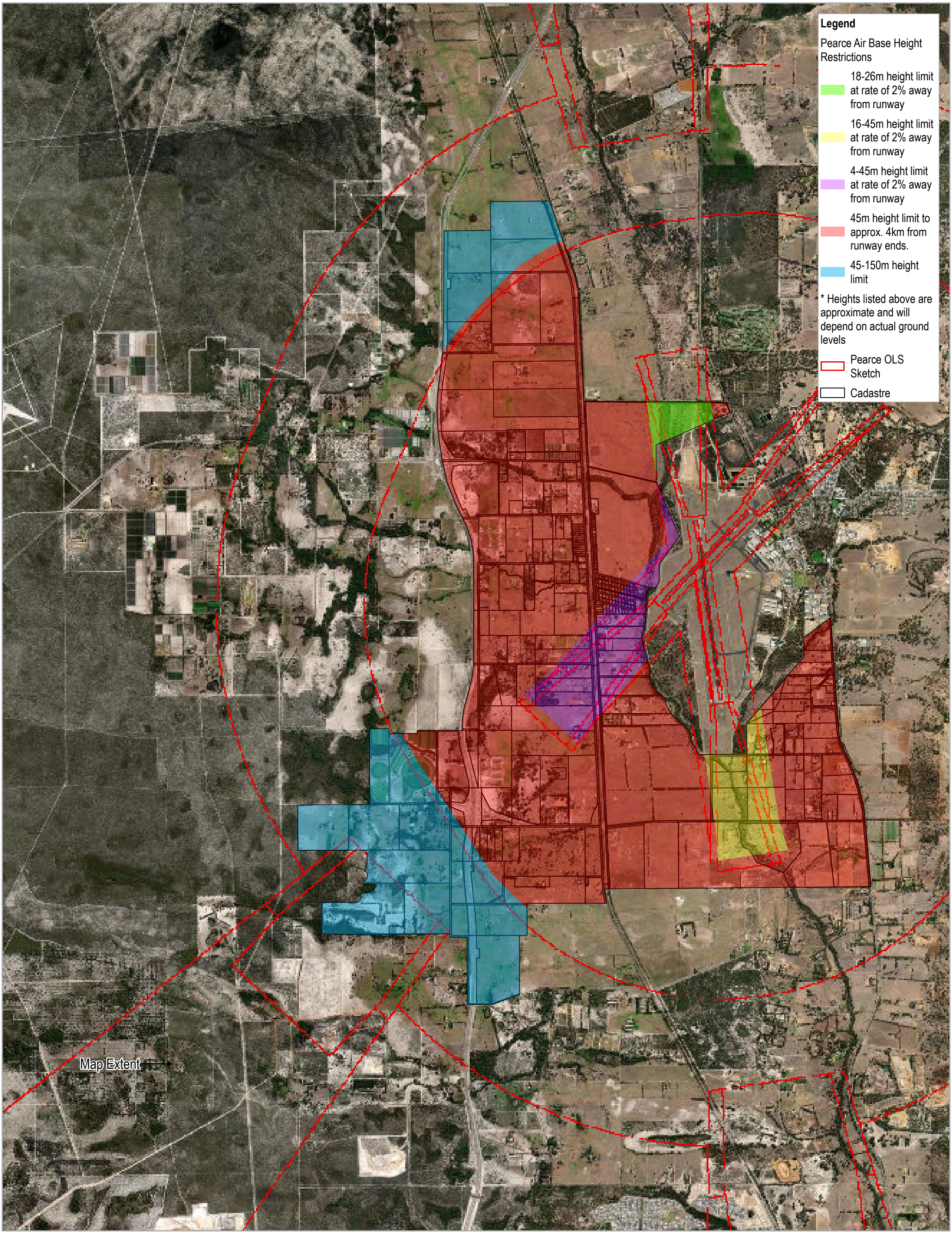
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Data source: Landgate: Imagery (August 2018); OBRM: Bushfire Prone Areas - 20180603; GHD: Study Area - 20180702. Created by: wwang3

4.6 Royal Australian Air Force – Base Pearce

The RAAF Base Pearce adjoins the eastern and northern boundaries of the Strategy area and introduces several matters which should be considered when developing the land including:

- notifications on the Certificates of Title acknowledging that the RAAF Base Pearce operates 24/7 and aircraft noise is inevitable.
- outdoor lighting within six kilometres of the RAAF Base Pearce must comply with Department of Defence (DoD) guidelines to avoid glare from reflective surfaces for pilots. This may pose some design challenges for some industrial operators including the IMT and for hardstand yard lighting.
- activities leading to an increased likelihood of bird strike by aircraft should be avoided.
- in accordance with the Part 11A Defence Regulation 2016 development should not prejudice existing utility services for RAAF Base Pearce.
- as per the Part 11A Defence Regulation 2016 height restrictions apply to development within proximity to RAAF Base Pearce indicated on Figure 23.
- Any development within a kilometre radius of RAAF Base Pearce will require DoD approval for any structures that may pose a hazard to aircraft, and this will need to be addressed as part of the development application process.
- the DoD has plans to extend the runways at RAAF Base Pearce (the timing has not yet been determined as at the date of this Strategy). Accordingly, clearance/ height requirements should be re-checked at subsequent stages of the planning process.
- RAAF Base Pearce is likely to attract very specific and potentially atypical traffic patterns particularly if it is used for civil aviation, or increased defence aerospace industry.



Paper Size ISO A3

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Kilometers

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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Department of Planning, Lands & Heritage
Bullsbrook Freight and Industrial Regional Water Management Strategy

Project No. **61-37134**
Revision No. **A**
Date **5/10/2022**

Pearce Air Base Height Restrictions

FIGURE 23

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Print date: 05 Oct 2022 - 10:08

Data source:GHD: Site Boundary - 20180629; MRWA: Road centrelines - 20171211, Railways - 20150603; Imagery - accessed 20200424, Imagery accessed 20200424.World Imagery: Maxar. Created by: wwang3

5. Movement networks

The development of the Bullsbrook freight and industrial area will require the provision of transport linkages, both internally and externally. Of particular importance will be the provision of safe and efficient transport links between the IMT and other parts of the Strategy area. Furthermore, as a potential major employment node, the provision of passenger and active transport to the precinct should be a major consideration to enable safe and appropriate access for all users.

The relationship between the Bullsbrook freight and industrial area, the IMT and the other proposed industrial/employment nodes (at Muchea, North Ellenbrook, Wangara and Neerabup) must be considered, as does the potential distribution of employment and customer travel to and from the broader Bullsbrook industrial precinct.

Current planning for the IMT site seeks to facilitate a development that will ultimately cater for throughput of 250,000 TEU[1]/annum. Initial terminal capacity has been estimated as 150,000 TEU/annum. In addition to containerised cargo, it is expected that large volumes of light commercial vehicles and passenger cars (primarily used for commercial purposes) will access the IMT and the wider Bullsbrook freight and industrial area on a daily basis.

As a potential major employment centre, the provision of passenger transport to the precinct is a major consideration in the structure planning process. The significant distance between existing surrounding residential areas and the industrial precinct will be a major factor that is likely to make access by active and public transport challenging and will require careful planning of direct road connections to/from the precinct, particularly across significant barriers such as Tonkin Highway and the freight rail line. However, this distance will be lessened with the development of the Ellenbrook North (west and east) District Structure Plan areas to the south of Warbrook Road (west and east of Tonkin Highway). Development of these areas will bring a significant residential population base (and potential workforce) in proximity to the Bullsbrook freight and industrial area which will improve the viability of public transport services.

The Strategic Transport Strategy (Appendix E) provides several key recommendations to enable the road network to meet the requirements of the Bullsbrook freight and industrial area during development and at full build-out. The purpose of the recommendations is to:

- enable appropriate access to the industrial area to facilitate strategic industrial activity that fully utilises and integrates with the IMT.
- provide increased connectivity between the northern sub-regions to support greater employment self-sufficiency and access between urban areas and the Bullsbrook industrial employment node.
- provide safe and efficient access for the road freight network.
- safeguard accessibility of existing residents within the West Bullsbrook townsite to / from the 'Rural' area.

[1] A TEU (Twenty-foot Equivalent Unit) is a measure of containerised cargo mass based upon a standard 20-foot international shipping container. Double length (40 foot) containers are also commonly used to ship freight, which equates to two TEUs each.

- allow for integration with the broader road network and strategic movement corridors to facilitate freight and commuter access.

5.1 Roads

Given the predominantly rural nature of existing land uses within the Strategy area, the road network is sparse. The PDNH and GNH are the primary north-south roads within proximity of the Strategy area. Railway Parade, transecting the Strategy area, is a secondary north-south road. There are currently no east-west primary routes through the Strategy area. Secondary east-west routes include Warbrook Road in the south and Neaves and Rutland Roads in the north, however none of the connections provide direct access across the railway.

5.1.1 Perth – Darwin National Highway

The Perth Darwin National Highway, between Reid Highway and Muchea, is being delivered as part of the NorthLink project, which includes:

- The upgrade of Tonkin Highway between Guildford Road and Reid Highway; and
- The extension of Tonkin Highway from Reid Highway north to Muchea

The southern section from Guildford Road to The Promenade in Ellenbrook was completed in 2019, with the northern section to Muchea completed in late April 2020.

Interchanges within the Strategy area include those at Stock/Cooper Roads and Neaves/Rutland Roads. As part of the 2022-23 State Budget, the Minister for Transport has funded a new interchange on the Tonkin Highway, between Warbrook and Maralla roads, north of Ellenbrook. The new interchange aims to provide access for residential development proposed by the new North Ellenbrook District Structure Plans (East and West). No further interchanges are planned by Main Roads WA within and surrounding the Strategy area.

Main Roads WA is planning a road train assembly area at Muchea, with the intention that triple road trains (53.5 metres) will not proceed south of that point. To best integrate road and rail transport with the industrial land use at Bullsbrook (specifically including the IMT), and ensure maximum efficiency, it would be preferable that triple road trains be permitted along the PDNH to Stock Road and into the Bullsbrook freight and industrial area and IMT. However, the design of PDNH south of the Brand Highway interchange only accommodates 36.5 metre vehicles, thereby precluding this option.

5.1.2 Great Northern Highway

With the completion of PDNH, it is predicted that 2031 traffic volumes on GNH will be similar to present volumes, with a much lower proportion of heavy vehicle traffic due to much of it being diverted to PDNH (Urbsol, 2013).

GNH forms part of the OSOM road network. Main Roads does not propose to change the OSOM route along GNH following completion of the PDNH.

Upgrades will be required at existing and/or new intersections created by the development of the industrial land on the western side of GNH between Warbrook Road and Brig Way. GNH is expected to be duplicated at some point in the future, south of the Bullsbrook townsite, which will replace the

intermittent overtaking provisions in this location. In addition, changes to the intersection with Stock Road will be required to support increased traffic volumes at this location as well as its inclusion in the RAV network.

5.1.3 Stock Road

Construction of Stock Road as a two-lane single carriageway is being undertaken by the City of Swan, with completion expected within the 2022/23 financial year. Stock Road should be upgraded to provide a four-lane dual carriageway between the PDNH and GNH and to provide a grade separation over the railway. As part of this upgrading, the current stagger between Stock Road East and Stock Road West, should be remedied.

The upgrading of Stock Road provides an opportunity to alter the RAV network, to include Stock Road and the PDNH (north of Stock Road). Main Roads WA has advised that GNH would need to remain as an OSOM route as the Stock Road interchange with PDNH will not cater for the largest OSOM loads. Whilst the section of Stock Road west of the proposed IMT site will not provide a 10 m x 10 m clearance, there is potential to design and construct the section of Stock Road between the IMT and GNH to provide such clearance.

5.1.4 Neaves Road

Neaves Road provides a major east-west route linking Perth's northeast and northwest corridors and is forecast to carry approximately 9,000 vehicles per day by 2031 (Worley Parsons, 2013). In the *Transport @ 3.5 Million Plan*, Neaves Road (west of the PDNH) is identified as a Secondary Freight Route. It is proposed to be connected with Rutland Road and thereby to GNH, including an overpass of the freight rail line and a connection to Railway Parade. This will provide a connection between Mitchell Freeway in the west to the PDNH and GNH in the east.

5.1.5 Railway Parade/spine road

The Bullsbrook IMT Planning Study (GHD, 2016) considered options for the treatment of Railway Parade and recommended that it be realigned west of the proposed IMT, with a four-way intersection with Stock Road about mid-way between the railway and the PDNH. This recommendation is supported as it would provide substantial benefits, including:

- elimination of the need for a level crossing where trains enter and exit the IMT.
- retention of north-south connectivity, together with a convenient connection between Stock Road and Railway Parade.
- provision of a frontage road along the west side of the IMT to create a safe and efficient entry and exit for trucks servicing the IMT.

A need has been identified for a new north-south road mid-way between the PDNH and the existing Railway Parade. The spine road is recommended to continue south of Stock Road to connect to the existing Sawpit Road, terminating at Maralla Road.

5.1.6 Restricted access vehicle network

The restricted access vehicle (RAV) network includes routes that accommodate B-Doubles and above as outlined below.

- GNH (with conditions), Rutland Road, Warren Road, Neaves Road – 27.5 metre routes
- Stock Road, Tonkin Highway – 36.5 metre truck routes

5.2 Rail

The existing narrow-gauge Millendon–Narngulu freight railway, which runs north-south through the middle of the study area, will remain the sole external rail link and will have a spur to connect to the IMT. The IMT site has been sized to accommodate 650-metre trains, with provision for extension to 900-metre trains in future, if necessary[2]. The spacing of internal sidings and turnouts has been designed to allow upgrade to dual gauge if warranted in future. The approach siding will extend from just north of Warbrook Road to Stock Road, which is sufficient to accommodate an 1800-metre interstate train, which would then be broken into 900-metre rakes for shunting into the IMT. The siding will be located within the existing railway reserve and positioned to allow future duplication of the main line, should this ever prove necessary.

Trains to/from the north would initially use the southern approach siding by way of a crossover. If demand grows in the future, the IMT layout must be flexible enough to allow for a direct approach from the north.

Provision has been made in the planning of the IMT to accommodate 1800-metre standard gauge trains in future, however it is expected that the existing narrow-gauge line will be the only rail freight service in the short to medium term. For interstate trains to access the IMT, considerable infrastructure upgrades would be required, including reconstruction of the existing line from Millendon to Bullsbrook as dual gauge, with consequent upgrades to bridges, culverts, and signals. Conversion of the Millendon Junction to a triangle arrangement would allow direct access to the upgraded line but is likely to be strongly resisted on social impact grounds.

Operational changes would also be necessary for interstate trains to access the IMT. This might include provision of a siding south of Millendon, where trains could be reversed. Alternatively, trains could be sent to Forrestfield/Kewdale, however this is less efficient.

The construction of a standard gauge link to give rail access to the eastern states is complex and will require additional studies beyond the scope of this Strategy.

5.2.1 Level crossings

There are several at grade railway crossings throughout the Strategy area. The existing at-grade railway crossings at Stock and Rutland Roads will be grade separated under current proposals to upgrade these links. However, grade separation of Stock Road is a future proposal and does not form part of current upgrade works. The design is expected to accommodate double stacked railway

[2] The IMT masterplan study (GHD 2016) noted that the primary market for the Bullsbrook IMT would be container (and some break-bulk) commodities coming over the wharves at Fremantle and Kwinana, for distribution to Perth's north-west and north-east corridors, and areas north of Perth. For this purpose, the 650-metre port shuttle was adopted as the design train.

vehicles (height of 7.2 metres). The span of the bridge crossing at Stock Road must be sized to incorporate sidings along the west side of the main railway line.

"Formal" sealed level crossings currently exist near West Road and Strachan Road, providing connectivity to the residential area on the east side of the railway line along Almeria Parade. These are likely to remain in the near term, with the potential to upgrade the level of control to improve safety (i.e., install boom gates). However, in the longer term, these will require assessment and it is anticipated that they may be removed in line with State Government policy. Should this occur, alternative connections should be provided, prior to removal of the crossings.

Several unsealed railway crossings also exist, the status of these as formal or informal crossings is not known. In the near term, it is recommended that these be closed or upgraded to a controlled crossing, where feasible, to improve safety.

5.3 Freight network

The NESRPF forecasts the volume of freight movement on the regional road and rail networks to increase substantially by 2050. This increase will be centred on interstate road and rail routes, particularly those servicing port facilities and connecting with intermodal terminals located at Kewdale, Hope Valley/Wattleup (Latitude 32), Bullsbrook and Mundijong.

The PDNH is identified as the primary freight route north-east of Perth, with GNH becoming a secondary route. Stock Road is required to connect the two with Neaves Road providing the connector to other routes to the west.

The proposed Bullsbrook IMT will have an important role in the freight network having rail connections to Fremantle Port and the proposed Kwinana Outer Harbour, as well as to regions north of Perth. Rail and road access to the potential IMT requires detailed planning and protection from encroachment by incompatible development. Similarly, the design, construction, upgrade, and operation of the infrastructure within these corridors should seek to minimise impacts on surrounding land uses.

5.4 Public transport

The Strategy area is served by one Transperth bus service (Route 311), which operates between Bullsbrook and Midland Station, with three services between 7.00 am and 8.00 am on weekdays. The return journey in the PM peak from Midland Station to Bullsbrook has three services (which departs Midland Station at 3:08 pm, 3:48 pm and 5.49 pm). These bus services are not directly connected to other major activity centres.

Transperth has advised that no additional public transport routes are planned for the area in the short-term. In the longer term, the extensive residential developments east of GNH and north of Ellenbrook together with the delivery of new jobs within the Bullsbrook freight and industrial area will likely drive demand for increased bus services.

Typically, Transperth would undertake bus network planning once an area is substantially developed. As development levels permit, peak period bus routes should be considered to service the area along the major north-south spines of GNH and Railway Parade and across to the Bullsbrook town site east of the RAAF Base Pearce.

There is no existing train station in the immediate vicinity of the Strategy area, although through the METRONET project, the Ellenbrook station will soon be developed. This station will be in the Ellenbrook town centre, approximately 10.8 kms from the Strategy area. While it is not confirmed whether bus services will operate out of the Ellenbrook station, the provision of such a service would greatly increase the viability of public transport usage in the region, including the Strategy area.

5.5 Pedestrian and cycling

The primary road routes within the Strategy area do not contain any adjacent walking or cycling paths, however the road reserve widths allow for their accommodation. Almost all roads in the area are sealed two-lane carriageways with marginal or no sealed shoulders. The only existing active transport infrastructure within the Strategy area is limited to a small section of footpath on Almeria Parade adjacent the residential area east of the railway.

The provision of Principal Shared Paths (PSP) along the primary routes of the PDNH, GNH, Maralla Road, Stock/Cooper Road, Neaves/Rutland Road, and Railway Parade to cater for walking and cycling are recommended.

5.6 Future network requirements

The future primary road network within the Strategy area is shown in Figure 24. It includes four north-south links (the new PDNH, a new central spine road, a realigned Railway Parade and a duplicated GNH along the eastern boundary) and two east-west links (Stock/Cooper Roads and Rutland/Neaves Roads).

Over the longer term, an additional east-west road connection between the north-west sub-region (the future Whiteman – Yanchep Highway) and the Bullsbrook freight and industrial area may be required. Several roads have been considered for this connection, including Cooper Road, Warbrook Road and Maralla Road.

The westward extension of Cooper Road is problematic due to significant environmental constraints, primarily that it passes through an extensive area of native vegetation and much of the length is in the Priority 1 water catchment area.

Warbrook Road was considered however, Main Roads WA has advised that an interchange at this location is too close to Stock Road (2.35 km). Maralla Road was also considered as a potential alignment but was found unsuitable due to environmental constraints.

Accordingly, it is recommended that an interchange be built at the PDNH, approximately mid-block between Warbrook and Maralla Roads. It is unlikely however that this alignment would connect to GNH or to the future Whiteman-Yanchep Highway due to the proposed residential developments on either side of PDNH and the desire to prevent the dissection of these estates with a major cross-regional road.

Should this situation arise, Gnangara and Neaves Roads would take on greater importance as east-west connections with the Strategy area. Connectivity to/from the west may then become an issue. This lack of direct connectivity to/from the west may reduce the efficiency of transport operations in the precinct and impede access by future workforce.

Proposed road reservation widths for each of the primary roads within the Strategy area are shown in Table 5.

In addition, vehicle access to the residential enclave will require special consideration with future incremental development of adjoining Precincts, to ensure residential vehicle access can be maintained, and where possible improved (i.e., removal of level crossings) and local residential traffic is compatible with future industrial traffic.

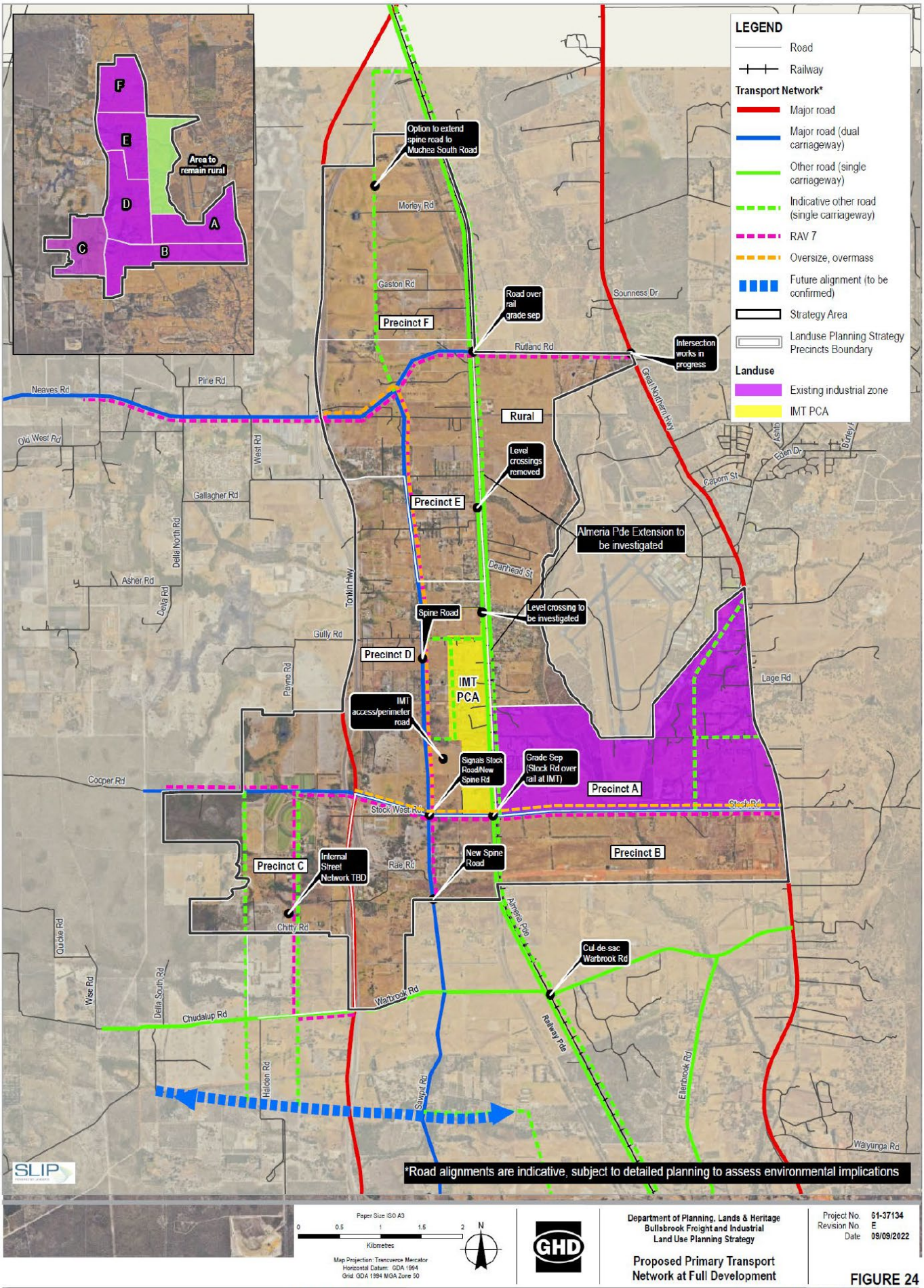

LEGEND
Road
Railway
Transport Network*
Major road
Major road (dual carriageway)
Other road (single carriageway)
Indicative other road (single carriageway)
RAV 7
Oversize, overmass
Future alignment (to be confirmed)
Strategy Area
Landuse Planning Strategy Precincts Boundary
Landuse
Existing industrial zone
IMT PCA
F
E
D
C
B
A
Area to remain rural
Option to extend spine road to Muchea South Road
Morley Rd
Gaston Rd
Road over rail grade sep
Precinct F
Rutland Rd
Sounness Dr
Intersection works in progress
Great Northern Hwy
Neaves Rd
Pirie Rd
Old West Rd
West Rd
Rural
Level crossings removed
Precinct E
Gallagher Rd
Della North Rd
Asher Rd
Della Rd
Tonkin Hwy
Almeria Pde Extension to be investigated
Dearnhead St
Spine Road
Level crossing to be investigated
Gully Rd
Precinct D
Payne Rd
IMT PCA
Lage Rd
IMT access/perimeter road
Signals Stock Road/New Spine Rd
Grade Sep (Stock Rd over rail at IMT)
Precinct A
Cooper Rd
Stock West Rd
Stock Rd
Precinct C
Internal Street Network TBD
Rae Rd
New Spine Road
Precinct B
Chitty Rd
Almeria Pde
Cul de sac Warbrook Rd
Quicke Rd
Wise Rd
Della South Rd
Warbrook Rd
Chudalup Rd
Railway Pde
Halden Rd
Sawpit Rd
Ellenbrook Rd
Wayunga Rd
*Road alignments are indicative, subject to detailed planning to assess environmental implications
SLIP
Paper Size ISO A3
0 0.5 1 1.5 2
Kilometres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50
GHD
Department of Planning, Lands & Heritage
Bullsbrook Freight and Industrial
Land Use Planning Strategy
Proposed Primary Transport Network at Full Development
Project No. 61-37134
Revision No. E
Date 09/09/2022
FIGURE 24

Table 5 - Primary road reservation widths and cross sections

Road	Section	Arterial type	RAV status	Reserve width	Cross section
Stock Road	GNH to Tonkin Highway	Primary Distributor	RAV 7 & OSOM (Spine Road to GNH)	60.0 m	Two carriageways, each with • 2 x 3.5 m traffic lanes • 3.0 m outside shoulder • 1.0 m median shoulder 6.0 m median 3.0 m off-road cycleway 10.0 m vertical clearance (GNH to Spine Road)
Cooper Road	Tonkin Highway to west of study area	Regional Distributor	RAV 7	40.0 m	Single carriageway • 2 x 3.5 m traffic lanes • 2.0 m shoulders
Neaves Road	Tonkin Highway to rail line	Primary Distributor	RAV 7, OSOM	50.0 m	Two carriageways, each with • 2 x 3.5 m traffic lanes • 3.0 m outside shoulder • 1.0 m median shoulder 6.0 m median 3.0 m off-road cycleway 10.0 m vertical clearance (GNH to Spine Road)
Rutland Road	All	Primary Distributor	RAV 7, OSOM		
GNH	Warbrook Road to Brig Way	Primary Distributor	RAV 7 Remains OSOM	Variable, mostly per existing	Variable depends on local features. Focus on intersection treatments in the short to medium term
Muchea South Road	Rutland Road to north of study area	Regional Distributor	RAV 4	40.0 m	Single carriageway • 2 x 3.5 m traffic lanes • 2.0 m shoulders

Road	Section	Arterial type	RAV status	Reserve width	Cross section
Spine Road	All	Regional Distributor	RAV 7 & OSOM	40m	Two carriageways, each with • 2 x 3.5 m traffic lanes • 2.0 m outside shoulder • 1.0 m median shoulder • 6.0 m median

Changes to the road network within the Strategy area will be driven by:

- the now completed PDNH
- traffic generated by new industries and subdivision within the Strategy area
- provision for an IMT on the west side of the railway line
- external traffic generators, such as the rapidly growing residential areas at Bullsbrook east of GNH and the future urban areas to the immediate south of the Strategy area

6. Servicing infrastructure

The Strategy area is large and remote from established and serviced urban fronts, with an extended development timeframe.

The Strategy area is not currently serviced and the Water Corporation has advised they have not undertaken any long-term planning to provide servicing of the Strategy area, except for the areas that are already zoned for industrial development immediately south of the Bullsbrook Townsite.

While the need for a review of the water and wastewater service planning for the Strategy area is identified, the ultimate solution will be dependent on a range of factors, these being:

- how much land will ultimately be set aside for Industrial use.
- timing of upgrades in the adjacent water and sewer system network.
- finalisation of transport corridors and crossings.
- uptake in industrial land.

The proposed water and sewer upgrades for the Bullsbrook Townsite are anticipated to occur in the next 15 years. As development planning progresses within the area developers should liaise with Water Corporation to assess the status of water and wastewater service provision.

6.1 Water

In order to service industrial and service/commercial land use within the Strategy area, new scheme water distribution infrastructure will need to be planned and built within and near the Strategy area.

The Water Corporation have advised that long term water infrastructure planning has not been undertaken for the Strategy area. The area adjoins two existing, planned water schemes: the Ellenbrook Gravity Supply Scheme and the Bullsbrook Gravity Supply Scheme (refer Appendix B), which have a long-term, planned interdependence for water source and bulk transfer. These water schemes have not been planned to provide water storage and distribution to the Strategy area.

The Water Corporation have advised that due to the height of the existing Ellenbrook storage tank and the planned height of longer-term Bullsbrook water storages, it is likely that the Strategy area could be provided with water from either gravity scheme, or a combination of both. Further water planning is required to determine the preferred long term water servicing strategy.

To meet additional industrial demand in the long-term, increased storage will be required to supplement the Gnangara Reservoir supply and provide adequate capacity for the southern parts of the proposed industrial area. Engineering investigations will need to be completed to determine the hydraulic limits of gravity supply from the Gnangara Reservoir and a plan prepared for the staged construction of required water distribution infrastructure.

For those parts of the Strategy area outside of existing or planned Water Corporation scheme water upgrades, additional upstream planning is required. Any additional demand will require reinforcement from another source along with further tanks to provide the additional capacity. The feasibility to service discrete parts of the area with short term, or temporary infrastructure solutions will depend largely on the geographic location of the land in question and the capacity of the developers of the land to pay for short term servicing solutions.

Challenges to be resolved include arrangements for rail and highway crossings, including the alignment in Stock Road and crossing of Ellen Brook and consideration of the impact of shallow ground water in the low-lying areas. These can be substantial cost items and are likely to impact on the overall alignment and distance of water distribution. In addition, light and general industries have highly variable water demands, and more detailed planning is required to enable estimates of scheme water demand.

Increasing demand for water coupled with declining water availability may result in the need for development within the Strategy area to reduce its reliance on reticulated water and look to alternative fit for purpose water source options.

Many factors will influence the availability of cost-effective, suitable fit for purpose water supplies, with the preferred options likely to vary at the precinct scale based on the proposed industry types, intensity of land use and timeframe for development. Options for future evaluation may include rainwater storage systems, groundwater, and recycled water.

6.2 Sewer

The Strategy area is not serviced by reticulated sewerage and the Water Corporation have advised that there is no capacity available in the neighbouring sewerage networks at Bullsbrook or Ellenbrook to service projected industrial and freight development.

With the decommissioning of the Bullsbrook Wastewater Treatment Plant (WWTP), reticulated wastewater service provision for the Bullsbrook Townsite will be directed to Beenyup WWTP, with reuse as part of the groundwater replenishment scheme. As stated above, the Water Corporation have identified that the proposed sewer pressure main does not have capacity to accept additional out-of-catchment wastewater from the Strategy area. Additionally, there are environmental risks associated with transferring wastewater through the Gnangara Reservoir which may influence future sewer pressure main alignments from Ellenbrook, as it is necessary to pump additional sewer effluent demand over to the coastal treatment plant systems.

Infrastructure to serve the industrial area will need to be planned and constructed in stages. The Water Corporation has conducted high level, conceptual, long term wastewater planning which places the Strategy area and the North Ellenbrook Urban Investigation areas within a much-expanded Bullsbrook Sewer District. Because of the extensive area that it covers and the implications on downstream infrastructure, wastewater servicing of land will be costly and problematic to stage. As far as possible, development within the area must be controlled through the zoning and structure planning process so that it occurs in a logical and orderly sequence in consultation with the Water Corporation.

Development of the area will need to follow a logical and orderly sequence and should be subject to more detailed structure planning to assist servicing agencies with their planning. Isolated, standalone developments that either leapfrog the development front, or generate small wastewater flows that need to be pumped over large distances will not be feasible to connect to the Corporation's networks. Developers of land that is remote from available sewerage discharge points may need to investigate their own alternative wastewater collection, treatment and disposal including third party service providers that deal with small-scale wastewater package treatment solutions. Some landholdings that are relatively close to the available sewer networks may be able to employ private internal sewerage systems with private pump stations and pressure mains discharging to the Corporation's networks.

The Government Sewerage Policy (Sewerage Policy) outlines a number of requirements for the connection to reticulated sewerage. Relevantly, the Sewerage Policy identifies the following key matters relating to on-site sewerage treatment which are relevant to the proposed development of the Strategy area:

- where reticulated sewerage is not provided the potential impacts to development include low intensity development and restricted or reduced flexibility to change or intensify land use in future.
- a one-hectare minimum lot size is applied to land within high groundwater level (for example, less than 0.5 metres below natural ground level) and/or sewage sensitive areas to manage cumulative impacts on the environment and water resources.
- the majority of the strategy area is mapped as within 1km of significant wetlands, and part of Precinct F is mapped as "Habitats of specially protected water-dependent fauna, and within 1km of groundwater dependent threatened and priority ecological communities" to the east of Neaves Road (DPLH 2019).
- separation distances for on-site disposal from water resources and groundwater.
- on-site systems should not be sited in areas that are low-lying and prone to flooding.
- industrial development proposals are required to provide detail of likely trade waste, details of proposed method of disposal of trade waste and contingency measures such as emergency response to spills.

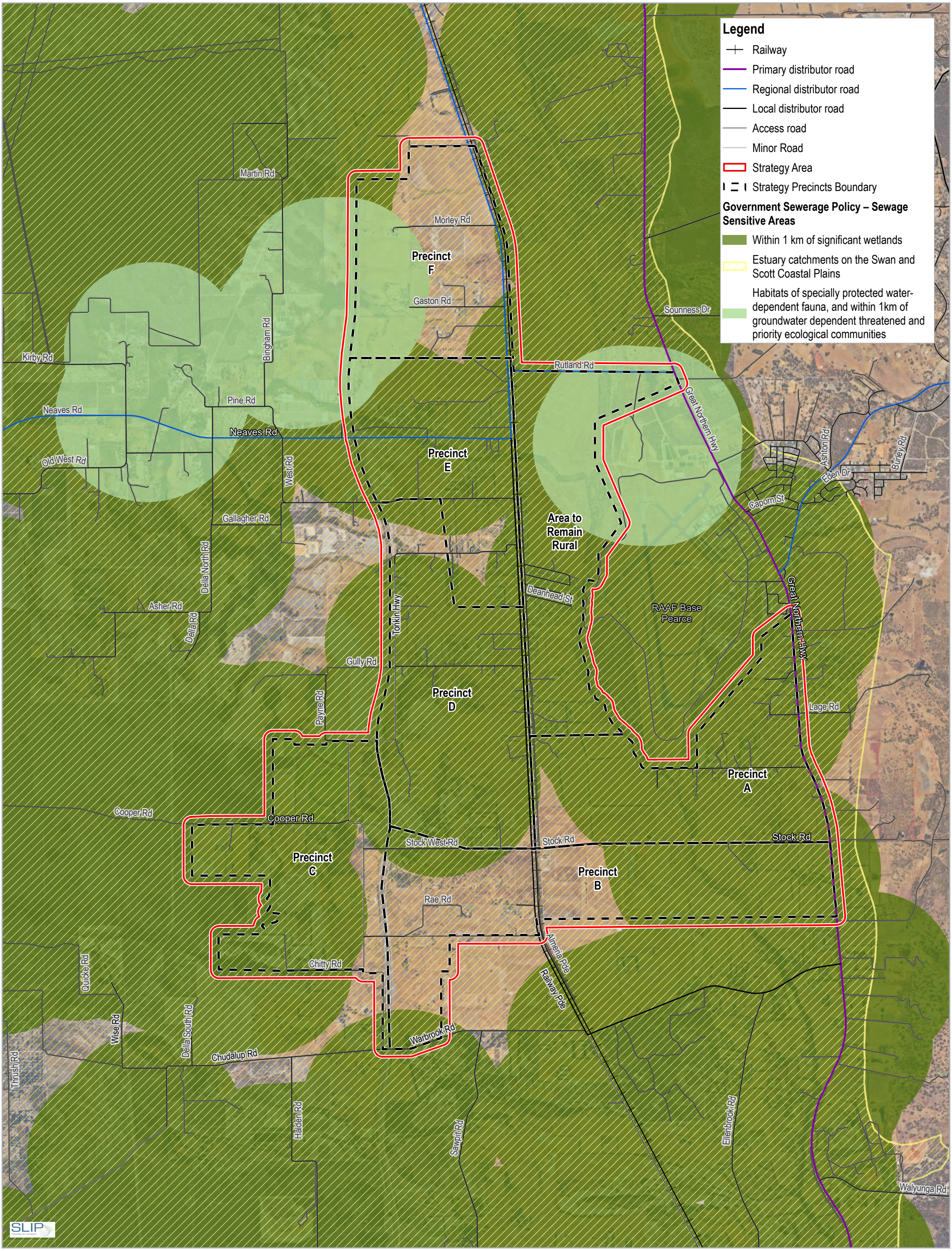
The objectives of Draft SPP2.9 – *Planning for Water* - to ensure that planning and development considers water resource management and includes appropriate water management measures to achieve optimal water resource outcomes. Draft SPP2.9 identifies the following Policy Outcomes which are relevant to provision of sewerage in the Strategy area:

- Development connects to or provides for reticulated sewerage to protect public health, amenity, and the environment and to minimise financial burden to future communities.
- Onsite wastewater disposal is only provided where reticulated sewerage is not a viable option and where the associated risks are appropriately managed.

While on-site disposal may be considered, this should be assessed at the subdivision and/or development application stage based on the specific land capability (e.g., soil types, depth to groundwater) across each precinct. On-site disposal may not be suitable for large parts of the Strategy area due to the presence of sewage sensitive areas (water dependent ecological communities and wetlands), waterways and shallow depth to groundwater (limiting infiltration capacity of soils and resulting in insufficient land available for sewage disposal). Additionally, in sewerage sensitive areas, lot sizes for on-site disposal are restricted to one hectare, and development will likely be restricted to dry industry only. This is unlikely to result in the desired range of industrial land uses or employment densities.

An option for wastewater servicing across the majority of the Strategy area is provision of reticulated sewerage through small package treatment plant(s) or decentralised system(s), operated by a service provider. However, operation of a local WWTP requires economic evaluation at the precinct scale for provision of services. Where land development occurs prior to the volumes required to make a local WWTP operationally and economically viable, developers will be required

to investigate and fund temporary servicing arrangements to convey wastewater. The proposed water and sewer upgrades for the Bullsbrook Townsite are anticipated to occur in the next 15 years. The Water Corporation has advised that the ultimate solution will depend on the required demand determined by how much land will ultimately be set aside for industrial use, timing of upgrades in the adjacent water and sewer system network, finalisation of transport corridors and crossings, and uptake in industrial land.



Paper Size ISO A3

0 0.5 1 1.5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

Department of Planning, Lands & Heritage
Bullsbrook Freight and Industrial Regional Water Management Strategy

Sewerage Sensitive Area

Project No. **61-37134**
Revision No. **G**
Date **3/10/2022**

FIGURE 25

G:\61\37134\GIS\Maps\Working\6137134\6137134.aprx\6137134_014_SewageSensitiveArea_RevG
Print date: 03 Oct 2022 - 15:08

Data source: GHD: Masterplan Boundary, Transport Network - 20180702, Concept Plan - 20181102; Landgate: Roads, Railway - 20180820, Government Sewerage Policy, Imagery accessed 20200424. Created by: wwang3

6.3 Power

There is available capacity at the Muchea Zone Substation over the next 5 years to service initial stages of the industrial development, but this is dependent upon load demand and timing. A limiting factor is the existing 22kV power line capacity. The existing 22kV feeders from the Muchea Zone Substation will only be able to service a limited amount of development before upgrades are required. Initially upgrades such as capacitors and upstream line augmentation may be sufficient, however as the development demand triggers larger load requirements, new 22kV cable feeders from the Muchea Zone Substation will be required to provide extra capacity.

Ultimately a new 132kV zone substation or 330kV terminal station will be required to service the broader industrial area, dependent on future load requirements. A line assessment study will be required prior to the construction of the line(s) to determine the final route and associated restriction zones. Western Power anticipates the restriction zones could be a minimum width of 20 metres for 132kV and 60-70 metres for 330kV depending on span lengths and would restrict building development within these zones. The restriction zone would need to be protected by a Western Power transmission line easement over any freehold properties affected to ensure that Western Power has unobstructed access, safety standards are met, and the asset is protected.

A “Public Purpose – SEC” reservation would be required under the Metropolitan Region Scheme (MRS) to protect and manage the zone substation or terminal station assets.

6.4 Telecommunications

Various providers are able to service industrial developments in the Strategy area with telecommunications, whether it be fixed line or wireless systems.

6.5 Gas

ATCO Gas has an existing distribution main along the Railway Parade corridor that is capable of servicing industrial demand, and thus the expansion of capacity can occur as required.

7. Industrial land market

7.1 Overview

Emerging trends occurring in industrial land markets across Australia reveals how the use of industrial land is changing. The globalised economy emphasises a requirement for innovation and specialisation to establish a competitive niche. This has resulted in changes to the planning and positioning of industrial estates, with lots needing to be more flexible and adaptable to tenant needs and requirements. Key trends include:

- more flexible lot sizes
- bigger more efficient warehousing
- greater accessibility by road, rail, and public transport for both business and employees
- convenient location close to growing residential areas and hence access to workforce
- greater importance placed on competitive advantage
- reduction in land costs in order to be more competitive
- an ability to have an increased number of functions occurring at any one site

The Bullsbrook freight and industrial area, once environmental, drainage and servicing constraints are addressed, is well placed to respond to the factors described above, due to its high accessibility to rail and road and relatively large landholdings enabling flexibility in lot sizes to adapt to market conditions.

7.2 Competition

Muchea located approximately 20 km north of the Strategy area, at the intersection of the Brand Highway and GNH, is well positioned with strategic location factors very similar to Bullsbrook, including access to GNH, the future PDNH, the northwest sub-region and freight rail as well as a sustainable employment base. Due to its location north of Bullsbrook and provision of a large vehicle break-down area, Muchea provides an advantage for businesses involved in transporting large equipment and other goods to and from locations in the Mid-West and Northwest.

Expansion of the Muchea employment node is constrained by the lack of suitable land for industry and may not be able to provide enough land for the total forecast demand or more importantly, land suitable for the prescribed uses. Bullsbrook, however, is relatively flat and as such is able to provide land suitable for industrial use, in particular large lot development.

Other competitive areas include Meridian Park (Neerabup), Forrestdale, Hazelmere and to a lesser extent the Flinders Precinct at Latitude 32. Meridian Park in Neerabup is identified as a more direct competition for the Strategy area due to its ability to release larger lots to the market, its location in the northern suburbs, proximity to the existing industrial estate in Wangara (which already has a critical mass) and the employment catchment expected through the northern sub-regions.

Notably, the Stockyards Estate in Hazelmere has been very successful. This can be attributed to its attractiveness to freight and logistics users due to its proximity to the airport and major arterial

routes as well as the consolidated land ownership, which facilitates the ability to deliver large lots to the market with custom-built facilities in a relatively short timeframe.

7.3 Comparative Advantage

A key competitive advantage of the Strategy area is its strategic location, with great north-south connectivity and proposed improved east-west connectivity. The completion of NorthLink WA in particular, provides a catalytic boost to the accessibility of the strategy area. The Bullsbrook freight and industrial area's connectivity to road and rail infrastructure will provide access to:

- metropolitan industrial areas (Neerabup and Muchea)
- northwest sub-region
- Midland-Geraldton railway line providing port access at Fremantle and proposed outer harbour
- agricultural areas
- broader regional freight network, including Mid-west and North West
- a sustainable employment base

Additionally, the identification of a future IMT has the potential to catalyse a micro-economy driving freight and logistics, distribution centres and head offices as well as other supporting sectors. Adequate industrial land supply is critical to support agglomeration and clustering of industrial activities.

7.4 Demand

Several factors drive industrial demand, primarily:

- export and import driven economic growth (including mining)
- domestic industrial production and construction
- population and employment growth

7.4.1 Economic growth

Western Australia's annual economic growth rate of -2.7 per cent was the slowest growth of all the states and territories and over the past 10 years with the state averaging 3.9 per cent growth per year (Macroplan, 2020). Forward projections indicate that there will be a quick turnaround in State economic growth from the 2017/18 financial year onwards with Western Australia's economy projected to grow at an annual average of 3.0 per cent in the long-term (Macroplan, 2020).

Economic conditions are a key driver of population growth in Perth. This is primarily due to the employment prospects created in a strong economy, which attract additional permanent migrants.

7.4.2 Production and construction

Mining investment is expected to fuel demand for labour and create significant flow-on multiplier benefits for the Western Australian economy. There is significant capital expenditure in the mining sector within Western Australia, with more than $176 billion in capital expenditure in projects.

Even under conservative assumptions there will be demand for more than 25,000 construction jobs and more than 4,000 operational jobs. The flow on impacts into other supporting sectors such as mining service, building and construction services, and materials manufacturing, will drive strong industrial growth within the Perth market (Macroplan, 2020).

7.4.3 Population

Population growth and dwelling construction will be a key driver of industrial land demand given the synergies regarding construction and building services, distribution centres for retail operators and other local industrial service precincts.

Perth's northwest urban corridor remains the biggest greenfield sub-region of Perth and Peel and will require increased linkages to the northeast sub-region to provide sufficient employment generating lands within suitable commuting distances for the growing population.

The population within the northwest sub-region is expected to double to 740,330 people by 2050, increasing annually by three percent. In the northeast sub-region, population growth is occurring at a rate of two percent per annum more than doubling by 2050 from 209,150 people in 2011 to 450,580 by 2050.

7.4.4 Employment

Perth's population has an average annual growth of 4.1 percent across the past decade, matched by equally strong growth in employment. Between 2006 and 2016, the composition of employment within Perth altered slightly as the general economy moved towards a service sector base however over the five years leading up to 2016, there has been a noticeable shift in the industry composition.

The mining industry now accounts for 5.0 percent of employment, construction 9.9 percent and transport and warehousing about 4.6 percent. This shift in trend has implications for the future industrial land requirements of Perth. As employment in these industries continues to grow faster than average employment growth, the demand for industrial land will continue.

Demand for business and technology parks will continue to grow, and large intermodal and freight hubs will be required as knowledge and innovation-based businesses linked to mining and minerals seek to move into the supply chain.

7.4.5 Demand analysis

Perth, while isolated from the rest of Australia, has strong international connectivity with economic links to Asia. From a trade perspective, these connections are more efficient than the eastern states due to time zones and transport costs. The implications are that Perth can accommodate businesses and absorb investment from overseas potentially more effectively than the eastern states.

The Bullsbrook freight and industrial area provides an opportunity to help service this export growth, building an efficient, high-technology IMT facility without interrupting existing operational facilities.

The large area available for development could deliver a long-term solution to meet the needs of Western Australia's growing economy while providing land supply and keeping prices contained to facilitate economic development. With opportunities in traditional areas of Kewdale and Welshpool diminishing, the Strategy area is ideally located to become the next freight and logistics hub, actively servicing areas in the north-west such as Geraldton and the Pilbara. The inclusion of a potential IMT further enhances its appeal to the freight and logistics sector.

The Strategy area has several potential industry segments, particularly those related to the transport industry, including:

- heavy haulage and ancillary uses
- freight and logistics
- transport related services (i.e., mechanical workshops)
- agriculture
- mining related industries (i.e., product testing)

The overall size, zoning, and composition of industrial employment land within the Strategy area will depend on the end user. As such, potential employment sectors have been identified along with the associated infrastructure requirements, lot sizes and implications for the overall project (Table 6).

The lots sizes should reflect the target industries and the natural competitive advantages of the precinct(s). There are a number of market gaps in Perth's industrial market, with an under-representation of larger lots. The Strategy area could address this current market gap through flexible lot sizes dictated by market forces and end user requirements.

Table 6 - Land use specification and schedule

Target market	Infrastructure requirements	Lot sizes	Project Outcome
Transport and logistics	• Good ingress and egress for B-Double/B-Triple • Intermodal facilities • Access to port and rail	10+ ha	Be developed to be the next transport and logistics hub in the northern sub-regions
Heavy haulage and ancillary uses including Highway Service centre	• Good ingress and egress • Wider roads • Dual road access • Lay down areas • Hardstand areas • Fuel and road service	1 – 10 ha	Help to create a cluster of transport and related industries. Provide support services to the transport and logistics tenants
Agriculture/rural including processing and storage	• Flexible zoning • Flexible lot sizes • High power	1 – 2 ha	Potential to attract from the existing worker profile and use of the area
Mining related	• Flexible lot sizes • High power • High on-site security	Up to 2 ha	Help add diversification to the estate while also complementing other targeted industrial uses

Target market	Infrastructure requirements	Lot sizes	Project Outcome
Non-industrial uses including storage	• Flexible lot sizes • Parking	Up to 2000 sqm	Provide on-site amenity for tenants, increasing the estate's appeal and increasing employment opportunities for the local population

7.5 Employment generation and economic value

Over the longer term, development of the Strategy area in conjunction with the Muchea employment node will ideally form an employment corridor in much the same way as Dandenong South in Melbourne and the Casey Cardinia Employment Corridor.

The proposed industrialisation of the Strategy area will serve three key objectives:

- Provide industrial land with the flexibility to respond to future requirements.
- Provide much needed supply and hence competition to the industrial market assisting in keeping the general cost of land at more affordable levels.
- Create employment opportunities to promote population growth.

Delivery of industrial land at Bullsbrook will provide significant opportunities for local employment and industrial activities to support the Bullsbrook area. These employment opportunities can be classified into three categories:

- Direct employment generation: the initial number of ongoing jobs directly created by the proposed construction/development phase and other expenditure flows.
- Indirect employment generation: additional ongoing jobs indirectly created by the proposed development.
- Long-term supported employment in industrial land.

Long-term supported employment has been calculated from a review of the likely employment land mix within the Strategy area to the benchmarks established in Table 7.

Table 7 - Job densities by industry (Source: Macroplan 2020)

Industry	Jobs (per ha)
Manufacturing	33-40
Construction	33-50
Wholesale trade	20
Transport and storage	20
Support services	18

Based on the above schedule and the employment land mix identified, an average density of 30 jobs per hectare is likely to be achieved. It is estimated that there will be approximately 1,395 hectares of land that can be developed after conservation and transition areas are taken into account. This suggests that the Bullsbrook freight and industrial area is likely to generate around 41, 850 jobs once fully developed. The following table (Table 8) outlines the anticipated jobs generated in the short, medium, and long term.

Table 8 - Job generation (Source: Macroplan 2018)

Development Timeframe	Period	Developable Land (ha)	Direct Employment
Short-term	2020-2040	270	8,100
Medium-term	2030-2075	450	13,500
Long-term	2050-2100+	675	20,250
Total	2020-2100+	1,395	41,850

8. Strategy vision and objectives

The vision for the Bullsbrook freight and industrial area is:

"To provide for a range of traditional and emerging industries with a focus on supporting the freight objectives for the broader metropolitan region and increasing employment opportunities in the north metropolitan subregions, while recognising the need to protect environmental attributes and the amenity of the residential and other sensitive uses within and adjacent to the area."

The key objectives of the Strategy can be broadly classified into key categories including economy and employment, development interfaces, transport and infrastructure and environment. Local Structure Plans prepared for land within the Strategy area will be required to demonstrate how these objectives will be met and implemented. The objectives are detailed below:

Economy and Employment

1. protect industrial and employment lands from encroachment of incompatible land uses
2. allow for flexibility in land use as the economy and cyclical factors determine demand for industrial development in the future

Development Interfaces

3. maximise opportunities for freight related land uses surrounding the IMT
4. achieve a high level of amenity and built form outcomes within a modern well-planned industrial estate
5. transition industrial uses to provide appropriate interfaces to sensitive development

Transport and Infrastructure

6. integrate broader road and movement networks to facilitate industrial access
7. ensure that connectivity for existing residents is maintained and accessibility for future residents and workforce is maximised
8. ensure that land is appropriately serviced to accommodate anticipated and desired industrial land uses

Environment

9. protect the natural environment from adverse impacts
10. acknowledge and respect cultural heritage

9. Strategies and actions

The objectives of the Strategy have been developed to address key land use and planning issues upon which a framework for further detailed planning can be developed.

The following section analyses the key issues that influence each planning objective and provides appropriate planning strategies and actions to resolve these issues to achieve the Strategy's intended purpose. These strategies and actions also provide the context for the Strategy.

9.1 Economy and Employment

Objective 1: protect industrial and employment lands from encroachment of incompatible land uses

The key drivers to industrial land demand are population growth and export volumes. Growth in exports, particularly around the mining industry has a flow on effect for employment, freight movements and population growth. This in turn drives demand for industrial land to support the expansion of warehousing and storage facilities, the need for additional IMTs and other population driven industrial uses.

The NESRPF indicates that demand for industrial land in the north-east sub-region is expected to grow to 2, 810 ha by 2050, representing an average take up rate of 34.7 ha per annum. In comparison, it is estimated that the Strategy area could achieve a take up rate of between 12-15 ha per annum over the same period.

In view of this, protection of the existing rural zone is required until the land is required for industrial purposes. This will prevent land fragmentation and minimise the potential for encroachment from incompatible uses prejudicing the future use of the land for industrial purposes.

Strategy	Action
1.1 protect existing rural land as an interim measure	a. preserve rural zonings until land us required for industrial purposes b. maintain current framework for decision making c. limit the number of discretionary land uses within the rural zone which may prejudice the objectives of this Strategy. For example, retirement villages, educational establishments, places of public worship

Objective 2: allow for flexibility in land use as the economy and cyclical factors determine demand for industrial development in the future

Full build-out of the Strategy area is a long-term proposition, therefore, the planning of this area must be highly responsive to changes in economic cycles and in the way land may be developed as the estate evolves and matures. This will entail ensuring there is the flexibility for a diversity of industrial uses and developments, recognising that land requirements can vary considerably, from smaller sites (1,000m^2 – 2,000m^2) for service commercial/light industry, through to large sites of several hectares for freight and logistics activities.

Having flexible lot sizes, with the ability to accommodate custom built facilities based on tenant requirements, will enhance the attractiveness of the estate. Additionally, land assembly mechanisms should allow adaptive responses to changing industry needs and requirements.

Strategy	Action
2.1 Provide a range of industrial lot sizes to accommodate the needs of various industry types.	a. Require that the mix of industrial lot sizes proposed as part of future structure planning have regard to up-to-date industrial land demand and supply modelling b. Incorporate minimum lot size restrictions into structure plans to preserve large lots that can be customised to suit tenant requirements
2.2 Provide flexibility in land assembly.	a. Promote flexible land tenure options such as leasehold arrangements to prevent land fragmentation b. Create lot sizes/configurations which provide for larger lots and/or allow for lots to be consolidated/amalgamated as required

9.2 Land Uses and Interfaces

Objective 3: maximise opportunities for freight related land uses surrounding the IMT

Bullsbrook is located within 20 kilometres of the planned Muchea Industrial Park which shares the same characteristics of high accessibility to road and rail networks and a sustainable employment base. While in the longer term it is envisaged that Bullsbrook and Muchea will ultimately form an employment corridor, it will be necessary in the short to medium-term to ensure that both industrial areas can be sustained independently of each other.

Bullsbrook has the opportunity to be focused on distribution centres for the northern metropolitan sub-regions, interstate freight and import processing. The presence of an IMT within the Strategy area provides an opportunity to rationalise freight transport within the Perth metropolitan region, especially by using rail to transport goods and commodities to and from the ports at Fremantle and Kwinana. This would assist in managing many of the externalities and issues associated with the movement of containerised freight through Perth, particularly as the Fremantle inner-harbour and its major servicing roads approach their practical capacity limits.

Land use activities that are aligned with and support this change in the freight task should be supported. The Bullsbrook freight and industrial area represents the most significant area for proposed future industrial development in the northeast sub-region. The proposed intermodal terminal will facilitate freight related strategic employment, optimise the use of existing road and rail infrastructure, and provide for increased containerised freight movements, thereby maximising supply chain efficiencies and decreasing freight conflicts on the road network.

The development of the Bullsbrook freight and industrial area requires the provision of transport linkages, both within the Strategy area and externally. Of particular importance will be the provision of safe and efficient transport links between the proposed IMT and other parts of the Strategy area.

Freight operators require the capacity to move goods on a 24/7 basis. As international freight movement has become more rapid and responsive to customer demand, the activities of logistics and distribution centres have increasingly become dependent on the timing of other supply chain activities. It is likely that future trends in freight movement and supply chain management strategies will influence the demands and activity that occurs within the Strategy area, particularly the IMT.

Current planning for the IMT site seeks to facilitate a development that will ultimately cater for throughput of 250,000 TEU[3]/annum. Initial terminal capacity has been estimated as 150,000 TEU/annum. In addition to containerised cargo, it is expected that large volumes of light commercial vehicles and passenger cars (primarily used for commercial purposes) will access the IMT and the wider Bullsbrook freight and industrial area on a daily basis.

Strategy	Action
3.1 provide a safe and efficient transport network to better integrate the IMT with surrounding industrial land uses	a. provide direct road access to the IMT site by realigning Railway Parade along the west boundary of the IMT site b. provide access to the IMT from Neaves Road via Railway Parade and the PDNH c. upgrade Stock Road to dual carriageway to accommodate OSOM vehicles along Stock Road between the IMT and GNH d. construct Stock Road East to provide a road connection between GNH and the PDNH
3.2 encourage the development of freight related land uses by modifying and upgrading the rail network to accommodate potential future freight demand including interstate rail traffic	a. upgrade the railway between Millendon Junction and Bullsbrook to dual gauge with higher axle capacities b. make provision to accommodate 1800 metre trains in the southern approach siding, with internal sidings capable of expansion to 900 metres c. space turnouts and sidings to allow future upgrade to dual gauge d. design rail corridors to allow for future standard gauge conversion e. design new grade separations that allow for double stacked rolling stock f. provide flexibility in the IMT layout to accommodate direct approach for trains to/from the north
3.3 encourage the location of key anchor tenants adjacent to the IMT	a. work with landowners and the Department of Transport to catalyse development of a freight and logistics hub adjacent to proposed IMT facility b. provide suitable land for transport, logistics and heavy haulage activities focused on intrastate/interstate and metropolitan demand, adjacent to the IMT c. optimise rail/container access and identify key locations for intermodal freight and handling facilities

[3] A TEU (Twenty-foot Equivalent Unit) is a measure of containerised cargo mass based upon a standard 20-foot international shipping container. Double length (40 foot) containers are also commonly used to ship freight, which equates to two TEUs each.

Objective 4: achieve a high level of amenity and built form outcomes within a modern well-planned industrial estate

The Bullsbrook freight and industrial area interfaces with existing rural and future urban areas and is traversed by a number of high-volume roads. Existing residents will naturally be concerned with the impacts of industrial development on the amenity of the locality. Additionally, the attractiveness of the industrial estate will impact the willingness of new investors and future residents to locate to Bullsbrook.

The siting and design of buildings is an important element in enhancing the visual appearance and attractiveness of the Bullsbrook freight and industrial area. It is important that future industrial development presents an attractive frontage, particularly if fronting high volume roads or close to rural and residential developments. As a minimum, future development within the Bullsbrook freight and industrial area should respond to the following principles:

- sensitivity to the scale and character of adjoining areas
- retain active frontages where possible to key roads and locations
- ensure a high standard of design particularly where fronting major roads and sensitive uses e.g., residential
- sensitivity to the interfacing between built development and wetlands and waterways that intersect with the Strategy area.
- incorporate landscaping to frame buildings, outdoor storage areas and car parks

Strategy	Action
4.1 incorporate measures that promote high amenity development	a. consider the use of vegetation buffers where appropriate to screen industry from rural and residential property b. include requirements in the local structure plan(s) requiring the preparation of Design Guidelines c. ensure development is sensitively designed and sited with respect to environmental assets, wetlands and waterways, rural landscape, major road vistas and amenity d. include provisions in local structure plans to provide for built form that incorporates environmentally sensitive design principles including passive solar design, energy, and water efficiency principles
4.2 promote active frontages to key roads	a. provide opportunities for commercial, bulky goods retailing and associated service business along portions of Stock Road, GNH and local distributor roads

Objective 5: transition industrial uses to provide appropriate interfaces to sensitive development

Managing the interface between industries and sensitive uses is necessary not only to prevent adverse impacts on residents and other sensitive users but also to protect the ongoing employment and economic benefits associated with industrial development.

Different types and scales of industry deliver different sorts of benefits to the local and regional economy and have different impacts on adjoining development. Land use conflicts can be effectively managed by separating industries, which have the potential to generate off-site impacts, from residential and other sensitive uses. This can be achieved by managing the interface and transitioning the different types of industry where they are in close proximity to residential or other sensitive land uses.

Light industrial development generally comprises light and service industries. Conversely, general industry provides for a broad range of industrial, service, logistical and storage activities, which, by the nature of their operations, should be isolated from residential and sensitive uses. Where there is a potential for land use conflict, local structure plans and local planning scheme zones should make provision for the transitioning of compatible land use zones for example, by placing Light Industry between the General Industry and Residential zones.

Additionally, where rural residences or sensitive uses are located in proximity to a General Industry zone, consideration should be given to limiting the permissible land uses within the General Industry zone, allowing some lighter industrial uses which could provide an appropriate transition between the two zones. This is a significant issue for residents of the rural enclave which was raised during consultation and will require careful consideration and implementation during further planning stages for Precincts adjacent the rural enclave (Precincts D and E).

There is also potential for land use conflicts to arise from future development and the continued operations of the RAAF Base Pearce. Provisions should be identified in any future local structure plans and included in the local planning scheme to ensure that areas impacted by the operations of the RAAF Base Pearce airbase are cognisant of the development restrictions which may apply under Part 11A of the *Defence Regulation 2016.*

Strategy	Action
5.1 transition industrial uses between General Industry and Residential and Rural zones	a. develop land adjacent to future residential areas for Light Industry to manage impacts from general industrial uses b. include provisions within the planning framework which limits the land use permissibility's of industries within the General Industry zone within proximity to the Bullsbrook rural enclave, to those land uses which are complementary to residential development
5.2 recognising the development requirements from the RAAF Base Pearce	a. include provisions within the local planning framework requiring that development impacted by the RAAF Base Pearce operations, comply with Part 11A of the *Defence Regulation 2016*[4]

[4] https://www.legislation.gov.au/Details/F2020C01014

9.3 Transport and Infrastructure

Objective 6: integrate broader road and movement networks to facilitate industrial access

The proposed intermodal terminal will facilitate freight related strategic employment, optimise the use of existing road and rail infrastructure and provide for increased containerised freight movements, thereby maximising supply chain efficiencies and decreasing freight conflicts on the road network.

The development of the Bullsbrook freight and industrial area requires the provision of transport linkages both within the Strategy area and externally. Of particular importance will be the safe and efficient transport links from the IMT, and other industrial areas to the Bullsbrook freight and industrial area. It is linked by good east-west road connections and well located to growing workforces and employment centres in the north-west sub-region.

Challenges to be resolved include arrangements for rail and highway crossings, including the alignment in Stock Road and crossing of Ellen Brook, and consideration of the impact of shallow groundwater in the low-lying areas.

Strategy	Action
6.1 reclassify/reserve roads to reflect their purpose and function in the broader road network	a. reserve the portion of Stock Road between GNH and the PDNH for regional road purposes (status to be determined) in the MRS b. reserve the section of Neaves Road west of the PDNH for Other Regional Road purposes in the MRS
6.2 upgrade roads and intersections to accommodate industrial and local traffic	a. upgrade Stock Road to dual carriageway and the section of Stock Road between the IMT and GNH to accommodate OSOM b. connect Stock Road to Tonkin Highway and GNH with grade separation over the railway c. realign Railway Parade with Stock Road and the IMT d. construct a new north-south spine road through the precinct by extending Sawpit Road to connect Neaves Road e. realign and duplicate Neaves Road to connect to Rutland Road and GNH with a grade separation over the railway line f. consider duplication of GNH particularly the southern approach to the Bullsbrook townsite g. extend Almeria Parade south to connect to Stock Road and future industrial area at Lot 300 h. design road connections suitable for heavy vehicle use (up to 36.5 metres)
6.3 network changes and upgrades to the railway line should Bullsbrook become a destination for interstate rail traffic	a. upgrade railway between Millendon Junction and Bullsbrook as dual gauge, to accommodate greater rail transport capacity to and from Bullsbrook b. provision to accommodate 1800m trains in the southern approach siding, with

Strategy	Action
	internal sidings being capable of expansion to 900m c. the design of all rail corridors should allow for standard gauge conversion and for future double stacked rolling stock d. IMT layout to be flexible to allow for direct approach from the north

Objective 7: ensure that connectivity for existing residents is maintained and accessibility for future residents and workforce is maximised

The potential for freight infrastructure to influence (and be impacted by) urban development should be considered by further detailed planning.

As a potential major employment centre, the provision of passenger transport to the Strategy area should be considered in future local structure planning processes. The distance between the surrounding residential areas and the Strategy area will be a major factor that could make access by active and public transport challenging and will require careful planning of direct road connections to and from the precinct, particularly across significant barriers such as the PDNH and the freight rail line.

The relationship between the Strategy area, the IMT and the other existing and future industrial/employment nodes (at Muchea, North Ellenbrook, Wangara and Neerabup) must also be considered, as well as the potential distribution of employment and customer travel to and from the broader Strategy area.

Strategy	Action
7.1 promote alternate modes of transport	a. provide off-road shared paths along PDNH, GNH, Stock/Cooper Roads, Neaves/Rutland Roads and Railway Parade for pedestrians and cyclists b. road reserves should be wide enough for cycling to provide a 'last mile' connection from the primary routes c. require the provision of end of trip facilities for all development d. provide safe pedestrian crossing facilities at signalised intersections and adjacent to public transport stops
7.2 investigate opportunities to develop a public transport network	a. undertake bus network planning once subdivision and development in the area is sufficiently progressed b. investigate potential for bus routes linking the future Ellenbrook station and Bullsbrook town centre via the industrial area
7.3 increase east west connectivity between the industrial area and existing and future residential areas	a. make provision for an additional interchange to the PDNH mid-way between Warbrook and Maralla Roads b. investigate the opportunity for a new east west road linking future populations and workforce in East Wanneroo to the PDNH

Strategy	Action
	c. maintain the level crossings at Strachan and West Roads to enable continued east west access to the existing enclave of rural residences to the east of the rail line d. investigate opportunities for increased controls at retained crossing (i.e., boom gates for increased safety)
7.4 provide for safe and efficient access for all road users	a. prepare access strategies that accommodate the safe access and movement of commuter and freight traffic while maintaining road functionality

Objective 8: ensure that land is appropriately serviced to accommodate anticipated and desired industrial uses

At present, the provision of water and wastewater is constrained by limited capacity of existing water sources, costs relating to increased distribution and uncertainty around the ultimate requirements. In addition, light and general industries have highly variable water demands and as such, more detailed planning is required to enable estimates of scheme water demand.

There is currently no capacity within the existing Bullsbrook WWTP and until a viable alternative can be identified, the lack of sewerage will restrict the types of industries that may be contemplated.

Before land is rezoned for industrial use, the State Government and its servicing agencies will need to establish a clear understanding of ultimate servicing needs and staging requirements in order to deliver a coordinated and proactive response for the staged release of industrial land within the Strategy area.

In the short-term, a lack of available service infrastructure may restrict the development of industrial zoned land to those industries which are not reliant on major infrastructure such as trunk sewer/water for example, freight and logistics and intermodal facility.

Strategy	Action
8.1 ensure that future development makes adequate provision for wastewater disposal	a. investigate and plan for provision of sewerage services b. undertake groundwater modelling to inform the planning and siting of service infrastructure c. liaise with the Water Corporation to explore opportunities to construct sewer infrastructure that supports a wide range of industrial uses within the Strategy area
8.2 improve access to and distribution of reticulated water supply	a. liaise with the Water Corporation to identify opportunities to strategically extend the reticulated water supply system
8.3 encourage early investment and planning in extending and augmenting power supply	a. liaise with Western Power to prioritise important electricity supply upgrades

9.4 Environment

Objective 9: protect the natural environment from adverse impacts

The Bullsbrook freight and industrial area is subject to several environmental constraints including seven Bush Forever sites, water dependent ecosystems and the potential presence of conservation significant flora and fauna. Additionally, the potential for any off-site impacts on the Western Swamp Tortoise habitat and the Gnangara Moore River State Forrest will have to be appropriately managed.

In addition to the statutory protection of environmental attributes (where appropriate), environmentally sustainable land use and development should also be encouraged. This could include measures of Ecologically Sustainable Development (ESD) such as water sensitive urban design, rainwater harvesting, greywater recycling and the treatment of stormwater. ESD measures will be implemented through structure planning and local planning policy.

Strategy	Action
9.1 protect native vegetation, environmentally sensitive areas and ecological linkages	a. identify foreshore and buffer areas to waterways and conservation category wetlands as part of the rezoning process b. protect foreshore reserves and wetland buffers as part of the local planning scheme amendment process c. undertake flora and fauna surveys on the ground to identify, retain, protect, and manage significant remnant vegetation within the Strategy area. Surveys and other flora and fauna management issues will be considered in later stages of planning. d. amend the local planning scheme to apply the new Environmental Conservation reserve to Crown reserves in instances where it is desirable to retain native vegetation e. insert provisions into the local planning scheme to avoid areas of native vegetation when developing structure plans for land within the Strategy area f. ensure that appropriate interfaces are provided between development and environmentally sensitive areas
9.2 encourage environmentally sensitive design	a. Through a structure planning or local planning policy framework, implement design guidelines which incorporate environmentally sensitive design principles and solutions which are to be satisfied as part of subdivision and/or development
9.3 support integrated water management in accordance with State Planning Policy 2.9 – Water Resources	a. work with the Department of Water and Environmental Regulation to prepare a District Water Management Strategy that will build upon the Regional Water Management Strategy that was prepared as part of this document b. require local water management strategies to be produced as part of the local structure planning processes c. require urban water management plans to be produced as a condition of subdivision
9.4 integrate bushfire risk into local planning decisions	a. require that bushfire assessments in accordance with SPP 3.7 are undertaken at the relevant stages of the planning process

Objective 10: acknowledge and respect cultural heritage

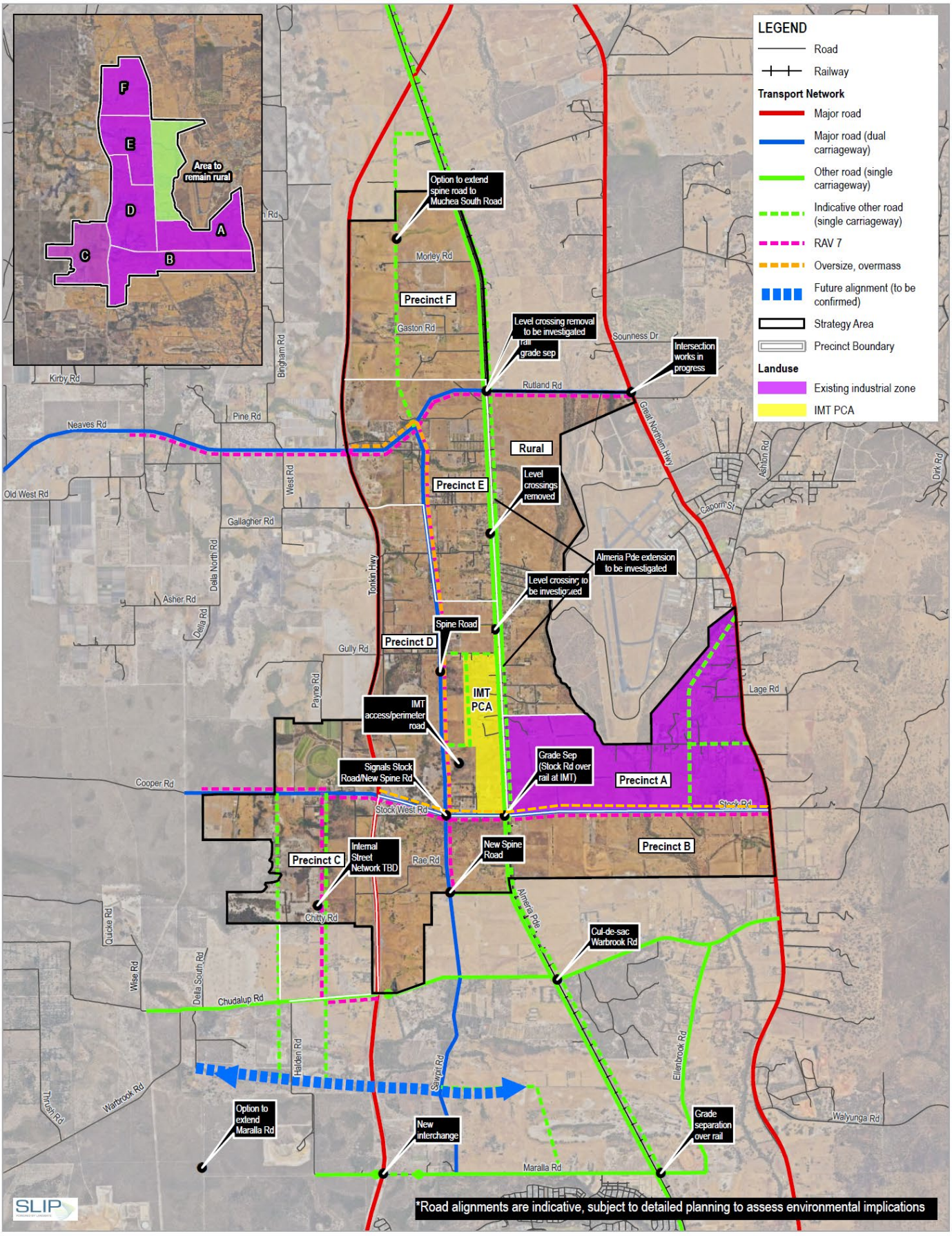
All planning and development must consider the requirements of heritage and cultural protection afforded under State and Commonwealth legislation. Land use should embrace the cultural history of the area by incorporating interpretation, conservation, and protection of culturally sensitive sites, where appropriate.

Strategy	Action
10.1 Recognise sites of Aboriginal heritage significance.	a. Support the protection of sites with heritage/cultural values b. Require that matters of Aboriginal heritage are addressed in local structure plans and design guidelines c. In consultation with Indigenous communities develop management plans, to ensure Indigenous heritage places and values are appropriately respected

10. Strategic Land Use Plan

The strategic land use plan provides an overall framework for the future planning of the Strategy area (refer Figure 26). It identifies preferred land uses and key movement networks in the context of the specific six precincts as identified earlier under Section 2.3. It also outlines the actions required to resolve any issues within each precinct, in relation to the provision of appropriate servicing and drainage infrastructure.

It is noted that the six precincts have been informed by staging triggers, preferred uses, the proposed movement network, locational opportunities as well as environmental and servicing constraints. The intent of the land use precincts shown in the Strategic land use plan is to specify the general objectives and considerations that should be taken into account when undertaking further detailed planning for the area. The precinct boundaries provide strategic guidance and should not be read as absolute, with the ultimate extent and type of land uses to be defined through more detailed structure planning.



Paper Size ISO A3

0 0.5 1 1.5 2

Kilometres

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

GHD

Department of Planning, Lands & Heritage
Bullsbrook Freight and Industrial
Land Use Planning Strategy

Strategy Plan

Project No. 61-37134
Revision No. B
Date 3/10/2022

FIGURE 26

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Data source: GHD: Masterplan Boundary, Transport Network - 20180702, Concept Plan - 20181102; Landgate: Roads, Railway - 20180820. Created by: wwang3

10.1 Precinct A

This precinct should be developed in accordance with the endorsed local structure plans (i.e., Bullsbrook Townsite District Structure Plan and South Bullsbrook Industrial Precinct Local Structure Plan No. 1 and No 2). The precinct is likely to accommodate a wide range of large-scale industrial uses that may have some potential for off-site impacts in accordance with its Industrial zoning under the MRS, as well as an area of commercial activity within the Highway Service zone as identified in the endorsed local structure plan.

Example land uses which may be suitable for Precinct A (subject to further detailed planning)

- service station
- transport depot
- warehouse/storage
- incidental office

10.2 Precinct B

Development within Precinct B is intended to be a mix of general industrial and light industrial uses capitalising on the precinct's transport linkages to adjacent major arterial roads while recognising the proximity of sensitive environmental areas. Further detailed planning will be required to respond to the following:

- Provide a variety of lots sizes which are appropriately located and configured to accommodate more intense industrial activity such as light industrial and service commercial uses over time. The higher intensity lots are generally to be located adjacent to Stock Road, GNH and the local distributor roads.
- Consider establishment of limited service-commercial development along Stock Road, the realigned Railway Parade and GNH. Alternative locations can be considered where it can be demonstrated that it will be exposed to high volumes of traffic and can provide high amenity, proximity to urban development, appropriate car parking and vehicular access and has the ability to service local workers.
- The preparation of an access strategy which identifies how access to Stock Road and GNH will be appropriately managed to ensure that direct access from these roads to lots is limited. The access strategy is to address the grade separation along Stock Road and consider the possibility of OSOM vehicles using Stock Road.

Example land uses that may be suitable for Precinct B (subject to further detailed planning)

- manufacturing, dismantling, processing, assembly servicing, maintenance or repair of goods/products
- large-format sale of goods (showroom) e.g. white goods, furniture, outdoor furniture (along major arterial roads only)
- service commercial (servicing local residents and workers) e.g. automotive and appliance repairs, hardware shop and office supplies

- The road network in Precinct B should be designed to a RAV 4 standard.
- Ensure that the land is appropriately serviced to accommodate the anticipated development. Where available, development is to be connected to reticulated sewer. In the absence of reticulated sewerage, development is to be restricted to dry industry only, subject to a Department of Health assessment (site and soil evaluation) demonstrating that the quality and quantity of effluent can be disposed of on-site in accordance with the Government Sewerage Policy.

- Provide appropriate interfaces to any future urban areas and the Western Swamp Tortoise habitat, ensuring that any impacts are effectively mitigated.
- Create an attractive streetscape through built form and landscaping of frontages along Stock Road the realigned Railway Parade, and GNH to improve visual amenity along major roads.

10.3 Precinct C

Precinct C will accommodate a mix of uses predominantly smaller scale light and service industrial activities that capitalise on adjacent urban development and population driven activity. The local structure plan and any development within Precinct C is required to respond to the following:

- The co-ordination and efficient extension of trunk infrastructure with the expansion and development of adjacent urban areas. Connection to reticulated sewer and water will be required.
- Ensure development within the precinct provides a suitable land use interface to rural land and/or residential development.
- The provision of a hard road interface between industrial development and environmentally sensitive areas.
- Deliver street frontages with high-quality landscaping, building design and adequate setbacks to minimise noise and visual impact of industrial development and the PDNH.
- Retain and protect areas of high environmental value. Development of areas of extreme bushfire hazard and significant environmental value are to be precluded unless it can be demonstrated that management will not compromise the protection of environmental assets, people, property, and infrastructure.

Example land uses that may be suitable for Precinct C (subject to further detailed planning)

- garden centre
- large-format sale of goods (showroom)
- equipment hire
- trade display
- light industrial and service commercial e.g. automotive repairs, tyre outlets, hardware stores, curtain manufacturers, furniture shops, paint stores, lighting showrooms etc. (low impact – servicing local residents and workers)

- The preparation of an access strategy which identifies how access to Stock Road, Cooper Road and Warbrook Road will be appropriately managed to ensure that direct access to these roads is prevented.
- Provide a variety of lot sizes between 2000m^2 up to 1 ha, responsive to market demand.
- The road network in Precinct C should be designed to a RAV 4 standard.

10.4 Precinct D

Precinct D encompasses the preferred IMT site and transition area which will provide for general large scale industrial uses that are complementary to the IMT. The broader precinct will be focused on transport, freight, and logistics as well as vehicle related services that benefit from direct access to the major arterial road network.

Further detailed planning within Precinct D is required to respond to the following:

- Prevent the encroachment of land uses and activities which may compromise the establishment of a future IMT. Encourage uses that add value to and complement the IMT activities, including but not limited to distribution centres, mechanical workshops, processing and packaging, transport depots and manufacture and component assembly.
- Ensure the road network is designed to accommodate industrial traffic including heavy haulage vehicles, providing high levels of accessibility for freight vehicles between adjoining precincts and between the IMT and major roads.

Example land uses that may be suitable for Precinct D (subject to further detailed planning)

- Distribution centre
- workshop
- transport depot
- Warehouse

- Where appropriate alternative access can be provided, at-grade crossings should be removed as the precinct develops to provide adequate safety for users.
- RAAF Base Pearce development restrictions including, but not limited to, height (inclusive of temporary structure such as cranes), storage of hazardous materials, lighting, bin storage and noise.
- The preparation of an access strategy which identifies how direct access to Stock Road and the proposed north-south spine road is to be restricted, with access being obtained off secondary roads.
- The road network in Precinct D should be designed to a maximum RAV 7 standard.
- Provide lot sizes that are capable of accommodating large format industrial uses. The precinct should provide a variety of lot sizes of 0.5 hectare and above.
- Limit subdivision of land where proposed lot sizes are less than 20 ha to avoid fragmentation of the land and maintain future flexibility and adaptability as the precinct develops. Subdivision to lot sizes less than 20 ha may be considered where it can be demonstrated that the proposed subdivision meets the key objectives of this Strategy and satisfies the abovementioned criteria.
- Manage the interface appropriately between future industrial uses within the northern section of the Precinct and sensitive land uses within the rural enclave for the protection of health and amenity for people and the environment.

10.5 Precinct E

Precinct E is suitable for value adding industries, manufacturing, and processing in the longer-term. This precinct presents opportunities due to the east-west road connectivity to support general industrial land uses such as showroom and warehouse developments along portions of Neaves Road as well as industries that complement the development of Muchea.

Further detailed planning within Precinct E is required to respond to the following:

- RAAF Base Pearce development restrictions including, but not limited to, height (inclusive of temporary structure such as

Example land uses that may be suitable for Precinct E (subject to further detailed planning)

- processing and packaging
- mining support industries
- manufacture and component assembly

cranes), storage of hazardous materials, lighting, bin storage and noise.

- Retention and protection of areas of high environmental value. Development of areas of extreme bushfire hazard and significant environmental value are to be precluded unless it can be demonstrated that management will not compromise the protection of environmental assets, people, property, and infrastructure.
- Ensure that the land is appropriately serviced to accommodate the anticipated development. Where available, development is to be connected to reticulated sewer. In the absence of reticulated sewerage, development is to be restricted to dry industry only, subject a site and soil evaluation by the Department of Health.
- The preparation of an access strategy which identifies how access to Neaves Road and the internal north-south spine road will be appropriately managed to ensure that direct access to these roads is limited.
- The road network in Precinct E shall be designed to a RAV 7 standard.
- Limit subdivision of land where proposed lot sizes are less than 20 ha to avoid fragmentation of the land and maintain future flexibility and adaptability as the precinct develops. Subdivision to lot sizes less than 20 ha may be considered where it can be demonstrated that the proposed subdivision meets the key objectives of this Strategy and satisfies these criteria.
- Manage the interface appropriately between future industrial uses within the southern section of the Precinct and sensitive land uses within the rural enclave for the protection of health and amenity for people and the environment.

10.6 Precinct F

Take-up of land within Precinct F is expected to be over the longer-term and is anticipated to be the last precinct to be developed within the Strategy area, with an expected development timeframe greater than 70 years. Development of this precinct will be best determined through future local structure planning which responds to the market, demand, and technology requirements of the time.

The local structure plan and any development within Precinct F is required to respond to the following:

- Limit subdivision of land where proposed lot sizes are less than 20 ha to avoid fragmentation of the land and maintain future flexibility and adaptability as the precinct develops. Subdivision to lot sizes less than 20 ha may be considered where it can be demonstrated that the proposed subdivision meets the key objectives of this Strategy and satisfies these criteria.

Example land uses that may be suitable for Precinct F (subject to further detailed planning)

- to be determined (potential for head offices, non-mainstream training facilities and knowledge intensive industry e.g. mining/agriculture research)

- Deliver street frontages with high-quality landscaping, building design and adequate setbacks to minimise visual impact of industrial development.
- Ensure that the land is appropriately serviced to accommodate the anticipated development. Where available, development is to be connected to reticulated sewer. In the absence of

reticulated sewerage, development is to be restricted to dry industry only, subject to a Department of Health assessment (site and soil evaluation) demonstrating that the quality and quantity of effluent can be disposed of on-site in accordance with the Government Sewerage Policy.

- Retention and protection of areas of high environmental value. Development of areas of extreme bushfire hazard and significant environmental value are to be precluded unless it can be demonstrated that management will not compromise the protection of environmental assets, people, property, and infrastructure.

11. Implementation

The Strategy is a high-level planning framework for development of the Bullsbrook freight and industrial area. It provides, amongst other things, the broad spatial allocation of land uses, movement networks and infrastructure provision.

It is likely to take several decades before the area is completely developed. Consequently, a flexible and adaptable planning framework that is able to accommodate a range of industrial land uses in a proper and orderly manner is required.

The Strategy area is divided into six land use precincts with general objectives and considerations for each that should be taken into account when undertaking further detailed planning. Which areas are developed first will be contingent on infrastructure requirements for the various industries and resolution of issues relating to the coordination and efficient provision of necessary infrastructure.

Prior to subdivision and development, the land is required to be appropriately zoned under the MRS and local planning scheme. Given the complexity of issues associated with development of this area, there are various investigations and studies that will likely need to be undertaken prior to the WAPC and City of Swan initiating the required amendments.

Fundamental to the future development of the Bullsbrook freight and industrial area is the resolution of water management issues. The area is highly constrained by environmental issues, shallow groundwater, and water dependent ecosystems. The management of water resources will ultimately determine the amount of land that can be developed and whether the level of servicing required to generate the anticipated employment densities can be achieved.

The amount of fill required to achieve the necessary separation of any future development to the groundwater table warrants further investigations early on. In addition, widescale filling may have unacceptable impact on environmentally sensitive areas. It is likely that an innovative approach combining a range of measures will be required, for example, controlled groundwater levels and sub-soil drainage. For these reasons it is recommended that issues relating to water management are fully understood and addressed as part of progressing any rezoning of land within the Strategy area.

Developer Contribution Plans will be required to coordinate delivery of district level infrastructure. The WAPC and City of Swan will need to understand key infrastructure requirements to support initiation of amendments to the local planning scheme.

Table 9 below identifies the various studies that are required to be undertaken to support the various planning stages within the Strategy area.

Table 9 - Rezoning requirements

Stage of Planning Process	Requirement	Justification	Key Stakeholders
MRS / Local Planning Scheme Amendment	District Water Management Strategy	The area comprises a series of water dependent ecosystems, environmentally sensitive areas and land which is seasonally inundated. This presents challenges for development	Developer Department of Water and Environmental Protection City of Swan DPLH

Stage of Planning Process	Requirement	Justification	Key Stakeholders
		including fill requirements, drainage, servicing, and road planning. As such, water management strategy should form part of the early understanding of the issues relating to water management to inform infrastructure planning, developable area/land use and protection of environmental attributes.	
	Service Infrastructure Strategic Planning	Strategic planning of service infrastructure is required to confirm availability of services, identify major infrastructure requirements, and confirm intensity and suitability of land uses.	Service Agencies DPLH
	Preparation of development contribution plan (district level infrastructure)	The WAPC and City of Swan will need to understand key infrastructure requirements to support initiation of amendments to the local planning scheme.	Developers City of Swan DPLH WAPC
	Preparation of major road design concept plans and land requirement plans for road upgrades.	The land requirement plans will be used to determine the reserve width and required upgrades for the major roads within the Strategy area having regard to drainage, service infrastructure, traffic, and any public transport requirements. These land requirement plans will inform development contribution plan(s) as well as the rezoning of the land and identification of triggers for the staging of these upgrades.	Developers City of Swan MRWA DPLH
	Undertake vegetation, wetland assessments and/or flora and fauna surveys	Assessments required to allow identification and assessment of environmental/conservation areas. Landowners to undertake further consultation with relevant agencies to determine what specific surveys or wetland assessments are required.	Developers Department of Water and Environmental Regulation Department of Biodiversity, Conservation and Attractions.
	Preparation of a Bushfire Hazard Level Assessment	Developers to undertake relevant investigations in	Developers City of Swan DFES

Stage of Planning Process	Requirement	Justification	Key Stakeholders
	and Bushfire Management Plan	consultation with the City of Swan and DFES	
	Identification of broad spatial land use patterns	There is a need to identify the land use patterns to ensure alignment with the strategic objectives for the area including the management of land use interfaces.	Developers City of Swan DPLH WAPC
	Preparation of Traffic Impact Assessment	To assess the impacts of any modifications to the road network and/or impacts arising from development	Developer City of Swan MRWA
Local Structure Plans	Developer Contribution Plan (Local)	A DCP (local) is to be prepared in accordance with State Planning Policy 3.6 Infrastructure Contributions.	Developer City of Swan DPLH
	District/Local water Management Strategy	A DWMS/LWMS is to be prepared in accordance with Better Urban Water Management (WAPC 2008), State Planning Policy 2.9 Water Resources (WAPC 2006) and Planning Bulletin 92 Urban Water Management (WAPC 2008).	Developer Department of Water and Environment Protection City of Swan
	Bushfire Hazard Risk and Assessment	Required to be prepared in accordance with WAPC's Guidelines for Planning in Bushfire Prone Areas (Dec 2015), SPP 3.7 – Planning in Bushfire Prone Areas and the Australian Standard AS3959-2009 Construction of buildings in bushfire prone areas (AS3959) (Standards Australia 2009).	Developer City of Swan Department of Fire and Emergency Services DPLH
	Engineering Servicing Report	An Engineering Servicing Report is to be prepared to investigate ground conditions, sewerage, water supply, power supply, telecommunications, gas, and stormwater management and drainage.	Developer City of Swan Service agencies
	Environmental Summary Report / Level 2 Flora and Vegetation Assessment	Developer to undertake consultation with relevant agencies to determine level of investigation required	Developers City of Swan DWER DBCA
	Transport Impact Assessment	To assess the impacts of any modifications to the road network and/or impacts arising from development.	Developer City of Swan MRWA DPLH
	Preparation of management plans	Management plan/s required to allow identification and	Developer DWER

Stage of Planning Process	Requirement	Justification	Key Stakeholders
	for wetlands, public open space and conservation areas, including the Ellen Brook foreshore.	assessment of environmental / conservation areas.	DBCA
Subdivision and Development	Endorsed local structure plan	Subdivision and development are required to generally be in accordance with an endorsed local structure plan.	Developer City of Swan WAPC
	Amendment(s) to local planning scheme	Where the land is not appropriately zoned or where required to allow statutory enforcement of a local structure plan, an amendment to the local planning scheme may also be required.	Developer City of Swan WAPC
	Preparation of management plans	Where identified in the local structure plans, management plans are to be prepared prior to subdivision and development.	Developer Relevant agencies
	Bushfire management plan	A bushfire management plan consistent with the requirements of SPP 3.7. This bushfire management plan is to consider, where applicable, conservation and environmental outcomes associated with any wetland, environmental and remnant vegetation management plans.	Developer City of Swan DFES
	Urban Water Management Plan	Consistent with Better Urban Water Management Framework, an Urban Water Management Plan is to be prepared to support subdivision and/or development.	Developer Department of Water and Environment Protection City of Swan
	Preparation of Design Guidelines	Design guidelines as identified in local structure plans, to support subdivision and development where the following objectives are desirable: ○ High quality built-form solutions providing attractive industrial streetscapes ○ Ensure that the built form, signage, streetscape and landscaping provide an	City of Swan Department of Defence

Stage of Planning Process	Requirement	Justification	Key Stakeholders
		appropriate interface to more sensitive land uses ○ Efficient use of energy, stormwater harvesting and water sensitive design ○ Landscaping that complements land uses, integrates with adjoining natural environment areas and demonstrates best practice urban water sensitive design ○ Consider other requirements (for example, DoD operating restrictions).	

11.1 Staging

The Bullsbrook freight and industrial area is likely to take several decades to be complete as identified within the industrial land demand and market analysis conducted by Macroplan (refer Appendix G). Whilst the protracted timeframes associated with the delivery of the Strategy area may delay investment across the Bullsbrook freight and industrial area, it does allow time to resolve the various infrastructure constraints which have been identified. Consequently, progressing along the requisite studies and detailed planning and keeping a planning framework that is adaptable and flexible to accommodate a range of industrial land uses is pertinent in the short to medium term.

The initial stages of development is expected to occur within Precinct A where the land is already zoned for industrial purposes. The urbanisation of the North Ellenbrook area will provide demand for population driven industry which could result in the early delivery of light and service industries in Precincts B and C.

Planning for the remaining precincts within the Strategy area will progressively be refined through future scheme amendment proposals (under both the MRS and LPS 17) and the preparation local structure plans.

Ultimately, the staging and development of the Bullsbrook freight and industrial area will be a decision for the WAPC as part of future MRS amendments. In submitting requests to the WAPC to amend the MRS, developers will be required to demonstrate that:

- comprehensive local structure plan(s) have been prepared
- there is a strategy for the efficient provision and staging of infrastructure
- the area represents frontal development in terms of servicing and development fronts
- appropriate servicing capacity is identified
- that water management has been satisfactorily and sustainably addressed across the Strategy area
- the development of the area will not prejudice the broader objectives of Bullsbrook freight and industrial area or orderly and proper planning
- there is satisfactory access from the existing road network

- environmental impacts have been satisfactorily addressed
- satisfactory arrangements have been made for developer contributions towards district and local level infrastructure

Following rezoning of the land, the timing of industrial subdivision and development will largely be dependent on:

- provision of key services and infrastructure
- ability and willingness of individual landowners/developers to address road construction/upgrades, environmental, drainage and water management issues
- demand and development take-up rate for industrial land

Appendices

Appendix A - Engagement Register

Date	Organisation / Authority	Type of session e.g. meeting, site visit, workshop, consultation	Session purpose
29/05/2018	Department of Planning, Lands and Heritage, City of Swan	Site Visit	Site visit to understand existing context, opportunities and constraints
31/05/2018	MRWA	Meeting	Meeting to discuss connectivity, movement and interfacing road projects
15/06/2018	Stakeholder Reference Group	Workshop	Alignment Workshop to identify, review and determine major project risks. Develop and agree on mitigation strategies
22/06/2018	Stakeholder Reference Group	Workshop	Workshop held to align expectations of the structure plan and site's purpose and function
29/08/2018	RAAF Base Pearce	Meeting	Meeting to discuss base operational requirements, future planning and impacts on the district structure plan
3/09/2018	Stakeholder Reference Group	Workshop	Workshop held to review outcomes of technical studies, understand and identify emerging issues and agree on key elements of the concept
19/09/2018	Department of Water and Environment Regulation	Meeting	Meeting to discuss development of the DWMS
5/10/2018	Sirona (now Harvis), City of Swan	Meeting	Meeting to understand Harvis' plans for the existing general industry local structure plan areas
8/10/2018	Bullsbrook Residents and Ratepayers Association	Consultation	Consultation with Bullsbrook Residents and Ratepayers Association to provide background information on the project.
1/11/2018	Donald Veal Consultants	Meeting	Meeting to discuss structure plan
5/11/2018	Lendlease	Meeting	Meeting to discuss progression of structure plan
15/11/2018	Lendlease, CLE, City of Swan	Meeting	Meeting to understand plans for urban investigation area to the south of the structure plan area.
21/11/2018	Western Australia Planning Commission	Briefing	Brief WAPC on preliminary concept for district structure plan
26/11/2018	Stakeholder Reference Group	Workshop	To identify any fatal flaws and garner feedback on proposed concept plan prior to formulation of draft
26/11/2018	Donald Veal Consultants	Email	Email to request information on industrial land yields.

27/11/2018	Local Community	Community Consultation	Provide information on the project, seek input from the community
5/12/2018	Water Corporation	Meeting	Meeting with Water Corporation to understand what information Water Corporation requires to provide high-level infrastructure and servicing advice to support delivery of the DSP
6/12/2018	City of Swan	Meeting	Meeting with City of Swan to discuss the proposed concept, land uses and yields with City of Swan with regard to their LPS review
6/12/2018	Department of Water and Environment Regulation and Environmental Protection Authority	Meeting	Meeting with Department of Water and Environment Regulation and Environmental Protection Authority to inform any future MRS Amendments and identify the issues that need to be considered at each of the subsequent planning stages including local structure plan, local scheme amendments and subdivision
6/12/2018	Lendlease, Parcel, Rowe Group, City of Swan	Meeting	Meeting with landowners and developers to understanding timeframes and plans for development of the urban investigation to the south of the Bullsbrook Freight and Industrial area
13/02/2019	City of Swan	Meeting	Meeting to discuss preferred land uses and City of Swan recommendations for DSP
25/02/2019	DPLH, DoT, CoS	Workshop	Discuss comments received from SRG and preliminary DSP Part One
8/04/2019	Department of Water and Environment Regulation	Meeting	
16/04/2019	DPLH	Meeting	To discuss the Muchea DSP and level of information available particularly in relation to water management
27/05/2019	Department of Water and Environment Regulation	Meeting	To discuss DWER requirements for DWMS
31/05/2019	Parcel Property	Meeting	To discuss status of planning for their developments and to exchange information on proposed transport network
9/07/2019	Rowe Group	Phone call	Rod contacted my to query status of structure plan and technical studies
12/07/2019	Lendlease	Meeting	Anthony requested meeting to discuss status and timing of project as well as potential grade separated crossing over the PDNH south of Warbrook

Appendix B - Environmental Study



Department of Planning, Lands and Heritage

Bullsbrook Freight and Industrial Land Use Planning Strategy

Environmental Study

December 2020

Executive summary

GHD has been commissioned by Department of Planning, Lands and Heritage to prepare a desktop Environmental Study to support the Bullsbrook Freight and Industrial Land Use Planning Strategy for an area of land located within Bullsbrook, Western Australia (hereon referred to as the 'study area').

The key findings of the study are summarised below:

- The study area is located within the south-west of Western Australia and experiences a Mediterranean climate. Average temperature data (sourced from Pearce RAAF – Station number: 009053) ranges from 8.2 °C in August to 33.5 °C in January. Mean annual rainfall is 654 mm (BoM 2018).
- The study area lies immediately east of the Darling Scarp foothills, has a predominantly flat topographic profile and is considered to have poor drainage, with one permanent surface water body (Twin Swamps Nature Reserve) located within 1 km of the study area boundary.
- The surface geology of the study area comprises mainly Pebbly Silt, Sand, Limestone, and Peaty Clay (Geological Survey of Western Australia 1984).
- Acid Sulfate Soil (ASS) risk mapping obtained through the Australian Soil Resource Information System (ASRIS 2018) indicates that the study area contains soils with ASS risk high to moderate risk and Moderate to low risk of ASS occurrence.
- No known or suspected contaminated sites lie within 5 km of the study area (DWER 2018).
- One DBCA managed land lies within the boundaries of the study area – the Gnangara-Moore River State Forest (F 6, Class A) which intersects the western boundary. This portion of Gnangara-Moore River State Forest is also listed as Bush Forever Sites No. 6 and 399. Nine other DBCA-managed conservation areas are located within 5 km of the study area.
- Seven Bush Forever sites intersect the study area (Bush Forever sites 6, 100, 97, 294, 296, 298 and 399) (Government of Western Australia, 2000). An additional 9 Bush Forever sites are located within 5 km of the study area.
- No Regional Parks intersect the study area or occur within a 5 km buffer of the study area.
- The Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011 is in place to protect habitat suitable for the long-term survival of wild populations of the Western Swamp Tortoise. The Policy defines an area which includes Ellen Brook and Twin Swamps Nature Reserves. A search of the study area found that its southern border is located approximately 0.8 km north of the Twin Swamps Nature Reserve (R 27621), and 4.7 km north of Ellen Brook Nature Reserve (R 27620) for the preservation of fauna, namely the Western Swamp Tortoise. The study area also intersects the northern extent of the policy area as defined in the Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011.
- A number of Environmentally Sensitive Areas (ESAs) occur or intersect the study area. These ESAs are likely aligned with Threatened Ecological Communities (TECs), DBCA-managed lands, Bush Forever and geomorphic wetlands.
- The study area is situated in the Southwest Botanical Province of WA (Beard 1990) within the Swan Coastal Plain bioregion and the Perth subregion as described by the Interim Biogeographic Region of WA (IBRA).

- Four vegetation complexes on Aeolian deposits of the Swan Coastal Plain are present within the study area: Yangara Complex, Beermullah Complex, Bassendean Complex and Guilford Complex (Heddle *et al*. 1980).
- Within the 5 km buffered study area, 905 native flora taxa representing 100 families and 351 genera have been identified. Dominant families recorded included Fabaceae, Myrtaceae, Poaceae, Proteaceae and Cyperaceae.
- Searches of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (PMST), *NatureMap* database identified the present/potential presence of 39 conservation significant flora taxa within a 5 km buffer of the study area.
- Five habitat linkages intersect the study area: Link ID 27, 28, 29, 30, and 31.
- A search of the *NatureMap* database identified 425 species within the 5 km of the study area. The search included 13 amphibians, 108 birds, 4 fish, 235 invertebrates, 13 mammals and 52 reptiles (DBCA 2007–).
- Searches of the EPBC Act PMST, *NatureMap* database and DBCA Threatened and Priority Fauna database identified the present/potential presence of 13 conservation significant fauna taxa within a 5 km buffer of the study area

The Bullsbrook Freight and Industrial Land Use Planning Strategy will respond to the key findings of the Environmental Study by providing guidance on appropriate responses as part of further detailed planning to protect existing environmental assets and values within and surrounding the site.

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1. Introduction

1.1 Background

Located in the north-east fringe of the metropolitan area approximately 35 kilometres (km) from the Perth CBD, Bullsbrook consists of mainly rural and rural residential land with a small population base. However, significant growth is expected within the Bullsbrook Townsite within the next 15 to 20 years, with the population expected to triple. In addition, the State strategic planning framework has identified a significant portion of land for urban expansion within the City of Swan over the next 30 years.

As the population continues to grow across the broader Perth and Peel regions, there will be increasing demand for employment opportunities both within and across sub-regions. Highly efficient freight services will also be required to maintain the supply chains necessary for servicing this population. The State has acknowledged the need to identify existing and future freight corridors and strategic sites to avoid land use and transport conflicts and to manage the interface between communities and freight corridors and centres.

1.2 Purpose of this report

GHD Pty Ltd (GHD) was engaged by the Department of Planning, Lands and Heritage (DPLH) on behalf of the Western Australian Planning Commission (WAPC) to prepare the Bullsbrook Freight and Industrial Land Use Planning Strategy (the 'Strategy') for the proposed Bullsbrook Intermodal Terminal (IMT) and surrounding area. This Environmental Study Report has been prepared to support the Strategy.

1.3 Location

The Bullsbrook Freight and Industrial Land Use Planning Strategy study area (the 'study area') is located in the north-west corridor in the City of Swan. The study area is bounded by the RAAF Base Pearce and Great Northern Highway to the east, Shire of Chittering to the north, the Perth – Darwin National Highway (PDNH) to the west and rural land identified for urban expansion to the south, and covers approximately 3,509 hectares (ha).

1.4 Scope of work

The scope of work for the Environmental Study was to undertake a desktop study of the study area to identify the biodiversity and natural area assets to ensure significant environmental values are considered in the structure planning process.

1.5 Relevant legislation, conservation codes and background information

In Western Australia significant communities, and flora and fauna are protected under both Federal and State Government legislation. In addition, regulatory bodies also provide a range of guidance and information on expected standards and protocols for environmental surveys.

An overview of key legislation and guidelines, conservation codes and background information relevant to this assessment are provided in Appendix B.

1.6 Limitations

This report has been prepared by GHD for DPLH and may only be used and relied on by DPLH for the purpose agreed between GHD and the DPLH as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than DPLH arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report (June 2018). Minor updates to the report were completed in December 2020, limited to the project name. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by DPLH and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Methodology

2.1 Desktop study

A desktop assessment was undertaken to identify relevant environmental information pertaining to the study area. The assessment included viewing GIS spatial files available from Government of Western Australia (GoWA 2018) and reviewing relevant reports and publicly available, government managed databases. The information sources utilised in this assessment are presented in Table 1.

Table 1 Information sources

Aspect	Information source
Climate	Bureau of Meteorology (BoM) Climate Statistics (2018) and WeatherZone (2018)
Contaminated sites	Department of Water and Environmental Regulation (DWER) Contaminated Sites Database (DWER 2018b)
Geology, topography and soils	Geological Survey of Western Australia 1984
Acid Sulfate Soils	Australian Soil Resources Information System (ASRIS 2018)
Conservation areas	Bush Forever Areas 2000 (DOP-071) Department of Biodiversity, Conservation and Attractions (DBCA) – Legislated Lands and Waters (DBCA-011) DBCA – Lands of Interest (DBCA-012) Regional Parks (DBCA-026)
Environmentally Sensitive Areas	DWER Clearing Permit System (DWER 2018a)
Hydrology	Ramsar Sites (DBCA-010) Directory of Important Wetlands in Australia - Western Australia (DBCA-045) Geomorphic Wetlands, Swan Coastal Plain (DBCA-019)
Vegetation	Pre-European Vegetation (DPIRD-006) Vegetation Complexes – Swan Coastal Plain
Threatened and Priority Ecological Communities	Threatened Ecological Community (TEC) and Priority Ecological Community (PEC) spatial dataset *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (DEE 2018)
Flora diversity and conservation significant flora	DBCA *NatureMap* database (DBCA 2007–)
Fauna diversity and conservation significant fauna	DBCA *NatureMap* database (DBCA 2007–)
Aboriginal heritage	Aboriginal Heritage Inquiry System (Department of Planning, Lands and Heritage (DPLH) 2018)

Aspect	Information source
European heritage	*inHerit* database (Heritage Council State Heritage Office 2018)
Matters of National Environmental Significance (MNES)	EPBC Act PMST (DEE 2018)

2.2 Data limitations

The desktop study uses a variety of online resources such as the WA Museum and DBCA *NatureMap* database (DBCA 2007–), and the EPBC Act PMST (DEE 2018). The EPBC Act PMST is based on bioclimatic modelling for the potential presence of species. As such, this does not represent actual records of the species within the area. The records from the DBCA searches provide more accurate information for the general area. However, some records of collections, sightings or trappings cannot be dated and often misrepresent the current range of species.

3. Existing environment

3.1 Climate

The study area is located in the south-west of Western Australia and experiences a Mediterranean climate with mild, wet winters and hot, dry summers. The nearest Bureau of Meteorology weather station with long-term data is Pearce RAAF Base (Station number: 009053) located directly adjacent to the study area.

Climatic data from this site indicates the mean maximum temperature of the area ranges from 17.9 °C in July to 33.5 °C in January and the mean minimum temperature ranges from 8.2 °C in August to 17.6 °C in February. The mean annual rainfall is 654.6 mm with an average of 57.5 rain days per year (BoM 2018). Climate statistics for this station are summarised in Plate 1 (source: Weather Zone 2018).

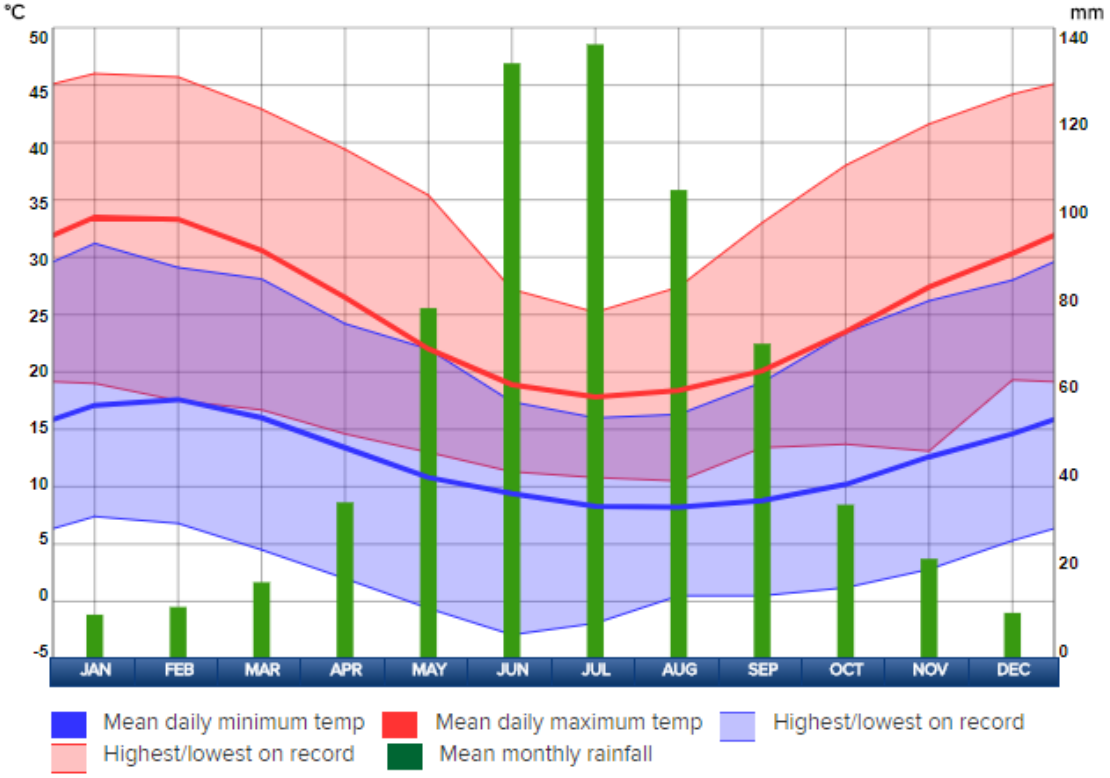


Plate 1 Pearce annual temperature and rainfall (source WeatherZone 2018)

3.2 Geology, landforms, soils

The study area is located at the base of the foothills immediately east of the Darling Scarp. The study area is generally flat and is considered to be poorly drained with one permanent surface water body (Twin Swamps Nature Reserve) located within 1 km of the study area boundary.

According to the Perth Metropolitan Region 1:50 000 Environmental Geology Series Muchea Survey (Geological Survey of Western Australia 1984) the surface geology of the study area comprises Pebbly Silt (Mgs_1: strong brown silt with common fine to occasionally course grained, sub-rounded laterite, quartz, heavily weathered granite pebbles, some fine to medium-grained quartz sand, of alluvial origin), Sand (S_{11}: light grey, medium grained, sub-angular to rounded quartz and feldspar, moderately sorted), Limestone (LS_5: white, fine-grained, in places algal laminated, some kankar development, of alluvial origin), Peaty Clay (Cps: dark grey and black with variable sand content, of lacustrine origin), Sand (S_8: very light grey at surface, yellow at

depth, fine to medium-grained, sub-rounded quartz, moderately well sorted, of eolian origin), and Sand over Pebbly Silt (S_{10}: sand as S_8 overlying Mgs_1 gravelly silt).

3.3 Acid sulfate soils

A review of Acid Sulfate Soil (ASS) risk mapping indicates that the study area contains soils with ASS risk high to moderate risk and Moderate to low risk of ASS occurrence (ASRIS 2018) (Figure 1).

3.4 Contamination

DWER holds information on known contaminated sites on the Contaminated Sites Database which have been classified by the DWER as one of the following:

- Contaminated – remediation required
- Contaminated – restricted use
- Remediated for restricted use.

A review of the Contaminated Sites Database on 6th June 2018 indicated the study area is not known to be contaminated.

3.5 Conservation areas

3.5.1 DBCA managed lands

The study area intersects a portion of the Gnangara-Moore River State Forest (F 65, Class A) along its western boundary. This portion of Gnangara-Moore River State Forest is also listed as Bush Forever Sites No. 6 and 399. Gnangara-Moore River State Forest extends from Pinjar to Whiteman Park covering approximately 66,000 ha.

Nine other DBCA-managed conservation areas are located within 5 km of the study area (Table 2).

Table 2 DBCA managed lands within 5 km of the study area

Name and ID	Class	Location
Twin Swamps Nature Reserve (R 27621)	Class A	0.8 km south of the study area
Walyunga National Park (R 2065)	Class A	1.3 km east of the study area
Bullsbrook Nature Reserve (R 1654)	-	1.8 km east of the study area
Un-name Nature Reserve (R 46875)	Class A	1.8 km south of the study area
Un-named Nature Reserve (R 46919)	Class A	1.8 km south of the study area
Neaves Road Nature Reserve (R 47146)	Class A	2.15 km west of the study area
Un-named Nature Reserve (R 2336)		4.4 km north of the study area
Un-named Nature Reserve (R 44622)	Class A	4.4 km north of the study area
Ellen Brook Nature Reserve (R 27620)	Class A	4.7 km south of the study area

3.5.2 Bush Forever

The study area intersects seven Bush Forever sites (Table 3). An additional nine Bush Forever sites are located within 5 km of the study area.

Table 3 Bush Forever sites intersecting the study area

Name	Site No.	Location
Neaves Road Creek	100	Intersects the northern extent of the study area
Kirby Road Bushland	97	Intersects north-west extent of study area
Pearce Aerodrome and Adjacent Bushland	294	Intersects the eastern boundary of study area
Ellen Brook	296	Intersects the south-east part of the study area
Della Road South Bushland	298	Occurs within the south-west part of study area
Melaleuca Park and Adjacent Bushland	399	Intersects the western boundary of the study area
Cooper Road Water Reserve and Adjacent Bushland	6	Intersects the southern boundary of the study area

3.5.3 Regional Parks

No Regional Parks intersect the study area or occur within a 5 km buffer of the study area.

3.5.4 Western Swamp Tortoise Habitat

The Western Swamp Tortoise (*Pseudemydura umbrina*) is listed as Critically Endangered under the EPBC Act and the *Biodiversity Conservation Act 2016* (BC Act). The tortoise is found in two remnant habitats (Ellen Brook and Twin Swamps Nature Reserves) and two translocated (re-introduced) habitats (Moore River Nature Reserve and Lake Wannamal Nature Reserve at Mogumber).

The Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011 is in place to protect habitat suitable for the long-term survival of wild populations of the Western Swamp Tortoise. The Policy defines an area which includes Ellen Brook and Twin Swamps Nature Reserves as well as adjacent areas, and covers approximately 2,250 ha.

The study area is located approximately 0.8 km north of Twin Swamps Nature Reserve (R 27621) and 4.7 km north of Ellen Brook Nature Reserve (R 27620). The study area also intersects the northern extent of the policy area as defined in the Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011.

3.6 Environmentally Sensitive Areas

A number of ESAs occur within or intersect the study area. These ESAs are likely aligned with TECs, DBCA-managed lands, Bush Forever and geomorphic wetlands.

3.7 Hydrology

3.7.1 Surface water

A number of drainage lines occur within the study area. The main drainage line is Ellen Brook, which flows in a south westerly direction for the entire length of the study area. Ellen Brook is a natural waterway that extends approximately 65 km, discharging into the upper Swan Estuary near West Swan Road in Belhus. The brook is ephemeral with flows generally from May to

December. Tributaries associated with Ellen Brook also intersect the study area including Nambab Brook and Ki-it Monger Brook. These brooks generally flow east to west and join Ellen Brook along its length. A number of other drainage lines occur within the study area, these are likely to be minor and ephemeral.

3.7.2 Wetlands

RAMSAR wetlands

There are no RAMSAR listed wetlands within or in 5 km of the study area.

Wetlands of National Significance

There are no Wetlands of National Significance within or in 5 km of the study area.

Geomorphic wetlands

There are 64 Geomorphic Wetlands that intersect the study area. These are listed in Table 4.

Table 4 Summary of the Geomorphic Wetlands located within the study area

UFI	Type	Category	Location
8533	Floodplain	Conservation	South-western portion of study area
8536	Floodplain	Conservation	South-western portion of study area
8538	Dampland	Resource Enhancement	South-western portion of study area
8773	Palusplain	Conservation	Northern portion of study area
8779	Sumpland	Resource Enhancement	Northern portion of study area
8783	Sumpland	Resource Enhancement	Central portion of study area
8784	Floodplain	Multiple Use	Central portion of study area
8785	Floodplain	Multiple Use	Central portion of study area
8787	Dampland	Resource Enhancement	South-western portion of study area
8788	Dampland	Conservation	South-western portion of study area
8789	NA	Conservation	South-western portion of study area
8908	Sumpland	Resource Enhancement	South-western portion of study area
8909	Palusplain	Conservation	Northern portion of study area
8910	Palusplain	Conservation	Northern portion of study area
8911	Palusplain	Conservation	Northern portion of study area
8912	Palusplain	Conservation	Central portion of study area
8913	Palusplain	Conservation	Central portion of study area
8914	Palusplain	Conservation	Central portion of study area

UFI	Type	Category	Location
8915	Palusplain	Resource Enhancement	Central portion of study area
8916	Palusplain	Resource Enhancement	Central portion of study area
8917	Palusplain	Multiple Use	Central portion of study area
8918	Palusplain	Multiple Use	Central portion of study area
8919	Sumpland	Multiple Use	Central portion of study area
8920	Palusplain	Conservation	Central portion of study area
8921	Palusplain	Conservation	Central portion of study area
8922	Palusplain	Conservation	Central portion of study area
8923	Palusplain	Resource Enhancement	Central portion of study area
8924	Sumpland	Resource Enhancement	Central portion of study area
8925	Palusplain	Resource Enhancement	Central portion of study area
8926	Sumpland	Conservation	South-western portion of study area
8927	Palusplain	Multiple Use	Southern portion of study area
9172	Palusplain	Resource Enhancement	Central portion of study area
9175	Palusplain	Multiple Use	Central portion of study area
9176	Palusplain	Conservation	Central portion of study area
9177	Palusplain	Multiple Use	Southern study area
12254	Palusplain	Conservation	Northern portion of study area
12415	Palusplain	Conservation	South-eastern portion of study area
12417	Palusplain	Conservation	South-eastern portion of study area
12418	Dampland	Multiple Use	South-eastern portion of study area
12419	Palusplain	Conservation	South-eastern portion of study area
12424	Palusplain	Conservation	South-eastern portion of study area
12433	Palusplain	Conservation	South-eastern portion of study area
12433	Palusplain	Conservation	South-eastern portion of study area
12434	Palusplain	Conservation	South-eastern portion of study area
12495	Palusplain	Conservation	Eastern portion of study area
12531	Palusplain	Multiple Use	Eastern portion of Site
12534	Palusplain	Conservation	Eastern portion of study area

UFI	Type	Category	Location
12535	Palusplain	Conservation	Northern portion of study area
12536	Palusplain	Conservation	Central portion of study area
12537	Palusplain	Conservation	Central portion of study area
12538	Palusplain	Conservation	Central portion of study area
12539	Palusplain	Conservation	Central portion of study area
12681	Palusplain	Conservation	South-eastern portion of study area
12686	Palusplain	Multiple Use	South-eastern portion of study area
12687	Palusplain	Conservation	South-eastern portion of study area
13391	Sumpland	Conservation	South-western portion of study area
14417	Dryland	NA	South-western portion of study area
15042	Sumpland	Conservation	South-western portion of study area
15044	Floodplain	Resource Enhancement	South-western portion of study area
15046	Floodplain	Conservation	South-western portion of study area
15057	Floodplain	Multiple Use	South-western portion of study area
15282	Palusplain	Multiple Use	South Eastern portion of study area
15732	Palusplain	Multiple Use	Majority of study area
15734	Palusplain	Conservation	Southern study area

3.8 Vegetation and flora

3.8.1 Regional biogeography

The study area is situated in the Southwest Botanical Province of WA (Beard 1990) within the Swan Coastal Plain bioregion and the Perth subregion as described by the Interim Biogeographic Region of WA (IBRA).

The Swan Coastal Plain bioregion is a low lying coastal plain, mainly covered with woodlands. It is dominated by Banksia or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas. In the east, the plain rises to duricrusted Mesozoic sediments dominated by Jarrah woodland. The Perth subregion is composed of colluvial and Aeolian sands, alluvial river flats and coastal limestone. It is dominated by Heath and/or Tuart woodlands on limestone, Banksia and Jarrah-Banksia woodlands on Quaternary marine dunes of various ages and Marri on colluvial and alluvials. The subregion also includes a complex series of seasonal wetlands (Mitchell *et al.* 2002).

3.8.2 Broad vegetation mapping

Regional vegetation has been mapped by Heddle *et al*. (1980) based on major geomorphic units on the Swan Coastal Plain. The Heddle *et al*. (1980) mapping indicates that four

vegetation complexes on aeolian and fluviatile deposits of the Swan Coastal Plain are present within the study area:

- Yanga Complex: Predominantly a closed scrub of *Melaleuca* species and low open forest of *Casuarina obesa* (Swamp Sheoak) on the flats subject to inundation. On drier sites the vegetation reflects the adjacent vegetation complexes of Bassendean and Coonambidgee.
- Beermullah Complex: Mixture of low open forest of *Casuarina obesa* (Swamp Sheoak) and open woodland of *Corymbia calophylla* (Marri) - *Eucalyptus wandoo* (Wandoo) – *E. marginata* (Jarrah). Minor components include closed scrub of *Melaleuca* species and occurrence of *Actinostrobus pyramidalis* (Swamp Cypress).
- Bassendean Complex-North: Vegetation ranges from a low open forest and low open woodland of *Banksia* species and *Eucalyptus todtiana* (Pricklybark) to low woodland of *Melaleuca* species and sedgelands which occupy the moister sites.
- Guildford Complex: A mixture of open forest to tall open forest of *Corymbia calophylla* (Marri) - *Eucalyptus wandoo* (Wandoo) – *E. marginata* (Jarrah) and woodland *of E. wandoo* (with rare occurrences of *Eucalyptus lane-poolei* (Salmon White Gum)). Minor components include *E. rudis* (Flooded Gum) - *Melaleuca rhaphiophylla* (Swamp Paperbark).

The native vegetation within the study area has been extensively cleared with less than 10% of the pre-European extent remaining. Remnant vegetation is limited to isolated patches, largely within Bush Forever sites and along watercourses.

3.8.3 Conservation significant ecological communities

A search of the EPBC Act PMST identified five EPBC Act-listed TECs potentially occurring within the study area (with 5 km buffer). These TECs were also identified in a search of the DBCA TEC/PEC database, where one is listed as a Critically Endangered TEC and another is listed as a Priority 3 PEC by DBCA. Details of these communities are provided in Table 5.

Table 5 Threatened and Priority Ecological Communities identified in the desktop searches

Community type	EPBC Act	BC Act / DBCA	Description	Location
Assemblages of plants and invertebrate animals of tumulus (organic mound) springs of the Swan Coastal Plain	Endangered	Critically Endangered	This ecological community is characterised by continuous discharge of groundwater in raised areas of peat. The peat and surrounds provide a stable, permanently moist series of micro habitats. This community has a high heterogeneity of invertebrate fauna assemblages and commonly contain Ostracoda, Nematoda, Cladocera, Copepods, Oligochaeta, Tardigrada, Turbellaria and Insecta. Dominant vascular plants typically associated with the community include *Banksia littoralis, Melaleuca preissiana* and *Eucalyptus rudis* and the shrubs *Agonis linearifolia*, *Pteridium esculentum*, *Astartea fascicularis* and *Cyclosorus interruptus*	Community known to occur within the 5 km buffered study area
Banksia Woodlands of the Swan Coastal plain (TEC)	Endangered	Priority 3	The ecological community is a woodland associated with the SCP of southwest WA. A key diagnostic feature is a prominent tree layer of *Banksia*, with scattered *Eucalyptus* and other tree species often present among or emerging above the *Banksia* canopy. The understorey is a species rich mix of sclerophyllous shrubs, graminoids and forbs. The ecological community is characterised by a high endemism and considerable localised variation in species composition across its range.	Community considered likely to occur within the 5 km buffered study area
Clay Pans of the Swan Coastal Plain	Critically Endangered	Comprises four TECs listed as Vulnerable and Endangered	The ecological community occurs in WA where clay soils form an impermeable layer close to the landscape surface, and wetlands form that rely solely on rainfall to fill and then dry to impervious pans in summer. The ecological community generally occurs as shrubland over a ground layer of geophytes, herbs and sedges. There are no dominant species which characterise the entire ecological community although the community shows similar landform and vegetation structural features across its range.	Community known to occur within the 5 km buffered study area
Corymbia calophylla – Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain	Endangered	Critically Endangered	The ecological community is located on heavy soils of the eastern side of the SCP between Bullsbrook, and Capel. Dominant species in the community are the trees *Corymbia calophylla* (Marri), and occasionally *Eucalyptus wandoo* (Wandoo); the shrubs *Xanthorrhoea preissii, Acacia pulchella, Banksia dallanneyi, Gompholobium marginatum*, and *Hypocalymma*	Community known to occur within the 5 km buffered study area

Community type	EPBC Act	BC Act / DBCA	Description	Location
			angustifolium and the herbs *Burchardia congesta, Cyathochaeta avenacea* and *Neurachne alopecuroidea.* The introduced species *Briza maxima* and *Hypochaeris glabra* are also common, but weed levels in most occurrences are generally quite low.	
Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain	Endangered	Endangered	This ecological community occurs on the heavy soils of the eastern side of the Swan Coastal Plain. Dominant native species in the community include trees *Casuarina obesa*, *Eucalyptus decipiens* and *Eucalyptus foecunda* and the shrubs *Melaleuca huegelii, Alyogyne huegelii* var*. huegelii, Grevillea curviloba* ssp*. incurva, Grevillea curviloba* ssp*. curviloba, Grevillea evanescens, Melaleuca acerosa, Melaleuca huegelii,* and the herb *Thysanotus arenarius.*	Community known to occur within 5 km buffered study area

3.8.4 Flora diversity

A search of the *NatureMap* database identified 905 flora taxa representing 100 families and 351 genera within 5 km of the study area (Appendix C). This total comprised 767 native taxa and 138 naturalised (introduced) taxa. Dominant families recorded included Fabaceae, Myrtaceae, Poaceae, Proteaceae and Cyperaceae.

3.8.5 Conservation significant flora

Searches of the EPBC Act PMST and *NatureMap* database identified the present/potential presence of 39 conservation significant flora taxa within a 5 km buffer of the study area (Table 6). The DBCA Threatened and Priority Flora and WA Herbarium databases also a indicate number of significant flora records within and adjacent to the study area (Figure 4).

Table 6 Conservation significant flora recorded within 5 km of the study area

Family	Taxon	Status		Source
		EPBC Act	BC Act/ DBCA	
Apiaceae	*Eryngium pinnatifidum* subsp. *Palustre* (G.J. Keighery 13459)		P3	DBCA, WAHerb
Apiaceae	*Platysace ramosissima*		P3	DBCA, TPFL, WAHerb
Araliaceae	*Hydrocotyle lemnoides*		P4	DBCA, TPFL, WAHerb
Araliaceae	*Hydrocotyle striata*		P1	DBCA
Asteraceae	*Millotia tenuifolia* var. *laevis*		P2	DBCA, WAHerb
Boraginaceae	*Halgania corymbosa*		P3	WAHerb
Centrolepidaceae	*Centrolepis caespitosa*		P4	DBCA, TPFL
Cyperaceae	*Cyathochaeta teretifolia*		P3	DBCA, TPFL, WAHerb
Cyperaceae	*Eleocharis keigheryi*	VU	T	DBCA, EPBC, TPFL, WAHerb
Cyperaceae	*Schoenus capillifolius*		P3	DBCA, TPFL, WAHerb
Cyperaceae	*Schoenus griffinianus*		P4	WAHerb
Cyperaceae	*Schoenus natans*		P4	DBCA
Cyperaceae	*Schoenus* sp. Bullsbrook (J.J. Alford 915)		P2	DBCA, WAHerb
Dasypogonaceae	*Calectasia cyanea*	CR	T	DBCA, EPBC
Dasypogonaceae	*Calectasia elegans*		P2	WAHerb
Droseraceae	*Drosera occidentalis* subsp. *occidentalis*		P4	DBCA, TPFL, WAHerb
Elaeocarpaceae	*Tetratheca pilifera*		P3	TPFL, WAHerb
Ericaceae	*Styphelia filifolia*		P3	DBCA, WAHerb
Fabaceae	*Acacia anomala*	VU	T	DBCA, EPBC, TPFL, WAHerb

Family	Taxon	Status		Source
		EPBC Act	BC Act/ DBCA	
Fabaceae	*Acacia drummondii* subsp. *affinis*		P3	DBCA, WAHerb
Fabaceae	*Acacia oncinophylla subsp. oncinophylla*		P3	WAHerb
Fabaceae	*Isotropis cuneifolia* subsp. *glabra*		P2	DBCA
Haemodoraceae	*Anigozanthos humilis subsp. chrysanthus*		P4	WAHerb
Haemodoraceae	*Haemodorum loratum*		P3	DBCA, TPFL, WAHerb
Haemodoraceae	*Phlebocarya pilosissima* subsp. *pilosissima*		P3	DBCA, WAHerb
Haloragaceae	*Meionectes tenuifolia*		P3	DBCA, TPFL
Hydatellaceae	*Trithuria occidentalis*	EN	T	DBCA, EPBC, TPFL, WAHerb
Malvaceae	*Guichenotia tuberculata*		P3	DBCA, WAHerb
Malvaceae	*Lasiopetalum glutinosum subsp. glutinosum*		P3	WAHerb
Myrtaceae	*Beaufortia purpurea*		P3	WAHerb
Myrtaceae	*Darwinia foetida*	CR	T	DBCA, EPBC, TPFL, WAHerb
Myrtaceae	*Oxymyrrhine coronata*		P4	TPFL, DBCA
Myrtaceae	*Verticordia serrata* var. *linearis*		P3	DBCA, WAHerb
Orchidaceae	*Caladenia huegelii*	EN	T	DBCA, EPBC, TPFL
Orchidaceae	*Cyanicula ixioides* subsp. *ixioides*		P4	DBCA, WAHerb
Phyllanthaceae	*Poranthera moorokatta*		P2	DBCA, WAHerb
Proteaceae	*Adenanthos cygnorum* subsp. *chamaephyton*		P3	DBCA, TPFL, WAHerb
Proteaceae	*Grevillea althoferorum* subsp. *fragilis*	EN	T	DBCA, EPBC, TPFL, WAHerb
Proteaceae	*Grevillea curviloba* subsp. *curviloba*	EN	T	DBCA, EPBC, TPFL, WAHerb
Proteaceae	*Grevillea curviloba* subsp. *incurva*	EN	T	DBCA, EPBC, TPFL, WAHerb
Proteaceae	*Persoonia rudis*		P3	DBCA, TPFL, WAHerb
Proteaceae	*Synaphea grandis*		P4	DBCA, WAHerb
Restionaceae	*Hypolaena robusta*		P4	WAHerb
Stylidiaceae	*Stylidium aceratum*		P3	DBCA, WAHerb

Family	Taxon	Status		Source
		EPBC Act	BC Act/ DBCA	
Stylidiaceae	*Stylidium longitubum*		P4	DBCA, TPFL, WAHerb
Stylidiaceae	*Stylidium paludicola*		P3	DBCA, WAHerb
Stylidiaceae	*Stylidium squamellosum*		P2	DBCA, WAHerb
Stylidiaceae	*Stylidium trudgenii*		P3	DBCA, WAHerb
Xanthorrhoeaceae	*Chamaescilla gibsonii*		P3	DBCA, WAHerb

3.9 Fauna

3.9.1 Ecological linkages

Five ecological linkages intersect the study area. These comprise:

- Link ID 27: Links to Link number 28, 31, 29, 128, 26, 35 and links Bush Forever Sites 294 (located within the study area), 296 (located within the study area), 301 via Ellen Brook
- Link ID 28: Links to Link number 30, 94, 93, 27 and links Bush Forever Sites 80, 87, 82, 291, 292, 294 (located within the study area)
- Link ID 29: Links Bush Forever Sites 296, 294 via Kit-Monger Brook and then links Bush Forever Sites 89, 88, 86 with Link number 34
- Link ID 30: Links Bush Forever Sites 380, 462, 97 (located within the study area), 92 with Link number 28
- Link ID 31: Links Bush Forever Sites 399 (located within the study area), 6, 294 (located within the study area) and Link number 13, 27

3.9.2 Fauna diversity

A search of the *NatureMap* database identified 425 species within the 5 km of the study area. The search included 13 amphibians, 108 birds, 4 fish, 235 invertebrates, 13 mammals and 52 reptiles. There are nine invasive birds (Common Myna, House Sparrow, Common Stirling etc.), 12 invasive mammals (including rabbit, pig fox, domestic dog, cat etc.), and two invasive reptiles listed as likely to occur within the study area.

3.9.3 Conservation significant fauna

Searches of the EPBC Act PMST, *NatureMap* database and DBCA Threatened and Priority Fauna database identified the present/potential presence of 13 conservation significant fauna taxa within a 5 km buffer of the study area (Figure 5). This total does not include those species that are exclusively marine as no marine habitat is present within the study area.

Table 7 Conservation significant fauna recorded within 5 km of the study area

Species	Common name	Status		Search
		BC Act/ DBCA	EPBC Act	
Botaurus poiciloptilus	Australasian Bittern	EN	EN	NM
Calyptorhynchus banksii subsp. *naso*	Forest Red-tailed Black Cockatoo	VU	VU	NM, EPBC
Calyptorhynchus latirostris	Carnaby's Cockatoo	EN	EN	NM, EPBC
Falco peregrinus	Peregrine Falcon	OS		NM
Leioproctus contrarius	a short-tongued bee	P3		NM
Leioproctus douglasiellus	a short-tongued bee	EN	CR	NM, EPBC
Westralunio carteri	Carter's Freshwater Mussel	VU	VU	NM, EPBC
Dasyurus geoffroii	Chuditch, Western Quoll	VU	VU	NM, EPBC
Isoodon fusciventer	Quenda, southwestern brown bandicoot	P4		NM
Macrotis lagotis	Bilby, Dalgyte, Ninu	VU	VU	NM
Notamacropus irma	Western Brush Wallaby	P4		NM
Neelaps calonotos	Black-striped Snake, black-striped burrowing snake	P3		NM
Pseudemydura umbrina	Western Swamp Tortoise, Western Swamp Turtle	CR	CR	NM, EPBC

3.10 Matters of National Environmental Significance

MNES are factors that require legislated protection in order to conserve biodiversity, protect World Heritage and National Heritage Places, and comply with international treaties. The following MNES were identified in the desktop searches:

- No World Heritage properties lie within the buffered (5 km) study area
- No National Heritage places lie within the buffered (5 km) study area
- No Wetlands of International Importance lie within the buffered (5 km) study area

- There are 5 listed Threatened Ecological Communities that are known or likely to occur within the buffered (5 km) study area
- There are 9 migratory species or their habitats that are likely or may occur within the buffered (5 km) study area
- There are 37 threatened species or their habitats that are likely or may occur within the buffered (5 km) study area.

Other Matters Protected by the EPBC Act were also identified in the desktop searches:

- There are 14 parcels of Commonwealth Land located with the buffered (5 km) study area
- There are 8 State and Territory Reserves with the buffered (5 km) study area
- One Regional Forest Agreement lies with the buffered (5 km) study area
- There are 38 invasive species or their habitats that are likely to occur within the buffered (5 km) study area.

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Appendices

Appendix A – Figures

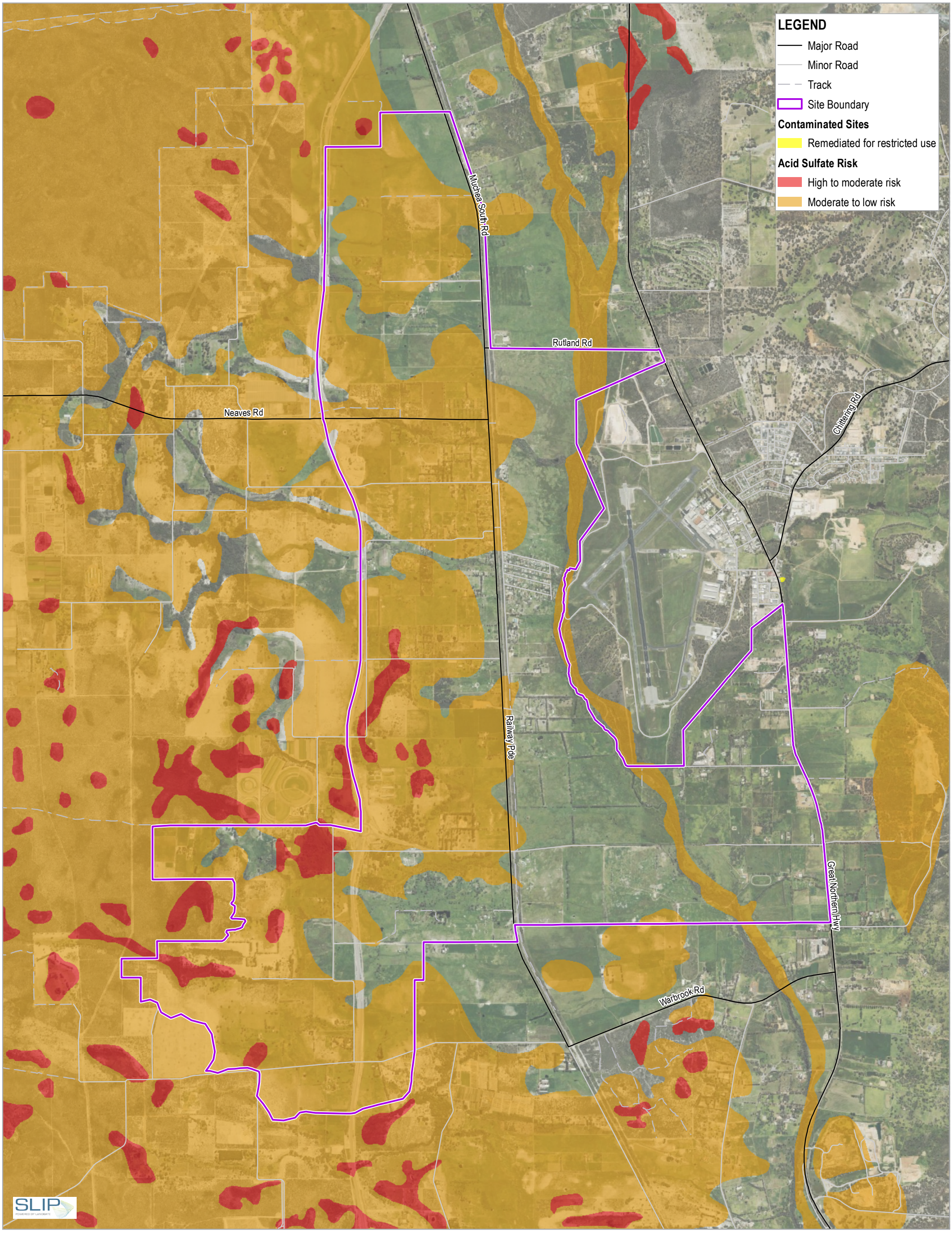
Figure 1 **Acid Sulfate Soils and contamination**

Figure 2 **Conservation Areas**

Figure 3 **Surface water and wetlands**

Figure 4 **Native vegetation, TECs and PECs and conservation significant flora records**

Figure 5 **Ecological linkages and conservation significant fauna records**



Paper Size ISO A3

0 200 400 600 800 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

Department of Planning, Lands and Heritage
Bullsbrook Freight and Industrial
Land Use Planning Strategy

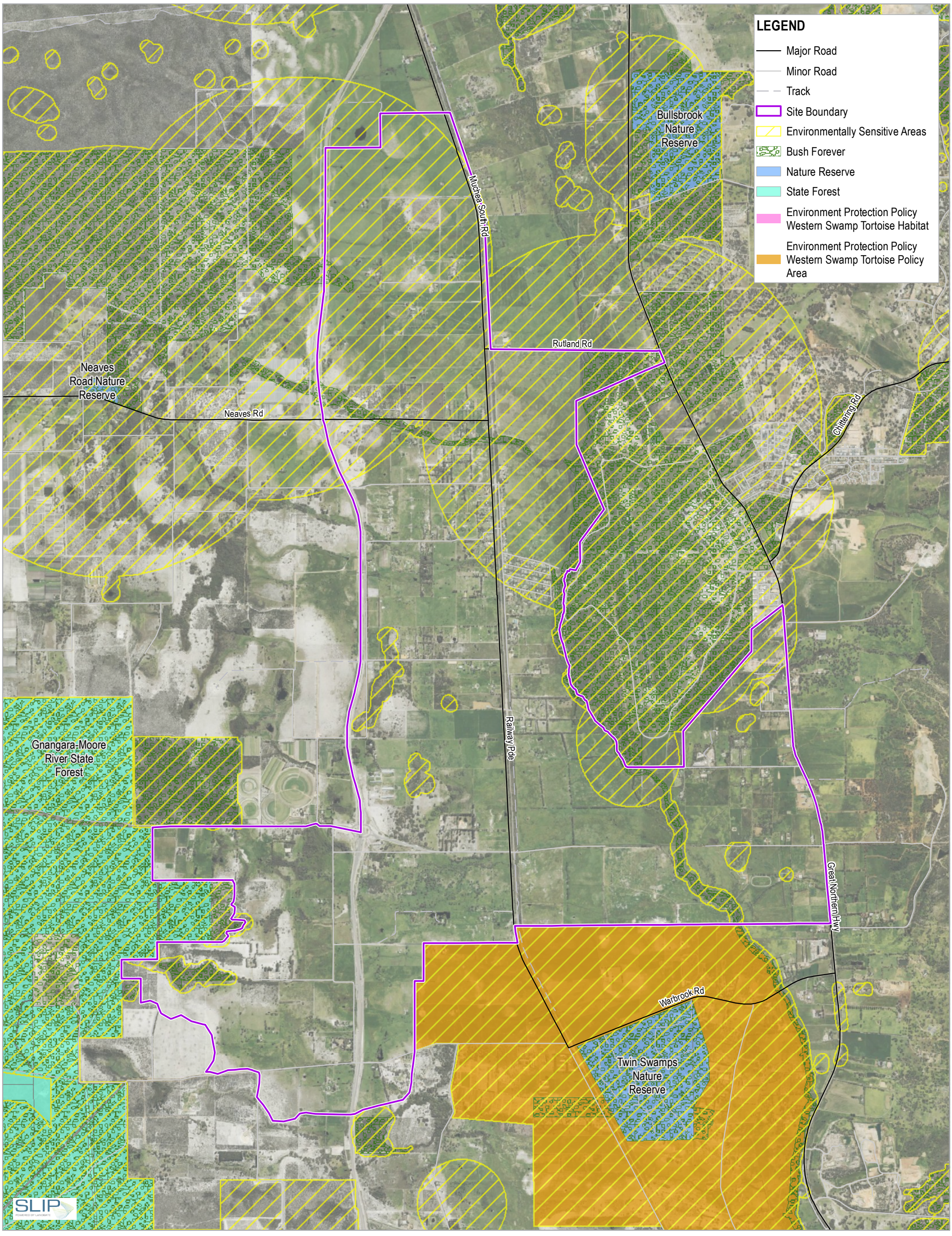
Acid Sulphate Soil and Contaminated Land

Project No. **61-37134**
Revision No. **0**
Date **10 Dec 2020**

FIGURE 1

G:\61\37134\GIS\Maps\Working\Environment Report\6137134_001_Fig1ASSContamLand_Rev0.mxd
Print date: 10 Dec 2020 - 15:13

Data source: GHD: Site Boundary - 20180702; DWER: Acid Sulfate Risk - 20171219, Contaminated Sites - 20180516; Landgate: Imagery - (August 2018), Roads - 20180820. Created by: kaadams



Paper Size ISO A3

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Metres

Map Projection: Transverse Mercator
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GHD

Department of Planning, Lands and Heritage
Bullsbrook Freight and Industrial Land Use Planning Strategy

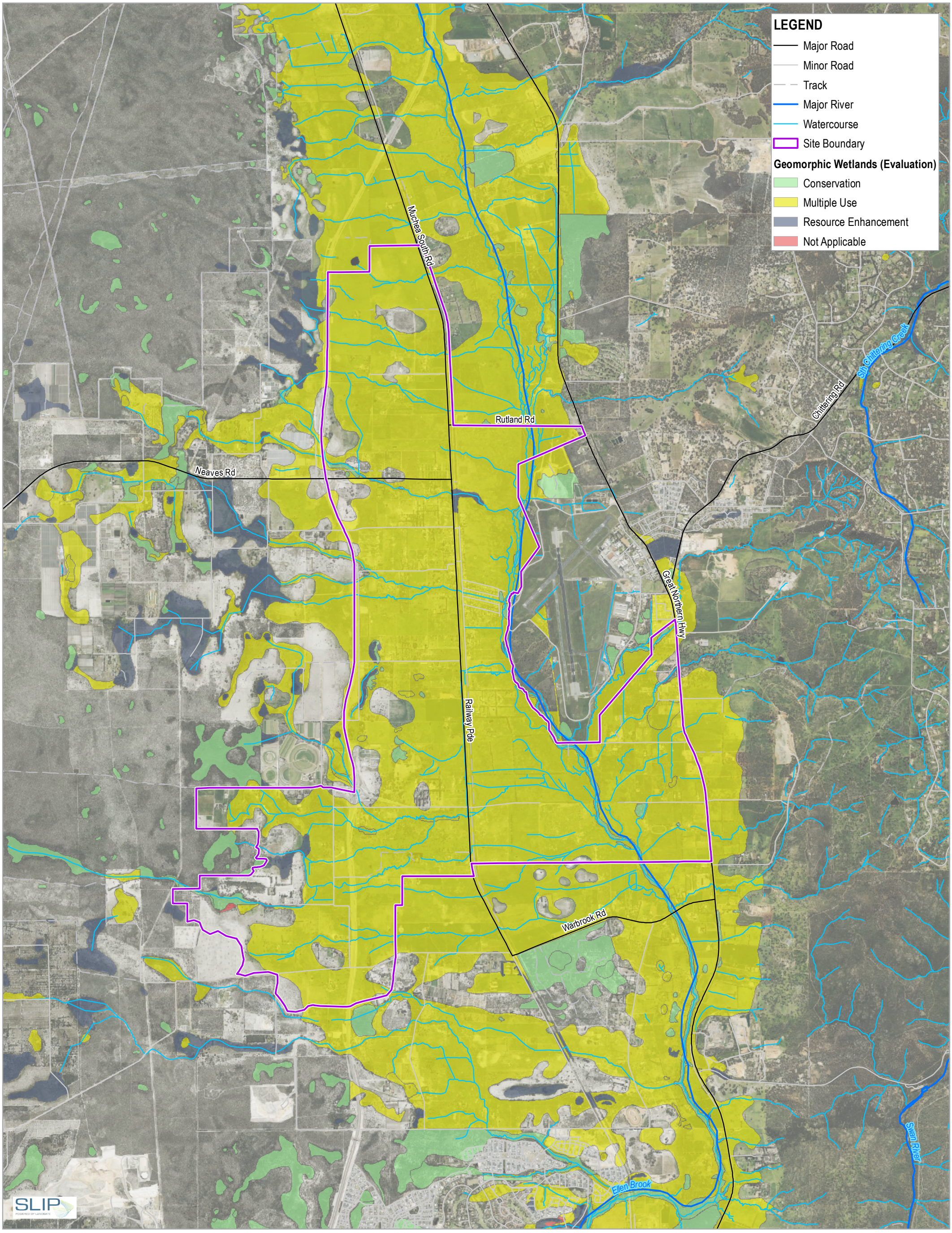
Conservation Areas

Project No. **61-37134**
Revision No. **0**
Date **10 Dec 2020**

FIGURE 2

G:\61\37134\GIS\Maps\Working\Environment Report\6137134_002_Fig2ConservationAreas_Rev0.mxd
Print date: 10 Dec 2020 - 15:21

Data source: GHD: Site Boundary - 20180702; DBCA: Managed Lands - 20180517; DoP: Bush Forever; EPA: Environment Protection Policy Western Swamp Tortoise Habitat, Western Swamp Tortoise Policy Area, Environmentally Sensitive Areas; Landgate: Imagery (August 2018), Roads - 20180516. Created by: kaadams



Paper Size ISO A3

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Kilometres

Map Projection: Transverse Mercator
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Grid: GDA 1994 MGA Zone 50

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GHD

Department of Planning, Lands and Heritage
Bullsbrook Freight and Industrial
Land Use Planning Strategy

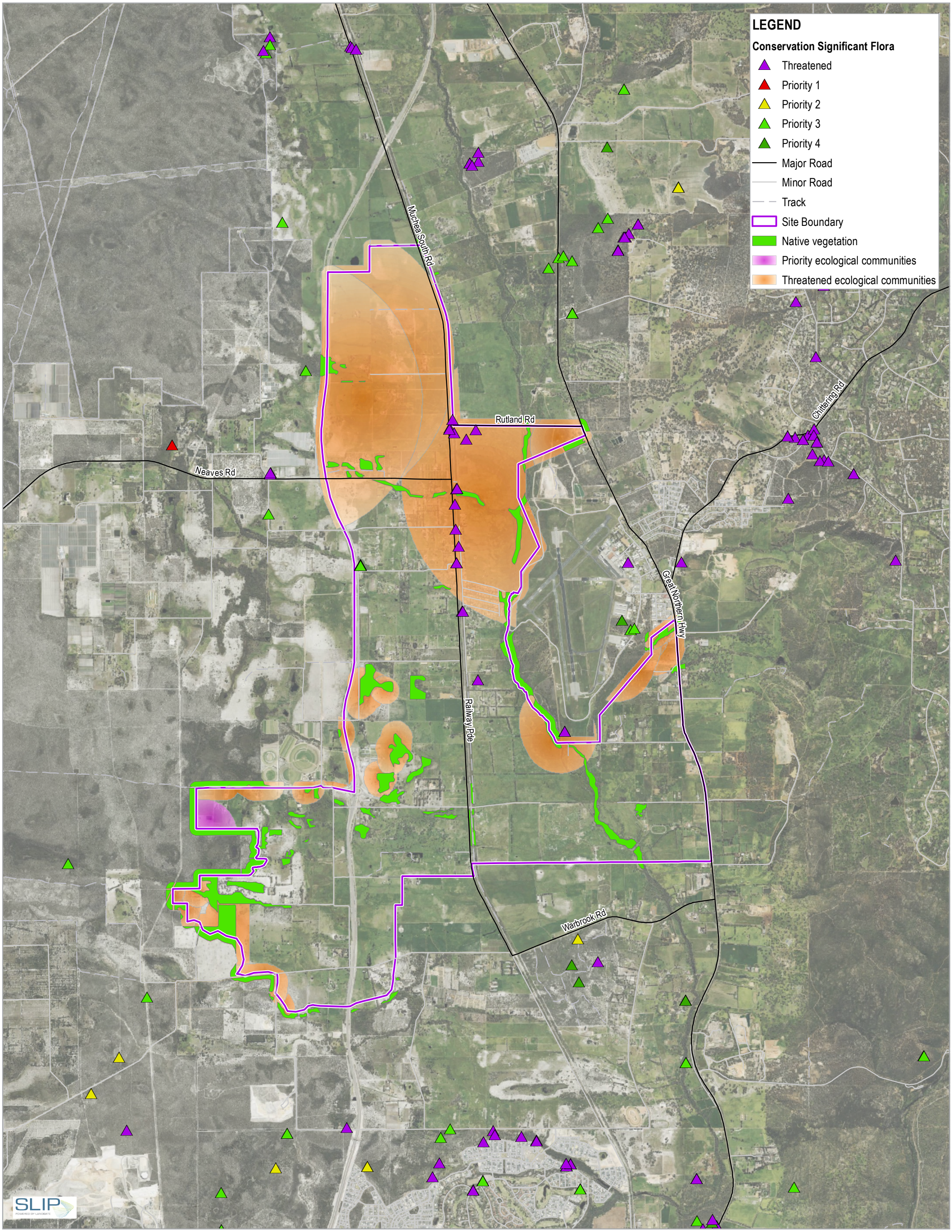
Hydrology Aspects

Project No. **61-37134**
Revision No. **0**
Date **10 Dec 2020**

FIGURE 3

G:\61\37134\GIS\Maps\Working\Environment Report\6137134_003_Fig3HydrologicalAspects_Rev0.mxd
Print date: 10 Dec 2020 - 15:17

Data source: DPLH: Site Boundary - 20180702; DBCA: Geomorphic Wetlands - 20180223; Landgate: Imagery (August 2018), Roads - 20180516, Watercourses - 20160128. Created by: kaadams



Paper Size ISO A3

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

Department of Planning, Lands and Heritage
Bullsbrook Freight and Industrial
Land Use Planning Strategy

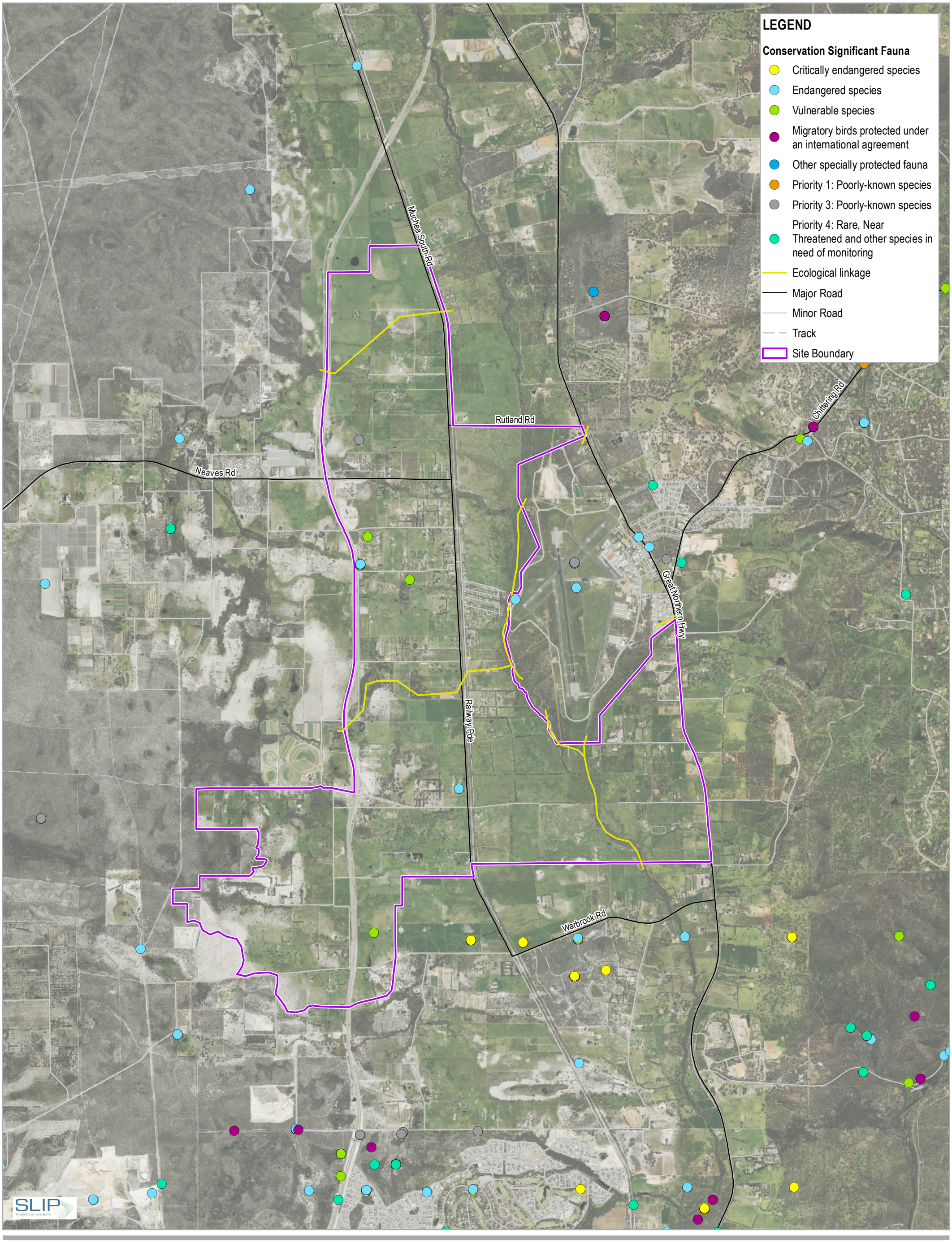
Native vegetation and conservation significant ecological communities and flora

Project No. **61-37134**
Revision No. **0**
Date **10 Dec 2020**

FIGURE 4

G:\61\37134\GIS\Maps\Working\Environment

Data source: DPLH: Site Boundary - 20180702; Landgate: Imagery (August 2018), Roads - 20180820; DBCA: Conservation Significant Flora, Conservation Significant Fauna, TEC/PEC; DPIRD: Native Vegetation - 20171026. Created by: kaadams



Paper Size ISO A3

0 0.5 1 1.5 2

Kilometres

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

GHD

Department of Planning, Lands and Heritage
Bullsbrook Freight and Industrial Land Use Planning Strategy

Ecological linkages and Conservation Significant Fauna

Project No. 61-37134
Revision No. 0
Date 10 Dec 2020

FIGURE 5

G:\61\37134\GIS\Maps\Working\Environment Report\6137134_005_Fig5EcologicalLinkagesAndConservationSignificantFauna_Rev0.mxd
Print date: 10 Dec 2020 - 15:20

Data source: Landgate: Imagery (August 2018), Roads - 20180820; GHD: Site Boundary - 20180702; DPLH: Ecological Linkages; DBCA: Conservation Significant Fauna. Created by: kaadams

Appendix B – Relevant Legislation, Conservation codes and Background information

Relevant legislation

Federal *Environment Protection and Biodiversity Conservation Act 1999*

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Federal Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, which are defined in the EPBC Act as Matters of National Environmental Significance (MNES).

The biological aspects listed as MNES include:

- Nationally threatened flora and fauna species and ecological communities
- Migratory species

A person must not undertake an action that has, will have, or is likely to have a significant impact (direct or indirect) on MNES, without approval from the Federal Minister for the Environment.

The EPBC Act is administered by the Department of the Environment and Energy (DoEE).

State *Environmental Protection Act 1986*

The *Environmental Protection Act 1986* (EP Act) is the primary legislative Act dealing with the protection of the environment in Western Australia. The Act allows the Environmental Protection Authority (EPA), to prevent, control and abate pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing. Part IV of the EP Act is administered by the EPA and makes provisions for the EPA to undertake environmental impact assessment of significant proposals, strategic proposals and land use planning schemes.

The Department of Water and Environment Regulation (DWER) is responsible for administering the clearing provisions of the EP Act (Part V). Clearing of native vegetation in Western Australia requires a permit from the DWER, unless exemptions apply. Applications for clearing permits are assessed by the Department and decisions are made to grant or refuse the application in accordance with the Act. When making a decision the assessment considers clearing against the ten clearing principles as specified in Schedule 5 of the EP Act:

a) Native vegetation should not be cleared if it comprises a high level of biodiversity.

b) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a significance habitat for fauna indigenous to Western Australia.

c) Native vegetation should not be cleared if it includes, or is necessary, for the continued existence of rare flora.

d) Native vegetation should not be cleared if it comprises the whole or part of native vegetation in an area that has been extensively cleared.

e) Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.

f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.

g) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.

h) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.

i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

j) Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.

Exemptions for clearing include clearing that is a requirement of a written law or authorised under certain statutory processes (listed in Schedule 6 of the EP Act) and exemptions for prescribed low impact day-to-day activities (prescribed in the Environmental Protection (Clearing of Native Vegetation) Regulations 2004); these exemptions do not apply in environmentally sensitive areas (ESAs).

State *Biodiversity and Conservation Act 2016*

The *Biodiversity Conservation Act 2016* (BC Act) provides for the conservation and protection of biodiversity and biodiversity components, as well as the promotion of the ecologically sustainable use of biodiversity components in Western Australia. The BC Act replaces both the repealed *Wildlife Conservation Act 1950* (WC Act) and the *Sandalwood Act 1929* (Sandalwood Act), as well as their associated regulations. To attain the objectives of the BC Act, principles of ecological sustainable development have been established:

- Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations
- If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation
- The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations
- The conservation of biodiversity and ecological integrity should be a fundamental consideration indecision-making
- Improved valuation, pricing and incentive mechanisms should be promoted.

The BC Act is administered by the Department of Biodiversity Conservation and Attractions (DBCA).

State *Biosecurity and Agriculture Management Act 2007*

The *Biosecurity and Agriculture Management Act 2007* (BAM Act) and associated regulations are administered by the Department of Primary Industries and Regional Development (DPIRD) and replace the repealed *Agriculture and Related Resources Protection Act 1976.* The main purposes of the BAM Act and its regulations are to:

- Prevent new animal and plant pests (vermin and weeds) and diseases from entering WA
- Manage the impact and spread of those pests already present in the state
- Safely manage the use of agricultural and veterinary chemicals
- Increased control over the sale of agricultural products that contain violative chemical residues

The Western Australian Organism List (WAOL) provides the status of organisms which have been categorised under the BAM Act. A Declared Pest is a prohibited organism or an organism for which a declaration under Section 22(2) of the Act is in force. Declared Pests may be assigned a control category including: C1 (exclusion), C2 (eradication) and C3 (management). The category may apply to the whole of the State, LGAs, districts, individual properties or even paddocks, and all landholders are obliged to comply with the specific category of control. Categories of control are defined below.

DPIRD Categories for Declared Pests under the BAM Act

Control class code	Description
C1 (Exclusion)	Pests will be assigned to this category if they are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2 (Eradication)	Pests will be assigned to this category if they are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3 (Management)	Pests will be assigned to this category if they are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Background information

Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are declared by the Minister for Environment under Section 51B of the EP Act. The Table below outlines the aspects of areas declared as ESA in the Environmental Protection (Environmentally Sensitive Areas) Notice 2005.

Aspects of ESAs

Aspects of Environmentally Sensitive Areas
A declared World Heritage property as defined in Section 13 of the EPBC Act.
An area that is included on the Register of the National Estate (RNE), because of its natural values, under the *Australian Heritage Commission Act 1975* of the Commonwealth (the RNE was closed in 2007 and is no longer a statutory list – all references to the RNE were removed from the EPBC Act on 19 February 2012).
A defined wetland and the area within 50 m of the wetland. Defined wetlands include Ramsar wetlands, conservation category wetlands and nationally important wetlands.
The area covered by vegetation within 50 m of rare flora, to the extent to which the vegetation is continuous with the vegetation in which the rare flora is located.
The area covered by a Threatened Ecological Community.
A Bush Forever Site listed in "Bush Forever" Volumes 1 and 2 (2000), published by the Western Australia Planning Commission, except to the extent to which the site is approved to be developed by the Western Australia Planning Commission.
The areas covered by the *Environmental Protection (Gnangara Mound Crown Land) Policy 1992*.
The areas covered by the *Environmental Protection (Western Swamp Tortoise Habitat) Policy 2002*.
The areas covered by the lakes to which the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (EPP Lakes) applies.
Protected wetlands as defined in the *Environmental Protection (South West Agricultural Zone Wetlands) Policy 1998*.

Reserves and conservation areas

Bush Forever

Bush Forever, which was released in December 2000 and proclaimed in 2010, is a Government initiate aimed to retain and protect regionally significant bushland on the Swan Coastal Plain within the Perth Metropolitan Region. Bush Forever aims to protect more than 51,000 hectares of regionally significant bushland within 287 sites across the metropolitan portion of the Swan Coastal Plain (Government of Western Australia (GoWA) 2000). Bush Forever sites constitute ESAs as declared by a notice under Section 51B of the EP Act.

Department of Biodiversity, Conservation and Attractions managed lands and waters

DBCA manages lands and waters throughout Western Australia to conserve ecosystems and species, and to provide for recreation and appreciation of the natural environment. DBCA managed lands and waters include national parks, conservation parks and reserves, marine parks and reserves, regional parks, nature reserves, State forest and timber reserves. DBCA managed conservation estate, is

vested with the Conservation Commission of Western Australia. Access to, or through, some areas of DBCA managed lands may require a permit or could be restricted due to management activities. Proposed land use changes and development proposals that abut DBCA managed lands will generally be referred to DBCA throughout the assessment process.

Wetlands

Wetlands include not only lakes with open water, but areas of seasonally, intermittently or permanently waterlogged soil. Approximately 25 percent of the Swan Coastal Plain between Moore River and Mandurah is classified as wetland (Hill et al. 1996).

Though extensive in area, not all wetlands retain significant ecological values due to the concentration of urban and agricultural development in the region. Most wetlands have been cleared, filled or developed over, leaving only 20 percent of all the wetlands that were present on the Swan Coastal Plain prior to European settlement. Of these, an estimated 15 percent of the wetland area has retained high ecological values (Hill et al. 1996).

Ramsar Listed Wetlands

The Convention of Wetlands of International Importance was signed in 1971 at the Iranian town of Ramsar. The Convention has since been referred to as the Ramsar Convention. Ramsar Listed wetlands are “sites containing representative, rare or unique wetlands, or wetlands that are important for conserving biological diversity … because of their ecological, botanical, zoological, limnological or hydrological importance” (DoEE 2017b). Once a Ramsar Listed Wetland is designated, the country agrees to manage its conservation and ensure its wise use. Under the Convention, wise use is broadly defined as “maintaining the ecological character of a wetland” (DoEE 2017b).

Nationally important wetlands

Wetlands of national significance are listed under the Directory of Important Wetlands in Australia. Nationally important wetlands are wetlands which meet at least one of the following criteria (DoEE 2017a):

- It is a good example of a wetland type occurring within a biogeographic region in Australia
- It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex
- It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail
- The wetland supports one percent or more of the national populations of any native plant or animal taxa
- The wetland supports native plant or animal taxa or communities which are considered endangered or vulnerable at the national level
- The wetland is of outstanding historical or cultural significance

Lakes covered under the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992*

The *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (EPP Lakes) protects the environmental values of selected lakes/wetlands on the Swan Coastal Plain.

Geomorphic wetlands

Categorisation of wetlands has been conducted by Hill et al. (1996), delineating Swan Coastal Plain wetlands into levels of protection and management categories. Conservation Category Wetlands are wetlands that support high levels of attributes and functions. Resource Enhancement Wetlands are those that have been partly modified but still support substantial functions and attributes. Multiple Use

Wetlands are classified as those wetlands with few attributes that still provide important wetland functions. Multiple Use wetlands have few important ecological attributes and functions remaining.

The Geomorphic Wetlands Swan Coastal Plain dataset displays the location, boundary, geomorphic classification (wetland type) and management category of wetlands on the Swan Coastal Plain.

Vegetation extent and status

The National Objectives and Targets for Biodiversity Conservation 2001–2005 (Commonwealth of Australia 2001) recognise that the retention of 30 percent or more of the pre-clearing extent of each ecological community is necessary if Australia's biological diversity is to be protected. This is the threshold level below which species loss appears to accelerate exponentially and loss below this level should not be permitted. This level of recognition is in keeping with the targets recommended in the review of the National Strategy for the Conservation of Australia's Biological Diversity (ANZECC 2000).

The extent of remnant native vegetation in WA has been assessed by Shepherd et al. (2002) and the GoWA (2019), based on broadscale vegetation association mapping by Beard (various publications). The GoWA produces Statewide Vegetation Statistics Reports that are used for a number of purposes including conservation planning, land use planning and when assessing development applications. The reports are updated every 2-3 years.

Vegetation condition

The vegetation condition can be assessed in accordance with the vegetation condition rating scale for the South West and Interzone Botanical Provinces (EPA 2016a). The scale recognises the intactness of vegetation and consists of six rating levels as outlined below.

Vegetation condition rating scale for the South West and Interzone Botanical Provinces

Condition	South West and Interzone Botanical Provinces description
Pristine	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.

Condition	South West and Interzone Botanical Provinces description
Completely Degraded	The structure of vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

Conservation codes

Species of significant flora, fauna and communities are protected under both Federal and State Acts. The Federal EPBC Act provides a legal framework to protect and manage nationally important flora and communities. The State WC Act is the primary wildlife conservation legislation in Western Australia. Information on the conservation codes is summarised in the following sections.

Ecological communities

Conservation significant communities

Ecological communities are defined as naturally occurring biological assemblages that occur in a particular type of habitat (English and Blyth 1997). Federally listed Threatened Ecological Communities (TECs) are protected under the EPBC Act. The BC Act provides for the Minister to list an ecological community as a TEC (section 27), or as a collapsed ecological community (section 31) statutory listing of State TECs by the Minister. The legislation also describes statutory processes for preparing recovery plans for TECs, the registration of their critical habitat, and penalties for unauthorised modification of TECs.

Possible TECs that do not meet survey criteria are added to the DBCA Priority Ecological Community (PEC) List under Priorities 1, 2 and 3. These are ecological communities that are adequately known; are rare but not threatened, or meet criteria for Near Threatened. PECs that have been recently removed from the threatened list are placed in Priority 4. These ecological communities require regular monitoring. Conservation dependent ecological communities are placed in Priority 5. PECs are not listed under any formal Federal or State legislation, however, may be listed as TECs under the EPBC Act.

Codes and definitions for TECs listed under the EPBC Act and/ or BC Act

Categories	Definition
Federal Government Conservation Categories (EPBC Act)	
Critically Endangered (CR)	An ecological community if, at that time, is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria (as outlined in Environment Protection and Biodiversity Conservation Regulations 2000)
Endangered (EN)	An ecological community if, at that time: A) is not critically endangered; and B) is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria (as outlined in Environment Protection and Biodiversity Conservation Regulations 2000)

Categories	Definition
Vulnerable (VU)	An ecological community if, at that time: A) is not critically endangered or endangered; and B) is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria (as outlined in Environment Protection and Biodiversity Conservation Regulations 2000)
Western Australia Conservation Categories (BC Act)	
Threatened Ecological Communities	
Critically Endangered (CR)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.
Collapsed ecological communities	
An ecological community is eligible for listing as a collapsed ecological community at a particular time if, at that time – (a) there is no reasonable doubt that the last occurrence of the ecological community has collapsed); or (b) the ecological community has been so extensively modified throughout its range that no occurrence of it is likely to recover – (i) its species composition or structure; or (ii) its species composition and structure. Section 33 of the BC Act provides for a collapsed ecological community to be regarded as a threatened ecological community if it is discovered in a state that no longer makes it eligible for listing as a collapsed ecological community.	

Conservation categories and definitions for PECS as listed by the DBCA

Category	Description
Priority 1	Poorly known ecological communities. Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤100 ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Category	Description
Priority 2	Poorly known ecological communities. Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200 ha). At least some occurrences are not believed to be under immediate threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
Priority 3	Poorly known ecological communities. (i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.
Priority 4	Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. (i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. (ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (iii) Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority 5	Conservation Dependent ecological communities. Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Other significant vegetation

Vegetation may be significant for a range of reasons other than a statutory listing. The EPA (2016a, b) states that significant vegetation may include vegetation that includes the following:

- Restricted distribution
- Degree of historical impact from threatening processes
- A role as a refuge
- Providing an important function required to maintain ecological integrity of a significant ecosystem
- Local endemism in restricted habitats
- Novel combinations of taxa

- A role as a key habitat for Threatened species or large population representing a significant proportion of the local to regional total population of a species
- Being representative of a vegetation unit in 'pristine' condition in a highly cleared landscape, recently discovered range extensions, or isolated outliers of the main range.

This may apply at a number of levels, so the unit may be significant when considered at the fine-scale (intra-locality), intermediate-scale (locality or inter-locality) or broad-scale (local to region).

Flora and fauna

Conservation significant flora and fauna

Species of significant flora are protected under both Federal and State legislation. Any activities that are deemed to have a significant impact on species that are recognised by the EPBC Act, and/or the BC Act can warrant referral to the DEE and/or the EPA.

The Federal conservation level of flora and fauna species and their significance status is assessed under the EPBC Act. The significance levels for flora and fauna used in the EPBC Act align with the International Union for Conservation of Nature (IUCN) Red List criteria, which are internationally recognised as providing best practice for assigning the conservation status of species. The EPBC Act also protects land and migratory species that are listed under International Agreements. The list of migratory species established under section 209 of the EPBC Act comprises:

- Migratory species which are native to Australia and are included in the appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals Appendices I and II)
- Migratory species included in annexes established under the Japan-Australia Migratory Bird Agreement (JAMBA) and the China–Australia Migratory Bird Agreement (CAMBA)
- Native, migratory species identified in a list established under, or an instrument made under, an international agreement approved by the Minister, such as the republic of Korea–Australia Migratory Bird Agreement (ROKAMBA)

The State conservation level of flora and fauna species and their significance status also follows the IUCN Red List criteria. Under the BC Act flora and fauna can be listed as Threatened, Extinct and as Specially Protected species.

Threatened species are those are species which have been adequately searched for and are deemed to be, in the wild, either rare, under identifiable threat of extinction, or otherwise in need of special protection, and have been gazetted as such. The assessment of the conservation status of Threatened species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria. Specially protected species meet one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection. Species that are listed as Threatened or Extinct species under the BC Act cannot also be listed as Specially Protected species.

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

For the purposes of this assessment, all species listed under the EPBC Act, BC Act and DBCA Priority species are considered significant.

Categories and definitions for EPBC Act and BC Act listed flora and fauna species

Conservation category	Definition
Threatened species	
Critically Endangered (CR)	Threatened species considered to be "facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines.
Endangered (EN)	Threatened species considered to be "facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines
Vulnerable (VU)	Threatened species considered to be "facing a high risk of extinction in the wild in the medium term future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines.
Extinct species	
Extinct (EX)	Species where "there is no reasonable doubt that the last member of the species has died", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).
Extinct in the Wild (EW)	Species that "is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).
Specially protected species	

Conservation category	Definition
Migratory (MI)	Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act). Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species
Species of special conservation interest (conservation dependent fauna) (CD)	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.
Other specially protected fauna (OS)	Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Conservation codes for DBCA listed Priority flora and fauna

Priority category	Definition
Priority 1	Poorly-known taxa Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
Priority 2	Poorly-known taxa Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
Priority 3	Poorly-known taxa Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and

Priority category	Definition
	known threatening processes exist that could affect them. Such species are in need of further survey.
Priority 4	Rare, Near Threatened and other taxa in need of monitoring A. Rare: Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. B. Near Threatened. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. C. Taxa that have been removed from the list of threatened taxa during the past five years for reasons other than taxonomy.

Other significant flora

Flora species, subspecies, varieties, hybrids and ecotypes may be significant for a range of reasons, other than a statutory listing. The EPA (2016a, b) states that significant flora may include taxa that have/are:

- A keystone role in a particular habitat for Threatened or Priority flora or fauna species, or large populations representing a considerable proportion of the local or regional total population of a species
- Relictual status, being representation of taxonomic or physiognomic groups that no longer occur widely in the broader landscape
- New species or anomalous features that indicate a potential new species
- Being representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range)
- Unusual species, including restricted subspecies, varieties, or naturally occurring hybrids
- Local endemism (a restricted distribution) or association with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems).

Other significant fauna

Fauna species may be significant for a range of reasons other than those protected by international agreement or treaty, Specially Protected or Priority Fauna. Significant fauna may include short-range endemic species, species that have declining populations or declining distributions, species at the extremes of their range, or isolated outlying populations, or species which may be undescribed (EPA 2010).

Introduced plants (weeds)

Declared Pests

Information on species considered to be Declared Pests is provided under *State Biosecurity and Agriculture Management Act 2007.*

Weeds of National Significance

The spread of weeds across a range of land uses or ecosystems is important in the context of socio-economic and environmental values. The assessment of Weeds of National Significance (WoNS) is based on four major criteria:

- Invasiveness
- Impacts
- Potential for spread
- Socio-economic and environmental values

Australian state and territory governments have identified thirty-two Weeds of National Significance (WoNS); a list of 20 WoNS was endorsed in 1999 and a further 12 were added in 2012.

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English, V and Blyth, J 1997, *Identifying and Conserving Threatened Ecological Communities in the South West Botanical Province*, Perth, Department of Conservation and Land Management.

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Shepherd, DP, Beeston, GR & Hopkins, AJM 2002, *Native Vegetation in Western Australia – Extent, Type and Status, Resource Management Technical Report 249*, Perth, Department of Agriculture.

Appendix C – Desktop searches

EPBC Act PMST Report

NatureMap Flora Report

NatureMap Fauna Report

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.

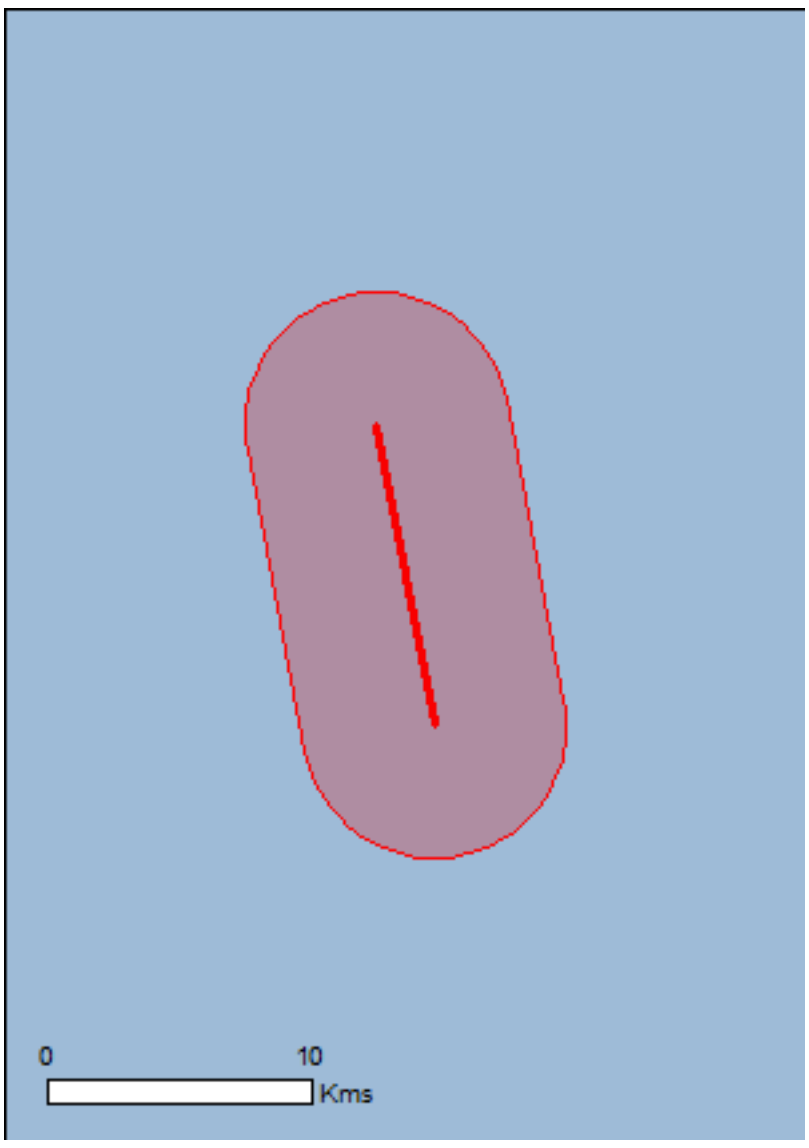
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

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

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Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

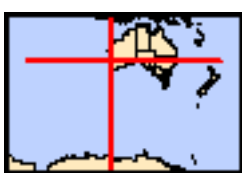
Caveat
Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates

Buffer: 5.0Km



Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	37
Listed Migratory Species:	9

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	14
Commonwealth Heritage Places:	None
Listed Marine Species:	15
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:	8
Regional Forest Agreements:	1
Invasive Species:	38
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

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
Assemblages of plants and invertebrate animals of tumulus (organic mound) springs of the Swan Coastal Plain	Endangered	Community known to occur within area
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area
Clay Pans of the Swan Coastal Plain	Critically Endangered	Community likely to occur within area
Corymbia calophylla - Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain	Endangered	Community known to occur within area
Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain	Endangered	Community known to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Calyptorhynchus baudinii Baudin's Cockatoo, Long-billed Black-Cockatoo [769]	Endangered	Species or species habitat likely to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Fish		
Galaxiella nigrostriata Blackstriped Dwarf Galaxias, Black-stripe Minnow [88677]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Insects		
Leioproctus douglasiellus a short-tongued bee [66756]	Critically Endangered	Extinct within area
Mammals		
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat may occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area
Petrogale lateralis lateralis Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Translocated population known to occur within area
Other		
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat may occur within area
Plants		
Acacia anomala Grass Wattle, Chittering Grass Wattle [8153]	Vulnerable	Species or species habitat likely to occur within area
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat likely to occur within area
Anigozanthos viridis subsp. terraspectans Dwarf Green Kangaroo Paw [3435]	Vulnerable	Species or species habitat likely to occur within area
Anthocercis gracilis Slender Tailflower [11103]	Vulnerable	Species or species habitat may occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat known to occur within area
Chamelaucium sp. Gingin (N.G.Marchant 6) Gingin Wax [88881]	Endangered	Species or species habitat may occur within area
Conospermum densiflorum subsp. unicephalatum One-headed Smokebush [64871]	Endangered	Species or species habitat may occur within area
Darwinia foetida Muchea Bell [83190]	Critically Endangered	Species or species habitat known to occur within area
Diplolaena andrewsii [6601]	Endangered	Species or species habitat likely to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat may occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat may 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
Eleocharis keigheryi Keighery's Eleocharis [64893]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat known to occur within area
Eucalyptus leprophloia Scaly Butt Mallee, Scaly-butt Mallee [56712]	Endangered	Species or species habitat may occur within area
Eucalyptus x balanites Cadda Road Mallee, Cadda Mallee [87816]	Endangered	Species or species habitat may occur within area
Grevillea althoferorum [64906]	Endangered	Species or species habitat likely to occur within area
Grevillea christineae Christine's Grevillea [64520]	Endangered	Species or species habitat likely to occur within area
Grevillea curviloba subsp. curviloba Curved-leaf Grevillea [64908]	Endangered	Species or species habitat known to occur within area
Grevillea curviloba subsp. incurva Narrow curved-leaf Grevillea [64909]	Endangered	Species or species habitat known to occur within area
Lepidosperma rostratum Beaked Lepidosperma [14152]	Endangered	Species or species habitat likely to occur within area
Synaphea sp. Fairbridge Farm (D. Papenfus 696) Selena's Synaphea [82881]	Critically Endangered	Species or species habitat likely to occur within area
Thelymitra dedmaniarum Cinnamon Sun Orchid [65105]	Endangered	Species or species habitat likely to occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat likely to occur within area
Reptiles		
Pseudemydura umbrina Western Swamp Tortoise [1760]	Critically Endangered	Translocated population known 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 may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat 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

Commonwealth Land [Resource Information]

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

Name
Commonwealth Land -
Defence - MUCHEA ARMAMENT RANGE
Defence - PEARCE - AP11OBSTRUCTION BEACON NO.5
Defence - PEARCE - AP15 WATER TREATMENT PLANT
Defence - PEARCE - AP17 WATER SUPPLY TANKS
Defence - PEARCE - AP19 HF RECEIVER STATION BULLSBROOK
Defence - PEARCE - AP3 RADAR STATION BULLSBROOK
Defence - PEARCE - AP4 AERIAL FARM
Defence - PEARCE - AP5 OPERATIONS SITE
Defence - PEARCE - AP6 OBSTRUCTION BEACON NO.3
Defence - PEARCE - AP8 BORE SITES
Defence - PEARCE - AP9 OBSTRUCTION BEACON NO.4
Defence - PEARCE - RAAF BASE
Defence - VACANT LAND - BULLSBROOK AP102

Listed Marine Species [Resource Information]

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

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat 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

State and Territory Reserves	[Resource Information]
Name	State
Bullsbrook	WA
Ellen Brook	WA
Neaves Road	WA
Twin Swamps	WA
Unnamed WA46875	WA
Unnamed WA46919	WA
Unnamed WA49300	WA
Walyunga	WA

Regional Forest Agreements	[Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
South West WA RFA	Western Australia

Invasive Species

[Resource Information]

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

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		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

Name	Status	Type of Presence
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista 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
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

Name	Status	Type of Presence
		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
Ramphotyphlops braminus Flowerpot Blind Snake, Brahminy Blind Snake, Cacing Besi [1258]		Species or species habitat likely to occur within area

Nationally Important Wetlands	[Resource Information]
Name	State
Ellen Brook Swamps System	WA

Caveat

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

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World 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

-31.647675 115.996516,-31.735022 116.016085,-31.735022 116.016085

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.

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

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report Flora 5 km

Created By Guest user on 18/06/2018

Kingdom	Plantae
Current Names Only	Yes
Core Datasets Only	Yes
Method	'By Line'
Vertices	31° 36' 55" S,115° 59' 19" E 31° 38' 10" S,115° 59' 48" E 31° 43' 15" S,116° 00' 03" E 31° 43' 49" S,116° 00' 04" E
Group By	Family

Family	Species	Records
Acrobolbaceae	1	1
Amaranthaceae	5	5
Anarthriaceae	3	14
Apiaceae	12	32
Araceae	2	6
Araliaceae	6	33
Asparagaceae	29	111
Asteraceae	46	211
Bignoniaceae	1	1
Boraginaceae	1	1
Boryaceae	2	11
Brassicaceae	2	4
Bryaceae	1	1
Campanulaceae	9	26
Caryophyllaceae	7	8
Casuarinaceae	3	11
Celastraceae	1	3
Centrolepidaceae	9	66
Chenopodiaceae	2	3
Colchicaceae	5	26
Commelinaceae	1	2
Convolvulaceae	1	1
Crassulaceae	5	11
Cupressaceae	1	8
Cyatheaceae	1	1
Cyperaceae	61	208
Dasypogonaceae	3	14
Dennstaedtiaceae	1	2
Dilleniaceae	16	82
Droseraceae	29	126
Dryopteridaceae	1	1
Elaeocarpaceae	2	5
Ericaceae	26	122
Euphorbiaceae	4	11
Fabaceae	80	241
Gentianaceae	4	14
Geraniaceae	2	2
Goodeniaceae	20	63
Haemodoraceae	33	112
Haloragaceae	7	15
Hemerocallidaceae	15	37
Hydatellaceae	3	16
Hypoxidaceae	1	1
Iridaceae	13	53
Isoetaceae	1	1
Juncaceae	6	21
Juncaginaceae	6	11
Lamiaceae	6	16
Lauraceae	7	17
Lentibulariaceae	5	10
Linaceae	1	3
Loganiaceae	1	6
Loranthaceae	2	3
Lycopodiaceae	2	3
Lythraceae	1	1
Macarthuriaceae	2	4
Malvaceae	6	7
Marsileaceae	1	2
Menyanthaceae	2	6
Molluginaceae	1	1
Montiaceae	3	6
Moraceae	1	1
Myrtaceae	77	319
Onagraceae	2	3
Orchidaceae	39	78
Orobanchaceae	4	20
Oxalidaceae	3	4
Papaveraceae	1	2
Philydraceae	1	8
Phrymaceae	1	1
Phyllanthaceae	3	10
Phytolaccaceae	1	1
Pittosporaceae	4	5
Plantaginaceae	2	3
Poaceae	62	212

Polygalaceae	4	6
Polygonaceae	5	9
Portulacaceae	1	1
Primulaceae	2	9
Proteaceae	62	252
Ranunculaceae	3	4
Restionaceae	17	79
Rhamnaceae	5	10
Rubiaceae	3	4
Rutaceae	4	18
Santalaceae	2	7
Sapindaceae	2	4
Schizaeaceae	1	1
Scrophulariaceae	3	5
Selaginellaceae	1	7
Solanaceae	4	8
Stylidiaceae	38	176
Surianaceae	1	2
Thelypteridaceae	1	1
Thymelaeaceae	4	10
Typhaceae	1	1
Violaceae	1	3
Xanthorrhoeaceae	7	33
Zamiaceae	1	1
Zygophyllaceae	1	1
TOTAL	**905**	**3159**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Acrobolbaceae					
1.		*Lethocolea pansa*			
Amaranthaceae					
2.	2652	*Alternanthera nodiflora (Common Joyweed)*			
3.	2668	*Amaranthus powellii (Powell's Amaranth)*	Y		
4.	2716	*Ptilotus declinatus (Curved Mulla Mulla)*			
5.	2742	*Ptilotus manglesii (Pom Poms, Mulamula)*			
6.	2751	*Ptilotus polystachyus (Prince of Wales Feather)*			
Anarthriaceae					
7.	1060	*Anarthria laevis*			
8.	1097	*Lyginia barbata*			
9.	18049	*Lyginia imberbis*			
Apiaceae					
10.	6205	*Actinotus leucocephalus (Flannel Flower)*			
11.	17700	*Coriandrum sativum (Coriander)*	Y		Y
12.	6218	*Daucus glochidiatus (Australian Carrot)*			
13.	6219	*Eryngium pinnatifidum (Blue Devils)*			
14.	41801	*Eryngium pinnatifidum subsp. Palustre (G.J. Keighery 13459)*		P3	
15.	15446	*Eryngium pinnatifidum subsp. pinnatifidum*			
16.	6222	*Homalosciadium homalocarpum*			
17.	11132	*Platysace ramosissima*		P3	
18.	6284	*Xanthosia candida*			
19.	6285	*Xanthosia ciliata*			
20.	6287	*Xanthosia fruticulosa*			
21.	6289	*Xanthosia huegelii*			
Araceae					
22.	1051	*Lemna disperma (Duckweed)*			
23.	1049	*Zantedeschia aethiopica (Arum Lily)*	Y		
Araliaceae					
24.	6223	*Hydrocotyle alata*			
25.	6226	*Hydrocotyle callicarpa (Small Pennywort)*			
26.	6229	*Hydrocotyle diantha*			
27.	6233	*Hydrocotyle lemnoides (Aquatic Pennywort)*		P4	
28.	11074	*Hydrocotyle striata*		P1	
29.	6280	*Trachymene pilosa (Native Parsnip)*			
Asparagaceae					
30.	1205	*Acanthocarpus canaliculatus*			
31.	1287	*Dichopogon capillipes*			
32.	1289	*Dichopogon preissii*			
33.	1307	*Laxmannia ramosa (Branching Lily)*			
34.	11911	*Laxmannia ramosa subsp. ramosa*			
35.	11464	*Laxmannia sessiliflora subsp. australis*			
36.	1309	*Laxmannia squarrosa*			
37.	1223	*Lomandra caespitosa (Tufted Mat Rush)*			
38.	1228	*Lomandra hermaphrodita*			
39.	1232	*Lomandra micrantha (Small-flower Mat-rush)*			
40.	14542	*Lomandra micrantha subsp. micrantha*			
41.	1234	*Lomandra nigricans*			
42.	1239	*Lomandra preissii*			
43.	1243	*Lomandra sericea (Silky Mat Rush)*			
44.		*Lomandra sp.*			
45.	1246	*Lomandra suaveolens*			
46.	1312	*Sowerbaea laxiflora (Purple Tassels)*			
47.	1318	*Thysanotus arbuscula*			
48.	1319	*Thysanotus arenarius*			
49.	1320	*Thysanotus asper (Hairy Fringe Lily)*			
50.	1328	*Thysanotus dichotomus (Branching Fringe Lily)*			
51.	1338	*Thysanotus manglesianus (Fringed Lily)*			
52.	1339	*Thysanotus multiflorus (Many-flowered Fringe Lily)*			
53.	1343	*Thysanotus patersonii*			
54.		*Thysanotus sp.*			
55.	1351	*Thysanotus sparteus*			
56.	1354	*Thysanotus tenellus*			
57.	1357	*Thysanotus thyrsoideus*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
58.	1358	*Thysanotus triandrus*			
Asteraceae					
59.	7833	*Angianthus preissianus*			
60.	7838	*Arctotheca calendula (Cape Weed, African Marigold)*	Y		
61.	7851	*Asteridea pulverulenta (Common Bristle Daisy)*			
62.	7855	*Bidens pilosa (Cobbler's Pegs)*	Y		
63.	7867	*Brachyscome bellidioides*			
64.	7878	*Brachyscome iberidifolia*			
65.	7882	*Brachyscome perpusilla*			
66.	7916	*Centaurea melitensis (Maltese Cockspur, Malta Thistle)*	Y		
67.	7945	*Cotula coronopifolia (Waterbuttons)*	Y		
68.	7946	*Cotula cotuloides (Smooth Cotula)*			
69.	7961	*Dittrichia graveolens (Stinkwort)*	Y		
70.	15137	*Euchiton sphaericus*			
71.	7991	*Gnephosis drummondii*			
72.	12741	*Hyalosperma cotula*			
73.	8086	*Hypochaeris glabra (Smooth Catsear)*	Y		
74.	8092	*Ixiolaena viscosa (Sticky Ixiolaena)*			
75.	18585	*Lagenophora huegelii*			
76.	8099	*Leontodon saxatilis (Hairy Hawkbit)*	Y		
77.	8105	*Millotia myosotidifolia*			
78.	8106	*Millotia tenuifolia (Soft Millotia)*			
79.	14337	*Millotia tenuifolia var. laevis*		P2	
80.	8114	*Myriocephalus appendiculatus (White-tip Myriocephalus)*			
81.	8116	*Myriocephalus guerinae*			
82.	8117	*Myriocephalus helichrysoides*			
83.	8143	*Olearia paucidentata (Autumn Scrub Daisy)*			
84.	8175	*Podolepis gracilis (Slender Podolepis)*			
85.	8177	*Podolepis lessonii*			
86.	8179	*Podolepis nutans (Nodding Podolepis)*			
87.	8182	*Podotheca angustifolia (Sticky Longheads)*			
88.	8183	*Podotheca chrysantha (Yellow Podotheca)*			
89.	8184	*Podotheca gnaphalioides (Golden Long-heads)*			
90.	8188	*Pogonolepis stricta*			
91.	13255	*Pterochaeta paniculata*			
92.	8195	*Quinetia urvillei*			
93.	13300	*Rhodanthe citrina*			
94.	13312	*Rhodanthe pyrethrum*			
95.	20663	*Senecio multicaulis subsp. multicaulis*			
96.	8224	*Siloxerus filifolius*			
97.	8225	*Siloxerus humifusus (Procumbent Siloxerus)*			
98.	8230	*Sonchus asper (Rough Sowthistle)*	Y		
99.	8231	*Sonchus oleraceus (Common Sowthistle)*	Y		
100.	8251	*Trichocline spathulata (Native Gerbera)*			
101.	8255	*Ursinia anthemoides (Ursinia)*	Y		
102.	38388	*Ursinia anthemoides subsp. anthemoides*	Y		
103.	8257	*Vellereophyton dealbatum (White Cudweed)*	Y		
104.	8282	*Waitzia suaveolens (Fragrant Waitzia)*			
Bignoniaceae					
105.	19713	*Campsis radicans*	Y		
Boraginaceae					
106.	6681	*Echium plantagineum (Paterson's Curse)*	Y		
Boryaceae					
107.	1272	*Borya scirpoidea*			
108.	1273	*Borya sphaerocephala (Pincushions)*			
Brassicaceae					
109.	3016	*Heliophila pusilla*	Y		
110.	3061	*Raphanus raphanistrum (Wild Radish)*	Y		
Bryaceae					
111.	32380	*Gemmabryum pachythecum*			
Campanulaceae					
112.	7394	*Grammatotheca bergiana*	Y		
113.	7396	*Isotoma hypocrateriformis (Woodbridge Poison)*			
114.	7398	*Isotoma pusilla (Small Isotome)*			
115.	9289	*Lobelia anceps (Angled Lobelia)*			
116.	7408	*Lobelia tenuior (Slender Lobelia)*			
117.	7410	*Monopsis debilis*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
			Y		
118.	37440	*Monopsis debilis var. depressa*	Y		
119.	7384	*Wahlenbergia capensis (Cape Bluebell)*	Y		
120.	7389	*Wahlenbergia preissii*			
Caryophyllaceae					
121.	2891	*Corrigiola litoralis (Strapwort)*	Y		
122.	19825	*Petrorhagia dubia*	Y		
123.	2909	*Silene gallica (French Catchfly)*	Y		
124.	15972	*Silene gallica var. gallica*	Y		
125.	11803	*Silene gallica var. quinquevulnera*	Y		
126.	33636	*Spergularia brevifolia*			
127.	2918	*Stellaria media (Chickweed)*	Y		
Casuarinaceae					
128.	1728	*Allocasuarina fraseriana (Sheoak, Kondil)*			
129.	1732	*Allocasuarina humilis (Dwarf Sheoak)*			
130.	1742	*Casuarina obesa (Swamp Sheoak, Kuli)*			
Celastraceae					
131.	4737	*Tripterococcus brunonis (Winged Stackhousia)*			
Centrolepidaceae					
132.	1117	*Aphelia cyperoides*			
133.	1120	*Centrolepis alepyroides*			
134.	1121	*Centrolepis aristata (Pointed Centrolepis)*			
135.	1123	*Centrolepis caespitosa*		P4	
136.	1125	*Centrolepis drummondiana*			
137.	1131	*Centrolepis inconspicua*			
138.	1132	*Centrolepis mutica*			
139.	1133	*Centrolepis pilosa*			
140.	1134	*Centrolepis polygyna (Wiry Centrolepis)*			
Chenopodiaceae					
141.	2491	*Chenopodium macrospermum*	Y		
142.	48433	*Salicornia blackiana*			
Colchicaceae					
143.	1382	*Baeometra uniflora*	Y		
144.	1383	*Burchardia bairdiae*			
145.	12770	*Burchardia congesta*			
146.	1385	*Burchardia multiflora (Dwarf Burchardia)*			
147.	12072	*Wurmbea dioica subsp. alba*			
Commelinaceae					
148.	1162	*Cartonema philydroides*			
Convolvulaceae					
149.	6663	*Cuscuta epithymum (Lesser Dodder, Greater Dodder)*	Y		
Crassulaceae					
150.	17701	*Crassula closiana*			
151.	3137	*Crassula colorata (Dense Stonecrop)*			
152.	11563	*Crassula colorata var. colorata*			
153.	3142	*Crassula natans*	Y		
154.	15706	*Crassula natans var. minus*	Y		
Cupressaceae					
155.	36600	*Callitris pyramidalis (Swamp Cypress)*			
Cyatheaceae					
156.	51	*Cyathea cooperi*	Y		
Cyperaceae					
157.	740	*Baumea arthrophylla*			
158.	741	*Baumea articulata (Jointed Rush)*			
159.	743	*Baumea juncea (Bare Twigrush)*			
160.	747	*Baumea rubiginosa*			
161.	749	*Bolboschoenus caldwellii (Marsh Club-rush)*			
162.	760	*Caustis dioica*			
163.	763	*Chorizandra enodis (Black Bristlerush)*			
164.	768	*Cyathochaeta avenacea*			
165.	16245	*Cyathochaeta teretifolia*		P3	
166.	783	*Cyperus congestus (Dense Flat-sedge)*	Y		
167.	806	*Cyperus polystachyos (Bunchy Sedge)*	Y		
168.	815	*Cyperus tenellus (Tiny Flatsedge)*	Y		

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
169.	816	*Cyperus tenuiflorus (Scaly Sedge)*	Y		
170.	822	*Eleocharis acuta (Common Spikerush)*			
171.	17605	*Eleocharis keigheryi*		T	
172.	20216	*Ficinia nodosa (Knotted Club Rush)*			
173.	907	*Gahnia trifida (Coast Saw-sedge)*			
174.	910	*Isolepis cernua (Nodding Club-rush)*			
175.	20200	*Isolepis cernua var. setiformis*			
176.	912	*Isolepis cyperoides*			
177.	14540	*Isolepis hystrix*	Y		
178.	917	*Isolepis marginata (Coarse Club-rush)*			
179.	919	*Isolepis oldfieldiana*			
180.	921	*Isolepis producta*			
181.	924	*Isolepis stellata (Star Club-rush)*			
182.	925	*Lepidosperma angustatum*			
183.	42742	*Lepidosperma calcicola*			
184.	936	*Lepidosperma leptostachyum*			
185.	937	*Lepidosperma longitudinale (Pithy Sword-sedge)*			
186.	940	*Lepidosperma pubisquameum*			
187.		*Lepidosperma sp.*			
188.	946	*Lepidosperma striatum*			
189.	953	*Mesomelaena graciliceps*			
190.	955	*Mesomelaena pseudostygia*			
191.	957	*Mesomelaena tetragona (Semaphore Sedge)*			
192.	973	*Schoenus asperocarpus (Poison Sedge)*			
193.	975	*Schoenus bifidus*			
194.	978	*Schoenus brevisetis*			
195.	980	*Schoenus capillifolius*		P3	
196.	982	*Schoenus clandestinus*			
197.	984	*Schoenus curvifolius*			
198.	985	*Schoenus discifer*			
199.	986	*Schoenus efoliatus*			
200.	987	*Schoenus elegans*			
201.	991	*Schoenus grammatophyllus*			
202.	994	*Schoenus humilis*			
203.	8312	*Schoenus maschalinus*			
204.	1002	*Schoenus nanus (Tiny Bog Rush)*			
205.	1003	*Schoenus natans (Floating Bog-rush)*		P4	
206.	1006	*Schoenus odontocarpus*			
207.	17614	*Schoenus plumosus*			
208.	1011	*Schoenus rigens*			
209.	1013	*Schoenus sculptus (Gimlet Bog-rush)*			
210.	16279	*Schoenus sp. Bullsbrook (J.J. Alford 915)*		P2	Y
211.	16254	*Schoenus sp. G Broad Sheath (K.L. Wilson 2633)*			
212.	1017	*Schoenus subbulbosus*			
213.	1018	*Schoenus subfascicularis*			
214.	1023	*Schoenus tenellus*			
215.	1026	*Schoenus unispiculatus*			
216.	17409	*Schoenus variicellae*			
217.	1036	*Tetraria octandra*			
Dasypogonaceae					
218.	1213	*Calectasia cyanea (Blue Tinsel Lily)*		T	
219.	19309	*Calectasia narragara*			
220.	1218	*Dasypogon bromeliifolius (Pineapple Bush)*			
Dennstaedtiaceae					
221.	13758	*Histiopteris incisa*			
Dilleniaceae					
222.	5108	*Hibbertia acerosa (Needle Leaved Guinea Flower)*			
223.	5112	*Hibbertia aurea*			
224.	5114	*Hibbertia commutata*			
225.	5118	*Hibbertia cunninghamii*			
226.	5134	*Hibbertia huegelii*			
227.	5135	*Hibbertia hypericoides (Yellow Buttercups)*			
228.	45534	*Hibbertia hypericoides subsp. hypericoides*			
229.	45533	*Hibbertia hypericoides subsp. septentrionalis*			
230.	5139	*Hibbertia lasiopus (Large Hibbertia)*			
231.	5154	*Hibbertia perfoliata*			
232.	5162	*Hibbertia racemosa (Stalked Guinea Flower)*			
233.	43280	*Hibbertia sericosepala*			
234.	5171	*Hibbertia spicata*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
235.	5172	*Hibbertia stellaris (Orange Stars)*			
236.	48381	*Hibbertia striata*			
237.	5173	*Hibbertia subvaginata*			
Droseraceae					
238.	3095	*Drosera erythrorhiza (Red Ink Sundew)*			
239.	13217	*Drosera erythrorhiza subsp. erythrorhiza*			
240.	13212	*Drosera erythrorhiza subsp. magna*			
241.	3097	*Drosera gigantea (Giant Sundew)*			
242.	15453	*Drosera gigantea subsp. gigantea*			
243.	3098	*Drosera glanduligera (Pimpernel Sundew)*			
244.	13195	*Drosera helodes*			
245.	3101	*Drosera heterophylla (Swamp Rainbow)*			
246.	13197	*Drosera hyperostigma*			
247.	3106	*Drosera macrantha (Bridal Rainbow)*			
248.	14298	*Drosera macrantha subsp. macrantha*			
249.	3109	*Drosera menziesii (Pink Rainbow)*			
250.	11853	*Drosera menziesii subsp. menziesii*			
251.	13216	*Drosera menziesii subsp. penicillaris*			
252.	3113	*Drosera neesii (Jewel Rainbow)*			
253.	11768	*Drosera neesii subsp. neesii*			
254.	3114	*Drosera nitidula (Shining Sundew)*			
255.	3115	*Drosera occidentalis (Western Sundew)*			
256.	13191	*Drosera occidentalis subsp. occidentalis*		P4	
257.	3117	*Drosera paleacea (Dwarf Sundew)*			
258.	13188	*Drosera paleacea subsp. paleacea*			
259.	3118	*Drosera pallida (Pale Rainbow)*			
260.	3119	*Drosera parvula (Small Sundew)*			
261.	3123	*Drosera platystigma (Black-eyed Sundew)*			
262.	3124	*Drosera pulchella (Pretty Sundew)*			
263.	8911	*Drosera rosulata*			
264.	13185	*Drosera spilos*			
265.	3131	*Drosera stolonifera (Leafy Sundew)*			
266.	13607	*Drosera x badgerupii*			Y
Dryopteridaceae					
267.	17952	*Cyrtomium falcatum*	Y		
Elaeocarpaceae					
268.	4524	*Platytheca galioides*			
269.	48342	*Tetratheca hirsuta subsp. hirsuta*			
Ericaceae					
270.	6311	*Andersonia heterophylla*			
271.	6314	*Andersonia lehmanniana*			
272.	11471	*Andersonia lehmanniana subsp. lehmanniana*			
273.	6328	*Astroloma glaucescens*			
274.	6330	*Astroloma macrocalyx (Swan Berry)*			
275.	6334	*Astroloma pallidum (Kick Bush)*			
276.	6337	*Astroloma stomarrhena (Red Swamp Cranberry)*			
277.	6339	*Astroloma xerophyllum*			
278.	6341	*Brachyloma preissii (Globe Heath)*			
279.	6347	*Conostephium minus (Pink-tipped Pearl flower)*			
280.	6348	*Conostephium pendulum (Pearl Flower)*			
281.	6349	*Conostephium preissii*			
282.	13527	*Croninia kingiana*			
283.	6360	*Leucopogon australis (Spiked Beard-heath)*			
284.	6374	*Leucopogon conostephioides*			
285.	6397	*Leucopogon glaucifolius*			
286.	6425	*Leucopogon oxycedrus*			
287.	6434	*Leucopogon polymorphus*			
288.	6436	*Leucopogon propinquus*			
289.	6439	*Leucopogon pulchellus (Beard-heath)*			
290.	40803	*Leucopogon squarrosus subsp. squarrosus*			
291.	6451	*Leucopogon tenuis*			
292.	6456	*Lysinema ciliatum (Curry Flower)*			
293.	6458	*Lysinema elegans*			
294.	34736	*Lysinema pentapetalum*			
295.	48297	*Styphelia filifolia*		P3	
Euphorbiaceae					
296.	4638	*Euphorbia peplus (Petty Spurge)*	Y		
297.	4662	*Monotaxis grandiflora (Diamond of the Desert)*			

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298.	4666	*Monotaxis occidentalis*			
299.	4713	*Stachystemon axillaris (Leafy Stachystemon)*			
Fabaceae					
300.	3219	*Acacia anomala (Grass Wattle)*		T	
301.	15466	*Acacia applanata*			
302.	15469	*Acacia barbinervis subsp. barbinervis*			
303.	3254	*Acacia celastrifolia (Glowing Wattle)*			
304.	11926	*Acacia drewiana subsp. drewiana*			
305.	11229	*Acacia drummondii subsp. affinis*		P3	
306.	3324	*Acacia erinacea*			
307.	3374	*Acacia huegelii*			
308.	18217	*Acacia iteaphylla*	Y		
309.	3409	*Acacia lasiocarpa (Panjang)*			
310.	15721	*Acacia lasiocarpa var. sedifolia*			
311.	3454	*Acacia nervosa (Rib Wattle)*			
312.	3502	*Acacia pulchella (Prickly Moses)*			
313.	15481	*Acacia pulchella var. glaberrima*			
314.	15483	*Acacia pulchella var. pulchella*			
315.	15480	*Acacia pulchella var. reflexa*			
316.	3527	*Acacia saligna (Orange Wattle, Kudjong)*			
317.	30033	*Acacia saligna subsp. lindleyi*			
318.	30032	*Acacia saligna subsp. saligna*			
319.	3541	*Acacia sessilis*			
320.	3602	*Acacia willdenowiana (Grass Wattle)*			
321.	3686	*Aotus cordifolia*			
322.	3688	*Aotus gracillima*			
323.	3710	*Bossiaea eriocarpa (Common Brown Pea)*			
324.	35838	*Cristonia biloba subsp. biloba*			
325.	3793	*Daviesia angulata*			
326.	15656	*Daviesia brachyphylla*			
327.	3805	*Daviesia decurrens (Prickly Bitter-pea)*			
328.	18560	*Daviesia divaricata subsp. divaricata*			
329.	3815	*Daviesia horrida (Prickly Bitter-pea)*			
330.	3819	*Daviesia longifolia*			
331.	3824	*Daviesia nudiflora*			
332.	3832	*Daviesia physodes*			
333.	3835	*Daviesia preissii*			
334.	3845	*Daviesia triflora*			
335.	3872	*Euchilopsis linearis (Swamp Pea)*			
336.	3880	*Eutaxia virgata*			
337.	3895	*Gastrolobium calycinum (York Road Poison)*			
338.	20473	*Gastrolobium ebracteolatum*			
339.	20483	*Gastrolobium linearifolium*			
340.	20512	*Gastrolobium praemorsum*			
341.	19733	*Gastrolobium retusum*			
342.	3924	*Gastrolobium spinosum (Prickly Poison)*			
343.	10909	*Gompholobium confertum*			
344.	3950	*Gompholobium knightianum*			
345.	3951	*Gompholobium marginatum*			
346.	3955	*Gompholobium preissii*			
347.	11083	*Gompholobium scabrum*			
348.	3957	*Gompholobium tomentosum (Hairy Yellow Pea)*			
349.	3961	*Hardenbergia comptoniana (Native Wisteria)*			
350.	3968	*Hovea trisperma (Common Hovea)*			
351.	12907	*Hovea trisperma var. grandiflora*			
352.	12859	*Hovea trisperma var. trisperma*			
353.	3992	*Isotropis cuneifolia (Granny Bonnets)*			
354.	16317	*Isotropis cuneifolia subsp. glabra*		P2	
355.	4010	*Jacksonia floribunda (Holly Pea)*			
356.	4012	*Jacksonia furcellata (Grey Stinkwood)*			
357.	4029	*Jacksonia sternbergiana (Stinkwood, Kapur)*			
358.	4042	*Kennedia nigricans (Black Kennedia)*			
359.	4044	*Kennedia prostrata (Scarlet Runner)*			
360.	11289	*Labichea lanceolata subsp. lanceolata*			
361.	4052	*Latrobea tenella*			
362.	4059	*Lotus angustissimus (Narrowleaf Trefoil)*	Y		
363.	8564	*Lotus subbiflorus*	Y		
364.	4065	*Lupinus angustifolius (Narrowleaf Lupin)*	Y		
365.	4079	*Medicago polymorpha (Burr Medic)*	Y		
366.	4085	*Melilotus indicus*			

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			Y		
367.	4113	*Ornithopus compressus (Yellow Serradella)*	Y		
368.	4114	*Ornithopus pinnatus (Slender Serradella)*	Y		
369.	4172	*Pultenaea ericifolia*			
370.	4181	*Pultenaea reticulata*			
371.	4205	*Sphaerolobium linophyllum*			
372.	4211	*Sphaerolobium vimineum (Leafless Globe Pea)*			
373.	17542	*Trifolium arvense var. arvense*	Y		
374.	17763	*Trifolium campestre var. campestre (Hop Clover)*	Y		
375.	4295	*Trifolium dubium (Suckling Clover)*	Y		
376.	4313	*Trifolium subterraneum (Subterranean Clover)*	Y		
377.	34772	*Vachellia karroo*	Y		
378.	4322	*Vicia sativa (Common Vetch)*	Y		
379.	4325	*Viminaria juncea (Swishbush, Koweda)*			
Gentianaceae					
380.	6539	*Centaurium erythraea (Common Centaury)*	Y		
381.	6542	*Centaurium tenuiflorum*	Y		
382.	6543	*Cicendia filiformis (Slender Cicendia)*	Y		
383.	41660	*Schenkia australis*			
Geraniaceae					
384.	4332	*Erodium botrys (Long Storksbill)*	Y		
385.	4339	*Geranium molle (Dove's Foot Cranesbill)*	Y		
Goodeniaceae					
386.	12724	*Anthotium junciforme*			
387.	7428	*Dampiera coronata (Wedge-leaved Dampiera)*			
388.	7454	*Dampiera linearis (Common Dampiera)*			
389.	7482	*Dampiera teres (Terete-leaved Dampiera)*			
390.	8614	*Goodenia claytoniacea*			
391.	29362	*Goodenia coerulea*			
392.	12551	*Goodenia micrantha*			
393.	7538	*Goodenia pulchella*			
394.	7568	*Lechenaultia biloba (Blue Leschenaultia)*			
395.	7572	*Lechenaultia expansa*			
396.	7574	*Lechenaultia floribunda (Free-flowering Leschenaultia)*			
397.	7595	*Scaevola anchusifolia*			
398.	7603	*Scaevola canescens (Grey Scaevola)*			
399.	7613	*Scaevola glandulifera (Viscid Hand-flower)*			
400.	7619	*Scaevola lanceolata (Long-leaved Scaevola)*			
401.	7634	*Scaevola phlebopetala (Velvet Fanflower)*			
402.	12585	*Scaevola repens*			
403.	13182	*Scaevola repens var. repens*			
404.	7665	*Velleia trinervis*			
405.	7666	*Verreauxia reinwardtii (Common Verreauxia)*			
Haemodoraceae					
406.	11470	*Anigozanthos bicolor subsp. bicolor*			
407.	1409	*Anigozanthos humilis (Catspaw)*			
408.	11434	*Anigozanthos humilis subsp. humilis*			
409.	1411	*Anigozanthos manglesii (Mangles Kangaroo Paw, Kurulbrang)*			
410.	29487	*Anigozanthos manglesii var. x angustifolius*			
411.	1416	*Anigozanthos viridis (Green Kangaroo Paw, Kurulbardang)*			
412.	29436	*Anigozanthos viridis subsp. Cataby (S.D. Hopper 1786)*			
413.	11566	*Anigozanthos viridis subsp. viridis*			
414.	1417	*Blancoa canescens (Winter Bell)*			
415.	1418	*Conostylis aculeata (Prickly Conostylis)*			
416.	11826	*Conostylis aculeata subsp. aculeata*			
417.	11552	*Conostylis aculeata subsp. bromelioides*			
418.	11513	*Conostylis aculeata subsp. cygnorum*			
419.	12109	*Conostylis aculeata subsp. preissii*			
420.	1420	*Conostylis androstemma (Trumpets)*			
421.	1423	*Conostylis aurea (Golden Conostylis)*			
422.	1429	*Conostylis caricina*			
423.	12035	*Conostylis caricina subsp. caricina*			
424.	1436	*Conostylis juncea*			
425.	1454	*Conostylis setigera (Bristly Cottonhead)*			
426.	11597	*Conostylis setigera subsp. setigera*			
427.	1455	*Conostylis setosa (White Cottonhead)*			
428.	1465	*Haemodorum discolor*			
429.	1468	*Haemodorum laxum*			

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430.	1469	*Haemodorum loratum*		P3	
431.	1472	*Haemodorum simplex*			
432.	1475	*Haemodorum spicatum (Mardja)*			
433.	1477	*Macropidia fuliginosa (Black Kangaroo Paw)*			
434.	1478	*Phlebocarya ciliata*			
435.	1479	*Phlebocarya filifolia*			
436.	11557	*Phlebocarya pilosissima subsp. pilosissima*		P3	
437.	1481	*Tribonanthes australis*			
438.	1483	*Tribonanthes longipetala*			
Haloragaceae					
439.	6143	*Glischrocaryon aureum (Common Popflower)*			
440.	6159	*Gonocarpus nodulosus*			
441.	6161	*Gonocarpus pithyoides*			
442.	34676	*Meionectes brownii (Swamp Raspwort)*			
443.	33638	*Meionectes tenuifolia*		P3	
444.	6189	*Myriophyllum crispatum*			
445.	6192	*Myriophyllum drummondii*			
Hemerocallidaceae					
446.	23474	*Agrostocrinum hirsutum*			
447.	1261	*Agrostocrinum scabrum (Blue Grass Lily)*			
448.	23501	*Agrostocrinum scabrum subsp. scabrum*			
449.	1264	*Arnocrinum preissii*			
450.	1276	*Caesia micrantha (Pale Grass Lily)*			
451.	1285	*Corynotheca micrantha (Sand Lily)*			
452.	11283	*Corynotheca micrantha var. micrantha*			
453.	1259	*Dianella revoluta (Blueberry Lily)*			
454.	1293	*Hensmania turbinata*			
455.	1295	*Johnsonia acaulis*			
456.	1298	*Johnsonia pubescens (Pipe Lily)*			
457.	19632	*Johnsonia pubescens subsp. pubescens*			
458.	1260	*Stypandra glauca (Blind Grass)*			
459.	1361	*Tricoryne elatior (Yellow Autumn Lily)*			
460.	1363	*Tricoryne tenella*			
Hydatellaceae					
461.	1139	*Trithuria bibracteata*			
462.	32658	*Trithuria occidentalis (Swan Hydatella)*		T	
463.	1141	*Trithuria submersa*			
Hypoxidaceae					
464.	43761	*Pauridia occidentalis var. occidentalis*			
Iridaceae					
465.	1520	*Gladiolus caryophyllaceus (Wild Gladiolus)*	Y		
466.	1524	*Gladiolus undulatus (Wild Gladiolus)*	Y		
467.	1526	*Hesperantha falcata*	Y		
468.	19179	*Moraea flaccida (One-leaf Cape Tulip)*	Y		
469.	19180	*Moraea miniata (Two-leaf Cape Tulip)*	Y		
470.	1546	*Patersonia juncea (Rush Leaved Patersonia)*			
471.	1550	*Patersonia occidentalis (Purple Flag, Koma)*			
472.	30471	*Patersonia occidentalis var. angustifolia*			
473.	30472	*Patersonia occidentalis var. occidentalis*			
474.	1556	*Romulea rosea (Guildford Grass)*	Y		
475.	11544	*Romulea rosea var. australis (Guildford Grass)*	Y		
476.	14924	*Romulea rosea var. communis*	Y		
477.	18118	*Watsonia meriana var. meriana*	Y		
Isoetaceae					
478.	11	*Isoetes drummondii (Quillwort)*			
Juncaceae					
479.	1178	*Juncus bufonius (Toad Rush)*	Y		
480.	1180	*Juncus capitatus (Capitate Rush)*	Y		
481.	1184	*Juncus holoschoenus (Jointleaf Rush)*			
482.	1188	*Juncus pallidus (Pale Rush)*			
483.	1190	*Juncus planifolius (Broadleaf Rush)*			
484.	1195	*Juncus subsecundus (Finger Rush)*			
Juncaginaceae					
485.	40661	*Cycnogeton lineare*			
486.	19039	*Triglochin bulbosa*	Y		
487.	33676	*Triglochin calcitrapa*			

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488.	147	*Triglochin mucronata*			
489.	148	*Triglochin muelleri*			
490.	150	*Triglochin stowardii*			
Lamiaceae					
491.	6838	*Hemiandra linearis (Speckled Snakebush)*			
492.	6839	*Hemiandra pungens (Snakebush)*			
493.	6842	*Hemigenia barbata*			
494.	17209	*Lachnostachys verbascifolia var. verbascifolia*			
495.	6897	*Microcorys longifolia*			
496.	6930	*Stachys arvensis (Staggerweed)*	Y		
Lauraceae					
497.	2951	*Cassytha flava (Dodder Laurel)*			
498.	2952	*Cassytha glabella (Tangled Dodder Laurel)*			
499.	11211	*Cassytha glabella forma dispar*			
500.	2956	*Cassytha pomiformis (Dodder Laurel)*			
501.	2957	*Cassytha racemosa (Dodder Laurel)*			
502.	11242	*Cassytha racemosa forma pilosa*			
503.	11799	*Cassytha racemosa forma racemosa*			
Lentibulariaceae					
504.	7131	*Utricularia dichotoma (Fairy Aprons)*			
505.	7138	*Utricularia inaequalis*			
506.	7148	*Utricularia multifida*			
507.	7153	*Utricularia tenella*			
508.	7157	*Utricularia violacea (Violet Bladderwort)*			
Linaceae					
509.	4363	*Linum trigynum (French Flax)*	Y		
Loganiaceae					
510.	16177	*Phyllangium paradoxum*			
Loranthaceae					
511.	2380	*Amyema miquelii (Stalked Mistletoe)*			
512.	2401	*Nuytsia floribunda (Christmas Tree, Mudja)*			
Lycopodiaceae					
513.	12783	*Lycopodiella serpentina*			
514.	4	*Phylloglossum drummondii (Pigmy Clubmoss)*			
Lythraceae					
515.	5281	*Lythrum hyssopifolia (Lesser Loosestrife)*	Y		
Macarthuriaceae					
516.	2838	*Macarthuria apetala*			
517.	2839	*Macarthuria australis*			
Malvaceae					
518.	16952	*Guichenotia tuberculata*		P3	
519.	5034	*Lasiopetalum glabratum*			
520.	45082	*Lasiopetalum glutinosum subsp. latifolium*			
521.	4959	*Lawrencia squamata*			
522.	5080	*Thomasia foliosa*			
523.	5084	*Thomasia grandiflora (Large Flowered Thomasia)*			
Marsileaceae					
524.	78	*Pilularia novae-hollandiae (Austral Pillwort)*			
Menyanthaceae					
525.	36160	*Liparophyllum capitatum*			
526.	36177	*Ornduffia albiflora*			
Molluginaceae					
527.	2836	*Glinus oppositifolius*			
Montiaceae					
528.	2846	*Calandrinia calyptrata (Pink Purslane)*			
529.	2856	*Calandrinia liniflora (Parakeelya)*			
530.	16365	*Calandrinia sp. Kenwick (G.J. Keighery 10905)*			
Moraceae					
531.	1747	*Ficus carica (Common Fig)*	Y		
Myrtaceae					
532.	20350	*Astartea affinis (West-coast Astartea)*			
533.	5330	*Astartea fascicularis (Recherche Astartea)*			

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534.	20283	*Astartea scoparia (Common Astartea)*			
535.	36441	*Babingtonia camphorosmae (Camphor Myrtle)*			
536.	5382	*Beaufortia elegans (Elegant Beaufortia)*			
537.	5387	*Beaufortia macrostemon (Darling Range Beaufortia)*			
538.	5415	*Calothamnus lateralis*			
539.	5426	*Calothamnus quadrifidus (One-sided Bottlebrush, Kwowdjard)*			
540.	5429	*Calothamnus sanguineus (Silky-leaved Blood flower, Pindak)*			
541.	5439	*Calytrix angulata (Yellow Starflower)*			
542.	5458	*Calytrix flavescens (Summer Starflower)*			
543.	5460	*Calytrix fraseri (Pink Summer Calytrix)*			
544.	5476	*Calytrix sapphirina*			
545.	5479	*Calytrix strigosa*			
546.	5485	*Calytrix variabilis*			
547.	35598	*Chamelaucium sp. Winchester (C. Chapman s.n. PERTH 07879180)*			
548.	5498	*Chamelaucium uncinatum (Geraldton Wax)*			
549.	17104	*Corymbia calophylla (Marri)*			
550.	5508	*Darwinia citriodora (Lemon-scented Darwinia)*			
551.	34773	*Darwinia foetida*		T	Y
552.	5531	*Darwinia thymoides*			
553.	13950	*Eremaea asterocarpa subsp. asterocarpa*			
554.	5541	*Eremaea pauciflora*			
555.	14104	*Eremaea pauciflora var. pauciflora*			
556.	5542	*Eremaea purpurea*			
557.	5708	*Eucalyptus marginata (Jarrah, Djara)*			
558.	13547	*Eucalyptus marginata subsp. marginata (Jarrah)*			
559.	13548	*Eucalyptus marginata subsp. thalassica (Blue-leaved Jarrah)*			
560.	5763	*Eucalyptus rudis (Flooded Gum, Kulurda)*			
561.	5790	*Eucalyptus todtiana (Coastal Blackbutt)*			
562.	5797	*Eucalyptus wandoo (Wandoo, Wondu)*			
563.	5817	*Hypocalymma angustifolium (White Myrtle, Kudjid)*			
564.	35074	*Hypocalymma angustifolium subsp. Dandaragan plateau (S. Patrick 702A)*			
565.	35070	*Hypocalymma angustifolium subsp. Swan Coastal Plain (G.J. Keighery 16777)*			
566.	5825	*Hypocalymma robustum (Swan River Myrtle)*			
567.	15498	*Kunzea glabrescens (Spearwood)*			
568.	5835	*Kunzea micrantha*			
569.	17461	*Kunzea micrantha subsp. micrantha*			
570.	5841	*Kunzea recurva*			
571.	5847	*Leptospermum erubescens (Roadside Teatree)*			
572.	5850	*Leptospermum laevigatum (Coast Teatree)*	Y		
573.	5857	*Leptospermum spinescens*			
574.	5880	*Melaleuca bracteosa*			
575.	5881	*Melaleuca brevifolia*			
576.	5900	*Melaleuca cuticularis (Saltwater Paperbark)*			
577.	5920	*Melaleuca huegelii (Chenille Honeymyrtle)*			
578.	5926	*Melaleuca lateritia (Robin Redbreast Bush)*			
579.	20297	*Melaleuca osullivanii*			
580.	5952	*Melaleuca preissiana (Moonah)*			
581.	5958	*Melaleuca radula (Graceful Honeymyrtle)*			
582.	5959	*Melaleuca rhaphiophylla (Swamp Paperbark)*			
583.	19365	*Melaleuca ryeae*			
584.	5964	*Melaleuca seriata*			
585.	5978	*Melaleuca teretifolia (Banbar)*			
586.	5983	*Melaleuca trichophylla*			
587.	5984	*Melaleuca uncinata (Broom Bush, Kwidjard)*			
588.	5987	*Melaleuca viminea (Mohan)*			
589.	13280	*Melaleuca viminea subsp. viminea*			
590.	11109	*Pericalymma crassipes*			
591.	6006	*Pericalymma ellipticum (Swamp Teatree)*			
592.	16477	*Pericalymma ellipticum var. ellipticum*			
593.	16478	*Pericalymma ellipticum var. floridum*			
594.	6012	*Regelia ciliata*			
595.	6014	*Regelia inops*			
596.	6033	*Scholtzia involucrata (Spiked Scholtzia)*			
597.	20135	*Taxandria linearifolia*			
598.	6076	*Verticordia densiflora (Compacted Featherflower)*			
599.	15432	*Verticordia densiflora var. densiflora*			
600.	6077	*Verticordia drummondii (Drummond's Featherflower)*			
601.	6088	*Verticordia huegelii (Variegated Featherflower)*			
602.	15434	*Verticordia insignis subsp. insignis*			
603.	6101	*Verticordia nitens (Morrison Featherflower, Kodjeningara)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
604.	6103	*Verticordia ovalifolia*			
605.	6107	*Verticordia pennigera*			
606.	6110	*Verticordia plumosa (Plumed Featherflower)*			
607.	12449	*Verticordia plumosa var. brachyphylla*			
608.	12460	*Verticordia serrata var. linearis*		P3	
Onagraceae					
609.	6131	*Epilobium billardiereanum (Glabrous Willow Herb)*			
610.	16347	*Oenothera laciniata*	Y		
Orchidaceae					
611.	1586	*Caladenia discoidea (Dancing Orchid)*			
612.	1592	*Caladenia flava (Cowslip Orchid)*			
613.	15348	*Caladenia flava subsp. flava*			
614.	15354	*Caladenia hirta subsp. hirta*			
615.	1596	*Caladenia huegelii (Grand Spider Orchid)*		T	
616.	1602	*Caladenia longicauda (Common White Spider Orchid)*			
617.	1605	*Caladenia marginata (White Fairy Orchid)*			
618.	15503	*Caladenia paludosa*			
619.	15380	*Caladenia splendens*			
620.	18019	*Caladenia vulgata*			
621.	15114	*Cyanicula gemmata*			
622.	13826	*Cyanicula ixioides subsp. ixioides*		P4	
623.	19649	*Disa bracteata*	Y		
624.	11049	*Diuris corymbosa*			
625.	1634	*Diuris laxiflora (Bee Orchid)*			
626.	1644	*Elythranthera emarginata (Pink Enamel Orchid)*			
627.	1645	*Epiblema grandiflorum (Babe-in-a-cradle)*			
628.	1646	*Eriochilus dilatatus (White Bunny Orchid)*			
629.	1653	*Leporella fimbriata (Hare Orchid)*			
630.	10954	*Microtis media (Tall Mignonette Orchid)*			
631.	15419	*Microtis media subsp. media*			
632.	23500	*Paracaleana hortiorum*			
633.	1667	*Paracaleana nigrita (Flying Duck Orchid)*			
634.	1671	*Prasophyllum elatum (Tall Leek Orchid)*			
635.	1672	*Prasophyllum fimbria (Fringed Leek Orchid)*			
636.		*Pterostylis aff. nana*			
637.	1686	*Pterostylis barbata (Bird Orchid)*			
638.	44723	*Pterostylis glebosa*			
639.	1693	*Pterostylis recurva (Jug Orchid)*			
640.	12217	*Pterostylis sanguinea*			
641.	18658	*Pterostylis sp. short sepals (W. Jackson BJ259)*			
642.	1698	*Pterostylis vittata (Banded Greenhood)*			
643.	16367	*Pyrorchis nigricans (Red beaks, Elephants ears)*			
644.	1701	*Thelymitra antennifera (Vanilla Orchid)*			
645.	10856	*Thelymitra benthamiana (Leopard Orchid)*			
646.	1702	*Thelymitra campanulata (Shirt Orchid)*			
647.	1705	*Thelymitra crinita (Blue Lady Orchid)*			
648.	1707	*Thelymitra flexuosa (Twisted Sun Orchid)*			
649.	20731	*Thelymitra vulgaris*			
Orobanchaceae					
650.	15037	*Bartsia trixago*	Y		
651.	7122	*Orobanche minor (Lesser Broomrape)*	Y		
652.	7089	*Parentucellia latifolia (Common Bartsia)*	Y		
653.	7090	*Parentucellia viscosa (Sticky Bartsia)*	Y		
Oxalidaceae					
654.	4355	*Oxalis perennans*			
655.	4356	*Oxalis pes-caprae (Soursob)*	Y		
656.	4358	*Oxalis purpurea (Largeflower Wood Sorrel)*	Y		
Papaveraceae					
657.	2969	*Fumaria capreolata (Whiteflower Fumitory)*	Y		
Philydraceae					
658.	1173	*Philydrella pygmaea (Butterfly Flowers)*			
Phrymaceae					
659.	7061	*Glossostigma drummondii (Mudmat)*			
Phyllanthaceae					
660.	4675	*Phyllanthus calycinus (False Boronia)*			
661.	4691	*Poranthera microphylla (Small Poranthera)*			

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662.	42022	*Poranthera moorokatta*		P2	
Phytolaccaceae					
663.	2793	*Phytolacca octandra (Red Ink Plant)*	Y		
Pittosporaceae					
664.	25788	*Billardiera fraseri (Elegant Pronaya)*			
665.	3165	*Billardiera variifolia*			
666.	3169	*Cheiranthera preissiana*			
667.	17636	*Marianthus coeruleopunctatus (Blue-spotted Marianthus)*			
Plantaginaceae					
668.	14282	*Gratiola pubescens*			
669.	7085	*Misopates orontium (Lesser Snapdragon)*	Y		
Poaceae					
670.	184	*Aira caryophyllea (Silvery Hairgrass)*	Y		
671.	185	*Aira cupaniana (Silvery Hairgrass)*	Y		
672.	187	*Aira praecox (Early Hairgrass)*	Y		
673.	20184	*Amphipogon laguroides subsp. laguroides*			
674.	200	*Amphipogon turbinatus*			
675.	207	*Aristida contorta (Bunched Kerosene Grass)*			
676.	17233	*Austrostipa campylachne*			
677.	17234	*Austrostipa compressa*			
678.	17237	*Austrostipa elegantissima*			
679.	17240	*Austrostipa flavescens*			
680.	17241	*Austrostipa hemipogon*			
681.	17244	*Austrostipa macalpinei*			
682.	17254	*Austrostipa tenuifolia*			
683.	234	*Avena fatua (Wild Oat)*	Y		
684.	235	*Avena sativa (Common Oat)*	Y		
685.	8661	*Brachypodium distachyon (False Brome)*	Y		
686.	244	*Briza maxima (Blowfly Grass)*	Y		
687.	245	*Briza minor (Shivery Grass)*	Y		
688.	249	*Bromus diandrus (Great Brome)*	Y		
689.	250	*Bromus hordeaceus (Soft Brome)*	Y		
690.	253	*Bromus rubens (Red Brome)*	Y		
691.	258	*Cenchrus ciliaris (Buffel Grass)*	Y		
692.	41567	*Cenchrus macrourus (African Feather Grass)*	Y		
693.	41568	*Cenchrus setaceus (Fountain Grass)*	Y		
694.	267	*Chloris gayana (Rhodes Grass)*	Y		
695.	272	*Chloris virgata (Feathertop Rhodes Grass)*	Y		
696.	283	*Cynodon dactylon (Couch)*	Y		
697.	290	*Dactyloctenium radulans (Button Grass)*			
698.	17736	*Digitaria aequiglumis*	Y		
699.	311	*Digitaria ciliaris (Summer Grass)*	Y		
700.	320	*Digitaria sanguinalis (Crab Grass)*	Y		
701.	346	*Ehrharta brevifolia (Annual Veldt Grass)*	Y		
702.	347	*Ehrharta calycina (Perennial Veldt Grass)*	Y		
703.	349	*Ehrharta longiflora (Annual Veldt Grass)*	Y		
704.	353	*Eleusine indica (Crowsfoot Grass)*	Y		
705.	374	*Eragrostis cilianensis (Stinkgrass)*	Y		
706.	376	*Eragrostis curvula (African Lovegrass)*	Y		
707.	378	*Eragrostis dielsii (Mallee Lovegrass)*			
708.	11451	*Hemarthria uncinata var. uncinata*			
709.	444	*Holcus lanatus (Yorkshire Fog)*	Y		
710.	445	*Holcus setiger (Annual Fog)*	Y		
711.	20019	*Lachnagrostis filiformis*			
712.	19955	*Lachnagrostis plebeia*			
713.	468	*Lamarckia aurea (Goldentop)*	Y		
714.	478	*Lolium rigidum (Wimmera Ryegrass)*	Y		
715.	485	*Microlaena stipoides (Weeping Grass)*			
716.	492	*Neurachne alopecuroidea (Foxtail Mulga Grass)*			
717.	516	*Parapholis incurva (Coast Barbgrass)*	Y		
718.	40424	*Pentameris airoides subsp. airoides*	Y		
719.	40422	*Pentameris pallida*	Y		
720.	551	*Phalaris minor (Lesser Canary Grass)*	Y		
721.	571	*Poa annua (Winter Grass)*	Y		
722.	573	*Poa drummondiana (Knotted Poa)*			
723.	577	*Poa poiformis (Coastal Poa)*			
724.	582	*Polypogon monspeliensis (Annual Beardgrass)*	Y		
725.	583	*Polypogon tenellus*			

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726.	40425	*Rytidosperma caespitosum*			
727.	40426	*Rytidosperma occidentale*			
728.	40427	*Rytidosperma setaceum*			
729.	635	*Sporobolus virginicus (Marine Couch)*			
730.	722	*Vulpia bromoides (Squirrel Tail Fescue)*	Y		
731.	724	*Vulpia myuros (Rat's Tail Fescue)*	Y		
Polygalaceae					
732.	4550	*Comesperma calymega (Blue-spike Milkwort)*			
733.	4554	*Comesperma flavum*			
734.	4561	*Comesperma scoparium (Broom Milkwort)*			
735.	4564	*Comesperma virgatum (Milkwort)*			
Polygonaceae					
736.	2412	*Muehlenbeckia adpressa (Climbing Lignum)*			
737.	13911	*Persicaria decipiens*			
738.	2432	*Rumex conglomeratus (Clustered Dock)*	Y		
739.	2433	*Rumex crispus (Curled Dock)*	Y		
740.	46434	*Rumex hypogaeus*	Y		
Portulacaceae					
741.	2884	*Portulaca oleracea (Purslane, Wakati)*			
Primulaceae					
742.	36375	*Lysimachia arvensis (Pimpernel)*	Y		
743.	6483	*Samolus junceus*			
Proteaceae					
744.	1775	*Adenanthos cygnorum (Common Woollybush)*			
745.	11336	*Adenanthos cygnorum subsp. chamaephyton*		P3	
746.	11837	*Adenanthos cygnorum subsp. cygnorum (Common Woollybush)*			
747.	1779	*Adenanthos drummondii*			
748.	1791	*Adenanthos obovatus (Basket Flower)*			
749.	32682	*Banksia armata var. armata*			
750.	1800	*Banksia attenuata (Slender Banksia, Piara)*			
751.	32679	*Banksia bipinnatifida subsp. multifida*			
752.	32523	*Banksia fraseri var. fraseri*			
753.	1822	*Banksia ilicifolia (Holly-leaved Banksia)*			
754.	1834	*Banksia menziesii (Firewood Banksia)*			
755.	1835	*Banksia micrantha*			
756.	1852	*Banksia telmatiaea (Swamp Fox Banksia)*			
757.	15607	*Conospermum acerosum subsp. acerosum*			
758.	15041	*Conospermum canaliculatum*			
759.	15516	*Conospermum canaliculatum subsp. canaliculatum*			
760.	1875	*Conospermum huegelii (Slender Smokebush)*			
761.	1880	*Conospermum polycephalum*			
762.	1882	*Conospermum stoechadis (Common Smokebush)*			
763.	15520	*Conospermum stoechadis subsp. sclerophyllum*			
764.	15611	*Conospermum stoechadis subsp. stoechadis (Common Smokebush)*			
765.	1885	*Conospermum triplinervium (Tree Smokebush)*			
766.	14106	*Grevillea althoferorum*			
767.	33559	*Grevillea althoferorum subsp. fragilis*		T	
768.	19628	*Grevillea bipinnatifida subsp. bipinnatifida*			
769.	1984	*Grevillea curviloba*			
770.	14408	*Grevillea curviloba subsp. curviloba*		T	
771.	14409	*Grevillea curviloba subsp. incurva*		T	
772.	8836	*Grevillea obtusifolia (Obtuse Leaved Grevillea)*			
773.	2066	*Grevillea pilulifera (Woolly-flowered Grevillea)*			
774.	2080	*Grevillea quercifolia (Oak-leaf Grevillea)*			
775.	14421	*Grevillea synapheae subsp. synapheae*			
776.	2149	*Hakea cristata (Snail Hakea)*			
777.	2158	*Hakea erinacea (Hedge-hog Hakea)*			
778.	2166	*Hakea incrassata (Marble Hakea)*			
779.	2175	*Hakea lissocarpha (Honey Bush)*			
780.	2197	*Hakea prostrata (Harsh Hakea)*			
781.	2203	*Hakea ruscifolia (Candle Hakea)*			
782.	31413	*Hakea sp. Walyunga (B. Keighery 2599)*			
783.	2212	*Hakea sulcata (Furrowed Hakea)*			
784.	2215	*Hakea undulata (Wavy-leaved Hakea)*			
785.	2216	*Hakea varia (Variable-leaved Hakea)*			
786.	2221	*Isopogon asper*			
787.	2229	*Isopogon dubius (Pincushion Coneflower)*			
788.	14083	*Lambertia multiflora var. darlingensis*			

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789.	2258	*Persoonia comata*			
790.	2271	*Persoonia rudis*		P3	
791.	2273	*Persoonia saccata (Snottygobble)*			
792.	2284	*Petrophile biloba (Granite Petrophile)*			
793.	20391	*Petrophile juncifolia*			
794.	2299	*Petrophile linearis (Pixie Mops)*			
795.	2301	*Petrophile macrostachya*			
796.	2308	*Petrophile seminuda*			
797.	2310	*Petrophile shuttleworthiana*			
798.	2312	*Petrophile striata*			
799.	12856	*Stirlingia abrotanoides*			
800.	2316	*Stirlingia latifolia (Blueboy)*			
801.	2321	*Synaphea acutiloba (Granite Synaphea)*			
802.	2323	*Synaphea gracillima*			
803.	16867	*Synaphea grandis*		P4	
804.	2329	*Synaphea spinulosa*			
805.	15532	*Synaphea spinulosa subsp. spinulosa*			
Ranunculaceae					
806.	2932	*Ranunculus colonorum (Common Buttercup)*			
807.	2933	*Ranunculus muricatus (Sharp Buttercup)*	Y		
808.	11927	*Ranunculus sessiliflorus var. sessiliflorus*			
Restionaceae					
809.	1056	*Alexgeorgea nitens*			
810.	17685	*Chaetanthus aristatus*			
811.	17833	*Chordifex microcodon*			
812.	31112	*Chordifex sp. Ellenbrook (M. Trudgen MET 20790)*			Y
813.	17692	*Cytogonidium leptocarpoides*			
814.	16595	*Desmocladus flexuosus*			
815.	46362	*Desmocladus lateriflorus*			
816.	17838	*Dielsia stenostachya*			
817.	1070	*Hypolaena exsulca*			
818.	1075	*Lepidobolus preissianus*			
819.	18074	*Lepidobolus preissianus subsp. preissianus*			
820.	1077	*Leptocarpus canus (Hoary Twine-rush)*			
821.	1078	*Leptocarpus coangustatus*			
822.	46375	*Leptocarpus decipiens*			
823.	1080	*Leptocarpus scariosus*			
824.	46383	*Leptocarpus tephrinus*			
825.	1088	*Lepyrodia macra (Large Scale Rush)*			
Rhamnaceae					
826.	13470	*Cryptandra arbutiflora var. arbutiflora*			
827.	9076	*Cryptandra myriantha*			
828.	4839	*Trymalium angustifolium*			
829.	13479	*Trymalium ledifolium var. rosmarinifolium*			
830.	33418	*Trymalium odoratissimum subsp. odoratissimum*			
Rubiaceae					
831.	7321	*Galium divaricatum*	Y		
832.	7323	*Galium murale (Small Goosegrass)*	Y		
833.	18255	*Opercularia vaginata (Dog Weed)*			
Rutaceae					
834.	17665	*Boronia purdieana subsp. purdieana*			
835.	4438	*Boronia ramosa*			
836.	11381	*Boronia ramosa subsp. anethifolia*			
837.	18529	*Philotheca spicata (Pepper and Salt)*			
Santalaceae					
838.	2344	*Leptomeria empetriformis*			
839.	2350	*Leptomeria pauciflora (Sparse-flowered Currant Bush)*			
Sapindaceae					
840.	4746	*Diplopeltis huegelii*			
841.	18589	*Diplopeltis huegelii subsp. lehmannii*			
Schizaeaceae					
842.	24	*Schizaea fistulosa (Narrow Comb Fern)*			
Scrophulariaceae					
843.	7055	*Dischisma capitatum (Woolly-headed Dischisma)*	Y		
844.	17175	*Eremophila glabra subsp. albicans*			
845.	7289	*Myoporum caprarioides (Slender Myoporum)*			

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Selaginellaceae					
846.	6	*Selaginella gracillima (Tiny Clubmoss)*			
Solanaceae					
847.	6949	*Anthocercis littorea (Yellow Tailflower)*			
848.	6974	*Nicotiana glauca (Tree Tobacco)*	Y		
849.	7013	*Solanum hoplopetalum (Thorny Solanum)*			
850.	7022	*Solanum nigrum (Black Berry Nightshade)*	Y		
Stylidiaceae					
851.	7672	*Levenhookia octomaculata (Eight-spotted Stylewort)*			
852.	7676	*Levenhookia pusilla (Midget Stylewort)*			
853.	7677	*Levenhookia stipitata (Common Stylewort)*			
854.	18564	*Stylidium aceratum*		P3	
855.	7679	*Stylidium adpressum (Trigger-on-stilts)*			
856.	7681	*Stylidium affine (Queen Triggerplant)*			
857.	12846	*Stylidium albolilacinum*			
858.	7684	*Stylidium amoenum (Lovely Triggerplant)*			
859.	30278	*Stylidium androsaceum*			
860.	25831	*Stylidium araeophyllum (Stilt Walker)*			
861.	48457	*Stylidium bindoon*			
862.	7693	*Stylidium brunonianum (Pink Fountain Triggerplant)*			
863.	7694	*Stylidium bulbiferum (Circus Triggerplant)*			
864.	7696	*Stylidium calcaratum (Book Triggerplant)*			
865.	7699	*Stylidium carnosum (Fleshy-leaved Triggerplant)*			
866.	7709	*Stylidium crossocephalum (Posy Triggerplant)*			
867.	7710	*Stylidium cygnorum*			
868.	7713	*Stylidium dichotomum (Pins-and-needles)*			
869.	7716	*Stylidium diuroides (Donkey Triggerplant)*			
870.	11808	*Stylidium diuroides subsp. diuroides*			
871.	7717	*Stylidium divaricatum (Daddy-long-legs)*			
872.	7719	*Stylidium ecorne (Foot Triggerplant)*			
873.	7734	*Stylidium guttatum (Dotted Triggerplant)*			
874.	7742	*Stylidium inundatum (Hundreds and Thousands)*			
875.	7756	*Stylidium longitubum (Jumping Jacks)*		P4	
876.	25800	*Stylidium paludicola*		P3	
877.	7773	*Stylidium petiolare (Horn Triggerplant)*			
878.	7774	*Stylidium piliferum (Common Butterfly Triggerplant)*			
879.	25837	*Stylidium purpureum (Purple Fountain Triggerplant)*			
880.	33106	*Stylidium recurvum*			
881.	7785	*Stylidium repens (Matted Triggerplant)*			
882.	20521	*Stylidium rigidulum*			
883.	25806	*Stylidium scariosum*			
884.	7798	*Stylidium schoenoides (Cow Kicks)*			
885.	7801	*Stylidium squamellosum (Maize Trigger Plant)*		P2	
886.	45594	*Stylidium tenue subsp. majusculum (Showy Fountain Triggerplant)*			
887.	20603	*Stylidium trudgenii*		P3	
888.	7806	*Stylidium utricularioides (Pink Fan Triggerplant)*			
Surianaceae					
889.	3181	*Stylobasium australe*			
Thelypteridaceae					
890.	54	*Cyclosorus interruptus*			
Thymelaeaceae					
891.	5244	*Pimelea floribunda*			
892.	11404	*Pimelea imbricata var. major*			
893.	11402	*Pimelea imbricata var. piligera*			
894.	12041	*Pimelea suaveolens subsp. suaveolens*			
Typhaceae					
895.	99	*Typha orientalis (Bulrush, Cumbungi)*			
Violaceae					
896.	5216	*Hybanthus calycinus (Wild Violet)*			
Xanthorrhoeaceae					
897.	1280	*Chamaescilla corymbosa (Blue Squill)*			
898.	11299	*Chamaescilla corymbosa var. corymbosa*			
899.	19338	*Chamaescilla gibsonii*		P3	
900.	8788	*Chamaescilla versicolor*			
901.	1252	*Xanthorrhoea drummondii*			
902.	1253	*Xanthorrhoea gracilis (Graceful Grass Tree, Mimidi)*			

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903.	1256	*Xanthorrhoea preissii (Grass tree, Palga)*			

Zamiaceae

904.	18119	*Macrozamia fraseri*			

Zygophyllaceae

905.	4383	*Tribulus terrestris (Caltrop)*	Y		

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.

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report Fauna 5 km

Created By Guest user on 18/06/2018

Kingdom	Animalia
Current Names Only	Yes
Core Datasets Only	Yes
Method	'By Line'
Vertices	31° 36' 55" S,115° 59' 19" E 31° 38' 10" S,115° 59' 48" E 31° 43' 15" S,116° 00' 03" E 31° 43' 49" S,116° 00' 04" E
Group By	Species Group

Species Group	Species	Records
Amphibian	13	221
Bird	108	1003
Fish	4	5
Invertebrate	235	886
Mammal	13	130
Reptile	52	624
TOTAL	**425**	**2869**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Amphibian					
1.	25398	*Crinia georgiana (Quacking Frog)*			
2.	25399	*Crinia glauerti (Clicking Frog)*			
3.	25400	*Crinia insignifera (Squelching Froglet)*			
4.	25408	*Heleioporus albopunctatus (Western Spotted Frog)*			
5.	25409	*Heleioporus barycragus (Hooting Frog)*			
6.	25410	*Heleioporus eyrei (Moaning Frog)*			
7.	25411	*Heleioporus inornatus (Whooping Frog)*			
8.	25415	*Limnodynastes dorsalis (Western Banjo Frog)*			
9.	25378	*Litoria adelaidensis (Slender Tree Frog)*			
10.	25388	*Litoria moorei (Motorbike Frog)*			
11.	25420	*Myobatrachus gouldii (Turtle Frog)*			
12.	25426	*Neobatrachus pelobatoides (Humming Frog)*			
13.	25433	*Pseudophryne guentheri (Crawling Toadlet)*			
Bird					
14.	24559	*Acanthagenys rufogularis (Spiny-cheeked Honeyeater)*			
15.	24260	*Acanthiza apicalis (Broad-tailed Thornbill, Inland Thornbill)*			
16.	24261	*Acanthiza chrysorrhoa (Yellow-rumped Thornbill)*			
17.	24262	*Acanthiza inornata (Western Thornbill)*			
18.	24560	*Acanthorhynchus superciliosus (Western Spinebill)*			
19.	25535	*Accipiter cirrocephalus (Collared Sparrowhawk)*			
20.	25536	*Accipiter fasciatus (Brown Goshawk)*			
21.	24312	*Anas gracilis (Grey Teal)*			
22.	24313	*Anas platyrhynchos (Mallard)*			
23.	24316	*Anas superciliosa (Pacific Black Duck)*			
24.	24561	*Anthochaera carunculata (Red Wattlebird)*			
25.	24562	*Anthochaera lunulata (Western Little Wattlebird)*			
26.	25670	*Anthus australis (Australian Pipit)*			
27.	24599	*Anthus australis subsp. australis (Australian Pipit)*			
28.	24285	*Aquila audax (Wedge-tailed Eagle)*			
29.	24340	*Ardea novaehollandiae (White-faced Heron)*			
30.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
31.	24353	*Artamus cyanopterus (Dusky Woodswallow)*			
32.		*Barnardius zonarius*			
33.	24345	*Botaurus poiciloptilus (Australasian Bittern)*		T	
34.	25713	*Cacatua galerita (Sulphur-crested Cockatoo)*			
35.	24721	*Cacatua galerita subsp. galerita (Sulphur-crested Cockatoo)*	Y		
36.	25714	*Cacatua pastinator (Western Long-billed Corella)*			
37.	25715	*Cacatua roseicapilla (Galah)*			
38.	25716	*Cacatua sanguinea (Little Corella)*			
39.	24729	*Cacatua tenuirostris (Eastern Long-billed Corella)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
			Y		
40.	25598	*Cacomantis flabelliformis (Fan-tailed Cuckoo)*			
41.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
42.	24731	*Calyptorhynchus banksii subsp. naso (Forest Red-tailed Black Cockatoo)*		T	
43.	24734	*Calyptorhynchus latirostris (Carnaby's Cockatoo, White-tailed Short-billed Black Cockatoo)*		T	
44.	24321	*Chenonetta jubata (Australian Wood Duck, Wood Duck)*			
45.	24431	*Chrysococcyx basalis (Horsfield's Bronze Cuckoo)*			
46.	24432	*Chrysococcyx lucidus subsp. plagosus (Shining Bronze Cuckoo)*			
47.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
48.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
49.	25592	*Corvus coronoides (Australian Raven)*			
50.	24417	*Corvus coronoides subsp. perplexus (Australian Raven)*			
51.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
52.	25595	*Cracticus tibicen (Australian Magpie)*			
53.	25596	*Cracticus torquatus (Grey Butcherbird)*			
54.	24322	*Cygnus atratus (Black Swan)*			
55.	30901	*Dacelo novaeguineae (Laughing Kookaburra)*	Y		
56.	25673	*Daphoenositta chrysoptera (Varied Sittella)*			
57.	24470	*Dromaius novaehollandiae (Emu)*			
58.		*Egretta novaehollandiae*			
59.	24290	*Elanus caeruleus subsp. axillaris (Australian Black-shouldered Kite)*			
60.	47937	*Elseyornis melanops (Black-fronted Dotterel)*			
61.		*Eolophus roseicapillus*			
62.	24567	*Epthianura albifrons (White-fronted Chat)*			
63.	25622	*Falco cenchroides (Australian Kestrel, Nankeen Kestrel)*			
64.	24472	*Falco cenchroides subsp. cenchroides (Australian Kestrel, Nankeen Kestrel)*			
65.	25623	*Falco longipennis (Australian Hobby)*			
66.	25624	*Falco peregrinus (Peregrine Falcon)*		S	
67.	25727	*Fulica atra (Eurasian Coot)*			
68.	24761	*Fulica atra subsp. australis (Eurasian Coot)*			
69.	24763	*Gallinula tenebrosa subsp. tenebrosa (Dusky Moorhen)*			
70.	42314	*Gavicalis virescens (Singing Honeyeater)*			
71.	25530	*Gerygone fusca (Western Gerygone)*			
72.	47962	*Glyciphila melanops (Tawny-crowned Honeyeater)*			
73.	24443	*Grallina cyanoleuca (Magpie-lark)*			
74.	47965	*Hieraaetus morphnoides (Little Eagle)*			
75.	24491	*Hirundo neoxena (Welcome Swallow)*			
76.	24511	*Larus novaehollandiae subsp. novaehollandiae (Silver Gull)*			
77.	25661	*Lichmera indistincta (Brown Honeyeater)*			
78.		*Lophoictinia isura*			
79.	24326	*Malacorhynchus membranaceus (Pink-eared Duck)*			
80.	24551	*Malurus pulcherrimus (Blue-breasted Fairy-wren)*			
81.	25654	*Malurus splendens (Splendid Fairy-wren)*			
82.	24583	*Manorina flavigula (Yellow-throated Miner)*			
83.	25663	*Melithreptus brevirostris (Brown-headed Honeyeater)*			
84.	24598	*Merops ornatus (Rainbow Bee-eater)*			
85.	25610	*Myiagra inquieta (Restless Flycatcher)*			
86.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
87.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
88.	25682	*Pardalotus striatus (Striated Pardalote)*			
89.	48061	*Petrochelidon nigricans (Tree Martin)*			
90.	48066	*Petroica boodang (Scarlet Robin)*			
91.	24659	*Petroica goodenovii (Red-capped Robin)*			
92.	25698	*Phalacrocorax melanoleucos (Little Pied Cormorant)*			
93.	24666	*Phalacrocorax melanoleucos subsp. melanoleucos (Little Pied Cormorant)*			
94.		*Phalacrocorax sp.*			
95.	24667	*Phalacrocorax sulcirostris (Little Black Cormorant)*			
96.	25699	*Phalacrocorax varius (Pied Cormorant)*			
97.	24409	*Phaps chalcoptera (Common Bronzewing)*			
98.	48071	*Phylidonyris niger (White-cheeked Honeyeater)*			
99.	24596	*Phylidonyris novaehollandiae (New Holland Honeyeater)*			
100.	24841	*Platalea flavipes (Yellow-billed Spoonbill)*			
101.	24747	*Platycercus spurius (Red-capped Parrot)*			
102.	25721	*Platycercus zonarius (Australian Ringneck, Ring-necked Parrot)*			
103.	24750	*Platycercus zonarius subsp. semitorquatus (Twenty-eight Parrot)*			
104.	24751	*Platycercus zonarius subsp. zonarius (Port Lincoln Parrot)*			
105.	30854	*Polytelis anthopeplus subsp. westralis (Regent Parrot)*			
106.	25731	*Porphyrio porphyrio (Purple Swamphen)*			
107.		*Purpureicephalus spurius*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
108.	48096	*Rhipidura albiscapa (Grey Fantail)*			
109.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
110.	25534	*Sericornis frontalis (White-browed Scrubwren)*			
111.	30948	*Smicrornis brevirostris (Weebill)*			
112.	24645	*Stagonopleura oculata (Red-eared Firetail)*			
113.	25597	*Strepera versicolor (Grey Currawong)*			
114.	25590	*Streptopelia senegalensis (Laughing Turtle-Dove)*	Y		
115.	25705	*Tachybaptus novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
116.	24682	*Tachybaptus novaehollandiae subsp. novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
117.	24331	*Tadorna tadornoides (Australian Shelduck, Mountain Duck)*			
118.	24845	*Threskiornis spinicollis (Straw-necked Ibis)*			
119.	25549	*Todiramphus sanctus (Sacred Kingfisher)*			
120.	24852	*Tyto alba subsp. delicatula (Barn Owl)*			
121.	25765	*Zosterops lateralis (Grey-breasted White-eye, Silvereye)*			
Fish					
122.		*Bostockia porosa*			
123.		*Edelia vittata*			
124.	34028	*Galaxias occidentalis (Western Minnow)*			
125.		*Gambusia sp.*			
Invertebrate					
126.		*Ablabesmyia notabilis*			
127.		*Acariformes sp.*			
128.		*Acarina sp.*			
129.		*Acercella falcipes*			
130.		*Acritoptila globosa*			
131.		*Aedes alboannulotus*			
132.		*Agraptocorixa sp.*			
133.		*Alboa worooa*			
134.		*Allodessus bistrigatus*			
135.		*Allothereua maculata*			
136.		*Alona sp.*			
137.		*Alonella sp.*			
138.		*Amblyomma triguttatum*			
139.		*Amphisopodidae sp.*			
140.		*Aname mainae*			
141.		*Ancylidae sp.*			
142.		*Anisops hyperion*			
143.		*Anisops occipitalis*			
144.		*Anisops sp.*			
145.		*Anisops stali*			
146.		*Anisops thienemanni*			
147.		*Anopheles (Cellia) sp.*			
148.		*Anopheles annulipes s.l.*			
149.		*Antiporus sp.*			
150.		*Araneus cyphoxis*			
151.		*Archepleuroxus baylyi*			
152.		*Arrenurus sp.*			
153.		*Austracantha minax*			
154.		*Australocyclops australis*			
155.		*Austrochiltonia subtenuis*			
156.		*Austrolestes analis*			
157.		*Austrolestes annulosus*			
158.		*Austrolestes aridus*			
159.		*Austrolestes io*			
160.		*Badumna insignis*			
161.		*Baetidae sp.*			
162.		*Bennelongia australis*			
163.		*Bennelongia cygnus*			
164.		*Berosus pulchellus*			
165.		*Berosus sp.*			
166.		*Bidessini sp.*			
167.		*Boeckella bispinosa*			
168.		*Boeckella robusta*			
169.		*Branchinella sp.*			
170.		*Caenidae sp.*			
171.		*Calamoecia attenuata*			
172.		*Calamoecia tasmanica subattenuata*			
173.		*Canthocamptus australicus*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
174.		*Carabidae sp.*			
175.		*Ceinidae sp.*			
176.		*Ceratopogonidae sp.*			
177.		*Cercophonius sulcatus*			
178.		*Ceriodaphnia sp.*			
179.	33939	*Cherax cainii (Marron)*			
180.		*Cherax quinquecarinatus*			
181.		*Cherax sp.*			
182.		*Chironominae sp.*			
183.		*Chironomus aff. alternans (V24) (CB)*			
184.		*Chironomus tepperi*			
185.		*Chostonectes sp.*			Y
186.		*Chrysomelidae sp.*			
187.		*Chydoridae sp.*			
188.		*Chydorus sp.*			
189.		*Cladopelma curtivalva*			
190.		*Copelatus sp.*			
191.		*Corduliidae sp.*			
192.		*Corixidae sp.*			
193.		*Corynoneura australiensis*			Y
194.		*Corynoneura scutellata*			
195.		*Culex (Culex) annulirostris*			
196.		*Culex (Culex) australicus*			
197.		*Culex globocoxitus*			
198.		*Culex sp.*			
199.		*Culex stricklandi*			Y
200.		*Culicidae sp.*			
201.		*Curculionidae sp.*			
202.		*Cybister sp.*			
203.		*Cypretta aff. globosa*			
204.		*Cypretta baylyi*			
205.		*Cypretta sp.*			
206.		*Cypretta sp. 272*			Y
207.		*Cypricercus n sp. 314 (dorsal hump)*			Y
208.		*Cypricercus sp. 327 (TWS)*			Y
209.		*Cyprinotus cingalensis (ex edwardi)*			
210.		*Cyzicus sp.*			
211.		*Daphnia carinata*			
212.		*Diaphanosoma sp.*			
213.		*Dicrotendipes conjunctus*			
214.		*Dingosa serrata*			
215.		*Diptera sp.*			
216.		*Dugesiidae sp.*			
217.		*Dunhevedia aff crassa*			Y
218.		*Dytiscidae sp.*			
219.		*Echinisca sp.*			
220.		*Empididae sp.*			
221.		*Enochrus elongatulus*			
222.		*Enochrus sp.*			
223.		*Eretes australis*			
224.		*Eucypris virens*			
225.		*Eulimnadia sp.*			
226.		*Exocelina ater*			
227.		*Exocelina ferrugineus*			
228.		*Eylais sp.*			
229.		*Gastropoda marine sp. RCM1*			
230.		*Graptoleberis sp.*			Y
231.		*Gripopterygidae sp.*			
232.		*Gyraulus sp.*			
233.		*Gyrinidae sp.*			
234.		*Haliplus sp.*			
235.		*Haliplus testudo*			
236.		*Hebridae sp.*			
237.		*Hellyethira malleoforma*			
238.		*Hellyethira simplex*			
239.		*Hellyethira sp.*			
240.		*Hemianax papuensis*			
241.		*Hemiboeckella andersonae*			Y
242.		*Hemicordulia tau*			
243.		*Hemicorduliidae sp.*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
244.		*Heterocypris incongruens*			
245.		*Hirudinea sp.*			
246.		*Holconia westralia*			
247.		*Hydaticus sp.*			
248.		*Hyderodes crassus*			
249.		*Hydridae sp.*			
250.		*Hydrochus sp.*			
251.		*Hydrophilidae sp.*			
252.		*Hydroptilidae sp.*			
253.		*Hyphydrus elegans*			
254.		*Hyphydrus sp.*			
255.		*Idiommata blackwalli*			
256.		*Ilyodromus sp. 255 (south-west, CB)*			
257.		*Laccophilus sp.*			
258.		*Lacrimicypris kumbar*			
259.		*Lancetes sp.*			
260.		*Latonopsis sp.*			
261.		*Latrodectus hasseltii*			
262.	33982	*Leioproctus contrarius (a short-tongued bee)*		P3	
263.	33983	*Leioproctus douglasiellus (a short-tongued bee)*		T	
264.		*Lepidoptera sp.*			
265.		*Leptoceridae sp.*			
266.		*Limbodessus inornatus*			
267.		*Limbodessus sp.*			
268.		*Limnesia sp.*			
269.		*Limnichidae sp.*			
270.		*Limnocythere dorsosicula*			
271.		*Limnocythere mowbrayensis*			
272.		*Limnocythere sp.*			
273.		*Limnophyes sp.*			
274.		*Limnoxenus zelandicus*			
275.		*Lymnaeidae sp.*			
276.		*Lynceus sp.*			
277.		*Macrothrix sp.*			
278.		*Macrothrix sp. A (CB)*			
279.		*Macrothrix sp. b (of RJS) (SAP)*			
280.		*Megaporus howitti*			
281.		*Megaporus solidus*			
282.		*Megaporus sp.*			
283.		*Mesamphisopodidae sp.*			
284.		*Mesocyclops brooksi*			
285.		*Mesocyclops sp.*			
286.		*Microcyclops sp. EB1*			Y
287.		*Microcyclops sp. EB2*			Y
288.		*Micronecta robusta*			
289.		*Micronecta sp.*			
290.		*Missulena granulosa*			
291.		*Mixocyclops sp. LG1*			Y
292.		*Moina sp.*			
293.		*Moinidae sp.*			Y
294.		*Necterosoma regulare*			
295.		*Neothrix armata*			
296.		*Nephila edulis*			
297.		*Newnhamia fenestrata*			
298.		*Notonectidae sp.*			
299.		*Oecobius navus*			
300.		*Oligochaeta sp.*			
301.		*Oniscidae sp.*			
302.		*Onychohydrus atratus*			
303.		*Onychohydrus scutellaris*			
304.		*Onychohydrus sp.*			
305.		*Oribatida sp.*			
306.		*Orthocladiinae sp.*			
307.		*Palaemonidae sp.*			
308.		*Paracymus pygmaeus*			
309.		*Paralimnocythere sp. 275 (south-west, CB)*			
310.		*Paralimnophyes pullulus (V42)*			
311.		*Paramerina levidensis*			
312.		*Paramphisopus palustris*			
313.		*Parastacidae sp.*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
314.		*Paratanytarsus parthenogeneticus*			Y
315.		*Paroster ellenbrookensis*			
316.		*Paroster niger*			
317.		*Paroster sp.*			
318.		*Pedidromus velox*			Y
319.		*Pescecyclops sp. (EB1 sp. 250)*			Y
320.		*Physa sp.*			Y
321.		*Physastra sp.*			
322.		*Physidae sp.*			
323.		*Piona murleyi*			
324.		*Piona sp.*			
325.		*Planorbidae sp.*			
326.		*Platynectes sp.*			
327.		*Pleuroxus sp.*			
328.		*Procladius villosimanus*			
329.		*Promochlonyx australiensis*			
330.		*Ptilodactylidae sp.*			
331.		*Rhantus sp.*			
332.		*Rhantus suturalis*			
333.		*Richardsonianidae sp.*			
334.		*Sarscypridopsis aculeata*			
335.		*Scapholeberis kingi*			
336.		*Scapholeberis sp.*			
337.		*Sciomyzidae sp.*			
338.		*Scirtidae sp.*			
339.		*Simocephalus sp.*			
340.		*Simuliidae sp.*			
341.		*Spencerhydrus pulchellus*			
342.		*Staphylinidae sp.*			
343.		*Sternopriscus browni*			
344.		*Sternopriscus marginatus*			
345.		*Sternopriscus minimus*			
346.		*Sternopriscus sp.*			
347.		*Strandesia sp. 323 (TWS)*			Y
348.		*Stratiomyidae sp.*			
349.		*Succinea sp.*			Y
350.		*Tabanidae sp.*			
351.		*Tanypodinae sp.*			
352.		*Tanytarsus fuscithorax/semibarbitarsus*			
353.		*Tanytarsus sp.*			
354.		*Tasmanicosa leuckartii*			
355.		*Tipulidae sp.*			
356.		*Triplectides australis*			
357.		*Turbellaria sp.*			
358.		*Urodacus novaehollandiae*			
359.	34113	*Westralunio carteri (Carter's Freshwater Mussel)*		T	
360.		*Xanthagrion erythroneurum*			
Mammal					
361.	24251	*Bos taurus (European Cattle)*	Y		
362.	24092	*Dasyurus geoffroii (Chuditch, Western Quoll)*		T	
363.	48588	*Isoodon fusciventer (Quenda, southwestern brown bandicoot)*		P4	
364.	24132	*Macropus fuliginosus (Western Grey Kangaroo)*			
365.	24168	*Macrotis lagotis (Bilby, Dalgyte, Ninu)*		T	
366.	24223	*Mus musculus (House Mouse)*	Y		
367.	48022	*Notamacropus irma (Western Brush Wallaby)*		P4	
368.	48027	*Nyctophilus geoffroyi subsp. geoffroyi (Lesser Long-eared Bat)*			
369.	24195	*Nyctophilus gouldi (Gould's Long-eared Bat)*			
370.	24245	*Rattus rattus (Black Rat)*	Y		
371.	24167	*Tarsipes rostratus (Honey Possum, Noolbenger)*			
372.	25521	*Trichosurus vulpecula (Common Brushtail Possum)*			
373.	24206	*Vespadelus regulus (Southern Forest Bat)*			
Reptile					
374.	42368	*Acritoscincus trilineatus (Western Three-lined Skink)*			
375.	44629	*Anilios australis*			
376.	24990	*Aprasia pulchella (Granite Worm-lizard)*			
377.	24991	*Aprasia repens (Sand-plain Worm-lizard)*			
378.	42380	*Brachyurophis fasciolatus subsp. fasciolatus (Narrow-banded Shovel-nosed Snake)*			
379.	42381	*Brachyurophis semifasciatus (Southern Shovel-nosed Snake)*			
380.	43380	*Chelodina colliei (South-western Snake-necked Turtle)*			

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381.	24980	*Christinus marmoratus (Marbled Gecko)*			
382.	24918	*Crenadactylus ocellatus subsp. ocellatus (Clawless Gecko)*			
383.	30893	*Cryptoblepharus buchananii*			
384.	25020	*Cryptoblepharus plagiocephalus*			
385.	30899	*Ctenophorus adelaidensis (Southern Heath Dragon, Western Heath Dragon)*			
386.	25027	*Ctenotus australis*			
387.	25039	*Ctenotus fallens*			
388.	25047	*Ctenotus impar*			
389.	25766	*Delma fraseri (Fraser's Legless Lizard)*			
390.	24929	*Diplodactylus granariensis subsp. granariensis*			
391.	25251	*Echiopsis curta (Bardick)*			
392.	25100	*Egernia napoleonis*			
393.	25250	*Elapognathus coronatus (Crowned Snake)*			
394.	25475	*Hemiergis peronii*			
395.	25119	*Hemiergis quadrilineata*			
396.	25128	*Lerista christinae*			
397.	25133	*Lerista elegans*			
398.	25148	*Lerista lineopunctulata*			
399.	25165	*Lerista praepedita*			
400.	25005	*Lialis burtonis*			
401.	25184	*Menetia greyii*			
402.	25191	*Morethia lineoocellata*			
403.	25192	*Morethia obscura*			
404.	25248	*Neelaps bimaculatus (Black-naped Snake)*			
405.	25249	*Neelaps calonotos (Black-striped Snake, black-striped burrowing snake)*		P3	
406.	25252	*Notechis scutatus (Tiger Snake)*			
407.	25253	*Parasuta gouldii*			
408.	25509	*Pletholax gracilis (Keeled Legless Lizard)*			
409.	25007	*Pletholax gracilis subsp. gracilis (Keeled Legless Lizard)*			
410.	25510	*Pogona minor (Dwarf Bearded Dragon)*			
411.	24907	*Pogona minor subsp. minor (Dwarf Bearded Dragon)*			
412.	25261	*Pseudechis australis (Mulga Snake)*			
413.	25345	*Pseudemydura umbrina (Western Swamp Tortoise, Western Swamp Turtle)*		T	
414.	25511	*Pseudonaja affinis (Dugite)*			
415.	25259	*Pseudonaja affinis subsp. affinis (Dugite)*			
416.	42416	*Pseudonaja mengdeni (Western Brown Snake)*			
417.	25008	*Pygopus lepidopodus (Common Scaly Foot)*			
418.	25266	*Simoselaps bertholdi (Jan's Banded Snake)*			
419.	24943	*Strophurus spinigerus subsp. inornatus*			
420.	24942	*Strophurus spinigerus subsp. spinigerus*			
421.	25203	*Tiliqua occipitalis (Western Bluetongue)*			
422.	25519	*Tiliqua rugosa*			
423.	25207	*Tiliqua rugosa subsp. rugosa*			
424.	24983	*Underwoodisaurus milii (Barking Gecko)*			
425.	25526	*Varanus tristis (Racehorse Monitor)*			

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.

GHD

Level 10
999 Hay Street
T: 61 8 6222 8222 F: 61 8 9463 6012 E: permail@ghd.com

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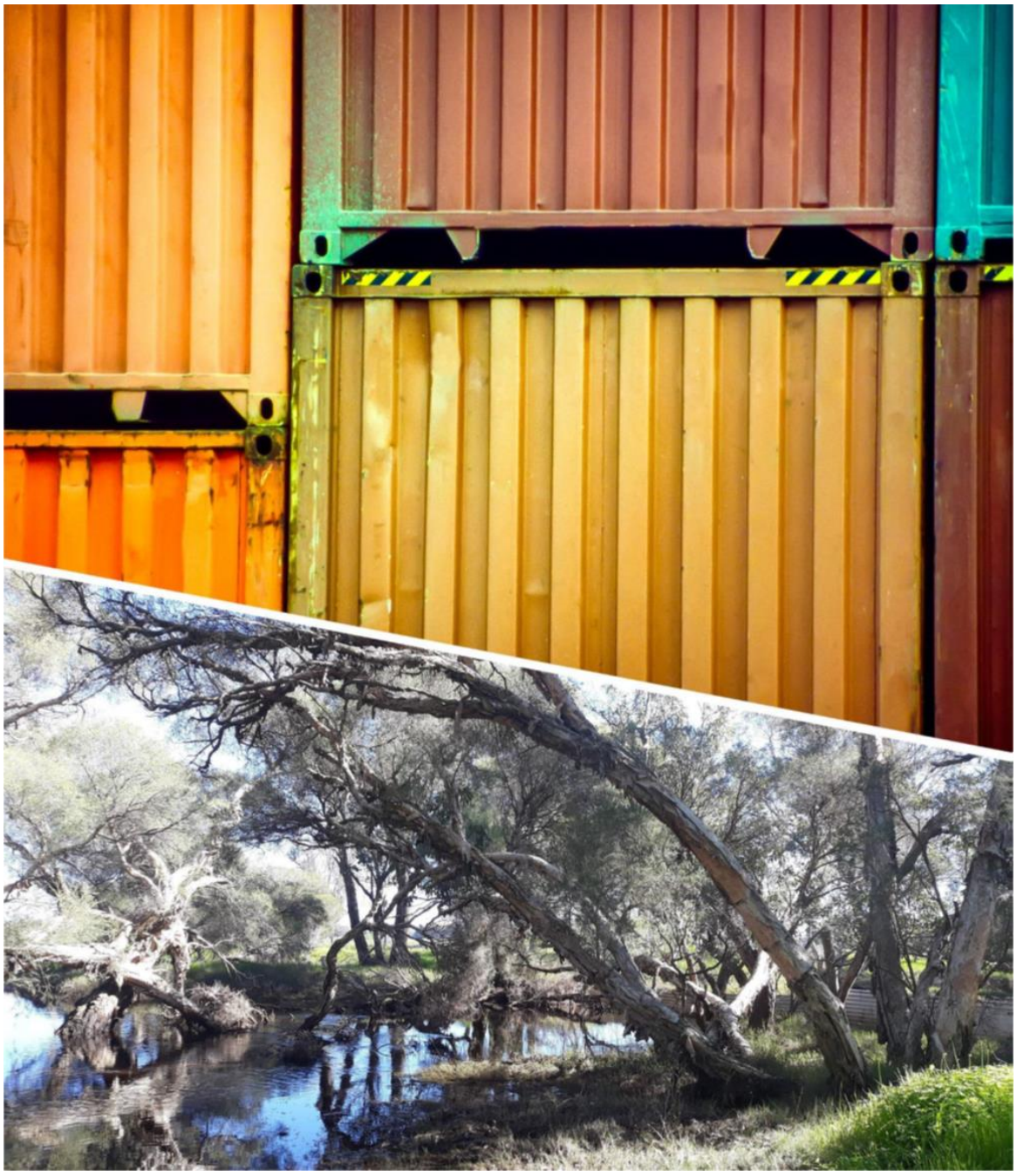
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Revision	Author	Reviewer		Approved for Issue		
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Appendix C - Regional Water Management Strategy



Department of Planning, Lands and Heritage

Bullsbrook Freight and Industrial Land Use Strategy
Regional Water Management Strategy

June 2021

Executive summary

The *Bullsbrook Freight and Industrial Regional Water Management Strategy* has been prepared for the Department of Planning, Lands and Heritage to inform and support the Land Use Planning Strategy. The Bullsbrook Freight and Industrial Land Use Planning Strategy is being developed to identify suitable areas and land use types over the Industrial Investigation areas and Industrial Expansion areas as identified in the North-East Sub-Regional Framework.

The pre-development setting of the strategy area comprises a series of wetlands, rivers, creeks which are highly interconnected with the superficial aquifer throughout the majority of the area. During winter the strategy area's prevailing condition is of wet landscapes resulting from excess water. A number of the surface water features and remnant vegetation across the strategy area are significant water dependent ecosystem or environmentally sensitive areas.

The strategy area is also large, remote from established and serviced urban fronts, has an extended development timeframe, no current water or wastewater servicing, and no planned provision for future wastewater reticulation for industrial development.

The seasonally wet landscape and the lack of planned water and wastewater servicing present challenges for development and are key determinants for water management for the strategy area.

Development of the strategy area will need to ensure integrated management of surface and groundwater to ensure that the water quality and ecological functions of water dependent ecosystems are maintained, and people and property are protected from risk of flooding and inundation.

A number of key water issues and planning considerations have been identified for the strategy area that require detailed consideration at the precinct scale to progress integrated water management and development planning.

This strategy gives an overview of the pre-development conditions and status of water resources, and provides more detailed consideration of the key water issues for the identified precincts. Guidance on further investigation of the development potential of parts of the strategy area, with regards to key water resource management and consideration of development in wet landscapes is provided. These investigations are required in order to demonstrate the capability of the land to support proposed development prior to rezoning.

The strategy identifies key design criteria and water management strategies for consideration for future development, to enable integrated water management and protection of water resources in conjunction with land use planning and development.

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Appendix E – Groundwater Quality

Appendix F – Bullsbrook Water Supply (Water Corporation 2010)

Appendix G – Bullsbrook Wastewater Conceptual Planning Long-Term Scheme (Water Corporation, 2018)

Abbreviations

AEP	Annual Exceedance Probability
ARI	Annual Recurrence Interval
AHD	Australian Height Datum
BoM	Bureau of Meteorology
CCW	Conservation Category Wetlands
CoS	City of Swan
DBCA	Department of Biodiversity, Conservation and Attractions
DoW	Department of Water
DPAW	Department of Parks and Wildlife
DPS	District Planning Strategy
DWER	Department of Water and Environment Regulation
EPA	Environmental Protection Authority
EPP	Environmental Protection Policy
ESA	Environmentally Sensitive Area
HRAP	Healthy Rivers Action Plan
IMT	Intermodal Terminal
LPS17	Local Planning Scheme No. 17
LSP	Local Structure Plan
MRS	Metropolitan Region Scheme
MUW	Multiple Use Wetland
NESRF	North-East Sub-Regional Framework
PEC	Priority Ecological Community
PDWSA	Public Drinking Water Supply Areas
PFAS	Per- and poly-fluoroalkyl substances
REW	Resource Enhancement Wetlands
RIWI	Rights in Water and Irrigation
RWMS	Regional Water Management Strategy
SBIP	South Bullsbrook Industrial Precinct
SRT	Swan River Trust
TEC	Threatened Ecological Community
WAPC	Western Australian Planning Commission
WDE	Water Dependent Ecosystem
WIR	Water Information Reporting
WWTP	Wastewater Treatment Plant

1. Introduction

1.1 Bullsbrook Freight and Industrial Land Use Planning Strategy area

The Bullsbrook Freight and Industrial Land Use Planning Strategy area (the strategy area) is located within the suburb of Bullsbrook, within the north-west corridor of the City of Swan local government area. The strategy area is approximately 3,509 hectares and is bounded by the RAAF Base Pearce and Great Northern Highway to the east, Shire of Chittering to the north, the Perth to Darwin National Highway (NorthLink Stage 3) to the west and rural land identified for urban expansion to the south (Figure 1).

A draft Bullsbrook Freight and Industrial Land Use Planning Strategy has been prepared for the site, which identifies a change in land use from predominantly rural to predominantly industrial, with transition to commercial and residential in the south linking to proposed residential development. The draft Land Use Planning Strategy identifies several development precincts (Figure 2) across the strategy area, with the aim to:

- Plan and deliver industrial and employment lands which respond to prevailing site conditions (land use and environmental opportunities and constraints).
- Provide a clear strategic vision for future development, service infrastructure, transport and intermodal requirements to support development and provide long term employment opportunities.
- Ensure successful integration of the proposed intermodal transport (IMT) site and surrounding industrial and employment lands with transport infrastructure to support a safe and efficient strategic freight transport network capable of servicing the North East and North West sub-regions' population and employment clusters.
- Provides a framework that can be used by state and local governments and stakeholders to inform the preparation of structure plans and to guide future amendments to the Metropolitan Region Scheme and local planning scheme.

1.2 Purpose of this report

This Regional Water Management Strategy is one of several supporting documents prepared for the Department of Planning, Lands and Heritage to support the Bullsbrook Freight and Industrial Land Use Planning Strategy.

This document has been prepared on the basis of currently available information, input from other technical studies and key stakeholders to identify key issues, opportunities, strategies and management actions to guide water management across the strategy area.

A District Water Management Strategy (DWMS) will be required to support any district structure plan, local planning strategy or Metropolitan Region Scheme (MRS) amendment, depending on individual site opportunities and/or constraints.

1.3 Consideration of natural features

The strategy area is large, low lying, features numerous sensitive environmental receptors and is poorly serviced, presenting a number of constraints to traditional land development. Planning has progressed in parts of the strategy area and this document has incorporated information from these development areas where available to ensure a consistent and coherent approach to drainage planning and associated arterial flood management, and

management of risks to the numerous sensitive environmental receptors within and in proximity to the strategy area.

Protection of the environmental assets within the strategy area has been considered at all stages during the development of the Land Use Planning Strategy. Key features of the Land Use Planning Strategy precincts (location, density, proposed built form and industry types) have been informed by the prevailing natural features of the site. The long term staging of the development has considered key information gaps and servicing constraints, as well as the need to protect environmentally significant areas.

The *Bullsbrook Freight and Industrial Regional Water Management Strategy* was developed alongside the Land Use Planning Strategy, with key principles and strategies that aim to:

- Deliver best practice environmentally sustainable development and water management strategies.
- Ensure that environmental, pollution control and drainage systems are designed and managed so that there are no adverse impacts on the Twin Swamps Nature Reserve Western Swamp Tortoise habitat and other significant natural areas, including the Ellen Brook.
- Protect high value wetlands, groundwater dependent ecosystems and waterways.

1.4 Scope and limitations

This report: has been prepared by GHD for Department of Planning, Lands and Heritage and may only be used and relied on by Department of Planning, Lands and Heritage for the purpose agreed between GHD and the Department of Planning, Lands and Heritage as set out in section 1.2 of this report.

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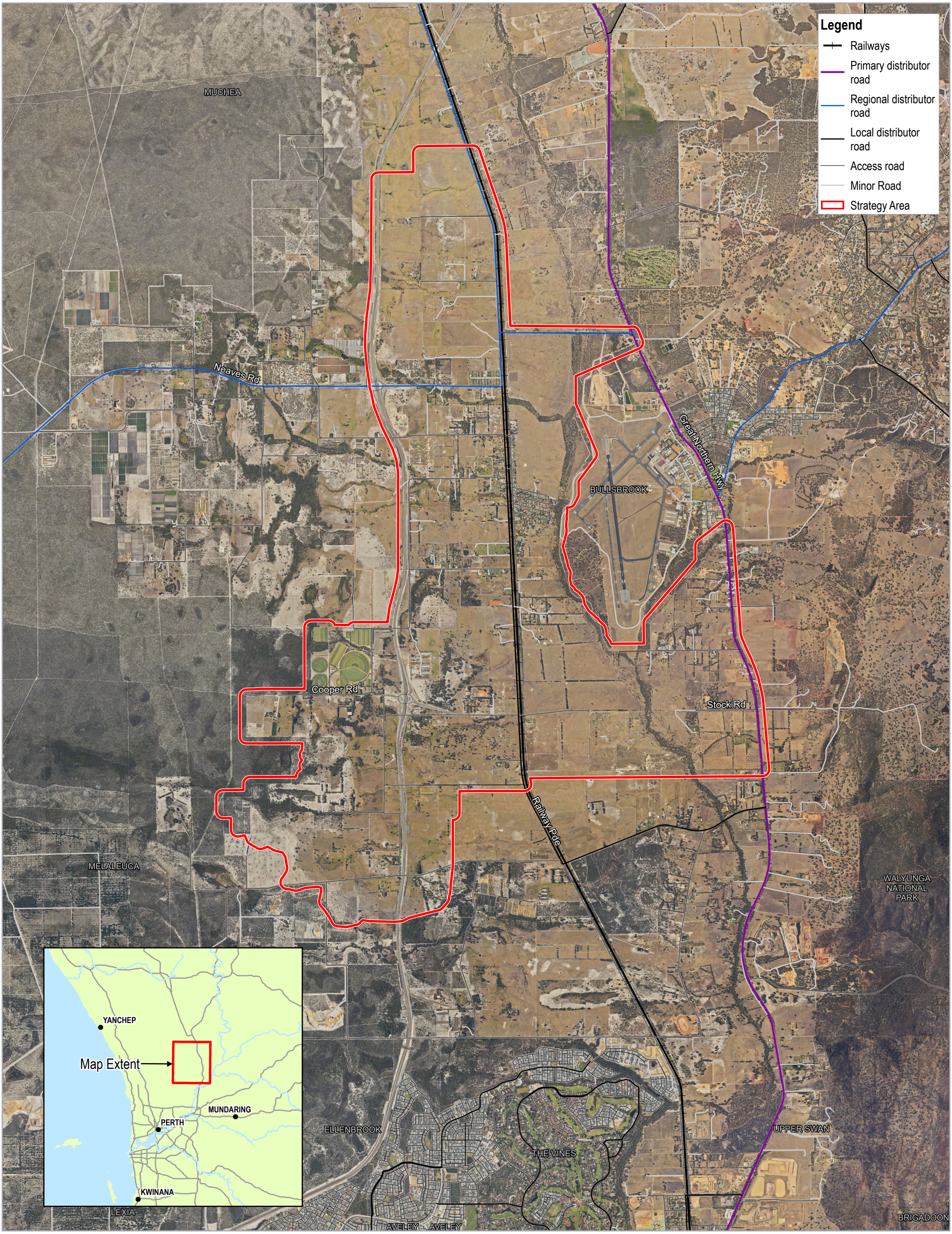
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1.5 Assumptions

This Regional Water Management Strategy document has been prepared based on information derived from a number of reports, investigations and management strategies that have been completed for parts of the strategy area. Site specific conditions vary across the strategy area and site-specific investigations should be completed to verify local conditions to inform site suitability for development and development design.



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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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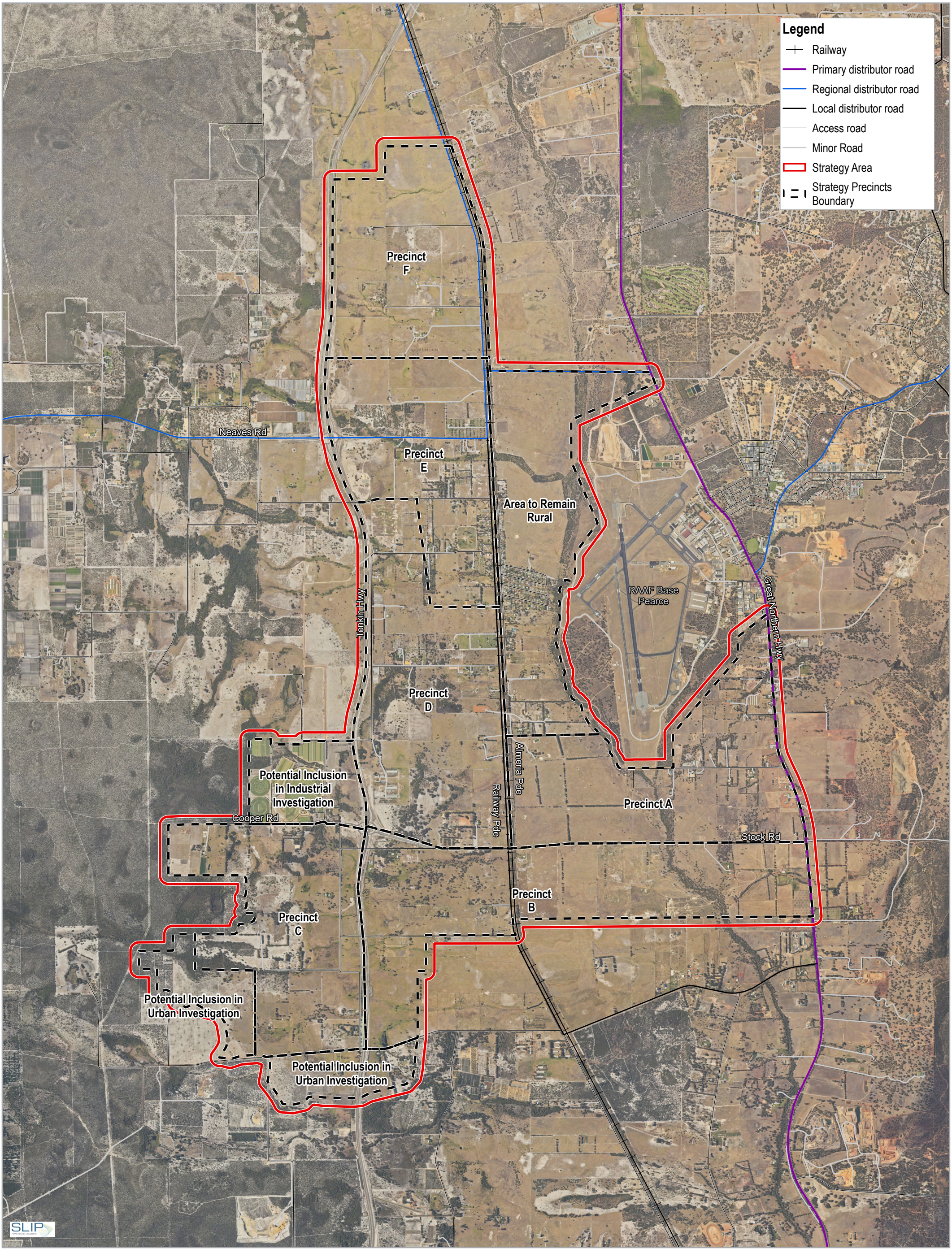
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Locality

FIGURE 1

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Strategy Plan

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FIGURE 2

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Data source: GHD: Masterplan Boundary, Transport Network - 20180702, Concept Plan - 20181102; Landgate: Roads, Railway - 20180820, Imagery - accessed 20200424. Created by: htaniza

1.6 Guidance documents and previous studies

1.6.1 Planning background

The Regional Water Management Strategy has been prepared with regard to the following key policy, management documents and guidelines for water management and development within the strategy area:

- *Decision process for stormwater management in Western Australia* (Department of Water and Environmental Regulation (DWER) 2017)
- *Swan Canning Water Quality Improvement Plan* (Swan River Trust 2009)
- *Environmental Protection (Western Swamp Tortoise Habitat) Policy* (Environmental Protection Authority (EPA) 2002)
- *Stormwater management Manual for WA* (Department of Water (DoW) 2004-2007)
- *Better Urban Water Management* (Western Australian Planning Commission (WAPC) 2008)
- *Government Sewerage Policy* (Government of Western Australia 2019a)
- *State Planning Policy 2.9: Water resources (WAPC 2006)*
- *Guidelines for Industrial Development* (Perth Region NRM 2010)

1.6.2 Perth & Peel @3.5 million and the Northeast Sub-Regional Planning Framework

The Northeast Sub-regional Planning Framework (NESRPF) forms part of the Perth and Peel @ 3.5 Million suite of documents to guide the future growth and development of the northeast sub-region.

The NESRPF is based on a number of key principles to avoid, protect and mitigate the environmental attributes of the sub-region. The principles of direct relevance to water and environmental resources include:

- Provide effective and sustainable management of water resources including public drinking water source areas, drainage and water allocation to minimise environmental impacts, particularly in a drying climate.
- Avoid, protect and mitigate impacts on environmental attributes (with an emphasis on avoiding and protecting) when allocating proposed land uses, or address impacts through an improved conservation estate where those impacts cannot be avoided or mitigated.

The NESRPF identifies a significant area of land for industrial expansion and industrial investigation within the Bullsbrook locality, noting that these areas may contain significant environmental attributes and further detailed planning is required. The key considerations for the industrial expansion and industrial investigation areas include:

- Best practice drainage and nutrient management
- Protection of Bush Forever areas and conservation category wetlands
- Protection of remnant native vegetation of complex with less than 30% of its original Perth and Peel regions extent remaining
- Protection of threatened flora populations
- Offsite impacts on Western Swamp Tortoise habitat (EPP)

1.6.3 Local planning scheme no. 17 (LPS17)

The majority of land within the strategy area is zoned 'General Rural' with the exception of the land zoned 'Special Use' to the north of Stock Road under LPS17.

The rezoning of any additional land to 'Industrial' under the MRS will require such land to similarly rezoned under the local planning scheme. LPS17 industrial zones include:

- Light Industrial (generally small-scale industrial development)
- General Industrial (manufacturing, servicing, storage and distribution)
- Industrial Development (requires structure plan)

1.6.4 City of Swan context

The City of Swan is the largest City in the Perth metropolitan area. The City is a Waterwise Council and has participated in the Water Sensitive Cities Index program by the Cooperative Research Centre for Water Sensitive Cities. The City has a number of strategic documents, policy and plans that inform water management including:

- *Strategic Community Plan* (2017-2027)
- *Sustainable Environment policy* (2010) (POL-C-084)
- *Sustainable Environment Strategy* (2012)
- *Operating Strategy for Ground Water Usage for the City's Ground Water Licenses* (2011)
- *Water Efficiency Action Plan 2016-2021* (2016)

The Water Efficiency Action Plan 2016-2021 provides guidance on water efficiency and water quality, identifying current key actions and focus areas for the City. The Strategic Community Plan is identified as the principle strategy and planning document for the City. Key water management objectives and strategies from the Strategic Community Plan are summarised in Table 1.

The City also has a number of Engineering and Technical Specifications that should be referred to during drainage design including:

- *Handbook of Stormwater Drainage Design* (2002a)
- *Development Design Specification D5 Stormwater Drainage Design* (2002b)
- *Development Design Specification D7: Erosion Control and Stormwater Management* (2002c)

Table 1 City of Swan key water management objectives

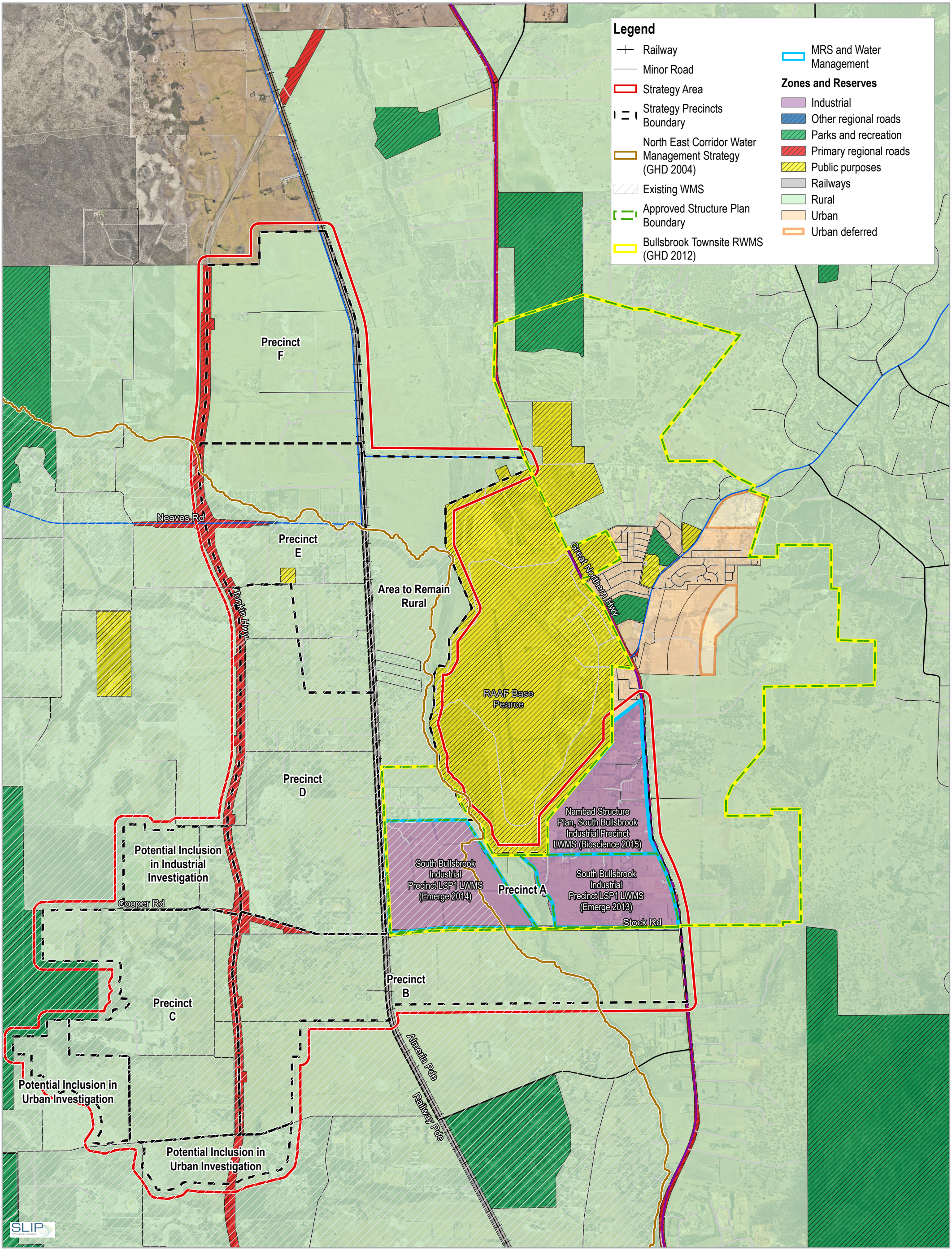
Document	Objective	Strategy
Strategic Community Plan	N1.1 Mitigate City's carbon footprint, reducing waste and greenhouse gas production	N1.1.1 Effectively manage resource consumption, including water, energy and non-renewable resources
	N2.2 Reduce adverse impacts on biodiversity	N2.2.1 Protect waterways through appropriate land management practices
		N2.2.2 Implement "best practice" in management of ground and surface water

1.6.5 Existing studies and management strategies

Several technical studies and water management strategies have been completed for areas within and surrounding the strategy area and have been referred to in the preparation of this Regional Water Management Strategy:

- *Ellen Brook Flood Study* (Waugh and Ng 1987)
- *NorthLink Public Environmental Report* (NorthLink 2015) (and supporting technical reports)
- *Neaves Rutland Other Regional Road Study Final Planning Report* (WorleyParsons Consulting 2016)
- *Local Water Management Strategy; South Bullsbrook Industrial Precinct LSP1* (Emerge 2013)
- *Local Water Management Strategy; South Bullsbrook Industrial Precinct LSP2* (Emerge 2014)
- *Local Water Management Strategy; South Bullsbrook Industrial Precinct* (Bioscience 2015)
- *Various Landholdings, Bullsbrook District Water Management Strategy* (hyd_20 2014)
- *South Bullsbrook Intermodal Terminal Stormwater Management Strategy* (GHD 2016)
- *Review of North East Corridor Drainage Management Strategy for DoW* (GHD 2004)
- *North East Corridor Urban Water Management Strategy for DoW* (GHD 2007)
- *Regional Water Management Strategy for Bullsbrook Townsite for City of Swan* (GHD 2012)
- *North East Metropolitan Sub-Region: Regional Water Management Strategy* (Urbaqua 2018)

The location of approved water management strategy boundaries within the strategy area boundary are shown in Figure 3.



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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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MRS Zoning and Approved Water Management Planning

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FIGURE 3

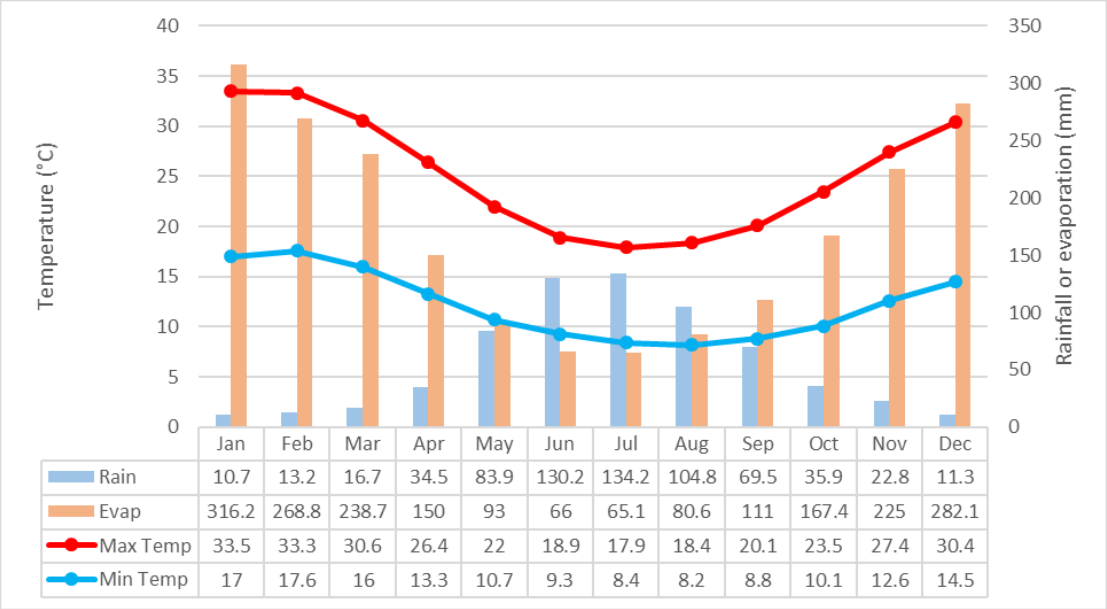
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2. Pre-development setting

2.1 Climate

The study area has a Mediterranean climate, with cool wet winters and hot, drier summers. The nearest Bureau of Meteorology (BoM) climate station with long-term data is Pearce RAAF base, adjacent to the study area (Station number 009053). The mean maximum summer temperature is 33.5°C and mean maximum winter temperature of 17.9°C (BoM 2018). Rainfall is highest in winter, and annual rainfall is 654.6 mm (Figure 4). The nearest station measuring evaporation is Perth Airport, 29.7 km away (site 009021), and the average annual evaporation is 2,063.9 mm.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rain	10.7	13.2	16.7	34.5	83.9	130.2	134.2	104.8	69.5	35.9	22.8	11.3
Evap	316.2	268.8	238.7	150	93	66	65.1	80.6	111	167.4	225	282.1
Max Temp	33.5	33.3	30.6	26.4	22	18.9	17.9	18.4	20.1	23.5	27.4	30.4
Min Temp	17	17.6	16	13.3	10.7	9.3	8.4	8.2	8.8	10.1	12.6	14.5

Figure 4 Climate statistics, Sites 009053 Pearce RAAF and 009021 Perth Airport (evaporation only) (BoM 2018)

Climate change is expected to impact on the future rainfall pattern for the study area. It is recognised that the average rainfall in the region has already declined by 20%-30% over the past few decades and that the long-term impact of climate change may lead to a shift in rainfall gradient to the west, as well as drier climatic conditions for the Perth metropolitan region (CSIRO 2007).

In the region, the winter decline in rainfall is accompanied by a sharp decrease in the totals of the extreme rainfall days with a strong decrease in the intensity of rain falling on very wet days, and in the number of very wet days (CSIRO 2007). A future reduction in rainfall intensity will place less demand on drainage infrastructure designed for intense rainfall events.

Projections for climate into the future suggest that the drying trend will continue (DoW 2015).

2.2 Existing land use and planning

Existing land use within the study area is currently predominantly rural. Small residential areas occur in the nearby townsites of Muchea and Bullsbrook. The suburb of Ellenbrook, a secondary centre under State Planning Policy 4.2 – Activity Centres for Perth and Peel, occurs to the south of the strategy area.

The majority of land within the study area is zoned 'Rural' under the MRS and 'General Rural' under LPS17, with development within these areas comprising mainly horse agistments, catteries, kennels and rural residential housing.

MRS Amendment 1219/41 rezoned two sites east of Railway Parade and north of Stock Road from 'Rural' to 'Industry' (Figure 3). The City of Swan subsequently rezoned the sites from 'General Rural' to 'Special Use' under LPS17. Currently the sites comprise cleared and undeveloped land however, are likely to accommodate early industrial activity to support residential growth in the area. Two structure plans totalling approximately 429 hectares have been approved over these industrial areas, identified in LPS17 as the South Bullsbrook Industrial Precinct (SBIP).

Residential development within the study area is generally dispersed throughout the rural areas. There is a pocket of residential development located between the rail line and the RAAF Pearce airbase, proposed to remain within the 'Rural' zone.

The North-East Sub-Regional Framework (NESRF) identifies land within the strategy area and to the north of Stock Road for Industrial Investigation whilst the land to the south of Stock Road, is identified for Industrial Expansion. There is land immediately south of the study area, which is subject to urban investigation under the NESRF. The interface between this proposed urban area and any industrial activity will need to be carefully managed to avoid land use conflicts by planning for appropriate land uses in transitional and interface areas.

Key transport features of the study area include NorthLink, which forms the western boundary of the study area through the central and northern sections, and the Millendon to Narngulu rail line, which runs north south through the study area, forming the eastern boundary in its northern extent and dissecting the study area through the central and southern sections. NorthLink introduces new culvert crossings as upstream boundary conditions for the study area. The rail line and adjacent roads (Railway Parade in the south, Almeria Parade in the centre and Muchea South Road in the north) also have a number of existing culvert crossings.

2.3 Heritage

2.3.1 Aboriginal heritage

Sites listed as Aboriginal heritage sites under the *Aboriginal Heritage Act* 1972 are protected from development or impact except with the approval of the Department of Aboriginal Affairs and the relevant Aboriginal custodians of the land. Four Registered Aboriginal Sites are present within the study area as listed in Table 2. Any future development within the heritage site boundary is required to have due regard to and comply with the requirements of the *Aboriginal Heritage Act* 1972.

Table 2 Registered Aboriginal Sites

ID	Name	Restriction	Status	Type
3525	Ellen Brook	No gender restrictions	Registered Site	Mythological
3583	Ki-It Monger Brook 2	No gender restrictions	Registered Site	Ceremonial, Modified Tree, Mythological
25735	Bingham Road Creek Artefact Scatter	No gender restrictions	Registered Site	Artefacts/Scatter
4362	South Bullsbrook	No gender restrictions	Registered Site	Artefacts/Scatter

2.3.2 European heritage

Two sites within the strategy area are identified as having historic heritage significance:

- West Bullsbrook Hall (25869) – heritage listed site of significant historic value to the local community
- Old shop (25963) – listed in the municipal inventory, the old shop has some historic value having served the community as a corner store.

It is unlikely that the Land Use Planning Strategy will affect the historic heritage sites as they are within the existing residential area. Nevertheless, they will need to be identified within the Land Use Planning Strategy .

2.4 Topography

The strategy area is generally flat, grading gently towards Ellen Brook. The majority of the study area grades west to east, with a strip along the eastern boundary grading towards the west. Elevation for the study area is shown on Figure 5. The maximum elevation along the western boundary is 57 m AHD in the northern corner, and falls to 40 m AHD in the south. The eastern boundary falls from 40 m AHD in the northern corner to around 30 m AHD in the south. However, due to the shape of the study area, the highest elevation is in the south west corner and is 64 m AHD. The minimum elevation is 24 m AHD, where Ellen Brook crosses the south eastern boundary.

2.5 Landform and soils

The main geological units in the study area are the Guildford Formation comprising alluvium and the Bassendean Sand comprising Aeolian sand. The soils across the majority of the study area are classified as Pinjarra Landscape Zone, comprising seasonally waterlogged flats (palusplains) (Figure 6). The Pinjarra Zone features numerous ephemeral waterways, natural or constructed, which intersect the palusplain. The Pinjarra Zone coincides with and is predominantly underlain by the fluvial deposits of the Guildford Formation (Low 1971).

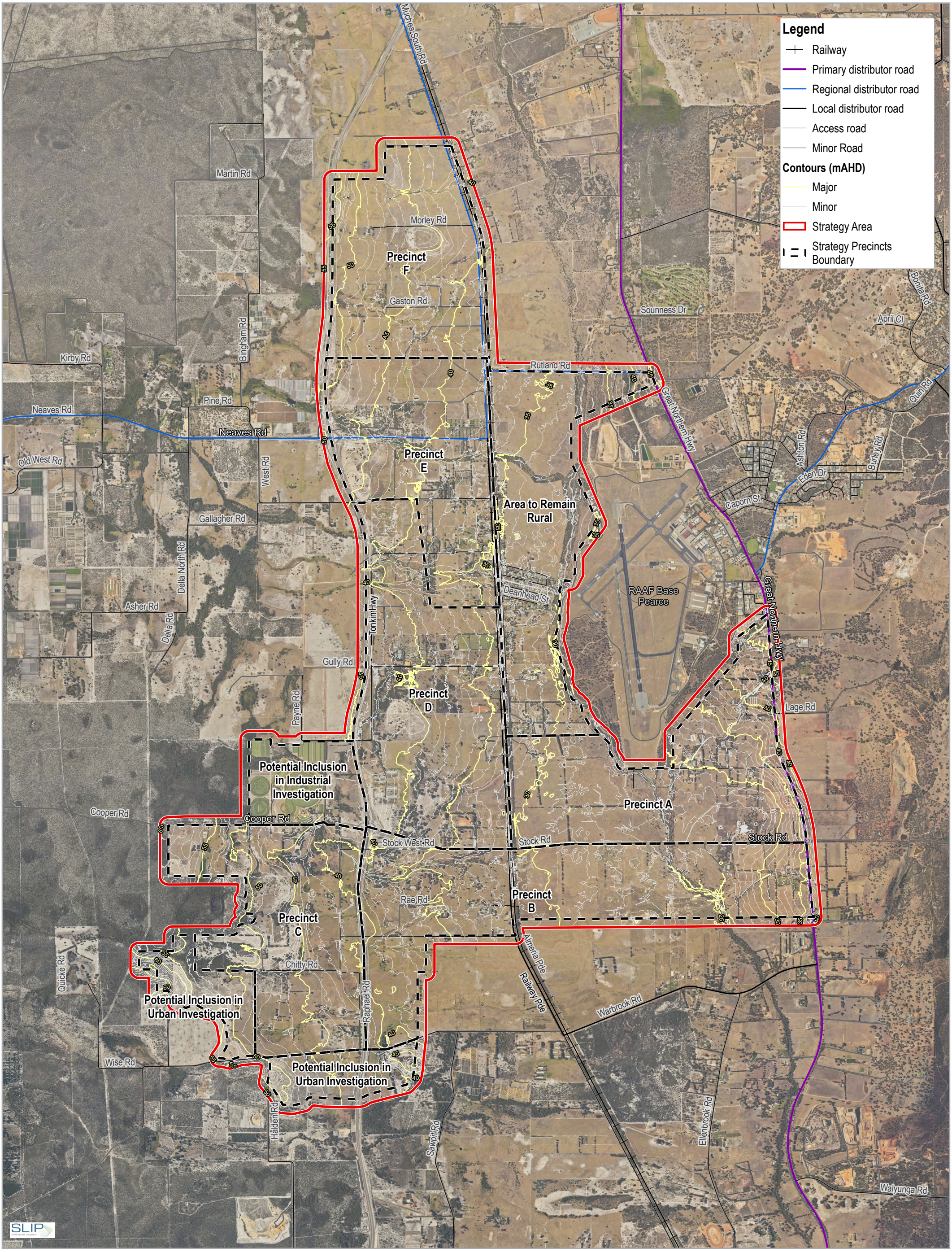
The Bassendean Dune System occurs along the western boundary of the study area. Along the eastern margin of the Bassendean Dunes relatively thin layers of sand are interspersed with silts and clays of riverine origin. A small portion in the south west corner of the study area and at the end of Strachan Road is Bassendean sands, non-calcerous sands and podsolised soils with low-lying wet areas. A section at the eastern end of Rutland Road is part of the Dandaragan Plateau soils, gently undulating plateau with areas of sandplain and laterite on cretaceous sediments.

Hydraulic conductivity testing completed for the NorthLink alignment indicated that hydraulic conductivity of the Bassendean Sand ranges between 10 m/d and 50 m/d while the Guildford Formation ranges between 0.01 m/d (clay) and 10 m/d (sand) (Northlink WA 2015f and 2015g).

Detailed site-specific geotechnical investigations will be required to support future Local Structure Plans and their associated Local Water Management Strategy (LWMS). Minimal geotechnical investigation may be required at the DWMS stage to inform modelling. This should be confirmed with the DWER at that stage.

2.6 Acid sulfate soils

Parts of the strategy area, including Ellen Brook and west of Railway Parade, have low to moderate risk of acid sulfate soils risk within the top 3 m of the ground's surface throughout (Figure 7). High to moderate risk areas are present between Gully Road and Warbrook Road, west of Railway Parade and Raphael Road.



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Kilometres

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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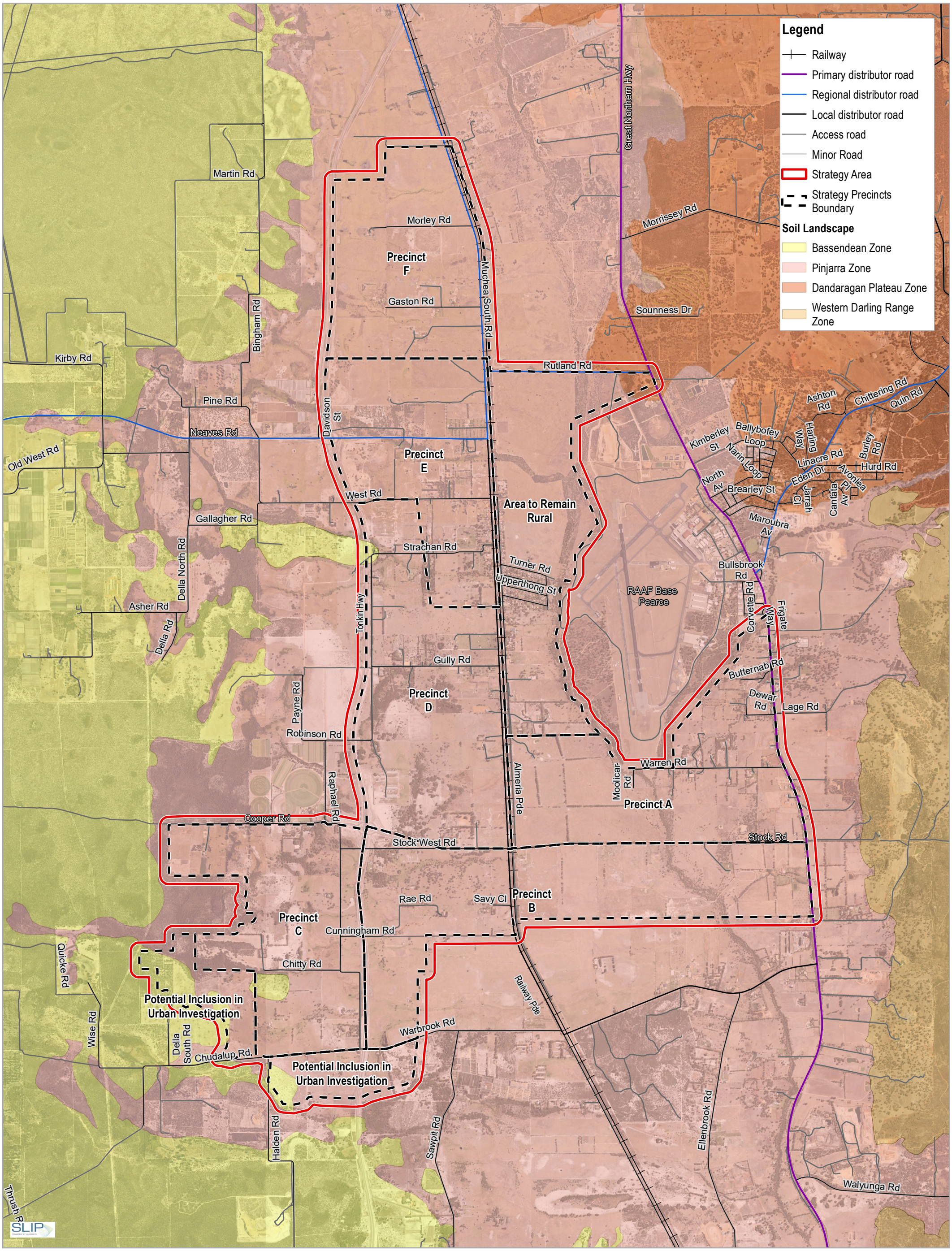
Topography

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FIGURE 5

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Data source: GHD: Masterplan Boundary, Transport Network - 20180702, Concept Plan - 20181102; Landgate: Roads, Railway - 20180820, Imagery - accessed 20200424. Created by: htaniza



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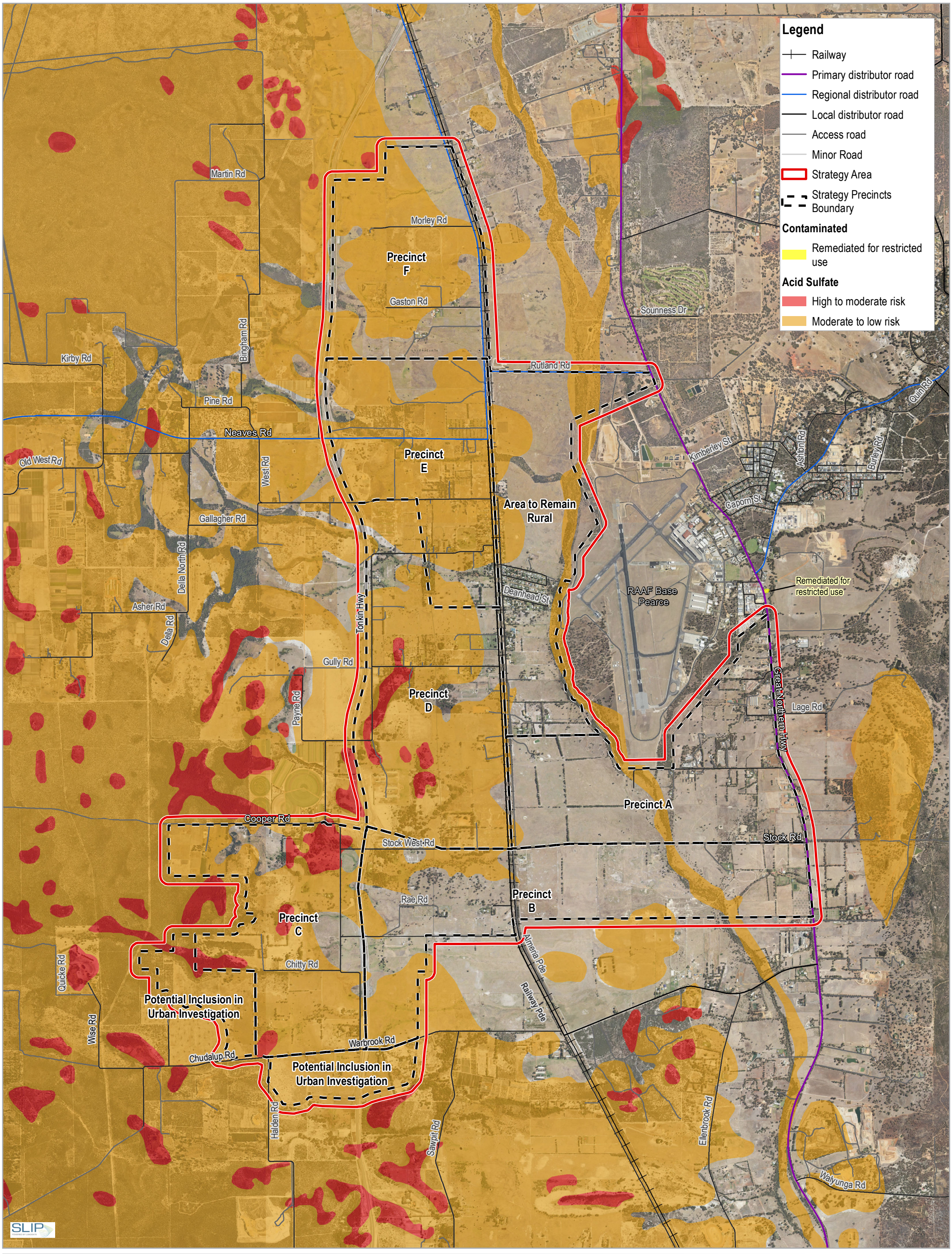
Project No. **61-37134**
Revision No. **E**
Date **10/1/2021**

Soil Landscape Zones

FIGURE 6

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Print date: 01 Oct 2021 - 14:57

Data source: GHD: Masterplan Boundary, Transport Network - 20180702, Concept Plan - 20181102; Landgate: Roads, Railway - 20180820, Imagery - accessed 20200424. Created by: htaniza



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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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Acid Sulfate Soil and Contaminated Land

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Revision No. **E**
Date **10/4/2021**

FIGURE 7

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Print date: 04 Oct 2021 - 15:41

Data source: GHD: Masterplan Boundary, Transport Network - 20180702, Concept Plan - 20181102; DWER: Acid Sulphate Risk - 20171219; Landgate: Roads, Railway - 20180820, Imagery - accessed 20200424. Created by: htaniza

2.7 Contaminated sites

There are no registered contaminated sites within the study area (DWER 2018). There is one contaminated site in proximity to the study area, at 2532 Great Northern Highway, just south of the intersection with Bullsbrook Road (Figure 7). It was classified *Remediated for restricted use* on 12 April 2013. The site was historically used as a service station and hydrocarbon impacted soils are beneath the building and forecourt area.

A preliminary site investigation completed for the Bullsbrook IMT site (GHD 2016a) identified evidence of potentially contaminating activities on some lots, and it was recommended that these sites be investigated further to determine if remediation is required.

Where a parcel of land has historically been used for intensive agricultural activities it is recommended that these sites be investigated further to assess if there is any evidence of potentially contaminating activities.

Per- and poly-fluoroalkyl substances (PFAS) contamination has been identified within the soil and water around the Pearce RAAF airbase in Bullsbrook, with contamination reported to have spread to groundwater within West Bullsbrook due to surface water overflow from the Ellen Brook to land, and interaction between the Ellen Brook and superficial groundwater (GHD 2018). Appropriate use of groundwater within the contaminated areas should be considered in consultation with the Department of Health primarily, and the DWER.

2.8 Conservation areas

2.8.1 DBCA managed lands

The study area intersects a portion of the Gnangara-Moore River State Forest (F 65, Class A) along its western boundary, a Department of Biodiversity, Conservation and Attractions (DBCA) managed conservation area. This portion of Gnangara-Moore River State Forest is also listed as Bush Forever Sites No. 6 and 399. Gnangara-Moore River State Forest extends from Pinjar to Whiteman Park covering approximately 66,000 ha.

Nine other DBCA managed conservation areas are located within 5 km of the Study Area (Table A-1 Appendix A). These comprise a number of nature reserves the closest of which is the Twin Swamps Nature Reserve (Figure 8).

2.8.2 Bush Forever

The study area intersects seven Bush Forever sites (Figure 8 and Table A-2 in Appendix A).

2.8.3 Regional Parks

No Regional Parks intersect the study area or occur within a 5 km buffer.

2.8.4 EPP Western Swamp Tortoise Habitat

The Western Swamp Tortoise (*Pseudemydura umbrina*) is listed as Critically Endangered under the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) and Schedule 1 of the WC Act. The Tortoise is found in two remnant habitats (Ellen Brook and Twin Swamps Nature Reserves) and two translocated (re-introduced) habitats (Moore River Nature Reserve and Lake Wannamal Nature Reserve at Mogumber).

The Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011 is in place to protect habitat suitable for the long-term survival of wild populations of the Western Swamp Tortoise. The Policy defines an area which includes Twin Swamps and Ellen Brook and Nature Reserves as well as adjacent areas, and covers approximately 2,250 ha (Figure 8).

The study area is located approximately 0.8 km north of Twin Swamps Nature Reserve (R 27621) and 4.7 km north of Ellen Brook Nature Reserve (R 27620), reserves for the preservation of fauna, namely the Western Swamp Tortoise. The study area also intersects the northern extent of the policy area as defined in the Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011.

2.8.5 Ecological linkages

There are five ecological linkages intersecting with the study area, shown on Figure 9 and summarised in Appendix A.

2.8.6 Environmentally Sensitive Areas

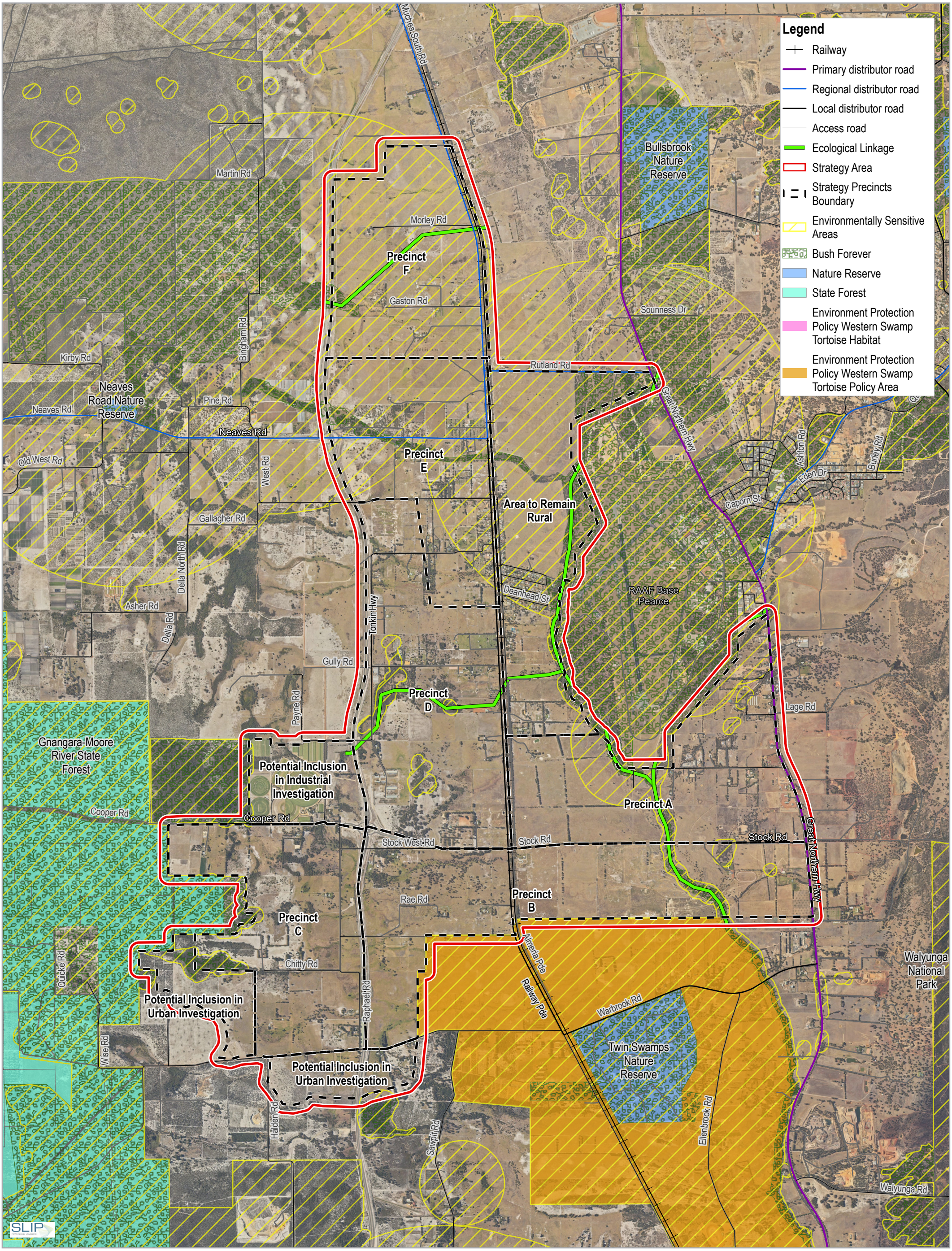
A number of Environmental Sensitive Areas (ESAs) occur or intersect the study area. These ESAs are likely aligned with Threatened Ecological Community's (TECs), DBCA-managed lands, Bush Forever and geomorphic wetlands.

Mound Springs of the Swan Coastal Plain

Two Mound Spring Swan Coastal Plain TECs occur to the west of the NorthLink transport corridor alignment. A hydrogeological assessment was completed to assess impacts of alignment options on the mound spring TEC (Groundwater Consulting Services Pty Ltd 2008).

The assessment identified that the potential for impact on the mound springs from the downgradient direction (i.e. east of the mound spring) was significantly reduced. As the groundwater flow is easterly movement of any contaminants would occur away from the springs.

Of note the groundwater quality from the springs is noted to be fresh and acidic, and containing elevated nutrients (Groundwater Consulting Services Pty Ltd 2008). The acidic nature of the groundwater has greater capacity to mobilise and transport heavy metals which may be expected from major transport corridors and certain industry types.



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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Conservation Areas

FIGURE 8

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Data source: GHD: Site Boundary - 20180702; DBCA: Managed Lands - 20180517; DoP: Bush Forever; EPA: Environment Protection Policy Western Swamp Tortoise Habitat, Western Swamp Tortoise Policy Area, Environmentally Sensitive Areas; Landgate: Roads - 20180516, Imagery accessed 20200424. Created by: htaniza

Legend

Conservation Significant Flora

- Threatened
- Priority 1
- Priority 2
- Priority 3
- Priority 4

Conservation Significant Fauna

- Critically endangered species
- Endangered species
- Vulnerable species
- Migratory birds protected under an international agreement
- Other specially protected fauna
- Priority 1: Poorly-known species
- Priority 3: Poorly-known species
- Priority 4: Rare, Near Threatened and other species in need of monitoring
- Ecological linkage
- Railway
- Primary distributor road
- Regional distributor road
- Local distributor road
- Access road
- Strategy Area
- Strategy Precincts Boundary
- Native vegetation
- Priority ecological communities
- Threatened ecological communities

Precinct F
Precinct E
Precinct D
Precinct A
Precinct B
Precinct C
Area to Remain Rural
Potential Inclusion in Industrial Investigation
Potential Inclusion in Urban Investigation
Potential Inclusion in Urban Investigation
RAAF Base Pearce
Martin Rd
Morley Rd
Gaston Rd
Bingham Rd
Kirby Rd
Pine Rd
Neaves Rd
Neaves Rd
West Rd
Rutland Rd
Sounness Dr
Great Northern Hwy
Ashton Rd
Eden Dr
Burley Rd
Dirk Rd
Caporn St
Gallagher Rd
Della North Rd
Asher Rd
Della Rd
Tonkin Hwy
Deanhead St
Great Northern Hwy
Lage Rd
Gully Rd
Payne Rd
Cooper Rd
Cooper Rd
Stock West Rd
Stock Rd
Stock Rd
Rae Rd
Chitty Rd
Raphael Rd
Almeria Pde
Railway Pde
Warbrook Rd
Wise Rd
Halden Rd
Sawpit Rd
Ellenbrook Rd
Walyunga Rd
Maralla Rd
SLIP

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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Conservation Significant Flora and Fauna

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FIGURE 9

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Data source: GHD: Site Boundary - 20180702; DBCA: Managed Lands - 20180517; DBCA: Conservation Significant Flora, Conservation Significant Fauna, TEC/PEC, Imagery - accessed 20200424; DPIRD: Native Vegetation - 20171026; DoP: Bush Forever; EPA: Environment Protection Policy Western Swamp Tortoise Habitat, Western Swamp Tortoise Policy Area, Environmentally Sensitive Areas; Landgate: Imagery (August 2018), Roads - 20180516. Created by: htaniza

2.9 Surface water

2.9.1 Regional surface water features

The strategy area is located within Ellen Brook sub-catchment of the Swan Avon, Lower Swan Catchment, within the Swan Coastal river basin. The Swan River System is a proclaimed surface water area under the *Rights in Water and Irrigation Act 1914* (RIWI Act), and is subject to the *Environmental Protection (Swan and Canning Rivers) Policy 1998*.

The major surface water feature of the study area is Ellen Brook which flows in a south westerly direction the length of the study area, and dissecting the southern portion (Figure 10). The Ellen Brook is the largest sub-catchment of the Swan River, extending approximately 65 km and discharges into the upper Swan River near West Swan Road in Belhus. The Brook is ephemeral with flows generally from May to December.

To the east of Ellen Brook key tributaries that flow east to west crossing Great Northern Highway include Nambab Brook and Ki-it Monger Brook (Figure 10). To the west of Ellen Brook several ephemeral, unnamed tributaries also join Ellen Brook along its length within the study area (Figure 10). The area also includes a significant number of minor creeks/waterways, many in a degraded state, and drains. Waterway and drain locations should be confirmed with DWER at the DWMS and LWMS stages.

2.9.2 Ellen Brook Flood Study

The Ellen Brook Flood Study (Waugh and Ng 1987) provides details of Ellen Brook flood levels, including how the flood levels were derived and information regarding design flood hydrographs. The DWER have advised that no flood mapping is available for the Ellen Brook upstream of Rutland Road, and there is no flood mapping for the tributaries to Ellen Brook within the study area (D. Grace pers. comm.).

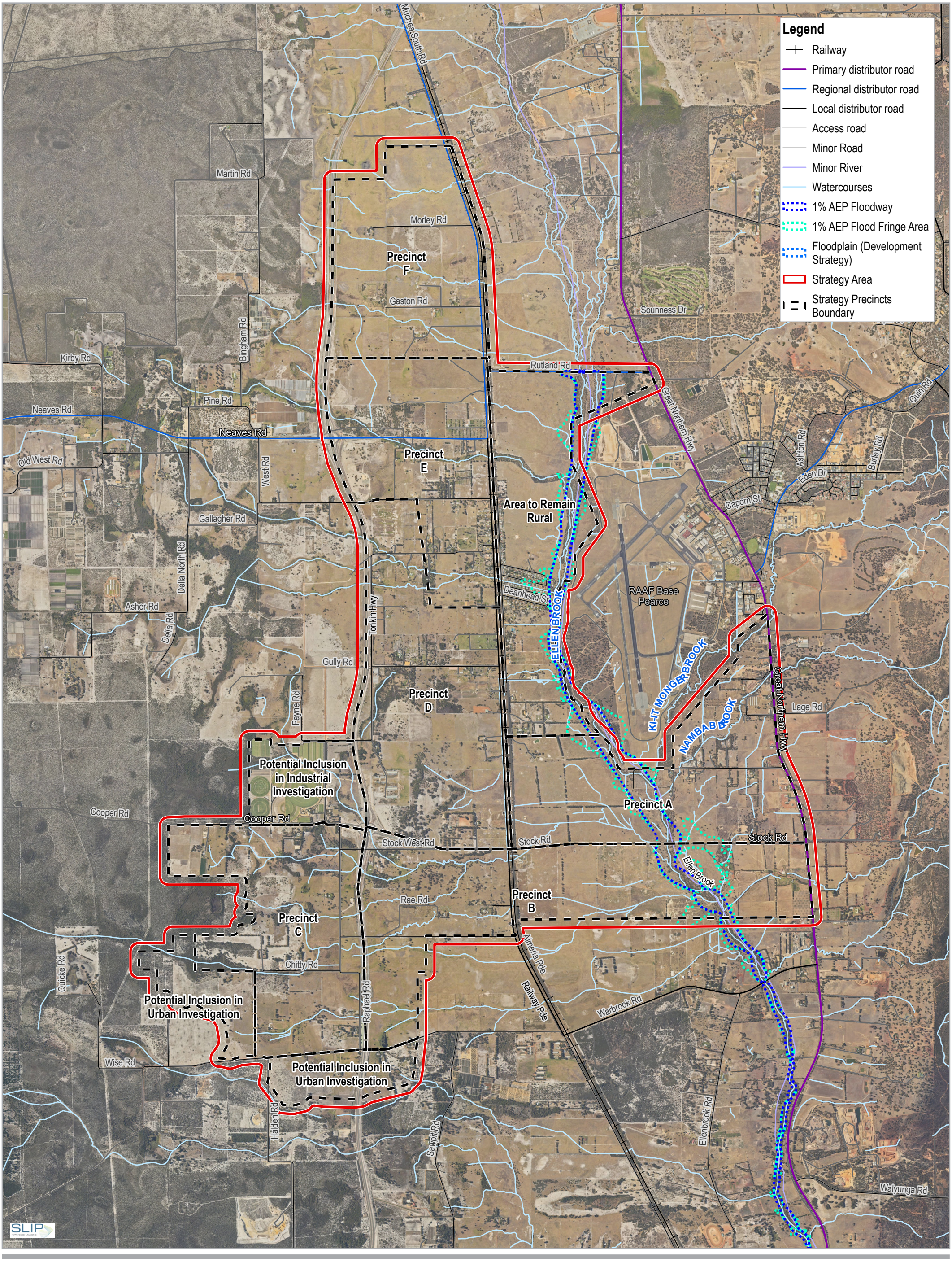
The DWER mapping of the Ellen Brook Floodplain Area and Floodplain Development Strategy are shown in Figure 10.

2.9.3 Existing drainage infrastructure

Existing land use across the area is predominantly grazing/agriculture and features little formalised drainage. Minor roads throughout the study area are generally drained by table drains with minor culverts at cross-roads. Key drainage infrastructure is associated with the following:

- Great Northern Highway;
- Muchea South Road;
- ARC Infrastructure railway running north-south through the site, parallel to Railway Parade and Muchea South Road;
- Ellen Brook;
- Neaves Road;
- Stock Road; and
- A major drain running between Brockholes St and Upperthong St to Ellen Brook.

A site visit in July 2018 to view the drainage structures and surface water features found that several areas across the strategy area were inundated, after rains during the previous week. Photographs are provided in Appendix B. Localised low points within paddocks and adjacent to roads were retaining surface water.



Paper Size ISO A3

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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Surface Water and Hydrology

FIGURE 10

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Data source: GHD: Masterplan Boundary, Transport Network - 20180702, Concept Plan - 20181102; DWER: Hydrography Hierarchy - 20200212; Landgate: Roads, Railway - 20180820, Imagery - accessed 20200424. Created by: htaniza

2.9.4 Pre-development peak flow estimates

A 2D pre-development surface water model was developed for the strategy area using Tuflow. Key input parameters included the hydrology parameters from the Ellen Brook Flood Study (Section 2.9.2), ARC railway culvert information, infrastructure and catchment information from the NorthLink reports and *Australian rainfall and runoff: a guide to flood estimation* (Ball *et al*. 2016).

A summary of the modelling approach, including model inputs and assumptions, is provided in Appendix D. Key results from the hydrologic and hydraulic modelling of pre-development conditions are also presented in Appendix D (Figures D1 to Figure D6). The modelling shows minor flooding across the study area, along defined stream paths that run between paddocks. This is consistent with the DWER waterway mapping (Figure 10) and observations from the site visit (Appendix B). The pre-development modelling of the RWMS area was based on information available at the time of modelling, and is considered preliminary at this stage. At the DWMS stage appropriate surface water modelling and current existing flood data should be confirmed with the DWER.

Table 3 Flow rates (m^3/s)

Flow location	20% AEP	10% AEP	5% AEP	1% AEP
Ellen Brook inflow to Site	36.21	46.04	55.59	88.5
Ellen Brook outflow from Site	40.34	51	63.08	109.14

2.9.5 Surface water quality

The *Swan Canning water quality improvement plan* (SRT 2009a) reviewed the water quality of the tributaries of the Swan and Canning rivers, identifying the Ellen Brook catchment as a priority nutrient management area, and categorising it as being of "unacceptable water quality".

The *Local Water Quality Improvement Plan; Ellen Brook Catchment* (SRT 2009b) notes that the annual contribution from the Ellen Brook is modelled at 71 tonnes (28%) of the total nitrogen (TN) and 10 tonnes (39%) of the total phosphorus (TP) entering the Swan Canning river system. Nutrient source modelling of the Ellen Brook catchment identified a number of point sources in the Ellen Brook as a number of intensive animal agricultural industries (including poultry farms, several closed piggeries, and feed lots) (Kelsey *et al*. 2010).

The *Local Water Quality Improvement Plan; Ellen Brook Catchment* includes long term load and nutrient concentration targets for the Ellen Brook catchment, as well as flow and non-nutrient targets. These are summarised with the short-term *Healthy Rivers Action Plan 2008-2013* nutrient targets (SRT 2008) in Table 4.

Table 4 Ellen Brook catchment water quality targets (SRT 2008; 2009b)

Parameter	Short term HRAP concentration target	Long term load target	Long term concentration target
Nitrogen	2.0 mg/L	22.1 tonne (69% reduction)	1.0 mg/L
Phosphorus	0.2 mg/L	2.1 tonne (79% reduction)	0.10 mg/L

Parameter	Short term HRAP concentration target	Long term load target	Long term concentration target
Non-nutrients	Meet ANZECC guidelines for environmental health at all sites		

Swan Canning Catchment Nutrient Report

Surface water quality monitoring of the Ellen Brook has been undertaken consistently since 1999 (Site 6160755). The mean and total loads from 1999 to 2011 are reported in the *Swan Canning Catchment Nutrient Report 2011* (SRT 2011). The results from 2005 onwards were available on DWER's *Water Information Reporting* (WIR) online database. A minimum of four samples were taken each year, with mean and maximum for the year are provided in Table 5, and results showing exceedance of the short-term concentration targets for Total Nitrogen and Total Phosphorus.

Table 5 Surface Water Quality at WIR Site 6160755, Ellen Brook (WIR 2018)

Analyte	Total Nitrogen (mg/L)		Total phosphorus (mg/L)		pH		TSS (mg/L)	
Year	Mean	Max	Mean	Max	Mean	Max	Mean	Max
2005	2.90	3.50	0.52	0.72	7.04	7.73	14.75	36.00
2006	1.68	2.50	0.34	0.53	7.01	7.36	51.80	242.00
2007	2.50	3.00	0.42	0.56	7.29	7.52	10.00	17.00
2008	2.43	3.30	0.47	0.80	7.51	7.71	7.25	12.00
2009	2.35	2.70	0.38	0.45	7.21	7.48	9.50	22.00
2010	2.60	3.80	0.40	0.88	7.65	8.24	12.25	18.00
2011	2.33	2.80	0.40	0.50	7.02	7.16	3.50	5.00
2012	1.78	2.00	0.31	0.48	7.12	7.56	11.67	17.00
2013	2.48	3.80	0.49	1.00	7.23	7.55	6.00	8.00
2014	2.65	3.20	0.42	0.54	7.34	7.55	9.25	14.00
2015	2.50	2.90	0.44	0.79	7.72	7.93	8.00	18.00
2016	2.73	3.00	0.43	0.63	7.64	8.12	3.75	6.00
2017	3.03	3.70	0.65	0.96	7.17	7.27	6.00	8.00
2018	2.60	2.90	0.47	0.61	6.91	6.93	8.00	10.00

2.10 Wetlands

2.10.1 Nationally and international significant wetlands

There are no RAMSAR listed wetlands within, or in 5 km of the Study Area. The Directory of Important Wetlands in Australia identifies the Ellen Brook Swamps System (Reference Code WA076), which includes the Twin Swamps Nature reserve (Section 2.8.4) and Ellen Brook Swamp, is located approximately 0.8 km to the south of the study area.

2.10.2 Geomorphic wetlands

The DBCA's *Geomorphic Wetlands Swan Coastal Plain* dataset identifies numerous wetlands of conservation significance within the strategy area (Figure 11). Of the 63 Geomorphic Wetlands that intersect the strategy area (Table C-1, Appendix C) 37 are classified as Conservation

Category Wetlands (CCW) and a further 12 are classified as Resource Enhancement Wetlands (REW).

The majority of the strategy area is designated as Multiple Use Wetland (MUW) palusplain which has formed between the Gnangara Mound and Ellen Brook, and featuring the Ellen Brook floodplain (UFI 15732). East of Ellen Brook the floodplain palusplain is predominantly listed as MUW UFI 15282. The extensive areas of MUW palusplain corresponds with high groundwater conditions across the study area as discussed in Section 2.11.5.

The Ellen Brook, its banks and foreshore is identified as CCW palusplain UFI 15734 (Ellen Brook Floodplain). Numerous other CCW and REW occur along or in proximity to the Ellen Brook and its minor tributaries.

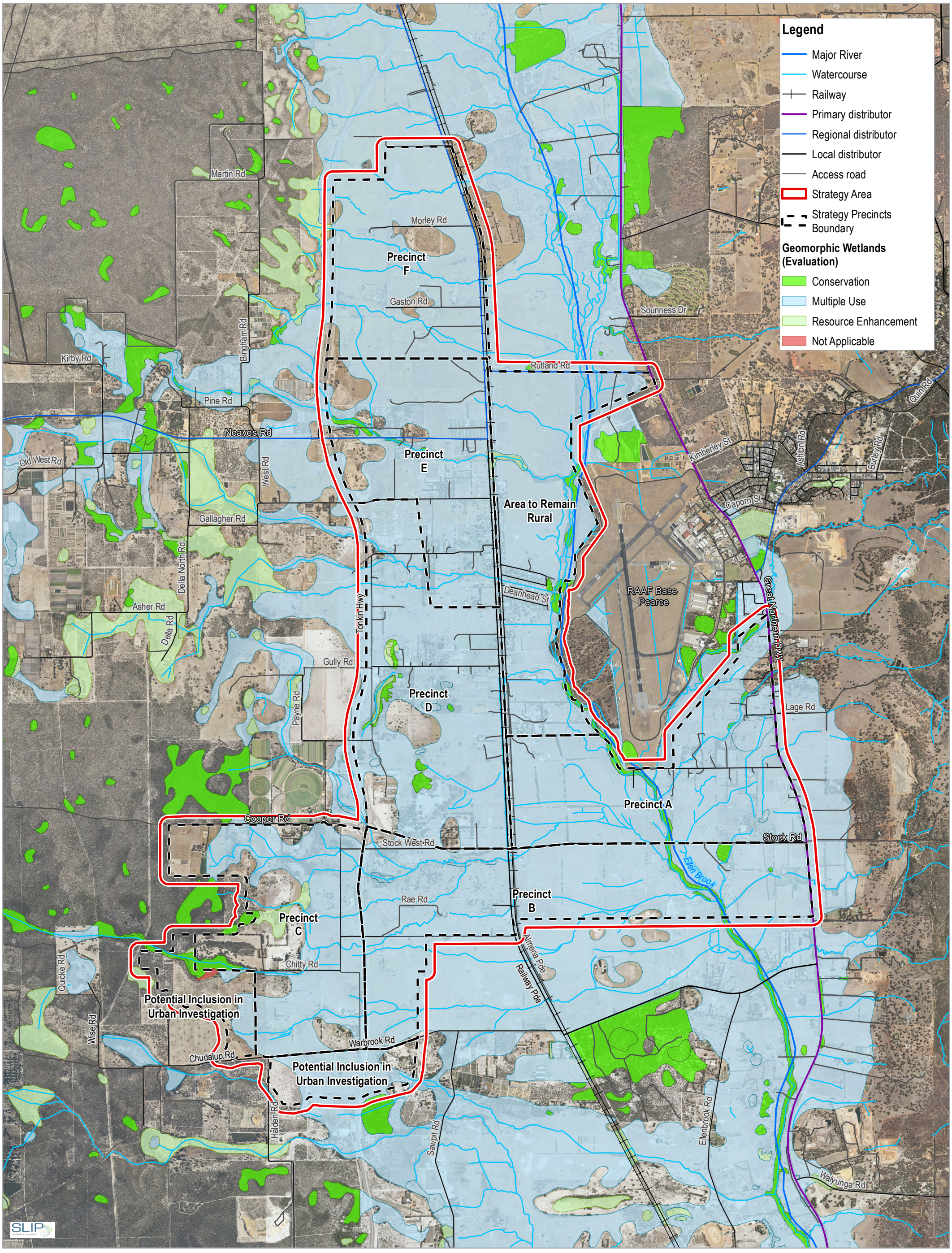
Wetlands of the Swan Coastal Plain typically operate as 'through flow' lakes, whereby the wetlands are hydraulically connected to the local groundwater system, being both an expression of the superficial aquifer and an opportunity for surface water recharge to groundwater depending on the season. As a result, maintaining both surface water and groundwater flows and water quality is required to protect these ecosystems given the extensive interconnection which exists between surface water and groundwater systems within the region.

2.10.3 Twin Swamps Nature Reserve

Information on the hydrology and hydrogeology of the Twin Swamps Nature Reserve is summarised in Smith and Shams (2002) and EPA (2006) including:

- The wetlands are perched on alluvial soils at the base of the Darling Scarp receiving water from direct rainfall and short-distance runoff including from drains and surrounding farmland.
- Inundation is seasonal, with a maximum water depth of 0.43 mm and the swamps dry out by mid-October or November.
- The hydrology of the Twin Swamps appear to be dominated by a balance between rainfall, surface inflows and outflows and evaporation, with the swamps understood to fill in response to first winter rains (direct rainfall and surface water runoff), with groundwater contribution in late winter with regional water table rise. It is suggested that there is some groundwater flow contribution from the eastern Darling Scarp catchment.
- The Twin Swamps are greatly affected by drought conditions and therefore any development or land use change that may reduce the quantity of water reaching the swamps will be detrimental to the survival of young tortoises and breeding adults.
- Water supplementation through groundwater abstraction has been implemented in drier years.

As part of the Perth-Darwin National Highway Public Environmental Review an assessment of topography was completed of the topography between the highway alignment and Twin Swamps. The assessment identified that runoff from the highway alignment would not flow into Twin Swamps (NorthLink WA 2015). The highway alignment dissects the southern part of the strategy area, and flow from the strategy area will flow along the same arterial flowpath.



Paper Size ISO A3

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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Geomorphic Wetlands

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FIGURE 11

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Print date: 04 Oct 2021 - 16:23

Data source: GHD: Masterplan Boundary, Transport Network - 20180702, Concept Plan - 20181102; Landgate: Roads, Railway - 20180820, Imagery accessed 20200424. Created by: htaniza

2.11 Groundwater

2.11.1 Groundwater area

The Bullsbrook area is located within the Swan Groundwater area which was proclaimed under the RIWI Act, and is managed under the *Gnangara Groundwater Areas Allocation Plan* (Department of Water 2009) which is currently under review.

2.11.2 Public drinking water source area

The Gnangara Underground Water Pollution Control Area, P1 area is located approximately 200 m east (upstream) of the most western extreme of the strategy area (Precinct C).

2.11.3 Regional hydrogeology

Information on the regional groundwater obtained from the DWER *Online Water Register* indicates that groundwater beneath the strategy area is a multi-layered aquifer system comprised of the following:

- Perth Superficial (unconfined)
- Perth Mirrabooka (semi-confined or locally confined)
- Perth Leederville (confined)
- Perth Yarragadee North (confined)

2.11.4 Local hydrogeology

Groundwater discharge from the Superficial (unconfined) occurs via several mechanisms including surface drainage to reduce seasonal inundation, interception by rivers, downward leakage, evapotranspiration and abstraction.

West of the boundary of Precincts E and F (Figure 2) groundwater discharge zones have been identified (i.e. springs and wetland seepage areas) that emanate from the eastern edge of the Gnangara Mound. Hydrogeological review of these areas (McHugh *et al.* 2011) suggests that seepage is a surface expression of the shallow depth-to-groundwater, rather than an upward potentiometric head from the base of the Superficial aquifer and underlying formations towards the ground surface, where the confluence of the Bassendean Sand and Guildford Formation result in slightly confined groundwater discharge and upward vertical gradients. In these areas the groundwater table is close to or in direct connection with the surface.

Hydrogeological investigations completed to determine a Design Groundwater Level for the Northlink project reported groundwater levels above the natural; ground surface in some monitoring wells in the vicinity of the western boundary of Precincts E and F (Golder 2017). Golder (2017) noted it was possible that groundwater level pressure in the aquifer was above ground (as measured) with the water dissipated when it reached the surface and drained away via surface flow pathways.

Geotechnical investigations for the Northlink project encountered Guildford Formation clays at shallow depths at isolated test locations, below the surficial Bassendean Sand unit, between Stock Road West and Neaves Road, in a low-lying area with several creek lines (Golder 2017). The potential for the formation of a perched water table was also noted due to the presence of near surface clayey soils (within 1m of ground surface) within a number of test pits along the Perth Darwin National Highway alignment that forms the western boundary of the strategy area (Golder 2017).

The Superficial aquifer within the strategy area supports a mix of remnant ephemeral, seasonal and permanent wetlands, and a number of rivers and creeks are also hydrologically linked to the groundwater system.

2.11.5 Groundwater levels

The strategy area lies on the eastern boundary of the Perth Groundwater Atlas's mapped data. The strategy area sits within a topographical low, with north-south trending highs on both sides.

Mapped historical minimum groundwater level contours follow a similar path to the topography, with a mapped high to the west of the study area associated with the Gnangara Mound. From the east, groundwater is mapped flowing in a south-westerly direction.

The DWER WIR online database was searched, with results filtered for available groundwater level data. 93 monitoring wells were identified, of which 82 monitor the superficial aquifer system. The remaining 11 wells are screened in lower aquifers, and exhibit artesian conditions and were therefore excluded from depth to groundwater considerations.

A transect of groundwater monitoring wells were monitored during 2016 (with some monitoring in 2017 for selected wells) for the Northlink project, with monitoring wells located along the Perth Darwin National Highway alignment.

Figure 12 presents the spatial distribution of these wells. Precincts B, E and F all have poor coverage of groundwater wells, and as such determining a depth to historical maximum groundwater surface would not provide suitable resolution between known monitoring locations. Further, groundwater level monitoring in some wells along the north-western boundary of the strategy area reported groundwater levels above ground surface (Golder 2017).

Instead, the risk of inundation was based on the Department of Primary Industries and Regional Development (DPIRD) Soil landscape land quality – Waterlogging Risk (DPIRD-015) dataset. This dataset is derived from land quality associated with soil-landscape mapping at the subsystem/phase level and is based on Resource Management Technical Report 298, Section 2.21 (Land Evaluation Standards for Land Resource Mapping, Department of Agriculture, Dec 2005). This is considered a more robust approach to mapping the depth to groundwater and hence inundation risk, than generating contours based on static water level information from wells.

The required future DWMS will need to ensure that sufficient groundwater monitoring has been undertaken to properly inform future surface water-groundwater modelling. The pre-development monitoring requirements should be confirmed with the DWER prior to their commencement (refer Section 6.1.2).

2.11.6 Groundwater quality

Groundwater has been identified to play a major role in the transport of nutrients to Ellen Brook and the Swan-Canning estuary, largely due to the close proximity to the natural ground surface during periods of inundations, causing mobilisation of nutrients (Smith and Shams 2002). Further the shallow and unconfined nature of groundwater across the strategy area makes it vulnerable to contamination from land use.

Groundwater quality sampling locations and results were taken from the Department of Water and Environmental WIR database and are presented in Appendix E.

Only sites that had physical parameters or nutrient results from the past 10 years (1998 -2018) are presented. Water quality results ranged from acidic to alkaline, and freshwater through to

saline waters. Nutrient concentrations in groundwater vary across the strategy area and are a reflection of local land uses.

Further investigations of local groundwater quality is recommended to support future planning works.

Per- and poly-fluoroalkyl substances (PFAS) contamination has been identified within the soil and water around the Pearce airbase in Bullsbrook (Section 2.7), with contamination reported to have spread to groundwater within West Bullsbrook due to surface water overflow from the Ellen Brook to land, and interaction between the Ellen Brook and superficial groundwater (GHD 2018).

2.11.7 Groundwater allocation

Groundwater allocation in Western Australia is regulated by DWER. For allocation purposes, aquifers are divided into specific groundwater areas and subareas. Each aquifer and groundwater subarea has a volume allocation for licencing purposes. In general, a licence to abstract (5C licence) will not be issued for areas that are fully allocated.

The strategy area is predominately located within the Radar groundwater subarea. A small region of the south west of the strategy area lies within the Neaves groundwater subarea, and small area of the south east of the strategy area lies within the Bandy Springs groundwater subarea. All three sub-areas are within the Swan groundwater area.

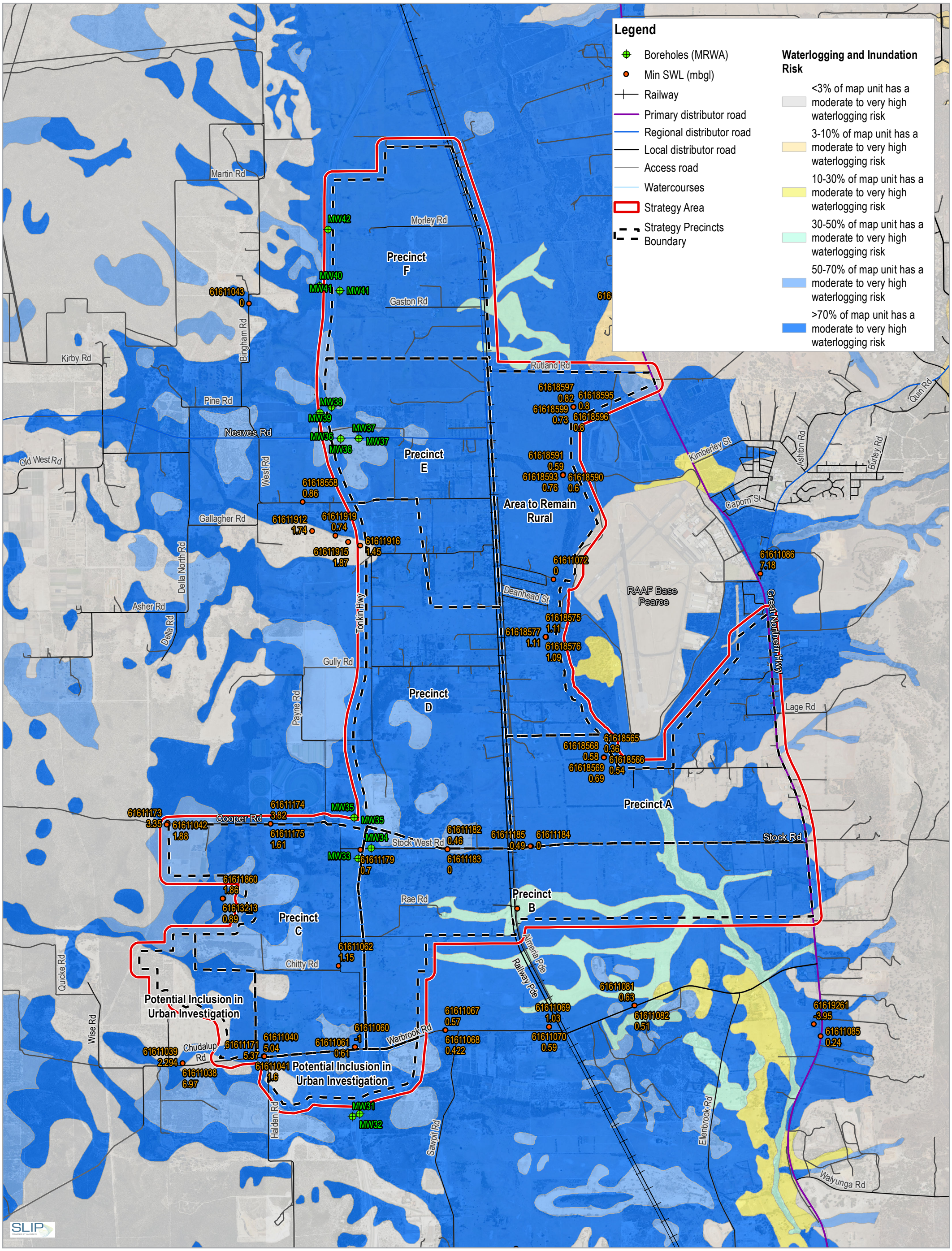
Licensed groundwater abstractions

Existing groundwater licenses (GWL) within and in proximity to the strategy area are shown in Figure 13.

All superficial aquifer allocated units are fully allocated within the strategy area. Leederville aquifer allocated units are also fully allocated, with some capacity still available from the Yarragadee aquifer (expected depth of greater than 600 metres).

As indicated by the high level of aquifer allocation, groundwater is well utilised within the strategy area. The majority of the groundwater use is for irrigation of agricultural land.

Groundwater allocation and trade/transfer of existing licenses is further discussed Section 5.5.2.



Paper Size ISO A3

0 0.5 1 1.5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

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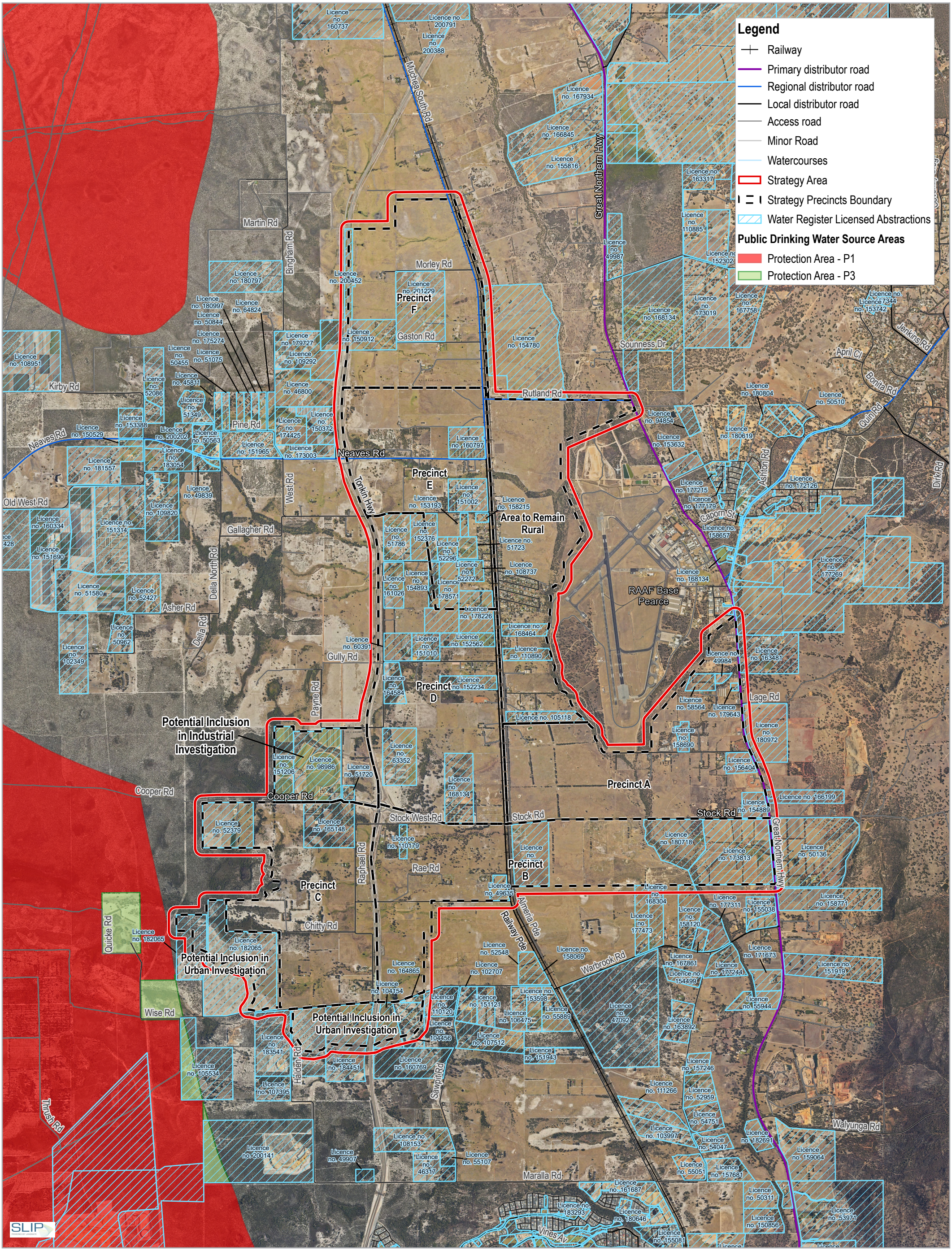
Waterlogging Risk and Groundwater Wells

Project No. **61-37134**
Revision No. **E**
Date **10/4/2021**

FIGURE 12

\\ghdnet.internal\ghd\AU\Perth\Projects\61\37134\GIS\Maps\Working\RWMS\6137134_019_WaterloggingRisk_RevE.mxd
Print date: 04 Oct 2021 - 16:38

Data source: GHD: Masterplan Boundary, Transport Network - 20180702, Concept Plan, Waterlogging and Inundation Risk - 20181102; DPIRD: Waterlogging and Inundation Risk - 20200212; Landgate: Roads, Railway - 20180820, Imagery accessed 20200424. Created by: htaniza



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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Project No. **61-37134**
Revision No. **F**
Date **1/18/2022**

Groundwater Resources

FIGURE 13

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Print date: 18 Jan 2022 - 15:48

Data source: GHD: Masterplan Boundary, Transport Network - 20180702, Concept Plan - 20181102; DWER: Water Register, Public Drinking Water Source Area - 20200212; Landgate: Roads, Railway - 20180820, Imagery accessed on 20200424. Created by: htaniza

2.12 Existing water and wastewater servicing

The strategy area is large and remote from established and serviced urban fronts, with an extended development timeframe.

The area is not currently serviced by either reticulated potable water or sewerage. The Water Corporation has advised they have not undertaken any long-term planning to provide servicing of the strategy area, with the exception of the areas that are already zoned for industrial development immediately south of Bullsbrook Townsite (e.g. South Bullsbrook Industrial Precinct, Precinct A, Figure 2).

2.12.1 Scheme water servicing

In order to service industrial and service/commercial land use within the strategy area new scheme water distribution infrastructure will need to be planned and built within and near the area.

Water Corporation have advised that there is limited capacity to service parts of the strategy area based on long term water planning to service urban expansion areas. Further detail is provided in Section 5.5.3.

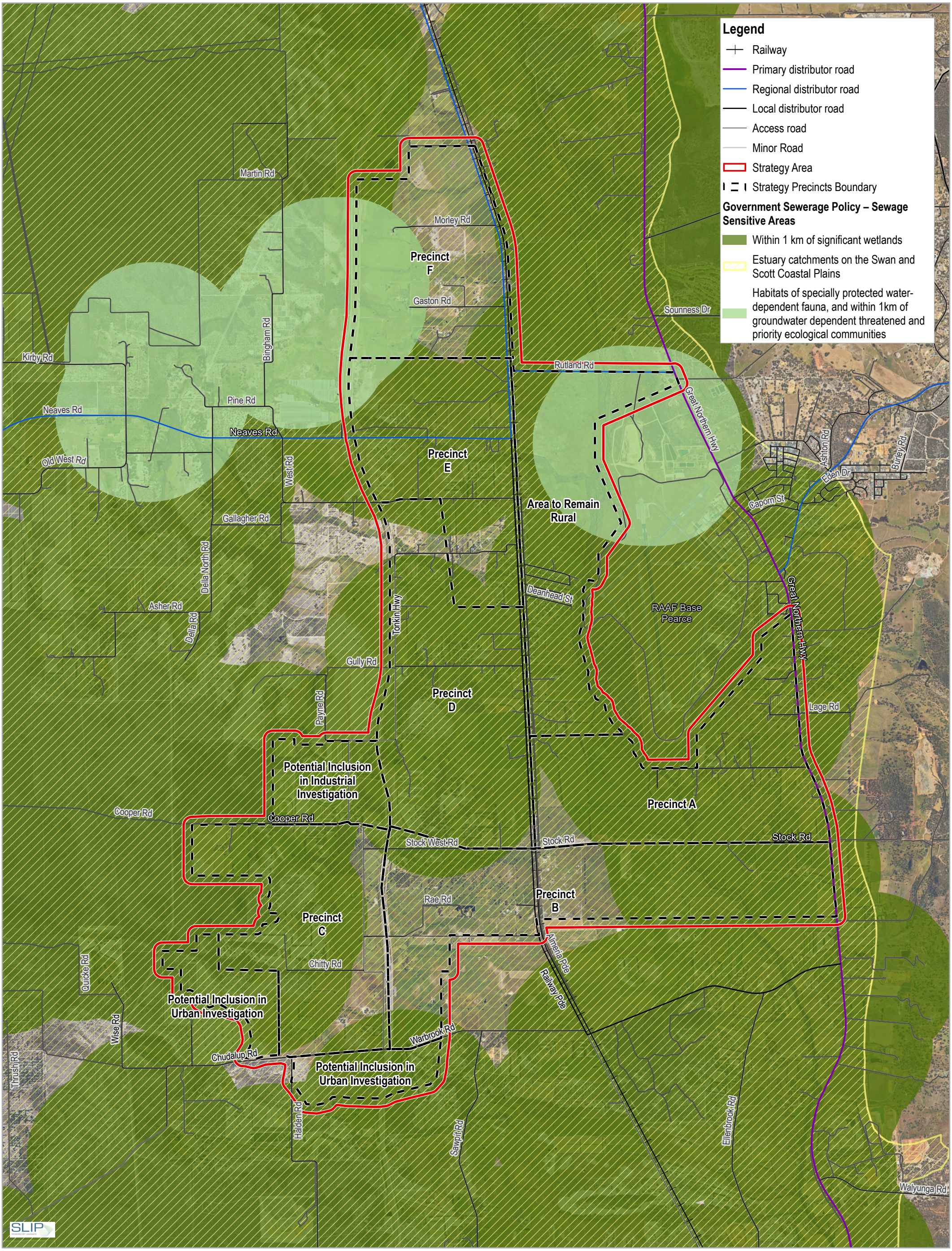
2.12.2 Wastewater servicing

Water Corporation has indicated that it has limited capacity for the provision of wastewater services to urban areas within the region. No provision for wastewater reticulation for industrial land use has been planned for.

With the decommissioning of the Bullsbrook Wastewater Treatment Plant (WWTP), reticulated wastewater service provision for the Bullsbrook Townsite will be directed to Beenyup WWTP, with reuse as part of the groundwater replenishment scheme. The Water Corporation have identified that the proposed sewer pressure main does not have capacity to accept additional out-of-catchment wastewater from the strategy area.

The recently released *Government Sewerage Policy* (Government of Western Australia 2019a) identifies requirements for new development areas to be serviced by reticulated sewerage. Where traditional reticulated sewerage cannot be provided the requirements for alternative service provision and on-lot disposal are identified. Further detail is provided in Section 5.5.3.

Mapping of sewerage sensitive areas (Figure 14) identifies that the majority of the strategy area is mapped as within 1km of significant wetlands, and part of Precinct F is mapped as "*Habitats of specially protected water-dependent fauna, and within 1km of groundwater dependent threatened and priority ecological communities to the east of Neaves Road*" (DPLH 2019).



Paper Size ISO A3

0 0.5 1 1.5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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GHD

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Sewerage Sensitive Area

Project No. **61-37134**
Revision No. **G**
Date **1/20/2022**

FIGURE 14

\\ghdnet.internal\ghd\AU\Perth\Projects\61\37134\GIS\Maps\Working\6137134\6137134.aprx\6137134_014_SewageSensitiveArea_RevG
Print date: 20 Jan 2022 - 15:22

Data source: GHD: Masterplan Boundary, Transport Network - 20180702, Concept Plan - 20181102; Landgate: Roads, Railway - 20180820, Government Sewerage Policy, Imagery accessed 20200424. Created by: htaniza

3. Land Use Planning Strategy

The Bullsbrook Freight and Industrial Land Use Planning Strategy is being developed to identify suitable areas for industrial development over the Industrial Investigation areas and Industrial Expansion areas as identified in the North-East Sub-Regional Framework.

The draft Land Use Planning Strategy identifying proposed precincts is shown in Figure 2.

Section 2 of this Regional Water Management Strategy has identified a number of key water issues and information gaps that are important to refine future planning of the strategy area.

The key water issues and planning considerations for the strategy area include the following:

- Development considerations in wet landscapes: The pre-development surface water hydrology is dominated by a broad low-lying floodplain palusplain, intersected by a network of minor and major surface drainage channels and high connection with the superficial aquifer. Conditions are variable across the strategy area including near surface groundwater, seasonally perched groundwater and slightly confined groundwater with upward vertical gradients.
- Protection of water resources and water dependent ecosystems: Due to the shallow nature of groundwater across the strategy area, and the high connectivity between surface and groundwater systems, the water resources and water dependent ecosystems (WDEs) are vulnerable to impacts from changes in water quantity and water quality. Surface and groundwater drainage design should consider the hydrological buffers to maintain pre-development water regimes.
- Lack of water and wastewater servicing infrastructure: The strategy area is large and remote from established and serviced urban fronts, with an extended development timeframe. Water Corporation has indicated there is limited capacity to provide scheme water servicing to parts of the strategy area, however wastewater servicing is limited to urban development. The Government Sewage Policy (Government of Western Australia 2019a) requires provision of wastewater reticulation to all new industrial development, and specifies minimum lot sizes for on-lot disposal. Extensive parts of the strategy area are constrained by sewage sensitive areas.
- Suitable land use types: Given the significant water resource, water supply and environmental constraints it is considered that any proposed change in land use to consider heavier industrial uses would be contingent upon provision of reticulated sewage and reticulated water, as well as implementation of the principles identified in the NESRPF (Section 1.6.2).

3.1 Precinct scale development considerations

The Land Use Planning Strategy identifies six precincts based on planning investigation areas, staging triggers, preferred uses, the proposed movement network, locational opportunities, and environmental and servicing constraints (Figure 2). The following section provides a precinct scale summary of the proposed land use and key water management features and development constraints that need to be considered during subsequent planning stages.

For the purposes of this precinct summary indicative foreshore areas for minor waterways (30 metres) and indicative wetland buffers (50 metres) have been adopted based on existing guidance, development approvals and land use planning within the strategy area. The Ellen Brook foreshore reserve for Precinct B is also indicative and based on the extent of the endorsed foreshore area in Precinct A, and the extent of floodplain mapping. Refinement and

finalisation of foreshore areas and buffers should be addressed through site specific assessments and in consultation with relevant state agencies at local structure planning stage.

3.1.1 Precinct A

Precinct A summary information includes:

- Approximately 508 hectares in area, bounded by Stock West Road to the south, Great Northern Highway to the east, RAAF Base Pearce to the north and the rail line to the west (Figure 2).
- Precinct A comprises the South Bullsbrook Industrial Precinct area subject to the endorsed South Bullsbrook Local Structure Plan, and associated technical studies. MRS zoning is shown in Figure 3.
- Development within this Precinct is subject to the endorsed Local Structure Plans, and any subsequent planning approvals. Development is proposed to comprise a mix of General Industry, service and light industry as well as commercial areas along high exposure roads.
- Integrated water management within this precinct is subject to the following existing approved Local Water Management Strategies and any subsequent Urban Water Management Plans:
    - *Local Water Management Strategy; South Bullsbrook Industrial Precinct Local Structure Plan 1* (Emerge 2014a)
    - *Local Water Management Strategy; South Bullsbrook Industrial Precinct Local Structure Plan 2* (Emerge 2014b)
    - *Local Water Management Strategy; South Bullsbrook Industrial Precinct* (Bioscience 2015)

3.1.2 Precinct B

Precinct B summary information includes:

- Approximately 590 hectares in area, bounded by Stock Road/Stock West Road to the north, Great Northern Highway to the east, the Land Use Planning Strategy boundary to the south and Perth Darwin National Highway to the west (Figure 15).
- Development within Precinct B is proposed to be a mix of General Industry and Light Industry, capitalising on the precinct's location transport links with adjacent major arterial roads while recognising its proximity to sensitive areas. Potential land use is identified as:
    - Manufacturing, dismantling, processing, assembly servicing, maintenance or repair of goods/products.
    - Large-format sale of goods along major arterial roads only (showroom e.g. white goods, furniture, outdoor furniture).
- Preliminary water management planning has occurred within the north-western corner of Precinct B in the report Various Landholdings, Bullsbrook District Water Management Strategy (hyd20 2014) to support a MRS amendment application. At the time of preparing this strategy the subject land between the Perth Darwin National Highway and Great Northern Highway (14 individual lots totalling 200 ha) has not been rezoned from rural within the MRS or SPP17. The District Water Management Strategy proposes waterway channel flood widths contained within foreshore and conservation reserve, proposes use of subsoil drainage and imported sand fill to provide separation to groundwater if required, and provides a district level post-development stormwater plan identifying catchments and stormwater storage locations.

Water management features:

- Ellen Brook flows north to south through Precinct B.
- West of Ellen Brook several waterways flow west to east through Precinct B flowing into the Ellen Brook. One waterway that starts in Precinct C flows through the southernmost portion of Precinct B, flowing to the north of Twin Swamps Nature Reserve through the EPP Policy area prior to joining Ellen Brook.
- Conservation category wetland associated with Ellen Brook, and two conservation category wetland to the east of Ellen Brook.
- Limited groundwater monitoring well network. Existing groundwater bores in the vicinity of Precinct B have recorded standing water level between 0 and 0.49 metre below ground level.
- Waterlogging risk mapping identifies that the majority of Precinct B has a moderate to very high waterlogging risk (Figure 12). Precinct B waterlogging risk mapping identifies the majority of the precinct has a >70% risk of moderate to very high risk of waterlogging (H2), with a portion associated with Ellen Brook and a minor waterway mapped as 30-50% risk (M2).
- Water Corporation have advised that the 80 ML Gnangara Reservoir is likely to have capacity to service the southern parts of proposed Precinct B. No provision for wastewater reticulation for industrial land use has been planned for.
- The majority of the precinct is mapped as a sewage sensitive area (Figure 14).

Development considerations:

- Structure planning to retain and protect areas of high environmental value.
- Foreshore areas will need to be established for the Ellen Brook and minor waterways that traverse the precinct. The minor waterway is displayed with an indicative 30 metre foreshore areas. The Ellen Brook foreshore area is indicative and encompasses the Ellen Brook floodplain mapping and is a continuation of the existing reserve within Precinct A (Figure 3). Site specific assessments should be completed to ensure the foreshore areas accommodate the biological, physical and cultural features associated with the Ellen Brook and other waterway.
- Wetlands are displayed with indicative 50 metre buffers. Wetland buffers will need to be refined through site specific assessments.
- General industry is not compatible within the hydrologic capture zone of sensitive water dependent ecosystems (e.g. Resource Enhancement and Conservation Category wetlands, Twin Swamps Nature Reserve).
- Provision of an appropriate Interface between industrial development and the Western Swamp Tortoise Habitat EPP area, Ellen Brook and waterway foreshore areas and wetlands.
- Shallow groundwater conditions are potentially present across Precinct B. Further site specific groundwater monitoring at the local scale will be required to characterise groundwater conditions.
- Provision of reticulated sewerage network for all new development. In the absence of reticulated sewerage minimum lot sizes should be in accordance with the Government Sewerage Policy (Government of Western Australia 2019a), and subject to satisfactory demonstration that the quality and quantity of effluent can be disposed of on-site without any adverse environmental or health impacts.

3.1.3 Precinct C

Precinct C summary information includes:

- Approximately 442 hectares in area, bounded by Cooper Road to the north, Precinct B to the east, Warbrook Road extension to the south and Gnangara-Moore River State Forest and urban investigation areas to the west (Figure 16).
- Development in Precinct C is proposed as a mix of uses, comprising predominantly smaller scale light and service industrial activities that capitalise on existing and urban investigation areas to the south, and associated population driven activity. Examples land uses include garden centres, showrooms, trade display, hardware stores.

Water management features:

- Several mapped waterways flow west to east through Precinct C.
- Conservation category and resource enhancement wetlands are located within the central western part of the precinct associated with mapped waterways.
- Waterlogging risk mapping identifies that the majority of Precinct C has a moderate to very high waterlogging risk (Figure 12), with risks between 50-70% and >70% of waterlogging across the precinct.
- Existing groundwater bores in the vicinity of Precinct C have recorded standing water level between >1.5 metre below ground level and above ground level.
- The majority of the precinct is mapped as a sewage sensitive area (Figure 14).

Development considerations:

- Structure planning to retain and protect areas of high environmental value.
- Foreshore areas will need to be established for minor waterways that traverse the precinct. The minor waterways are displayed with indicative 30 metre foreshore areas. Site specific assessments should be completed to ensure the foreshore areas accommodate the waterway biological, physical and cultural features.
- Wetlands are displayed with indicative 50 metre buffers. Wetland buffers will need to be refined through site specific assessments.
- Provision of an appropriate interface between industrial development and waterway foreshore areas and wetlands.
- Shallow groundwater conditions are potentially present across Precinct C. Further site-specific groundwater monitoring at the local scale will be required to characterise groundwater conditions.
- Water Corporation have advised that there is currently no provision for scheme water servicing of Precinct C. Review of long-term water planning for the Gnangara Reservoir is required.
- Provision of reticulated sewerage network for all new development. In the absence of reticulated sewerage provision minimum lot sizes should be in accordance with the Government Sewerage Policy (Government of Western Australia 2019a), and subject to satisfactory demonstration that the quality and quantity of effluent can be disposed of on-site without any adverse environmental or health impacts.

3.1.4 Precinct D

Precinct D summary information includes:

- Approximately 560 hectares in area, bounded by Precinct E to the north, the railway line to the east, Stock Road to the south and Perth Darwin National Highway to the west (Figure 17).
- Proposed development in Precinct D includes the preferred Intermodel Terminal site and transition area. Example land uses include distribution centre, workshop transport depot, warehouse, storage.

Water management features:

- Preliminary water management planning has been completed for the preferred Intermodel Transport site in the report Draft South Bullsbrook Intermodal Terminal Stormwater Management Strategy (GHD 2016).
- Three mapped waterways flow west to east through Precinct D.
- Several conservation category and resource enhancement wetlands.
- Waterlogging risk mapping identifies that the majority of Precinct D has a moderate to very high waterlogging risk (Figure 12). Precinct D waterlogging risk mapping identifies the majority of the precinct has a >70% risk of moderate to very high risk of waterlogging (H2), with small patches mapped as 50-70% risk (H1).
- Current Water Corporation planning does not accommodate scheme water provision.
- The majority of the precinct is mapped as a sewage sensitive area (Figure 14).

Development considerations:

- Structure planning to retain and protect areas of high environmental value.
- Foreshore areas will need to be established for minor waterways that traverse the precinct. The minor waterways are displayed with indicative 30 metre foreshore areas. Site specific assessments should be completed to ensure the foreshore areas accommodate the waterway biological, physical and cultural features.
- Wetlands are displayed with indicative 50 metre buffers. Wetland buffers will need to be refined through site specific assessments.
- Several TEC and their buffers occur within the south-western corner of Precinct D.
- Ecological corridor dissects Precinct D.
- Remnant native vegetation occurs throughout the precinct.
- Provision of an appropriate interface between industrial development and waterway foreshore areas, wetlands and other environmentally sensitive areas.
- Shallow groundwater conditions are potentially present across Precinct D. Further site-specific groundwater monitoring at the local scale will be required to characterise groundwater conditions.
- Water Corporation have advised that there is currently no provision for scheme water servicing of Precinct D. Review of long-term water planning for adjacent areas is required.
- Provision of reticulated sewerage network for all new development. In the absence of reticulated sewerage provision minimum lot sizes should be in accordance with the Government Sewerage Policy (Government of Western Australia 2019a), and subject to

satisfactory demonstration that the quality and quantity of effluent can be disposed of on-site without any adverse environmental or health impacts.

3.1.5 Precinct E

Precinct E summary information includes:

- Approximately 422 hectares in area, bounded by Precinct F to the north, the rail line to the east, Precinct D to the south and Perth Darwin National Highway to the west (Figure 18).
- Proposed development in Precinct E includes mining support industries, manufacture and component assembly and processing and packaging in the longer term.

Water management features:

- Two waterways are mapped as flowing west to east through Precinct E.
- Linear conservation category wetland associated with one of the waterways.
- Groundwater monitoring wells are limited to Northlink bores, with maximum recorded groundwater level reported above ground surface (MW38, Figure 12). The measured piezometric pressure indicates the potential for groundwater to rise within any placed fill, establishing a groundwater level that is higher than the ground surface.
- Waterlogging risk mapping identifies that the majority of Precinct E has a moderate to very high waterlogging risk (Figure 12). Precinct E waterlogging risk mapping identifies the majority of the precinct has a >70% risk of moderate to very high risk of waterlogging (H2), with small patches mapped as 50-70% risk (H1).
- The majority of the precinct is mapped as a sewage sensitive area (Figure 14).

Development considerations:

- Structure planning to retain and protect areas of high environmental value.
- Foreshore areas will need to be established for minor waterways that traverse the precinct. The minor waterways are displayed with indicative 30 metre foreshore areas. Site specific assessments should be completed to ensure the foreshore areas accommodate the waterway biological, physical and cultural features.
- Wetlands are displayed with indicative 50 metre buffers. Wetland buffers will need to be refined through site specific assessments.
- The majority of Precinct E is mapped as environmentally sensitive areas, which is primarily related to several TEC and their buffers that intersect at various locations.
- Remnant native vegetation occurs predominantly associated with the northern waterway alignment.
- Provision of an appropriate interface between industrial development and waterways, wetlands and other environmentally sensitive areas.
- Assessment of Controlled Groundwater Level for subsoil drainage should also ensure no impact to water regimes for any water dependent ecosystems which receive surface water flow that may be sustained by groundwater.
- Water Corporation have advised that planned scheme water upgrades for the Bullsbrook Townsite area (from 2040) could potentially service Precinct E. No provision for wastewater reticulation for industrial land use has been planned for.

- Provision of reticulated sewerage network for all new development. In the absence of reticulated sewerage provision minimum lot sizes should be in accordance with the Government Sewerage Policy (Government of Western Australia 2019a), and subject to satisfactory demonstration that the quality and quantity of effluent can be disposed of on-site without any adverse environmental or health impacts.

3.1.6 Precinct F

Precinct F summary information includes:

- Approximately 400 hectares, located within the northernmost portion of the DSP (Figure 19).
- Take-up of this land is expected to be over the longer-term and is anticipated to be the last precinct to be developed within the DSP area, with an expected development timeframe greater than 70 years.
- Development of this precinct will be best determined through future local structure planning which responds to the market, demand and technology requirements of the time, with potential for head offices, training and research facilities.

Water management features:

- Several waterways flow west to east through Precinct F.
- Groundwater monitoring wells are limited to Northlink bores, with maximum recorded groundwater levels reported above ground surface (MW42, Figure 12). The measured piezometric pressure indicates the potential for groundwater to rise within any placed fill, establishing a groundwater level that is higher than the ground surface.
- Waterlogging risk mapping identifies that the majority of Precinct F has a >70% risk of moderate to very high risk of waterlogging (H2) (Figure 12).

Development considerations:

- Structure planning to retain and protect areas of high environmental value.
- The majority of Precinct F is mapped as environmentally sensitive areas, which is primarily related to several TEC and their buffers that intersect at various locations.
- Foreshore areas will need to be established for minor waterways that traverse the precinct. The minor waterways are displayed with indicative 30 metre foreshore areas. Site specific assessments should be completed to ensure the foreshore areas accommodate the waterway biological, physical and cultural features.
- Provision of an appropriate interface between industrial development and waterways and other environmentally sensitive areas.
- Assessment of Controlled Groundwater Level for subsoil drainage should also ensure no impact to water regimes for any water dependent ecosystems which receive surface water flow that may be sustained by groundwater.
- Water Corporation have advised that planned scheme water upgrades for the Bullsbrook Townsite area (from 2040) could potentially service Precinct F. No provision for wastewater reticulation for industrial land use has been planned for.
- Provision of reticulated sewerage network for all new development. In the absence of reticulated sewerage provision minimum lot sizes should be in accordance with the Government Sewerage Policy (Government of Western Australia 2019a), and subject to satisfactory demonstration that the quality and quantity of effluent can be disposed of on-site without any adverse environmental or health impacts.

Precinct D
Precinct B
Precinct C
MW35
MW35
MW34
MW33
MW31
MW32
61611178 0.28
61611179 0.7
61611182 0.46
61611183 0
61611185 0.49
61611184 0
61618568 0.58
61618565 0.36
61618567 0.56
61618569 0.69
61611071 0.25
61611062 1.15
61611060 -1
61611061 0.61
61611067 0.57
61611068 0.422
61611069 1.03
61611070 0.59
61611081 0.63
61611082 0.51
61619261 -3.95
61611085 0.24

Legend

- Boreholes (MRWA)
- Min SWL (mbgl)
- Watercourses
- Strategy Area
- Strategy Precincts Boundary
- Foreshore
- 50m Buffer
- Seasonally waterlogged floodplain
- Environment Protection Policy Western Swamp Tortoise Policy Area

Geomorphic Wetlands (Evaluation)

- Conservation
- Resource Enhancement

Zones and

- Industrial
- Rural

Inset Map 1
Inset Map 2
Inset Map 3

Inset Map 1

Acid Sulfate Risk

- High to moderate risk
- Moderate to low risk

Inset Map 2

- Native vegetation
- Threatened ecological communities

Inset Map 3

- Ecological Linkage
- Environmentally Sensitive Areas
- Bush Forever

Paper Size ISO A3

0 125 250 375 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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Regional Water Management Strategy

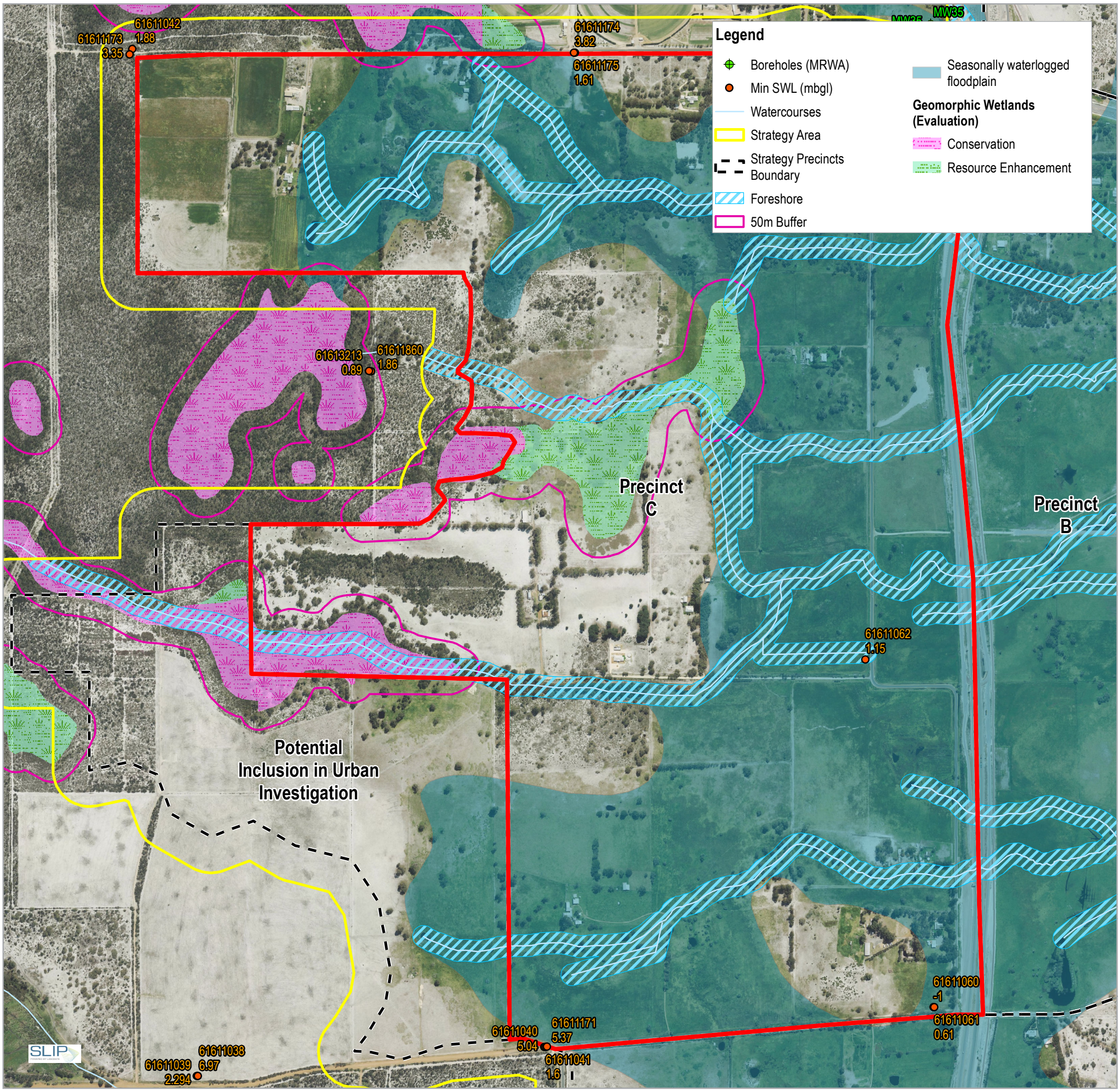
Precinct B

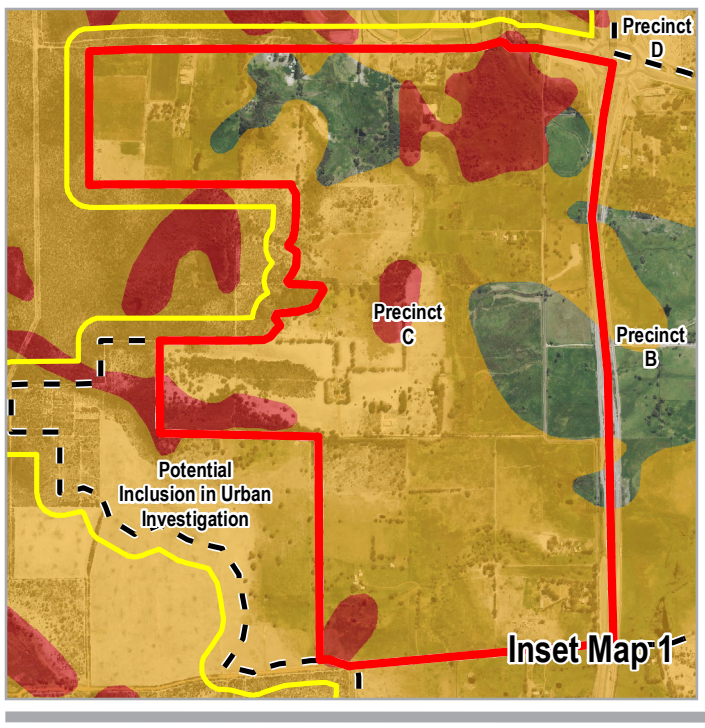
Project No. **61-37134**
Revision No. **D**
Date **10/5/2021**

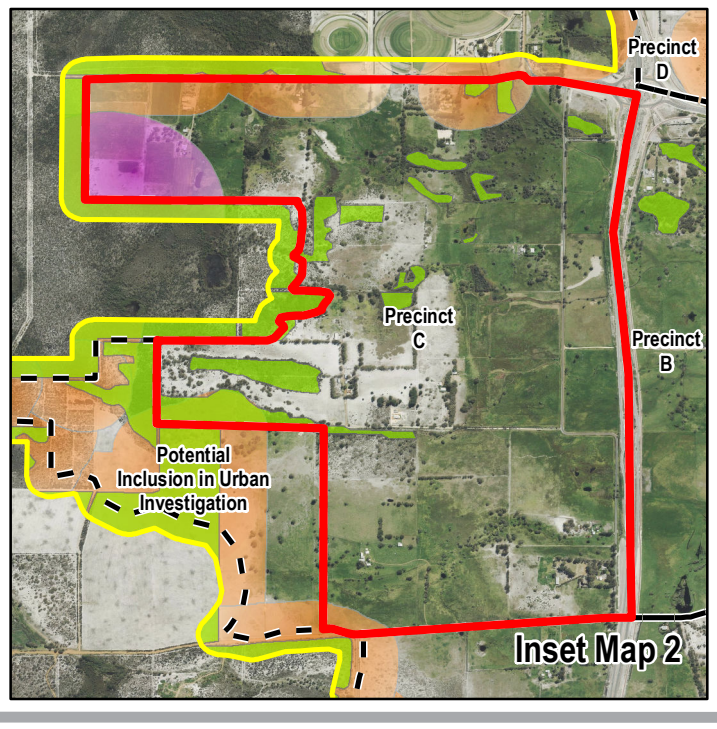
FIGURE 15

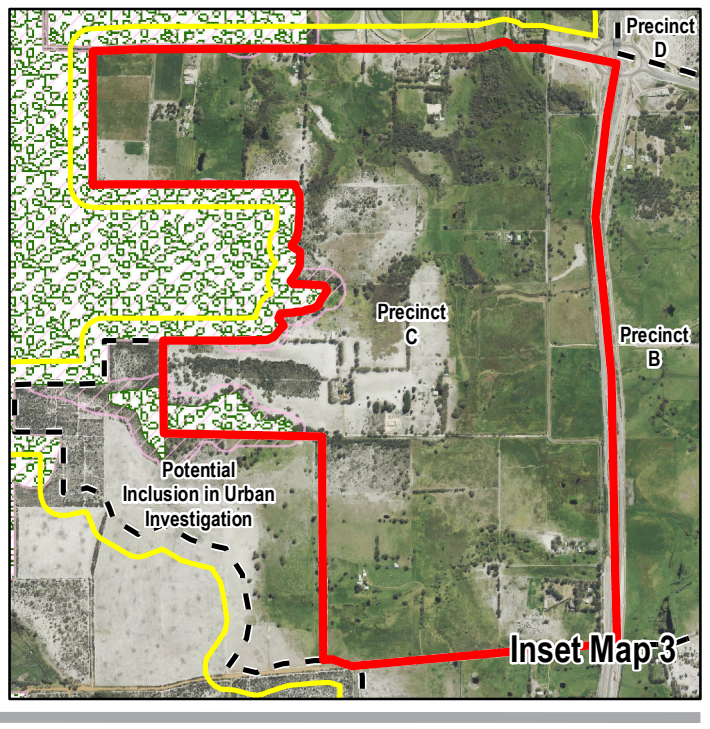
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Data source: DPLH: Masterplan boundary - 20180517, Western swamp tortoise habitat - 20180517; MRWA: Road centrelines - 20171211; DCBA: Geomorphic wetlands - 20171027, Managed lands and waters - 20170730; DPIRD: Native vegetation extent - 20171026; Landgate: Imagery accessed 20200424. Created by: htaniza









Inset Map 1

Acid Sulfate Risk

- High to moderate risk
- Moderate to low risk

Inset Map 2

- Native vegetation
- Priority ecological communities
- Threatened ecological communities

Inset Map 3

- Environmentally Sensitive Areas
- Bush Forever

Paper Size ISO A3

0 60 120 180 240

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

Department of Planning, Lands & Heritage
Bullsbrook Freight and Industrial Regional Water Management Strategy

Precinct C

Project No. **61-37134**
Revision No. **D**
Date **14/01/2021**

FIGURE 16

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Legend

- Boreholes (MRWA)
- Min SWL (mbgl)
- Watercourses
- Strategy Area
- Strategy Precincts Boundary
- Foreshore Area
- 50m Buffer
- Seasonally waterlogged floodplain

Geomorphic Wetlands (Evaluation)

- Conservation
- Resource Enhancement

Zones and Reserves

- Industrial
- Rural

61618558 0.86
61611912 1.74
61611919 0.74
61611915 1.87
61611916 1.45
61611072 0
61618576 1.09
61618577 1.11
61618578 1.13
61618575 1.11
61618566 0.54
61618565 0.36
61618567 0.56
61618569 0.69
61611174 3.82
61611175 1.61
MW35
61611179 0.7
MW34
61611178 0.28
MW33
61611183 0
61611182 0.46
61611185 0.49
61611184 0

Precinct E
Precinct D
Precinct C
Precinct B
Potential Inclusion in Industrial Investigation

SLIP

Inset Map 1
Inset Map 2
Inset Map 3

Area to Remain Rural

Inset Map 1

Acid Sulfate Risk

- High to moderate risk
- Moderate to low risk

Inset Map 2

- Native vegetation
- Threatened ecological communities

Inset Map 3

- Ecological Linkage
- Environmentally Sensitive Areas
- Bush Forever

Paper Size ISO A3

0 100 200 300 400

Metres

N

GHD

Department of Planning, Lands & Heritage
Bullsbrook Freight and Industrial
Regional Water Management Strategy

Precinct D

Project No. **61-37134**
Revision No. **D**
Date **1/20/2022**

FIGURE 17

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Precinct F

Precinct E

Precinct D

Area to Remain Rural

MW39
MW38
MW36
MW36
MW37
MW37

61618558
0.86

61611912
1.74

61611919
0.74

61611915
1.87

61611916
1.45

61611072
0

SLIP

Legend

- Boreholes (MRWA)
- Min SWL (mbgl)
- Watercourses
- Strategy Area
- Strategy Precincts Boundary
- Foreshore
- 50m Buffer
- Seasonally waterlogged floodplain

Geomorphic Wetlands (Evaluation)

- Conservation
- Resource Enhancement

Precinct F
Precinct E
Precinct D
Inset Map 1

Precinct F
Precinct E
Precinct D
Inset Map 2

Precinct F
Precinct E
Precinct D
Inset Map 3

Inset Map 1

Acid Sulfate Risk

- Moderate to low risk

Inset Map 2

- Native vegetation
- Threatened ecological communities

Inset Map 3

- Ecological Linkage
- Environmentally Sensitive Areas
- Bush Forever

Paper Size ISO A3

0 70 140 210 280

Metres

Map Projection: Transverse Mercator
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Grid: GDA 1994 MGA Zone 50

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GHD

Department of Planning, Lands & Heritage
Bullsbrook Freight and Industrial
Regional Water Management Strategy

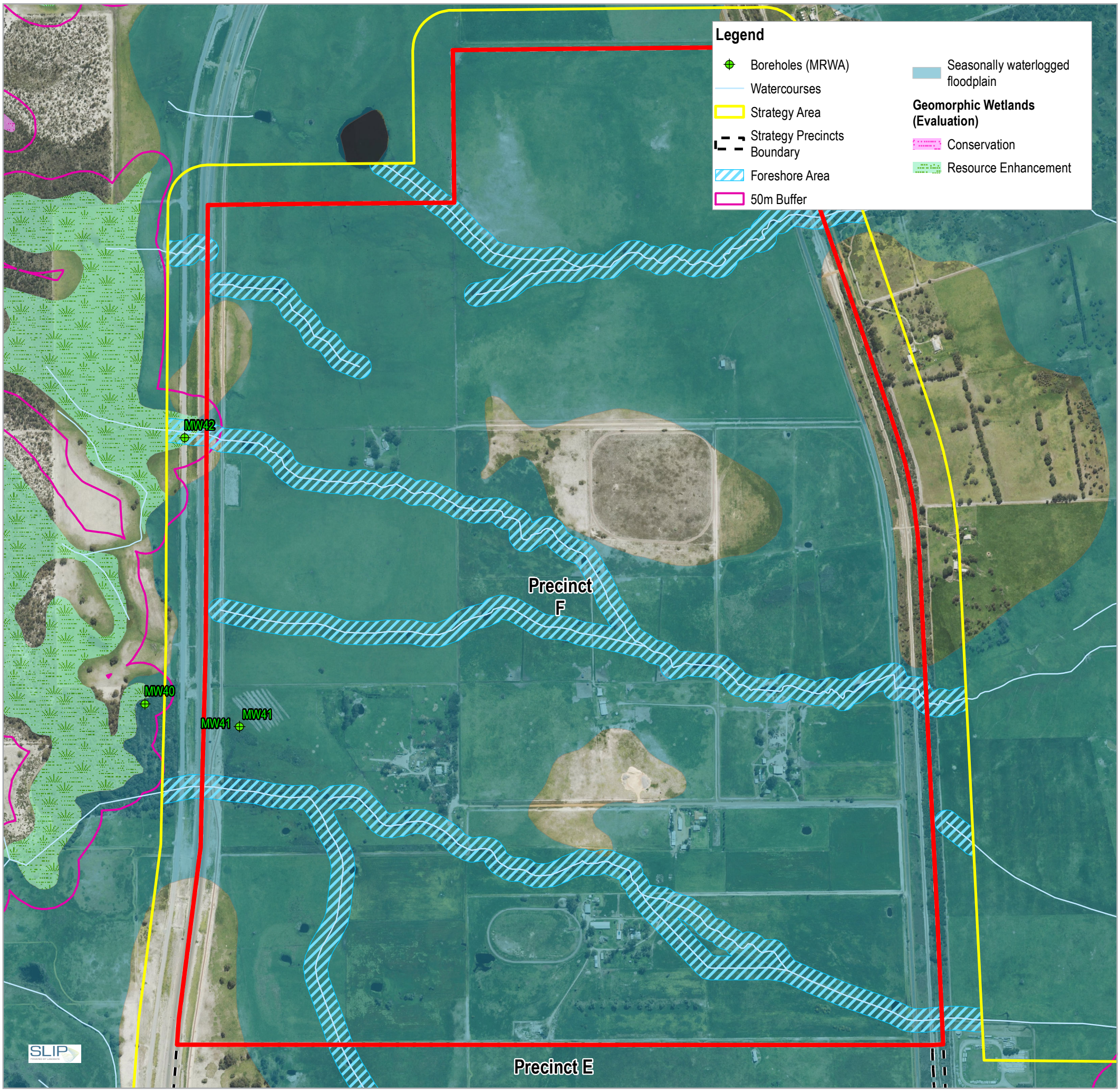
Precinct E

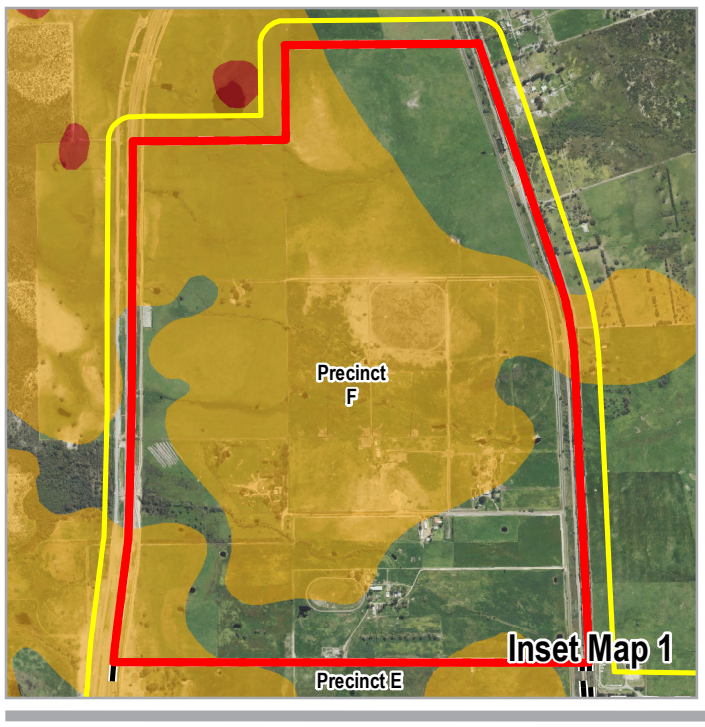
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Revision No. **D**
Date **14/01/2021**

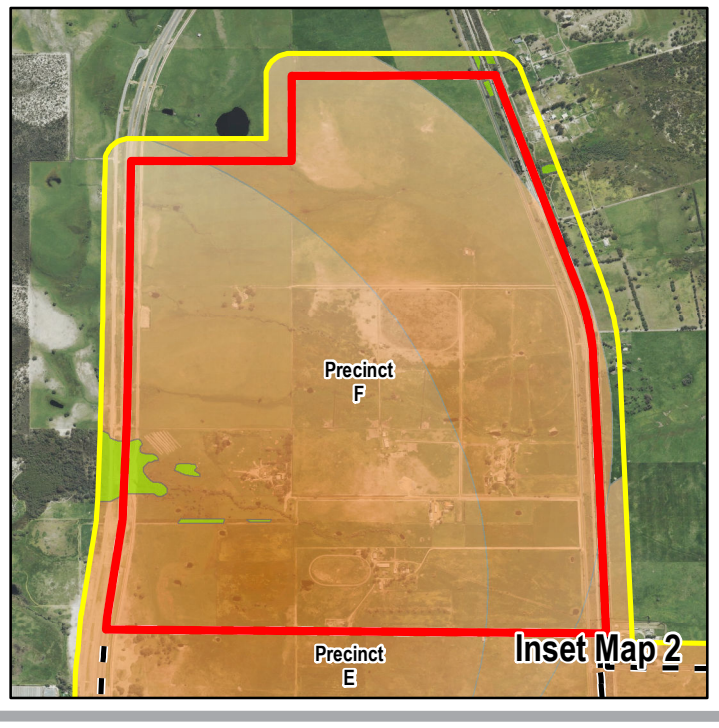
FIGURE 18

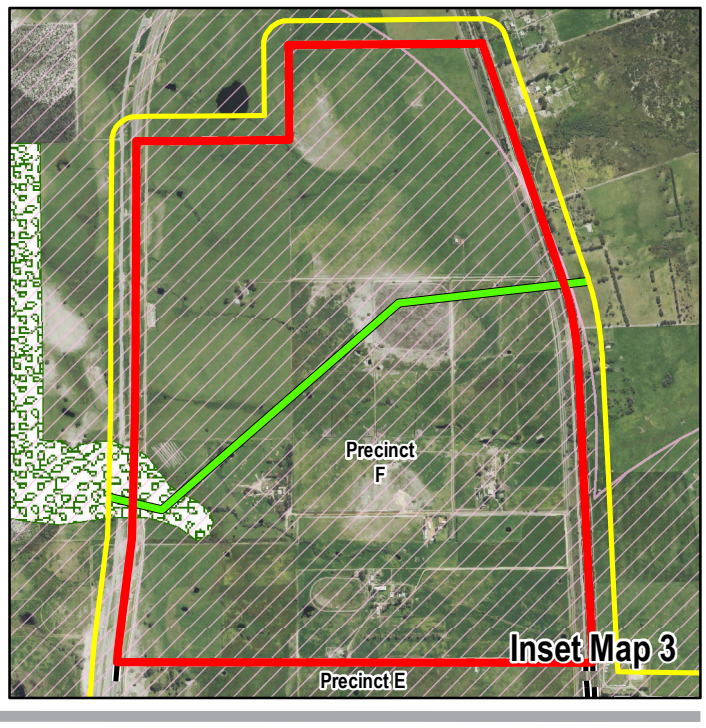
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Inset Map 1

Acid Sulfate Risk

- High to moderate risk
- Moderate to low risk

Inset Map 2

- Native vegetation
- Threatened ecological communities

Inset Map 3

- Ecological Linkage
- Environmentally Sensitive Areas
- Bush Forever

Paper Size ISO A3

0 50 100 150 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

Department of Planning, Lands & Heritage
Bullsbrook Freight and Industrial Regional Water Management Strategy

Precinct F

Project No. **61-37134**
Revision No. **D**
Date **14/01/2021**

FIGURE 19

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Print date: 14 Jan 2021 - 11:08

Data source: DPLH: Masterplan boundary - 20180517, Western swamp tortoise habitat - 20180517; MRWA: Road centrelines - 20171211; DCBA: Geomorphic wetlands - 20171027, Managed lands and waters - 20170730; DPIRD: Native vegetation extent - 20171026; Landgate: Imagery accessed 20200424. Created by: pjhernandez

4. Design criteria

4.1 Water quantity and quality

The following design criteria will inform surface and groundwater management and development planning throughout the strategy area, consistent with the *Decision Process for Stormwater Management in WA* (DWER 2017), and with consideration of site-specific conditions and development constraints.

4.1.1 Manage runoff from small rainfall events for ecological protection

Manage water quality

- Manage – retain and/or detain, and treat (if required) – stormwater runoff from constructed impervious surfaces generated by the first 15 mm of rainfall at-source as much as practical.
- Install off-line stormwater quality treatment systems at the outlet of pipes or lined channels that directly convey small rainfall event runoff from constructed impervious surfaces.
- Ensure the emptying time of stormwater management systems is based on the type of system, requirements for prevention of disease vector and breeding of nuisance insects, and amenity requirements for useability of systems post-rainfall.

Maintain form and hydrology of sensitive receiving environments

- Maintain pre-development peak flow rates and total volume runoff from the outlets of the development area for the critical 1 exceedance per year (1EY) event.

4.1.2 Minor rainfall events – serviceability, amenity and road safety

- Design stormwater management systems to provide serviceability, amenity and road safety during minor rainfall events.

4.1.3 Major rainfall events – flood protection

Manage catchment flooding

- Maintain the 1 per cent annual exceedance probability (AEP) pre-development flood regime (flood level, peak flow rates and storage volumes). Alteration to the pre-development flood regime depends on the constraints of the catchment and the receiving environments. Any proposed alterations to the flood regime will require assessment and/or modelling of the capacity of the entire system and the cumulative impacts from the change, to the satisfaction of the DWER and other relevant agencies.

Prevent building and critical infrastructure flooding

- Protect people and property from flooding by constructing residential, commercial and industrial building habitable floor levels with the following minimum clearances above the 1 per cent AEP flood level:
    - road drainage systems: 0.3 metres
    - terminal retention or detention areas with no overflow relief: 0.5 metres
    - major drainage system and waterways: 0.5 metres

4.1.4 Manage water quality

- Manage small event runoff in accordance with Section 4.1.1.
- Use a combination of non-structural and structural controls in a treatment train to prevent, reduce and treat pollutants.
- Water quality objectives should be based on the water quality targets in the Ellen Brook Water Quality Improvement Plan (Section 2.9.5).
- Install water quality treatment systems at controlled groundwater level subsoils and drains and/or at outlet points, unless investigations demonstrate that treatment is not required.

4.2 Water conservation and efficiency

Water conservation design criteria are proposed which are consistent with guidelines presented in *Better Urban Water Management* (WAPC 2008) and *Guidelines for Industrial Development* (Perth Region NRM 2011):

- Investigate options for fit-for-purpose water for non-drinking water uses, such as the re-use of stormwater and wastewater.
- Ensure the efficient use and reuse of water resources.
- No potable water use outside of buildings.
- Waterwise landscaping techniques should be employed throughout the strategy area.
- All buildings are to meet the 5 Star Plus provisions for all new fittings.
- Install water efficient industrial equipment and seek innovative designs that can be integrated into the built form.

5. Water management

The pre-development setting of the strategy area comprises a series of wetlands, rivers, creeks which are highly interconnected with the superficial aquifer throughout the majority of the area. During winter the strategy area's prevailing condition is of wet landscapes resulting from excess water. A number of the surface water features and remnant vegetation across the strategy area are significant water dependent ecosystem or environmentally sensitive areas.

The strategy area is also large, remote from established and serviced urban fronts, has an extended development timeframe, no current water or wastewater servicing, and no planned provision for future wastewater reticulation for industrial development.

The seasonally wet landscape and the lack of planned water and wastewater servicing present challenges for development and are key determinants for water management for the strategy area.

In particular development of the strategy area will need to ensure integrated management of surface and groundwater to ensure that the water quality and ecological functions of water dependent ecosystems are maintained, and people and property are protected from risk of flooding and inundation.

5.1 Regional floodplains, waterways and wetlands

Regional surface water features include the Ellen Brook and its floodplain, which encompasses a linear conservation category wetland, and a number of tributaries of the Ellen Brook including Nambab Brook, Ki-it Monger Brook and several unnamed waterways to the west of Ellen Brook.

Floodplain management in Western Australia is focused on planning for appropriate land use within floodplain areas. Key planning measures for floodplain management include (WRC 2000):

- Development (i.e. filling, building, etc.) that is located within the floodway and is considered obstructive to major river flows is not acceptable as it will increase flood levels upstream.
- Development (i.e. filling, building, etc.) that is located within the flood fringe is considered acceptable with respect to major river flooding. However, a minimum habitable floor level of 0.5 metres above the adjacent 100-year flood level is recommended to ensure adequate flood protection.

Proposed development areas are required to be outside the Ellen Brook floodway and flood fringe, and arterial drainage corridors for minor waterways.

Proposed residential, commercial and industrial buildings are to be provided protection from regional and arterial floodwaters with a minimum 0.5 metre freeboard above the 1 AEP (100 yr ARI) flood levels to the finished building floor levels.

For other stormwater drainage elements buildings are to be provided with a minimum 0.3 metre freeboard above the 1 AEP (100 yr ARI) flood levels from road drainage systems and detention storage areas.

Waterways should be managed to maintain or enhance the environmental values and objectives agreed for the waterway, and in particular, for ecological and hydrological values (EPA 2008). In accordance with *Operational policy 4.3: Identifying and establishing waterways foreshore areas* (DoW 2012) foreshore areas should be established for all waterways in the strategy area.

Development planning has progressed further for parts of the strategy area adjacent the Ellen Brook, in particular the South Bullsbrook Industrial Precinct (SBIP) (comprising Precinct A, Figure 2). Biophysical assessment of the Ellen Brook foreshore area adjacent to SBIP was completed to define a suitable foreshore area for the Ellen Brook, and support the scheme amendment for the SBIP (Cardno 2010).

The extent of the Ellen Brook foreshore area defined for SBIP LSP1 and LSP2 is zoned as Rural under the MRS (Appendix E), and 'General Rural' under the City of Swan LPS17 to accommodate the biological, physical and cultural features associated with the Ellen Brook.

The key environmental attributes that informed the foreshore area for the Ellen Brook within the SBIP area (Precinct A) included:

- Extent of remnant riparian vegetation.
- 100-year ARI floodway boundary for the Ellen Brook (DoW 2012).
- Indigenous heritage.
- Setback for the conservation category wetland associated with Ellen Brook.

Given the significance of the Ellen Brook and the proposed land use changes in proximity to the waterway it is recommended that the Ellen Brook foreshore reserve through the section of the Ellen Brook within Precinct B provides continuity with the identified reserve to the north, and considers clear separation of the foreshore area from the proposed industrial development.

The minimum acceptable foreshore width in most circumstances is 30 m from the outer edge of wetland vegetation or the high watermark (DoW 2012) and this indicative foreshore area width has been adopted for minor waterways within the strategy area. The 30 m buffer is also consistent with requirements specified in *Development Design Specification D7: Erosion Control and Stormwater Management* (CoS 2002b).

In many cases this indicative foreshore area may not adequately consider waterway function and services, or buffers for wetlands that are located adjacent to or are hydrologically connected to a waterway, and site-specific assessments are required.

Given the significant site constraints, refinement and finalisation of foreshore areas should be completed at the district planning level (DoW 2012). Existing guidance on how to identify a foreshore area is contained in the document *Determining foreshore reserves* (WRC 2001).

As part of the subdivision process it is considered likely that the foreshore area associated with the Ellen Brook (Precinct B) will be transferred to the Western Australian Planning Commission for ongoing management as a foreshore reserve, and subsequently reserved for Parks and Recreation pursuant to Part 7 of the *Planning and Development Act 2005*.

Foreshore areas for minor waterways will likely be vested with the local government, City of Swan, through the subdivision process and managed for conservation.

There are a large number of geomorphic wetlands mapped across the strategy area. Resource enhancement and conservation category wetlands are excluded from development unless otherwise approved by DBCA. The majority of the strategy area is mapped as multiple use palusplain wetland which does not preclude development however will require consideration with regard to groundwater levels and fill requirements.

The DBCA recommends a minimum 50 metre buffer to wetlands. The recommended 50 m buffer distance is considered to be generic and should be revised based on site specific wetland values. The extent of the buffer around a particular wetland should be based on an assessment which takes into account (EPA 2008):

- The wetland values.
- The activities, land uses or development near the wetland, existing or proposed.
- The threats posed by adjacent activities, land uses or development.

Development activities and new stormwater management systems (including pipes, constructed drains, detention areas and vegetated swales) are not permitted within foreshore areas and wetland buffers unless endorsed by the relevant agencies. Stormwater flow from arterial drainage pathways through foreshore areas and wetland buffers should occur via vegetated overland flow paths.

The hydrological buffer of water dependent ecosystems should also be determined. Drainage design or groundwater controls may impact the water regime of a water dependent ecosystem such as a wetland, and these structures are not permitted within the hydrological buffer zone, although development can occur within the buffer (DoW 2010b).

Local scheme provisions of LPS17 required development of Wetland and Waterways Management Strategy and Wetland and Waterway Management Plan for the South Bullsbrook Industrial Precinct area, and these management documents may be required for future development adjacent waterways in the strategy area.

5.2 Stormwater management

The high connectivity of the surface and groundwater hydrology, multiple land ownership and extended development timeframes present challenges to stormwater management across the strategy area.

The current drainage network throughout the strategy area consists of natural waterways and open drains between paddocks and adjacent to roads. Culverts are used extensively under local roads, major roads and the ARC railway to allow runoff to flow to Ellen Brook. Key infrastructure is listed in Section 2.9.3. Infiltration may be difficult in several areas of the strategy area as there is significant ponding after rainfall events (Sections 2.9.3 and 2.11.4).

District and local drainage design should be undertaken with a major/minor approach in accordance with the methodology of *Australian rainfall and runoff: a guide to flood estimation* (Ball *et al*. 2016) for hydraulic and hydrologic analyses, safety analyses, modelling and design.

5.2.1 Major drainage system

The major drainage system is defined as the arterial drainage alignments and road conveyance to provide safe, well defined overland flow paths for major events which exceed the capacity of the minor system.

Pre-development surface water modelling (Section 2.9.4, Appendix D) has defined regional scale arterial drainage alignments to convey existing flows, peak flow estimates and outlets.

Refinement of the arterial drainage network planning is required at the district planning stage to ensure coherent management of the arterial drainage over the staged timeline of the development. District scale planning should identify district flow pathways and flow at the precinct scale, and should identify the detention storage requirements for each precinct on a pro-rata peak flow basis.

Where existing arterial drainage is associated with natural waterways these drainage alignments should remain fixed, with limited provision for realignment, to maintain the existing hydrological regime of the area. However arterial drainage associated with manmade drains may have flexibility in their alignment within landholdings, provided there is adequate grade to realign the drain, adequate connection is provided from the upstream landholding to

the downstream outlet and it can be demonstrated that realignment will have no detrimental impact on water dependent ecosystems within or outside the precinct.

Arterial drainage channels should be sized to convey upstream flows and incorporate major event runoff from the development prior to discharge at pre-development peak flow rates.

Arterial outflow locations are to remain consistent with the pre-development conditions.

The major drainage system should consider the following:

- Pre-development 1% AEP (flood) storage areas should be maintained in their existing locations.
- For retained natural waterways the drainage channel should be restored to open swales/living streams to convey flows. Where waterways are degraded works to improve the channel profile may be acceptable subject to advice and approval of the DWER and City of Swan.
- Constructed arterial development drainage should be profiled and landscaped within widened road reserves as living streams or vegetated swales.
- Detention storage areas should be provided at the lowest point in sub-catchments, and provided with connection to arterial drainage.
- Swales or pipes may be used in key locations to convey flow from detention storage areas to the arterial drainage network. Flow to retained waterways and wetlands through a foreshore area or wetland buffer should be via vegetated overland flowpaths.
- The finished floor levels of proposed residential, commercial and industrial buildings are to be provided with a minimum 0.3 metres freeboard above the 1 AEP (100 yr ARI) flood levels from road drainage systems and detention storage areas. Lot levels can be lower than building pad levels.

5.2.2 Minor drainage system

The minor drainage system is defined as the system of pipes, kerbs/gutters, swales, bio-retention storage and living stream designed to carry and control flows from frequent runoff events. The minor drainage system also incorporates a treatment train of water sensitive urban design strategies that provide at source water quality treatment from small rainfall events (first 15 mm) that are generated from lot or development (i.e. road) drainage.

The minor drainage system should consider the following:

- Retention and/or detention of the first 15 mm of rainfall from impervious surfaces within lots and roads at source as much as practical using a treatment train of water sensitive urban design strategies.
- Vegetated infiltration options should be used where appropriate, however the suitability of these types of systems will be affected by site specific conditions including depth to groundwater and pre-existing tendency to inundation.
- Due to the seasonally waterlogged nature of much of the strategy area bio-retention elements may need to be constructed in fill above the existing ground and/or have a base drain to ensure the filter media drains between rainfall events. Alternatively pit and pipe networks may be required where open drains are not viable due to issues such as localised low points and high groundwater.
- Constructed arterial development drainage should incorporate a low flow channel where the channel is of sufficient width.

5.3 Groundwater level management

The key objectives for groundwater level management within the strategy area include:

- Protection of buildings and infrastructure from flooding and inundation by high seasonal groundwater levels, perching and/or soil moisture.
- Managing and minimising changes in groundwater levels following development.
- Protection of groundwater dependent ecosystems from impacts of groundwater management.

Given the high connectivity of surface and groundwater across the strategy area the predicted maximum groundwater levels are required to be determined through measurement and modelling in consultation with the DWER. Requirements for further monitoring and modelling are provided in Section 6.1.2 and Section 6.1.3.

Traditional development across the Swan Coastal Plain has typically relied on a combination of between 1.0 to 2.0 metres of imported sand fill and subsoil drainage where groundwater is within 1.5 metres of the finished surface level. The availability and cost of fill is likely to present a significant cost constraint to traditional development approaches across the strategy area, which experiences shallow groundwater conditions and seasonal inundation.

This key development constraint is acknowledged, and groundwater management should consider alternative subdivision and building and infrastructure design approaches where possible, in combination with provision of adequate separation to groundwater through use of fill and control of groundwater rise using subsoil drainage.

It is recommended that any development design work requiring depth to groundwater data be based on a detailed site investigation report incorporating onsite monitoring as there could be scope for reducing fill requirements with local scale water level data. The requirement for fill and subsoil drainage should consider the variability in local hydrogeology across the strategy area, with the appropriate groundwater level management approach for different precincts dependent upon the prevailing local conditions, which should be assessed on a site-by-site basis.

In particular the level at which subsoil drainage invert levels can be set, the Controlled Groundwater Level, requires careful consideration for different parts of the strategy area. The Controlled Groundwater Level should be determined with regard to the guidance in document *Water resource considerations when controlling groundwater levels in urban development* (DoW 2013a), and should be endorsed by the DWER.

The Controlled Groundwater Level should be developed with consideration of the ecological water requirements for groundwater dependent ecosystems such as wetlands. This includes areas where measured groundwater levels indicate slightly confined groundwater with upward vertical gradients. In these areas the depth at which Controlled Groundwater Levels should be set needs to consider the ecological water requirements of any water dependent ecosystems which receive surface water flow that may be sustained by groundwater.

Following endorsement of a Controlled Groundwater Level for a development area the fill levels that will be required to provide adequate separation to groundwater and protection of infrastructure should be determined and endorsed in consultation with the City of Swan. The required level of fill will be determined by a number of factors including building and infrastructure design, and subsoil drain spacing. Alternative foundations design for buildings and other infrastructure should be considered to reduce the fill requirement where possible.

Recent research of the mounding between subsoil drains within two new urban developments in Perth (one underlain by sand and one underlain by clay) measured mounding levels up to

0.9 metres between subsoil drains located ~80 metres apart in road verges (Davies *et al.* 2016). Spacing of subsoil drainage should therefore be a key consideration within large industrial lots.

An alternative to widespread sand filling may be considered in areas where larger lots are developed. Individual building sands pads elevated above the lot levels and surrounding palusplain may be a suitable alternative within these areas, providing free draining medium to reduce groundwater impact on building footings. Where large format buildings are proposed subsoil drains may be required within the individual building sand pads.

For development outside of floodplains the following fill levels are adopted for the strategy area:

- The finished floor levels of proposed residential, commercial and industrial buildings are to be provided with a minimum 0.3 metres freeboard above the 1 AEP (100 yr ARI) flood levels from road drainage systems and detention storage areas. Lot levels can be lower than building pad levels.
- Fill depth for buildings, roads and pavements, infrastructure and public open space to meet the *Specification Separation distances for groundwater controlled urban development* (IPWEA 2016).

5.4 Water quality management

Consistent with best practice water sensitive urban design a range of non-structural and structural controls are proposed to maintain, and where possible improve, the water quality for the strategy area.

Non-structural best management practices to control and reduce discharge of contaminants include institutional and pollution prevent practices. Within the strategy area non-structural controls include the following:

- Planning controls: Broad scale rezoning of land from agriculture to industrial development will reduce nutrient inputs via land use change.
- Planning controls: Land Use Planning Strategy design (Section 3) which considers the proposed land use based on key water management features and development constraints, including shallow depth to groundwater, proximity to sensitive environmental receptors and limitations to the provision of wastewater servicing infrastructure. The proposed land use should be further refined within subsequent planning stages across the strategy area based on individual site opportunities and/or constraints.
- Regulatory controls: Requirement for provision of reticulated sewerage for all new development, and minimum lot sizes in areas of shallow groundwater in accordance with *Government Sewerage Policy* (Government of Western Australia 2019a) (Section 5.5.3).
- Regulatory controls: Lots are required to comply with site practices provided in *Water Quality Protection Note 52: Stormwater Management at Industrial Sites* (DoW 2010).

Structural best management practices include the treatment train of water sensitive urban design strategies adopted for the minor drainage system (Section 5.2.2) and proposed groundwater management strategies (Section 5.3). This should further consider:

- Water quality objectives should be based on the water quality targets in the *Local Water Quality Improvement Plan; Ellen Brook Catchment* (SRT 2009b) (Section 2.9.5).
- Management of small rainfall events at source will assist with management of both surface and groundwater quality across the strategy area.
- Convey stormwater runoff overland through understorey vegetation where required.

- Maintain the natural time scale of groundwater movement by avoiding unnecessary interception of groundwater and promoting local infiltration of clean stormwater only.
- Where subsoil drainage is installed for groundwater level or soil moisture control a water quality treatment system (e.g. bio-retention area/vegetated swale) at each subsoil drain outlet point will be required. Alternatively subsoil drains may be lined with an appropriate treatment media. Refer to the *Stormwater Management Manual for Western Australia* (DoW 2004-2007) and *Water resource considerations when controlling groundwater levels in urban development* (DoW 2013) for guidance.
- Where appropriate, field investigations must be undertaken to identify acid sulfate soils. Any reduction in groundwater level should not expose acid sulfate soils to the air, as this may cause groundwater contamination. If field investigations identify acid sulfate soils, further advice should be sought from the DWER.
- Contaminated sites must be managed in accordance with the *Contaminated Sites Act 2003*.

5.5 Water supply and servicing

The strategy area has been identified as a proposed location for non-heavy industrial development within a range of planning documents. The proposed change in land use from predominantly agriculture to general and light industrial land uses and service/commercial uses will change the water demands across the strategy area and introduce new water servicing requirements.

The following sections provide an overview of key water conservation initiatives, potential fit for purpose water sources across the strategy area, and water and wastewater servicing, including existing infrastructure planning, as well as alternative options where current planning for water and wastewater infrastructure services do not extend.

5.5.1 Water conservation

Water conservation initiatives are important to reduce the demand for potable and fit-for-purpose water sources and include the following:

- The opportunities to optimise fit for purpose water transfer between industries should be considered at the precinct scale through completion of industrial ecology studies.
- Establishment of water efficient landscaping including use of drought resistant local vegetation and use of non-potable sources for irrigation.
- Installation of rainwater storage systems to supply water for non-potable uses and provide detention storage on lots.
- Substitution of potable water with alternative fit for purpose water sources for all non-potable water internal and external demands where possible.
- The Water Corporation require that any business or industry that use more than 20,000 kL of water annually participate in the Water wise Business Program, including submission of a Water Efficiency Management Plan.

5.5.2 Fit for purpose water sources

Increasing demand for water coupled with the declining water availability as a result of climate change requires that proposed industrial and commercial development of the strategy area reduces reliance on potable water and utilises alternative fit for purpose water source options.

The following sections provide an overview of potential non-potable fit for purpose water sources that may be available within the strategy area. Many factors will influence the availability of cost-effective, suitable fit for purpose water supplies, with the preferred options likely to vary at the precinct scale based on the proposed industry types, intensity of land use and timeframe for development.

Rainwater storage systems

Given the shallow groundwater conditions and potential for perched aquifers across large parts of the strategy area, the infiltration capacity of the superficial aquifer is limited. Rainwater storage systems (e.g. rainwater tanks, underground storage systems) should be implemented for all new buildings to supply water for non-potable uses, and perform a role in stormwater detention, in particular capture of small event runoff.

Small scale rainwater storage and distribution systems present opportunities for the collection and reuse of rainwater at the lot scale within industrial and service/commercial developments. These developments typically feature expansive roof areas that have the ability to capture significant quantities of rainwater. The use of this water is generally limited to internal fit-for-purpose demand such as toilets and wash-down bays, as well as irrigation of landscaped areas.

Use of rainwater storage systems results in a small reduction in potable demand however use is predominantly limited to winter periods. Key benefits in the strategy area include the reduction in lot infiltration provided they are plumbed into a facility with frequent wet season use.

It is recommended that the installation of rainwater storage systems be mandated through the preparation of Industrial Design Guidelines for the various precincts.

Groundwater

The DWER *Online Water Register* indicates that Bullsbrook is located within the Swan Groundwater Area and covers the Swan, Radar and Neaves sub-areas. The SGA comprises both unconfined and confined aquifers. The aquifers are, in increasing depth, the superficial aquifer, the Mirrabooka aquifer (where present), the Leederville aquifer and the Yaragadee aquifer.

DWER have advised (licensing database resource allocation information July 2018) that all aquifers are over-allocated (Table 6), and that short term opportunities for groundwater allocation trading will be limited. Opportunities for transfer of the all or part of existing groundwater licences may be assessed by the DWER under the *Operation policy 5.13 – Water entitlement transactions for Western Australia* (DoW 2010).

Table 6 Groundwater allocation in the Swan Groundwater Area

Aquifer	Subarea	Allocation limit (kL/yr)	Licensed entitlements (kL/yr)	Remaining volume (kL)	% Allocated and Committed
Superficial	Neaves	1,620,000	3,236,753	-1,616,753	199.80%
	Radar	1,430,000	2,868,851	-1,438,851	200.62%
Mirrabooka	Neaves	0	0	0	0
	Radar	180,000	408,864	-228,864	227.15%
Leederville	Swan Confined	4,500,00	5,124,661	-624,661	113.88%

Groundwater abstraction is one of the easiest and most cost-effective method of providing an alternative to scheme water for industry feedwater and irrigation purposes. Due to the long-

term nature of the proposed development of the strategy area the status of the groundwater allocations may change as land use changes. As development progresses the current availability of groundwater for the open space irrigation and industry specific use should be reassessed and reported.

The quality of the groundwater (salinity, alkalinity, heavy metal concentrations etc.) could affect the industrial processes, and therefore filtration or treatment of the groundwater may be required depending on the desired end use. Given the emerging risk of PFAS contamination within the Bullsbrook area (Section 2.7) groundwater quality testing should be considered prior to consideration of superficial groundwater within potentially affected areas.

Groundwater licences

As development planning progresses existing groundwater licences should be investigated to identify potential to transfer or trade allocations to provide an alternative fit for purpose water supply for proposed business and industry. The DWER *Online Water Register* can be used to search and view water availability information within the strategy area.

There are numerous water licences exceeding 20,000 kL/yr within the strategy area, with several in the order of 50,000 kL/yr, four between 90,000-130,000 kL/yr (one City of Swan licence) and one exceeding 200,000 kL/yr.

Groundwater licence transfer and trade applications should be confirmed as development and water management planning progresses, with vendor and purchasers required to complete applications to transfer or trade water licences within the DWER *Water Online* customer portal.

Subsoil drainage

This approach includes the installation of subsoil drainage with the subsoil discharge collected (e.g. storage or managed aquifer recharge) and reused as a water source.

The level at which subsoil drainage is set requires careful consideration for parts of the strategy area. Typically the subsoil drains are installed at an agreed Controlled Groundwater Level (CGL) determined through consultation with approving authorities (Section 5.3), with the subsoils collecting infiltrated stormwater and potentially intercepting groundwater under certain seasonal conditions (predominantly restricted to winter groundwater peaks).

Key risks associated with this approach include the potential for a decline in the subsoil discharge volume if drying climatic conditions continue as predicted (Section 2.1).

Potential issues with this approach include interception of groundwater levels associated with water dependent ecosystems. Subsoil drainage would therefore be constrained to areas outside the hydrological catchments of water dependent ecosystems.

Further in the parts of the strategy area there is potential for slightly confined groundwater with upward vertical gradients that contribute to surface flows when they reach the surface (Section 2.11.4). In these areas the level at which the Controlled Groundwater Level is set may require an assessment of the environmental water requirements of water dependent ecosystems which receive surface water flow that may be sustained by groundwater. Further detail on the requirements for subsoil drainage

The use of subsoil drainage as a fit for purpose water source is predominantly limited to winter periods. Assessment of a scheme should include the feasibility and economics of implementation and operation, and assess the environmental and social impacts.

Managed aquifer recharge

In a review of the potential for artificial recharge of the Perth region superficial aquifer Smith and Pollock (2010) identified that large parts of the Gnangara Mound are hydraulically suitable however large water sources are not available. Local groundwater control and aquifer storage in the Gnangara Mound area was identified as being more feasible than coastal limestone areas due to lower transmissivity of the superficial aquifer and reduced influence of the sea level boundary.

Detailed investigation of the local aquifer hydraulic properties and geochemistry are required to assess feasibility of a scheme (Smith and Pollock 2010). Feasibility assessment should also consider the economics of implementation and operation, as well as the environmental and social impacts.

Recycled water

The use of recycled water for industrial operations is identified as a preferred option as recycled water can be used for applications that require lower quality water, and wastewater is climate independent and available year-round (DoW 2008). Recycled water may be provided from a decentralised source (i.e. networking between businesses) or centralised source (i.e. local wastewater treatment plant).

Industrial processes can produce highly variable wastewater discharges, both in terms of quality and quantity, and it is important that recycled water is treated to an appropriate level to be fit for purpose. The demand for process water is also highly variable in terms of quality and quantity.

The feasibility of recycled water as a fit for purpose water source option will be dependent on the types of industrial development, and is likely more feasible within precincts with general industry, as opposed to commercial, light industrial or dry industry. Precinct planning should co-locate industry types that are able to supply and use recycled water.

Precinct scale planning for General Industrial areas should undertake industrial ecology studies to optimise opportunities for fit for purpose water transfer to support process water if required.

5.5.3 Water and sewerage servicing and infrastructure

Scheme water servicing requirements

In order to service industrial and service/commercial land use within the strategy area new scheme water distribution infrastructure will need to be planned and built within and near the area.

The Water Corporation have advised that there is some capacity within the long-term planning to service parts of the strategy area with scheme water (Appendix F) The 80 ML Gnangara Reservoir is likely to have capacity to service the proposed ‘Urban Investigation’ areas to the north of Ellenbrook and southern parts of proposed Precinct B in the strategy area.

Review of the long-term water planning for the Gnangara Reservoir is required to provide for future capacity in the north east urban corridor. Engineering investigations will need to be completed to determine the hydraulic limits of gravity supply from the Gnangara Reservoir (top water level of 93 mAHD), and a plan prepared for the staged construction of required water distribution infrastructure.

Current planned upgrades to service the full urban development of the Bullsbrook Townsite area further identify construction of large (2 x 20 ML) water storage tanks from 2040. Water

Corporation have identified that these tanks could potentially service the northern parts of the strategy area in proximity to the Bullsbrook Townsite (potentially Precincts E and F).

For those parts of the strategy area outside of existing or planned Water Corporation scheme water upgrades, additional planning upstream is required. Any additional demand will require reinforcement from another source along with further tanks to provide the additional capacity.

Light and general industries have highly variable water demands, and more detailed planning is required to enable estimates of scheme water demand.

Wastewater servicing requirements

The strategy area is not serviced by reticulated sewerage and Water Corporation have advised that outside of existing planning no provision for wastewater reticulation for industrial land use has been planned for (Appendix G).

With the decommissioning of the Bullsbrook Wastewater Treatment Plant (WWTP), reticulated wastewater service provision for the Bullsbrook Townsite will be directed to Beenyup WWTP, with reuse as part of the groundwater replenishment scheme. The Water Corporation have identified that the proposed sewer pressure main does not have capacity to accept additional out-of-catchment wastewater from the strategy area.

Government Sewerage Policy

The *Government Sewerage Policy* (Government of Western Australia 2019a) was jointly developed by the Department of Health, Department of Planning Lands and Heritage and DWER to establish the government position on wastewater services through the planning and development of land.

The policy outlines a number of requirements for the connection to reticulated sewerage. Of relevance to the strategy area Policy measure 5.1.1.7 requires that where the highest groundwater level is less than 0.5 m below the natural ground surface land can only be rezoned for lots of less than one hectare where reticulated sewerage is provided (Government of Western Australia 2019b).

The policy acknowledges that conventional reticulated sewerage servicing arrangements may not be relevant in strategic industrial zones, and encourages innovation in provision of reticulated sewerage for planning proposals in areas where connection to existing reticulated sewerage network is not feasible or preferred.

Where reticulated sewerage cannot be provided the policy outlines best practice approach for provision of on-site sewerage treatment in accordance with *Australian/New Zealand Standard 1547 On-site domestic wastewater management.*

Key matters relating to on-site sewerage treatment considered relevant for the proposed development of the strategy area include:

- Where reticulated sewerage is not provided the potential impacts to development include: low density development; restriction or reduced flexibility to change or intensify land use in future; and undermining future provision of reticulated sewerage.
- The government's position is that land with high groundwater level (for example, less than 0.5 metres below natural ground level) is unsuitable for on-site sewage disposal at lot sizes less than one hectare.
- The policy sets a one-hectare minimum lot size in sewage sensitive areas primarily to manage cumulative impacts on the environment and water resources. This is supported by AS/NZS 1547:2012, which recommends a conservative approach be adopted where cumulative environmental risks are deemed to be high, and catchment modelling

undertaken as part of the development of a number of water quality improvement plans throughout the state.

- Mapping of sewerage sensitive areas (Figure 14) identifies that the majority of the strategy area is mapped as within 1km of significant wetlands, and part of Precinct F is mapped as "Habitats of specially protected water-dependent fauna, and within 1km of groundwater dependent threatened and priority ecological communities to the east of Neaves Road" (DPLH 2019).
- The Policy identifies separation distances for on-lot disposal from water resources and groundwater.
- On-lot systems should not be sited in areas that are low-lying and prone to flooding.
- Industrial development proposals are required to provide detail of likely trade waste, details of proposed method of disposal of trade waste and contingency measures such as emergency response to spills.

Options for wastewater servicing

In accordance with the *Government Sewerage Policy* (Government of Western Australia 2019a the preferred option for wastewater servicing across the majority of the strategy area is provision of reticulated sewerage through small package treatment plant or decentralised system, operated by a service provider.

Small package treatment plant or decentralised system

Given the majority of the strategy area is mapped as sewerage sensitive areas (Figure 14), reticulated sewerage is required to enable the desired lot sizes and land use types (Section 3.1), with development in the majority of precincts proposing lot sizes below 1 hectare and a transition to intense industrial activity (e.g. light industry and service commercial) proposed to occur over time in parts of the strategy area.

Reticulated sewerage is considered both appropriate and viable as a servicing option for the development of greenfield 1,000 m² lots (Government of Western Australia 2019b). Reticulated sewerage must be provided in accordance with the terms of a licence issued by the Economic Regulation Authority, unless otherwise exempted by the Minister for Water.

Operation of a local WWTP requires economic evaluation at the precinct scale for provision of services. Where land development occurs prior to the volumes required to make a local WWTP operationally and economically viable, developers will be required to investigate and fund temporary servicing arrangements to convey wastewater.

On-lot disposal

Suitability of on-lot disposal should be assessed at the precinct scale based on site specific land capability (e.g. soil types, depth to groundwater) following site specific investigations. Large parts of the strategy area are constrained to on-lot disposal by the presence of sewage sensitive areas (water dependent TEC, PEC, significant wetlands), waterways and shallow depth to groundwater (limiting infiltration capacity of soils and resulting in insufficient land available for sewage disposal). Given these site constraints where on-lot disposal is proposed secondary treatment systems with nutrient removal will likely be required.

Where on-lot disposal is proposed outside of sewage sensitive areas industrial development may require more than one on-lot system comprising standard primary/secondary treatment for staff building amenities and a further grease and/or oil separator system for trade waste.

In sewerage sensitive areas (Figure 14) lot sizes for on-lot disposal are restricted to 1 hectare, and development will likely be restricted to dry industry only.

Separation distances to protect receiving waterbodies for on-lot disposal within the strategy area include (Government of Western Australia 2019a and 2019b):

- 100 metres of a waterway or significant wetland and not within a waterway foreshore area or wetland buffer. The separation distance should be measured outwards from the outer edge of riparian or wetland vegetation;
- 100 metres of a drainage system that discharges directly into a waterway or significant wetland without treatment; or
- Any area subject to inundation and/or flooding in a 10 per cent Annual Exceedance Probability (AEP) rainfall event.

Separation distances for on-lot disposal to the highest groundwater level, taking into account seasonal groundwater conditions and possible groundwater rise following development, include (Government of Western Australia 2019a and 2019b):

- Two (2) metres in public drinking water source areas;
- 1.5 metres in sewage sensitive areas; and
- 0.6 to 1.5 metres in all other areas, depending on soil type and the type of treatment system used.

6. Implementation

6.1 Future work to support development planning

Planning within the strategy area will be progressively refined through subsequent planning stages within each precinct. This will allow for more detailed land use planning including confirming drainage, open space and service infrastructure requirements for specific industrial and service/commercial zones within each precinct.

6.1.1 Water management reporting

Better urban water management (WAPC 2008) provides the framework for the integration of total water cycle planning into the land use planning and developments approvals process in accordance with *State Planning Policy 2.9: Water Resources* (WAPC 2006).

This strategy shall be implemented through the land use planning process, with proponents of development required to develop water management strategies and plans at each planning stage. The required water management report is defined by the planning proposal.

District water management strategy

In accordance with *Better urban water management* (WAPC 2008) and *Guidelines for district water management strategies* (DoW 2013b) a district water management strategy (DWMS) is required in support of a MRS amendment or district structure plan for future urban and/or industrial land development, and for the lifting of urban deferment if no previous DWMS has been prepared and approved. The objective of the DWMS is to demonstrate that the area can support the proposed future development with regards to the water supply planning, flood mitigation, drainage management and water quality protection. For the strategy area it is considered that DWMS should be completed at the precinct scale, and should be consistent with *Better urban water management* (WAPC 2008), the *North East Metropolitan Sub-Region: Regional Water Management Strategy* (Urbaqua 2018) and this strategy.

Given the significant site constraints more detailed planning, site investigations and assessment are required to identify developable areas and set aside appropriate land for water management and environmental protection. These are considered to include further groundwater monitoring (Section 6.1.2) and surface water-groundwater interaction modelling (Section 6.1.3). Further, given the potentially polluting nature of the proposed industrial development foreshore area boundaries should be established at the district scale particularly for Precinct B (Section 6.1.5).

Local water management strategy

A local water management strategy (LWMS) is prepared to support land use planning proposals at the local level (local planning scheme amendment or local structure plan). The LWMS should demonstrate the integration of the sites water resources with the proposed development structure and implementation of best practice water management strategies while achieving sustainable and environmental outcomes. The LWMS should be consistent with *Better urban water management* (WAPC 2008), the *North East Metropolitan Sub-Region: Regional Water Management Strategy* (Urbaqua 2018) and this strategy.

Urban water management plan

An urban water management plan is required at subdivision stage to support subdivision approval. *Better urban water management* (WAPC 2008) recommends that large greenfield subdivisions (generally more than 25 lots) or small subdivisions within priority catchments are

supported by a UWMP. The UWMP should be consistent with the principles and strategies for water sensitive urban design outlined in an approved LWMS, and should be developed in consultation with the City of Swan, with advice from the DWER as required.

6.1.2 Monitoring

At the time of preparation site specific groundwater information is limited across parts of the strategy area, with the spatial distribution of monitoring bores insufficient to characterise groundwater conditions in a number of precincts (Section 2.11.5 and Section 3.1). The current distribution of groundwater wells across the RWMS area is presented in Figure 12, with distribution within individual precincts also presented in Figure 15 through Figure 19. The status of the existing bores is unknown and should be verified through site investigations.

Additional groundwater monitoring information is required at the district scale to improve knowledge of groundwater conditions, and to support the development and calibration of district scale surface water-groundwater models (Section 6.1.3). Recommendations for additional groundwater monitoring at the district scale are summarised below and in Table 7.

In addition to the district scale groundwater monitoring *Better urban water management* (WAPC 2008) requires monitoring to establish the pre-development condition of surface water and groundwater. Given the extended timeframes for development across the Bullsbrook RWMS area, pre-development monitoring of local scale surface water and groundwater features should be undertaken during the period immediately preceding either MRS amendments or local structure planning.

To further refine the characterisation of groundwater conditions at the local scale 18 months of monthly groundwater-level monitoring, including a minimum of two winters will be required to establish the seasonal groundwater trends within a development area.

Proposed District Scale Groundwater Monitoring Network Additions

Additional monitoring locations are proposed in light of the currently limited groundwater monitoring network across much of the strategy area. The aim of these additional monitoring locations is primarily to assist with determining the direction of groundwater flow on a site wide, and also precinct level scale to inform surface water-groundwater interaction modelling requirements. Increased refinement of groundwater levels will also help to delineate any sensitive groundwater dependent ecosystems, and groundwater expressions in what is already a very low-lying area.

It would be preferable to have monitoring wells located up-gradient, down-gradient, and cross gradient of each precinct to accurately determine groundwater flow and levels. In some locations it would also be necessary to install nested (i.e. shallow and deep) monitoring wells. This would enable a shallow well to monitor groundwater levels within the superficial aquifer system, and a deeper well to monitor levels in deeper aquifer units to account for any upward or downwards leakage of water. This is important information which would be used to inform future surface water and groundwater modelling.

Table 7 provides guidance on the minimum recommended groundwater bores along Precinct boundaries that are targeted towards providing a greater understanding of groundwater flow across the strategy area. Consultation with DWER identifies that a general density of one groundwater bore per 10 hectares should be achieved which will require placement of additional groundwater bores within Precinct boundaries to provide further understanding of local groundwater conditions. Monitoring requirements should be confirmed with DWER prior to commencement.

6.1.3 Modelling

Broad scale pre-development surface water modelling was completed as part of this strategy to quantify minor and major storm event flows and peak water levels associated with the waterways that traverse the strategy area (Section 2.9.4, Appendix D).

The strategy area is also located within the regional GARAMS (Gingin Arrowsmith Regional Aquifer Modelling System) model boundary which simulates major hydraulic processes at a regional scale based on simplified geology and hydrogeology.

Due to the high level of interconnectivity between surface and groundwater within the strategy area more detailed surface water-groundwater interaction modelling is required to appropriately characterise surface water and groundwater interactions, inform arterial drainage requirements and environmentally acceptable controlled groundwater level at the DWMS stage, to support district scale engineering design and planning.

The proposed district scale model would use more detailed groundwater monitoring information to improve knowledge of groundwater conditions, and be informed by a conceptual hydrogeological model. The conceptual hydrogeological model should identify important aquifers, aquifer parameters, and site water balance with respect to abstraction and recharge, and be compatible with the regional GARAMS model.

Using the existing regional scale model inputs and 2D arterial drainage modelling a numerical surface water-groundwater model should be constructed that incorporate major flow components (processes), flow in the saturated zone, flow in the unsaturated zone, evapotranspiration and overland channel flow. The district scale model should be calibrated using available groundwater data and surface water flow time series data, and recharge percentages determined in the regional model, and used to model predictive scenarios including DWER endorsed climate change scenarios.

6.1.4 Acid sulfate soils

Due to the prevailing conditions across the strategy area limited cut is likely for the purposes of development. Where excavation is required for provision of services the potential for disturbance of acid sulfate soils should be recognised and managed in accordance with current DWER guidance:

- *Identification and investigation of acid sulfate soils and acidic landscapes* (DER 2015a)
- *Treatment and management of soils and water in acid sulfate soil landscapes* (DER 2015b)

6.1.5 Waterways, wetlands and water dependent ecosystems

Precinct scale mapping provided in Section 3 includes indicative foreshore areas and wetland buffers only. More appropriate foreshore area and buffer widths are required to be determined. Given the high risks associated with development in the strategy area (potentially polluting land uses, significant site constraints) the DWER recommend that foreshore areas are refined and finalised at the district scale of planning (DoW 2012). The identification of foreshore areas should occur in advance of MRS rezoning.

Determination of wetland buffer widths depends on the intended purpose of the buffer as well as the surrounding land use and groundwater control methods.

Based on the outcomes of the surface water-groundwater interaction modelling the hydrologic buffer zone of water dependent ecosystems may be determined and used to limit the risk of adverse impacts to water quantity and water quality.

Refer to Section 5.1 for guidance on management of waterways, wetlands and water dependent ecosystems.

Table 7 Proposed precinct boundary groundwater monitoring network additions

Precinct	Description	Key Constraints	Monitoring Considerations
Precinct A	General Industry	Precinct already rezoned	Monitoring in accordance with approved LWMS and UWMPs
Precinct B	General Industry	Primarily mapped as >70% risk of moderate to very high risk of waterlogging (H2), with a portion associated with Ellen Brook and a minor waterway mapped as 30-50% risk (M2) Limited monitoring network	Proposed monitoring wells on eastern boundary (1), northern boundary (1), southern boundary (1) and western boundary (1) to determine flow direction and velocity.
Precinct C	Light Industry	Primarily mapped as > 70% risk of waterlogging and inundation (H2), centre, and western corner mapped as 50-70% risk areas (H1) Limited monitoring network	Proposed monitoring wells on eastern boundary (2), and western boundary (1) to determine flow direction and velocity.
Precinct D	IMT Freight and Logistics	Primarily mapped as> 70% risk of waterlogging and inundation (H2), isolated 50-70% risk areas (H1) areas within centre and southern section. Very limited monitoring network	Proposed monitoring wells on eastern boundary (2), northern boundary (3), southern boundary (1) and western boundary (1) to determine flow direction and velocity.
Precinct E	Value Added Industry	Primarily mapped as > 70% risk of waterlogging and inundation (H2), centre, and north western corner mapped as 50-70% risk areas (H1) Very limited monitoring network	Proposed monitoring wells on eastern boundary (3), northern boundary (1), southern boundary (1) and western boundary (3) to determine flow direction and velocity.
Precinct F	Technology and Business	Primarily mapped as > 70% risk of waterlogging and inundation (H2) Monitoring network limited to NorthLink wells	Proposed monitoring wells on eastern boundary (3), northern boundary (1), southern boundary (1) and western boundary (1) to determine flow direction and velocity.
Rural	Rural	Primarily mapped as > 70% risk of waterlogging and inundation (H2), north east corner mapped as 50-70% risk (H1) No downstream monitoring wells	Proposed monitoring wells (3) on western boundary to determine flow direction and velocity.
Potential Inclusion in Urban Investigation	Potential Inclusion in Urban Investigation	Primarily mapped as >70% risk of waterlogging and inundation (H2), east corner mapped as 50-70% (H1), west corner mapped as <3% risk (L1) Very limited monitoring network currently	Proposed monitoring wells on eastern boundary (1), southern boundary (1), and western boundary (1) to determine flow direction and velocity.

*Note: Department of Primary Industries and Regional Development – Waterlogging and Inundation Risk

H1: 50-70% of map unit has a moderate to very high waterlogging risk H2: >70% of map unit has a moderate to very high waterlogging risk

M1: 10-30% of map unit has a moderate to very high waterlogging risk M2: 30-50% of map unit has a moderate to very high waterlogging risk

L1: <3% of map unit has a moderate to very high waterlogging risk L2: 3-10% of map unit has a moderate to very high waterlogging risk

6.1.6 Water and wastewater servicing

Water Corporation have identified opportunities for provision of scheme water servicing to parts of the strategy area as development planning progresses in areas adjacent to the strategy area (Section 2.12, Section 3 and Section 5.5).

As development planning progresses within the area developers should liaise with Water Corporation to assess the status of water service provision. Water Corporation have identified a need for a review of the water and wastewater service planning for the strategy area, however the ultimate solution will depend on the required demand determined by how much land will ultimately be set aside for Industrial use, timing of upgrades in the adjacent water and sewer system network, finalisation of transport corridors and crossings, and uptake in industrial land. The proposed water and sewer upgrades for the Bullsbrook Townsite are anticipated to occur in the next 15 years.

Water Corporation have advised that provision of reticulated wastewater servicing for industrial development within the strategy area is currently not provided for, and alternate service provision should be investigated. Reticulated sewerage is considered both appropriate and viable as a servicing option for the development of greenfield 1,000 m² lots (Government of Western Australia 2019b), and alternative, local-scale solutions should be investigated early in the planning process (Section 5.5.3). When assessing the viability of development proposals in highly constrained parts of the strategy area proponents should consider the requirements for service provision, and provide an appropriate level of information to demonstrate technical feasibility for any proposal (Urbaqua 2018).

Precinct scale planning for General Industrial areas should undertake industrial ecology studies to optimise opportunities for fit for purpose water transfer to support process water if required.

6.2 Implementation strategy

The RWMS identifies the key water management considerations that need to be considered to progress planning for the Bullsbrook Freight and Industrial Land Use Planning Strategy area, and identifies key information gaps across the strategy area that are required to further refine the suitability of parts of the strategy area for proposed development.

The strategy area is large with multiple landholdings. A coordinated approach to completion of proposed future works to support development planning would be more cost effective, however there are extended time scales for development for parts of the strategy area it is likely that district scale studies will progress as development progresses from the south. Proponents should consider the full cost of infrastructure and servicing required when assessing the viability of proposed development.

In most instances future water management planning should occur concurrent to land planning to ensure integration and refinement of the key water issues identified at subsequent stages of the planning process. Some of the investigations identified should be completed in advance of planning to ensure sufficient information (e.g. groundwater monitoring) is available. This process will ensure that the appropriate level of water information is available to support land planning decisions, and is particularly important given the highly constrained nature of the strategy area to traditional development.

The responsibility to undertake the future work required to complete district scale studies at the precinct scale lies with the lot owner / lot developer, in consultation with the relevant state agencies and local government where required (Table 8).

Table 8 Implementation strategy

Future work	Issue	Timing	Responsibility
District scale groundwater monitoring	Waterlogging Inundation Flooding Clearance from groundwater	Prior to approval of MRS amendment	Owner / Developer, in consultation with DWER
District scale surface-water groundwater interaction modelling	Waterlogging Inundation Flooding Clearance from groundwater	Prior to approval of MRS amendment	Owner / Developer, in consultation with DWER
Buffer widths	Wetlands Water dependent ecosystems	Prior to approval of MRS amendment	Owner / Developer, in consultation with DBCA and DWER
Foreshore areas	Waterways	Prior to approval of MRS amendment	Owner / Developer, in consultation with DWER
Controlled groundwater level	Waterlogging Inundation Flooding Clearance from groundwater	Prior to approval of MRS amendment	Owner / Developer, in consultation with DWER
Scheme water service provision	Potable water	Prior to approval of MRS amendment	Owner / Developer, in consultation with Water Corporation
Wastewater service provision	Sewage sensitive areas Waterlogging Inundation Flooding Clearance from groundwater	Prior to approval of MRS amendment	Owner / Developer, in consultation alternative service providers, DWER, Department of Health and City of Swan

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Appendices

Appendix A – Conservation areas

DBCA managed lands with 5 km of strategy area

Nine DBCA-managed conservation areas are located within 5 km of the strategy area (Table A-1).

Table A-1 DBCA managed lands within 5 km of the strategy area

Name and ID	Class	Location
Twin Swamps Nature Reserve (R 27621)	Class A	0.8 km south of the strategy area
Walyunga National Park (R 2065)	Class A	1.3 km east of the strategy area
Bullsbrook Nature Reserve (R 1654)	-	1.8 km east of the strategy area
Un-name Nature Reserve (R 46875)	Class A	1.8 km south of the strategy area
Un-named Nature Reserve (R 46919)	Class A	1.8 km south of the strategy area
Neaves Road Nature Reserve (R 47146)	Class A	2.15 km west of the strategy area
Un-named Nature Reserve (R 2336)		4.4 km north of the strategy area
Un-named Nature Reserve (R 44622)	Class A	4.4 km north of the strategy area
Ellen Brook Nature Reserve (R 27620)	Class A	4.7 km south of the strategy area

Bush Forever

The strategy area intersects seven Bush Forever sites (Table A-2), with nine other Bush Forever sites located within 5 km of the strategy area.

Table A-2 Bush Forever sites intersecting the strategy area

Name	Site No.	Location
Neaves Road Creek	100	Intersects the northern extent of the strategy area
Kirby Road Bushland	97	Intersects north-west extent of strategy area
Pearce Aerodrome and Adjacent Bushland	294	Intersects the eastern boundary of strategy area
Ellen Brook	296	Intersects the south-east part of the strategy area
Della Road South Bushland	298	Occurs within the south-west part of strategy area
Melaleuca Park and Adjacent Bushland	399	Intersects the western boundary of the strategy area
Cooper Road Water Reserve and Adjacent Bushland	6	Intersects the southern boundary of the strategy area

Ecological Linkages

Ecological linkages that intersect the strategy area include:

- Link ID 27: links to ecological link number 28, 31, 29, 128, 26, 35. Also links Bush Forever Sites 294 (located within the strategy area), 296 (located within the strategy area) and 301 via Ellen Brook;
- Link ID 28: links to Link number 30, 94, 93, 27 and links Bush Forever Sites 80, 87, 82, 291, 292 and 294 (located within the strategy area);
- Link ID 29: links to Bush Forever Sites 296, 294 via Kit-Monger Brook and then links Bush Forever Sites 89, 88, 86 with Link number 34;
- Link ID 30: links Bush Forever Sites 380, 462, 97 (located within the strategy area) and 92 with Link number 28; and
- Link ID 31: links Bush Forever Sites 399 (located within the strategy area), 6, 294 (located within the strategy area) and Link numbers 13 and 27.

Appendix B – Site visit

A waterways engineer conducted a site visit, primarily along Railway Parade, on 16 July 2018. Rain over the previous days allowed for observation of areas that were prone to inundation. Surface waters were observed in paddocks and open drains throughout the Site. A series of photographs is provided below of inundation within the paddocks. The area between Muchea South Road and the rail line is typically low lying and was inundated with no clear flow paths.

Plate 1: Between Morley Road and Gaston Road, along Muchea South Road





Plate 2: Corner of Rutland Road and Muchea South Road





Plate 3: Rutland Road, crossing Ellen Brook



Plate 4: Corner of Stock West Rd and Muchea South Rd



Plate 5: Corner of Savy Close and Muchea South Road







Plate 6: South of Cunningham Road along Muchea South Road



Plate 7: Corner of Chitty Road and Raphael Road



Plate 8: Warbrook Road, adjacent to proposed NorthLink alignment





Appendix C – Geomorphic wetlands

Table C-1 Summary of geomorphic wetlands located within the strategy area

UFI	Type	Category	Location of strategy area
8533	Floodplain	Conservation	South-western portion
8536	Floodplain	Conservation	South-western portion
8538	Dampland	Resource Enhancement	South-western portion
8773	Palusplain	Conservation	Northern portion
8779	Sumpland	Resource Enhancement	Northern portion
8783	Sumpland	Resource Enhancement	Central portion
8784	Floodplain	Multiple Use	Central portion
8785	Floodplain	Multiple Use	Central portion
8787	Dampland	Resource Enhancement	South-western portion
8788	Dampland	Conservation	South-western portion
8789	NA	Conservation	South-western portion
8908	Sumpland	Resource Enhancement	South-western portion
8909	Palusplain	Conservation	Northern portion
8910	Palusplain	Conservation	Northern portion
8911	Palusplain	Conservation	Northern portion
8912	Palusplain	Conservation	Central portion
8913	Palusplain	Conservation	Central portion
8914	Palusplain	Conservation	Central portion
8915	Palusplain	Resource Enhancement	Central portion
8916	Palusplain	Resource Enhancement	Central portion
8917	Palusplain	Multiple Use	Central portion
8918	Palusplain	Multiple Use	Central portion
8919	Sumpland	Multiple Use	Central portion
8920	Palusplain	Conservation	Central portion
8921	Palusplain	Conservation	Central portion
8922	Palusplain	Conservation	Central portion

UFI	Type	Category	Location of strategy area
8923	Palusplain	Resource Enhancement	Central portion
8924	Sumpland	Resource Enhancement	Central portion
8925	Palusplain	Resource Enhancement	Central portion
8926	Sumpland	Conservation	South-western portion
8927	Palusplain	Multiple Use	Southern portion
9172	Palusplain	Resource Enhancement	Central portion
9175	Palusplain	Multiple Use	Central portion
9176	Palusplain	Conservation	Central portion
9177	Palusplain	Multiple Use	Southern portion
12254	Palusplain	Conservation	Northern portion
12415	Palusplain	Conservation	South-eastern portion
12417	Palusplain	Conservation	South-eastern portion
12418	Dampland	Multiple Use	South-eastern portion
12419	Palusplain	Conservation	South-eastern portion
12424	Palusplain	Conservation	South-eastern portion
12433	Palusplain	Conservation	South-eastern portion
12433	Palusplain	Conservation	South-eastern portion
12434	Palusplain	Conservation	South-eastern portion
12495	Palusplain	Conservation	Eastern portion
12531	Palusplain	Multiple Use	Eastern portion
12534	Palusplain	Conservation	Eastern portion
12535	Palusplain	Conservation	Northern portion
12536	Palusplain	Conservation	Central portion
12537	Palusplain	Conservation	Central portion
12538	Palusplain	Conservation	Central portion
12539	Palusplain	Conservation	Central portion
12681	Palusplain	Conservation	South-eastern portion
12686	Palusplain	Multiple Use	South-eastern portion
12687	Palusplain	Conservation	South-eastern portion

UFI	Type	Category	Location of strategy area
13391	Sumpland	Conservation	South-western portion
15042	Sumpland	Conservation	South-western portion
15044	Floodplain	Resource Enhancement	South-western portion
15046	Floodplain	Conservation	South-western portion
15057	Floodplain	Multiple Use	South-western portion
15282	Palusplain	Multiple Use	South Eastern portion
15732	Palusplain	Multiple Use	Majority of strategy area
15734	Palusplain	Conservation	Southern portion

Appendix D – Bullsbrook Freight and Industrial Land Use Strategy – Stormwater modelling

Introduction

A hydrologic and hydraulic surface water model was prepared for the existing land use to establish base line pre-development controls. The purpose of the pre-development stormwater modelling was to identify the arterial drainage network required to support development and minimise impacts on water dependent ecosystems.

Approach

Previous stormwater modelling was reviewed and considered during the development of the model for this study. Reports and prior modelling includes:

- Ellen Brook Flood Study (Waugh & Ng 1987)
- NorthLink drainage design reports for the northern section (Stage 3) (BG&E 2018)
  - Design Lot 7a – IFC Design Stage: Main Line and PSP – Drainage;
  - Design Lot 7b – IFC Design Stage: Stock Road West Interchange – Drainage;
  - Design Lot 7c – IFC Design Stage: Neaves Road Interchange – Drainage; and
  - Design Lot 7d – IFC Design Stage: Brand Highway Deviation Interchange – Drainage.

The model was developed using hydrology parameters from the Ellen Brook Flood Study, infrastructure and catchment information from the NorthLink reports and *Australian rainfall and runoff: a guide to flood estimation* (Ball *et al*. 2016).

Design Rainfall

The design rainfalls and temporal patterns used for the modelling are based on the Australian Rainfall and Runoff (AR&R 2016) Guidelines, coordinate Latitude 31.682395 (S) and Longitude 115.99681 (E) (Table D.1).

Table D.1 Design rainfall

Duration	Duration in min	Annual Exceedance Probability (AEP)						
		63.20%	50%	20%	10%	5%	2%	1%
1 min	1	1.5	1.67	2.23	2.64	3.08	3.69	4.19
2 min	2	2.56	2.84	3.73	4.39	5.06	6.03	6.83
3 min	3	3.46	3.83	5.07	5.97	6.91	8.26	9.37
4 min	4	4.22	4.68	6.21	7.34	8.52	10.2	11.6
5 min	5	4.87	5.4	7.21	8.53	9.92	11.9	13.5
10 min	10	7.17	7.99	10.7	12.7	14.8	17.8	20.2
15 min	15	8.68	9.67	13	15.4	17.9	21.5	24.4
30 min	30	11.5	12.8	17.1	20.2	23.5	28.1	31.9
1 hour	60	14.8	16.4	21.7	25.7	29.8	35.8	40.8
2 hour	120	18.9	20.8	27.5	32.6	38.1	46.2	53
3 hour	180	21.8	24	31.7	37.8	44.3	54.1	62.6
6 hour	360	28.2	31	41	49	58	71.7	83.9
12 hour	720	36.6	40.2	53.1	63.6	75.3	93.5	110
24 hour	1440	46.9	51.6	67.8	80.4	94.1	115	134
48 hour	2880	59.3	65.1	84.2	97.9	112	133	151
72 hour	4320	67.7	74.3	94.9	109	122	143	160
96 hour	5760	74.7	81.8	104	118	132	152	168
120 hour	7200	81	88.6	112	127	142	163	179
144 hour	8640	87.1	95.1	120	136	152	175	192
168 hour	10080	93.2	102	128	146	164	189	208

Catchment

The study area is within the Ellen Brook catchment. The current land use is primarily rural. A large upper catchment for Ellen Brook flows through the study area, also primarily rural.

The stream paths for the study area were identified using CatchmentSIM (Version 3.02). This, along with the DWER hydrographic sub catchments and the catchments used in the NorthLink drainage design were used to develop the boundary conditions for the model (DWER 2018). The catchment summary information is provided in Table D.2.

Hydrology

GHD used RORB (Version 6.31, April 20107) to develop runoff hydrographs of external catchments which are used as boundary flows in hydraulic modelling. The coefficients used to develop the inflow hydrographs for this study including the upper Ellen Brook catchment and the NorthLink inflow catchments outlined in Table D.4.

Hydrology Model Calibration

The West Australian Water Authority (now Water Corporation) completed the Ellen Brook Flood Study in 1987 (Waugh & Ng 1987). The coefficients used in RORB software and hydrograph from this study were used to calibrate the hydrographs for this DWMS by adjusting the impervious area of the upstream catchment. The hydrograph for the upper Ellen Brook catchment used for calibration is shown in Figure D.1. The coefficients used for RORB in the Ellen Brook Flood Study are provided in Table D.2.

Table D.2 Catchment summary

Catchment name (Refer Figure D.2)	Area (km^2)	Length (km)	Runoff Coefficient
Upper catchment	414	0.1	0.145
GHD_ID12	8.28	7.59	0.145
GHD_ID13	1.54	3.16	0.145
GHD_ID14	3.30	4.03	0.145
GHD_ID16	1.21	3.55	0.145
GHD_ID21	6.11	6.85	0.145
GHD_ID22	3.73	5.72	0.145
GHD_ID23	1.96	0.8	0.145
CT0783	1.02	1.5	0.145
CT0863	0.18	0.69	0.145
CT0908	8.83	7.2	0.145
CT0952	0.83	1.95	0.145
CT0981	2.47	3.2	0.145
CT1062	0.43	0.95	0.145
CT1090	2.21	2.9	0.145
CT1180	0.96	1.38	0.145
CT1237	7.30	7.2	0.145
CT1274	5.89	7.83	0.145
CT1290	12.39	9.7	0.145
CT1587	4.58	4.39	0.145
CT1724	7.45	6.21	0.145

Table D.3 RORB coefficients (Waugh & Ng 1987)

Coefficient	Value
K	34.3
m	0.85
Initial loss	0 mm
Runoff Coefficient	12.1%

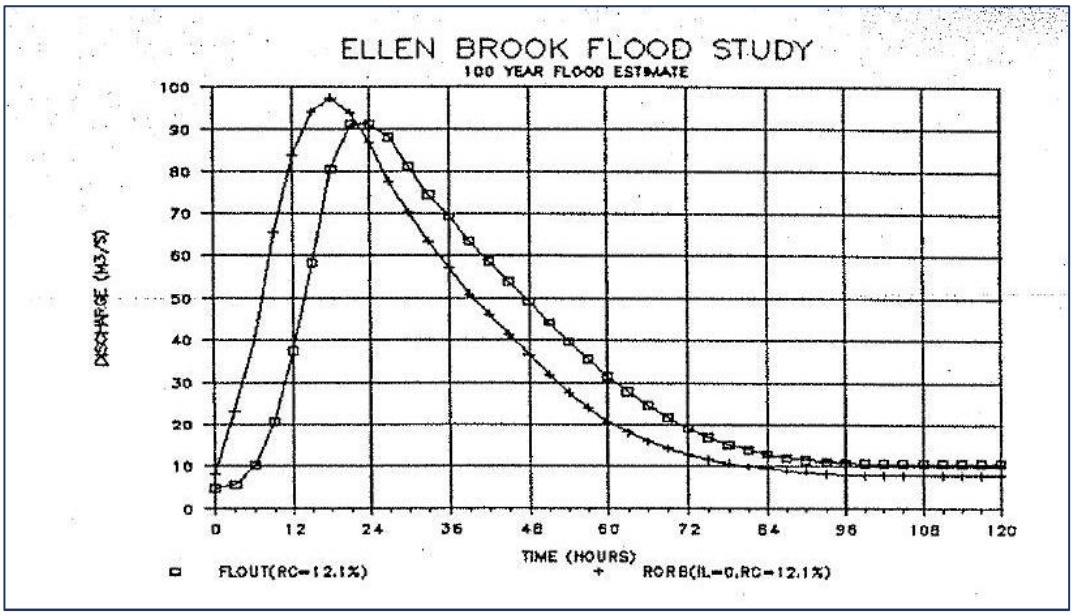


Figure D.1 Hydrograph for Ellen Brook, 100 y ARI from RORB (Waugh & Ng 1987)

Table D.4 Peak flow results from RORB

Catchment name (Figure D.2)	Storm event AEP and duration							
	20% 6hr	20% 48hr	10% 6hr	10% 48hr	5% 6hr	5% 48hr	1% 6hr	1% 48hr
Upper Catchment	32.31	34.42	40.75	38.36	48.76	44.04	67.36	79.75
GHD_ID12	1.36	0.71	1.95	1.10	2.35	1.27	3.12	2.54
GHD_ID13	0.34	0.20	0.52	0.29	0.63	0.33	0.90	0.57
GHD_ID14	0.65	0.36	0.96	0.53	1.16	0.62	1.61	1.12
GHD_ID16	0.28	0.17	0.43	0.23	0.51	0.27	0.74	0.46
GHD_ID21	1.06	0.57	1.55	0.86	1.87	1.00	2.52	1.94
GHD_ID22	0.72	0.40	1.06	1.09	1.28	0.68	1.76	1.24
GHD_ID23	0.42	0.24	0.63	0.35	0.76	0.41	1.09	0.71
CT0783	0.24	0.15	0.37	0.20	0.45	0.23	0.65	0.39
CT0863	0.06	0.03	0.08	0.04	0.10	0.05	0.15	0.08
CT0908	1.43	0.76	2.04	1.17	2.47	1.35	3.26	2.69
CT0952	0.20	0.12	0.31	0.17	0.38	0.20	0.55	0.33
CT0981	0.51	0.29	0.76	0.42	0.92	0.49	1.30	0.87
CT1062	0.12	0.07	0.18	0.10	0.21	0.11	0.32	0.18
CT1090	0.47	0.27	0.70	0.39	0.84	0.45	1.19	0.79
CT1180	0.23	0.14	0.35	0.19	0.42	0.22	0.62	0.37
CT1237	1.23	0.64	1.77	0.99	2.14	1.15	2.85	2.28
CT1274	1.03	0.55	1.51	0.84	1.82	0.97	2.45	1.88
CT1290	1.86	1.03	2.62	1.59	3.17	1.83	4.12	3.61
CT1587	0.84	0.46	1.24	0.69	1.50	0.80	2.05	1.50
CT1630	0.80	0.43	1.17	0.65	1.42	0.76	1.94	1.40
CT1657	0.39	0.23	0.58	0.32	0.70	0.37	1.00	0.65
CT1724	1.25	0.65	1.80	1.00	2.17	1.17	2.89	2.32
CT1805	0.18	0.11	0.27	0.15	0.32	0.17	0.48	0.28

Hydraulic modelling

Hydraulic modelling was completed using TUFLOW, version 2018. TUFLOW is an industry accepted computer program used for simulating surface water flow in two dimension. This allowed flood modelling to be based on topography rather than pre-defined channels.

Model domain

The model domain consists of the study area, including downstream catchment areas for Ellen Brook.

Topography

The model used a 10 m square grid, developed using the following inputs:

- High resolution LiDAR; and
- NorthLink roads and culverts.

Roughness

The model area was separated into three surface types. The surfaces and roughnesses used (Manning's "n") are provided in Table D.4. These were based on the table provided in AR&R 2016, Table 6.2.1 (AR&R 2016).

Table D.4 Manning's "n" roughness value

Surface type	Manning's "n"
Vegetated areas	0.045
Open paddocks and grassy areas	0.028
Impervious, hardstand areas including roads and rail line	0.013

Boundary conditions

The boundary conditions used for hydraulic modelling are described in Table D.5 and locations are shown in Figure D.2. The peak flows are provided in Table D.3, and are calculated as described in section Hydrology.

Table D.5 Boundary conditions of TUFLOW

Location	Boundary condition
Northern boundary, Ellen Brook upper catchment inflow	Hydrograph, flow over time Calculated as per section Hydrology
Southern boundary, Ellen Brook catchment outflow	Head versus flow water level boundary
Eastern boundary, external catchment inflows	Hydrographs, flow over time Calculated as per section Hydrology
Western boundary, NorthLink catchment inflows	Hydrographs, flow over time Calculated as per section Hydrology
Rainfall	Rain on grid 2016 AR&R rainfall events

Hydraulic features

The two major transport infrastructure features within the site are the NorthLink road and ARC railway. Both have many culverts to allow flow to Ellen Brook. Culvert information for the

railway was provided by ARC Infrastructure, and NorthLink WA provided culvert information for the construction of the Perth Darwin National Highway. Several culverts for NorthLink were missing spatial information, so this was estimated based on the mapping provided in drainage reports.

Results validation

The results of the flood modelling are presented in Figure D.3 to Figure D.6. The maximum of the 6 hour and 48-hour duration peak flows are summarised in Table D.6. The estimated 1% AEP flow is within the order of magnitude flows estimated in Ellen Brook Flood Study in 1987 (Waugh & Ng 1987), Figure D.1. The modelling shows minor flooding across the study area, along defined stream paths that run between paddocks. This is consistent with the DWER waterway mapping (Figure 10) and observations from the site visit (Appendix B).

Table D.6 Flow rates (m3/s)

Flow location	20% AEP	10% AEP	5% AEP	1% AEP
Ellen Brook inflow to Site	36.21	46.04	55.59	88.5
Ellen Brook outflow from Site	40.34	51	63.08	109.14

Recommendations

Any future surface water modelling should consider the following;

- Confirm appropriate surface water modelling and current existing flood data with DWER;
- Evaluate and include any surface water and groundwater interactions;
- Sensitivity analysis of parameters;
- Calibration of the model for updated gauged data, if available, at the time of modelling.

Appendix E – Groundwater Quality

Groundwater quality data summarised from DWER's Water Information Reporting

Table E.1 Groundwater Quality from WIR (DWER 2018)

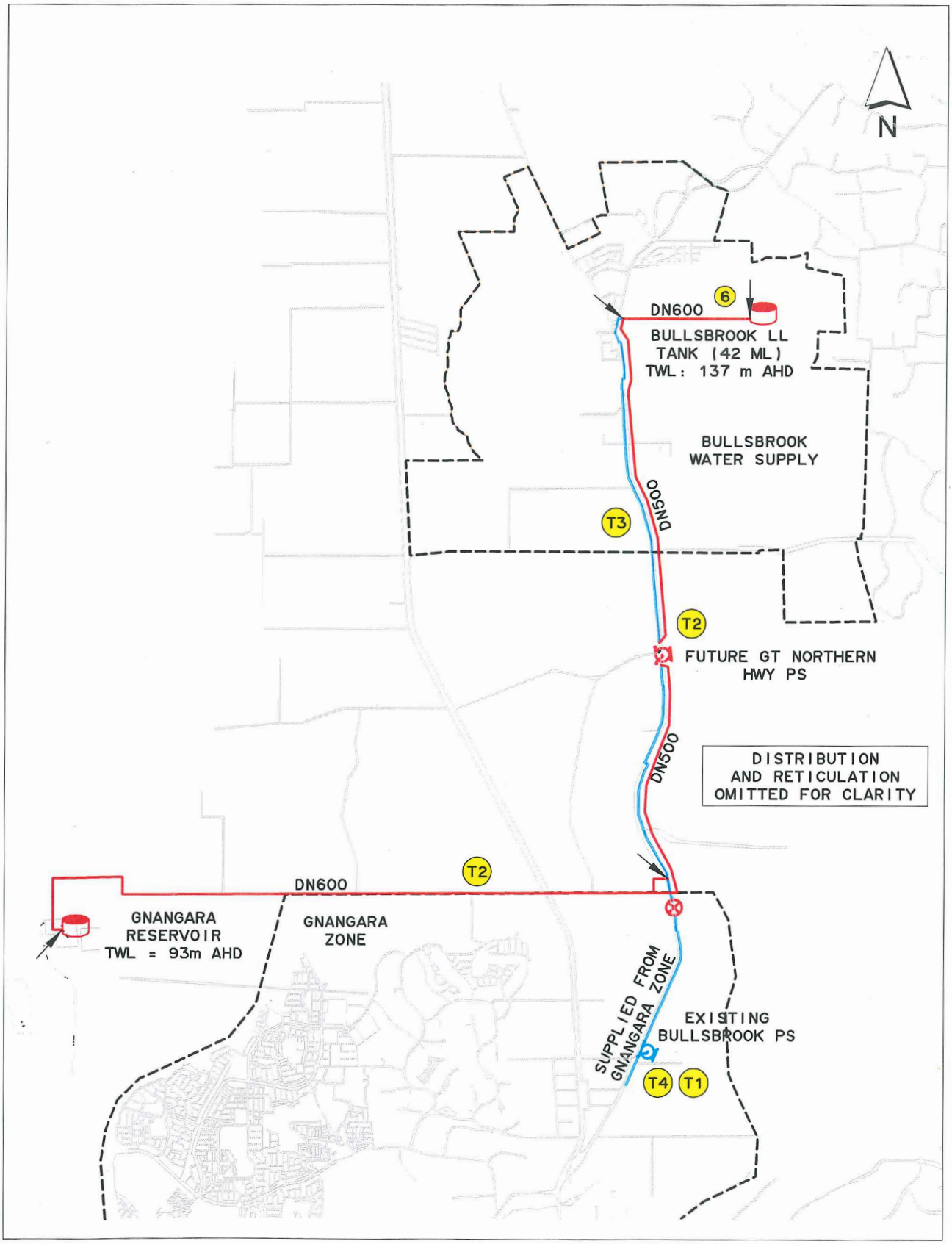
Site Reference	Sample date range		Number of samples	pH		Conductivity (µS/cm)		TDS (mg/L)		Total Nitrogen (mg/L)		Total Phosphorus (mg/L)	
				min	max	min	max	min	max	min	max	min	max
61611020	1/06/2000	1/06/2000	2	4.6	4.6								
61611040	27/05/1999	26/05/2000	2	5.8	5.8								
61611041	26/05/2000	26/05/2000	2	4.5	4.5								
61611042	15/05/2000	19/04/2001	2	3.86	3.96								
61611043	15/05/2000	19/04/2001	2	5.3	5.47								
61611071	26/05/1999	23/05/2000	2	7.4	7.6								
61611072	25/05/1999	31/05/2000	3	7.35	7.4					0.308	0.308	0.1833	0.1833
61611081	26/05/1999	29/05/2000	2	7.4	7.6								
61611082	25/05/1999	29/05/2000	3	7.1	7.23					0.578	0.578	0.0816	0.0816
61611083	25/05/1999	1/06/2000	3	5.2	5.45					0.204	0.204	0.3187	0.3187
61611171	1/06/1999	26/05/2000	2	7.2	8.5								
61611182	31/05/1999	30/05/2000	2	7.2	7.3								
61611183	31/05/1999	30/05/2000	2	5.1	5.1								
61611488	12/07/2010	25/06/2012	5	6.09	6.34					3.7	9.3	0.08	0.34
61611489	12/07/2010	5/10/2011	3	6.66	6.82					4.8	12	0.14	0.19
61611860	4/08/2008	4/08/2009	17	5.2	6	190	210	110	160	0.75	1.5	0.028	0.084
61611912	17/08/2000	15/05/2001	11	5	6.43					0.62	0.76	0.09	0.13
61611913	17/08/2000	17/08/2000	6	6	6					1.5	2.9	0.13	0.25
61611914	17/08/2000	17/08/2000	1	6	6								
61611915	17/08/2000	15/05/2001	11	6	6.34					0.43	0.61	0.07	0.11
61611916	17/08/2000	15/05/2001	11	4.58	5					1.4	5.1	0.29	0.52
61611917	17/08/2000	17/08/2000	1	6	6								
61611918	17/08/2000	17/08/2000	1	6	6								
61611919	17/08/2000	15/05/2001	11	5.79	6					0.51	0.63	0.19	0.23

61611923	17/08/2000	17/08/2000	1	6	6								
61611924	17/08/2000	17/08/2000	1	6	6								
61611925	17/08/2000	17/08/2000	1	5	5								
61611926	17/08/2000	17/08/2000	1	5	5								
61611927	17/08/2000	17/08/2000	1	5	5								
61611928	17/08/2000	17/08/2000	1	6	6								
61611929	17/08/2000	17/08/2000	1	6	6								
61611930	17/08/2000	17/08/2000	1	5	5								
61613213	4/08/2008	4/08/2009	17	3.65	5.53	560	1060	360	740	1.3	2.9	0.006	0.041
61618558	3/06/1999	9/06/2005	4	5.4	5.83								
61618565	8/07/1999	9/05/2001	17	7.3	12.2	2200	2600	1100	1500	0.51	2	0.01	0.12
61618566	8/07/1999	9/05/2001	17	7.4	12.1	1800	2200	780	1300	0.27	2	0.03	0.22
61618567	7/07/1999	9/05/2001	17	6.8	8.41	2000	2200	1100	1200	0.16	0.34	0.12	0.23
61618568	7/07/1999	9/05/2001	16	6.9	8.1	2200	6700	1200	5900	0.09	1.2	0.07	0.2
61618569	7/07/1999	9/05/2001	15	6.9	7.84	14000	23000	7700	12000	1.9	5.1	0.02	0.12
61618570	7/07/1999	10/05/2000	14	7	8.5	430	520	290	310	0.27	0.46	0.03	0.08
61618571	7/07/1999	10/05/2000	14	8	9.45	490	920	270	510	0.31	1.8	0.06	0.27
61618572	7/07/1999	10/05/2000	14	7.25	8.91	500	1200	310	660	0.27	1.8	0.03	0.21
61618573	7/07/1999	9/05/2000	15	6.5	7.8	1800	2400	940	1400	0.31	0.52	0.02	0.05
61618574	7/07/1999	9/05/2000	14	6.95	8	2600	4900	1500	2900	0.39	14	0.01	0.04
61618575	6/07/1999	11/05/2001	16	7.1	7.9	610	740	340	400	0.28	0.41	0.03	0.07
61618576	5/07/1999	11/05/2001	16	6.7	7.9	620	740	360	440	0.33	1.2	0.06	0.3
61618577	5/07/1999	11/05/2001	16	7.2	8.43	630	710	340	440	0.49	0.78	0.03	0.1
61618578	5/07/1999	11/05/2001	16	7.1	9.26	650	720	350	470	0.37	0.49	0.03	0.09
61618579	5/07/1999	11/05/2001	16	6.8	8.1	780	1000	420	600	0.41	1.4	0.03	0.17
61618580	5/07/1999	8/05/2000	14	6.4	11.4	1500	7100	880	4200	0.22	3.9	0.01	0.32
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61618582	2/07/1999	8/05/2000	14	6.5	8	1100	2100	600	1200	0.11	0.81	0.14	0.41

61618583	2/07/1999	8/05/2000	14	6.2	8	1900	2000	1000	1200	0.13	0.4	0.23	0.43
61618584	2/07/1999	8/05/2000	14	6.9	7.7	1900	1900	970	1200	0.24	0.98	0.09	0.52
61618585	2/07/1999	5/05/2000	14	6.8	9	1400	1900	730	1000	0.23	0.39	0.16	0.28
61618586	2/07/1999	5/05/2000	14	6.9	9.73	960	2100	500	1100	0.24	1.3	0.34	0.59
61618587	1/07/1999	5/05/2000	14	7	10.35	1100	2700	600	1500	0.27	1.2	0.13	0.53
61618588	1/07/1999	5/05/2000	14	6.6	7.5	2900	17000	1500	9100	0.26	4.9	0.01	0.37
61618589	1/07/1999	5/05/2000	14	6.5	7.2	12000	19000	6900	11000	5.3	23	0.01	0.1
61618590	1/07/1999	10/05/2001	17	7.18	8	2300	2800	1200	1700	0.94	1.5	0.2	0.31
61618591	30/06/1999	10/05/2001	17	6.7	7026	3800	4200	2000	2400	1.4	3.2	0.19	0.37
61618592	30/06/1999	10/05/2001	17	6.6	7.4	6300	7200	3200	3900	1.7	2.2	0.2	0.39
61618593	30/06/1999	10/05/2001	17	6.7	7.4	6000	7000	3200	3700	1.5	1.8	0.16	0.4
61618594	30/06/1999	10/05/2001	17	6.7	7.5	6500	18000	3300	9900	0.85	2.1	0.01	0.16
61618595	29/06/1999	10/05/2001	16	7	7.9	8300	11000	4400	5700	0.07	0.43	0.19	0.67
61618596	30/06/1999	8/05/2001	17	7	7.8	7200	12000	4400	5800	0.36	1	0.06	0.19
61618597	29/06/1999	8/05/2001	16	7	7.9	6000	7100	3300	3700	0.25	0.74	0.18	0.26
61618598	29/06/1999	8/05/2001	16	6.9	7.8	4000	7000	2200	3200	0.21	0.38	0.13	0.26
61618599	29/06/1999	8/05/2001	16	6.8	7.9	2400	2700	1400	1600	0.28	1.8	0.02	0.05
61670535	16/03/2010	16/03/2010	1	6.1	6.1								
61672192	13/03/2018	13/03/2018	1	8	8	7360	7360	4440	4440				
61672193	3/03/2018	3/03/2018	1	7.34	7.34	1480	1480	791	791				
Overall	25/05/1999	13/03/2018		3.65	12.2	190	23000	110	12000	0.07	23	0.006	0.67

Appendix F – Bullsbrook Water Supply (Water Corporation 2010)

Attachment provided by Brett Combes of the Water Corporation on 25 June 2018.



LEGEND

T1 CIP ITEM

LIMITS OF CIP ITEM - MAINS

COORDINATE SYSTEM: GDA 1994 MGA Zone 50

THE INFORMATION CONTAINED HEREIN IS SUBJECT TO ONGOING REVIEW AND AMENDMENTS AND SHOULD BE READ IN CONJUNCTION WITH THE ASSOCIATED REPORT.

PROJECT No:	AUTHOR: EDWATTS
GROUP: IPB - Spatial Systems	DATE: 25-Jun-2010
DOCUMENT: Dedicated Main to Bullsbrook.dgn	

WATER CORPORATION

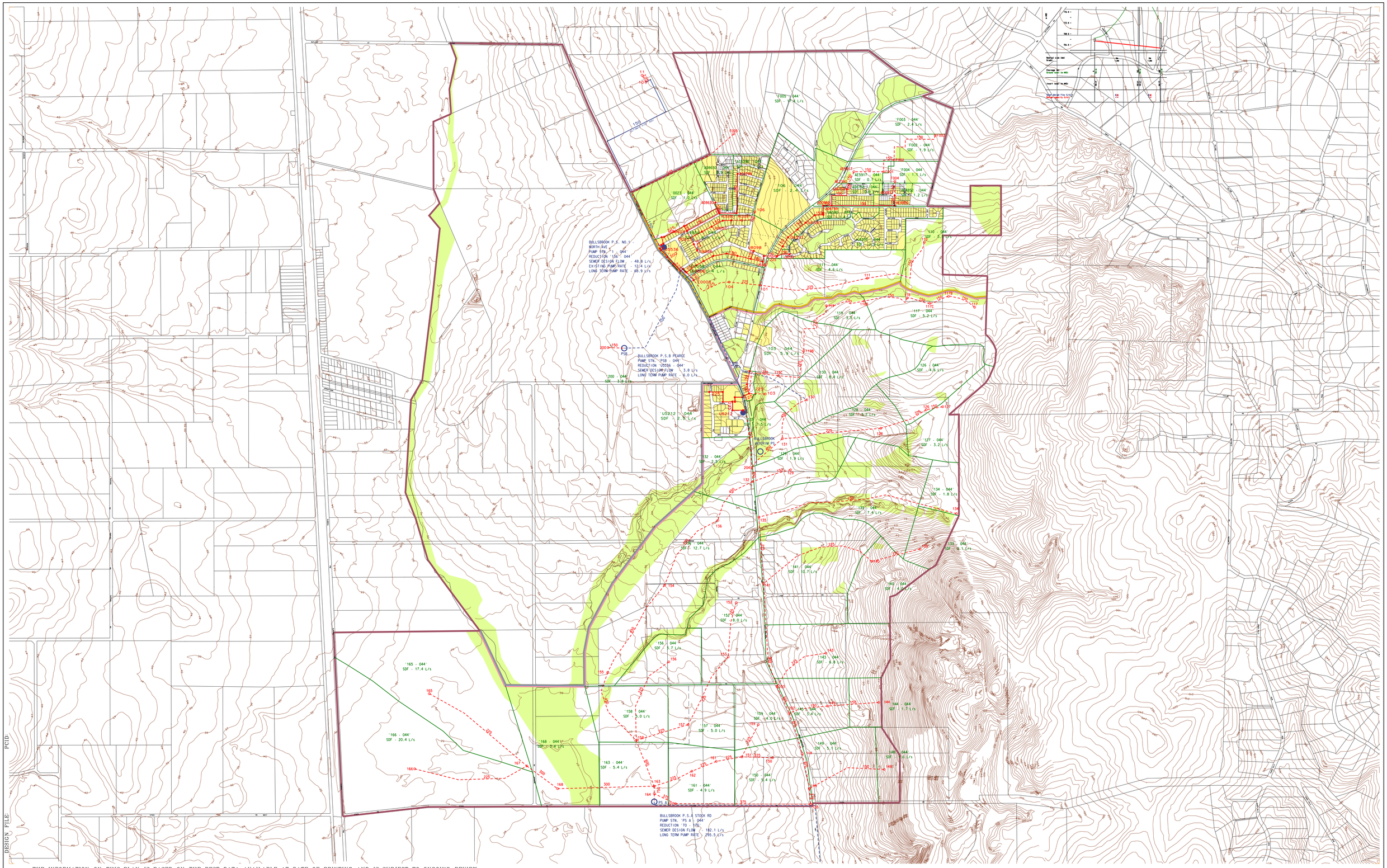
BULLSBROOK WATER SUPPLY DEDICATED MAIN TO BULLSBROOK CIP - TRANSFER

ATTACHMENT 1.2

...\Dedicated Main to Bullsbrook.dgn 29/06/2010 3:13:10 PM

Appendix G – Bullsbrook Wastewater Conceptual Planning Long-Term Scheme (Water Corporation, 2018)

Attachment provided by Brett Combes of the Water Corporation on 25 June 2018.



THE INFORMATION ON THIS PLAN IS BASED ON THE BEST DATA AVAILABLE AT DATE OF PRINTING AND IS SUBJECT TO ONGOING REVIEW AND AMENDMENT. NO RESPONSIBILITY IS ACCEPTED BY THE WATER CORPORATION FOR ACCURACY OF DATA SUPPLIED BY EXTERNAL AGENCIES.

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LEGEND

- EXISTING PUMPING STATION
- EXISTING PRESSURE MAIN
- EXISTING GRAVITY SEWER
- PROPOSED PUMPING STATION
- PROPOSED PRESSURE MAIN
- PROPOSED GRAVITY SEWER
- PARKS AND PUBLIC OPEN SPACE
- EXISTING SEWERED AREAS
- SEWERED BY PRIVATE PS
- NODE CATCHMENT
- PS AND SEWER CATCHMENTS
- SEWER DISTRICT CATCHMENT
- WWTP CATCHMENT

NOTATION

SEWER DISTRICT NUMBER
CATCHMENT NODE
CATCHMENT '7001 - 121'
R15 - 108.4 @75% (W)
GROSS AREA (ha)
'R' CODE ZONING
% OF LAND DEVELOPMENT
(W) - WET CONDITIONS
(D) - DRY CONDITIONS

SEWER DESIGN FLOW = 1.5 x AVERAGE DAILY FLOW RATE

DATE	REVISION DESCRIPTION	DRN	APPD
JAN 2018	LANDUSE UPDATE, SEWER DISTRICT BOUNDARY UPDATED, INTERIM PS ADDED	L. GABRIEL	T. ZHENG

SHEET INDEX

AQUA NO.

AQUA VERSION V1

WATER CORPORATION

ISSUED WITH THE AUTHORITY OF THE MANAGER ASSET PLANNING GROUP
629 NEWCASTLE STREET, LEEDERVILLE 6007
WESTERN AUSTRALIA.
TELEPHONE (08) 9420 2420, FAX (08) 9420 3179

WASTEWATER SCHEME PLANNING SERIES

BULLSBROOK - SD044
CONCEPTUAL PLANNING
LONG TERM SCHEME

PLANNING BY	COMPILED BY	ACCEPTED BY
R. APPOLONI	L. GABRIEL	T. ZHENG
SCALE 1:12,500	FULL REVIEW DECEMBER 2011	SD AQUA FILE NO. JT1 2011 11407 V01

A1

GHD

Level 10
999 Hay Street
T: 61 8 6222 8222 F: 61 8 9463 6012 E: permail@ghd.com

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6137134-87236-341/https://projects.ghd.com/oc/WesternAustralia3/bullsbrookfreightand/Delivery/Documents/District Water Management Strategy/6137134-REP-0_Bullsbrook Freight Industrial RWMS.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	J Stegena H Child K Hunt	N Gamage	On file	K Petani	On file	1/05/2020
B	K Hunt	N Gamage	On file	K Petani	On file	16/07/2020
0	K Hunt	K Petani	On file	K Petani	On file	20/01/2021
1	K Hunt	H Shigeyoshi	On file	S Barlow		17/06/2021

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Appendix D - Bushfire Hazard Assessment



Department of Planning, Lands and Heritage

Bullsbrook Freight and Industrial Land Use Planning Strategy

Bushfire Hazard Assessment

February 2021

Executive summary

GHD has been commissioned by Department of Planning, Lands and Heritage to prepare the Bullsbrook Freight and Industrial Land Use Planning Strategy for an area of land located within Bullsbrook (the site).

A bushfire hazard level assessment was undertaken for all bushfire prone areas within the site to consider how bushfire risk may influence future development. The assessment was undertaken in accordance with the methodology prescribed in the technical appendices to the Guidelines for Planning in Bushfire Prone Areas.

The majority of the strategy area is not mapped as bushfire prone. Areas within the bushfire prone area are, for the most part, influenced by a moderate bushfire hazard level. Whilst pockets of extreme hazard level were mapped, the small size and spatial extent means that in practice many of the areas would qualify for exclusion under AS3959 once surrounding pastures are managed or developed. However, extreme bushfire hazard occurs to the east of the site across the Gnangara mound. Future planning of land in the south eastern portion of the site identified for urban investigation will need to further consider bushfire risk. This is most appropriately done through consolidated bushfire management planning for all urban investigation areas that abut the regional reserve.

Bushfire hazard is unlikely to be a fatal flaw for the future industrial development of the site. Spatial demonstration of bushfire management strategies will be required to support future local structure plan and rezoning proposals.

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1. Introduction

1.1 Background

Located in the north-east fringe of the metropolitan area approximately 35 kilometres (km) from the Perth CBD, Bullsbrook consists of mainly rural and rural residential land with a small population base. However, significant growth is expected within the Bullsbrook Townsite within the next 15 to 20 years, with the population expected to triple. In addition, the State strategic planning framework has identified a significant portion of land for urban expansion within the City of Swan over the next 30 years.

As the population continues to grow across the broader Perth and Peel regions, there will be increasing demand for employment opportunities both within and across sub-regions. Highly efficient freight services will also be required to maintain the supply chains necessary for servicing this population. The State has acknowledged the need to identify existing and future freight corridors and strategic sites to avoid land use and transport conflicts and to manage the interface between communities and freight corridors and centres.

1.2 Purpose of this report

GHD Pty Ltd (GHD) was engaged by the Department of Planning, Lands and Heritage (DPLH) on behalf of the Western Australian Planning Commission (WAPC) to prepare this land use planning strategy (the Strategy) for the proposed Bullsbrook Intermodal Terminal (IMT) and surrounding area. This Bushfire Hazard Level Assessment has been prepared to support the Strategy.

1.3 Limitations

This report has been prepared by GHD for DPLH and may only be used and relied on by DPLH for the purpose agreed between GHD and the DPLH as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than DPLH arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report (December 2018). Minor updates were completed in December 2020, limited to the project name and the extent of land identified for future urban investigation. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by DPLH and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Proposal details

2.1 Location

The Bullsbrook freight and industrial area (the site) is located in the north-west corridor in the City of Swan. The site is bounded by the RAAF Base Pearce and Great Northern Highway to the east, Shire of Chittering to the north, the Perth – Darwin National Highway (PDNH) to the west and rural land identified for urban expansion to the south, and covers approximately 3,509 hectares (ha).

The majority of the 3,509 hectare site is not bushfire prone, being historically cleared for farming purposes. The bushfire prone area within the site is associated with strips of remnant vegetation along watercourses through the area, pockets of remnant vegetation, and pasture areas that have retained trees.

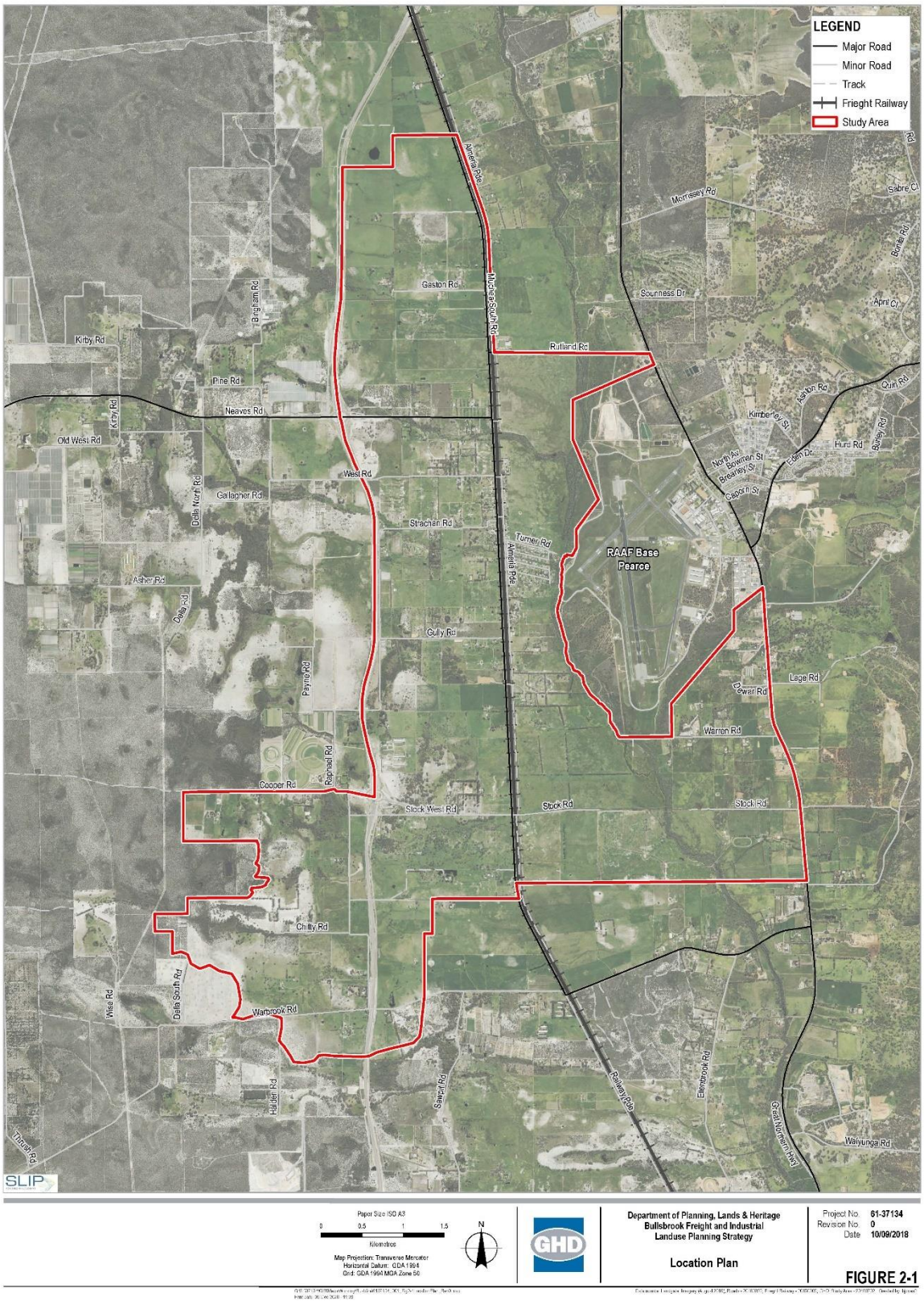


Figure 2-1 Location plan

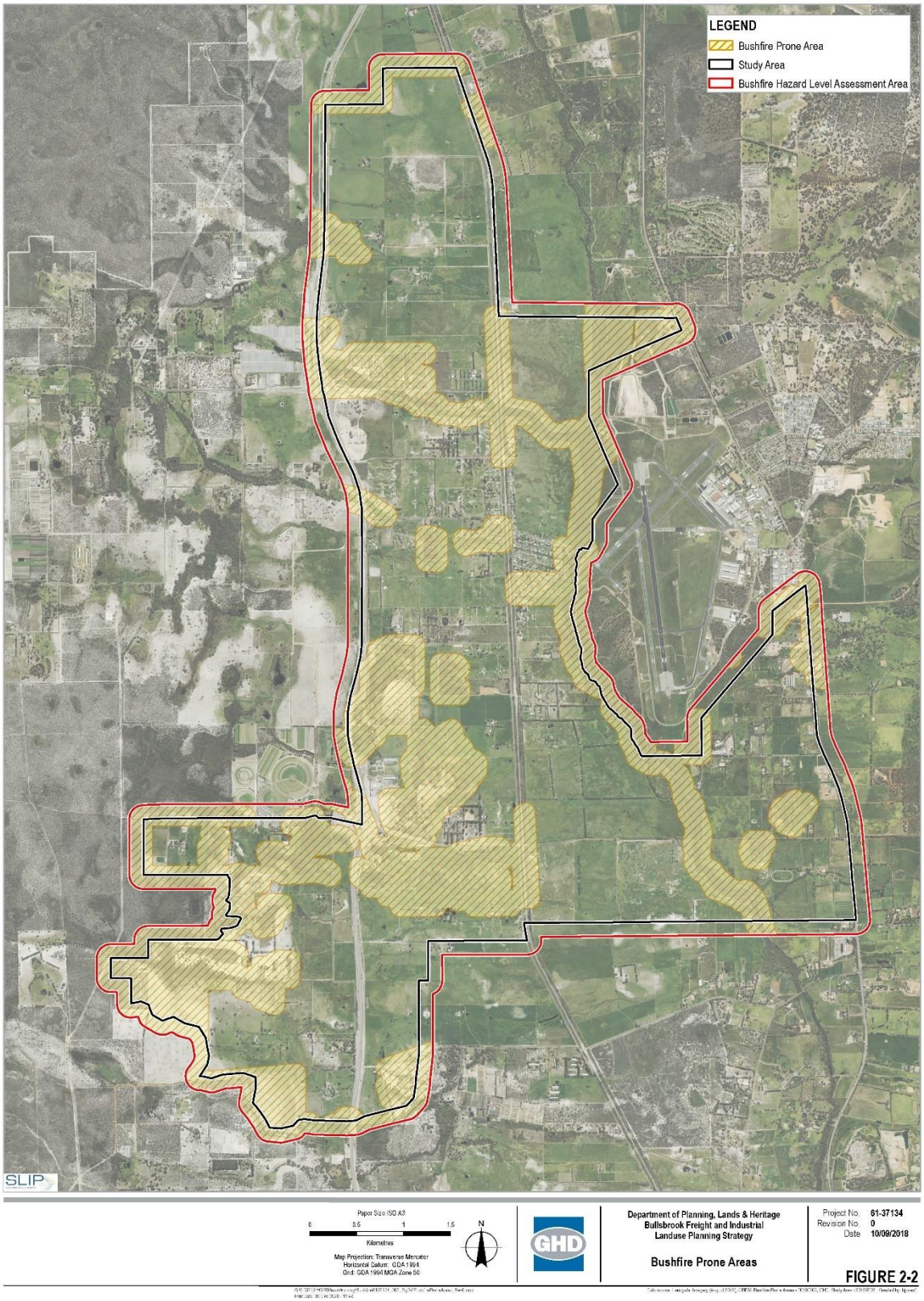


Figure 2-2 Bushfire prone areas

2.2 Proposed Strategy

The focus of the Strategy is to identify issues and considerations that will be required to be addressed prior to the rezoning of the land for future subdivision and development. Further detailed planning will be required to support any rezoning proposals including a district structure plan and subsequent local structure plans. In line with the role of high level planning strategies, this bushfire hazard level assessment identifies whether bushfire hazard presents a fatal flaw for the future development of the site for industrial and freight purposes. More detailed and spatial demonstration of bushfire management strategies will occur in the preparation of district and local structure plans.

A conceptual plan has been prepared to identify strategic land use areas and major transport links for the site(Strategy Plan). This is shown in Figure 2-3.

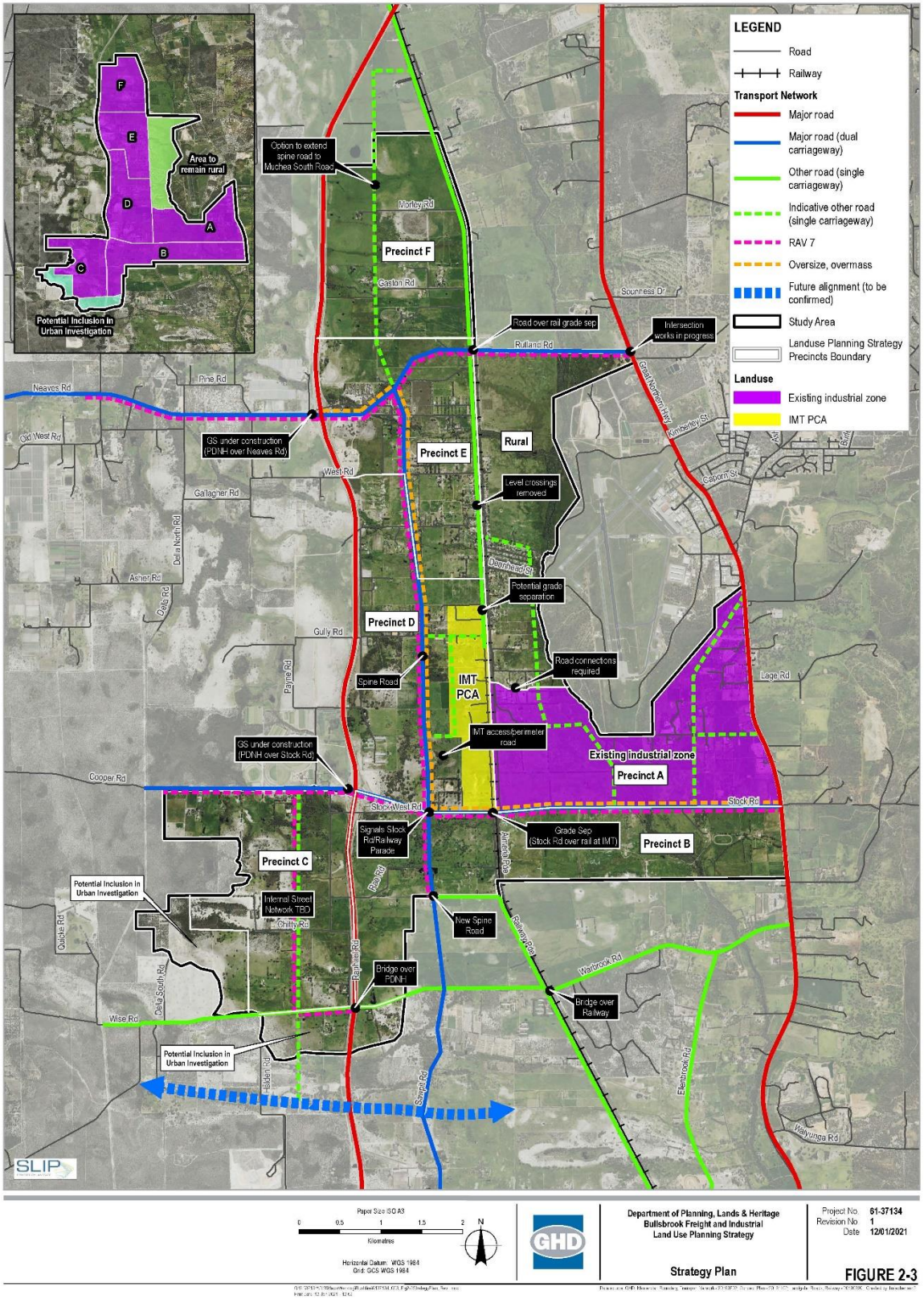


Figure 2-3 Strategy plan

3. Environmental considerations

3.1 Environmental characteristics

An environmental study has been undertaken for the site. The key findings relevant to the bushfire hazard assessment are summarised below, and figures included in Appendix A:

- One DBCA managed land lies within the boundaries of the site – the Gnangara-Moore River State Forest (F 6, Class A) which intersects the western boundary. This portion of Gnangara-Moore River State Forest is also listed as Bush Forever Sites No. 6 and 399. Nine other DBCA-managed conservation areas are located within 5 km of the site.
- Seven Bush Forever sites intersect the site (Bush Forever sites 6, 100, 97, 294, 296, 298 and 399) (Government of Western Australia, 2000). An additional 9 Bush Forever sites are located within 5 km of the site.
- No Regional Parks intersect the site or occur within a 5 km buffer of the site.
- The Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011 is in place to protect habitat suitable for the long-term survival of wild populations of the Western Swamp Tortoise. The Policy defines an area which includes Ellen Brook and Twin Swamps Nature Reserves. A search of the site found that its southern border is located approximately 0.8 km north of the Twin Swamps Nature Reserve (R 27621), and 4.7 km north of Ellen Brook Nature Reserve (R 27620) for the preservation of fauna, namely the Western Swamp Tortoise. The site also intersects the northern extent of the policy area as defined in the Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011.
- A number of Environmentally Sensitive Areas (ESAs) occur or intersect the site. These ESAs are likely aligned with TECs, DBCA-managed lands, Bush Forever and geomorphic wetlands.
- The site is situated in the Southwest Botanical Province of WA (Beard 1990) within the Swan Coastal Plain bioregion and the Perth subregion as described by the Interim Biogeographic Region of WA (IBRA).
- Four vegetation complexes on Aeolian deposits of the Swan Coastal Plain are present within the site: Yangara Complex, Beermullah Complex, Bassesdean Complex and Guilford Complex (Heddle et al. 1980).
- Within the 5 km buffered Study Area, 905 native flora taxa representing 100 families and 351 genera have been identified. Dominant families recorded included Fabaceae, Myrtaceae, Poaceae, Proteaceae and Cyperaceae.
- Searches of the EPBC Act PMST, *NatureMap* database identified the present/potential presence of 39 conservation significant flora taxa within a 5 km buffer of the site Five habitat linkages intersect the site: Link ID 27, 28, 29, 30, and 31.
- A search of the *NatureMap* database identified 425 species within the 5 km of the site. The search included 13 amphibians, 108 birds, 4 fish, 235 invertebrates, 13 mammals and 52 reptiles. (DBCA 2007).

Searches of the EPBC Act PMST, *NatureMap* database and DBCA Threatened and Priority Fauna database identified the present/potential presence of 13 conservation significant fauna taxa within a 5 km buffer of the site.

It is anticipated that areas of Bush Forever will be retained. The native vegetation within the site has been extensively cleared with less than 10 percent of the pre-European extent remaining. Remnant vegetation is limited to isolated patches, largely within Bush Forever sites and along

watercourses. Areas of native vegetation outside environmentally sensitive areas and Bush Forever sites are unlikely to be retained as groundwater conditions will require considerable disturbance to facilitate development. This is expected to result in a removal of much of the bushfire hazard outside of the retained Bush Forever and environmentally sensitive areas.

4. Bushfire assessment results

4.1 Methodology

The bushfire hazard level assessment was undertaken in accordance with Appendix 2 of the Guidelines for Planning in Bushfire Prone Areas (as amended).

The bushfire hazard level assessment area was determined as the study area and an additional 150 metre buffer extending outside the site.

Vegetation in the site was classified in accordance with Table 2.3 of AS3959-2009 (as amended) and the Visual Guide for Bushfire Risk Assessment in Western Australian (Department of Planning, 2016). The site is large in size, and much of the land within the designated bushfire prone area is privately owned and was not accessible as part of the site assessment. Therefore the strategic vegetation classification was undertaken through interrogation and interpretation of aerial photography, informed and augmented by a number of site observation points.

Consistent with the broad-brush nature of a bushfire hazard level assessment, the most appropriate vegetation classification was determined for contiguous stands of vegetation that broadly share similar structures and anticipated fire behaviour, although some minor variability may be recorded at individual assessment points across the sites. Any variation in vegetation within stands that would result in a higher hazard level was individually mapped (e.g. a minor area of low shrubland within a larger grassland area may not be separately mapped, however any areas of scrub would be). Being a broad-brush assessment, the classification took a conservative approach in relation to defining vegetation classes. Future assessments of bushfire attack level which look at smaller extents of vegetation may result in lesser classifications. For example, regrowth banksia woodland in the southwestern portion of the site currently represents as shrubland however these areas were conservatively identified as scrub considering their potential to present a higher level of fuel availability as they grow and mature.

Much of the site is cleared rural land currently actively grazed and or managed and would therefore be excluded under Clause 2.2.3.2 (f), however due to the presence of areas of unmanaged grassland and based on the cautionary approach taken in this assessment these areas have been classed as grassland, noting that the area would include exclusions under Clause 2.2.3.2 (f).

It should be noted that the outcomes of this assessment demonstrate the current, pre-development site conditions and does not take into account the vegetation clearance that will occur as part of the future development of the site. As discussed above, it is likely that the majority of vegetated land not identified as an environmentally sensitive area will be cleared as part of development and the extent of Clause 2.2.3.2 exclusions will increase as development progresses within the site.

Mapped vegetation classes were combined with slope analysis based on available contour data to model the appropriate bushfire hazard level. In line with AS3959, effective slope was calculated over 100 metres to smooth out short variations in slope/land undulation that would not influence bushfire hazard level.

4.2 Vegetation classes

Vegetation within the bushfire hazard level assessment area reflects Class B Woodland (at varied heights and density based on level of disturbance resulting in the three subclasses of Low Woodland (07), Open Woodland (06) and Woodland (05)), Class G Grassland, Class C

Shrubland and Class D Scrub. These relate to the original vegetation types across the overall study area at varying levels of clearing and degradation from the farming use of the locality.

The vegetation classes are described in Table 1. Figure 4-1 illustrates the broad distribution of vegetation classes across the bushfire hazard level assessment area. Appendix B provides field observations and identification of vegetation class for the site observation points.

Table 1 Vegetation classes

Vegetation class	Representative photo
Class B – Woodland *Woodland (05) and Open Woodland (06)* *Trees 10-30m high; 10-30% foliage cover dominated by eucalypts; understory or low trees to tall shrubs…*(AS3959, Table 2.3) Treed areas (greater than 10m average height) of varying foliage cover (10-30%) where the understory has been highly disturbed and replaced with pasture grasses. *Low Woodland (07)* *Low trees and shrubs 2-10m high…often have a grassy understory or low shrubs.* (AS3959, Table 2.3) Lower treed areas (less than 7m average height) where the understory has been highly disturbed and replaced with pasture grasses.	Woodland (05)  Open Woodland (06)  Low Woodland (07)

	
Class G – Grassland *All grassland forms, including situations with shrubs and trees, if the overstorey foliage cover is less than 10 percent* (AS3959, Table 2.3) Cleared land and pasture, with scattered trees with a foliage cover less than 10 percent.	
Class C - Shrubland *Low shrubland (12)* *Shrubs <2m high; greater than 30 percent foliage cover. Understoreys may contain grasses.* (AS3959, Table 2.3) Areas of highly disturbed vegetation with little remaining tree coverage, for example along rail corridor.	

Class D – Scrub *Closed scrub (13)* *Found in wet areas… >30% foliage cover… Shrubs >2m high. Typical of coastal wetlands and tall heaths.* (AS3959, Table 2.3) Areas of wetland dependant vegetation with shrub forms greater 2 metres and taller. Includes immature *Banksia* woodland that would be expected to have a scrub form at maturity.	

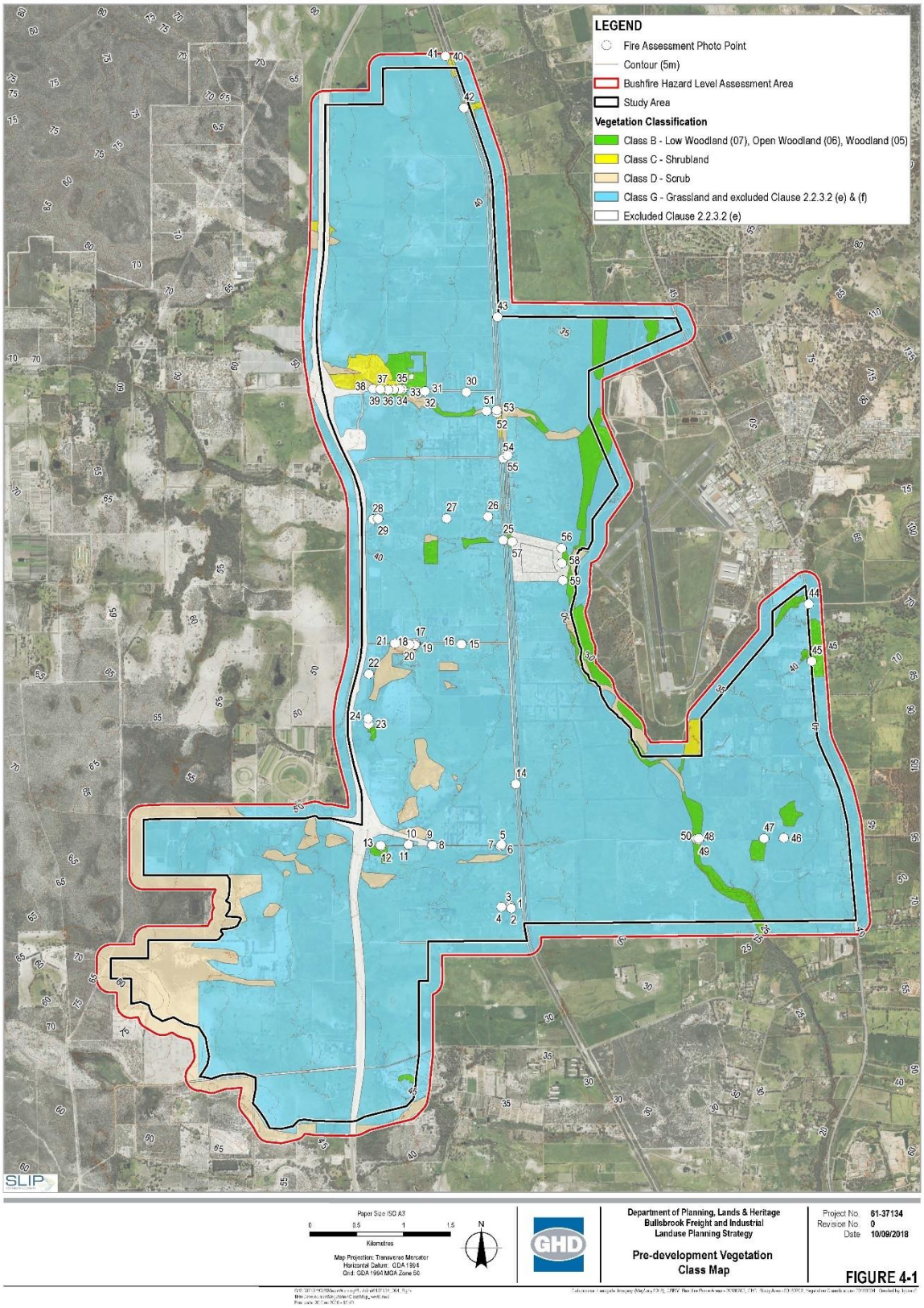


Figure 4-1 Pre-development vegetation class map

4.3 Assessment outputs

Bushfire hazard level in the bushfire hazard level assessment area is influenced by vegetation classification, as slope is generally flat. Figure 4-2 provides the modelled bushfire hazard level for the site.

The majority of the site is influenced by a moderate bushfire hazard level. The areas identified as moderate hazard are, for the most part, identified as Class G grassland vegetation, including areas that would be excluded under Clause 2.2.3.2 (e) and (f), which have been classified grassland as part of the assessment's broad-brush approach.

Smaller areas of extreme hazard occur as a result of more intense vegetation types.

The bushfire hazard level assessment methodology set out in the Planning in Bushfire Prone Areas Guidelines is a very broad-brush definition of hazard levels, and the actual hazard and anticipated bushfire behaviours based on vegetation classifications within the defined hazard levels may vary.

Areas of extreme hazard mapped through the site result from patches of higher density vegetation, including:

- Strips of remnant woodland trees along watercourses
- Patches of scrub associated with wetlands

Being restricted to small or narrow areas associated with wetlands and watercourses, the extent of these scrub and woodland areas would likely fall under one or a combination of the following vegetation characteristics, which are excluded as low-threat under AS3959 Clause 2.2.3.2:

- Single areas of vegetation less than 1 ha in area and not within 100m of other areas of vegetation being classified
- Multiple areas of vegetation less than 0.25 ha in area and not within 20 m of the site, or each other
- Strips of vegetation less than 20 m in width (measured perpendicular to the elevation exposed to the strip of vegetation) regardless of length and not within 20 m of the site or each other, or other areas of vegetation being classified

Therefore, while mapped as extreme in line with the bushfire hazard level assessment methodology, the strips and small patches of extreme hazard would likely qualify for exclusion under AS3959 once the surrounding pasture areas are managed or developed and thus classified as low threat and non-vegetated.

With respect to extreme bushfire risk at the southwestern portion of the site, this area is regenerating *Banksia* woodland, which has been overclassified as scrub (currently would be classified as shrubland) on the basis that it will present a higher hazard upon maturity unless otherwise removed for development purposes.

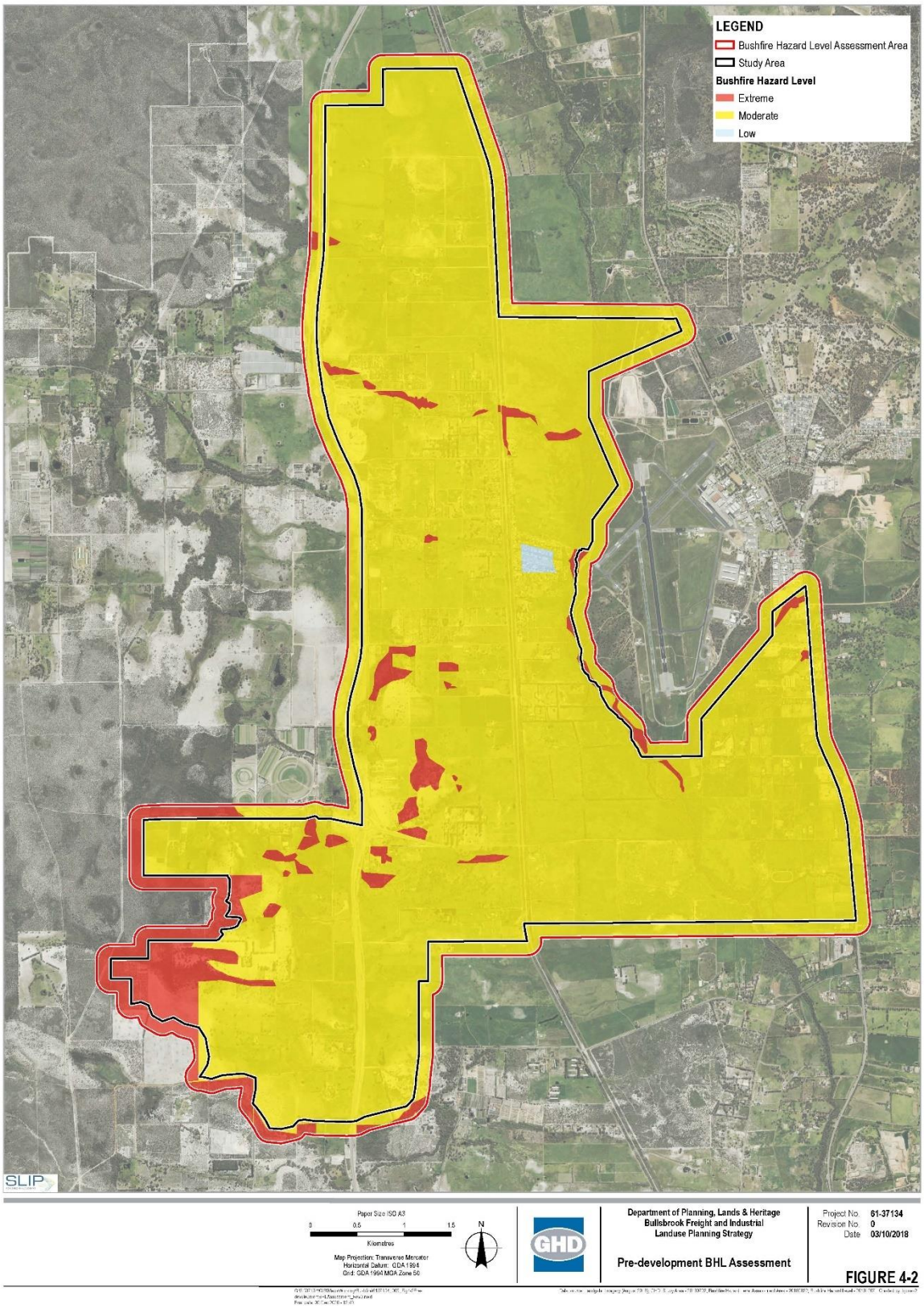


Figure 4-2 Pre-development BHL assessment

5. Bushfire hazard issues

Areas within the site are, for the most part, influenced by a moderate bushfire hazard level. Whilst pockets of extreme hazard level were mapped, these small or narrow areas include:

- Strips along watercourses
- Pockets of scrub

As previously discussed the small size and spatial extent of these areas means that in practice many of the areas would qualify for exclusion under AS3959 once surrounding pastures are managed or developed.

Those areas of extreme bushfire hazard with environmental values that require protection (for example Bush Forever) will be reserved and precluded from development. Other areas of hazard will be cleared to enable industrial development based on existing groundwater levels. If retained during development, areas of bushfire hazard are not likely to present any significant challenge in maintaining asset protection zones to achieve a desirable BAL on adjacent development land at the time of subdivision and development. No development will occur within the small areas of extreme hazard.

The assessment demonstrates that compliance with the bushfire protection criteria can be achieved through subsequent planning stages including the preparation of bushfire management plans as part of local structure planning and subdivision. Based on this, it is determined that bushfire hazard is unlikely to be a fatal flaw for the future development of the site.

6. Assessment against the bushfire protection criteria

In the absence of a lot layout, there is insufficient detail to demonstrate compliance with bushfire protection criteria. It is also noted that the criteria are designed predominantly to influence residential and rural residential development, not industrial areas.

Future local road layouts, public open space, and lot arrangements are planned as part of local structure plans – informed by transport investigations, local water management strategies, and bushfire attack level (BAL) contour maps, amongst other technical investigations. In the absence of all technical investigations, specific recommendations regarding vegetation retention, future hazard levels, access routes, reserved land and other elements would be unreliable for decision-making.

The following section therefore seeks to broadly demonstrate that compliance with the criteria *can* be achieved in subsequent planning stages and that bushfire hazard is not a fatal flaw for future development of the site. Section 7 sets out the requirements for bushfire mitigation at subsequent planning stages.

6.1 Location and siting

The majority of the site has a moderate hazard and therefore there is no further need to demonstrate in those locations that a low/moderate level can be achieved.

As discussed in the preceding section, the areas of extreme bushfire hazard within the bushfire prone area are small pockets or narrow strips. Due to their geographic characteristics, in reality these pockets would not present an extreme hazard. The majority of the site has a moderate bushfire hazard context as a result of grassland and pasture, some of which would be exclusions under Clause 2.2.3.2 of AS3959. Post development, residual bushfire hazard will exist within small, dispersed stands of vegetation within a broader industrial development context. There will not be any development located within an enclave surrounded by bushfire hazard that would necessitate comprehensive bushfire and evacuation management. Local roads will provide a separation between future development and retained vegetation stands, and detailed planning can allow for appropriate asset protection zones.

With respect to extreme bushfire risk at the southwestern portion of the site, this area is regenerating *Banksia* woodland, which has been overclassified as scrub (currently would be classified as shrubland) on the basis that it will present a higher hazard upon maturity. The concept plan identifies this land for potential inclusion in urban investigation area, therefore it is likely that the majority of this vegetation and associated bushfire hazard will be removed. The Strategy will not provide sufficient planning or detail to resolve bushfire issues for potential urban land in this area; consideration of bushfire issues for this area should be undertaken in a cohesive way with the abutting urban investigation area to the south, providing a consistent response to the bushfire hazard presented by the Gnangara mound area.

6.2 Vehicle access

Staged development within the site will need to ensure that all occupiers and visitors have access to at least two vehicular access routes at all times.

The site vehicular movement network currently includes several major roads providing access and egress to various locations. Great Northern Highway and Railway Parade provide access north and south, and Stock Road, Rutland Road, Neaves Road and Warbrook Road provide additional access and egress routes to the east and west.

An objective of the Strategy is the provision of greater connectivity within and through the site, and future development will necessitate the provision of additional access and egress routes including those proposed in the concept plan (Figure 2-3). Implementation of the concept will provide additional access and egress west towards Perth-Darwin National Highway and the coast via Cooper Road, Maralla Road and Neaves Road as well as additional north-south connections providing access to Muchea and Ellenbrook.

The future internal local vehicular access network cannot be identified at this strategic planning stage and will be determined at subsequent planning stages. The network will be required to provide at least two vehicular access routes during and at completion of all development stages.

6.3 Water

With regards to bushfire management, all development areas will need access to either a reticulated water supply that meets water supply authority and DFES requirements (i.e. DS 63 'Water Reticulation Standard') or, where reticulated water supply is not available, water tanks must be supplied at a sufficient capacity at all times.

Local structure plans will be required to outline the water supply provision for each precinct and the location of hydrants will need to be identified along the internal road network prior to subdivision.

7. Responsibilities for implementation and management of the bushfire measures

At high level strategic planning, spatial demonstration of bushfire protection criteria/strategies for compliance are not achievable based on the level of spatial planning undertaken. Future local structure plans, applications for subdivision and development approval will be required to demonstrate compliance with bushfire protection criteria. Furthermore, BAL assessments and contour mapping should be undertaken prior to subdivision to ensure development will meet the bushfire protection criteria.

The pre-development bushfire hazard level assessment identifies that the site is located within a 'Moderate' bushfire hazard area with some small areas of extreme hazard. This assessment demonstrates that future development will occur within areas of low to moderate bushfire hazards; any development within patches of extreme hazard will result in the removal of that vegetation, and therefore the removal of that hazard.

Those areas of extreme bushfire hazard with environmental values that require protection (for example Bush Forever) will be reserved and precluded from development. Other areas of hazard will be cleared to enable industrial development based on existing groundwater levels. If retained during development, local structure plans are to demonstrate how the area will achieve a low to moderate bushfire hazard or are to preclude development within the area.

This assessment demonstrates that bushfire hazards can be managed subject to implementation of bushfire protection criteria at future planning stages:

- Spatial demonstration of bushfire protection criteria and strategies for compliance should be assessed at the local structure planning stage through preparation of a bushfire management plan. The bushfire management plan should accompany a local structure plan and provide recommendations and strategies to ensure all development will be limited to areas of low to moderate bushfire hazard.
- BAL assessments and contour mapping that implement local structure plan recommendations and strategies to comply with bushfire protection criteria must accompany subdivision applications.

Appendices

Appendix A – Environmental figures

Figure 1 **Acid Sulphate Soil and Contaminated Land**

Figure 2 **Conservation Areas**

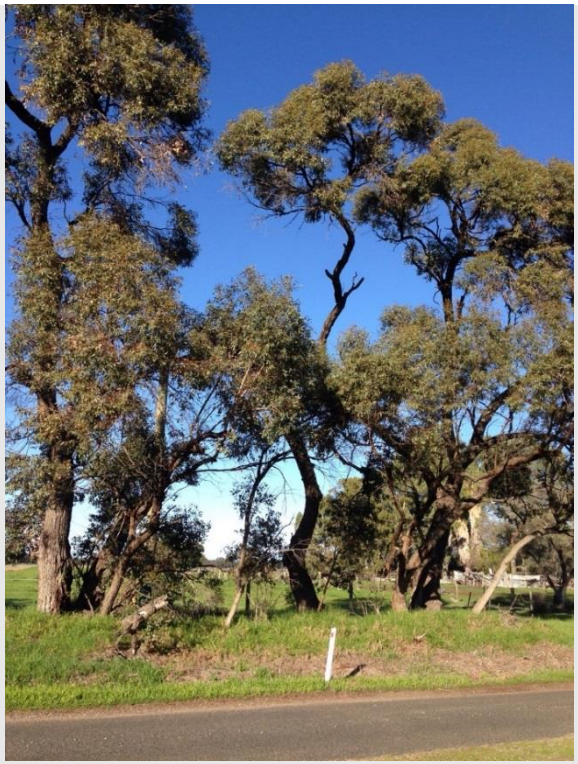
Figure 3 **Surface water and wetlands**

Figure 4 **Native vegetation, TECs and PECs and conservation significant flora records**

Figure 5 **Ecological linkages and conservation significant fauna records**

Appendix B – Site observation notes

ID	Vegetation classification	Vegetation Type	Notes	Site observation	Easting	Northing
1	Grassland	n/a	Trees <10% facing north		405113.7483	6491836.694

2	Grassland		Along road reserve facing south, narrow windbreak of trees		405122.119	6491813.551
3	Grassland		Facing south		405124.8916	6491815.249

4	Grassland		Facing north/north-east		405018.1463	6491828.103
5	Grassland		Stock Rd facing south, scrub in distance.		405008.0899	6492476.896

6	Woodland	Woodland	Small patch of woodland		405009.9522	6492476.416
7	Grassland		Stock Road facing north		405018.1579	6492493.012

8	Scrub				404277.5029	6492491.272
9	Woodland	Woodland	Facing south, 100 m from road reserve		404283.4328	6492483.904

10	Grassland		Grass with scattered trees		404025.5503	6492491.522
11	Woodland	Woodland	Facing north, 100 m from point behind grassland		404029.3987	6492493.734

12	Woodland	Woodland			403735.7781	6492474.552
13	Grassland				403729.5627	6492484.264

14	Grassland	Scrub in very far distance			405174.0193	6493138.223
15	Grassland		Facing south, potential scrub 100 m setback from point		404595.1666	6494634.288

16	Grassland		Tall scrub/woodland in distance.		404592.3156	6494631.268
17	Grassland				404098.7714	6494644.809

18	Grassland		Facing south-east		404099.8094	6494627.462
19	Woodland	Woodland			404091.9786	6494623.626

20	Scrub		scrub with scattered trees		404037.785	6494627.8
21	Scrub				403881.0199	6494638.754

22	Scrub				403604.742	6494314.225
23	Woodland	Woodland	Potential exclusion- APZ highly maintained		403602.602	6493780.256

24	Grassland				403597.2976	6493838.722
25	Grassland		Potential woodland behind (property boundary)		405038.4504	6495738.914

26	Woodland	Woodland/open woodland	(in distance)		404875.9626	6495990.721
27	Grassland		Woodland in distance		404434.5182	6495970.722

28	Woodland	Woodland	South-east		403650.6087	6495960.682
29	Grassland				403703.6488	6495965.845

30	Grassland		Woodland 100 m in front (facing south)		404646.1743	6497314.273
31	Woodland	Low Woodland	South		404203.32	6497325.422

32	Scrub		Disturbed vegetation. looking north.		404204.1525	6497324.017
33	Woodland	Low woodland	Detritus below		403968.316	6497349.539

34	Woodland	Low woodland			403959.2778	6497346.273
35	Grassland		Scattered trees and shrubs		403931.7382	6497345.427

36	Shrub				403868.2246	6497341.363
37	Woodland	Woodland	South facing		403807.9958	6497339.614

38	Scrub		Scrub with scattered trees		403653.6537	6497346.647
39	Shrub				403725.8999	6497345.819

40	Grassland				404421.509	6500897.731
41	Shrub				404421.9763	6500898.096

42	Shrub		North (Height 1.5-2m)		404620.0134	6500347.365
43	Grassland		grasses with scattered low shrubs		404976.787	6498116.351

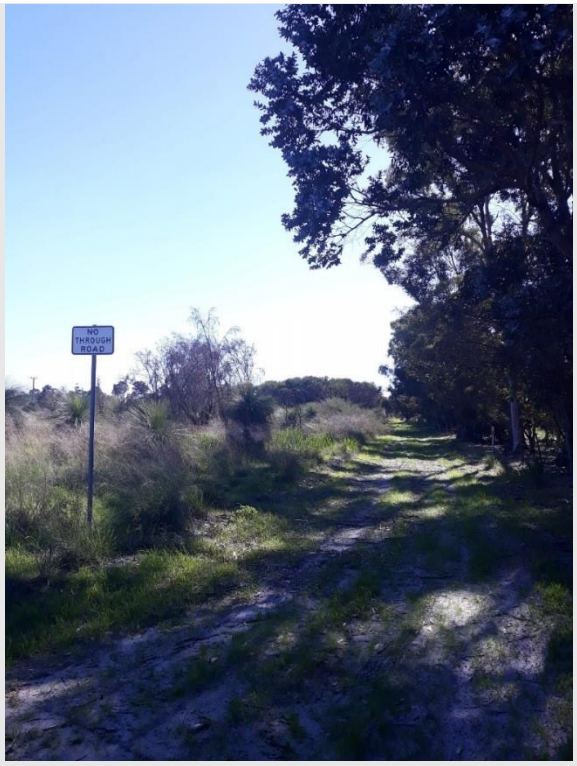
44	Woodland	Woodland			408299.6561	6495056.861
45	Woodland	Woodland	Around house,		408333.9526	6494449.692

46	Woodland	Open woodland			408033.3428	6492562.706
47	Woodland	Open woodland			407821.7213	6492557.495

48	Woodland	Open woodland/ low woodland	highly disturbed. 5-7m tree height		407101.4654	6492552.153
49	Grassland		tree density <10% out of creek		407125.3887	6492544.239

50	Woodland	Open woodland			407126.5344	6492557.367
51	Scrub		north-west, grassland in front		404862.9976	6497114.302

52	Grassland		wind break		404970.3787	6497092.931
53	Woodland	Low woodland	Tree height <10 metres. Closed canopy.		404968.8397	6497122.847

54	Scrub				405038.0451	6496607.644
55	Shrub				405087.1994	6496641.166

56	Woodland	Woodland			405663.198	6495653.742
57	Woodland	Woodland	weedy exotic understorey		405133.7288	6495720.215

58	Woodland	Open woodland			405666.3984	6495493.403
59	Grassland				405675.5157	6495307.991

GHD

Level 10
999 Hay Street
T: 61 8 6222 8222 F: 61 8 6222 8555 E: permail@ghd.com

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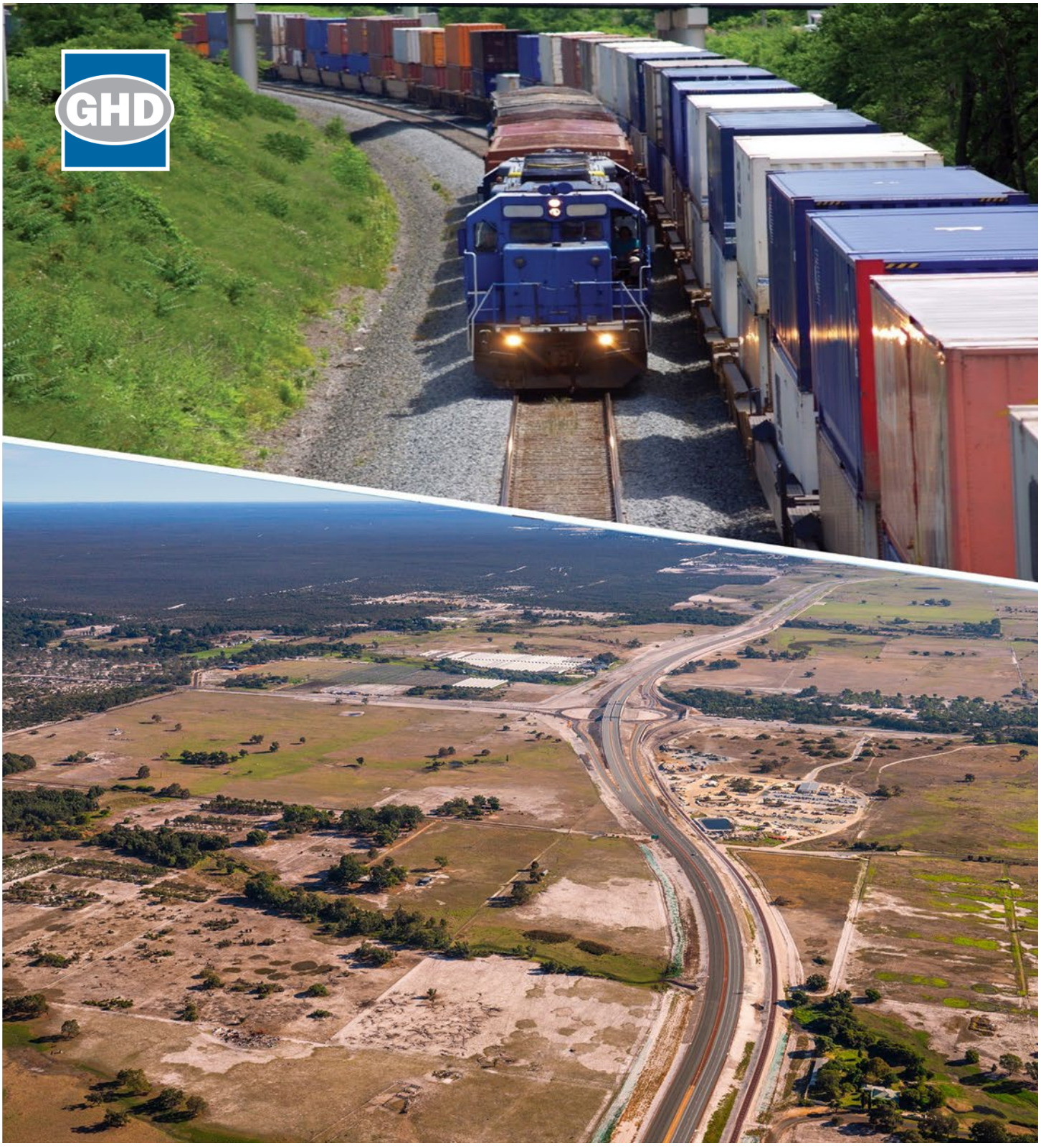
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Appendix E - Strategic Transport Strategy



Department of Planning, Lands and Heritage

Bullsbrook Freight and Industrial Land Use Strategy

Transport Strategy

October 2021

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Appendices

Appendix A - RAV Network Configurations

1. Summary

1.1 Overview

The Western Australian Planning Commission's (WAPC) North-East Sub-regional Planning Framework (March 2018) has identified an area at Bullsbrook as a future strategic industrial precinct to serve Perth's north-east sub-region and to act as a freight hub for the north-east and north-west sub-regions (study area). The area will provide employment opportunities and significant freight efficiencies for goods and commodities passing through the northern part of the Perth metropolitan region.

In considering potential options for industrial development in this area, which is a relatively undeveloped "greenfields" location, there is considerable opportunity to strategically plan for new freight and industrial activity, and to identify and "future proof" the transport infrastructure that will be required for the successful operation of an industrial area.

The development of an industrial area at Bullsbrook is likely to serve as a major employment centre for Perth's rapidly growing north-east sub-region and will likely also attract workers from the north-west sub-region. It is also likely to serve as a logistical hub for consumer products bound for Perth's northern coastal sub-region. Accordingly, excellent transport links will be required within the study area and between Bullsbrook and a wide range of origins and destinations.

Provision of any additional road infrastructure that might make commuting from nearby areas more desirable will likely influence urban development and potentially accelerate vehicle trip generation through the study area. The potential for freight infrastructure to influence (and be impacted by) residential or other urban development should be considered by the planning process.

1.2 Intermodal terminal

Intermodal terminals (IMTs), which are also known as "inland ports" or "dry ports", aim to provide a more competitive container freight handling option (than direct road movements from the maritime port) to a specific hinterland[1]. Often, they also host co-located logistics functions (such as points where loads are consolidated or deconsolidated) to provide freight services to a diverse set of users[2]. IMTs invariably attract clusters of industrial and logistics land uses, particularly where surrounding land is low-cost and geographically suited to such uses. This further strengthens their desirability for strategic planners aiming to facilitate economic development in peri-urban regions.

An IMT is proposed adjacent to the west side of the Millendon–Narngulu freight railway, just north of Stock Road. The IMT will be a key facility serving the proposed Bullsbrook industrial area, as well as providing a transport hub for the distribution of commodities from Fremantle and Kwinana, and to concentrate commodities going to those ports.

The presence of an IMT within the study area provides an exceptional opportunity to rationalise freight transport within the Perth metropolitan region, especially by using rail to transport goods and commodities to and from the ports at Fremantle and Kwinana. This would assist in managing many of the externalities and issues associated with the movement of containerised freight through Perth, particularly as the Fremantle inner-harbour and its

[1] Roso, Woxenius and Lumsden. 2009. "The dry port concept: connecting container seaports with the hinterland." Journal of Transport Geography. https://doi.org/10.1016/j.jtrangeo.2008.10.008

[2] Rodrigue, Debrie, Fremont and Gouvernal. 2010. "Functions and actors of inland ports: European and North American dynamics." *Journal of Transport Geography*, 18(4), 519-529.

major servicing roads approach their practical capacity limits. Perth's existing container movement routes pass through highly constrained residential areas, conflicting with increasing volumes of commuter and service vehicle traffic. This situation is highly undesirable for both industry and the broader public.

In establishing a new IMT, or inland port, it will be critical that the issues associated with existing freight corridors in Perth (such as close residential populations, poor design characteristics and co-location of freight and commuter traffic) are not repeated.

Ultimately, provision of an IMT at this location will support the government's desire to increase the use of rail rather than road as the preferred freight transport mode. This is supported by the *Westport Port and Environs Strategy Outcomes Report 2020* which identifies the Bullsbrook IMT in a ring of current and future IMTs located on the perimeter of the Perth metropolitan area that will provide critical supply chain linkages to the Fremantle and Kwinana ports.

Whilst the Bullsbrook IMT does not form part of the preferred design for the project business case for Westport, it was identified as a long-term IMT site or as an alternative (contingency) to the preferred IMT sites at Kenwick, Kewdale and Forrestfield. Furthermore, the development of an IMT facility at Bullsbrook is not precluded if local demand arises or the private sector seek to fund and develop these facilities.

1.3 Recommendations

This report details the transport matters associated with the industrial development at Bullsbrook, and forms part of the strategic planning for the area. It identifies major transport links within the study area (with the IMT at its hub), as well as external road and rail connections. Following on from recent commitments in the major road network within the north east corridor, this report assesses additional road network changes required to support the safe and efficient movement of people and freight to, from and within the study area.

The key recommendations of this report are included in Table 12 and summarised as follows:

- Ultimate construction and upgrade of Stock Road to dual carriageway. This should include grade separation of Stock Road over the railway line and a connection to Great Northern Highway (GNH).
- Create a new north-south spine road through the precinct by extending Sawpit Road northward to connect to Neaves Road. The road would pass by the western side of the proposed IMT and accommodate RAV 7 over size/over mass (OSOM) vehicles (north of Stock Road). This is because the Stock Road/Tonkin Highway interchange does not have sufficient clearance for over size vehicles to travel from Stock Road to the north.
- Realign Neaves-Rutland Roads with a bridge over the railway line so that they provide a direct connection between Tonkin Highway and GNH. The section between GNH and north-south spine road to be designed for RAV 7 and OSOM vehicles.
- Extension of Almeria Parade to the south to connect to the new Lot 300 industrial area.
- Undertake a comprehensive review of all railway level crossings in the study area (private, public, formal, and informal) to identify whether these should be retained, consolidated, closed or grade separated.

1.4 Limitations

This report has been prepared by GHD for the Department of Planning, Lands and Heritage and may only be used and relied on by the Department of Planning, Lands and Heritage for the purpose agreed between GHD and the Department of Planning, Lands and Heritage as set out in this report.

GHD otherwise disclaims responsibility to any person other than the Department of Planning, Lands and Heritage arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

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2. Introduction and background

2.1 Introduction

The Department of Planning, Lands and Heritage (DPLH), on behalf of the WAPC, has engaged GHD to prepare the Bullsbrook Freight and Industrial Land Use Planning Strategy (BFILUPS) for the area shown in Figure 2-1.

The North-East Sub-regional Planning Framework identified Bullsbrook as the location for a strategic industrial area that will provide an alternative to Kwinana for major industry, provide an employment hub for Perth's north-east and north-west corridors, and act as a freight hub for the northern parts of the metropolitan region.

The Department of Transport's (DoT) *Transport @ 3.5 million* plan (2017) proposes the development of an IMT within the Bullsbrook industrial precinct by the time Perth's population reaches 3.5 million. The preferred location for the IMT site is shown in Figure 2-2.

The aim of the BFILUPS is to develop a high-level strategic plan for the Bullsbrook industrial precinct, which will inform future amendments to the Metropolitan Region Scheme (MRS) and the City of Swan local planning scheme. This will facilitate supply of industrial employment land and ensure that the necessary infrastructure requirements are appropriately considered.

The extension of Tonkin Highway north to Muchea intersects the study area and is likely to catalyse additional investment in land along the corridor.

The proposed IMT will also interface with a number of existing and proposed industrial areas in Perth's north, including the proposed Ellenbrook North urban area, the proposed Muchea employment area, the expanding Wangara Industrial area and a number of emerging industrial areas located in the Neerabup/Pinjar area.

This report outlines the Transport Strategy to support the Land Use Planning Strategy.

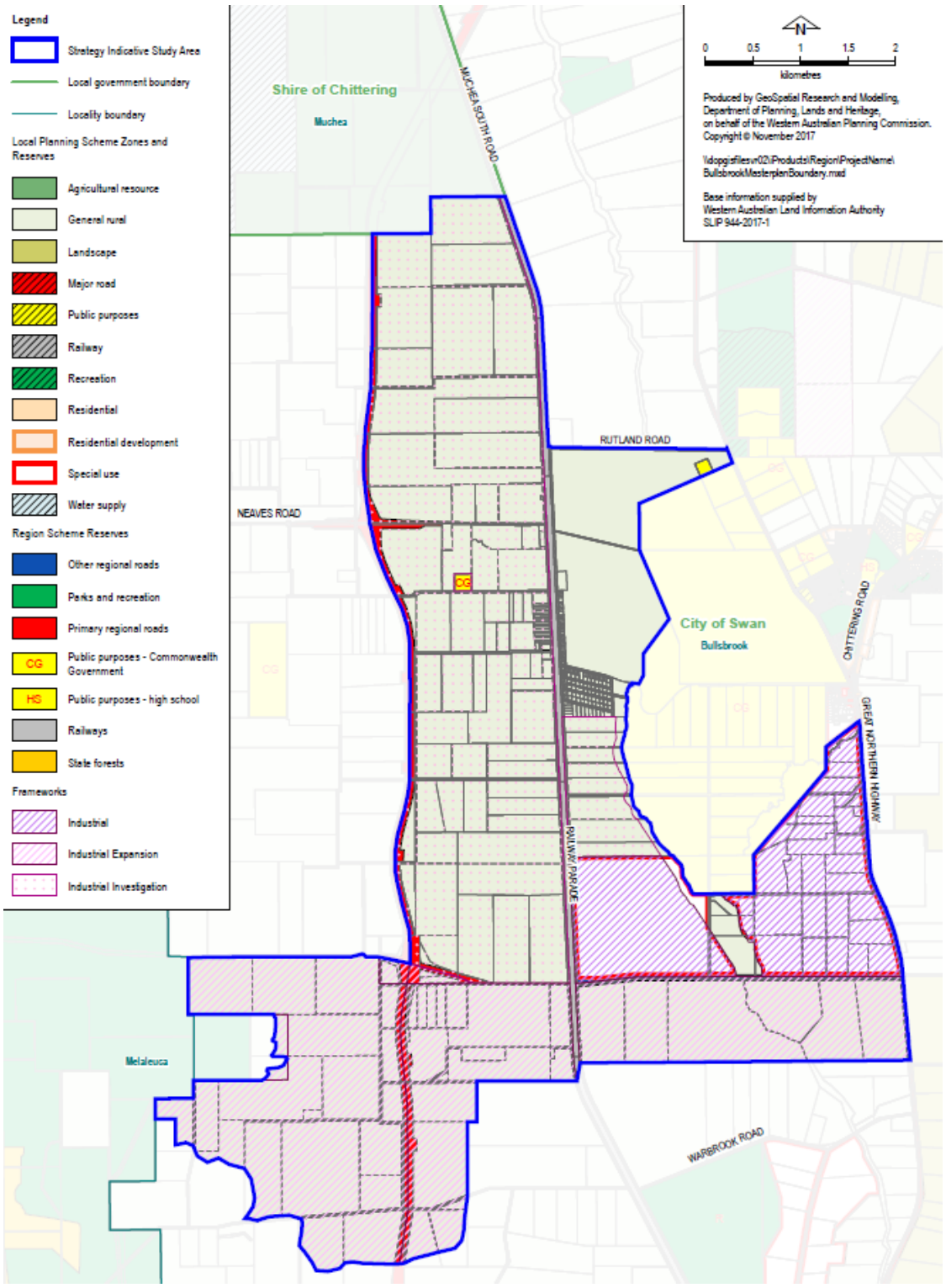


Figure 2-1 Indicative study area

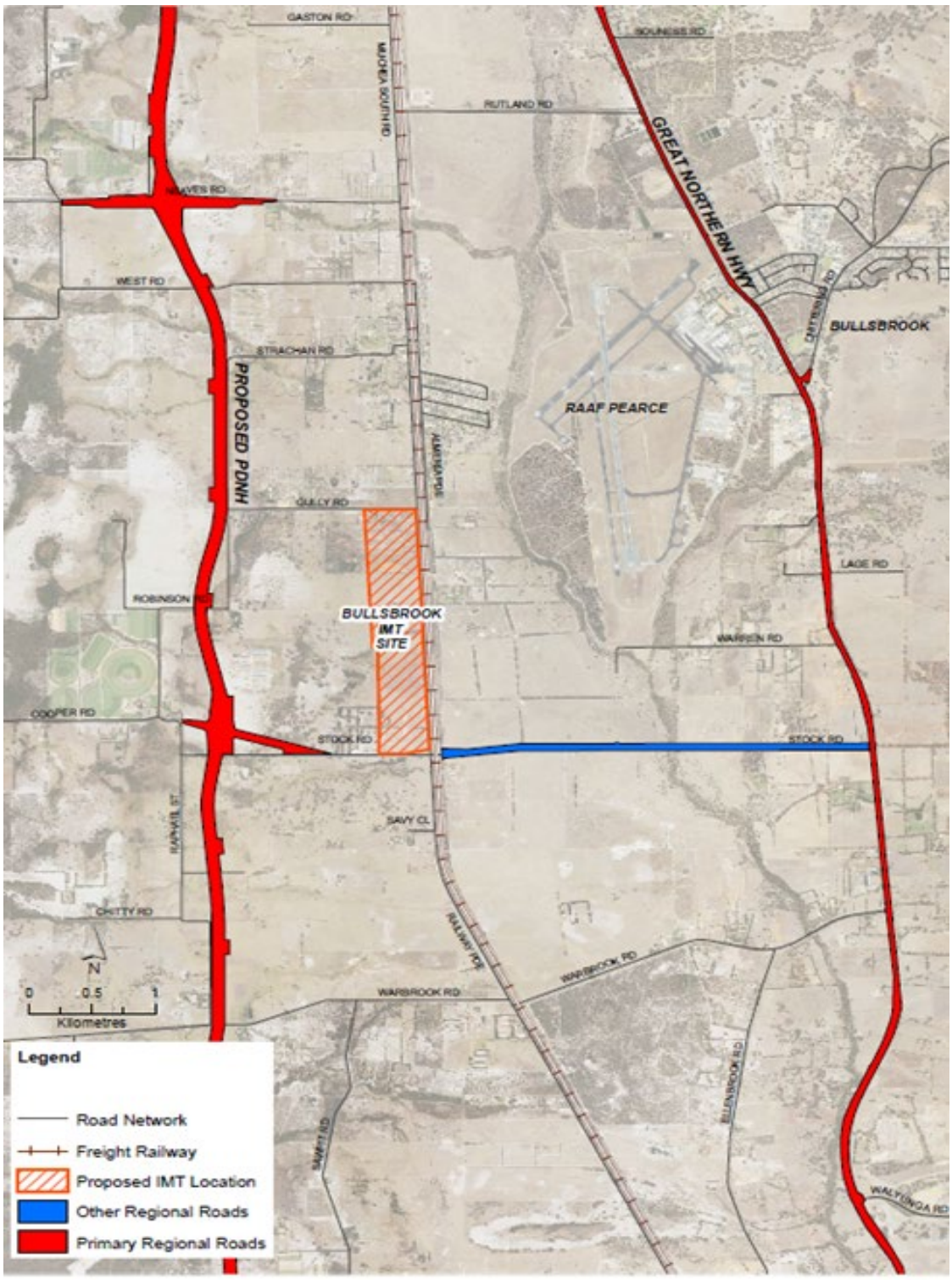


Figure 2-2 Preferred location for the Bullsbrook IMT (DoT)

2.2 Transport planning aims

The development of an industrial precinct at Bullsbrook, including an IMT, is consistent with several long-term strategic aims of the State Government, to:

1. Provide a road network that facilitates the safe and efficient movement of freight traffic to and from the Bullsbrook industrial precinct and IMT site, at local, regional, interstate, and international scales. The IMT is proposed to form a key point within international supply chains for containerised goods and a major location where

containerised loads will be broken down into smaller loads bound for individual destinations.

2. Protect major freight corridors from compromising sensitive land uses (particularly housing) and being compromised by those land uses.
3. Avoid, where possible, interaction and congestion associated with commuter movements reducing freight movement efficiency.
4. Reduce pressures on vulnerable parts of Perth's road network caused by logistics transport, particularly those that cannot easily be adapted to cater for freight transport demand.
5. Provide for social and economic opportunities, particularly for local employment and economic development (as per Perth Land Monitor).

It is critical that the implementation of these strategic aims matches the key commercial and operational requirements of industrial tenants and logistics operators to ensure the timely development of private investment in buildings, firms, and localised employment.

Freight and logistics firms often relocate to low-priced and large format land, particularly to escape operating restrictions, localised traffic congestion and conflicts with residential land uses. The establishment of an IMT within the Bullsbrook industrial precinct is likely to catalyse this change, though some initial development of low-cost land is likely now that the extension of Tonkin Highway[3] is complete (and where/when land use planning regulations permit).

Freight operators require the capacity to move goods on a 24/7 basis. As international freight movement has become more rapid and responsive to customer demand, the activities of logistics and distribution centres have increasingly become dependent on the timing of other supply chain activities. It is likely that future trends in freight movement and supply chain management strategies will influence the demands and activity that occurs within the study area, particularly the IMT.

2.3 Prior relevant transport planning studies

Several technical studies relevant to the study area and its surrounds have been previously undertaken. These have been reviewed as a major input to the structure planning process.

City of Swan Transport Strategy, September 2014[4]

This report was prepared for the City of Swan and focuses on an integrated transport model including land-use decisions, parking, public transport, road, and pedestrian/cycling infrastructure. The report confirms freight connectivity along strategic corridors and within industrial precincts, Roe Highway, Great Eastern Highway Bypass, Toodyay Road, Great Northern Highway, Gnangara Road and Beechboro Road serving Hazelmere, Bellevue, South Guildford, and Malaga industrial areas.

Future road freight is primarily expected to follow the major highways within the City of Swan, with the most noticeable change being the construction of the Tonkin Highway extension. Tonkin Highway will see a sizeable volume of freight vehicle use in preference to Great Northern Highway (GNH), although some freight vehicles are likely to remain on GNH as this is the only major regional north-south freight route that allows for "high and wide" freight vehicles (i.e., up to 10 metres high and 10 metres wide).

[3] The extension of Tonkin Highway from Reid Highway to Muchea has been variously referred to as "Perth Darwin National Highway", "PDNH", "NorthLink" and "Swan Valley Bypass".

[4] https://www.swan.wa.gov.au/Your-Council/About-us/Projects-initiatives/Our-plans-strategies/Transport-Strategy

The report notes that changes to Neaves/Rutland Roads may require duplication works and realignment of the eastern portion (east of Railway Parade) to provide better connectivity with GNH (Figure 2-3). While the pre-eminence of Tonkin Highway may serve to reduce traffic along this section of Neaves Road in the longer term, the overall function and usage of the eastern portion of Neaves Road will be greatly affected by the decision and timing of any realignment.

Main Roads WA has indicated that Neaves Road west of Tonkin Highway has the possibility of becoming a Primary Regional Road in the future.



Figure 2-3: Neaves/Rutland Roads (in yellow) definition (City of Swan Transport Strategy)

The report further notes that Stock Road will ultimately form a major link between the PDNH and GNH, in addition to being the primary access to the South Bullsbrook Industrial Estate (Northern Gateway) and the Bullsbrook residential development. This additional traffic is likely to necessitate an upgrade of the GNH/Stock Road intersection, as well as grade separation of the existing Stock Road rail crossing.

The report makes the following recommendations in relation to Bullsbrook:

- Investigate timing of Stock Road intersection treatments as a result of regional road upgrades and development.
- Undertake rail crossing upgrade study for the Stock Road rail crossing.

Bullsbrook Intermodal Terminal Planning Report 2016

In October 2016, a planning report was prepared for DoT for the proposed Bullsbrook IMT[5]. The report provides information to support a MRS amendment to reserve land for the IMT on the west side of the railway (north of Stock Road). It also includes a preliminary design concept plan showing a future layout of the IMT, along with possible road and rail connections.

The report identifies that, in addition to the proposed IMT, the Bullsbrook corridor is likely to host significant industrial and logistical land uses, which will benefit from access to the IMT, as well as the PDNH.

Prior reports focusing on the Bullsbrook IMT were summarised in the *Planning Report*, and are listed below:

- Worley Parsons (2012), South Bullsbrook/North Ellenbrook Intermodal Terminal – Site Options and Servicing Requirements Assessment
- Neil Matthews Consulting (2014), Metropolitan Intermodal Network Development Assessment
- Laurie Piggott Consulting (2014), Bullsbrook IMT Preliminary Design Advice
- Department of Transport (2015), South Bullsbrook Intermodal Terminal site Investigation Report
- Beyond Rail Solutions (2015), Proposed IMT at Bullsbrook – Location Assessment

Metropolitan Region Scheme Amendments 1323/41, 1324/41, 1325/41 Amendments in the Bullsbrook Urban Precinct (South, Central, North) Amendment Report WAPC (March 2018)[6]

This report, prepared by the WAPC, details the proposed amendments to facilitate planning for the Bullsbrook area. It includes the following commentary regarding regional roads in the locality:

"Main Roads WA acknowledges that the Perth-Darwin National Highway will attract and divert some freight traffic away from Great Northern Highway. However, Great Northern Highway will remain a major freight route and distributor road from these precincts. It is likely that Great Northern Highway will need to be upgraded through the Bullsbrook area in order to cater for the proposed increased traffic volumes. Future planning work for this has not yet commenced. Access to the Perth-Darwin National Highway will be via Stock Road to the south or via Rutland Road to Neaves Road to the north. These roads will need to be upgraded to highway standard or possibly four lane dual carriageways".

This report raises the connection of Stock Road to the Tonkin Highway extension (Perth Darwin National Highway) as an important element of structure planning. The report sets out that prior to the rezoning of the land, confirmation is required on the upgrading requirements to support the proposed scale of development.

[5] GHD (2016), *Bullsbrook Intermodal Terminal Planning Report*

[6] Available at: https://www.planning.wa.gov.au/dop_pub_pdf/Amendments_in_the_Bullsbrook_Urban_Precinct_South_Central_North.pdf

Neaves/Rutland Roads

In 2016, DPLH commissioned the Neaves Rutland Other Regional Road Study to develop a regional road reserve from GNH to the boundary of the City of Swan, generally following the existing Neaves Road and Rutland Road reserves[7]. A reference group consisting of key government and corporate stakeholders was convened to guide the study process.

A proposed connection of Neaves Road with Rutland Road and GNH, with a connection to Railway Parade was developed through the study, as shown in Figure 2-4[8].

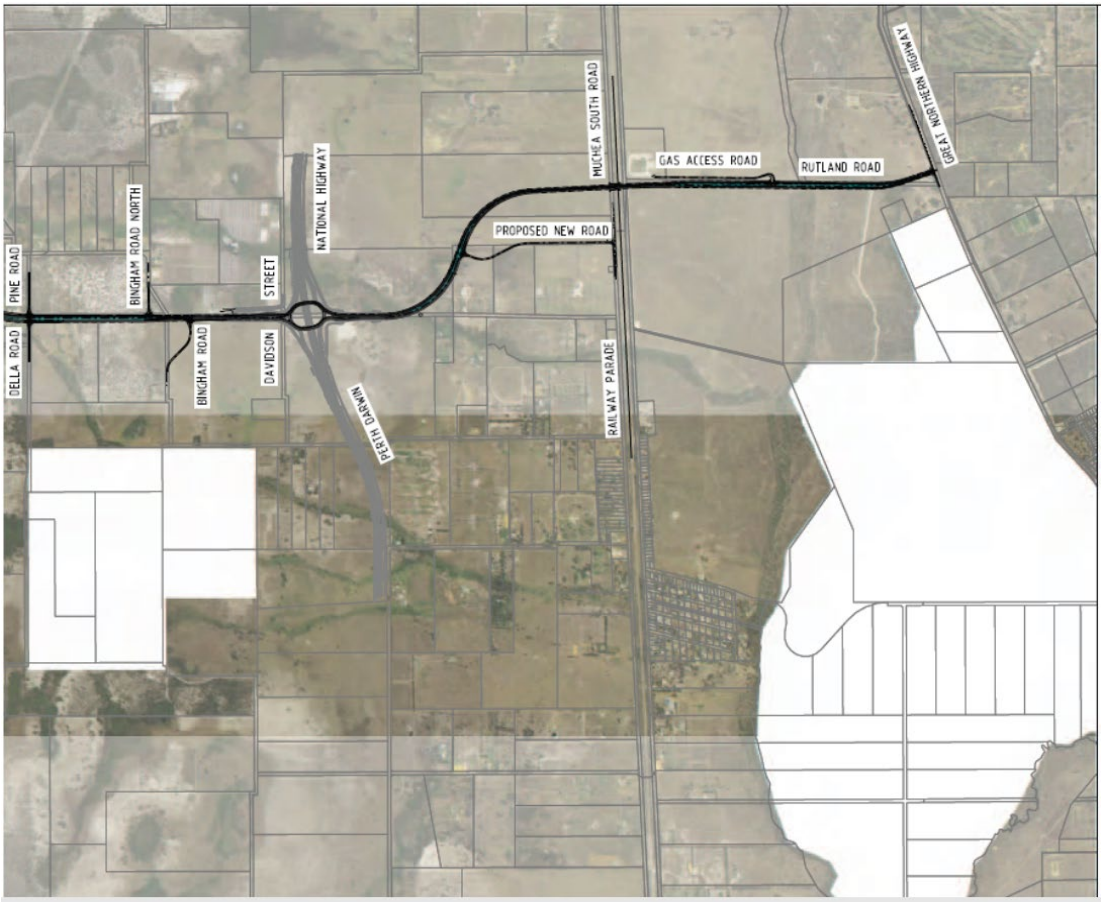


Figure 2-4 Proposed Neaves/Rutland road connection/realignment (DPLH)

[7] Worley Parsons (2016), *Neaves Rutland Other Regional Road Study – Final Planning Report*

[8] Note this figure does not include the proposed north-south spine road.

3. Existing planning framework

3.1 North-East Sub-regional Planning Framework

The North-East Sub-regional Planning Framework[9] (NESRPF) comprises the City of Swan and the Shires of Mundaring and Kalamunda, covering an area of 2,010 square kilometres. It aims to establish a long-term integrated planning framework to guide future growth across the sub-region. This includes consideration of where future residential and employment areas will be located; what community and social infrastructure will be required; integrated use of existing infrastructure; protection of important environmental assets and critical services; and staging and sequencing of future development.

The NESRPF recognises the need for an intermodal freight terminal at South Bullsbrook and identifies land surrounding the terminal as 'Industrial', 'Industrial Investigation' and 'Industrial Expansion', as shown in Figure 3-1.

[9] Department of Planning, Lands and Heritage, March 2018

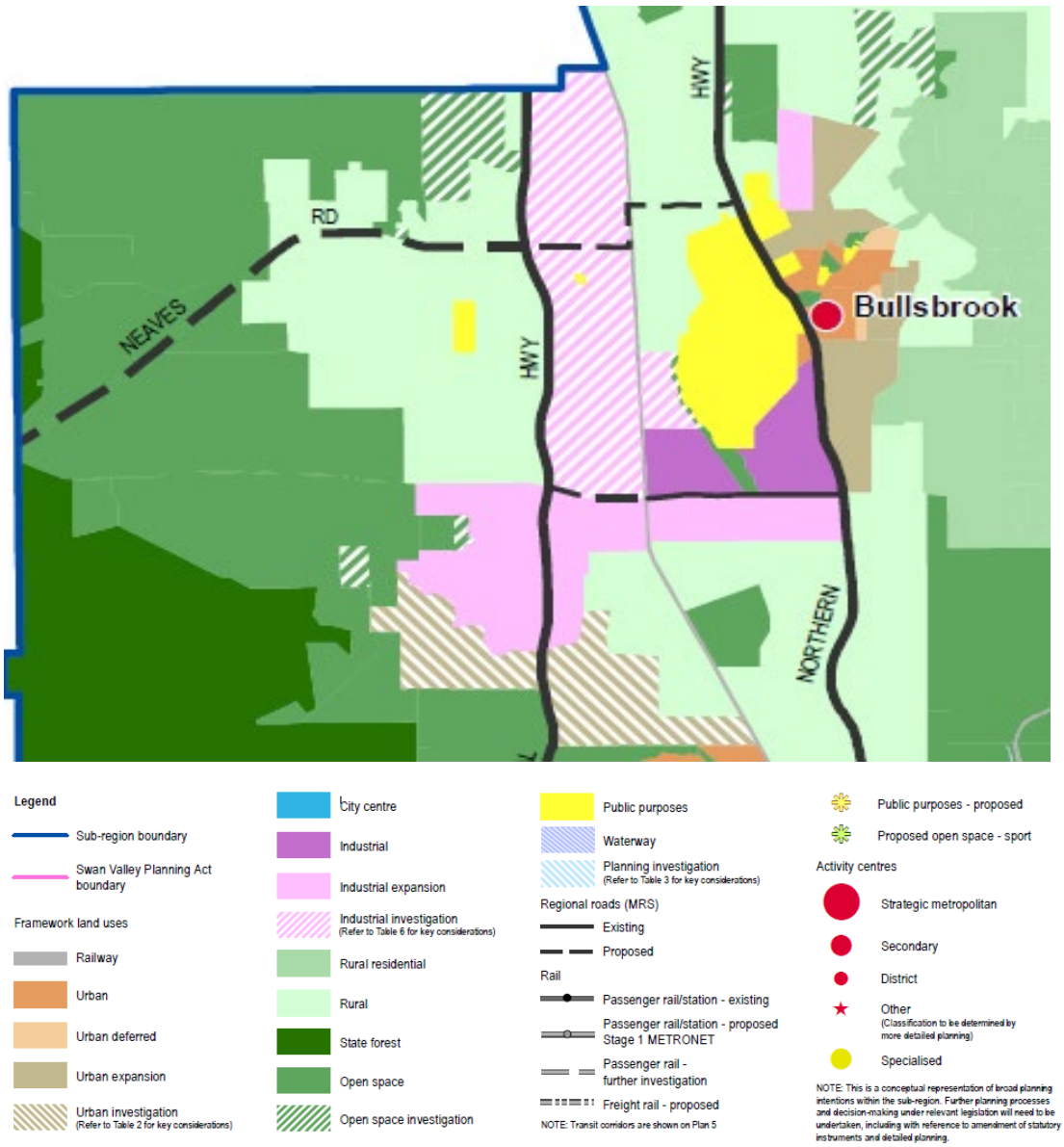


Figure 3-1 NESRPF (Plan 1)

The NESRPF includes identification of new and upgraded primary distributor and integrator arterial roads within the study area as described below and shown in Figure 3-2.

Perth Darwin National Highway - A new Primary Distributor connecting Tonkin Highway with GNH at Muchea to improve freight transport and general traffic capacity through the northern part of the sub region diverting some traffic from GNH, West Swan Road and Lord Street.

Neaves Road – An important east-west link that connects the North-West sub region to the North-East sub-region. It provides access to PDNH, the Bullsbrook employment node, the planned Bullsbrook IMT, and the Muchea Industrial Park.

network in this area and the potential impacts on the Gnangara Priority 1 Water Protection Area, adjacent bushland, and other environmental attributes.

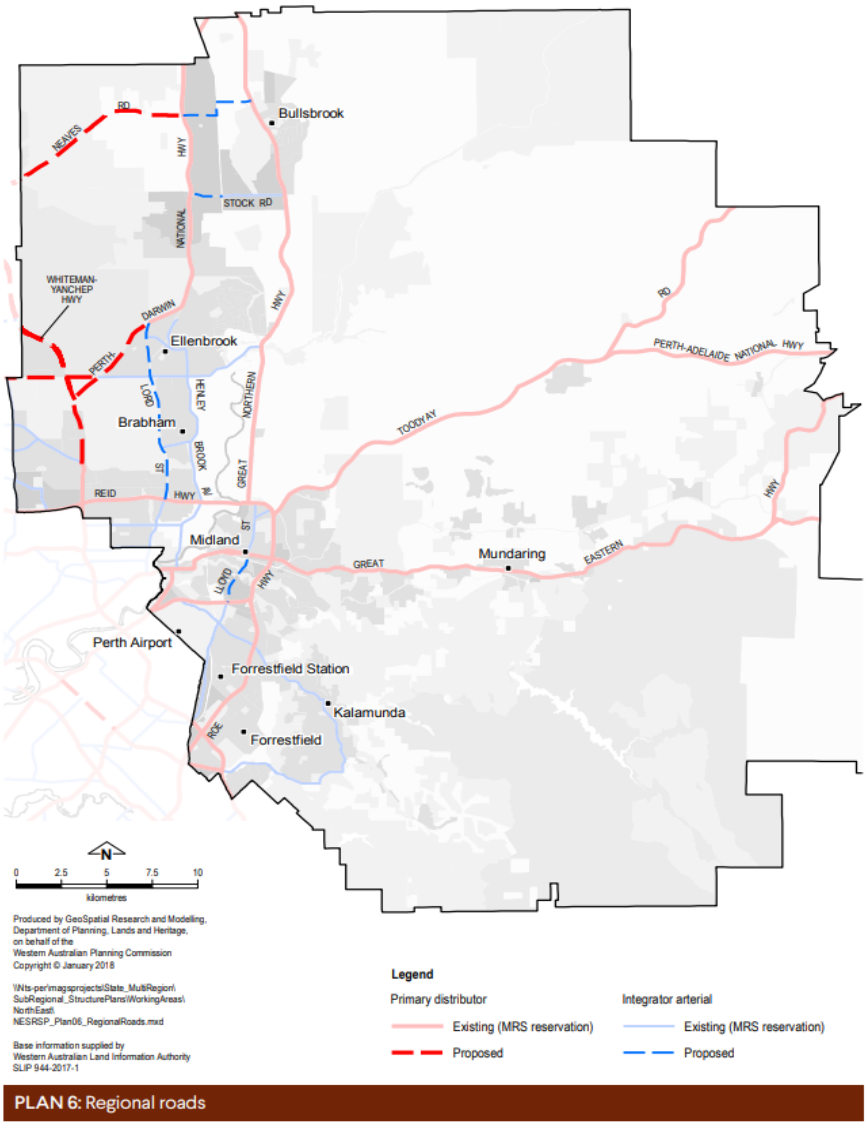


Figure 3-2 2050 North east region regional roads (NESRPF March 2018)

3.1.1 Freight

The NESRPF forecasts the volume of freight movement on the regional road and rail networks to increase substantially by 2050. This increase will be centred on interstate road and rail routes, particularly those servicing port facilities and connecting with intermodal terminals located at Kewdale, Hope Valley/Wattleup (Latitude 32), Bullsbrook and Mundijong. Overall, the proportion of freight on rail is expected to increase[10].

Figure 3-3 shows the 2050 freight network as reflected in the NESRPF. Tonkin Highway/PDNH is identified as the primary freight route north-east of Perth, with GNH becoming a secondary route. Stock Road is required to connect the two with Neaves Road providing the connector to other routes to the west.

[10] See BITRE 2009, p. 9 (https://bitre.gov.au/publications/2009/files/is_034.pdf) and Freight @ 3.5 Million, DoT 2015

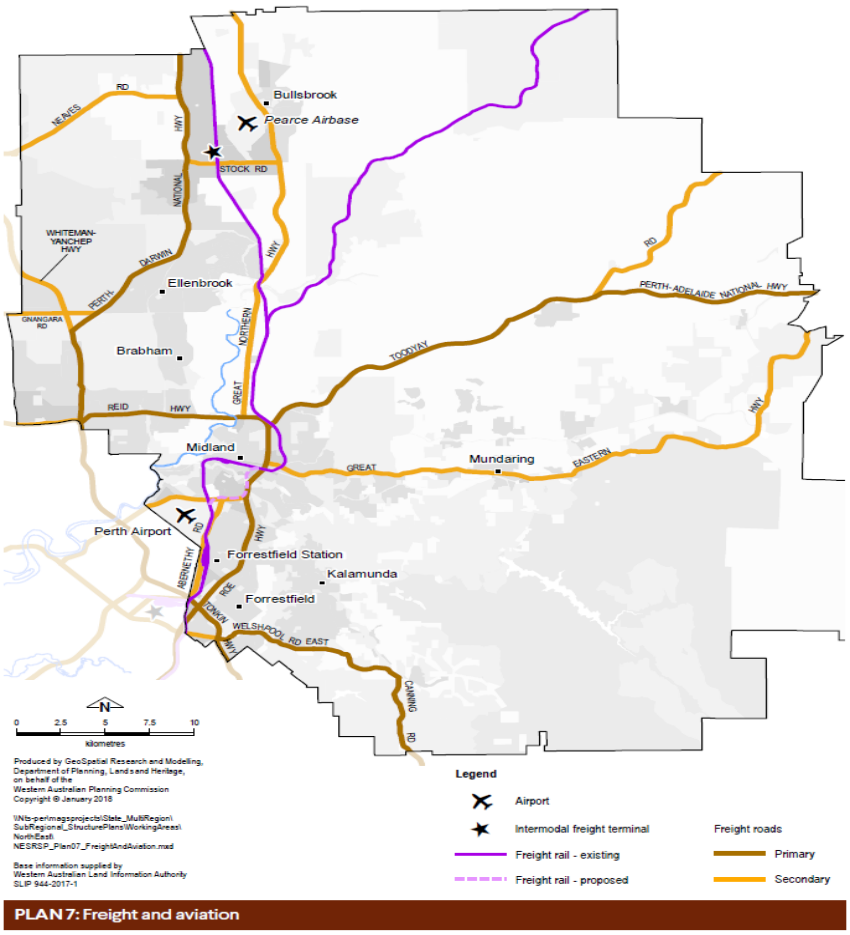


Figure 3-3 2050 North east region freight network (NESRPF March 2018)

The proposed Bullsbrook IMT will have an important role in the freight network having rail connections to Fremantle Port and the proposed Kwinana Outer Harbour, as well as to regions north of Perth. Rail and road access to the potential IMT requires detailed planning and protection from encroachment by incompatible development and is an important consideration when identifying locations for infill housing development. State Planning Policy 5.4 provides clear guidance on mitigating conflicts between sensitive land uses and freight transport corridors. Similarly, the design, construction, upgrade, and operation of the infrastructure within these corridors should seek to minimise impacts on surrounding land uses.

3.2 South Bullsbrook Industrial Precinct Local Structure Plan No 1 (WAPC) January 2015

This document identifies the following:

- Warren Road is subject to a 5-metre road widening on the south side.
- Direct access to Stock Road and GNH is not permitted without prior approval of Main Roads WA and/or the WAPC.

- Traffic signals are proposed at the Stock Road/GNH intersection[11].
- Left in/out is proposed at the Warren Road/GNH junction.

3.3 South Bullsbrook Local Structure Plan No 2 (WAPC) February 2016

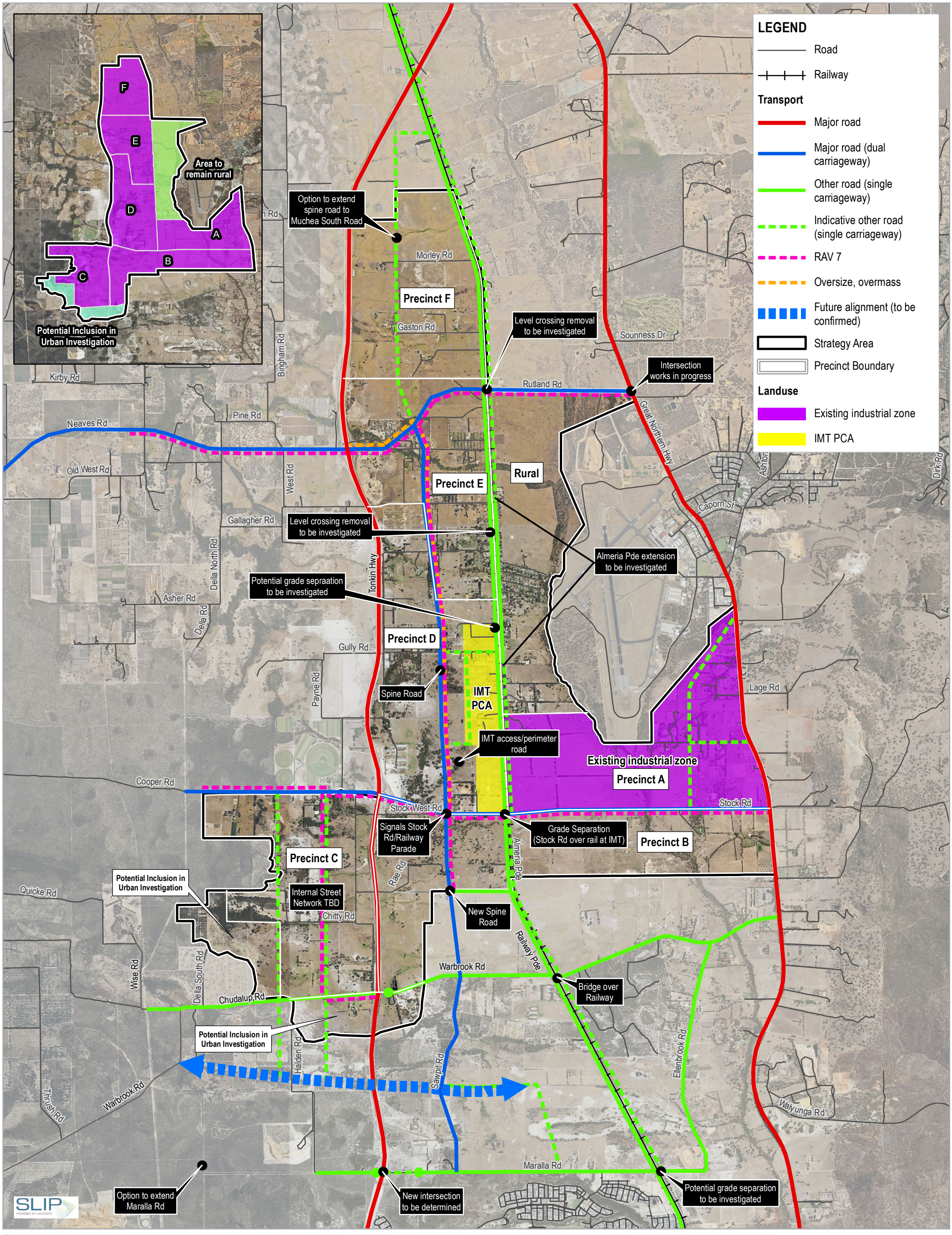
This document identifies the following:

- Stock Road is classified as an Other Regional Road and is subject to a 20-metre road widening to the north of the existing reserve, to be ceded at subdivision stage.
- Direct lot access to Stock Road is not permitted without the prior approval of Main Roads WA and/or the WAPC.
- The existing intersection of Almeria Parade and Stock Road is to be formally closed at the time of subdivision of the land adjacent.

3.4 Bullsbrook Freight and Industrial Land Use Planning Strategy

The proposed Strategy Plan for the Bullsbrook Freight and Industrial Area is shown in Figure 3-4.

[11] This is not the current planning for Stock Road/GNH - a roundabout is recommended for the intersection.


LEGEND
Road
Railway
Transport
Major road
Major road (dual carriageway)
Other road (single carriageway)
Indicative other road (single carriageway)
RAV 7
Oversize, overmass
Future alignment (to be confirmed)
Strategy Area
Precinct Boundary
Landuse
Existing industrial zone
IMT PCA
A
B
C
D
E
F
Area to remain rural
Potential Inclusion in Urban Investigation
Option to extend spine road to Muchea South Road
Morley Rd
Precinct F
Gaston Rd
Level crossing removal to be investigated
Sounness Dr
Intersection works in progress
Rutland Rd
Great Northern Hwy
Kirby Rd
Bingham Rd
Pine Rd
Neaves Rd
Old West Rd
West Rd
Precinct E
Rural
Gallagher Rd
Level crossing removal to be investigated
Caporn St
Ashton
Dirk Rd
Almeria Pde extension to be investigated
Della North Rd
Tonkin Hwy
Potential grade sepraation to be investigated
Asher Rd
Della Rd
Precinct D
Gully Rd
Payne Rd
Spine Road
IMT PCA
Lage Rd
IMT access/perimeter road
Existing industrial zone
Precinct A
Cooper Rd
Stock West Rd
Stock Rd
Signals Stock Rd/Railway Parade
Grade Separation (Stock Rd over rail at IMT)
Precinct B
Precinct C
Almeria Pde
Rae Rd
Potential Inclusion in Urban Investigation
Quicke Rd
Internal Street Network TBD
Chitty Rd
New Spine Road
Railway Pde
Wise Rd
Della South Rd
Warbrook Rd
Chudalup Rd
Bridge over Railway
Potential Inclusion in Urban Investigation
Halden Rd
Sawpit Rd
Ellenbrook Rd
Thrush Rd
Warbrook Rd
Walyunga Rd
Maralla Rd
Option to extend Maralla Rd
New intersection to be determined
Potential grade separation to be investigated
SLIP
Paper Size ISO A3
0 0.5 1 1.5 2
Kilometres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50
GHD
Department of Planning, Lands & Heritage
Bullsbrook Freight and Industrial
Land Use Planning Strategy
Strategy Plan
Project No. 61-37134
Revision No. 2
Date 12/01/2021
FIGURE 3-4
Data source: GHD: Masterplan Boundary, Transport Network - 20180702, Concept Plan - 20181102; Landgate: Roads, Railway - 20180820. Created by: htaniza

4. Existing transport network

4.1 Active transport

The primary road routes within the study area do not contain any adjacent walking or cycling paths, however the road reserves are all wide enough for them to be installed. Almost all roads in the area are sealed two-lane carriageways with marginal or no sealed shoulders.

The only existing active transport infrastructure within the study area is limited to a small section of footpath on Almeria Parade adjacent the residential area east of the railway.

The Bullsbrook townsite has a reasonable path network within and surrounding it, however the City of Swan considers Bullsbrook as a separate townsite, which is too far to be connected to other urban locations to the south via active transport infrastructure. Accordingly, the City of Swan's Transport Strategy (2014)[12] does not propose any active transport infrastructure for the area. In addition, there are no plans to provide east-west path connections to the PSP on the eastern side of Tonkin Highway.

Surveys/counts have not been undertaken; however, it is likely that walking and cycling volumes outside Bullsbrook and the small town site (approximately 360 people in 140 dwellings) near Turner Road would be low, owing to long distances and absence of suitable infrastructure.

4.2 Public transport

The Strategy area is served by one Transperth bus service (Route 311), shown in Figure 4-1.

The route operates between Bullsbrook and Midland Station, with three services between 7.00 am and 8.00 am on weekdays. The return journey in the afternoon peak from Midland Station to Bullsbrook has only one service (which departs Midland Station at 5.49 pm). This bus service is not directly connected to other major activity centres.

Previously, between approximately 1993 and 2015, this route extended beyond Bullsbrook to also service the Muchea town site[13].

[12] https://www.swan.wa.gov.au/Your-Council/About-us/Projects-initiatives/Our-plans-strategies/Transport-Strategy

[13] The Advocate. 2015. Bus Service Changes. https://www.pressreader.com/australia/the-advocate-perth/20150304/281496454744066

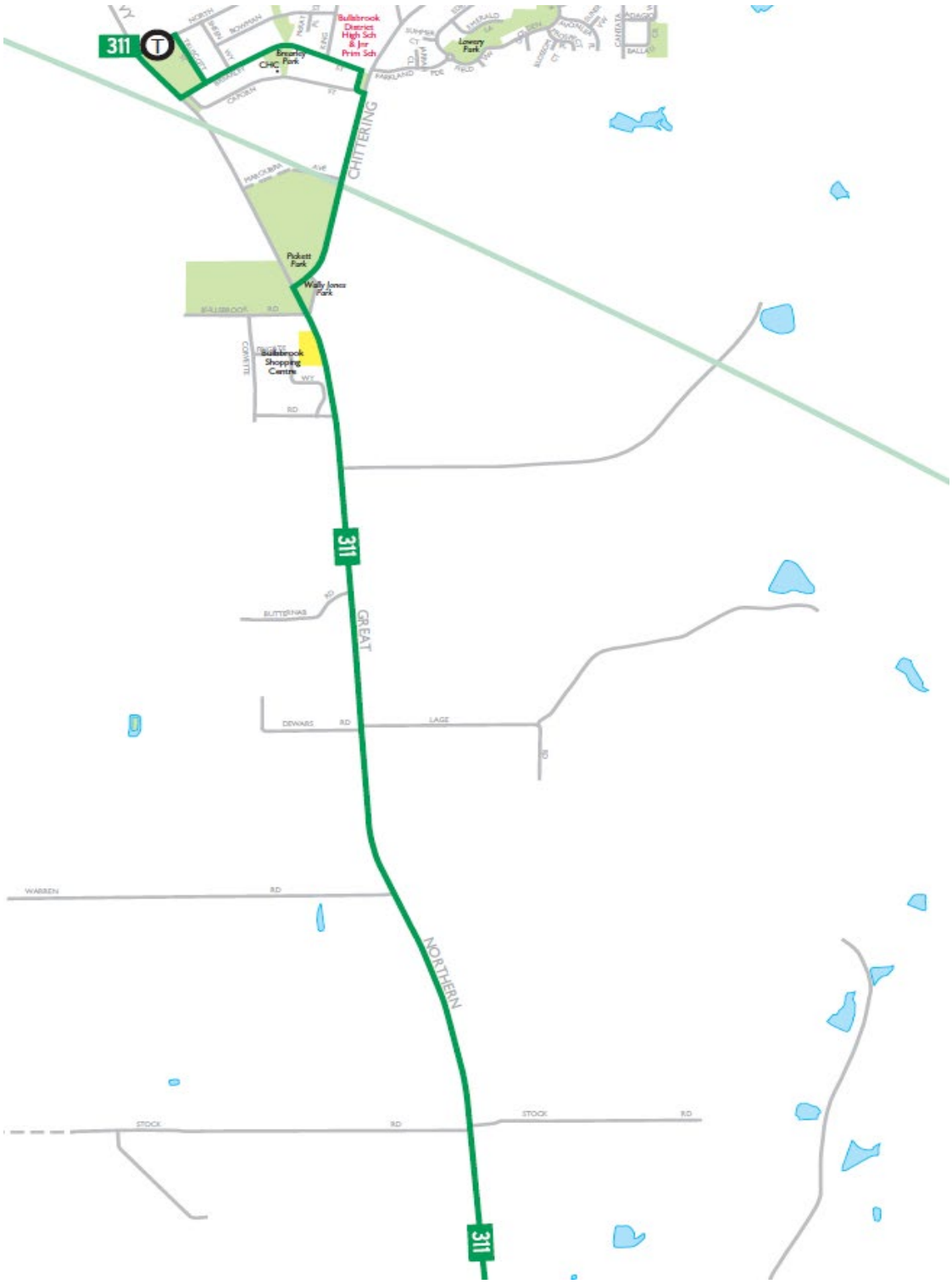


Figure 4-1 Existing bus service - Route 311 (Transperth)

4.3 Rail

The Millendon Junction – Narngulu narrow gauge railway runs through the centre of the study area and is the sole rail link (Figure 4-2). The line is used for freight purposes only, i.e. no passenger rail services.

4.4 Roads

Given the predominantly rural nature of existing land use within the study area, the road network is sparse with few major routes passing by or through it (Figure 4-2). Tonkin Highway and GNH are the primary north-south roads within proximity of the Strategy area. Railway Parade, transecting the Strategy area, is a secondary north-south road. Secondary east-west routes include Warbrook Road in the south and Neaves and Rutland Roads in the north, however none of the connections provide a direct connection across the railway.

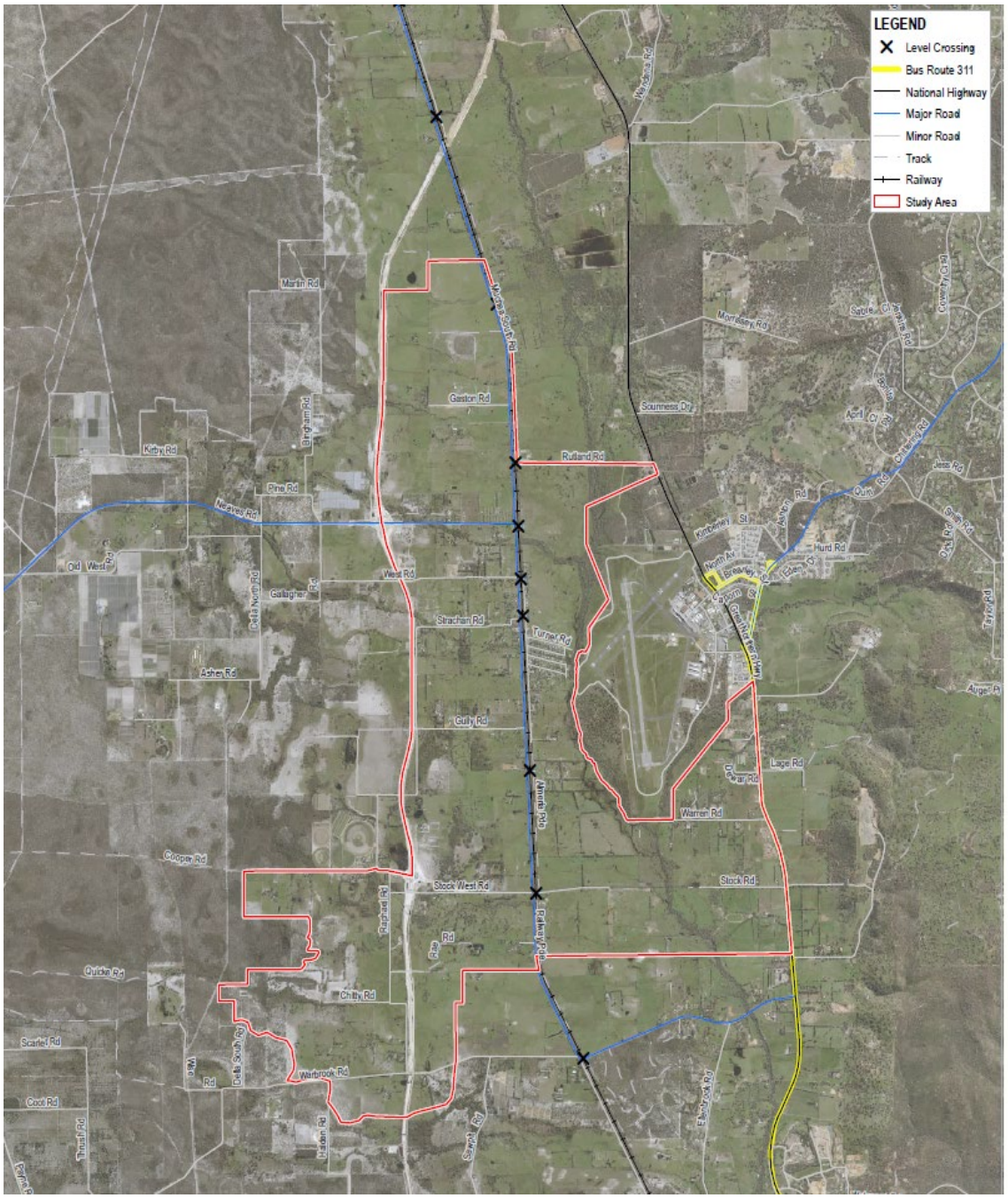


Figure 4-2 Existing transport network

4.4.1 Road hierarchy

Figure 4-3 shows the existing road classification/hierarchy within and surrounding the study area.

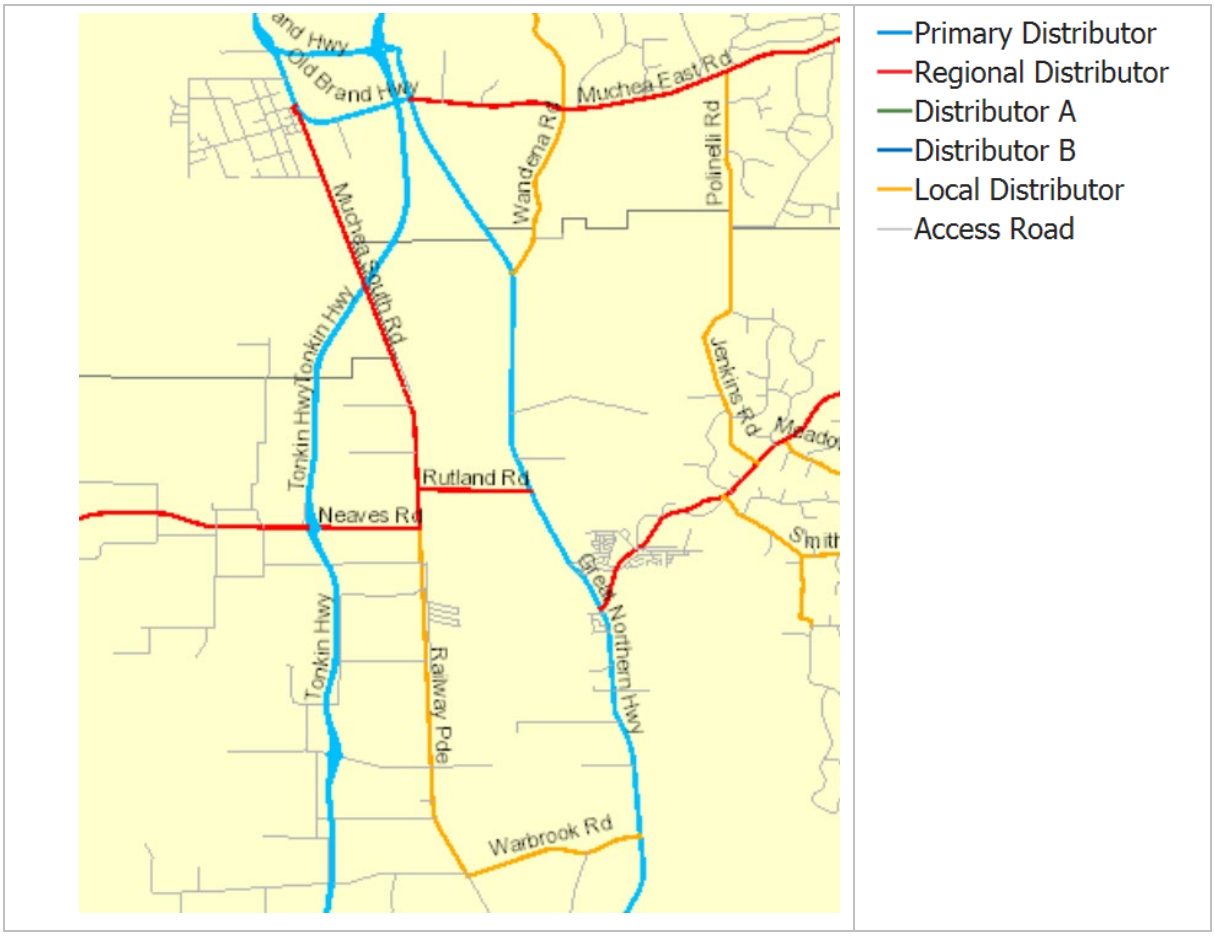


Figure 4-3 Road hierarchy within & surrounding the study area (MRWA)

Table 1 shows the classification and controlling authority of roads within and surrounding the study area.

Table 1 Road classifications and controlling authority

Road	Classification	Controlling authority
Stock Road	Access Road	City of Swan
Railway Parade	Local Distributor	City of Swan
Neaves Road	Regional Distributor	City of Swan
Rutland Road	Regional Distributor	City of Swan
Muchea South Road	Regional Distributor	City of Swan
Great Northern Highway	Primary Distributor	Main Roads WA
Perth Darwin National Highway	Primary Distributor	Main Roads WA

4.4.2 Speed limits

As shown in Figure 4-4, access roads surrounding the site generally have a speed limit of 50 kilometres per hour (km/h). GNH has a speed limit approaching Bullsbrook town site of 100 km/h (south) and 110 km/h (north). It is 60 km/h through the town site.

Railway Parade is 50 km/h through the southern portion of the study area, rising to 90 km/h in the north, as it becomes Muchea South Road. Neaves and Rutland Roads are 90 km/h and 100 km/h respectively, whilst Warbrook Road is 90 km/h.

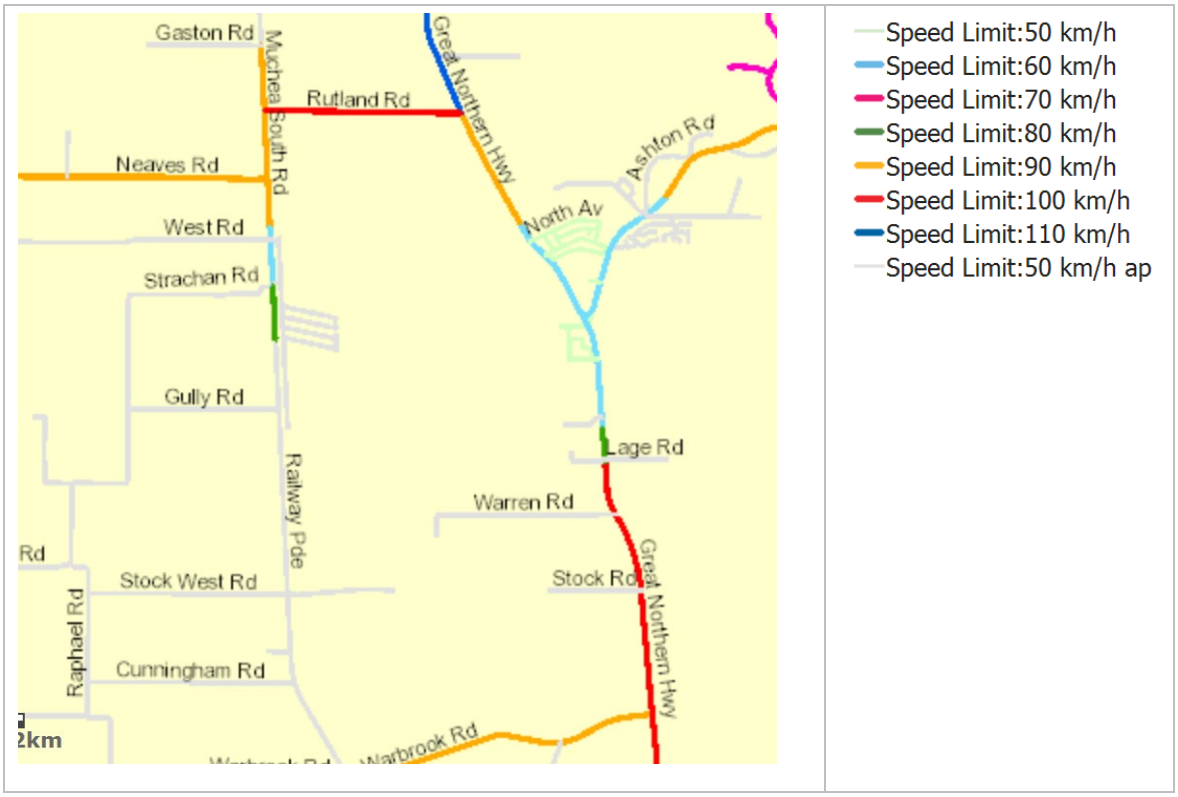


Figure 4-4 Speed limits in the study area (MRWA)

4.4.3 Restricted access vehicle network

The restricted access vehicle (RAV) network is shown in Figure 4-5 and includes routes that accommodate B-Doubles and above.

- GNH, Rutland Road, Warren Road – 36.5-metre road train routes.
- Stock Road, part of Railway Parade, Neaves Road – 27.5-metre truck routes.

The existing network for each RAV type within and surrounding the study area is shown in Appendix A.

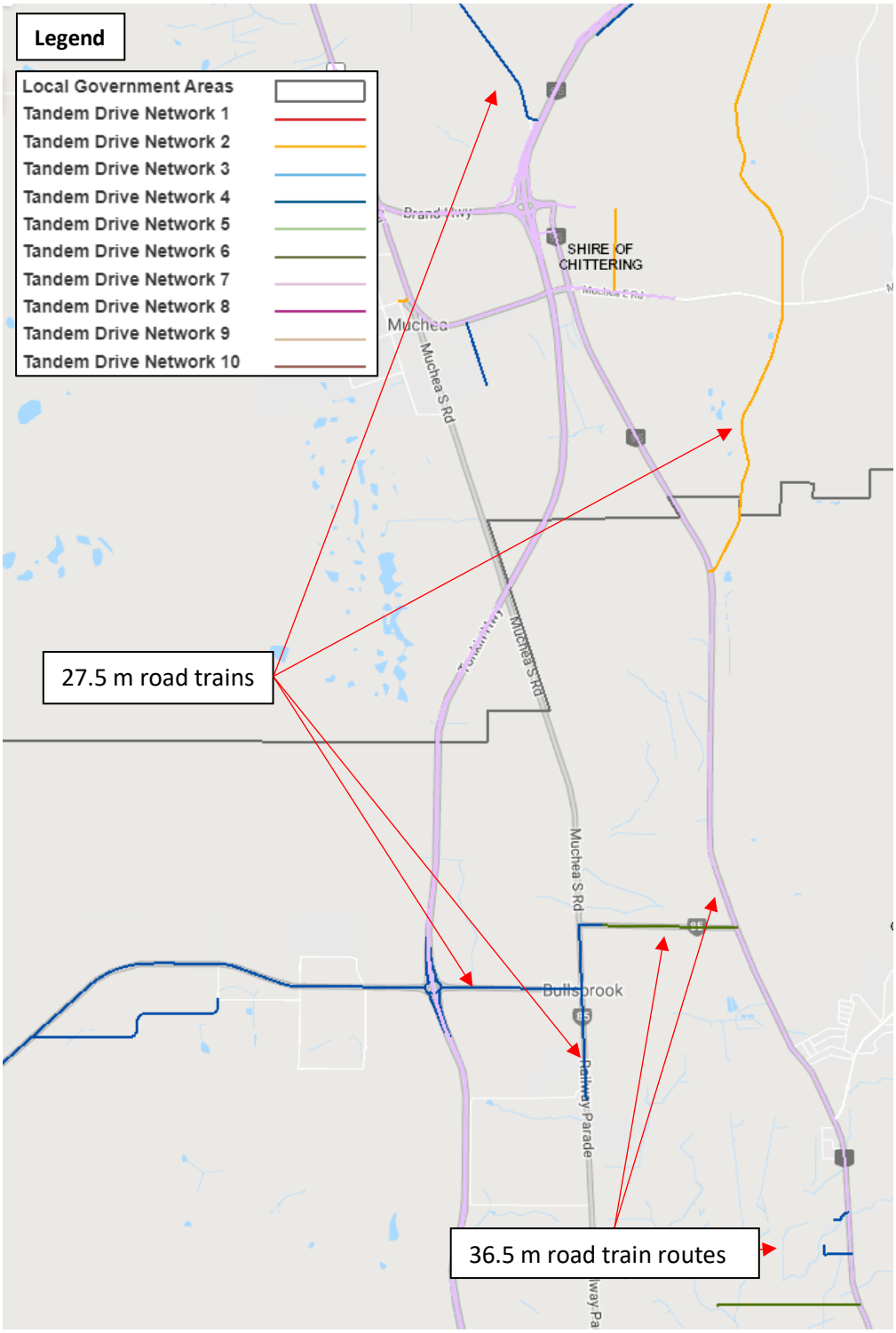


Figure 4-5 Existing RAV network within study area (MRWA)

4.4.4 Over size/over mass network

Figure 4-6 shows the existing over size/over mass (OSOM) corridor near the study area. This corridor has a clearance envelope of 10-metres wide by 10-metres high. GNH forms part of OSOM Corridor 3. Main Roads WA does not propose to change the OSOM route along GNH following completion of the Tonkin Highway extension/PDNH.

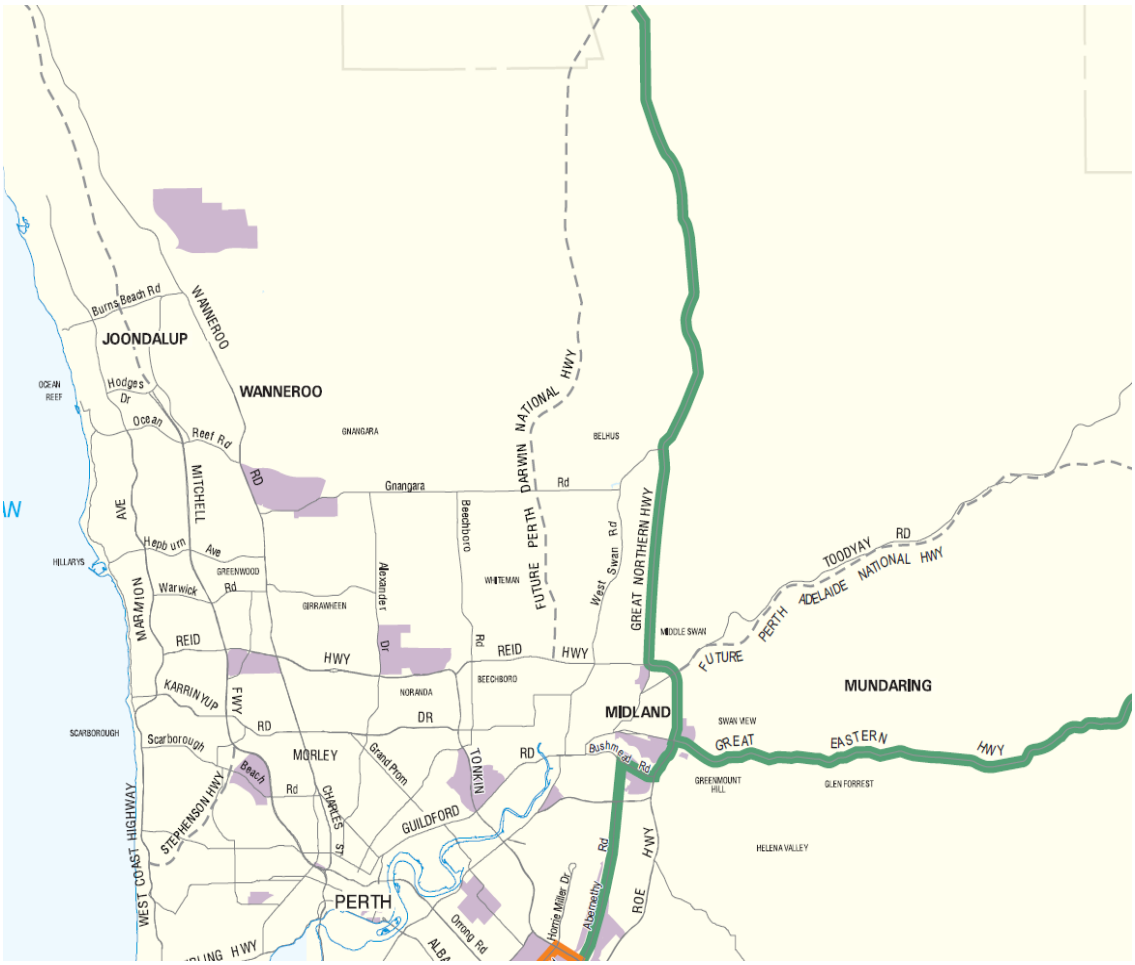


Figure 4-6 Existing OSOM corridor (MRWA)

The Stock Road interchange with Tonkin Highway cannot cater for OSOM vehicles. The interchange can cater for vehicles up to a clearance envelope of 8.5-metres wide by 6.5-metres high (north of Stock Road) and 7.0 metres wide by 6.5 metres high (south of Stock Road), as shown in Figure 4-7.

Stock Road is proposed to have a 10.0 metre by 10.0 metre clearance envelope between the IMT and GNH.

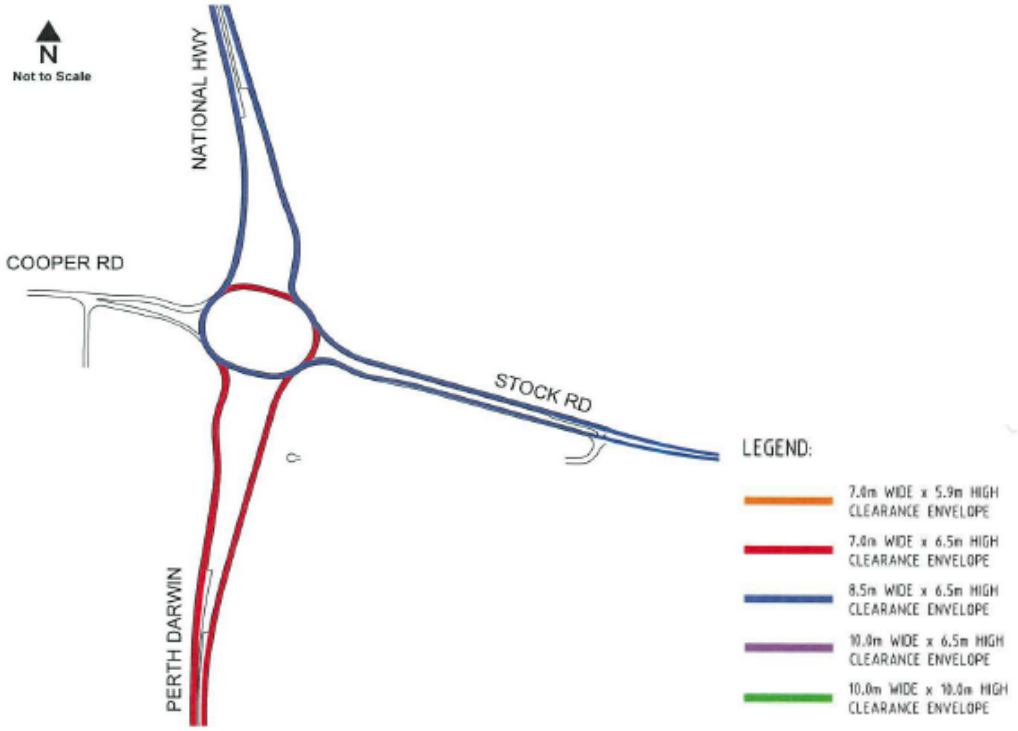


Figure 4-7 Stock Road and PDNH OSOM clearance envelopes (MRWA)

4.5 Railway crossings

There are several at grade railway crossings through the project area. The existing at-grade railway crossings at Stock and Rutland Roads will be grade separated under current proposals to upgrade these links. The design of grade separations is expected to accommodate double stacked railway vehicles (height of 7.2 metres). The spans of the bridge crossing at Stock Road must be sized to incorporate approach sidings along the west side of the main railway line.

"Formal" sealed level crossings currently exist near West Road and Strachan Road, providing connectivity to the residential area on the east side of the railway line along Almeria Parade. Several unsealed railway crossings also exist.

The level crossings are likely to remain in the near term, however, it is considered that a comprehensive review of all level crossings in the area should be undertaken to determine whether crossings can be rationalised or removed where practical or deemed necessary.

It is expected that additional crossings may be required as the industrial area develops. Current state government policy is that new level crossings should not be provided, which raises the question of how best to service future industrial sites and the rural-residential enclave east of the railway line.

4.6 Traffic volumes

Table 2 shows the daily traffic volumes on the primary routes within the study area[14]. It shows that heavy vehicles comprise a significant proportion of traffic movements on the primary roads.

[14] Obtained from Main Roads WA's web site (Traffic Map) in May 2018.

Table 2 Daily traffic volumes

Location	Vehicles per day	Year
Great Northern Highway south of Bullsbrook Road	13,870 (23% heavy vehicles)	2015/16
Great Northern Highway north of Warbrook Road	8,231 (15.2% heavy vehicles)	2020/21
Stock Road (west of Great Northern Highway)	38 (21% heavy vehicles)	2014/15
Neaves Road west of Railway Parade	5,562 (20% heavy vehicles)	2020/21
Tonkin Highway North of Stock Road	11,807 (32.8% heavy vehicles)	2020/21
Tonkin Highway North of Neaves Road	8,140 (26.3% heavy vehicles)	2020/21

4.7 Crash analysis

The following crash statistics for the primary roads with the study area relate to the period between 1 January 2013 and 31 December 2017. With changed road layouts and traffic patterns following the opening of the Tonkin Highway extension in 2020, patterns are likely to change significantly, requiring further analysis in future.

- **Stock Road/Great Northern Highway intersection -** no reported crashes.
- **Warren Road/Great Northern Highway intersection -** no reported crashes.
- **Rutland Road/Great Northern Highway intersection -** 38 reported crashes in five years (five hospital, eight medical treatment, 20 property damage only (PDO) major and five PDO minor). The collision diagram indicates predominant patterns are rear end collisions in Rutland Road and right-angle collisions involving the right turn out colliding with northbound traffic on GNH. It is apparent that a safety issue exists at this intersection and should be addressed by Main Roads WA and the City of Swan.
- **Rutland Road/Muchea South Road intersection -** Five reported collisions, all PDO major. It is apparent that a safety issue exists at this intersection. It is expected that the crash pattern will alter significantly after the opening of the Tonkin Highway extension.
- **Neaves Road/Railway Road intersection -** 13 reported crashes (two medical, eight PDO major and three PDO minor). The collision diagram indicates predominant patterns are rear end collisions in Neaves Road. It is apparent that a safety issue exists at this intersection. It is expected that traffic patterns (and hence crash patterns) will change significantly following the opening of the Tonkin Highway extension.

Table 3 summarises road section and level crossing crash data

Table 3 Road section and level crossing crash data

Road	Section	No of crashes	Crash types
Rutland Road	Full length excluding terminating intersections.	4	3 PDO major, 1 PDO minor. 2 rear end, 1 run off road, 1 reversing in traffic.
Great Northern Highway	Muchea Road to Rutland Road excluding intersections (end)	26	1 Hospital, 2 medical, 19 PDO major, 4 PDO minor. 13 rear end/sideswipe, 6 run off road.
Great Northern Highway	Rutland Road to Chittering Road excluding intersections (end)	12	5 hospital, 1 medical, 3 PDO major, 3 PDO minor. 3 head on, 2 rear end, 4 run off carriageway.
Great Northern Highway	Chittering Road to Stock Road excluding intersections (end)	23	1 fatal, 2 hospital, 4 medical, 14 PDO major, 2 PDO minor. 10 rear end/side swipe, 5 driveway, 4 run off carriageway.
Railway Parade	Neaves Road to Stock Road excluding intersections (end)	5	1 hospital, 2 medical, 1 PDO major, 1 PDO minor. 1 head on, 1 rear end, 2 run off road.
Warbrook Road Rail crossing	-	0	-
Stock Road west	-	0	-
Rutland Road rail crossing	-	0	-
Almeria Parade	-	0	-

5. Strategic transport context

5.1 The freight and passenger transport task

The development of the Bullsbrook industrial precinct requires the provision of transport linkages, both within the study area and externally. Of particular importance will be the provision of safe and efficient transport links between the proposed IMT and other parts of the study area.

The IMT is proposed as a transit point for containerised cargo arriving at Fremantle Port and/or the proposed future outer harbour at Kwinana for forwarding to the northern parts of the Perth metropolitan area and elsewhere within WA (primarily the Geraldton/Midlands area and the Wheatbelt). It will also be a collection point for container cargo to be forwarded to the ports for export. A further possibility is the inclusion of other rail related activities (marshalling, maintenance, etc.).

The relationship between the Bullsbrook industrial precinct, the IMT and the other proposed industrial/employment nodes (at Muchea, North Ellenbrook, Wangara and Neerabup) must also be considered, as does the potential distribution of employment and customer travel to and from the broader Bullsbrook industrial precinct.

Current planning for the IMT site seeks to facilitate a development that will ultimately cater for throughput of 250,000 TEU[15]/annum. Initial terminal capacity has been estimated as 150,000 TEU/annum. In addition to containerised cargo, it is expected that large volumes of light commercial vehicles and passenger cars (primarily used for commercial purposes) will access the IMT and the wider Bullsbrook industrial precinct on a daily basis.

As a potential major employment centre, the provision of passenger transport to the precinct is a major consideration in the structure-planning process. The significant distance between existing surrounding residential areas and the industrial precinct will be a major factor that is likely to make access by active and public transport challenging and will require careful planning of direct road connections to/from the precinct, particularly across significant barriers such as Tonkin Highway and the freight rail line. However, this distance will be lessened with the development of the Ellenbrook North (west and east) District Structure Plan areas to the south of Warbrook Road (west and east of Tonkin Highway). Development of these areas will bring a significant residential population base (and potential workforce) in proximity to the Bullsbrook industrial precinct which will improve the viability of public transport services.

5.2 Integration with surrounding area/network

The Strategy area is located close to several existing and future trip attractors that it must integrate with to ensure its successful development and operation. These are outlined in the following sections.

5.2.1 Muchea industrial area

The Muchea and Bullsbrook industrial areas are expected to complement each other given their different focus. Muchea, approximately 5 km north of the northern end of the structure plan area, is geared towards agricultural industries whilst Bullsbrook is to focus on containerised/break bulk freight.

[15] A TEU (Twenty-foot Equivalent Unit) is a measure of containerised cargo mass based upon a standard 20-foot international shipping container. Double length (40 foot) containers are also commonly used to ship freight, which equates to two TEUs each.

There is a road train assembly area (RTAA) in Muchea, approximately 14 km north of the proposed Bullsbrook IMT location. As such, a RTAA cannot be located at or adjacent to the IMT.

5.2.2 Bullsbrook town centre

This is presently the nearest urban town centre, approximately 4.5 km north east of the site. Trips between the IMT, industrial precinct and the town centre will likely comprise primarily employee commuter trips. Depending on the ultimate degree of employment located within the IMT precinct, this may eventually become a significant source of traffic. Traffic from Bullsbrook bound for Tonkin Highway is likely to use Stock Road.

5.2.3 Ellenbrook urban area

Ellenbrook (including the growing corridor consisting of Brabham, Dayton, and Bennett Springs), is approximately 5 km south of the site and is a major residential area that is likely to host a significant proportion of the future workforce once the facility becomes functional. It is therefore crucial that north-south connections between the industrial precinct and this area is provided, including GNH and Tonkin Highway.

In addition to the existing Ellenbrook area to the south of Maralla Road, there are also planned residential developments to the immediate north of Maralla Road on the west and east sides of Tonkin Highway (North Ellenbrook West and East District Structure Plan areas). The precinct's interface with these areas should be an important consideration. Both areas should be looked at holistically as there will be a large amount of shared infrastructure, with timings of infrastructure in the industrial area heavily influenced by traffic from the proposed North Ellenbrook residential areas.

5.2.4 Neerabup Industrial Area

While presently small, this area, located approximately 20 km west of the site, is expected to be a major employment area as the North-West Sub-region grows. Freight between the study area and Neerabup is expected to almost entirely be via Neaves Road.

5.2.5 Wangara Industrial Area

Wangara is an established industrial area located 20 km south west of the site. It is expected to continue to grow, particularly near Ocean Reef Road. The East Wanneroo Structure Plan Amendment[16] was finalised and approved in December 2020 and is expected to support further urban development between the Wangara and Neerabup industrial areas. Freight between the study area and Wangara is expected to almost entirely be via Gnangara Road.

5.2.6 RAAF Pearce Air Force Base

The study area partially surrounds the Royal Australian Air Force's (RAAF) Pearce air base. There are several issues to be considered, including:

- As an industrial land use, it is not considered a noise sensitive receptor. The Department of Defence (DoD) requests that future land sales include a title condition acknowledging that the air force operates 24/7 and aircraft noise is inevitable.
- Outdoor lighting within six kilometres of the airfield must comply with DoD guidelines to avoid glare from reflective surfaces for pilots. Care should be taken in the IMT

[16] See https://www.planning.wa.gov.au/east-wanneroo.aspx

design stage to ensure this does not occur. This may pose some design and enforcement challenges for hardstand yard lighting, etc.

- Activities leading to an increased likelihood of bird strike by aircraft should be avoided.
- DoD requests that development does not prejudice existing utility services for RAAF Base Pearce.
- The site is within a 15-kilometre radius of the base and will require DoD approval for any structures that may pose a hazard to aircraft – this includes height limitations (Figure 5-1). The only structures at the IMT that may be affected would be lighting towers, which would be addressed at the detailed design stage. Other structures throughout the industrial precinct will need to be assessed against the height restrictions as part of the development application process.
- The DoD has plans to extend the runways at Pearce Airbase (the timing has not yet been determined as at the date of this report). Accordingly, clearance/ height requirements should be re-checked at subsequent stages of the project.
- The base is likely to attract very specific and potentially atypical traffic patterns. In the very long term, this site could attract significant freight flows if the site is used for civil aviation, or increased defence aerospace industry.

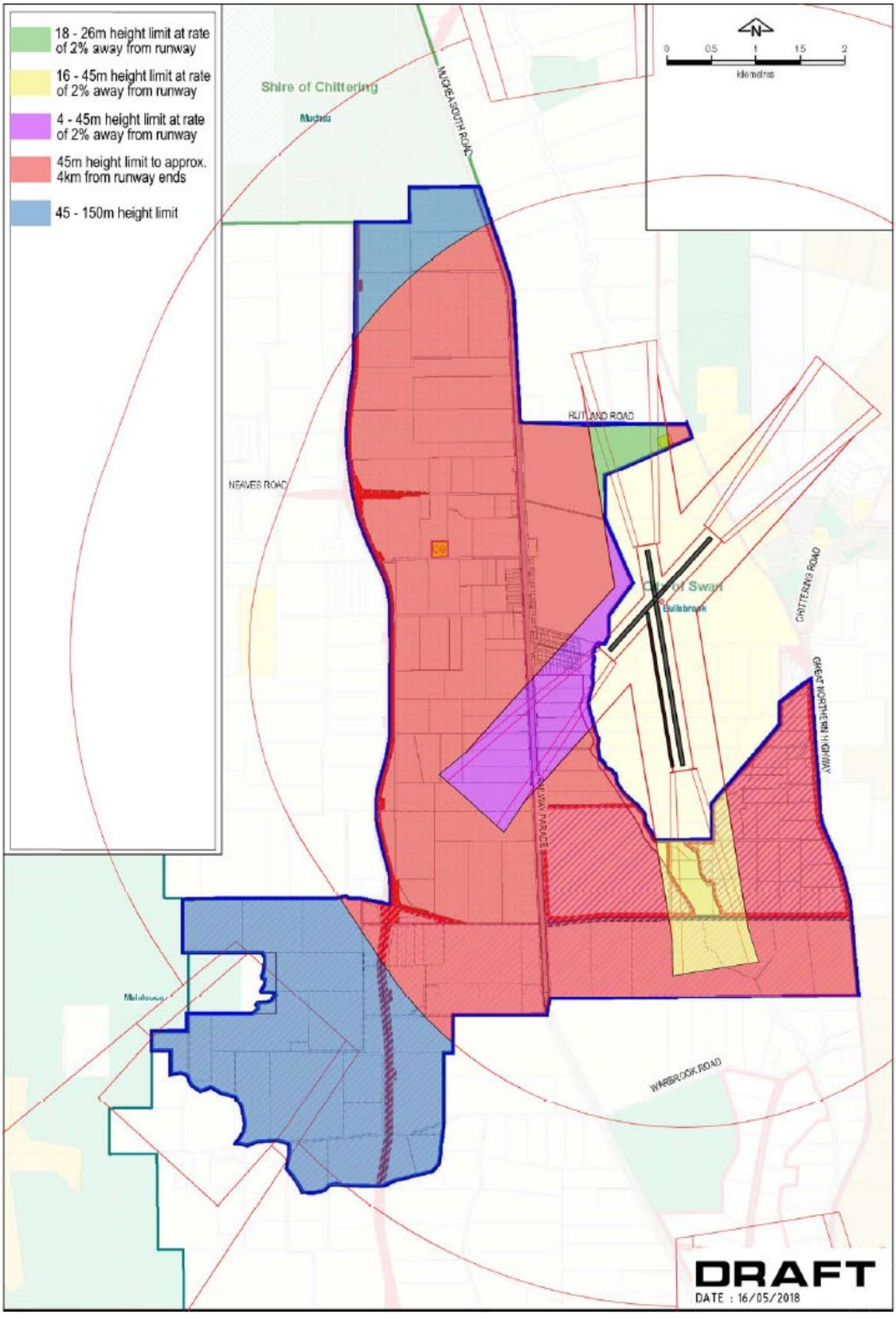


Figure 5-1 Pearce Airbase – height restrictions (DoD)

6. Proposed transport networks

6.1 Internal network

The proposed primary transport network within the study area at full development is shown in Figure 6-1.

6.1.1 Rail

The existing narrow-gauge Millendon–Narngulu freight railway, which runs north-south through the middle of the study area, will remain the sole external rail link and will have a spur to connect to the IMT. The IMT site has been sized to accommodate 650-metre trains, with provision for extension to 900-metre trains in future, if necessary[17]. The spacing of internal sidings and turnouts has been designed to allow upgrade to dual gauge if warranted in future. The approach siding will extend from just north of Warbrook Road to Stock Road, which is just sufficient to accommodate an 1800-metre interstate train, which would then be broken into 900-metre rakes for shunting into the IMT. The siding will be located within the existing railway reserve and positioned to allow future duplication of the main line, should this ever prove necessary.

Trains to/from the north would initially use the southern approach siding by way of a crossover. If demand grows in the future, the IMT layout must be flexible enough to allow for a direct approach from the north.

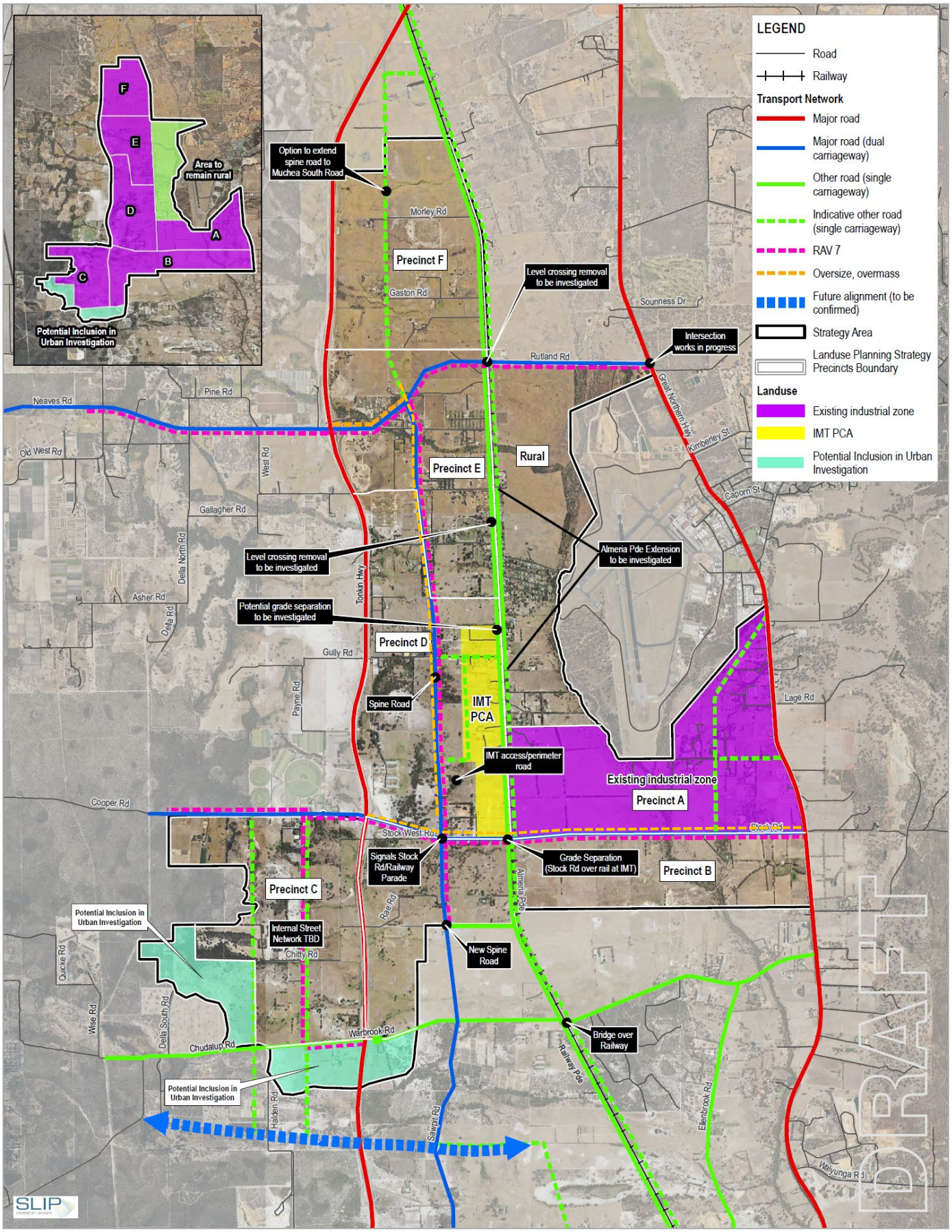
It is anticipated that train control within the proposed IMT and its approach sidings will be under the control of the terminal operator. The exact arrangements for demarcation of control will be determined closer to the time of construction. They will reflect the ownership/ management of the terminal and main line at that time, together with any changes in signalling technology between now and then.

Provision has been made in the planning of the IMT to accommodate 1800-metre standard gauge trains in future, however it is expected that the existing narrow-gauge line will be the only rail freight service in the short to medium term. For interstate trains to access the IMT, considerable infrastructure upgrades would be required, including reconstruction of the existing line from Millendon to Bullsbrook as dual gauge, with consequent upgrades to bridges and culverts, signals, and other such infrastructure. Conversion of the Millendon Junction to a triangle arrangement would allow direct access to the upgraded line but is likely to be strongly resisted on social impact grounds.

Operational changes would also be necessary for interstate trains to access the IMT. This might include provision of a siding south of Millendon, where trains could be reversed. Alternatively, trains could be re-routed to Forrestfield/Kewdale and back, however this is less efficient.

The potential construction of a standard gauge link to give rail access to the eastern states is complex and will require additional studies beyond the scope of this Strategy.

[17] The IMT masterplan study (GHD 2016) noted that the primary market for the Bullsbrook IMT would be container (and some break-bulk) commodities coming over the wharves at Fremantle and Kwinana, for distribution to Perth's north-west and north-east corridors, and areas north of Perth. For this purpose, the 650-metre port shuttle was adopted as the design train.



Paper Size ISO A3

0 0.5 1 1.5 2 Kilometres

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

GHD

Department of Planning, Lands & Heritage
Bullsbrook Freight and Industrial
Land Use Planning Strategy

Proposed Primary Transport Network at Full Development

Project No. 61-37134
Revision No. B
Date 03/02/2021

FIGURE 6-1

Data source: GHD: Masterplan Boundary, Transport Network - 20200203, Created by: Haniza

6.1.2 Active transport

Because of the low density and relatively large distances involved in a strategic industrial estate, demand for pedestrian and cycle infrastructure and facilities will be generally limited, however there will be some variation between precincts. For example, precincts designated for service industrial will accommodate more intensive land use with a larger workforce, which would therefore justify a more comprehensive cycle/pathway network that should be sufficiently provided for.

There is a north-south Principal Shared Path on the east side of Tonkin Highway. Provision for shared path connectivity should be provided for in the designs of the major east-west connectors of Maralla Road, Warbrook Road, Stock/Cooper Road, Neaves-Rutland Road, and the connector road for the potential mid-block interchange with Tonkin Highway between Maralla and Warbrook Roads.

Provision should also be made in the proposed north-south spine road/Sawpit Road and along GNH as far north as Rutland Road, particularly as the residential cells to the east of GNH develop. Elsewhere, road reserves should be wide enough to accommodate generous shoulders suitable for cycling to provide a "last mile" connection from the primary routes.

The provision of paths will support the introduction of bus services once development has substantially occurred as it will allow pedestrians to easily access the stops.

6.1.3 Public transport

Transperth has advised that no additional public transport routes are planned for the area in the short term. In the longer term, the extensive residential developments east of GNH and south of Warbrook Road (Ellenbrook North), along with the delivery of new jobs within the Bullsbrook industrial precinct, will likely drive demand for increased bus services to/from the industrial area, particularly from those without a driver's licence or access to a personal vehicle (e.g., young people/ apprentices). The extent to which services may be extended into the study area, along with their frequencies, remains to be determined as it is very much dependant on the availability of finding for any new or extended routes. However, the low density/very large lot nature of strategic industrial sites tends to complicate the provision of public transport, particularly at high frequencies. Accordingly, a small number of direct routes at a reasonable frequency (e.g., 20 minutes in the peaks) across the precinct will likely form the basis of the ultimate configuration of the network.

The local distribution and intensity of jobs will depend on the specific location of firms within the study area. This will, in turn, partly determine the demand for public transport routes through the precinct. Accordingly, it is recommended that Transperth undertake bus network planning following the substantial completion of the subdivision and land development process.

It is likely that some local bus routes to and from Bullsbrook town centre would traverse the industrial precinct and provide onward connectivity with the Ellenbrook town centre and the future rail station in Ellenbrook.

6.1.4 Roads

The future primary road network within the strategy area is shown in Figure 6-1. It includes three north-south links (the Tonkin Highway extension, a new central spine road/realigned Railway Parade and a duplicated GNH along the eastern boundary) and two east-west links (Stock/Cooper Roads and Rutland/Neaves Roads).

Primary roads through the precinct must accommodate 36.5-metre vehicles. These assemblies (rated up to RAV 7), may transport up to four TEUs in one set of trailers. This will necessitate road engineering to incorporate relevant swept path geometry, acceleration and deceleration provision, and other key design elements.

Changes to the road network within the structure plan area will be driven by several factors, including:

- The completion of Tonkin Highway (2020).
- Traffic generated by new industries and subdivision within the Strategy area.
- Provision for an IMT on the west side of the railway line.
- External traffic generators, such as the rapidly growing residential areas at Bullsbrook east of GNH and in the future urban areas to the immediate south of the Strategy area (North Ellenbrook East and West).

Stock Road is considered the link that should be delivered as a priority to provide a connection between Tonkin and Great Northern Highways and to facilitate development of Lot 300 on the north side of Stock Road.

Other links will likely be required/delivered as the land that is currently zoned for industrial use is developed. The proposed north-south spine road is considered an important link (primarily between Stock and Neaves-Rutland Roads), however as the land through which it runs is not yet zoned for industrial use, it is unlikely to be delivered in the immediate future.

The following roads are already, or will likely become, controlled access roads as the Strategy area develops:

- Tonkin Highway
- Great Northern Highway
- Stock Road
- Neaves/Rutland Roads
- North-south spine road
- Cooper Road (west of Tonkin Highway)

All other roads will likely permit direct property access.

The following section describes the expected/recommended configuration of each major access road.

Tonkin Highway

The southern section of the Tonkin Highway extension (from Guildford Road to The Promenade in Ellenbrook) was completed in 2019, with the northern section to Muchea completed in April 2020. Tonkin Highway forms the main north-south road along the western edge of the Strategy area and is forecast to carry approximately 34,000 vehicles per day by 2051[18].

Interchanges within the Strategy area include those at Stock/Cooper Roads and Neaves/ Rutland Roads. No further interchanges are currently planned by Main Roads WA within the Strategy area; however, an additional interchange is being considered approximately midway between Warbrook and Maralla Roads.

[18] ROM 2021.

The northern section of the Tonkin Highway extension has been constructed as a dual carriageway to Muchea. As a result of construction, this section has four lanes and takes most of the heavy traffic away from GNH. These works were completed in April 2020 and included:

- Dual carriageway to Muchea
- Interchanges at Stock Road, Neaves Road and Brand Highway
- Deviation at Brand Highway
- Flyover bridges at Muchea South Road, railways and Ellenbrook

Tonkin Highway south of the Brand Highway interchange only accommodates 36.5-metre vehicles. Accordingly, triple road trains (53.5 metres) cannot directly direct access the IMT, they must break down at the road train assembly area at Muchea (north east of the Brand Highway interchange) before proceeding south to the IMT and/or into the metropolitan area. It is therefore recommended that the proposed internal spine road be designed for RAV 7 and OSOM.

Great Northern Highway

With the completion of the Tonkin Highway extension and the construction of the proposed north-south spine road, 2051 traffic volumes on GNH (just south of Stock Road) are forecast to be around 65,000 vpd and around 20% heavy vehicles and 15,800 vpd north of Stock Road (27-42% heavy vehicles).

Minor upgrades will be required at existing and/or new intersections created by the development of the industrial land on the western side of GNH between Warbrook Road and Brig Way. Duplication of the southern approach to the Bullsbrook town site is being considered by Main Roads WA, but there is currently no funding commitment. In addition, changes to the intersection with Stock Road will be required to support increased traffic volumes at this location as well as its inclusion in the RAV network.

Stock Road

Stock Road must provide a connection between Tonkin Highway and GNH and be grade separated from the railway. As part of this upgrade, the current stagger between Stock Road East and Stock Road West should be remedied. In addition, a significant proportion of Stock Road East requires construction as it is currently a dirt track. The connection should be upgraded/constructed as a four-lane dual carriageway to coincide with the development of Lot 300 on the north side of Stock Road. Consideration should also be given as to its appropriate classification, i.e., an ORR or a PRR.

A connection to this standard would provide an opportunity to alter the RAV network, as shown in Figure 6-2, to include Stock Road and Tonkin Highway (north of Stock Road). Main Roads WA has advised that GNH would need to remain as a HWL/OSOM route as the Stock Road interchange with Tonkin Highway does not cater for the largest of HWL/OSOM loads (10 m x 10 m)[19]. Whilst the section of Stock Road west of the proposed IMT site will not provide a 10 m x 10 m clearance, there is potential to design and construct the section of Stock Road[20] between GNH and the intersection with the north-south spine road to provide such clearance.

[19] As mentioned in the previous section, stakeholders expressed a strong preference for all HWL/OSOM traffic to be diverted along Stock Road to an alternative route and therefore off GNH and away from the Bullsbrook town site.
[20] With interstate transport operators expected to access the IMT, it is suggested that Stock Road be renamed to Cooper Road for its entire length to avoid confusion with Stock Road south of Perth, which shares the National Route 1 designation with GNH.

Cooper Road

There is potential for Cooper Road to be extended west in the longer-term to provide a westward connection to the wider regional road network, particularly if an alternative to Neaves Road becomes desired.

The NESRPF recognises the potential longer-term opportunity to provide an additional and more direct east-west road connection between the North-West Subregion and the North Ellenbrook/Bullsbrook industrial centre utilising the Cooper Road reserve alignment. This would connect directly to Stock Road (East) at Tonkin Highway, potentially form part of the future freight network and enhance access to the planned Bullsbrook IMT and Bullsbrook/ North Ellenbrook and South Bullsbrook employment nodes.

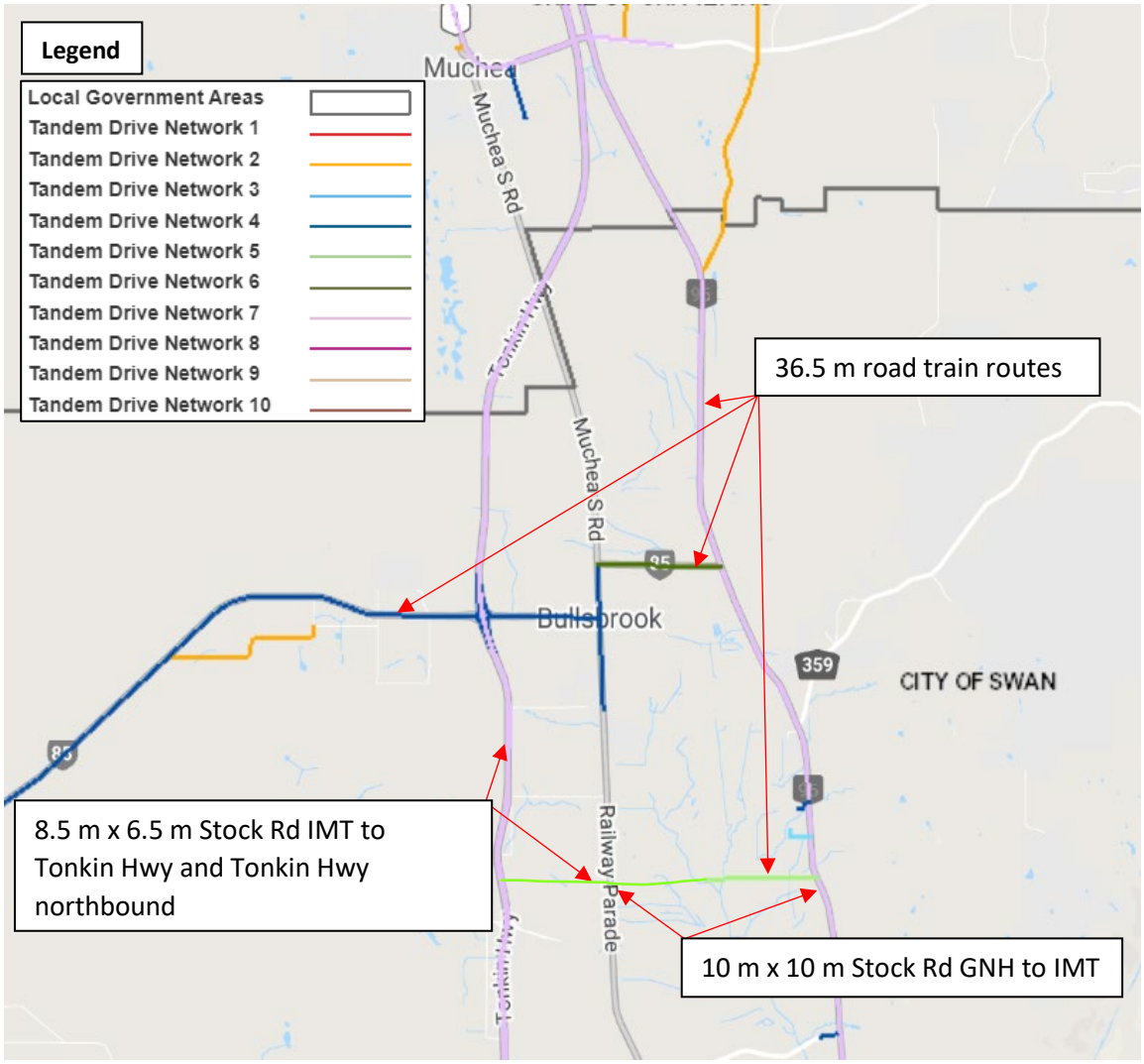


Figure 6-2 Suggested RAV and OSOM network after upgrade of Stock Road

Neaves-Rutland Road

Neaves Road provides a major east-west route linking Perth's north east and north west corridors and is forecast to carry approximately 35,200 vehicles per day by 2051[21]. In the *NESRPF*, Neaves Road (west of Tonkin Highway) is identified as a Secondary Freight Route. It is proposed to be connected with Rutland Road and thereby to GNH, including an overpass of the freight rail line and a connection to Railway Parade, as shown in Figure 6-3. This will provide a connection between Mitchell Freeway in the west to Tonkin Highway and GNH in the east. Accordingly, this route should be developed to cater for OSOM vehicles.

[21] ROM 2021.

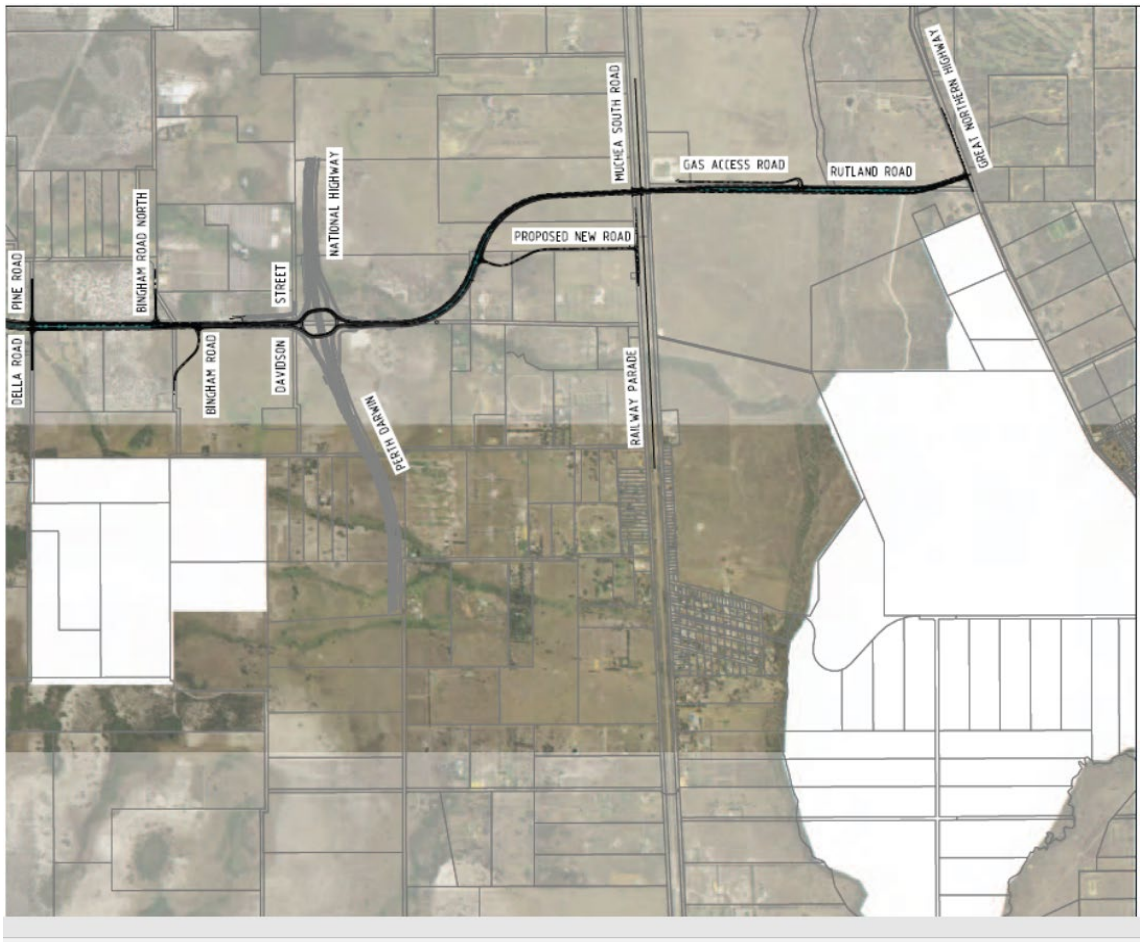


Figure 6-3 Proposed Neaves-Rutland Road connection (DPLH)

The proposed north-south spine road would also connect to the realigned Neaves-Rutland Road approximately mid way between Tonkin Highway and Railway Parade (connection not shown in Figure 6-3).

The DPLH has identified that there may be potential protected flora species present on the proposed alignment for the new/duplicated Rutland Road. This needs to be further investigated and a suitable solution found to protect this connection.

Neaves Road will be a PRR west of Tonkin Highway and an ORR east of Tonkin Highway.

Railway Parade/spine road

A previous study[22] considered options for the treatment of Railway Parade and recommended that it be realigned west of the proposed IMT, with a four-way intersection with Stock Road about mid-way between the railway and Tonkin Highway. This would create a new north-south road midway between Tonkin Highway and the rail line (see Figure 6-1). The spine road is recommended to continue south of Stock Road to connect to the existing Sawpit Road, terminating at Maralla Road. The spine road would provide the following benefits:

- Elimination of the need for a level crossing where trains enter and exit the IMT.
- Retention of north-south connectivity, together with a convenient connection between Stock Road and Railway Parade.

[22] GHD. 2016. *Bullsbrook IMT Planning Study*

- Provision of a frontage road along the west side of the IMT to create a safe and efficient entry and exit for trucks servicing the IMT.
- Facilitate the development of the IMT and complementary surrounding industry.

The location of the intersection of the proposed north-south spine road with Stock Road is tied to the required separation distances from the railway line and Tonkin Highway, as well as the desire to align the road to the west of the City of Swan's waste facility site. This would place the intersection approximately 800 m from Tonkin Highway and 850 m from the railway line. A signalised intersection will need to be examined based on forecast traffic volumes, including the potential for grade separation in the future should it be required.

The Stock Road intersection is recommended to provide a 10 m x 10 m clearance to prevent OSOM vehicles from having to travel along GNH through the Bullsbrook townsite. The redirection of heavy vehicles away from the Bullsbrook town centre is strongly supported by the local community and all stakeholders.

The intersection with Warbrook Road is recommended to be designed to restrict/prevent the movement of industrial traffic south of Warbrook Road (through the proposed North Ellenbrook residential area). This is particularly important due to the attraction of a proposed interchange on Tonkin Highway approximately halfway between Warbrook and Maralla Roads which industrial traffic may seek to use as an alternative to the Stock Road interchange (see section 6.2.2.

IMT internal network

The IMT internal network has been discussed in detail in GHD (2016)[23].

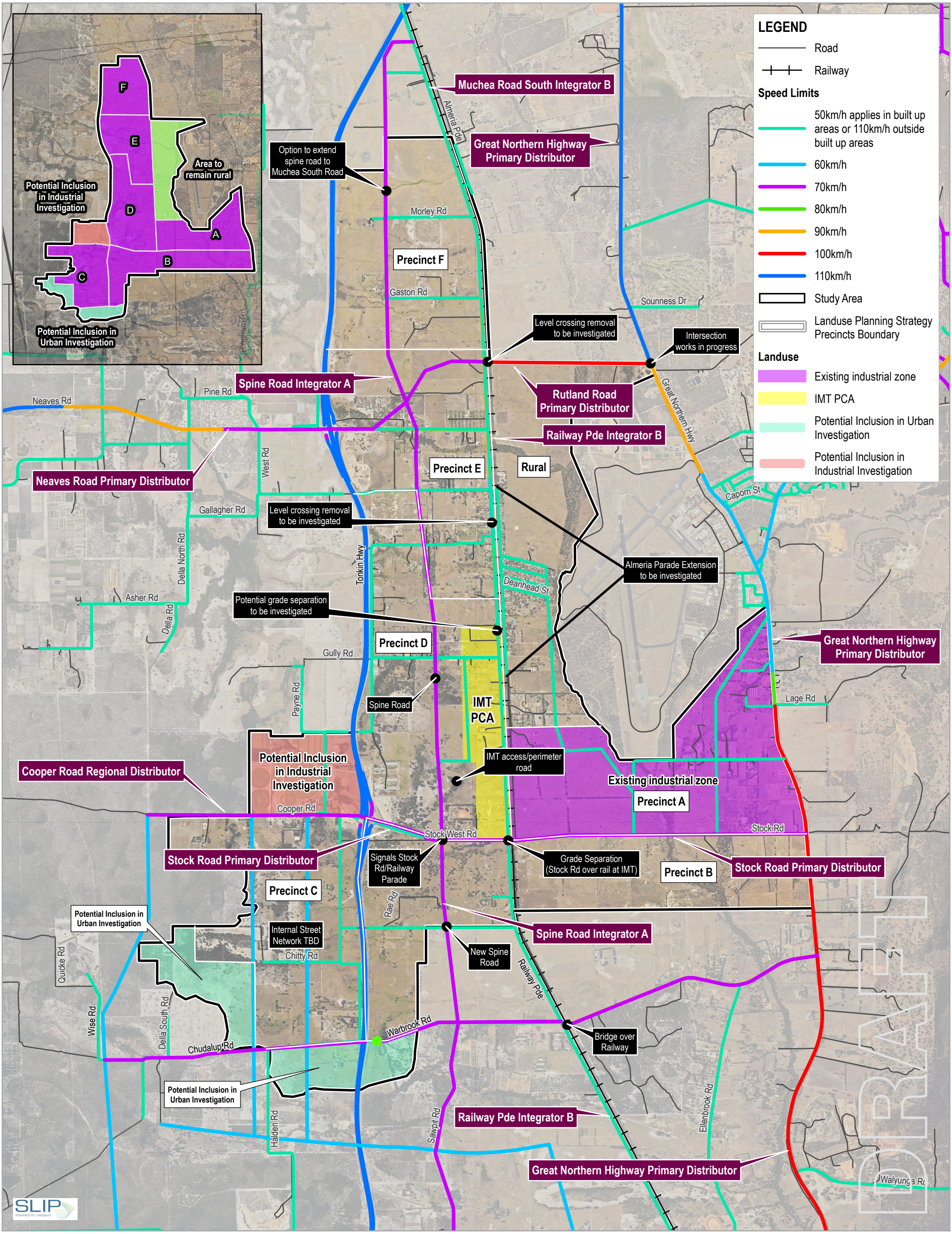
The IMT will require two access points to the road network, both of which will be on the realigned Railway Parade/Spine Road. It is noted that a direct connection from the IMT to Stock Road is undesirable due to potential congestion, and practical difficulties resulting from the gradient of the planned Stock Road grade separation over the railway line. Final alignments are not yet confirmed.

Proposed speed limits and road hierarchy (functional classification)

The current 100 km/h speed limit on GNH through South Bullsbrook (i.e., between Stock Road and Butternab Road) is likely to reduce when activity intensification in the area warrants the change. Traffic speeds will also be influenced by upgrades to intersections, including the signalisation of Stock Road/GNH.

Proposed speed limits and the proposed internal road hierarchy/functional classification in the Strategy area, can be seen in Figure 6-4.

[23] GHD, 2016, *Bullsbrook IMT Masterplan*



Paper Size ISO A3

0 0.5 1 1.5 2 Kilometres

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

GHD

Department of Planning, Lands & Heritage
Bullsbrook Freight and Industrial Land Use Planning Strategy

Proposed Internal Road Hierarchy and Speed Limits

Project No. 61-37134
Revision No. F
Date 1/18/2022

FIGURE 6-4

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Print date: 18 Jan 2022 - 09:59

Data source: GHD: Masterplan Boundary, Transport Network - 20200203, Created by: htaniza

Primary road reservation widths and cross-sections

Proposed road reservation widths for each of the primary roads within the Strategy area are shown in Table 4:

Table 4 Primary road reservation widths and cross sections

Road	Section	Classification	RAV status	Indicative reserve width	Cross section
Stock Road	GNH to Tonkin Highway	Primary Distributor	RAV 7 & OSOM	60.0 m	Two carriageways, each with • 2 x 3.5 m traffic lanes • 3.0 m outside shoulder • 1.0 m median shoulder 6.0 m median 3.0 m off-road cycleway 10.0 m vertical clearance (GNH to Spine Road)
Cooper Road	Tonkin Highway to west of study area	Regional Distributor	RAV 7	40.0 m	Single carriageway • 2 x 3.5 m traffic lanes • 2.0 m shoulders
Neaves Road	Tonkin Highway to rail line	Primary Distributor	RAV 7, OSOM	50.0 m	Two carriageways, each with • 2 x 3.5 m traffic lanes • 3.0 m outside shoulder • 1.0 m median shoulder 6.0 m median 3.0 m off-road cycleway 10.0 m vertical clearance (GNH to Spine Road)
Rutland Road	All	Primary Distributor	RAV 7, OSOM		
GNH	Warbrook Road to Brig Way	Primary Distributor	RAV 7 Remains OSOM	Variable, mostly per existing	Variable depends on local features. Focus on intersection treatments in the short to medium term.
Muchea South Road	Rutland Road to north of study area	Regional Distributor	RAV 4	40.0 m	Single carriageway • 2 x 3.5 m traffic lanes • 2.0 m shoulders

Road	Section	Classification	RAV status	Indicative reserve width	Cross section
Spine Road	All	Regional Distributor	RAV 7 & OSOM	40.0 m	Two carriageways, each with • 2 x 3.5 m traffic lanes • 2.0 m outside shoulder • 1.0 m median shoulder 6.0 m median

6.1.5 Level crossings

In the short term, the two existing formal level crossings of the railway at Strachan and West Roads that provide access to/from the existing rural-residential area on the east side of the railway will remain given the low frequency of train and vehicle movements across these crossings. There is potential for an increased level of control to be implemented at the crossings if deemed necessary (i.e., boom gates). In the long term, a comprehensive study is required to investigate the future treatment of level crossings in the area.

Should alternatives to level crossings be required, options include:

1. Extend Almeria Parade south to join with future internal roads within the industrial area to the immediate north east of the future Stock Road/railway line flyover.
2. Provide a grade separated crossing of the railway near the residential area. Potential locations include approximately 350 metres south of Deanhead Street or near Gully Road. A bridge would need to be sufficiently high to accommodate double stacked railway wagons and this may be difficult to achieve due to RAAF height restrictions. An underpass may also prove difficult due to the high-water table.

Option 1 is the most cost-effective option and is therefore the most recommended option to be delivered should the existing level crossings be removed at some point in the future. However, a second connection is necessary for both connectivity and emergency egress. Accordingly, option 2 is recommended to be investigated.

6.1.6 Traffic generation from study area – 2041+

Traffic generation from the Strategy area in 2041+ has been estimated based on the Main Roads WA ROM 24 data[24]. Forecast daily traffic volumes for 2041 network and ultimate land use are shown in Table 5.

Table 5 Forecast traffic generation from study area

ROM Zone	Vehicles per day (ultimate development)
1461	31,900
1460	34,400
1451	1000

[24] Title: ROM24 2041 Scenario - Link Volume Plot for Bullsbrook Freight and Industrial Development, All Day – Y41LU Y41NET Bullsbrook _R6 with Trip Adjustment2

ROM Zone	Vehicles per day (ultimate development)
1459	21,700
1458	22,500
1453	18,300
1452	16,000
1454	14,100
1455	13,100
1456	35,200
Total	**208,200**

6.1.7 Analysis of internal transport network

A review has been undertaken of the forecast traffic volumes using Main Roads WA ROM24 output for the 2041+ network and ultimate land use[25]. The ROM output includes Link Volume Plot (LVP) and Select-Link Plot (SLP) for the Bullsbrook study (model run/iteration #6). The latest updates include:

- Trip generation by the IMT is based on the information provided by the DoT (these are different to employment trips)
- Road network changes to replicate the proposed North Ellenbrook East and West District Structure Plans
- Final intersection treatments along Stock Road
- Two IMTs have been assumed in Zones 1458 and 1453 with approximately 3500 - 4000 additional vehicular trips (pcu) manually assigned to these two zones
- Assumed IMT capacity of 250,000 TEUs per annum for both terminals.

Austroads Guide to Traffic Management Part 3 indicates mid-block capacities for urban roads (Table 6 and Table 7 refer).

[25] DPLH advised of a minor discrepancy in the ROM. Approximately, 8,600 trips/day between Zones 546 and 548 use GNH as minor roads are not modelled in ROM. It is acknowledged therefore that forecast volumes on GNH are likely to be inflated in the vicinity of Zones 546 and 548.

Table 6 Typical mid-block capacities for urban roads with interrupted flows (Austroads)

Type of lane	One-way mid-block capacity (pc/h)
Median or inner lane	
Divided road	1000
Undivided road	900
Middle lane (of a 3 lane carriageway)	
Divided road	900
Undivided road	1000
Kerb lane	
Adjacent to parking lane	900
Occasional parked vehicles	600
Clearway conditions	900

Table 7 Road Capacities Road Reserves Review

Road Type	Capacity
Regional Roads	
Freeway (100km/h)	
4 lanes	60,000
6 lanes	90,000
8 lanes	120,000
Suburban Highways (80km/h) / Expressways	
4 lanes	54,400
6 lanes	81,600
8 lanes	108,800
Urban Arterials	
4 lanes undivided	29,000
4 lanes divided	38,000
6 lanes divided	58,000
District Roads	
2 lanes	12,000
4 lane undivided	14,000
4 lane divided (no parking)	30,000
4 lane divided (minimal frontage access	38,000
6 lane divided (no parking)	46,000
6 lane divided (minimal frontage access	58,000

Assuming mid-block capacities from Table 7 are 10% of daily capacity, then the following theoretical capacity applies to single and dual carriageways within the study area:

- Single carriageway one lane in each direction: 12,000 vehicles per day (vpd) (600 vehicles per hour x 2 x 10) - 18,000 vpd (900 vph x 2 x 10)
- Dual carriageway two lanes in each direction: 38,000 vpd (1000 vph + 900 vph x 2 x 10)

The study area is broken down into separable portions for ease of comment (northern section followed by central sections). An extract of the ROM is included for each section and a legend showing road cross sections is as follows:

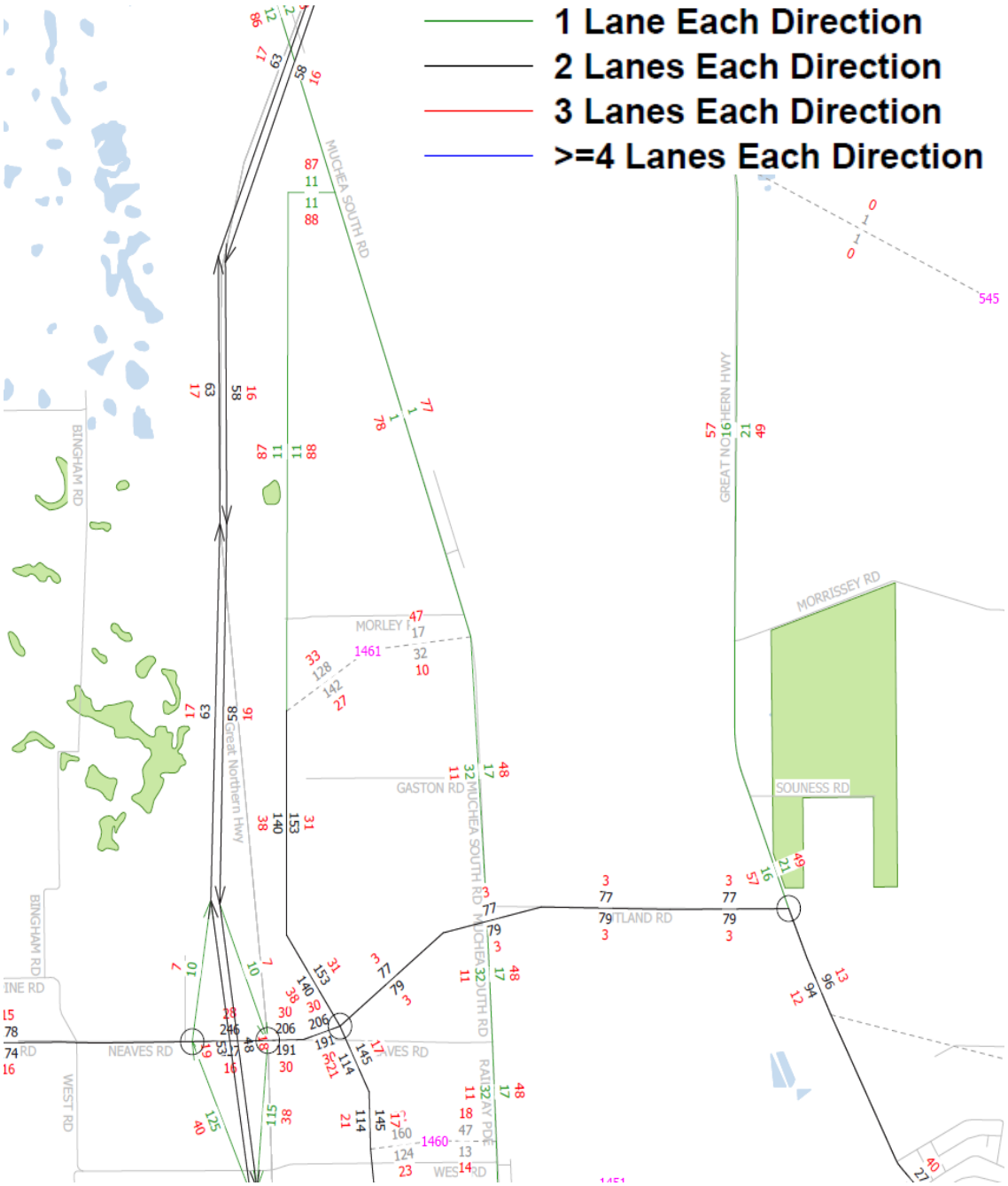


Figure 6-5 ROM Plot 2041+ Network at ultimate development (northern section)

Comparison of traffic volumes at 2041+ with capacity on the roads proposed as single carriageway in the northern section (Figure 6-5) indicates no issues (single carriageway capacity 12,000-18,000 vpd).

Comparison of traffic volumes with capacity on the roads proposed as dual carriageway indicates no issues (dual carriageway capacity 38,000 vpd). The section of Rutland Road between the proposed Spine Road and the Tonkin Highway ramp will need consideration of intersection geometry at each traffic signal. A check using Highway Capacity Software indicates three lanes in each direction are required.

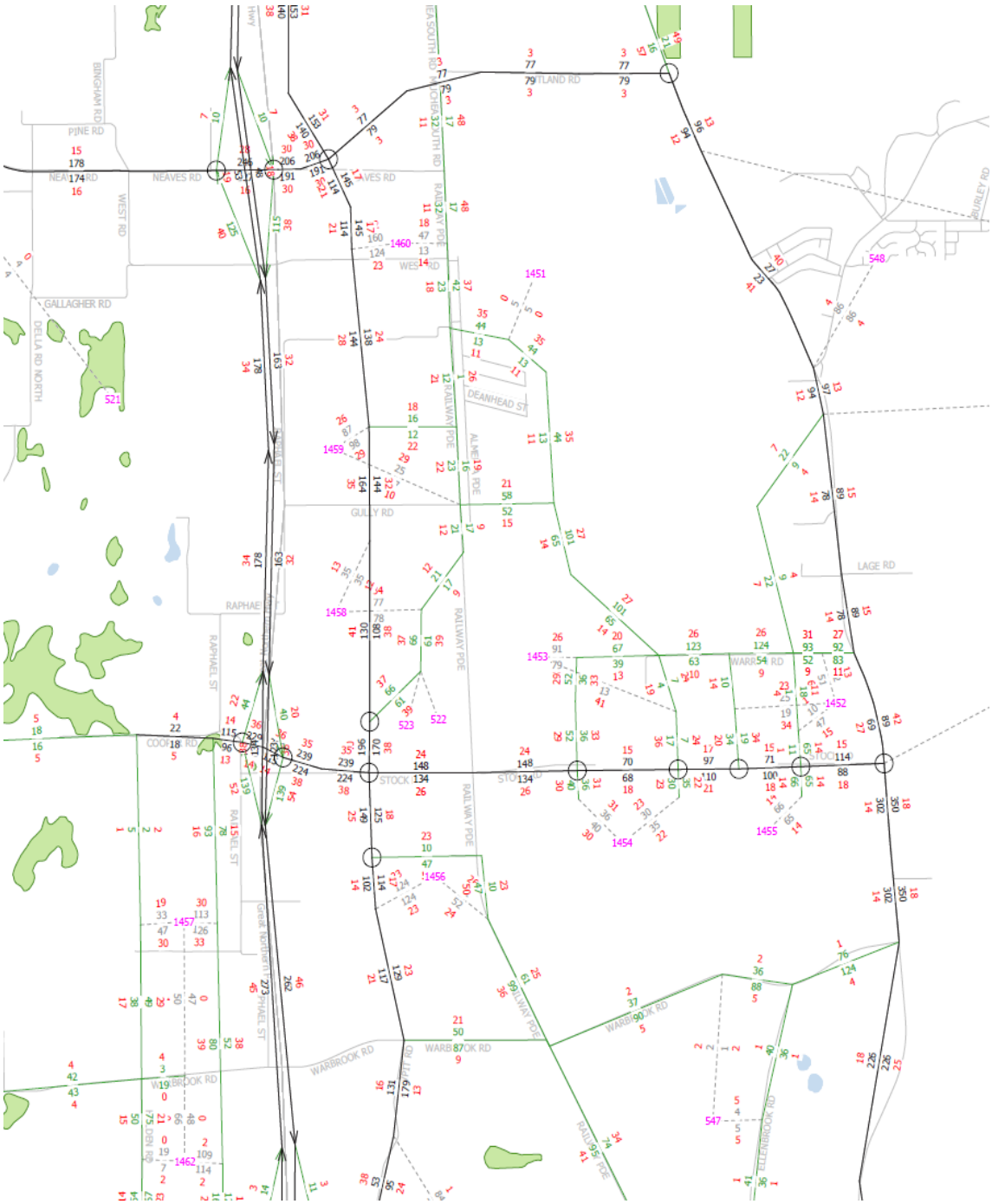


Figure 6-6 ROM Plot 2041+ Network ultimate development (central section)

Comparison of traffic volumes at 2041+ with capacity on the roads proposed as single carriageway in the central section (Figure 6-6) indicate no issues (single carriageway capacity 12,000-18,000 vpd).

Comparison of traffic volumes with capacity on the roads proposed as dual carriageway indicate no issues (dual carriageway capacity 38,000 vpd), with the exception of Stock Road between Tonkin Highway and the proposed north-south spine road (46,300 vpd forecast), which may require three lanes in each direction, not two as indicated on the ROM plot. A review using Highway Capacity software indicates three lanes in each direction is required to achieve a LoS of D.

GNH is proposed as a dual carriageway with two lanes in each direction. Forecast daily volumes of 60,500 vpd on GNH just south of Stock Road are above LoS C capacity (54,400 vpd from Road Reserves Review Table 7) but below the practical capacity of the road.

As traffic volumes approach full development levels, intersection treatments at Warbrook Road/GNH and Warren Road/GNH will require major upgrade, e.g., roundabout/signals. Warbrook Road provides an important road in the network with forecast volumes to 20,000 vpd indicating this road should remain open to serve the development with access across the rail line.

The capacity for a freeway with two lanes in each direction, is 60,000 vpd at a level of service of C (Table 7). The forecast traffic volume on Tonkin Highway (north of Warbrook Road) on full development is 53,500 vpd, which indicates adequate capacity on Tonkin Highway. It is noted however that daily volumes south of a proposed new interchange at Ellenbrook North (East/West) are 92,400 vpd indicating ultimate upgrade of Tonkin Highway is likely to be required to three lanes in each direction.

The intersection requirements on the major internal roads will need to be determined by detailed analysis, however based on the forecast traffic volumes, traffic signals or roundabouts will likely be required (Table 8).

Table 8 Likely intersection requirements

Intersection	Forecast traffic volumes vpd	Intersection treatment
Rutland Road	~20,000	
• GNH	~19,000	Roundabout/Signals
• Muchea South Road	~5,000	Flyover
• Spine Road	>25,000	Roundabout/Signals
Stock Road	~30,000	
• GNH	>65,000	Roundabout/Signals
• Spine Road	>36,000	Roundabout/Signals

Austroads Guide to Traffic Management Part 6 Intersections, Interchanges and Crossings indicates the suitability of traffic control to different road types based on operational and Safe Systems objectives as shown in Table 9.

Table 9 Suitability of traffic control to different road types based on operational and Safe Systems objectives

Road type	Primary arterial	Secondary arterial	Collector and local crossing road	Local street
Roundabouts				
Primary arterial	A	A	X	X
Secondary arterial	A	A	A	X
Collector & local crossing road	X	A	A	O
Local street	X	X	O	O
Traffic signals				
Primary arterial	O	O	O	X
Secondary arterial	O	O	O	X
Collector & local crossing road	O	O	X	X
Local street	X	X	X	X
***Stop* signs or *give way* signs**				
Primary arterial urban/(rural)	X/(X)	X/(O)	A	A
Secondary arterial urban/(rural)	X/(O)	X/(O)	A	A
Collector & local crossing road	A	A	A	A
Local street	A	A	A	A

A = Most likely to be an appropriate treatment
O = May be an appropriate treatment
X = Usually an inappropriate treatment.

6.2 External transport network

The external transport network will link the Bullsbrook industrial precinct with origins and destinations throughout Western Australia and beyond. The key links are as listed in Table 10.

Table 10 External transport links

Origin / Destination	Mode	Comments
Bullsbrook residential area	Road	via Stock Road and Rutland Road
Regional areas north and south of Perth	Road	via Tonkin Highway and GNH
	Rail	via Millendon – Narngulu freight railway
Muchea industrial area	Road	via Tonkin Highway and GNH, with a minor contribution via Muchea South Road
North-west corridor	Road	via Neaves Road or Tonkin Highway / Gnangara Road. There may be a need to consider an additional route via Cooper Road in future
Perth CBD	Road	via Tonkin Highway
Perth Airport	Road	via Tonkin Highway
Fremantle and Kwinana	Road	via Tonkin Highway
	Rail	via Millendon–Narngulu freight railway
Kewdale & Forrestfield Canning Vale	Road	via Tonkin Highway
	Rail	via Millendon–Narngulu freight railway
Eastern States	Road	via Tonkin Highway and/or GNH to Roe Highway
	Rail	via Millendon–Narngulu freight railway with connection to standard gauge line at Millendon or Kewdale

6.2.1 Rail network

The Millendon–Narngulu freight railway provides direct connections to Fremantle, Kwinana, Geraldton, and various points through the northern wheatbelt. It is expected that rail freight into and out of the precinct will travel via the proposed IMT on the western side of the railway line.

Initially, any trains to/from the north of Bullsbrook will use the southern approach siding, entering and leaving it via a crossover at the north end of the siding. The terminal has been designed to allow retrofitting of a direct entry/exit to the north, should this ever be required by a change in demand. In addition, it is also likely that electrification of the rail network and the introduction of autonomous trains will see most freight travel on rail rather than road. This possibility is not precluded by this plan.

For interstate rail traffic to access the Bullsbrook IMT, this would require substantial network changes and upgrades. In particular:

- Upgrading of the railway between Millendon Junction and Bullsbrook to dual gauge, with higher axle capacities. This will likely necessitate that one or more bridges or culverts be reconstructed.
- Provision would need to be made to accommodate 1800-metre trains in the southern approach siding, with internal sidings being capable of expansion to 900 metres, thus allowing an interstate train to be accommodated in two rakes.
- Turnouts and sidings within the terminal would need to be spaced to allow future upgrade to dual gauge if necessary.

Following the above, the design of all rail corridors should allow for standard gauge conversion in the future. Additionally, any new grade separations should allow for future double-stacked rolling stock.

6.2.2 Road network

The NESRPF and the *Perth and Peel @ 3.5 Million Transport Network* both include an overview of the anticipated road freight network in the north-east and north-west corridors (Figure 3-3).

The key external roads affected by the industrial precinct and IMT will be:

- Great Northern Highway
- Tonkin Highway
- Neaves Road and Gnangara Road
- Muchea South Road
- North-south spine road
- Railway Parade
- Maralla Road

Great Northern Highway

GNH will remain as an important transport route, though most freight traffic will be reallocated to Tonkin Highway. It is expected that truck traffic to and from the Eastern States would continue to use the more direct route via GNH unless regulatory controls were instituted. The largest HWL and OSOM vehicles are proposed to be directed to the new north-south Spine Road, bypassing the Bullsbrook town centre. GNH is expected to be duplicated at some point in the future, which will replace the intermittent overtaking provisions south of the Bullsbrook townsite.

Tonkin Highway extension

The Tonkin Highway extension between Reid Highway and Muchea was completed in mid-2020. It has become the primary north-south road to/from the study area, particularly for industrial/freight traffic coming from within the Perth metropolitan area.

Neaves Road and Gnangara Road

Neaves Road and Gnangara Road are the primary east-west links between the north-west and north-east corridors. Traffic to/from the northern part of the north-west corridor (i.e., Pinjar and Neerabup industrial areas and adjacent residential areas) would likely use Neaves Road as the main connector. Traffic to/from Wangara and surrounding areas is more likely to use Tonkin Highway and Gnangara Road.

Muchea South Road

Although it currently forms an important link between Neaves Road and Brand Highway, the Muchea South Road lost this regional traffic once the Tonkin Highway extension opened. Muchea South Road will still carry some north-south traffic and will service those parts of the industrial precinct north of Neaves Road.

North-south spine road

A new north-south spine road would be developed that extends Sawpit Road northward to Neaves Road. It would be designed to accommodate RAV 7 and OSOM access between Stock Road and Neaves Road, with restrictions on industrial traffic through movement south of Warbrook Road.

Railway Parade

With the opening of the Tonkin Highway extension and the construction of a north-south spine road, Railway Parade would no longer provide the primary north-south route west of the railway line. It would be realigned to the south of Stock Road and to the north of the IMT.

Future east-west link road

Connectivity to/from the west could potentially become an issue over the longer term. Currently, Gnangara and Neaves Roads are the only two east-west connections with the Bullsbrook Industrial precinct and these two connections are 18 km apart (Gnangara Road is 11 km to the south and Neaves Road connects to the precinct's northern boundary). Accordingly, an additional east-west road connection between the North-West Sub-region (the future Whiteman – Yanchep Highway) and the Bullsbrook industrial centre may be required as a lack of direct connectivity to/from the west may reduce the efficiency of transport operations in the precinct and impede workforce access.

Several roads have been considered for this connection, including Cooper Road, Warbrook Road and Maralla Road.

As mentioned in section 7.1.4, the NESRPF recognises the potential longer-term opportunity to provide an additional and more direct east-west road connection between the North-West Subregion and the North Ellenbrook/Bullsbrook industrial centre utilising the Cooper Road reserve alignment. Future investigations to determine the feasibility of this road connection will need to include consideration of efficiency benefits for the broader regional transport network in this area and the potential impacts on the Gnangara Priority 1 Water Protection Area, adjacent bushland, and other environmental attributes.

Warbrook Road was considered; however Main Roads WA considers an interchange at this location to be too close to Stock Road (2.35 km south). Maralla Road was also considered as a potential alignment but was also discarded due to environmental constraints.

Another possible option is for an interchange to be built at Tonkin Highway, approximately mid-block between Warbrook and Maralla Roads, however this interchange is likely to service the North Ellenbrook urban cells only with a potential connection from this to a future east-west link still to be determined.

6.2.3 Analysis of external transport networks

Forecast traffic volumes for the 2041 network and ultimate land use are summarised in Table 11 together with commentary.

Table 11 Forecast traffic volumes 2041 network and ultimate volumes

Road	Carriageway	Capacity vpd[26]	Forecast vpd	Comment
Great Northern Highway				
• North of Stock Road	Two lanes in each direction	54,400	24-25,000	No capacity issues anticipated
• South of Stock Road	Two lanes in each direction	54,400	<65,000	Forecast daily volumes above LoS C capacity but below practical capacity of road.
Tonkin Highway				
• North of Stock Road	Two lanes in each direction	60,000	35,000	No capacity issues anticipated
• South of Stock Road	Two lanes in each direction	60,000	56,000	No capacity issues anticipated

As indicated in Table 8, major intersections are likely to require traffic signals and roundabouts, specifically Rutland Road/GNH and Stock Road/GNH. Future dual carriageway of GNH will require channelization at unsignalised intersections to include right and left turn pockets.

6.3 Constraints to delivery of the transport network

There are several challenges/constraints that will need to be overcome to deliver an effective transport network for the Bullsbrook Industrial Area. These are summarised in the following sections.

6.3.1 Environmental[27]

- Gnangara Priority 1 Water Protection Area lies to the west of the precinct.
- Proximity of Conservation Category Wetlands.
- High water table through much of the precinct.
- Height restrictions posed by the air base may restrict bridge heights/locations.

6.3.2 Funding

- Cost to build transport infrastructure and who pays/delivers?
- Developer contribution plans will be required.

[26] Road reserves review

[27] Refer to Bullsbrook Freight and Industrial Land Use Planning Strategy Environmental Study (GHD 2021) for further information

6.3.3 Timing and intensity of development[28]

- How many jobs will the precinct create, when will they be created and where within the precinct will most of them be located? These will determine the nature, form and staging of the transport network, including the potential for frequent public transport services and the need to cater for active transport.

6.3.4 Geographic separation and connectivity

- The distance between the precinct and other activity centres makes it difficult to provide extensive connectivity, as well as encourage a high proportion of access by active transport. However, this will be addressed to some degree by the development of two urban cells to the south of Warbrook Road (Ellenbrook North (West and East) District Structure Plan areas).

6.3.5 Stock Road / Tonkin Highway interchange

- The Stock Road/Tonkin Highway interchange cannot accommodate the largest of vehicles (up to 53.5 m in length and a 10 m x 10 m clearance requirement). This constraint means that the development of a north-south spine road between Stock and Neaves Roads that is able to accommodate RAV 7 and OSOM vehicles is essential in order to prevent these large vehicles from having to travel along GNH and through the Bullsbrook town site.

6.3.6 Social

- Impact of new transport links on private land/property.

6.4 Opportunities for delivery of the transport network

6.4.1 Heavy vehicles

- Delivery of Stock Road connecting to GNH, north-south spine road from Stock Road to Neaves Road and a realigned Neaves-Rutland Road, each with capacity to accommodate a 10 m x 10 m clearance, would allow RAV 7 and OSOM vehicles to access the proposed IMT and will provide a significant reduction in the number of heavy vehicles going through the Bullsbrook town centre.

6.4.2 Safety

- Grade separation from the railway line will improve safety.

6.4.3 Connectivity

- Increased intensity of development will improve the ability to provide transport links to, from and through the precinct, particularly east-west.
- An increased population base in the Bullsbrook area and Ellenbrook North will increase demand on the transport network.
- Improved transport links will allow for travel to the area from current low self-contained employment areas.

[28] Refer to Bullsbrook Land Use Strategy (GHD 2021) and the Bullsbrook Freight and Industrial Market Needs Assessment (Macroplan 2020) for information on likely land development and staging

7. Summary & Recommendations

7.1 Summary

Regional and sub-regional planning for the Perth metropolitan region has identified a long-term requirement for an industrial precinct to be developed at South Bullsbrook, in Perth's north-east corridor. The industrial precinct is to include an intermodal freight terminal as its focal point, with much of the surrounding industrial precinct featuring services and industries complimentary to the IMT.

Previous studies have confirmed that the preferred location for the IMT is west of the Millendon Junction – Narngulu railway, north of Stock Road. A planning control area (No 115) has been established over a site stretching approximately 2,000 metres from Stock Road to Gully Road.

The IMT will primarily serve as a distribution point for containerised freight from Fremantle inner and outer harbours into Perth's north-east and north-west corridors, and regional areas north of Perth. Initial terminal capacity has been estimated as 150,000 TEU/annum, growing ultimately to 250,000 TEU/annum.

The Bullsbrook Freight and Industrial Land Use Planning Strategy area is forecast to generate 208,200 vpd onto the surrounding road network upon full development. Road access to the IMT will be via a new north-south spine road to the west of the site. The new spine road will connect to an upgraded Stock Road, which will be the major link east to GNH and west to Tonkin Highway.

7.2 Recommendations

Several recommendations have been developed to give effect to the transport strategy for the Bullsbrook industrial precinct. These are summarised in Table 12.

Table 12: Recommendations

Number	Item	Recommended action	Stakeholders	Timeframes
1	Stock Road	- Priority for development/construction. - Regional road (status to be determined). - Include it as a RAV 7 route. - Upgrade to dual carriageway and extend it eastward to connect Tonkin Highway with GNH. - Will likely require three lanes between Tonkin Highway and the spine road post 2041. - Once proposed development in the area that will generate additional freight train movements and/or traffic volumes is known, undertake an ALCAM[29] assessment to determine need for grade separation over the railway. - Consider renaming it to Cooper Road to avoid confusion with Stock Road south of Perth. - Section between IMT and GNH to accommodate OSOM vehicles.	MRWA, DPLH, City of Swan, PTA	Prior to establishment of IMT. When proposed development is known that will generate additional freight train movements and/or traffic volumes that will create a safety issue without separation.
2	Railway Parade	- Realign the section south of Stock Road to connect to future spine road (due to grade separation of Stock Road over rail and construction of IMT). - Realign the section north of the IMT so that it aligns with connectivity requirements of the IMT.	City of Swan, DPLH	Upon development of the IMT and/or the development of the land south of Stock Road (west of the railway). When Stock Road is grade separated over the railway.

[29] Australian Level Crossing Assessment Model

Number	Item	Recommended action	Stakeholders	Timeframes
3	North-south spine road	- Construct a restricted link from the northern end of Sawpit Road to Neaves Road. - The intersection with Warbrook Road should restrict through movements south of Warbrook Road to prevent/discourage industrial traffic movement through residential area to access PDNH at the proposed new interchange located between Warbrook and Maralla Roads. - Intersection with Stock Road to be approximately midway between Tonkin Highway and railway line (west side of City of Swan recycling centre). - Section between Stock and Neaves Roads to accommodate RAV 7 and OSOM access.	City of Swan, DPLH	Prior to establishment of IMT. Upon subdivision of the industrial area north of Warbrook Road. Restriction on through access south of Warbrook Road should be implemented at the time of subdivision of the North Ellenbrook (East and West) District Structure Plan areas.
4	Neaves Road	- Realign, duplicate, and connect with Rutland Road and GNH with a grade separation over the railway line. - Potential to reclassify realigned route to Primary Regional Road status. - To accommodate RAV 7 and OSOM access.	MRWA, City of Swan, DPLH	Prior to establishment of IMT. As development of Neerabup and Bullsbrook industrial areas occurs.
5	Great Northern Highway	- Minor upgrades will be required at new intersections created by the industrial precinct. - Consider duplication of some sections, particularly the southern approach to the Bullsbrook townsite.	MRWA, City of Swan, DPLH	Upon development of industrial lots fronting GNH.

Number	Item	Recommended action	Stakeholders	Timeframes
6	Almeria Parade (north of Stock Road)	- Consider alignment of Almeria Parade and extend south to connect to Stock Road and the future industrial area at Lot 300.	City of Swan, DPLH	Upon development of Lot 300. Upon extension of Stock Road to the east.
7	Planning process	- To consider the potential for freight transport infrastructure to influence (and be impacted by) residential or other incompatible urban development. - Several parcels of land may have frontage access to only one road with limited alternatives. Each "cell" within the industrial area will be required to have at least two access routes to different destinations to allow for evacuation and access by emergency services. - Access roads to the south west corner of the strategy area will be required for efficiency and convenience and to provide an interface between the industrial land and the proposed residential extension from the south. - Transport infrastructure planning for the industrial precinct to consider restrictions posed by RAAF Base Pearce.	Planning agencies, DPLH	Structure planning phase
8	Railway crossings	- Undertake a comprehensive study into level crossings of the railway within and immediately surrounding the study area. - Perform ALCAM assessments as required. - Design of any grade-separated crossings of the railway should accommodate double stacked railway wagons (height of 7.2 metres).	City of Swan, MRWA, PTA, Rail operator, DPLH	Prior to establishment of the IMT. Grade separation to be assessed once proposed development is known that will generate additional freight train movements/and or traffic volumes which

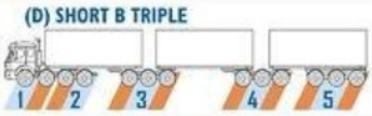
Number	Item	Recommended action	Stakeholders	Timeframes
				may create safety issues.
9	Road design	- New roads must accommodate 36.5-metre road trains, i.e., road engineering to incorporate relevant swept path geometry, acceleration and deceleration provision, and other key design elements. - Design and posted speeds *within* the industrial precinct must reflect safe system principles. Lower posted speeds are also likely to reduce the differential between light and heavy vehicle travel speeds, thereby reducing unsafe overtaking due to driver frustration.	City of Swan, MRWA, DPLH	Design phase.
10	Bus services	- Undertake bus network planning. The focus should be on the major north-south spines of GNH and Railway Parade/Spine Road to link residential with employment and service precincts. - Provide safe pedestrian crossing facilities near stops (particularly near signalised intersections).	Transperth/PTA, City of Swan, MRWA, DPLH	Following substantial completion of the subdivision and land development process.
11	Active transport infrastructure	- Provide off-road paths along the primary routes to cater for walking and cycling. Routes include: GNH as far north as Rutland Road, Stock/Cooper Road, Neaves/Rutland Road, Maralla Road, Warbrook Road, Railway Parade, the connector road for the potential mid-block interchange with Tonkin Highway between Maralla and Warbrook Roads, and the proposed north-south spine road/Sawpit Road. - Elsewhere, road reserves should be wide enough to accommodate generous shoulders suitable for cycling to provide a “last mile” connection from the primary routes. - Requirement for the provision of end of trip facilities to be included in development approvals for the industrial sites.	MRWA, City of Swan, Department of Transport, DPLH	Design phase of new roads.

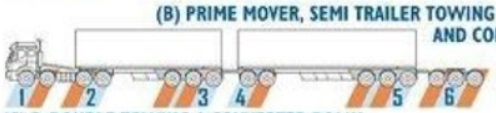
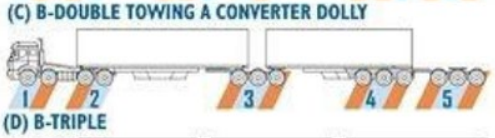
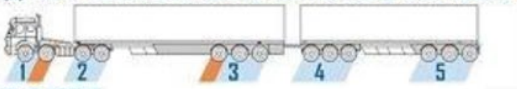
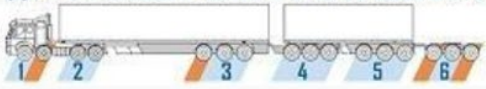
Number	Item	Recommended action	Stakeholders	Timeframes
12	Railway line	- Should Bullsbrook become a destination for interstate rail traffic, substantial network changes and upgrades would be required, including: o Upgrading of the railway between Millendon Junction and Bullsbrook to dual gauge, with higher axle capacities. This will likely necessitate that one or more bridges or culverts be reconstructed. o Provision to accommodate 1800-metre trains in the southern approach siding, with internal sidings being capable of expansion to 900 metres. o Turnouts and sidings within the terminal would need to be spaced to allow future upgrade to dual gauge if necessary. o The design of all rail corridors should allow for standard gauge conversion. Any new grade separations should allow for future double-stacked rolling stock. o Trains to/from the north would initially use the southern approach siding by way of a crossover. If demand grows in the future, the IMT layout must be flexible enough to allow for a direct approach from the north.	PTA, Railway Operator, DPLH	Once determination is made to route interstate rail to/from the Bullsbrook IMT.

Appendices

This document is in draft form. The contents, including any opinions, conclusions or recommendations contained in, or which may be implied from, this draft document must not be relied upon. GHD reserves the right, at any time, without notice, to modify or retract any part or all of the draft document. To the maximum extent permitted by law, GHD disclaims any responsibility or liability arising from or in connection with this draft document.

Appendix A - RAV Network Configurations

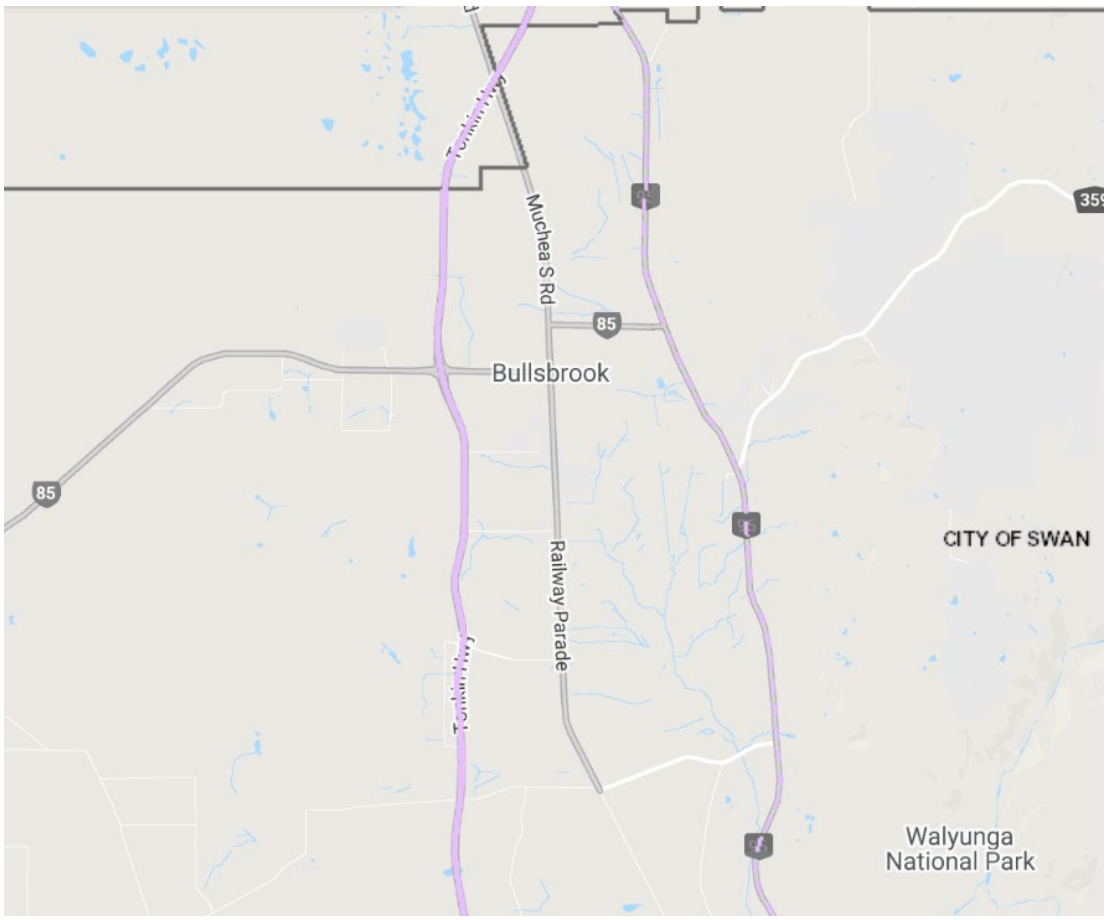
Category & RAV Network	Vehicle Description and Configuration	Length (m)	Max Mass (T)	Axle
Network 2	(A) PRIME MOVER, SEMI TRAILER TOWING A PIG TRAILER 	(A) ≤27.5	65.5	4
	(B) PRIME MOVER TOWING SEMI TRAILER 	(B) ≤20	47.5	3
	(C) B-DOUBLE 	(C) ≤27.5	67.5	4
	(D) SHORT B TRIPLE 	(D) ≤27.5	87.5	5
	(E) CAR CARRIER SEMI TRAILER 	(E) ≤25	42.5	3
Network 3	(A) PRIME MOVER, SEMI TRAILER TOWING A DOG TRAILER 	≤27.5	84	5

Network 4	(A) PRIME MOVER, SEMI TRAILER TOWING 6 AXLE DOG TRAILER 	≤27.5	87.5	5
Network 5	(A) PRIME MOVER, SEMI TRAILER TOWING A DOG TRAILER 	(A) >27.5, ≤36.5	84	5
	(B) PRIME MOVER, SEMI TRAILER TOWING A DOG TRAILER AND CONVERTER DOLLY 	(B) >27.5, ≤36.5	84+d	6
	(C) B-DOUBLE TOWING A CONVERTER DOLLY 	(C) >27.5, ≤36.5	67.5+d	5
	(D) B-TRIPLE 	(D) >27.5, ≤36.5	84	5
Network 6	(A) PRIME MOVER, SEMI TRAILER TOWING 6 AXLE DOG TRAILER 	(A) >27.5, ≤36.5	87.5	5
	(B) B-TRIPLE 	(B) >27.5, ≤36.5	87.5	5
	(C) PRIME MOVER SEMI TRAILER TOWING A 6 AXLE TRAILER & CONVERTER DOLLY 	(C) >27.5, ≤36.5	87.5+d	6

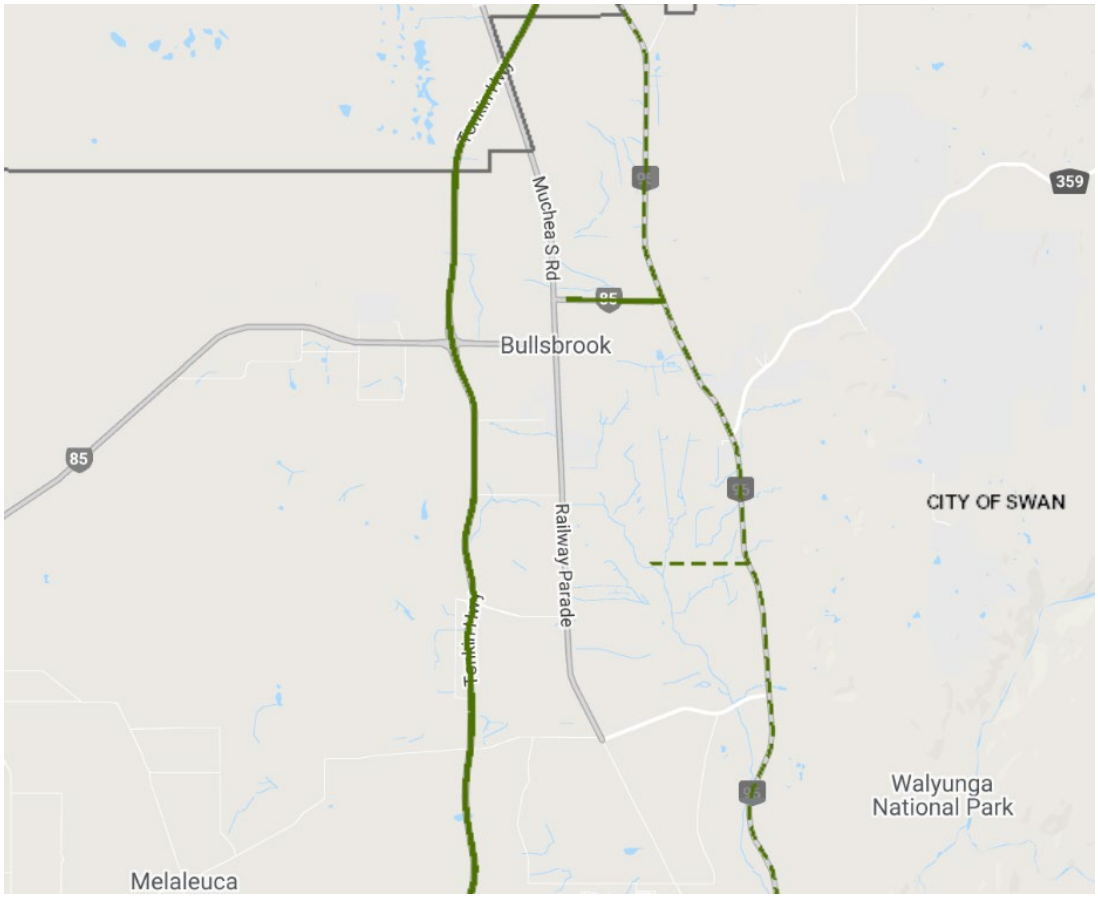
	(A) PRIME MOVER, TOWING SEMI TRAILER AND B DOUBLE  (B) B-DOUBLE TOWING A DOG TRAILER 	(A) >27.5, ≤36.5 (B) >27.5, ≤36.5	107.5 107.5	6 6

GNH is also approved for Tri Drive 4 combinations.

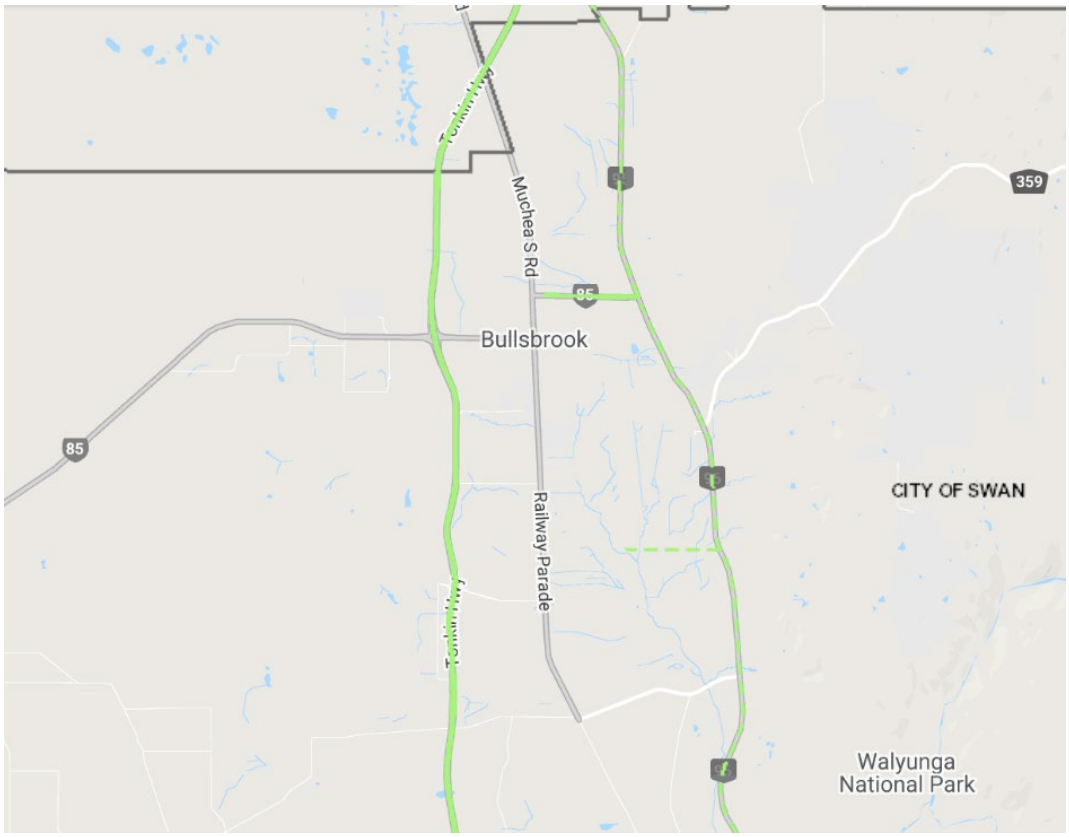
4	Vehicles not exceeding 36.5 m			
4(A)	Prime Mover, semi trailer & dog trailer		36.5	91
4(B)	Prime Mover, semi trailer & dog trailer towing a 2 or 3 axle converter dolly		36.5	91
4(C)	B Double towing a 2 or 3 axle converter dolly		36.5	71
4 (D)	B-Triple		36.5	91
4(E)	Prime Mover and semi trailer towing a B Double		36.5	111
4(F)	B-double towing a dog trailer		36.5	111



Network 7 RAV route (pink)



Network 6 RAV route (green)



Network 5 RAV route (light green)



Network 4 RAV route (blue)



Network 3 RAV route (light blue)



Network 2 RAV route (orange)

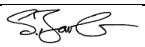
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Level 10
999 Hay Street
T: 61 8 6222 8222 F: 61 8 6222 8555 E: permail@ghd.com

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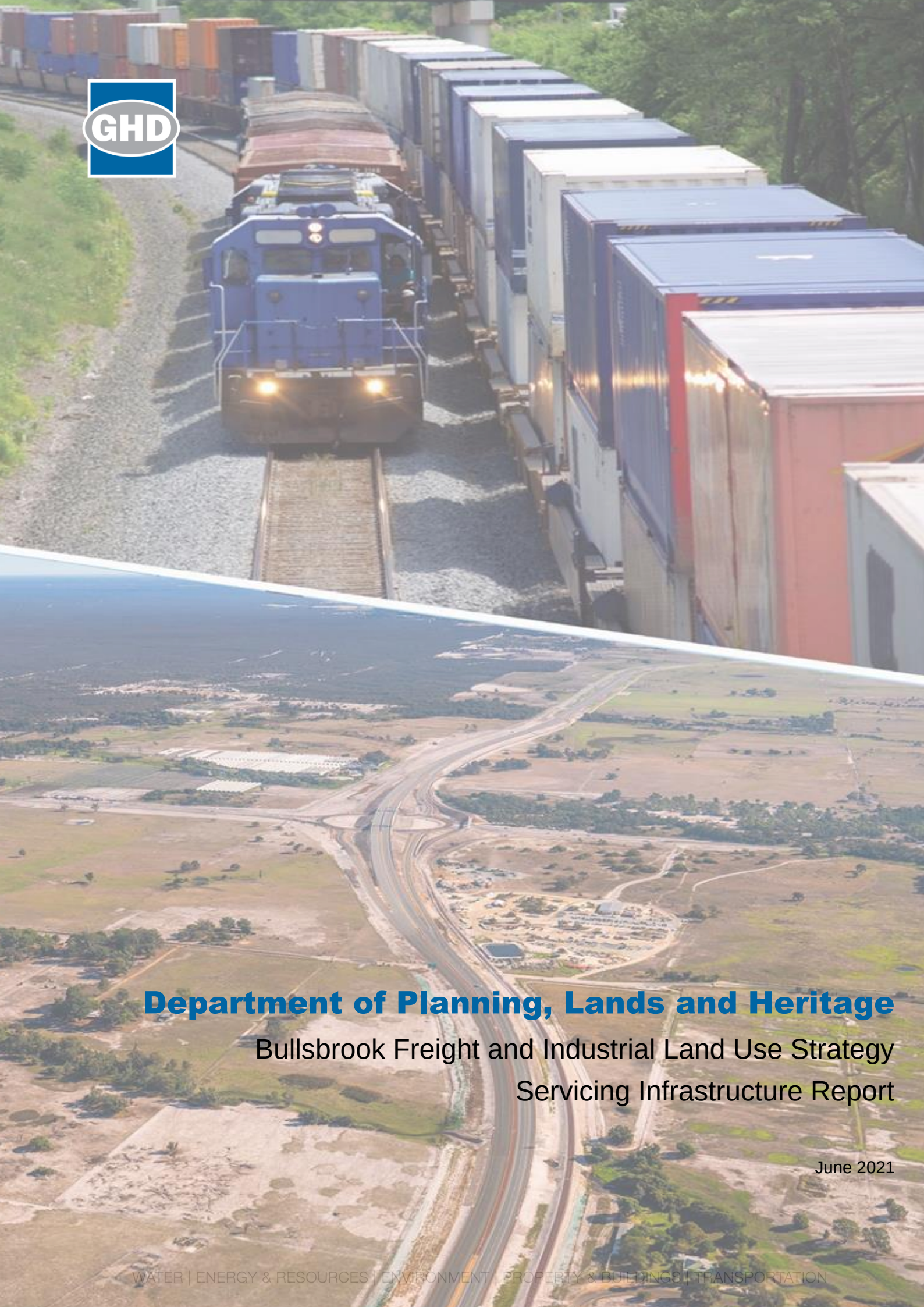
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Document Status

Revision	Author	Reviewer		Approved for Issue		
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Appendix F - Service Infrastructure Study



Department of Planning, Lands and Heritage

Bullsbrook Freight and Industrial Land Use Strategy

Servicing Infrastructure Report

June 2021

WATER | ENERGY & RESOURCES | ENVIRONMENT | PROPERTY & BUILDINGS | TRANSPORTATION

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Appendices

Appendix A – Metropolitan North East Sub-Regional Planning Framework

Appendix B – Bullsbrook Water Supply (Water Corporation, 2010)

Appendix C – Bullsbrook Wastewater Conceptual Planning Long-Term Scheme (Water Corporation, 2018)

1. Introduction

1.1 Background

The Bullsbrook Freight and Industrial Area covers an area by approximately 11 km (north to south) and 7 km (east to west). The area is relatively isolated from other established urban development fronts along the Perth Metropolitan coastal fringe. GHD has prepared this Servicing and Infrastructure Report to support the preparation of the Bullsbrook Freight and Industrial Land Use Planning Strategy.

The plan provides proposed servicing strategies for water, wastewater (sewerage), power, communications and gas infrastructure for the strategy area (refer to Figure 1). It should be noted that the area is currently not serviced with either reticulated potable water or sewerage. This report outlines the proposed servicing strategy for the area in consideration of stakeholder feedback, existing infrastructure networks and review of existing documentation as outlined in Section 1.3 below.

It is noted where feedback or clarification has not been received from servicing authorities an indicative plan has been provided which will require further detailed investigation and agreement with servicing authorities prior to subdivision and development.

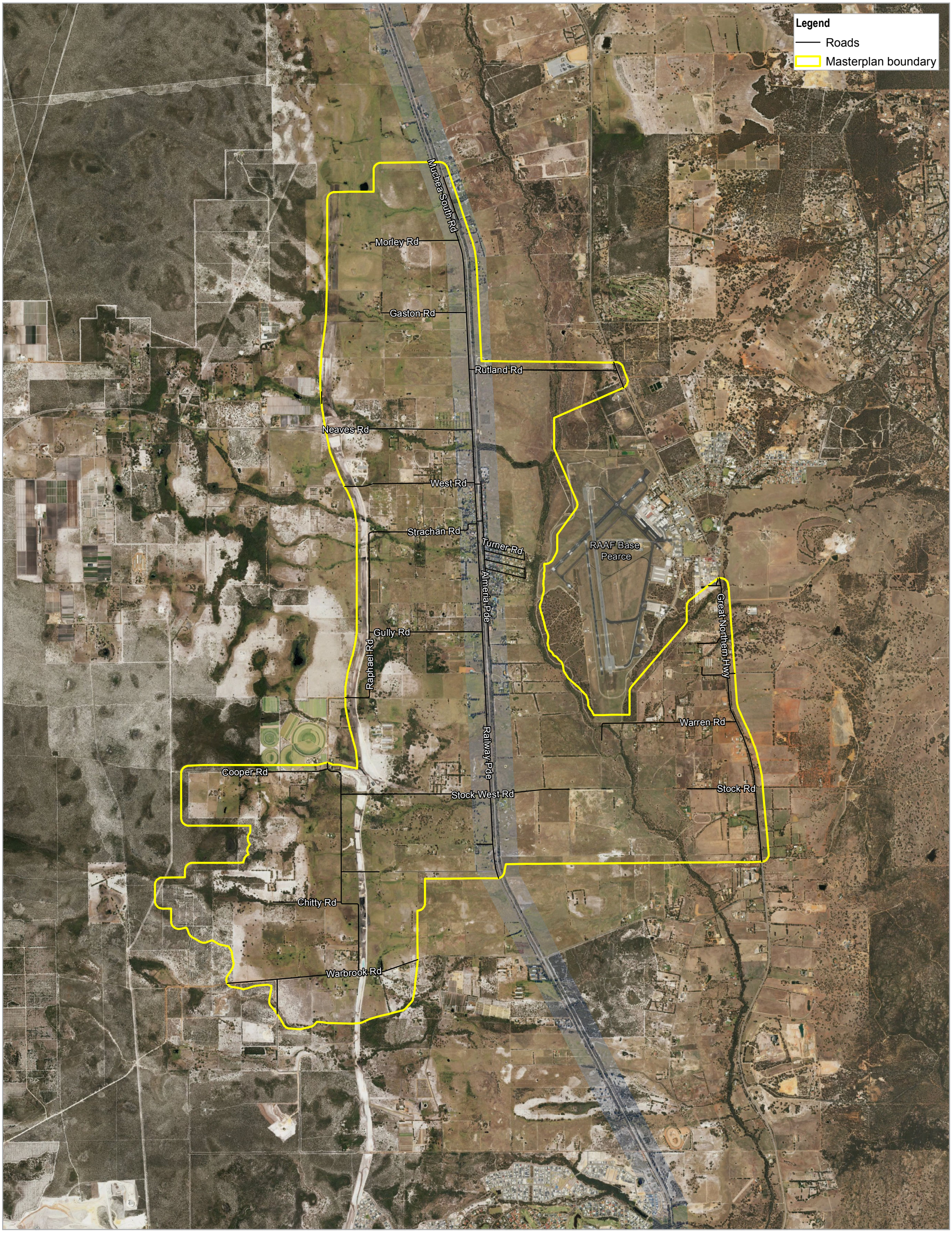
1.2 Purpose of this report

This report summarises a services infrastructure review to date, and includes a review of the water, sewerage, power, communications and gas for the purpose of industrial use.

1.3 Scope and limitations

Preliminary assessment for this Servicing and Infrastructure Report included a review of the water, sewerage, power, communications and gas infrastructure. Various reports were prepared over the past ten years focussing on further development of Bullsbrook and the proposed industrial area. The following documents were reviewed as part of the preliminary assessment, along with a meeting with the Water Corporation to review water and sewer capacity in the area:

- Worley Parsons assessment in 2012 in support of an IMT (Intermodal Terminal).
- City of Swan Masterplan from 2014 for the Bullsbrook Townsite, with mention of potential industrial demand.
- Current services infrastructure information obtained from Landgate, ESInet and DBYD.
- Distribution Network from Western Power Network Capacity Mapping Tool (NCMT).
- Water Corporation Bullsbrook Wastewater Conceptual Planning.
- Water Corporation Bullsbrook Water Supply.
- Metropolitan North East Sub-Regional Planning Framework (Appendix A). The framework establishes the long term distribution of land use for the north east metropolitan region including the Bullsbrook Freight and Industrial area. It aims to guide future growth and the provision of servicing infrastructure for the area.



Paper Size ISO A3

0 0.3 0.6 0.9 1.2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

DEPARTMENT OF PLANNING, LANDS & HERITAGE

BULLSBROOK MASTERPLAN

Masterplan Boundary

Project No. **61-37134**
Revision No. **A**
Date **18/06/2018**

FIGURE 1

G:\61\37134\GIS\Maps\Working\6137134_PlanBoundary_RevA.mxd
Print date: 18 Jun 2018 - 10:15

Data source: DPLH: Roads (Originally MRWA); Landgate: WA Now Aerial Imagery . Created by: jwball

In June 2019, comments were received from the relevant service authorities regarding the servicing of the Bullsbrook Freight and Industrial Area. These comments have been considered in the development of the infrastructure servicing strategies included in this report.

This report: has been prepared by GHD for Department of Planning, Lands and Heritage and may only be used and relied on by Department of Planning, Lands and Heritage for the purpose agreed between GHD and the Department of Planning, Lands and Heritage as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Department of Planning, Lands and Heritage arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section 1.4 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Department of Planning, Lands and Heritage and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

1.4 Assumptions

All information obtained from third parties (e.g. Water Corporation, Landgate, DBYD, Western Power) are correct at the time of writing this report.

2. Servicing

2.1 Water

The Bullsbrook Water Zone Planning Scheme (refer to Appendix B) has made limited allowance for the proposed industrial land directly north of Maralla Road. The proposed industrial area is currently not serviced with reticulated potable water and Water Corporation has not undertaken any long term planning for servicing the area. The current planned upgrades for the Bullsbrook area focus primarily on urban expansion to the north and east of the town site. With proposed development occurring in higher lying areas, elevated water storage tanks will be the focus of these expansions.

In the short to medium term, water supply for the proposed 'Urban Investigation' areas to the north of Ellenbrook and the southern parts of 'Precinct B' and 'Precinct C' industrial area may be supplied by the Gnangara Reservoir. The Water Corporation has recently constructed an 80 ML storage tank located in the Gnangara pine plantation to the west of the Ellenbrook suburb. The recently constructed Gnangara Reservoir (also referred to as Ellenbrook Reservoir in documentation) has capacity to service the proposed urban expansion to its direct north and north-east, and forms part of the strategy to reinforce the Bullsbrook town site expansion.

To meet additional industrial demand in the long term, increased storage will be required to supplement the Gnangara Reservoir supply and provide adequate capacity for the southern parts of the proposed industrial area. Future planning is required by Water Corporation to review the possibility of increased storage capacity at the Gnangara Reservoir site to service this area. Planning will need to comprise engineering investigations to determine the hydraulic limits of the gravity supply from Gnangara Reservoir (which has a top level of 93 m AHD).

To distribute the supply from the Gnangara Reservoir, the staged construction of the water distribution mains north of Maralla Road can be considered. Planning for this construction should be undertaken prior to the preparation of local structures plans. The water distribution main can be provided within the alignment of the proposed north-south road. Urban development will likely commence at the southern end adjacent to Maralla Road and extend progressively north.

Prior to defining the ultimate demand for the remainder of the strategy area, Water Corporation is not able to define the size and extent of a distribution main network and ultimate tank requirements that will be required to supply this entire industrial area. If a developer does construct a reticulation main to activate the area as shown in Appendix B, Water Corporation will likely have to construct a new distribution main supply in parallel in future.

Current planned upgrades to service the full urban development of the Bullsbrook Townsite area further identify construction of large (2 x 20 ML) water storage tanks from 2040. Water Corporation have identified that these tanks could potentially service the northern parts of the strategy area in proximity to the Bullsbrook Townsite (potentially Precincts E and F).

Challenges to be resolved to install a distribution main include arrangements for rail and highway crossings, including the alignment in Stock Road and crossing of Ellen Brook and consideration of the impact of shallow ground water in the low lying areas. These can be substantial cost items, and are likely to impact on the overall alignment and distance of water distribution. In addition, light and general industries have highly

variable water demands, and more detailed planning is required to enable estimates of scheme water demand.

2.2 Sewerage

There is currently no capacity within the Bullsbrook town site WWTP (Wastewater Treatment Plant) to accept discharge from any of the proposed industrial areas. The Bullsbrook WWTP, which is located at a site owned by the RAAF Pearce airbase to the north of the Bullsbrook townsite, is too small and has not been planned for expansion. The short term plan, over the next 5 years, is to decommission the Bullsbrook WWTP, which is approaching its maximum design capacity and the limits of sustainable disposal of treated wastewater to the local environment. No provision for wastewater reticulation for industrial land use has been planned for the strategy area.

Mapping of sewerage sensitive areas identifies that the majority of the strategy area is mapped as within 1km of significant wetlands, and part of Precinct F is mapped as "Habitats of specially protected water-dependent fauna, and within 1km of groundwater dependent threatened and priority ecological communities to the east of Neaves Road" (DPLH 2019).

Given the majority of the strategy area is mapped as sewerage sensitive areas, reticulated sewerage is required to enable the desired lot sizes and land use types. Note development in the majority of precincts proposes lot sizes below 1 hectare and a transition to intense industrial activity (e.g. light industry and service commercial) is proposed to occur over time in parts of the strategy area.

To accommodate future wastewater services for industrial land outside of the catchment in Appendix C, a new sewer scheme plan will be required to service the Strategy area. Connection to reticulated sewerage could be provided via a gravity sewer main along Railway Parade, with gravity flows west to east. The gravity sewer will connect to a wastewater pump station to the south Stock Road. This pump station could connect to a conveyancing system that is currently being planned to convey waste from the decommissioned Bullsbrook waste water treatment plant to the Beenyup wastewater treatment plant via a sewer pressure main along the north-south alignment connecting to Sawpit Road leading south.

Operation of a local WWTP requires economic evaluation at the precinct scale for provision of services. Where land development occurs prior to the volumes required to make a local WWTP operationally and economically viable, developers will be required to investigate and fund temporary servicing arrangements to convey wastewater.

Environmental risks associated with transferring wastewater through the Gnangara water mound will influence future sewer pressure main alignments from Ellenbrook, as it is necessary to pump additional sewer effluent demand over to the coastal treatment plant systems.

Challenges to be resolved for the servicing of the proposed industrial expansion is whether potable water and conventional sewerage will be necessary. In addition, it will also need to be determined whether the Water Corporation is going to be the licensed service provider, as it is possible that alternative, local-scale solutions and self-managed on-site wastewater treatment and reuse will be viable for some industries.

The Local Structure Plan will incorporate opportunities as confirmed with Water Corporation as these matters are further progressed. It is worth noting the proposed

water and sewer upgrades for the Bullsbrook town site are anticipated to occur in the next 15 years. Water Corporation stipulated that a strategy is in place to service this proposed industrial area, however the ultimate solution will depend on the required demand determined by how much land will ultimately be set aside for Industrial use, timing of upgrades in the adjacent water and sewer system network, finalisation of transport corridors and crossings, and uptake in industrial land.

2.3 Power

As per the Western Power Network Capacity Mapping Tool (NCMT), there is available capacity at the Muchea Zone Substation to service initial stages of the industrial development, but tis is dependent upon load demand and timing. A limiting factor is the existing 22kV network capacity. The existing 22kV feeders from the Muchea Zone will only be able to service a limited amount of development, before upgrades are required. Initially upgrades such as capacitors and upstream line augmentation may be sufficient, however as the demand triggers larger loads through increased developments, new 22kV cable feeders from the Muchea Zone Substation will be required to assist in bringing the extra capacity required to the industrial area.

As the Industrial Area continues to develop, the Muchea Zone Substation will run out of capacity, upon which a new 132kV/22kV zone substation or 330kV/132kV/22kV terminal substation will need to be built to supply the region. Since these are expensive solutions, Western Power will only allow this once all other avenues of supplying the development such as upstream network augmentation and network reconfiguration have been exhausted and it is deemed to be necessary. If a new substation is required, the land requirement is a minimum of 120m by 120m (this applies to a 132/22kV zone substation. A 330/132/22kV terminal substation will require a greater area). It will also require multiple 132kV or 330kV transmission lines to service it, each requiring typically a 20m or 60-70m easement respectively.

Extending 22kV feeder lines from the Muchea Zone Substation seems to be the solution for now and it would be many years before the load warrants installing a new substation. Any formative answers from Western Power will require an application to Western Power to undertake a study which will incur a fee.

2.4 Communications

It is anticipated that various providers are able to service industrial developments in the area with communications, whether it be fixed line or wireless systems.

2.5 Gas

ATCO Gas has an existing distribution main along the Railway Parade corridor that is capable of servicing industrial demand, and thus it is anticipated the expansion of capacity can occur as required.

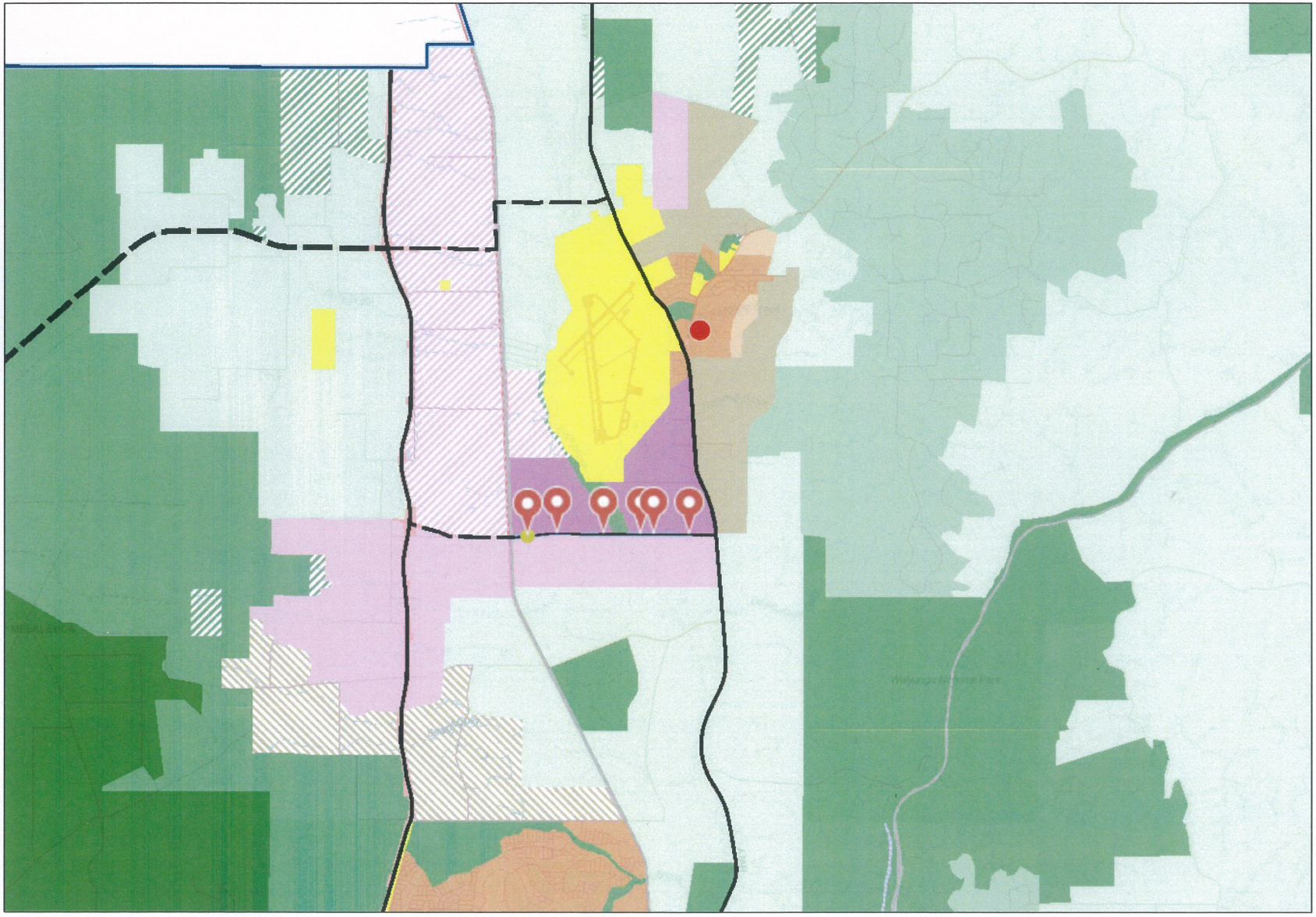
Appendices

Appendix A – Metropolitan North East Sub-Regional Planning Framework

Attachment from the website of the Department of Planning, Lands and Heritage on 29 August 2018.

Department of **Planning, Lands and Heritage**

Metropolitan North East Sub-Regional Planning Framework



Legend

Activity Centres
- District Centre

Existing Regional Roads
- Primary Distributor
- Integrator Arterial

Proposed Regional Roads
- Proposed Primary Distributor
- Proposed Integrator Arterial

Existing Region Scheme Road
- Integrator Arterial - Existing
- Primary Distributor - Existing

Framework Landuses
- Railway
- Urban
- Urban Deferred
- Urban Expansion
- Urban Investigation
- Industrial
- Industrial Expansion
- Industrial Investigation
- Rural Residential
- Rural
- State Forest
- Open Space
- Open Space Investigation
- Waterway
- Public Purposes

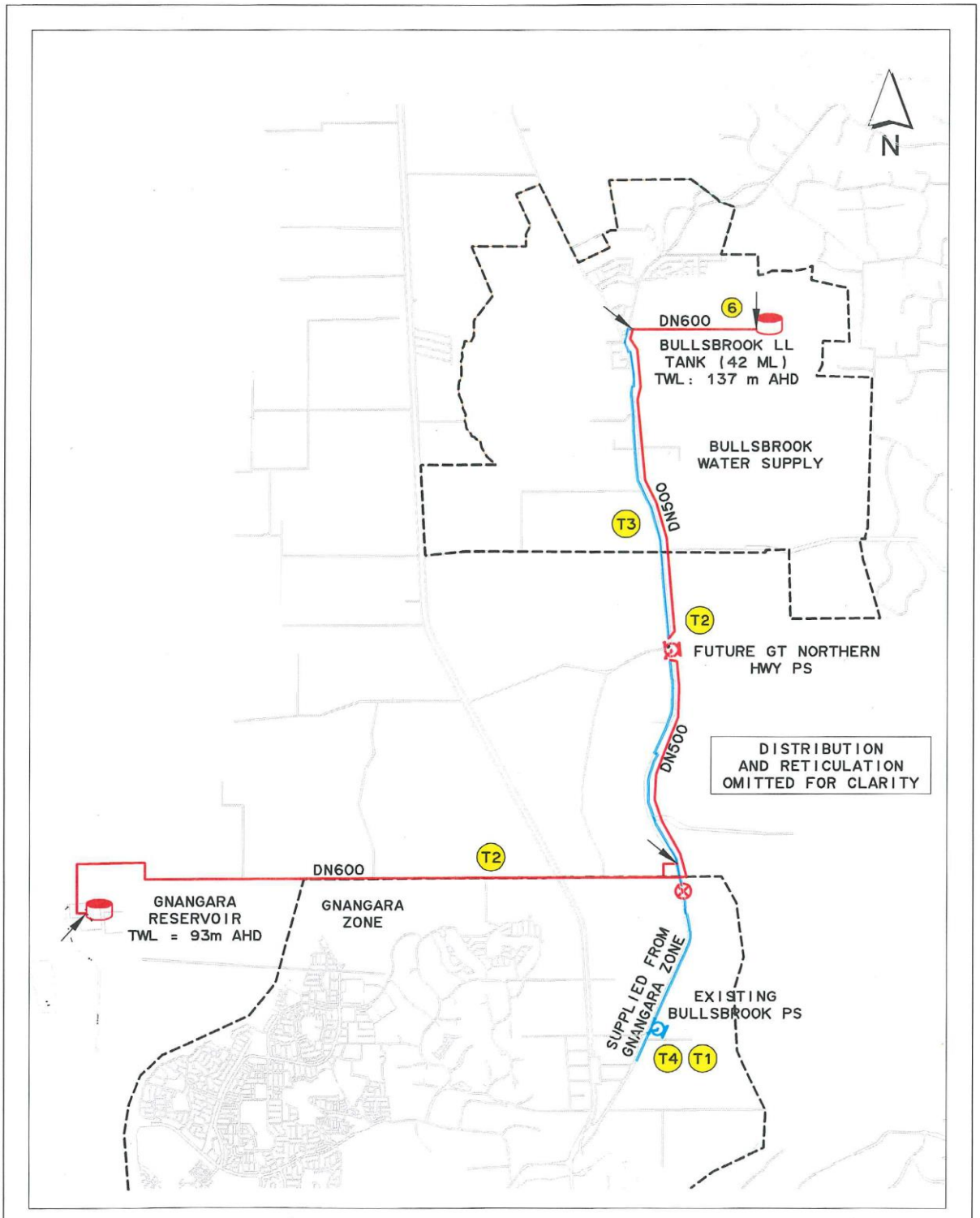
Notes

5.7 0 2.86 5.7 Kilometers

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.
THIS MAP IS NOT TO BE USED FOR NAVIGATION

Appendix B – Bullsbrook Water Supply (Water Corporation, 2010)

Attachment provided by Brett Combes of the Water Corporation on 25 June 2018.



LEGEND

T1 CIP ITEM

LIMITS OF CIP ITEM - MAINS

COORDINATE SYSTEM: GDA 1994 MGA Zone 50

THE INFORMATION CONTAINED HEREIN IS SUBJECT TO ONGOING REVIEW AND AMENDMENTS AND SHOULD BE READ IN CONJUNCTION WITH THE ASSOCIATED REPORT.

PROJECT No:	AUTHOR: EDWATTS
GROUP: IPB - Spatial Systems	DATE: 25-Jun-2010
DOCUMENT: Dedicated Main to Bullsbrook.dgn	

WATER CORPORATION

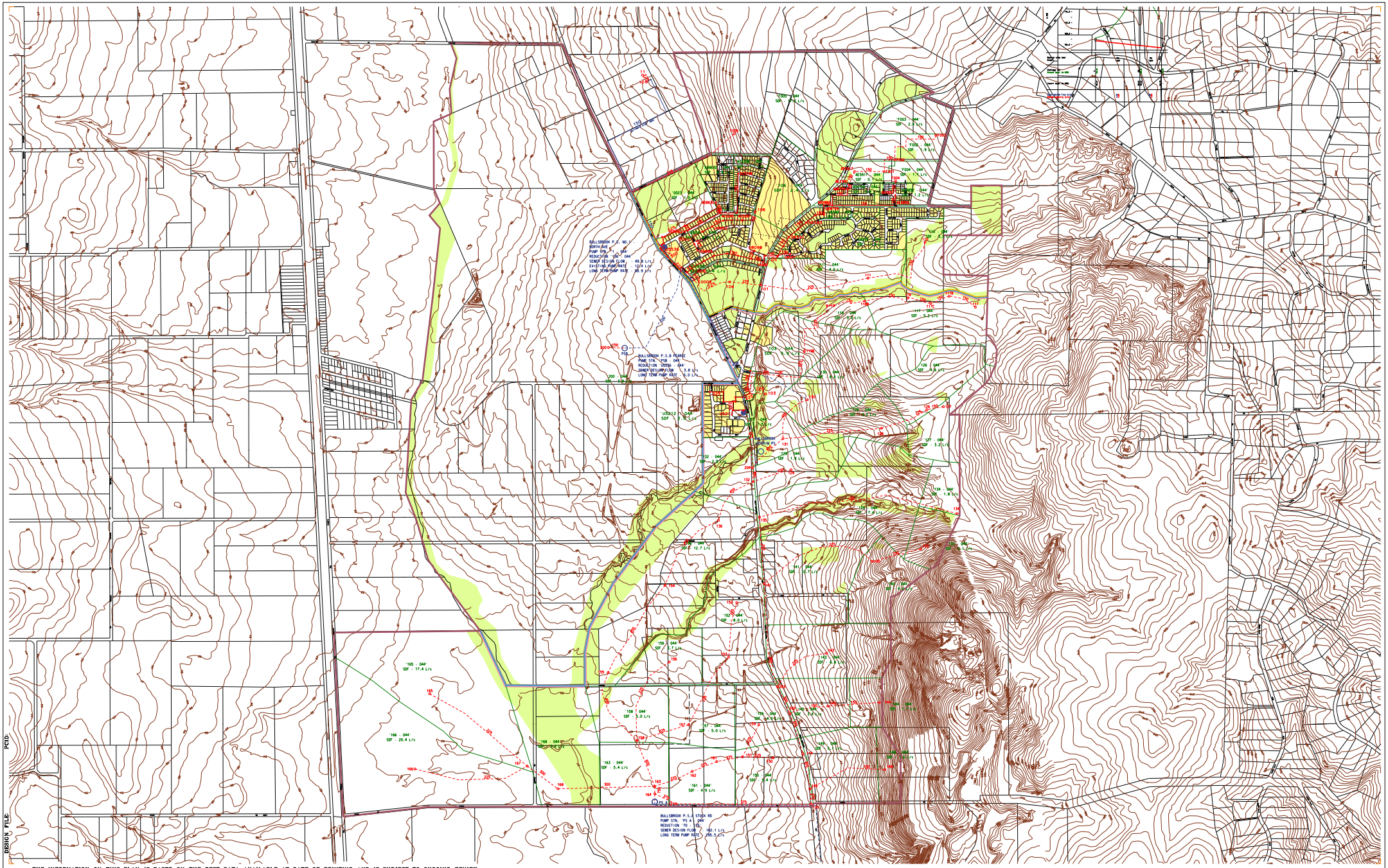
BULLSBROOK WATER SUPPLY
DEDICATED MAIN TO BULLSBROOK
CIP - TRANSFER

ATTACHMENT 1.2

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Appendix C – Bullsbrook Wastewater Conceptual Planning Long-Term Scheme (Water Corporation, 2018)

Attachment provided by Brett Combes of the Water Corporation on 25 June 2018.



THE INFORMATION ON THIS PLAN IS BASED ON THE BEST DATA AVAILABLE AT DATE OF PRINTING AND IS SUBJECT TO ONGOING REVIEW AND AMENDMENT. NO RESPONSIBILITY IS ACCEPTED BY THE WATER CORPORATION FOR ACCURACY OF DATA SUPPLIED BY EXTERNAL AGENCIES.

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DESIGN FILE:

PCID:

LEGEND

- EXISTING PUMPING STATION
- EXISTING PRESSURE MAIN
- EXISTING GRAVITY SEWER
- PROPOSED PUMPING STATION
- PROPOSED PRESSURE MAIN
- PROPOSED GRAVITY SEWER
- PARKS AND PUBLIC OPEN SPACE
- EXISTING SEWERED AREAS
- SEWERED BY PRIVATE PS
- NODE CATCHMENT
- PS AND SEWER CATCHMENTS
- SEWER DISTRICT CATCHMENT
- WWTP CATCHMENT

NOTATION

SEWER DISTRICT NUMBER
CATCHMENT NODE
CATCHMENT · 7001 - 121 ·
R15 - 108.4 @75% (W)
GROSS AREA (ha)
'R' CODE ZONING
% OF LAND DEVELOPMENT
(W) - WET CONDITIONS
(D) - DRY CONDITIONS

SEWER DESIGN FLOW = 1.5 x AVERAGE DAILY FLOW RATE

DATE	REVISION DESCRIPTION	DRN	APPD
JAN 2012	LANDUSE UPDATE, SEWER DISTRICT BOUNDARY UPDATED, INTERIM PS ADDED	L. GABRIEL	Y. ZHENG

SHEET INDEX

AQUA NO.

AQUA VERSION V1

WATER CORPORATION

ISSUED WITH THE AUTHORITY OF THE MANAGER ASSET PLANNING GROUP
629 NEWCASTLE STREET, LEEDERVILLE 6007
WESTERN AUSTRALIA.
TELEPHONE (08) 9420 2420, FAX (08) 9420 3179

WASTEWATER SCHEME PLANNING SERIES

BULLSBROOK - SD044
CONCEPTUAL PLANNING
LONG TERM SCHEME

PLANNING BY	COMPILED BY	ACCEPTED BY
R. APPOLONI	L. GABRIEL	T. ZHENG
SCALE: 1:12,500	FULL REVIEW: DECEMBER 2011	SD AQUA FILE NO.: JT1 2011 11407 V01

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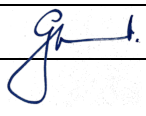
Level 10
999 Hay Street
T: 61 8 6222 8222 F: 61 8 6222 8555 E: permail@ghd.com

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6137134-49424/https://projects.ghd.com/oc/WesternAustralia3/bullsbrookfreightand/Delivery/Documents/Infrastructure Servicing Report/6137134-REP-0_Servicing Infrastructure Report.docx

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0	L. Johnson	G. Hendrie		M. Papachristos	on file	6/4/2022

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Appendix G - Industrial Demand and Market Analysis

Bullsbrook Freight and Industrial Market Needs Assessment

GHD

September 2019



MacroPlanDimasi

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Revised draft	3.0	RM, SM	5 December 2018	SM
Final report	4.0	RM, SM	11 March 2019	SM
Update (employment projections)	5.0	RM, SM	5 September 2019	SM
Update (precinct map)	6.0	SM	18 October 2021	SM

Approved for release:

Name	Signature	Date
Stuart McKnight		18 October 2021

Executive summary

This assessment considers the long-term market needs for industrial land as part of the investigations to support the preparation of the Bullsbrook Freight and Industrial District Structure Plan, incorporating the proposed Bullsbrook Intermodal Freight Terminal.

GHD commissioned MacroPlan Dimasi to assess the industrial market based on the requirements of the project brief prepared by the client – the Department of Planning, Lands and Heritage.

Bullsbrook is within the City of Swan in Perth's North-East Sub-region, approximately 32km from the Perth CBD. The subject site is referred to as the Bullsbrook Freight and Industrial Area in this report and covers a gross land area of 2,650 hectares across four major precincts:

- Bullsbrook South Extension A: 300 hectares gross (industrial expansion)
- Bullsbrook South Extension B: 100 hectares gross (industrial investigation)
- North Ellenbrook: 900 hectares gross (industrial expansion)
- North Ellenbrook Extension: 1,350 hectares gross (industrial investigation).

The proposed Bullsbrook Freight and Industrial area is a strategic project to meet long to very long-term demand and it has large-scale infrastructure constraints to match.

The developable yield for the across the area has yet to be refined, however, environmental constraints and infrastructure requirements in the area mean that the likely development yield may be around 50-70 per cent of the gross area or between 1,325 and 1,855 hectares.

The most practicable development scenario for the project would likely to be to link with the infrastructure requirements (trunk sewer, water, road connections) for the urban expansion of North Ellenbrook and Bullsbrook South.

Market analysis

The North-East Sub-regional Planning Framework indicates that demand for industrial land in the sub-region is expected to grow to 2,810 ha by 2050, an additional 1,352 ha and an average take up rate of 34.7 ha per annum. This land take-up will be distributed across about a dozen existing industrial areas in the sub-region as well as the new Bullsbrook Freight and Industrial Area.

The Bullsbrook Freight and Industrial Area could have two development fronts catering to different industrial needs (one focusing on freight and logistics and the other providing land for general and light industrial uses) and potentially achieve an average take-up of up to 20 hectares per annum. This would imply a development timeframe of at least 70 years across the whole area, although increases in employment land use intensity over that timeframe are likely to extend the supply beyond 2100.

Competition for the development comes from existing industrial areas that have substantial expansion capacity as well as from new areas. These include Muchea, Meridian Park (Neerabup), Latitude 32 (for intermodal freight) and Hazelmere South.

The Muchea Employment Node and Industrial Park are attracting investment which will meet many of the heavy transport and freight demands. The role of Muchea is likely to be focused on primary production, logistics and freight operations and provide for regional demand.

The Bullsbrook location will need to differentiate its unique advantages, including:

- Proximity to the metropolitan region and Perth Airport
- Nexus point between interstate, intrastate and metropolitan transport
- Major road and rail infrastructure
- Longer term potential for rail intermodal terminal
- High urban growth to provide large potential workforce

The timing of the potential rail intermodal will depend on many factors beyond the scope of this assessment. The planning and commitment to the Fremantle Outer

Harbour (West Port) and Latitude 32 will have the major influence when the Bullsbrook facility is required, however it is likely to be beyond 2050.

Given the lack of servicing (particularly water, sewer, telecommunications), the initial stages of the development could target tenants involved in transport and logistics, heavy haulage. These would rely on the existing road networks at present and service interstate and intrastate transport connecting with the Perth metro Central and North-East sub-regions.

As the metropolitan road networks develop further (particularly the east-west metro road connections), this would improve the ability to also service the North-West Sub-region from this location.

Jobs balance sheet

Based on the demand schedule and the employment land mix identified an average employment density of 30 jobs per net developable hectare is likely to be achieved at the proposed development. The estimated 1,395 ha of developable land would therefore accommodate more than 40,000 jobs once fully developed (albeit in the very long term).

MacroPlan has prepared employment projections by ROM zone as part of this assessment which are attached as Appendix 4 of this report.

Table 1. Summary of development constraints, proposed uses, staging and planning requirements

Bullsbrook Freight and Industrial Area	Area		Constraints and catalyst infrastructure	Proposed uses	Staging	Planning and other requirements
	Gross (ha)	Est. net (ha)				
Bullsbrook South Extension A	300	210	• Requires infrastructure commitment to stimulate investor interest. • East-west road connections (Neaves, Cooper, Stock) to access North-West Sub-region.	Catchment: • Perth metro North-East, North-West & Central sub-regions; Intrastate and interstate demand. Some local industry would service the catchment of Bullsbrook South urban expansion. Uses: • Freight and logistics meeting intrastate, interstate & metropolitan demand.	2020-2040 Land is zoned MRS industrial and Sirona Capital's 200 ha Northern Gateway Industrial Park is on the market). Catalyst investor/tenant could stimulate take-up.	Zoned MRS industrial. Planning framework and developer contributions plan (DCP) in place for major enabling infrastructure. Comprehensive infrastructure commitment would be needed to unlock development potential.
Bullsbrook South Extension B	100	60	• Requires land capability investigation • Similar servicing and infrastructure constraints as per 'Bullsbrook South Extension A.	Catchment: • Perth metro: North-East, North-West & Central sub-regions; Intrastate/interstate demand. Uses: • Freight and logistics with a focus on intrastate/interstate & metro demand. • Potential for an intermodal facility.	2030-2050 Staging is subject to land use investigation and rezoning.	Land use investigation required, followed by MRS and LPS rezoning. Will likely require an amendment to the DSP covering neighbouring land areas as it will share much of the same trunk and transport infrastructure.
North Ellenbrook (Industrial Expansion)	900	450	• Requires extension of trunk infrastructure (potential for coordinated solution with urban expansion).	Catchment: • Surrounding urban areas within the North-East Sub-region. Uses: • General industrial / enterprise park • Service commercial and light industrial • Large format retail • Office park (industry-related/dependent)	2030-2075 Initial development may include relocation of mining equipment and servicing currently located in South Guildford, Hazelmere & Midland.	Local structure planning required which should ideally be integrated with the urban expansion of North Ellenbrook. Infrastructure funding (DCP/pre-funding).
North Ellenbrook Investigation	1,350	675	• Very long-term requirement and existing rural uses should be protected in the meantime.	Catchment: • Perth metro North-East, North-West & Central sub-regions; Intrastate and interstate demand. Uses: • Freight and logistics with a focus on intrastate and interstate movements by road • Intermodal freight including import/export handling via Fremantle Port (inner and/or outer harbour) • Mining equipment and services • Construction materials (brickworks, manufacturing)	2050 – 2100+ Development of the freight intermodal terminal will dictate the staging for this precinct.	Protect existing rural uses and ensure no further encroachment from incompatible uses.
	2,650	**1,395**				

Source: MacroPlan Dimasi

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Introduction

Purpose

GHD commissioned MacroPlan Dimasi (MacroPlan) to provide an analysis of the industrial land demand market for Bullsbrook as part of the investigations to inform the preparation of the Bullsbrook Freight and Industrial District Structure Plan.

Methodology

Literature review

MacroPlan has reviewed the Perth and Peel @3.5 million – North-East Sub-regional Planning Framework (2018) and the Economic and Employment Lands Strategy: Non-Heavy Industrial (2012). These studies consider industrial land supply and demand with specific focus on the relationship to the State's economic cycles and the specific advantages of the North-East Sub-region of Perth as a future freight and logistics hub around a new intermodal terminal.

Demographics analysis

Population projections

MacroPlan assessed population projections for Bullsbrook and its employment and population-servicing catchments, including WAPC WA Tomorrow. Population breakdowns included age with specific focus on the people of working age to inform the future labour force within the City and the North-East and North-West sub-regions.

Employment assessment

MacroPlan assessed the employment self-sufficiency, skill-base required, and the long-term labour force impact on economic and investment opportunities. The assessment examined the trends in the labour force in the northern corridor including the main growth industries and long-term labour force requirements given the major structural shifts in employment (i.e. decline of manufacturing and primary industry employment, growth of services and logistics).

Market analysis

MacroPlan assessed the demand and supply of future industrial land, considering the locational advantages and spatial distribution of the demand (urban development areas) and the suppliers (including transport connections) as part of the assessment.

The assessment covered demand for industrial land by major land use including all staging and ultimate land demand for specific uses (i.e. logistics, intermodal freight, mining-related services, primary industry/agribusiness, business park). This provided a demand trajectory to plan for the medium and long-term requirements of the area to evolve over time whilst still protecting the requirements of the logistics/intermodal freight needs over the long term.

Staging

The staging assessment (hectares by year by use) informed the structure planning process and to guide appropriate investment in the District Structure Plan area.

Jobs balance sheet

MacroPlan prepared a jobs balance sheet incorporating the strategic employment as well population-base employment across the area to guide the local structure plans.

Scenario analysis

A SWOT assessment for the District Structure Plan area was undertaken which identified critical success factors for the development. MacroPlan assessed the long-term economic cycles for Western Australia considering the prospects for State development that can be supported from the District Structure Plan area. This became the basis for the three scenarios incorporating scale and rate of development – base case, low/slow and high/fast.

Subject site and surrounds

Bullsbrook is in the City of Swan in Perth's North-East Sub-region approximately 32km from the Perth CBD. In 2016, the City of Swan had an estimated resident population of 133,851 people, increasing by approximately 19.7 per cent or 26,345 people since 2011. The Western Australia Planning Commission projects the population will reach approximately 170,730 people by 2026. This is an increase of almost 3,700 people per annum.

The primary north-south road connections to the subject site are the Great Northern Highway and the Perth-to-Darwin National Highway (with the NorthLink component due for completion in 2019). East-west connections will consist of Stock Road and Neaves Road, however, these still need additional planning and as yet, there is no funding or timing commitment for construction.

The Perth-Geraldton railway line abuts the site to the west. It is the only direct freight line connection between Midland and Geraldton. Arc Infrastructure has confirmed that an industrial facility would be able to connect to and utilise the rail line providing a significant opportunity for intermodal freight connecting the State and national networks.

The area has traditionally been used for agricultural purposes and livestock grazing. The Ellen Brook is the key environmental consideration and forms part of the conservation area and Bush Forever portion of the site. The RAAF airbase is to the north east of the site and is complementary to the future planned industrial use of the subject site in that the site will provide a noise buffer for the future urban development south of North Ellenbrook.

Figure 1. Regional context



Map 1: Perth

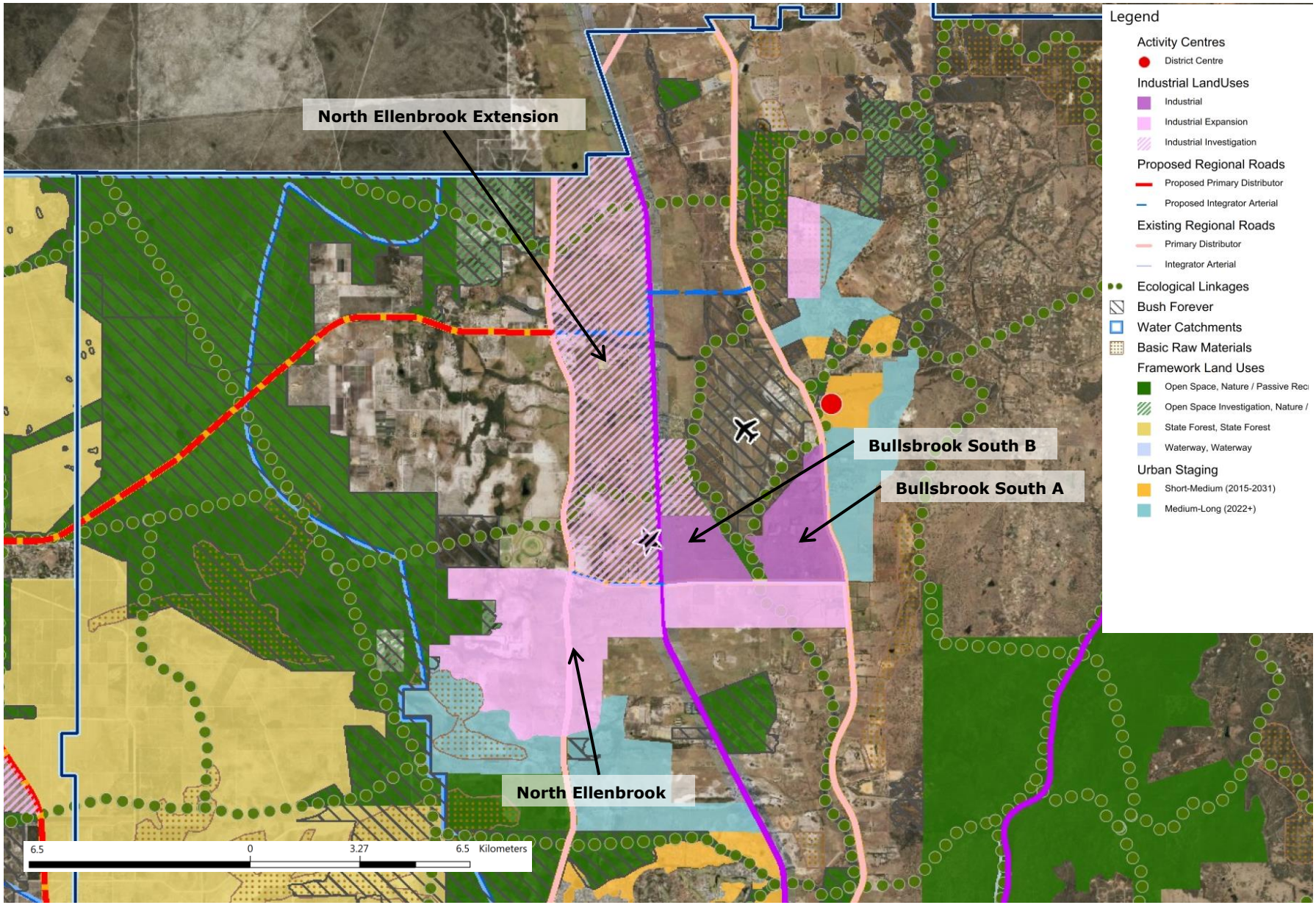
Major Activity Centres

Source: MacroPlan Dimasi 2018

The subject site is referred to as the Bullsbrook Freight and Industrial Area in this report and consists of four major precincts consisting of a total of 2,650 hectares:

- Bullsbrook South A (300 ha gross) – zoned industrial and is called the Northern Gateway Industrial Estate
- Bullsbrook South B (100 ha gross) – zoned industrial
- North Ellenbrook (900 ha gross) – identified as 'industrial expansion' in the Perth and Peel @3.5 million – North-East Sub-regional Planning Framework
- North Ellenbrook Extension (industrial investigation) (1,350 ha gross) - identified as 'industrial investigation' in the Perth and Peel @3.5 million – North-East Sub-regional Planning Framework.

Figure 2. Bullsbrook Freight and Industrial Area context and zoning



Source: Department of Planning, Lands and Heritage

Travel distance and time

The construction of the NorthLink component of the Perth–Darwin National Highway has provided substantial benefits to the accessibility of the Northern Gateway Industrial Park to the Perth metropolitan region.

The estimated travel distance and time between the subject site in relation to each of the Strategic Metropolitan Centres and the Capital City Centre (as defined by State Planning Policy 4.2 Activity Centres for Perth and Peel).

Table 2. Travel and distance estimates utilising the future Perth-to-Darwin National Highway (incorporating NorthLink benefits)

Capital and Strategic Metropolitan Centres	Bullsbrook Freight and Industrial Area	
	Time (hours)	Distance (km)
Perth	0.44	40.6
Armadale	0.45	57.0
Cannington	0.37	46.6
Fremantle	0.56	65.3
Joondalup	0.30	34.6
Mandurah	1.26	122.0
Midland	0.21	23.9
Morley	0.33	36.0
Rockingham	1.07	86.7
Stirling	0.38	43.5
Yanchep	0.47	57.6

Source: MacroPlan Dimasi (2018)

These calculations are for non-restricted access vehicles. Restricted access vehicles have such as B-doubles (vehicles not exceeding 36.5m) would only have access to Welshpool and Rockingham. Freight on smaller vehicles (up to 25m) would have access to all Strategic Metropolitan Centres.

Section 1: Literature review

This section of the report details the current relevant strategic planning relevant to industrial demand and supply in the North-East Sub-region.

1.1 State Planning Strategy 2050

The State Planning Strategy is the principal strategic land use planning document for Western Australia, integrating the strategic context and basis for the coordination and integration of land use planning and development. This document sets out the high-level principles for growth around five dimensions:

- Liveable
- Prosperous
- Connected
- Sustainable
- Collaborative

1.2 Perth and Peel @3.5 million

Perth and Peel @3.5 million provides the overarching strategic planning vision for the Perth metropolitan and Peel regions in Western Australia. The draft framework released in 2015 went through extensive stakeholder consultation to deliver the final framework in March 2018.

The fundamental assumption underpinning Perth and Peel @3.5 million is the rapid growth outlook for Perth and Peel from 2 million people to 3.5 million by 2050. Three scenarios assessed compared a Contained City (100 per cent infill), a Dispersed City (30 per cent infill, 10 per cent greenfield) and a Connected City (47 per cent infill, 53 per cent greenfield).

The preferred Connected City approach means that the North-East Sub-region was projected to increase mainly through the development of Greenfield areas (accommodating an additional 66,000 dwellings). The implications for the subject

site is that areas such as North Ellenbrook and Bullsbrook South were considered in more detail as part of the assessment of the final framework.

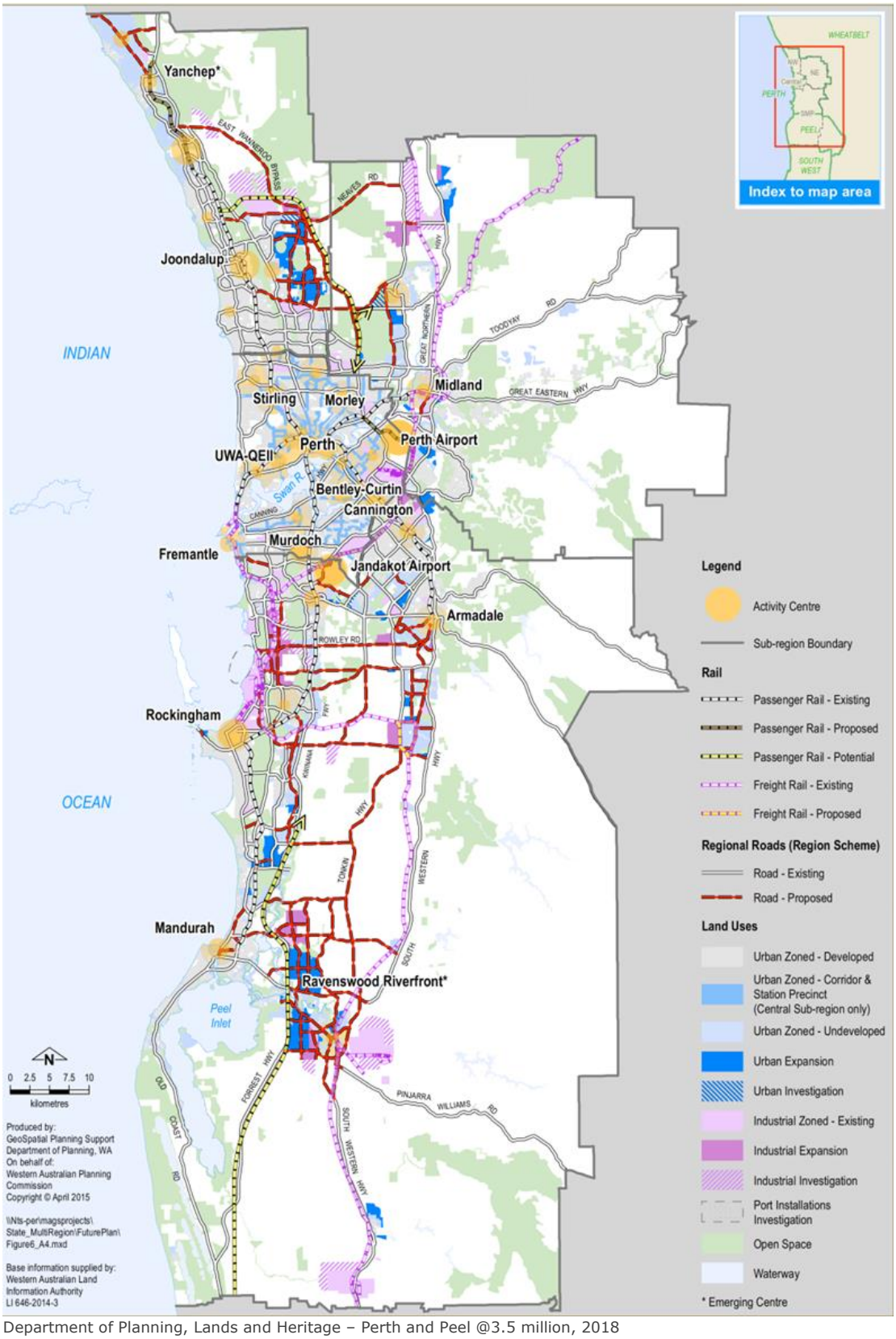
1.3 Perth and Peel @3.5 million – North-East Sub-regional Planning Framework

The Perth and Peel @3.5 million – North-East Sub-regional Planning Framework is the principal document for strategic planning guidance covering 2,010 square kilometres, comprised of the cities of Swan and Kalamunda, and the Shire of Mundaring. It guides future growth through establishing a long-term, integrated planning framework for land use and infrastructure.

An extract of the framework's objectives that are relevant to this study includes:

- strengthen key activity centres and employment nodes to meet the future needs of industry, commerce and the community
- provide transport linkages that connect people with key centres of activity and employment, and access to areas beyond the Perth and Peel regions
- facilitate and support a future regional transportation network and facilitate the provision of service infrastructure
- protect areas with basic raw materials for timely extraction
- provide ongoing consideration of water supply and protection of public drinking water source areas
- retain land for rural and agricultural purposes
- guide the staging and sequencing of future urban development.

Figure 3. Perth and peel spatial plan



Department of Planning, Lands and Heritage – Perth and Peel @3.5 million, 2018

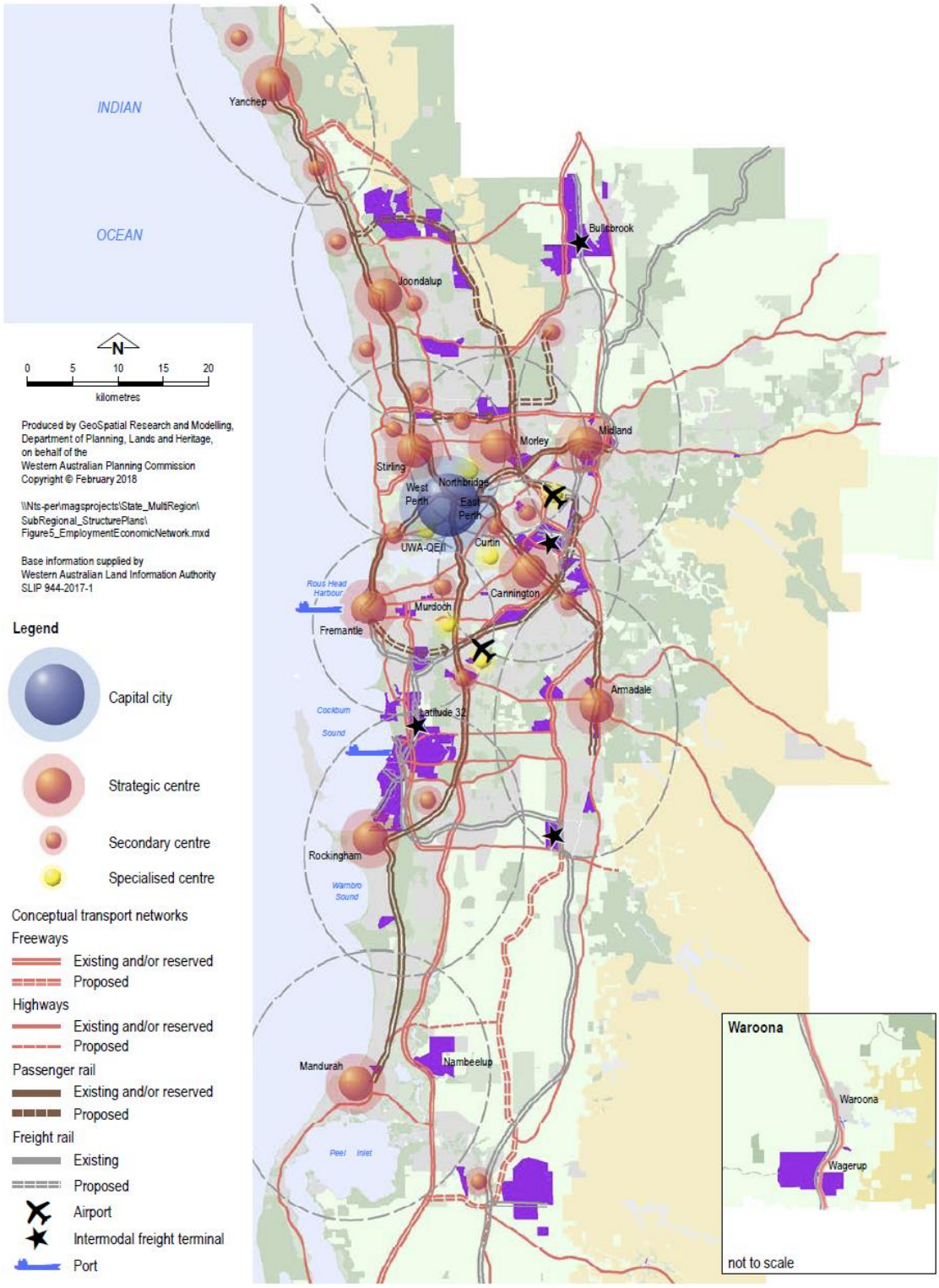
The framework indicates employment located within the sub-region will increase from 82,380 in 2011 to nearly 193,000 by 2050 – an increase of more than 110,500 jobs. Many of these jobs will directly service the population providing retail, education, health and other services.

In addition, the need to actively attract strategic employment will help to provide the population living within the sub-region with nearby jobs. This aims to reduce the burden on the transport system from commuting.

Employment for the subject site will come from nearby suburbs such as Ellenbrook and Bullsbrook Town Site, but could also have a broader employment catchment for higher uses from the wider North-East and North-West sub-regions.

The following figure shows the major employment areas including the activity centres hierarchy and the airports (specialised centres). Bullsbrook has the major transport advantages of the rail, easy access from the east and north for interstate and intrastate freight, in addition to the Road access to Perth Airport.

Figure 4. Employment and economic network 2050



Source: Perth and Peel @3.5 million – North-East Sub-regional Planning Framework

1.4 Economic and Employment Lands Strategy: Non-Heavy Industrial

The Economic and Employment Lands Strategy: Non-Heavy Industrial 2012 (EELS) identifies general and light industrial needs for the Perth Metropolitan Area and Peel Region. The strategy plans for ongoing economic growth and sustainability of employment land (industrial and commercial) over the next 20 years and beyond.

While the supply side of the EELS assessment has been superseded by the Perth and Peel @3.5 million – North-East Sub-regional Planning Framework, the demand assessment in EELS, remains current.

The EELs presents a whole of government approach to the prioritisation and timely delivery of employment land supply. Specifically the strategy aims to:

- Identify the areas, type and location of general and light industrial land required over the next 20 years
- Review the existing industrial land development program and identify possible extension opportunities
- Identify and evaluate the suitability of locations for new general and light industrial estates
- Develop a strategy to facilitate the delivery of general and light industrial land and assist in the restoration of the Government's long-term general and light industrial land bank.

At the time it was prepared, there was an anticipated shortfall development-ready industrial land (although sufficient vacant land was zoned, much of the vacant land was not serviced and required significant infrastructure investment to unlock its investment potential).

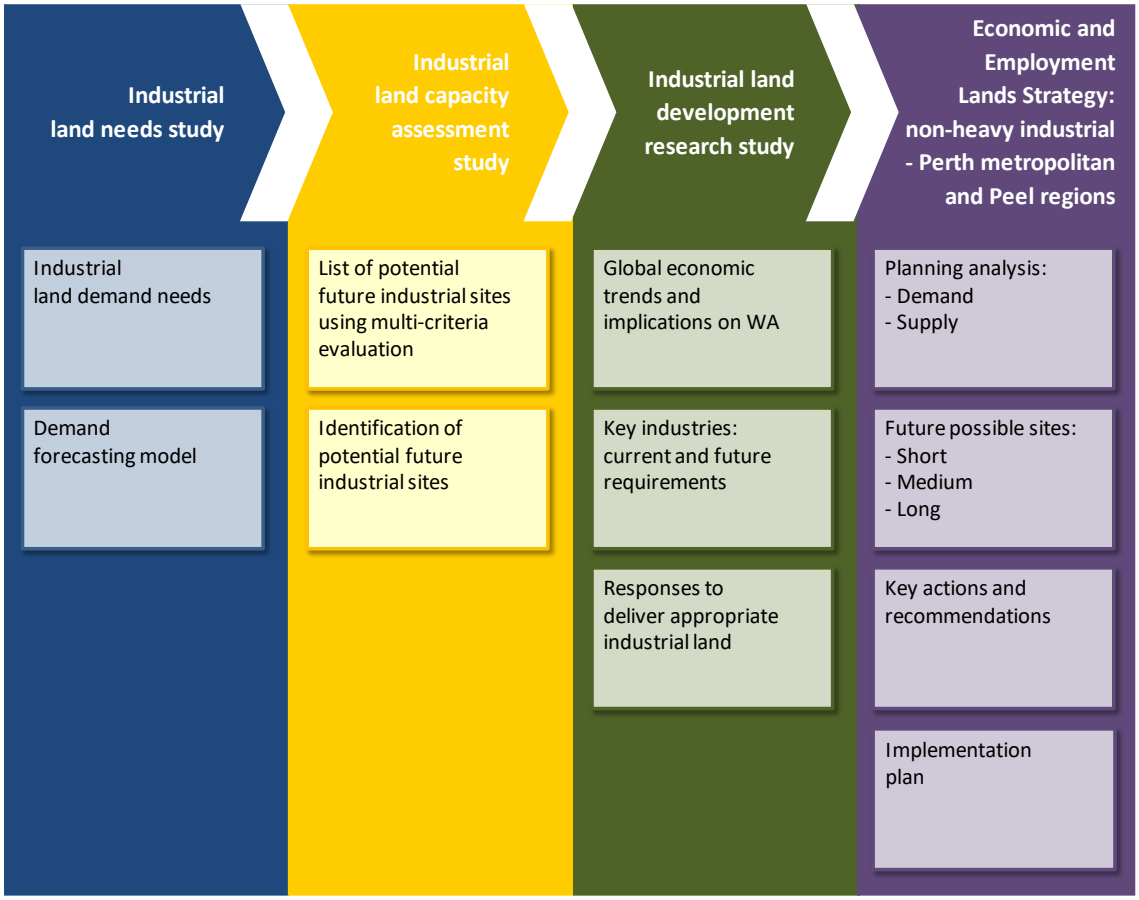
The strategy identified 37 sites totalling just under 13,000ha of potential gross developable land. Sites were identified for short- (0-4 years) medium- (4-10 years) and long-term (10+ years) release.

The EELS identified Bullsbrook South as a higher priority for delivery, based on its context and input from stakeholders. The strategy recommends the site is suitable for a mix of general and light industrial with options for general commercial zoning for a supporting neighbourhood centre. The land has since been developed released as the Northern Gateway Industrial Area by Sirona Capital.

As detailed in the following figure, the conclusions and recommendations of the EELS were based on the findings of three key studies:

- Industrial Land Needs Study (ILNS)
- Industrial Land Capacity Assessment (ILCA)
- Industrial Land Development and Research Study (ILDRS).

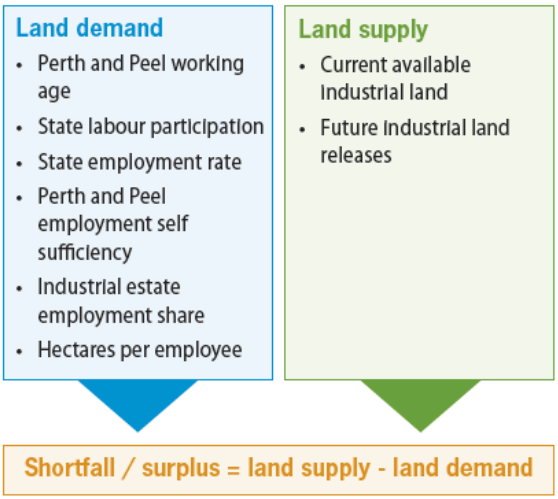
Figure 5. Economic and Employment Lands Strategy: Non-Heavy Industrial methodology



Source: Economic and Employment Lands Strategy: non-heavy industrial Perth metropolitan and Peel regions (April 2012)

The demand assessment for EELS is based on growth factors using population as an input to the model to determent the quantum of industrial land required.

Figure 6. EELS demand-supply modelling inputs



Source: Economic and Employment Lands Strategy: non-heavy industrial Perth metropolitan and Peel regions (April 2012)

Recommendations of EELS

Based on the key findings of the ILNS, ILCA and consultation, there were six recommendations outlined in the EELS:

- Ensure there is suitable governance and coordination of the planning and delivery of industrial land
- Develop and maintain a program to forecast and monitor the demand and supply of industrial land
- Maintain a 20-year land bank to ensure a regular industrial land supply
- Ensure the timely delivery of development-ready land
- Maintain a significant Government role in industrial land supply to facilitate greater participation by the private sector
- Ensure the industrial sites, particularly those considered to have state and regional significance, and located within the inner and middle sectors, are preserved.

Section 2: Urban growth, population, demographics and employment

Knowledge of local drivers is a critical component of the industrial assessment and establishing the workforce availability and nature of the area. The following section examines each of the main drivers of change affecting the study area to inform the analysis of the area.

2.1 Urban growth

Land developers provide an indication of their future lot production as part of the WAPC's Urban Development Program, Developers' Indentions Survey. This was most recently analysed and published in Land Development Outlook 2016/17, which indicates that the North-West Sub-region has the largest growth potential of all the urban corridors. It is also characterised by large land holdings which permit the bigger more experienced developers to deliver master planned estates, which typically have high population growth rates.

After the North West Sub-region, the second highest growth area is the South West Region. Developer intentions in these two areas combined could provide more than 138,263 additional dwellings.

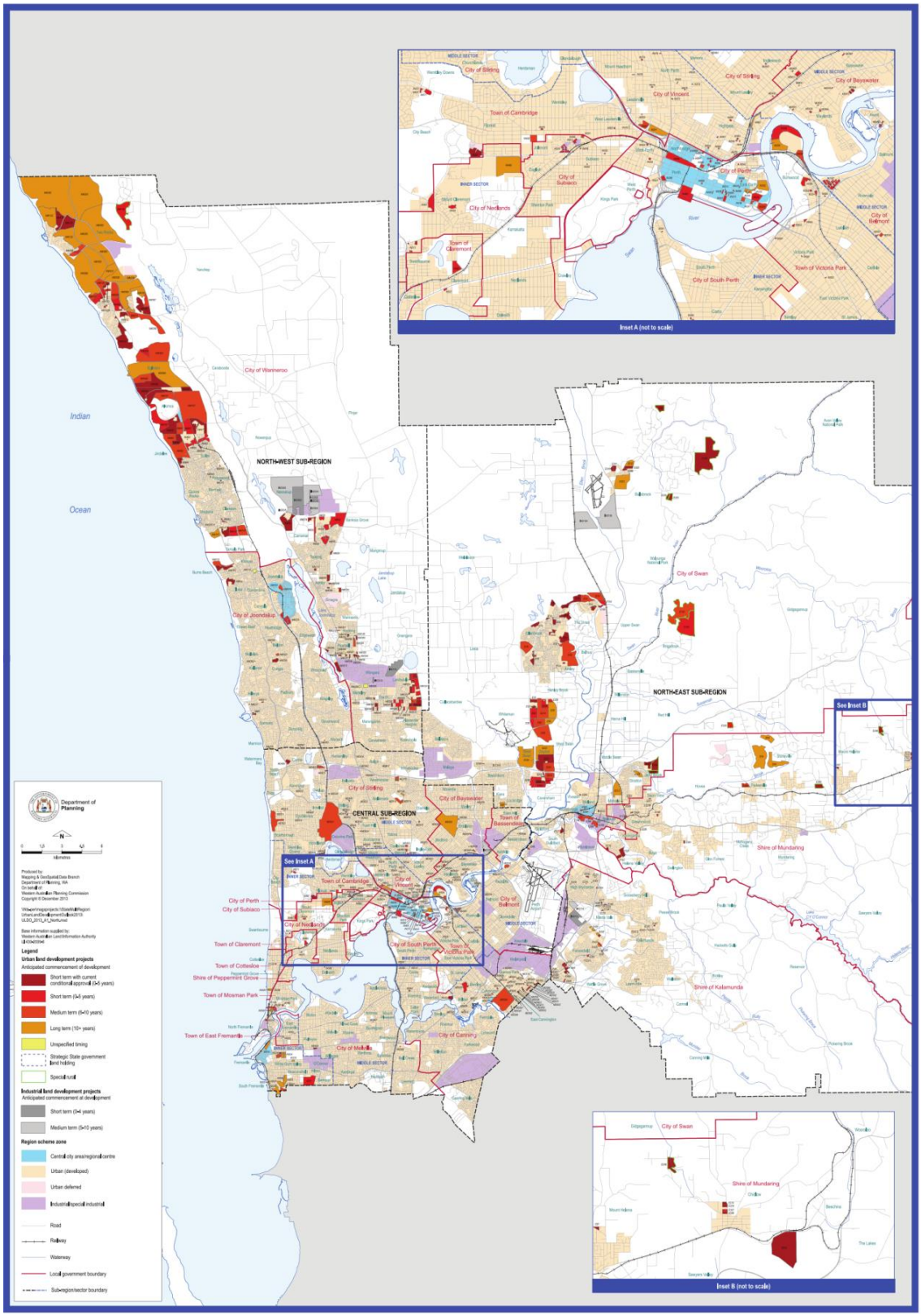
The following table and figure show the major urban growth areas, yields and approximate timing for Perth.

Table 3. Future dwelling releases by urban corridor in Perth

Map colour-code	Region	Central	North-West	North-East	South-East	South-West	Peel	TOTAL
	Short term dwelling release (0 to 4 years)	19,732	13,989	10,858	11,348	21,470	5,586	**82,983**
	Medium term dwelling release (5 to 10 years)	19,533	11,767	7,980	8,918	11,110	7,175	**66,483**
	Long term dwelling release (10+ years)	24,168	67,258	15,488	16,149	12,669	13,885	**149,617**
	Total additional dwellings	**63,433**	**93,014**	**34,326**	**36,415**	**45,249**	**26,646**	**299,083**

Source: WAPC Urban Land Development Outlook 2016/17

Figure 7. Urban growth areas in the North-West and North-East Sub-regions of Perth



Source: WAPC Urban Land Development Outlook 2016/17

MacroPlanDimasi

The North-East Sub-region has a relatively small stock of vacant land zoned for urban development, when compared to other growth corridors of Perth. This will be addressed through expansion and investigation urban land as identified in the Perth and Peel @3.5 million – North-East Sub-regional Planning Framework.

Much of the appeal of the North-East sub-region lies in its rural character, which is seen as a great asset, to the sub-region and the city. Preserving this character has resulted in a limited supply of land for urbanisation, relative to other sub-regions. More than half of the North-East Sub-region is zoned rural under the Metropolitan Region Scheme. The resulting pattern of development means infrastructure supply and planning approval constraints for developments in the sub-region.

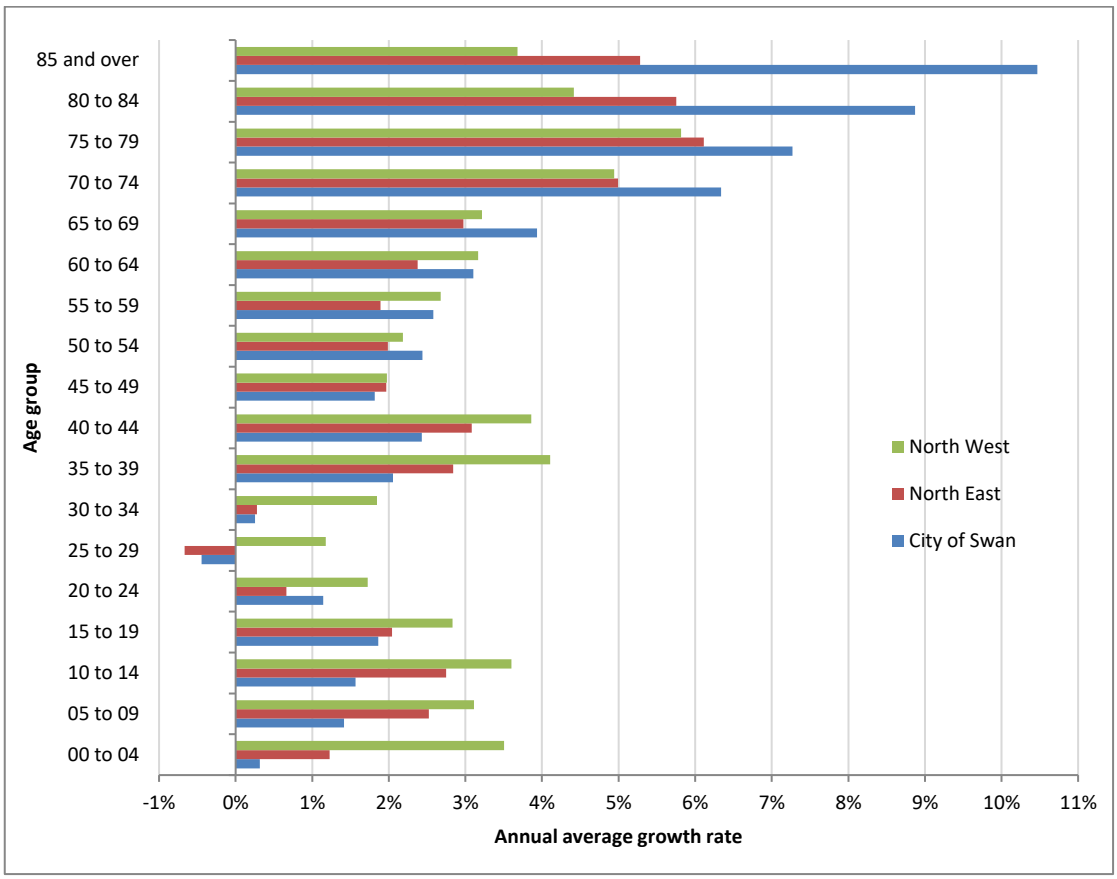
2.2 Population growth

The Western Australia Planning Commission projects the City of Swan and North-East and West sub-regions population to grow by an average annual 2.1, 2.2 and 3.0 per cent respectively.

Population growth by age

Growth in the City of Swan is expected to be driven by residents aged 80 years and older while the main driver in the wider sub-regions is 75-79-year olds. Projections indicate residents aged 15 – 64 will grow by an average annual 1.6 per cent in the City of Swan and 1.6 and 2.5 per cent in the North-East and North-West Sub regions respectively.

Figure 8. WAPC population growth projections 2016 - 2026



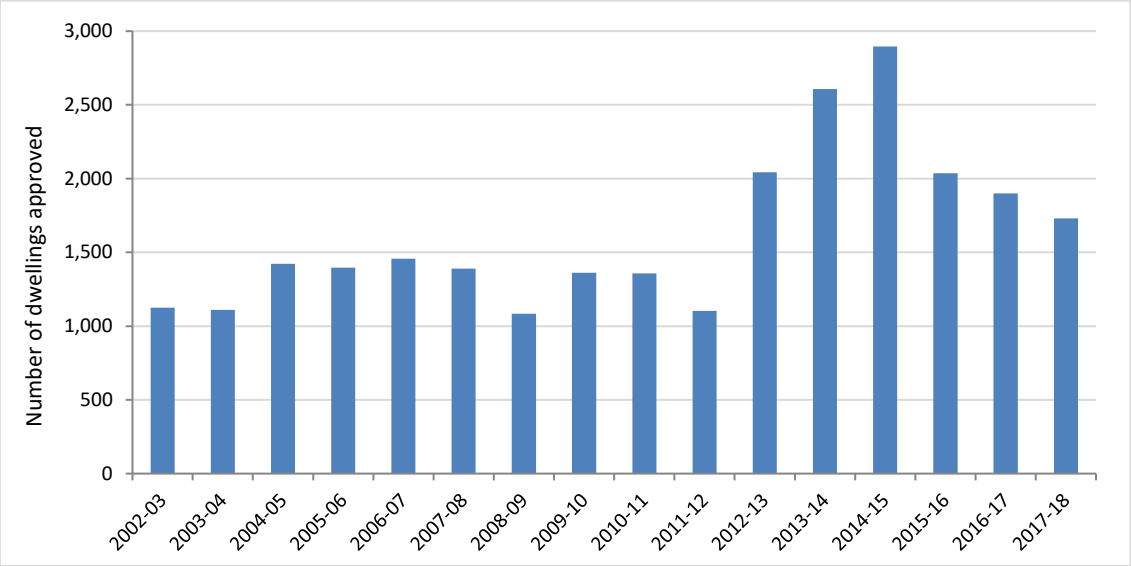
Source: Western Australia Planning Commission – WA Tomorrow 2015, ABS – Estimated Resident Population

Dwelling approvals

Dwelling approvals in the City of Swan over the period 2002/03 – 2017/18 indicate an average annual of 1,626 dwelling approvals over the 15-year period. This average provides a useful benchmark for a long-term assessment as it includes different periods of economic activity including the 'business as usual' period up to 2011-2012 and then the period of very high activity related to unusually-high population growth fuelled by the resource sector boom.

These dwelling approvals figures substantiate the population growth projections from WA Tomorrow.

Table 4. City of Swan dwelling approvals, 2002/03 – 2017/18 financial years



Source: Australian Bureau of Statistics, Building Approvals

2.3 Demographic profile

An analysis of the current socio-economic and market activity within the suburb of Bullsbrook and the City of Swan (Swan LGA) area will further inform demand drivers and future opportunities for the area.

Key observations from the 2016 Census of Population and housing are:

- The total population for Bullsbrook suburb and Swan LGA was 5,185 and 133,851 people respectively.
- The median age in the Swan LGA was 34 years, notably lower than Bullsbrook suburb which had a median age of 38 years.
- There was a high proportion of couple families with children in the population.

Table 5. Population overview

Census item	Bullsbrook	Swan (C)	Greater Perth	Western Australia
Population	5,185	133,851	1,943,858	2,474,410
• 0-14 years	20.2%	21.7%	19.1%	19.3%
• 15-24 years	14.6%	13.8%	13.0%	12.5%
• 25-54 years	41.2%	44.0%	43.1%	42.8%
• 55-74 years	20.9%	16.6%	18.8%	19.5%
• 75 years +	3.3%	4.0%	6.0%	5.9%
Household (no.)	1,660	45,633	701,970	881,085
Average household size	2.9	2.8	2.6	2.6
- Family households	**83.1%**	**78.6%**	**73.4%**	**73.1%**
Couple families with children	*39.1%*	*38.0%*	*34.0%*	*33.2%*
Couple families without children	*32.2%*	*26.0%*	*27.5%*	*28.1%*
Single parents families	*11.6%*	*13.4%*	*10.6%*	*10.6%*
Other families	*0.7%*	*1.2%*	*1.3%*	*1.2%*
- Non-family households	**16.9%**	**21.4%**	**26.6%**	**26.9%**
Lone person	*7.3%*	*9.2%*	*10.3%*	*10.9%*
Other household	*9.6%*	*12.2%*	*16.3%*	*16.0%*
Country of birth	5,185	133,851	1,943,858	2,474,410
Australia born	66.5%	60.2%	57.3%	60.3%
Overseas born	22.0%	32.9%	36.1%	32.2%
• *Asia*	*2.1%*	*10.3%*	*10.4%*	*8.8%*
• *Europe*	*11.1%*	*9.3%*	*12.2%*	*11.0%*
• *Other*	*27.3%*	*38.9%*	*41.9%*	*37.8%*
Country of birth not stated	11.2%	7.4%	7.1%	7.9%

Source: ABS Census of Population & Housing, 2016; MacroPlan Dimasi

The dwelling profile data show that:

- Dwellings in the area are predominantly separate houses in both Bullsbrook suburb and Swan LGA.
- While outright ownership of dwellings by their respective households is generally lower than the average for Greater Perth, the proportion of dwellings being purchased (with a mortgage) is higher than the benchmark.

Table 6. Dwelling type and tenure

Census item	Bullsbrook	Swan (C)	Greater Perth	Western Australia
Dwellings	1,749	48,714	776,015	999,649
Separate house	*91.4%*	*78.7%*	*68.4%*	*68.6%*
Semi-detached	*0.0%*	*10.9%*	*14.2%*	*12.3%*
Flat, unit, apartment	*0.0%*	*1.0%*	*5.9%*	*4.9%*
Other	*0.8%*	*0.6%*	*0.3%*	*0.6%*
Not stated	*0.4%*	*0.2%*	*0.2%*	*0.3%*
Unoccupied	*7.7%*	*8.7%*	*11.0%*	*13.3%*
Dwelling tenure				
Fully owned	8.0%	7.4%	10.1%	9.9%
Being purchased	18.2%	18.1%	15.1%	13.8%
Rented	4.6%	7.5%	9.6%	9.9%
• Real estate agent	*1.9%*	*3.7%*	*5.3%*	*4.9%*
• State or territory housing authority	*0.1%*	*1.1%*	*1.0%*	*1.2%*
• Person not in same household	*2.1%*	*2.1%*	*2.8%*	*2.7%*
• Housing co-operative/community/church group	*0.1%*	*0.1%*	*0.1%*	*0.2%*
• Other landlord type	*0.3%*	*0.3%*	*0.3%*	*0.7%*
• Landlord type not stated	*0.2%*	*0.1%*	*0.1%*	*0.2%*
Other	0.2%	0.2%	0.4%	0.4%
Tenure type not stated	0.6%	0.7%	0.8%	0.8%
Number of bedrooms	5,102	131,583	1,911,733	2,486,606
None (include bedsitters)	0.0%	0.1%	0.1%	0.1%
One bedroom	0.6%	0.6%	1.2%	1.2%
Two bedrooms	1.5%	2.3%	4.4%	4.3%
Three bedrooms	9.8%	12.1%	13.4%	13.2%
Four bedrooms	16.0%	16.0%	14.1%	13.2%
Five bedrooms	2.6%	1.8%	1.9%	1.8%
Six bedrooms	0.5%	0.3%	0.3%	0.3%
Not stated	0.6%	0.6%	0.7%	0.7%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: ABS Census of Population & Housing, 2016; MacroPlan Dimasi

The employment and income statistics indicate:

- The unemployment rate in the Swan LGA was 7.1 per cent, which was higher than the state average.
- The workforce size for Bullsbrook and Swan LGA is approximately 1,834 people and 52,342 people respectively.
- The gross median individual income is 24 dollars higher per week in Bullsbrook than for the Swan LGA with Bullsbrook at $730 per week and Swan LGA at $716 per week.
- Median rent and housing loan repayment in Bullsbrook are in line with the Swan LGA.

- Both areas have a high proportion of blue-collar jobs with high levels of technicians and trades workers. The white-collar jobs are mainly clerical and administrative workers, professionals and community service workers.

Table 7. Income and household expenditure

Census item	Bullsbrook	Swan (C)	Greater Perth	Western Australia
Income				
Median personal weekly income	730	716	728	724
Median family weekly income	1,827	1,811	1,955	1,910
Median household weekly income	1,714	1,623	1,643	1,595
Household expenses				
Median weekly rent	350	350	360	347
Median monthly mortgage repayments	2,000	2,000	2,000	1,993

Source: ABS Census of Population & Housing, 2016; MacroPlan Dimasi

The education statistics show:

- Attendance at TAFE is low for people living in Bullsbrook suburb, but the average across the Swan LGA is in line with the metropolitan benchmark.
- Attendance at university is relatively lower than the Greater Perth average.

Table 8. Education

Census item	Bullsbrook	Swan (C)	Greater Perth	Western Australia
Educational institution attending	1,689	42,360	605,065	766,992
Pre-school	2.8%	4.2%	3.9%	3.9%
Infants/Primary	25.8%	29.3%	27.1%	27.4%
Secondary	22.6%	22.7%	20.7%	20.5%
Technical or Further Educational Institution	3.9%	6.3%	6.3%	6.1%
University or other tertiary Institution	6.8%	11.3%	16.5%	13.9%
Other type of Educational Institution	1.9%	2.6%	2.6%	2.4%
Type of educational institution not stated	36.1%	23.7%	22.8%	25.8%

Source: ABS Census of Population & Housing, 2016; MacroPlan Dimasi

Vehicle ownership statistics from the Census indicate:

- The most predominant method of transport to work is overwhelmingly by cars with between 68–73 per cent of the employed travelling this way. This could suggest that there is a low level of public transport as well as long commutes.

- Vehicle ownership is relatively high in the Bullsbrook suburb and Swan LGA.

Table 9. Motor vehicle ownership

Census item	Bullsbrook	Swan (C)	Greater Perth	Western Australia
Dwellings with…				
No motor vehicles	1.1%	3.7%	4.9%	4.9%
1 motor vehicle	17.4%	27.9%	32.2%	31.6%
2 motor vehicles	37.8%	40.9%	39.4%	38.9%
3 motor vehicles	20.3%	15.5%	13.4%	13.7%
4 or more motor vehicles	20.0%	9.3%	7.4%	7.8%
All dwellings (with no. of motor vehicles stated)	96.6%	97.3%	97.3%	97.0%
Number of motor vehicles not stated	3.5%	2.7%	2.7%	3.0%
Dwellings with…				
No motor vehicles	18	1,663	33,694	42,620
1 motor vehicle	281	12,418	222,388	274,198
2 motor vehicles	611	18,205	271,887	337,355
3 motor vehicles	328	6,895	92,606	118,969
4 or more motor vehicles	324	4,123	50,906	67,709
All dwellings	1,561	43,302	671,490	840,844
Number of motor vehicles not stated	56	1,195	18,791	25,934
All dwellings	1,616	44,495	690,280	866,777

Source: ABS Census of Population & Housing, 2016; MacroPlan Dimasi

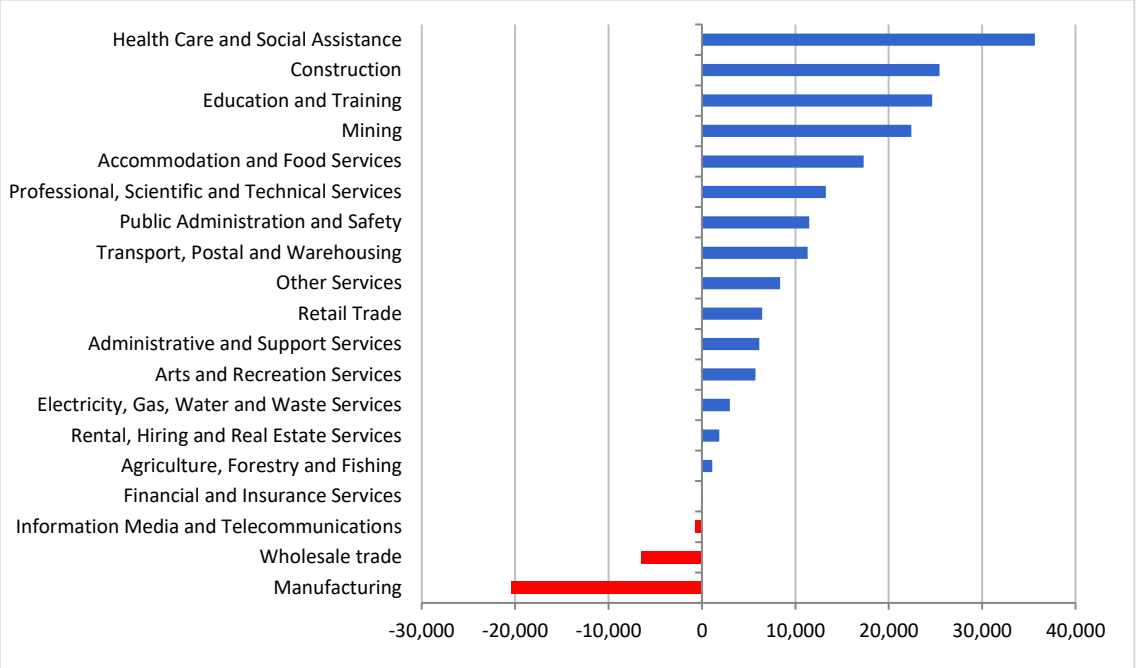
2.4 Employment assessment

Employment

Historically, Perth's population has grown by about 2.2 per cent across the past decade. This has been matched by equally strong growth in employment. Between 2006 and 2016, the composition of employment within Perth altered slightly as the general economy moved towards a service sector basis however over the most recent five years to 2016, there has been a noticeable shift in the industry composition.

The mining industry now accounts for 5.0 per cent of employment, construction 9.9 per cent and transport & warehousing about 4.6 per cent.

Figure 9. Employment growth, Greater Perth area, 2006 - 2016



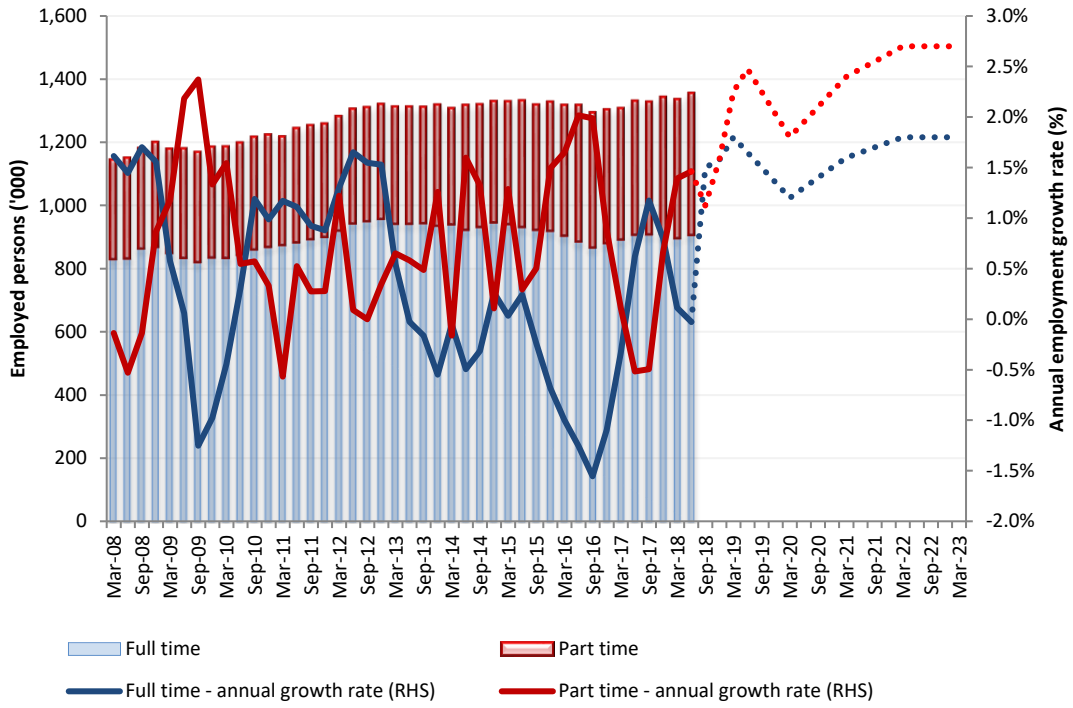
Source: ABS Census 2006, 2016

This shift in trend has implications for the future industrial land requirements of Perth. As employment in these industries continues to grow faster than average employment growth, the demand for industrial land will continue.

Larger inter-modal and freight hubs will be required and demand for business and technology parks will continue as headquarter premises are sought out and knowledge and innovation-based businesses linked to mining & minerals seek to move into the supply chain.

WA Treasury has forecast a gradual decline in unemployment rates from their current level. MacroPlan has forecast a small spike in the short term but then a decline in unemployment as the labour market shifts around.

Figure 10. WA employment growth outlook



Source: ABS 6202.0 - Labour Force, Australia, August 2018, WA Treasury 2018

Key points:

- Employment expectations are a key factor in households' decisions to consume.
- A forecast return to employment growth of over two per cent per annum will drive demand for housing.
- As finite construction and engineering projects represent much of the State's economic boost over the past decade, this past high employment growth will not be maintained unless there is a steady stream of business investment in new projects.
- Relatively high wages and low interest rates have increased the capacity of some households to afford more expensive dwellings.

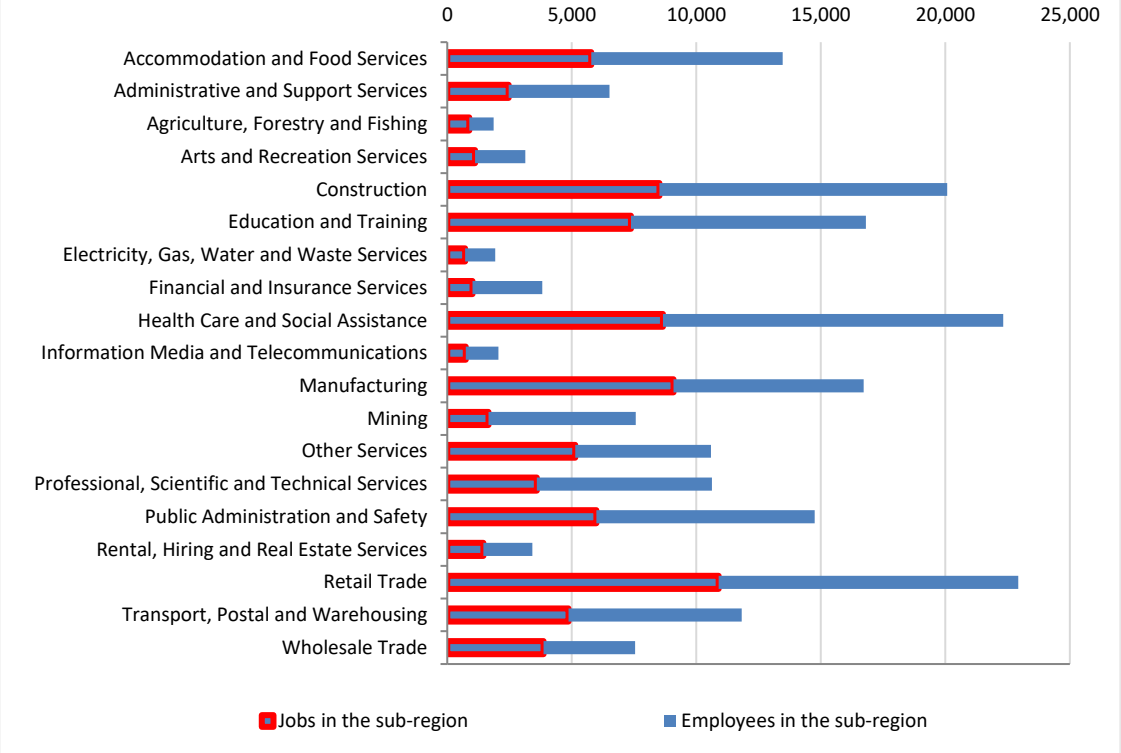
The WA Treasury forecasts indicate total employment in Western Australia to grow by 1.5 per cent in 2018-19, 2.0 per cent in 2019-20 and 2.5 per cent in 2020-21 and 2021-22.

Self-sufficiency

The City of Swan resident population has a high proportion of workers in the manufacturing and construction industries as well as retail trade and health services.

The North-East Sub-region has a reasonable level of employment self-sufficiency, at 68.1 per cent (68 jobs for every hundred resident workers). Achieving the *Perth and Peel @3.5 million Sub-regional Planning Framework 2018* targets for employment self-sufficiency in the sub-region will require the creation of approximately 104,100 additional jobs by 2050.

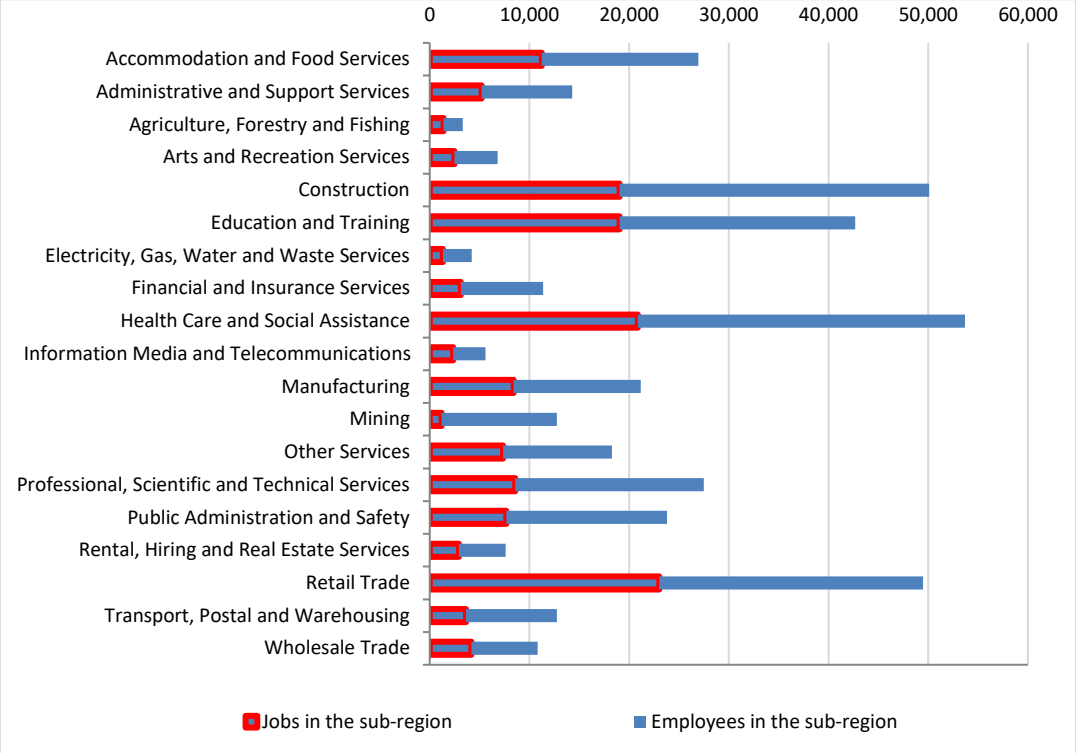
Figure 11. Relationship of jobs and employees in the North-East Sub-region



Note: Data do not include responses that were inadequately described or not stated.
Source: Australian Bureau of Statistics – Census of Population and Housing 2016

In contrast, the North-West Sub-region has a low level of employment self-sufficiency, at just 56.7 per cent (56 jobs for every hundred workers). Achieving the *Perth and Peel @3.5 million Sub-regional Planning Framework 2018* targets for employment self-sufficiency in the sub-region will require the creation of approximately 63,500 additional jobs by 2050.

Figure 12. Relationship of jobs and employees in the North-East Sub-region



Note: Data do not include responses that were inadequately described or not stated.
Source: Australian Bureau of Statistics – Census of Population and Housing 2016

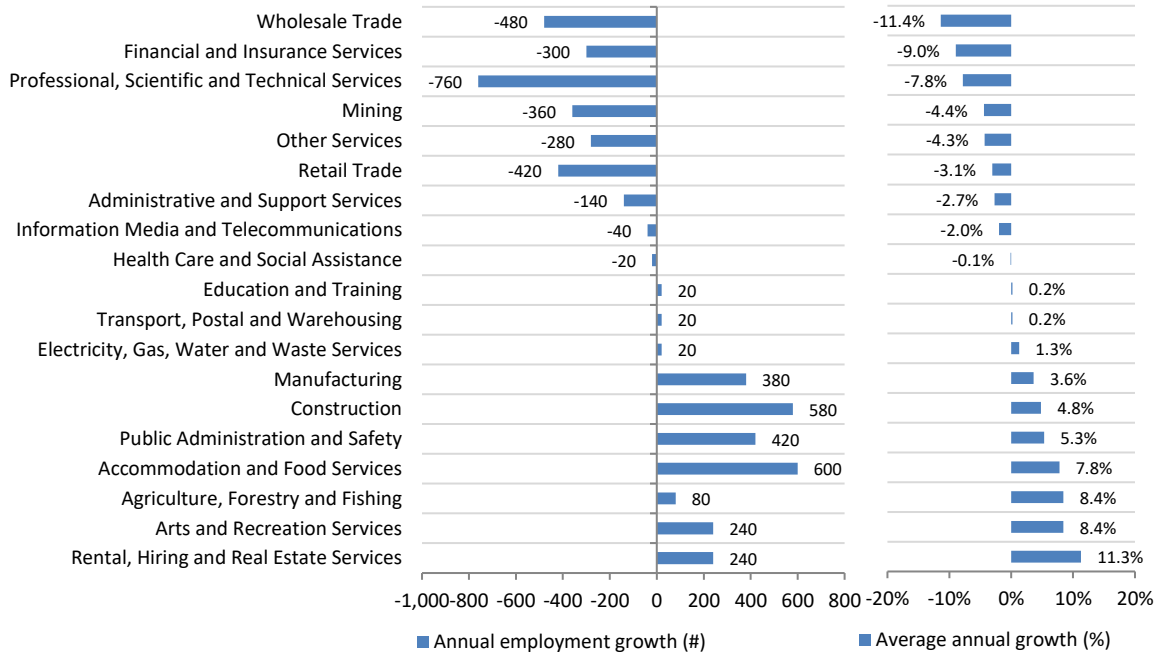
2.5 Employment growth opportunities

The job market in the North-East Sub-region is led by the health care and social assistance industry which was the largest industry in the region at 15,700 jobs but saw negative growth over the period at -0.1 per cent.

The following figure illustrates the change in employment in each industry over the period May 2013 to May 2018 in the North-East Sub-region. The fastest growing industries include the rental, hiring and real estate (11.3% growth), arts and recreation (8.4% growth), agriculture, forestry and fishing (8.4% growth), accommodation and food services (7.8% growth) and public administration and safety (5.3% growth).

The market is shifting away from the wholesale trade (-11.4% change), financial and insurance services (-9.0% change) and professional, scientific and technical services (-7.4% change) industries as these industries saw negative annual growth in employment over the period.

Figure 13. Change in employment by industry, Perth – North East, 2013 – 2018

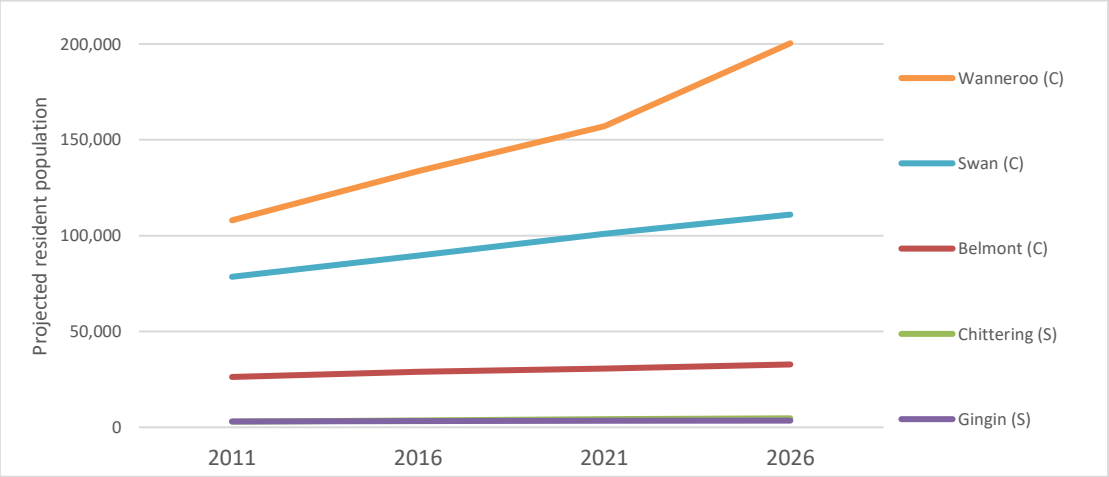


Source: Department of Jobs and Small Business, 2018

Working-age population and growth of catchment areas

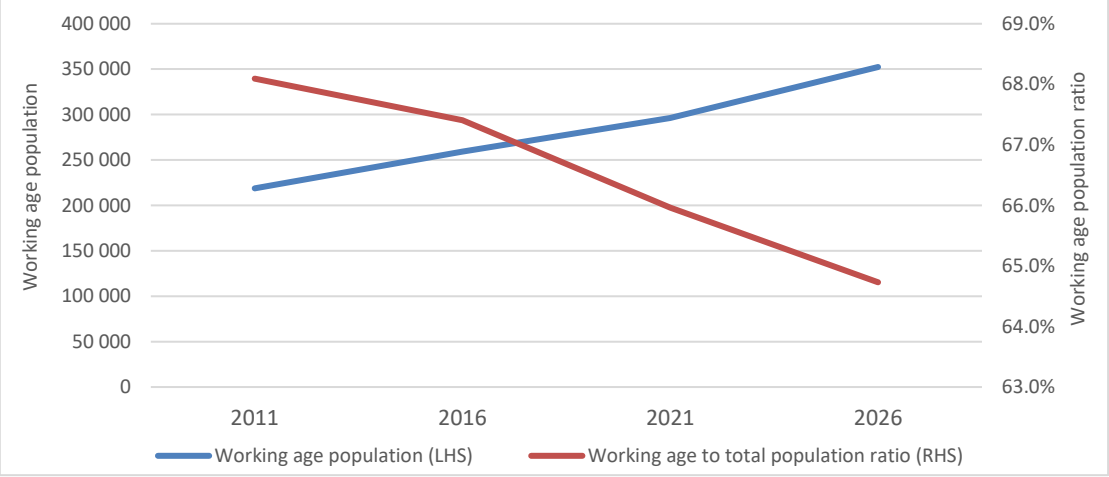
The future workforce for this area is expected to primarily be from the City of Swan (particularly Ellenbrook and Bullsbrook as the closest urbanised areas), however, depending on the total quantum, nature and specialisation of the work, the area may develop a much wider employment catchment for workers. On this basis the following figure shows the projected population growth in the likely catchment areas for workers in the Bullsbrook Freight and Industrial Area – the cities of Swan, Wanneroo, Chittering, Muchea and Belmont. These local governments are used for the following two figures showing the growth in the population by working age (aged 15 to 64 years).

Figure 14. Employment catchment – projected growth of working age population (15-64 years)



Source: Western Australia Planning Commission – WA Tomorrow 2015; MacroPlan Dimasi

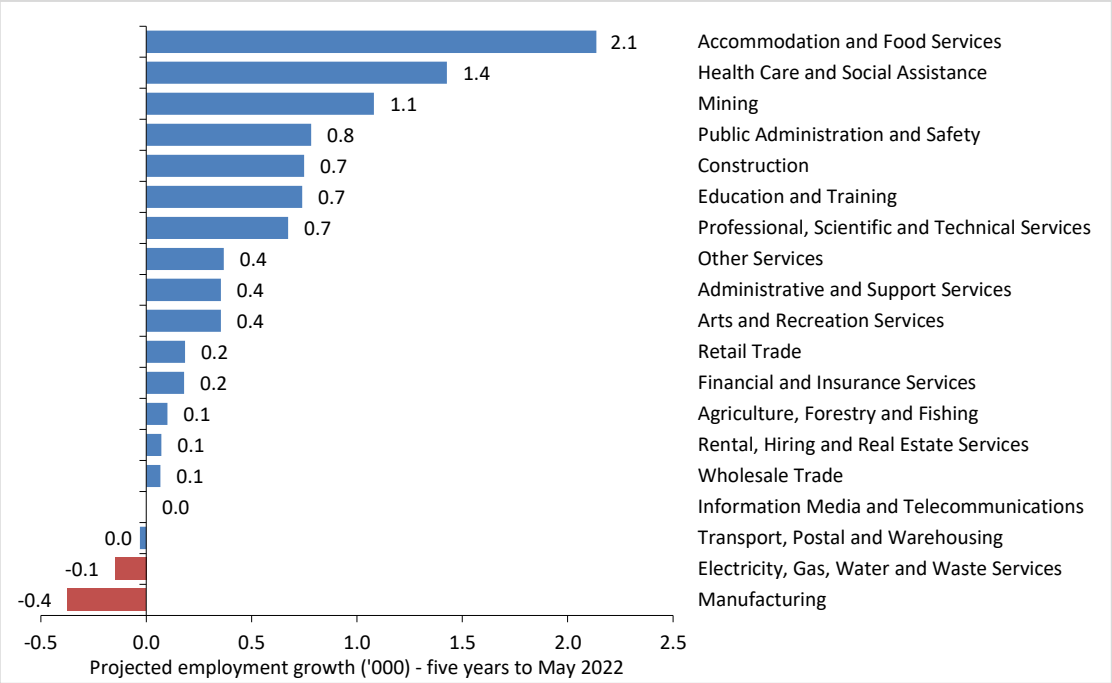
Figure 15. Employment catchment – projected growth of working age population (15-64 years)



Source: Western Australia Planning Commission – WA Tomorrow 2015; MacroPlan Dimasi

Employment projections for the North-east Sub-region indicate mining and construction employment will be one of the top five driving industries, while manufacturing and logistics employment decline. These projections reflect the trend in construction and mining wages outlined above. Note that these projections only extend to 2022, which is well short of the development timeframe for the Bullsbrook Freight and Industrial Area, however, it does provide a suggestion of the future potential growth if these trends continue into the medium and longer terms.

Figure 16. North-East Sub-regional employment projections to 2022



Source: Department of Jobs and Small Business (2018)

Section 3: National trends and Perth market

This section provides an overview of trends in industrial land demand in a national context as well as outlining the characteristics and drivers of the industrial land market within the Perth metropolitan region.

3.1 National trends in industrial demand

A look at emerging trends occurring in industrial land markets across Australia reveals how the use of industrial land is changing. The globalised economy emphasises a requirement for innovation and specialisation to establish a competitive niche. This has resulted in changes to the way new estates are being planned and positioned, with lots needing to be more flexible and adaptable to tenant needs and requirements.

The trends identified in the industrial market across the country include:

- More flexible lot sizes
- Bigger more efficient warehousing
- Greater accessibility by road, rail and public transport for both business and employees
- Convenient location close to growing residential areas and hence access to workforce
- Greater importance placed on competitive advantage
- Reduction in costs to be more competitive
- An ability to have an increased number of functions occurring at any one site.

The dominance of Asia as the global manufacturing hub has driven the need for more efficient and low-cost manufacturing in Australia. This has meant that industry has established new modes of production, with greater reliance on imported components, more automated manufacturing and assembly and with a greater emphasis on establishing market niche such as high-tech engineering.

The increased reliance on imported components in the manufacturing sector has resulted in an increased focus on assembly and packaging processes with lower overall value-add. There has been a growing emphasis on logistics and distribution, with the supply chain from production to delivery effectively becoming shorter and more efficient. Some of this could shift again with additive manufacturing (3D printing) providing a new disruption to the sector.

Australia's participation in the global free trade market and the removal of tariff protections/industry support from government has meant the industry sector has had to compete on productivity and cost. Agriculture and manufacturing are the leading examples were productivity has had to increase dramatically to compete.

Location decisions are a part of this drive to increased productivity and efficiency and the Bullsbrook Freight and Industrial Area has the fundamental locational characteristics that make it attractive for long-term investment.

Implications for Bullsbrook Freight and Industrial Area

The Bullsbrook Freight and Industrial Area is highly accessible by road, close to the rail network and complements the industry and worker-type in the area. Furthermore, it is a large land holding meaning lot sizes can be flexible and adaptable to market conditions.

There is currently a void in the market place for processing and packaging of rural produce. The historical uses of the area as an agricultural precinct along with its connectivity via road and rail provide an opportunity for the estate to cater for this market gap.

Industry segments

Industrial demand is segmented into several main categories. The following table provides an overview of the key features of these sectors and describes the various attributes and activity occurring on industrial land. These industry segments should be considered in the overall approach and understanding of market needs to ensure the correct delivery of industrial land within the Perth market.

Table 10. Industrial land user segments

Industry	Size and description	Opportunity
Heavy / Noxious / Offensive (5-50ha)	Heavy industries. e.g. Oil refinery, aluminium smelter	Not a consideration for the subject site
Transport/ Warehouse/ Storage (2ha+)	Trend in manufacturing/ importing to outsourcing storage - distribution combined. Major transport routes emerging as transport and distribution hub for increased efficiency and delivery.	Proximity to rail network, major existing and planned arterial roads make this segment a key candidate for the subject site.
Manufacturing / Component Assembly	Component assembly manufacturers vary from extensive land areas to less than 2 hectares.	Based on the worker profile, this may be a target market for the subject site
Light Industrial & Trade Park	In this sector, greatest demand is for smaller blocks between 500sqm and 1,000sqm ranging up to 1 ha for light industrial/ small local businesses. Examples include engineering and mechanical workshops. Less attention is paid to aspects such as landscaping, signage and setbacks. Lots and buildings tend to be at the more affordable end of the market.	The location attributes of the site in relation to transport and heavy haulage would suggest there is an opportunity to target mechanical workshops and related services.
Service Business Park (SBP)	SBP's attract a wide range of service providers and can include manufacturing and processing/ packaging/ distribution industries seeking a high amenity location as well as equipment hiring, places of worship, funeral directors and police and emergency services. Land parcel sizes 1000sqm to 2000sqm (up to 5000sqm).	This is the eventual evolution of the estate and could facilitate such uses once a critical mass is established. Manufacturing and distribution would be the target market segments.
Technology Parks	Similar block sizes to SBP, but high amenity values with high standards of landscaping and built form more akin to an office park. Land parcel sizes 1000 – 2000sqm (up to 5000sqm).	Not a consideration for the subject site in its initial stages.
Specific Uses	Restricted retail - large scale homemaker centres and showrooms Highway uses – car, boat and truck sale yards Recreation/entertainment - indoor complexes e.g. tennis, squash, basketball/netball, indoor cricket stadiums & outdoor activities such as motor sports e.g. go-carts Agri-business– packaging and processing, including for interstate and overseas exports.	There is an opportunity in this segment to provide for the rural sector. In the way of production, storage and distribution of rural products due to its location and historic land use.

Source: MacroPlan Dimasi 2018

3.2 Intermodal and freight demand trends

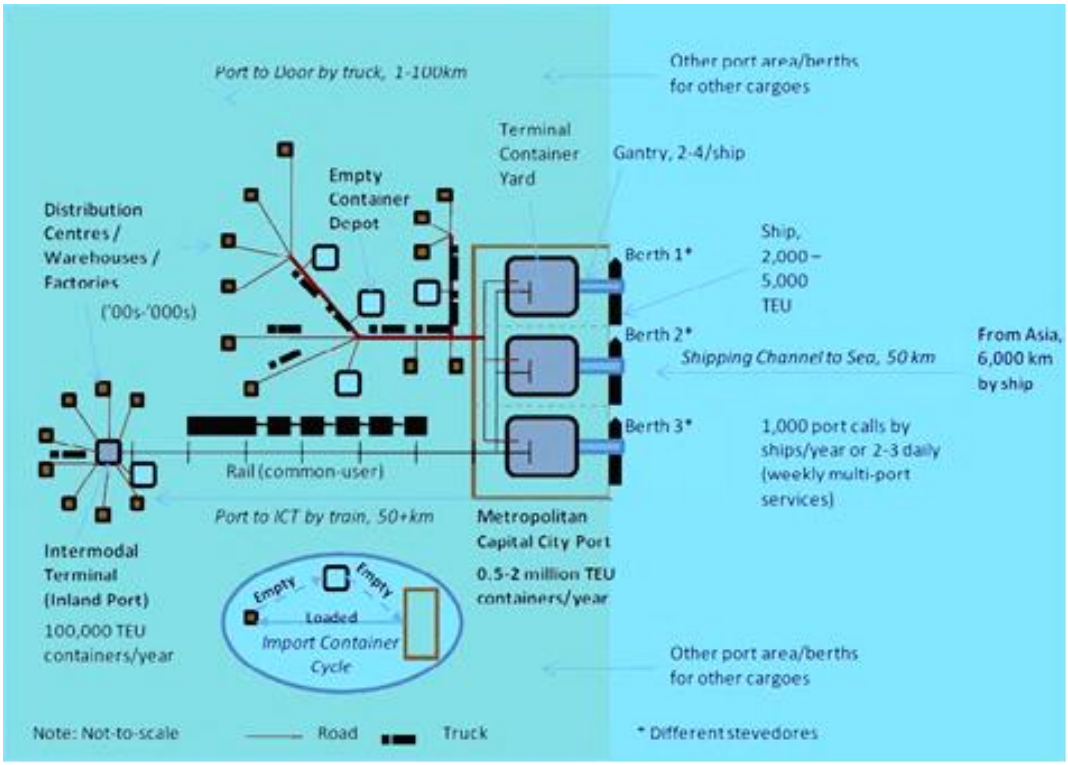
The global shift to free trade has opened the way for the growth of containerised trade. Essentially containers have unlocked the constraint of limited or highly-valuable land at the ports and allowed many freight functions to be shifted to inland locations, away from the coast.

Without the constraint of having to be near the coast, intermodal terminal operators can reprioritise their location decisions based on other factors such as access to markets, workforce availability and optimal road connections.

They are of course, still constrained by the need for rail, however, this is often an easier barrier to overcome than finding space around ports.

Functions such as customs processing, inspecting, sorting, and packing containers are some examples of tasks performed at intermodal terminals.

Figure 17. Typical inland terminal



Source: Colliers International

Typical uses at intermodal terminals include:

- Container handling
- Ancillary warehousing and storage
- Road-to-road cross docking
- Depot for empty container storage
- Wash, preparation and repairs and maintenance facilities
- Purpose built temperature-controlled storage facilities
- Industry park clusters

Locational factors affecting terminal owner/operator or supply include:

- suitable land area

- proximity to transport infrastructure (namely truck networks, railway lines and ports)
- accessibility
- appropriate return on capital.

User factors affecting intermodal demand include:

- proximity to industries, markets & CBD
- land rents
- types of intermodal freight/containers
- ease of rail access
- truck access type

Indirect factors that affect the attractiveness of intermodal terminal location include:

- the need to mitigate potential conflicts arising from competing land uses
- residential encroachment is an emerging issue for potential sites
- off-site impacts such as truck movements, 24/7 operation, noise and night light.

International examples

Intermodal terminals in other countries operate quite differently to those in Australia:

USA: While intermodal terminals have a significant role in long-haul transport of domestic and international containers, they have no role in the distribution of containers in metropolitan and regional centres around the ports and cities.

Europe: There has been significant development of rail shuttle services that interconnect major ports to inland intermodal terminals and servicing both regional and international markets however, there appear are few significant examples of intermodal networks servicing primarily metropolitan port freight distribution.

Australian examples

Intermodal terminals in Australia have three major functions:

- freight traffic related to international trade (equivalent to the primary function of terminals in the USA and Europe)
- interstate freight networks
- metropolitan distribution of freight direct from the intermodal terminal.

Intermodal terminals vary considerably in size and while there are dozens of intermodal terminals in Australia, very few are significant in scale and located in metropolitan locations. Major facilities are located in:

- Sydney: West and South West
- Melbourne: West and South East
- Brisbane: Australia TradeCoast (ATC), South and Outer South and the Outer South West
- Adelaide: North and Outer North
- Perth: East region (Kewdale and Forrestfield).

3.3 Jobs of the future

Given that the development of the Bullsbrook Freight and Industrial Area will be over a long timeframe of 20-30 years and beyond, trend assumptions are subject to considerable variation and disruption due to global political, economic and technological changes. This means that many of the jobs and industries of the future are likely to be quite different from those of today. This section addresses some of the factors affecting the future of industry and employment.

Smart jobs – those that are cognitive (as opposed to manual) and non-routine – have demonstrated the strongest growth over the past 20 years (Reserve Bank of Australia, 2016):

- The cognitive component of work has increased from 54.1 per cent of jobs in Australia in 1986 to 59.6 per cent by June 2016 (Reserve Bank of Australia, 2016). Underneath this overall gradual change is a transformational shift in some sectors of the economy because of structural change and techno-global drivers.
- Routine tasks reduced from an estimated 67.0 per cent of all labour in Australia in 1986 down to 53.5 per cent by mid-2016.

Over recent decades, there has been a noticeable decline in the share of people employed in routine manual jobs. This decline has affected job numbers in manufacturing, mining, agriculture and administration/services – all sectors that have high shares of routine manual occupations. One of the reasons behind this trend is that some of these jobs have been automated.

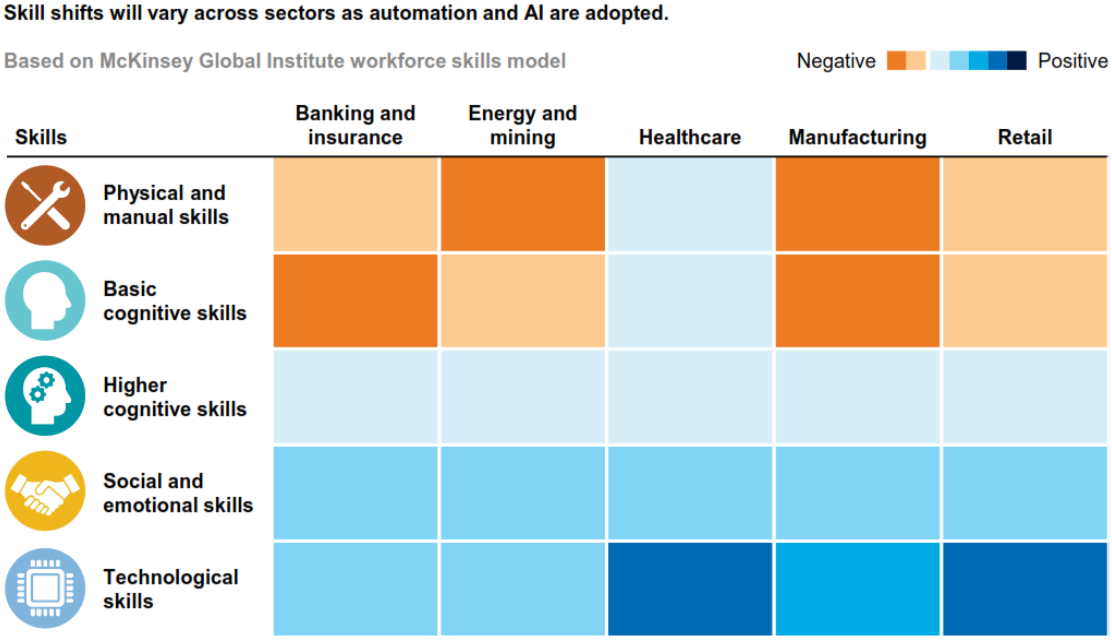
Routine cognitive jobs were relatively flat as a proportion of the total workforce until the early 2000s, however since then they have begun to decline as computer systems begin to have a more significant role in the accounting, legal and professional services jobs.

Parallel and related changes to the optimal size/scale of manufacturing plants, in tandem with declining international (sea and air) shipping costs, have seen industries concentrate in fewer locations globally. Large-scale plants require large land areas, and with continuing declines in the cost of trucking, their location next to sea ports has become less relevant.

At the same time, the threat of automation is much wider than it has been in the past due to two effects:

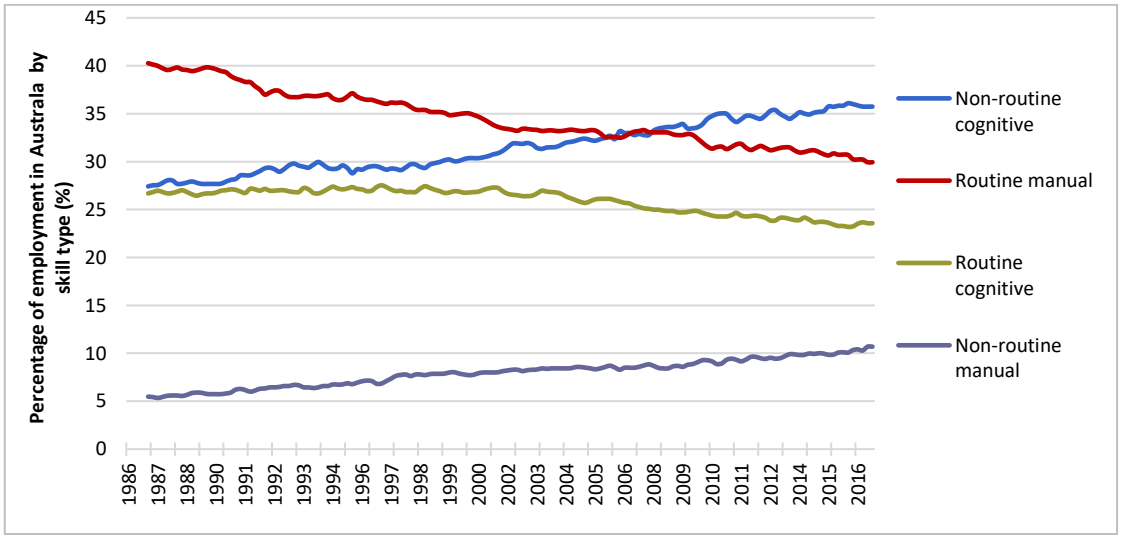
- Technical improvements in robots replacing routine manual labour. Significantly improved visual perception, dexterity and mobility means that robots can be applied in more situations requiring manual labour. The global robotics market was estimated at $71 billion in 2015, with compound growth of 17 per cent. The Asia-Pacific region accounts for some two-thirds of the global expenditure on robots (International Data Corporation, 2016).
- Algorithms and computing power replacing routine cognitive jobs. More sophisticated, aided by digitisation of more data and standardisation of metadata (i.e. global accounting standards).

Figure 18. Projected shift in skills needed in five industry sectors as technology changes the nature of work



Source: McKinsey & Company, 2018

Figure 19. Australian jobs shifting to non-routine cognitive and non-routine manual jobs



Source: Reserve Bank of Australia, 2016; Australian Bureau of Statistics, 2016; MacroPlan Dimasi

Smart jobs cut across both 'blue' and 'white' collar classifications of the labour force. This means that some typical white-collar jobs are just as 'threatened' as blue-collar workers (Frey & Osborne, 2013).

Technological change has allowed the movement of jobs that were typically considered as non-tradeable, making some of the routine cognitive jobs to be executed in other parts of the world where labour costs are lower such as offshore back-office functions and call centres.

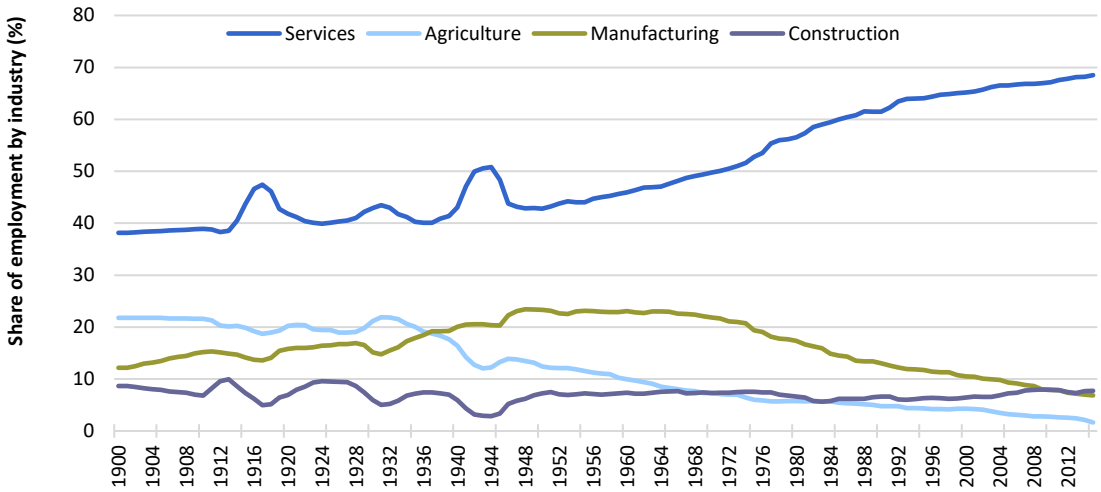
According to the Committee for Economic Development of Australia (CEDA), in 2015 approximately 40 per cent of occupations were highly susceptible to automation and similar research by the Department of Industry, Innovation and Science found that 44 per cent of jobs were vulnerable to computerisation.

Non-routine jobs have become steadily more important and the reason behind it is that these jobs tend to be more complicated to automate. For instance, some non-routine occupations, such as architecture, may require creativity and the ability to solve non-routine problems, while other, such aged care work, requires a physical human presence. The Australian workforce may also have a comparative advantage in many occupations in the non-routine category because of the high education levels of Australians.

Many jobs that are routine and manual have been replaced by robots, particularly in the agriculture, manufacturing and logistics sectors. Jobs that are routine and cognitive have been replaced with standardised systems and computers, which can process routine tasks very efficiently.

Agriculture and manufacturing are industries that had a long history of decline in the share of routine manual jobs due to technological change while the services sector has increased the number of jobs considerably.

Figure 20. Share of employment by industry

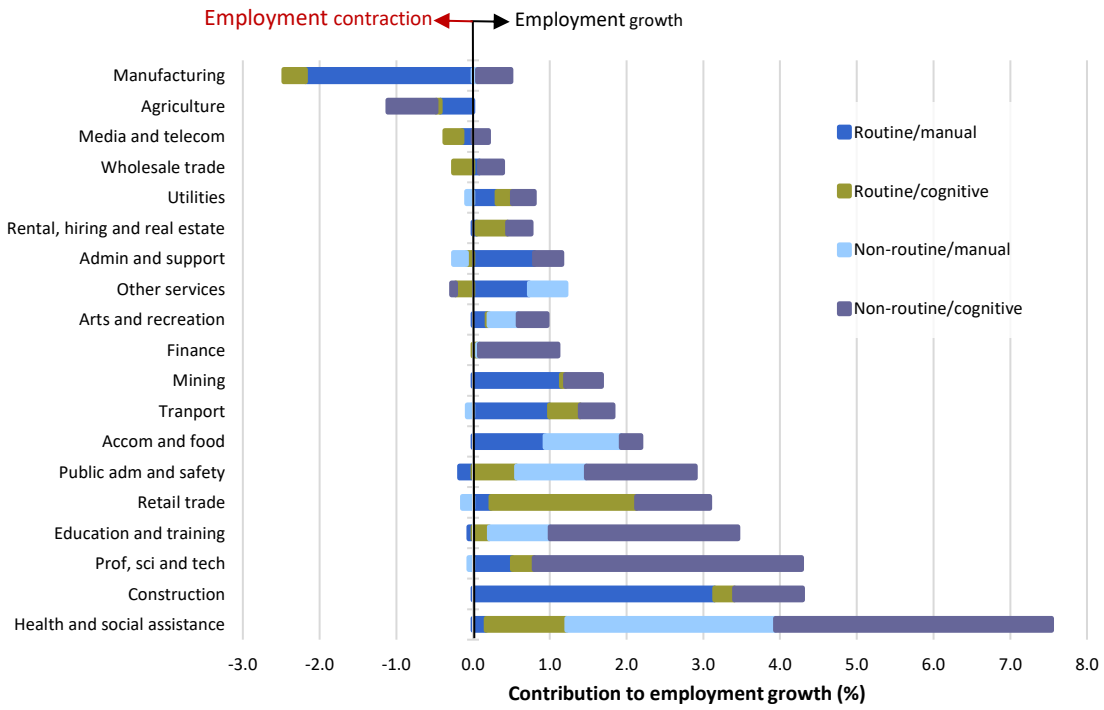


Source: Australian Bureau of Statistics, 2016; Reserve Bank of Australia, 2016

The following figure shows that the health care and social assistance industry has made the largest contribution to employment growth over the past 15 years, and most of this has been in non-routine work. The other two industries that made the largest contributions to growth in non-routine jobs over this period are professional, scientific and technical service and education and training.

The stability of relative wages in the health sector over most of the past 15 years suggest that the expansion of demand for health care workers has been more or less met by an increase in the number of people who are able to work in the sector.

Figure 21. Contribution to employment growth by industry employment and skill type, 2000/01 to 2015/16



Source: Australian Bureau of Statistics, 2016; Reserve Bank of Australia, 2016

Education and training, construction and mining have all experienced a trend increase in their relative wages over the past 15 years or so. This suggests that the supply of workers with the right skills has not kept up with the increase in the demand from these industries.

Research for the United States has shown that employment growth has been faster for occupations that have created more new jobs titles (National Bureau of Economic Research, 2016) emphasising the positive aspect of skill-biased technological change; although technological change makes some jobs redundant, history repeatedly demonstrates that others are created in their place.

The implications for the Bullsbrook Freight and Industrial Area are that it will need to cater for a highly technical workforce across all the relevant industry sectors. While some jobs will be lost to automation (especially manufacturing and agriculture), humans still operate in this fields, but their jobs are more likely to now be classified as 'professional, scientific and technical' (for example).

3.4 Economic and sectoral drivers in Perth

Development paradigms in the industrial market have undergone significant shifts post-GFC and the mining investment super cycle. A return to strong employment growth will lead population growth. This, combined with large-scale infrastructure investment and a high valued Australian dollar will influence and shape industrial land demand, scale and composition within Perth.

Of these issues, the Australian dollar is one of the most important factors impacting on the industrial landscape as high dollar makes imports cheap and exports comparatively uncompetitive. This changes the nature of industrial demand by shifting from local manufactures towards imports. This, in turn, shifts industrial land demand from manufacturing towards greater warehousing and logistics needs.

If imports increase, this will increase containerised trade and increase demand for intermodal rail hubs, or inland ports, as well as distribution centres close to major highways.

The following table highlights some of the key drivers of industrial land markets within Perth. These drivers will affect the various industrial sub-markets in different ways.

Table 11. Economic drivers

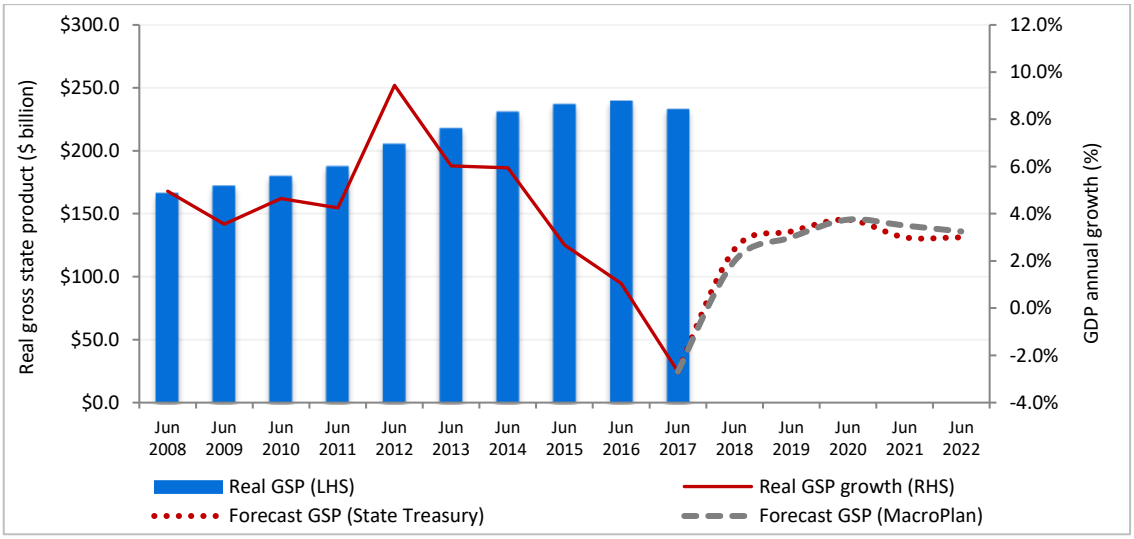
Driver	Measure
Economic growth	GDP, GSP (ABS)
Commodity prices	Iron ore, gold, base metals, mineral sands (lithium, titanium) (RBA)
Exploration activity	Mineral and petroleum exploration
Industrial production	Industrial production (ABS)
Engineering construction	Engineering construction, including resource-sector construction projects (ABS) & government capital works program
Population growth	Historical & future population growth
Employment growth	Employment/labour force growth by 'blue collar' industry
Port & freight projections	Port: container movements. Airport: freight tonnes
Inflation & interest rates	CPI and RBA Target Cash Rate
Exchange rates	Australian dollar relative to US
Freight activity	Freight movements – intrastate, interstate, overseas (BITRE)
Global frameworks / geopolitics / economy	Global economic conditions (eg. US, Asia, banking regulations)

Source: MacroPlan Dimasi (2018)

Economic production

Understanding the likely future growth for WA provides an insight into the on-going requirement for industrial land required to achieve forecast levels. In 2016-17, Western Australia had the fourth largest economy in Australia. The state's annual economic growth rate of -2.7 per cent was the slowest growth of all the states and territories and over the past 10 years, Western Australia's economy has averaged 3.9 per cent growth per year. Forward projections indicate that there will be a quick turnaround in State economic growth from the 2017/18 financial year onwards. This is based on Commonwealth and State government capital works investment as well as the non-mining construction sector (retail, hotels) picking up in the short to medium terms.

Figure 22. Western Australia Gross State Product and Australia Gross Domestic Product, Annual, 2008 to 2022



Source: ABS Australian National Accounts: National Income, Expenditure and Product 5206.0

Western Australia's economy is projected to grow at an annual average of 3.0 per cent in the long-term. This reflects lower levels than during the mining boom, however it is still in line with projected national growth. Provided labour force constraints can be avoided, there is potential for medium term growth to be revised upward of projections.

In the longer term, the economy will be subject to cyclical factors that may affect timing and structural changes which will affect the type of industrial development in demand.

Population growth

Population growth and dwelling construction will be key drivers of industrial land demand given the synergies regarding construction and building services, distribution centres for retail operators and other local industrial service precincts.

In an employment feedback loop, population growth is driven by employment opportunities and as such the size of the potential workforce which could be supported within industrial land precincts is dependent on the number of jobs created. Migration to a region generally occurs once employment is secured and many of the overseas migrants becoming permanent residents have already been working in the country before gaining citizenship. The Perth population grew by an average annual 2.2 per cent over the past decade and is expected to continue to do so over the medium to longer term.

Perth is a rapidly evolving city with several urban fronts being developed concurrently and this will continue to create strong economic multipliers, supporting industrial land demand through employment growth and construction fuelled supply chain demand.

Market share and competitive advantage

The establishment of major high-tech business parks and specialised precincts with linkages to mining and Asia should be encouraged as should a network of proper intermodal terminals that reduce road congestion and timing delays at the Port of Fremantle.

Movement of freight from road to rail or vice versa at locations in middle-to-outer metropolitan locations in proximity to regional highway routes will be important to ensure efficiencies are maximised and economic multipliers are fully harnessed.

Inter-modal precincts in themselves can become micro-economies driving freight and logistics, distribution centres & head-offices as well as other

supporting sectors. The development of the road/rail intermodal at Forrestfield should be just the beginning of this type of network.

The evolution of the global economy means major businesses now operate across the entire supply chain from value adding (direct distribution), to maintenance, to contracting (e.g. Toll, Linfox, TNT). This has implications for industrial land need such as large sites, access to a diverse worker base, transport networks and proximity to multiple markets. Accommodating more major national and global companies such as these will be possible with the right frameworks.

Section 4: Market analysis

This market assessment first considers the supply side of the equation with a focus on the estates that compete directly with the proposed Bullsbrook Freight and Industrial Area and then considers the factors and catalysts that can trigger the demand and investment.

4.1 Supply in competing estates

Muchea Industrial Park

Muchea is an employment node located at the intersection of the Brand Highway and Great Northern Highway, located approximately 20 km north of the proposed Bullsbrook Freight and Industrial Area. The District Structure Plan area comprises 1,113 ha of land, of which 343 is set aside for environmental purposes. Like the subject site in Bullsbrook, it is well positioned and has attractive strategic location attributes, including access to:

- Perth-to-Darwin National Highway
- Great Northern Highway
- Midland-Geraldton railway line providing access Fremantle Port and proposed outer harbour at Kwinana
- Agricultural areas
- A sustainable employment base.

Due to its locational attributes, it will provide benefits to businesses involved in transporting large equipment and other goods to locations in the State's Mid-West and North-West regions.

Modelling conducted in 2008 indicated that when fully completed, Muchea could provide approximately 1,000 jobs, likely driven by primary production, freight and logistics and local demand (as there was previously no industrial zoned land in the Shire of Chittering). The site already hosts the WA Meat Industry Association saleyards, and two poultry farms, and a relocation of Ingham's Sinagra operation by 2020.

Planning at Muchea is currently progressing with the first stage (Precinct 1) being zoned and a local structure plan in place. A Special Control Area applies to the structure plan area. Preliminary subdivision approval for the first 12 lots in Precinct 1 has been issued in 2018.

The Western Australian Planning Commission has recently endorsed an update to the Structure Plan to reflect changes in the planning environment since its initial release including the anticipated completion of NorthLink in 2019 and the relocation of the road train assembly area from Muchea to Wubin and to assist in co-ordinated infrastructure provision and land release.

Implications for Bullsbrook Freight and Industrial Area

The role of the Muchea Industrial Park is likely to be focused on primary production, logistics and freight operations and provide for regional demand. It can also provide a base to serve the agricultural needs of feedstock, fertiliser and seed for the Wheatbelt.

While Muchea will have an agricultural and food processing focus to drive demand, the Bullsbrook Freight and Industrial Area can focus on complementary industry including interstate freight, import processing and distribution centres for the North-West and North-East sub-regions.

With the Muchea land lacking essential services, the costs of bringing serviced land to market is likely to increase, which would place upward pressure on end prices. Furthermore, the proposed Bullsbrook intermodal terminal and proximity to the Perth CBD, Fremantle Port and other intermodal terminals in and south of Perth should differentiate the Bullsbrook location for potential tenants from what is available at the Muchea Industrial Park.

Meridian Park, Neerabup

Meridian Park in Neerabup provides an alternative location for prospective tenants and is fully serviced. With an ultimate development area of 540 hectares, it is expected to develop over a 30 to 50-year timeframe. It is within 4 km of the Mitchell Freeway (via Flynn Drive) and has been designed to accommodate Restricted Assess Vehicles (Category 4).

The estate has been on the market since 2008 and has sufficient stocks of land to meet the medium and some long-term demand.

Given that sales of these estates could continue for many years, the timeframes for these developments could potentially overlap with the proposed Bullsbrook Freight and Industrial Area.

Despite the location's transport access and proximity to the growth north-west urban corridor, it is not likely to become a major logistics hub. Instead it is ideally suited to provide construction-related goods and services which will be required as the Alkimos to Yanchep corridor grows over the next 25 years. The early provision of the METRONET passenger rail service to Yanchep with construction commencing in 2019 will provide a stimulus for urban development (as happened with the Perth to Mandurah rail opening up the South-West Sub-region following the Government's commitment in 2004).

Implications for Bullsbrook Freight and Industrial Park

While Meridian Park may attract some level of logistics and distribution investment to service the North-West Sub-Region, this location is not as attractive for full-scale development as is the Bullsbrook location (which can service two urban corridors as well as the Perth central area).

Instead, Meridian Park is likely to draw business that service the infrastructure, engineering and construction industry sectors.

Latitude 32, Postans/Wattleup

Latitude 32 is part of the Western Trade Coast and offers 1,400 ha of industrial land close to the potential new Outer Harbour development in Kwinana (the 'West Port' project) and is serviced by freight rail infrastructure. Therefore, Latitude 32 is the prime location to service many of the intermodal and freight needs of the Perth and Peel regions (and beyond).

The rapidly-developing urban areas within the South-West Sub-region mean there is an existing large workforce catchment for future employees.

Given the size of Latitude 32 and the substantial land supply, it will continue to develop over several decades and will overlap with the proposed timing of the Bullsbrook Freight and Industrial Area.

Implications for Bullsbrook Freight and Industrial Park

While Latitude 32 is a very large development and has major advantages for servicing the future Outer Harbour, to some degree development of the estate also depends on a commitment to West Port project.

The Bullsbrook Freight and Industrial Area is largely independent of the West Port project as it is readily serviced equally by either the existing Fremantle Inner Harbour or the proposed Outer Harbour (via the Midland – Geraldton rail).

Stockyards Estate, Hazlemere

The Stockyards Estate in Hazelmere has been very successful within a relatively short period of time. Key factors are:

- able to deliver large lots to the market with custom built facilities in a relatively short time
- proximity to major interstate and intrastate freight routes
- proximity to Perth Airport
- offered best-practice ESD initiatives and was flexible to tenant requirements.

The location attributes of the Stockyards estate also appealed to freight and logistics users due to proximity to Perth Airport and main arterial routes north and south, east and west.

Implications for Bullsbrook Freight and Industrial Park

The success of the Stockyards Estate provides a good signal for the proposed Bullsbrook Freight and Industrial Area as it shares several locational attributes. Given that the Stockyards is likely to be substantially developed by the time the Bullsbrook project comes on line the two estates are not likely to compete directly.

The proposed Hazelmere South Extension area as identified in the South-East Sub-regional Framework will provide an additional 50 hectares of industrial land, however, this is also likely to be taken up (based on the development rates of the Stockyards Estate) relatively quickly in the short term and therefore will not likely compete with the Bullsbrook development in the medium to longer terms.

Intermodal terminals

The intermodal terminals at Kewdale and Forrestfield will increase capacity over time through technological improvements and increased automation. This will mean that while they may not have vacant land available for development by the time that the Bullsbrook project can be developed, they will still provide direct competition for intermodal freight handling.

Implications for Bullsbrook Freight and Industrial Park

Bullsbrook is likely to be able to compete on land price and large lot availability over Kewdale and Forrestfield into the longer term.

4.2 Demand drivers

This section of the report assesses the more localised demand drivers that will influence the industrial land market across Perth. This section also identifies some of the broader competitive advantages of the Perth industrial land market and discusses methods and approaches that will potentially enable a greater market share of national and international major tenants for Perth.

Demand overview

Demand for industrial land can typically be considered from two-perspectives:

- Long-term planning perspective
- Short to medium term commercial market perspective.

Strategic planning should consider likely longer-term trends and growth underpinned by assumptions that will allow allocation of land precincts of sufficient size in appropriate locations to accommodate future economic and

employment growth. At the same time, disruption from technology will have a role in changing the nature of industrial operations over the longer term.

One of the most important facets is ensuring that there is a sufficient 'buffer stock' of industrial land supply within the metropolitan area. That means supply-side pressures should not constrain the market and lead to an upwards ratchetting of land and rental prices. A buffer of 10-20 years of available land supply is typically considered to be appropriate however this supply must consider constraints, serviceability as well as location attributes.

Inevitably, demand for industrial land will ebb and flow according to broader macroeconomic conditions and at the microeconomic level it will be influenced by factors such as infrastructure delivery and housing growth. Demand growth will not consistently track at the same pace each year. There will always be cyclical economic, social and political factors that will influence the market in the short term. Over the longer term, periods of particularly high economic growth, can increase demand substantially (as happened with the recent resources boom).

Generally, demand for industrial land will be driven by several factors, primarily:

- Export & import driven economic growth (including mining)
- Domestic industrial production & construction
- Population & employment growth.

Economic growth

Some of the key sectoral drivers for the Perth industrial land market have been discussed previously. Western Australia's economic growth is expected to reach 3.25 per cent in 2018-19 compared to the projections for Australia at 3.0 per cent. This is close to the long-term average growth and reflects WA's export links to the fast-growing economies Asian-Pacific region.

Understanding the likely future growth for WA provides an insight into the on-going requirement for industrial land required to achieve forecast levels.

Economic conditions are a key driver of population growth in Perth. This is primarily due to the employment prospects created in a strong economy, which attract additional permanent migrants – mainly from overseas. These are most often workers and their families, arriving as part of the skilled migration program.

Major mining projects

Mining investment is expected to fuel demand for labour and create significant flow-on multiplier benefits for the Western Australian economy. There is significant capital expenditure in the mining sector within WA alone, with more than $176 billion in capital expenditure in projects, including $144.3 billion committed or under construction and $31.8 billion under consideration. This equates to significant labour and capital needs.

Even under conservative assumptions there will be demand for more than 25,000 construction jobs and more than 4,000 operational jobs. The flow through impacts into other supporting sectors such as mining service, building & construction services, materials manufacturing will drive strong industrial demand within Perth over this timeframe.

Population growth

Population growth and dwelling construction will be a key driver of industrial land demand given the synergies between construction and building services, distribution centres for retail operators and other local industrial service precincts.

Population growth increased demand for housing and goods, which stimulates local business and employment. This creates a self-reinforcing cycle of growth that is fundamental to the State's prosperity. The key population growth trends are:

- The population growth rate shows that Western Australia has been through the worst of the cycle and that the renewed employment opportunities in mining projects should help to stem the outflow of people to other states and territories.
- Note that the GFC interrupted the normal growth cycles and caused a spike in population growth in late 2008 and throughout 2009.

- Following the GFC-driven population growth spike in 2008-09, Western Australia had an even stronger population growth cycle in 2012 and 2013 because of employment demand from the resources boom. This high growth created consequential impacts for the housing sector gearing up to meet that demand. While the State's population growth rate has reduced significantly, positive net migration from overseas and natural increase are keeping the population growth rate at about the same level as the national average.
- Perth's population growth has remained stronger than regional Western Australia.
- Population growth reached its low point in 2017 and the consensus projections over the next few years all indicate a return to an annual population growth rate of around two per cent over the next five years

Market indicators

The table below outlines the Perth industrial market indicators in 2012 and 2017. While rents, values and yields have fallen over the last five years there has been a shift in demand from the Perth East precinct to the North. As at October 2017, the North precinct leads both the prime and secondary markets in rents and the average land values for properties larger than 5,000m^2.

Table 12. Perth industrial market indicators, 2012, 2017

Precinct	Avg. Prime rent	Avg. Secondary rent	Core market yields		Avg. Land values	
	$/m² net	$/m² net	Prime	Secondary	<5,000m² $/m²	1 - 5 ha $/m²
As at October 2012						
North	$115	$80	8.0 - 8.75	9.0 - 10.5	$408	$235
South	$110	$80	8.0 - 8.75	9.0 - 10.5	$341	$228
East	$120	$85	8.0 - 8.75	9.0 - 10.5	$518	$304
As at October 2017						
North	$86	$67	6.75 – 7.50	8.00 – 9.00	$373**	$213
South	$81	$62	6.75 – 7.50	8.00 – 9.00	$284	$227
East	$88	$66	6.75 – 7.50	8.00 – 9.00	$363	$258

*average excludes Osborne Park values
**includes premises which are either vacant or currently available for lease greater than 2,000m2
Source: Knight Frank

Market implications

The success of the Stockyards Estate was its ability to provide large tracts of land and construct purpose-built facilities for likely tenants (including Coca Cola Amatil, Detroit Diesel and Toll Ipec).

In contrast, analysis of the industrial space on offer indicates that many of the current facilities on offer are either poorly-located, are too small, lack tenant requirements (e.g. power, hardstand areas) or have the wrong mix of office and warehouse space. These locations are likely to transition to other industry uses, better suited to high-value business activities.

With strong growth expected in the industrial sector over the medium-to-long term, the current supply pipeline is relatively low. Current estates at Nowergup, Nambeelup and Latitude 32 will offer some larger parcels of land for development, however there will be long-term demand for such precincts and as such, larger parcels of land need to be identified and brought to market to meet the growing demands of the Perth industrial sector.

The majority of Perth's industrial land being offered to the market has been sub 5,000sqm in size. Historically land and facilities for sale indicated that facilities representing the 0-3,000sqm market segment were most highly represented, while facilities larger than of 5,000sqm were under-represented. The changing demand from industrial businesses in Perth is evidenced by tenant enquiry which indicates 5,000-10,000sqm facilities are most sought after, followed by >10,000sqm facilities.

The Perth industrial landscape transformed in the last decade with changes to tenant requirements and design. The Perth industrial market has become more sophisticated and mature and have resulted in new benchmark levels being reached across all market indicators including rental levels and land values. This has also meant that institutional developers are required to develop and finance buildings for long-term rentals.

The drive for greater efficiency through the application of technology to the supply chain process has created a need for larger and more efficient warehouses. This had been evidenced in Western Australia with companies

such as Coles, Woolworths, Linfox, Toll and Aldi all operating out of new facilities large facilities, with the largest of these approaching 80,000sqm in size.

Critical mass

An important driver of activity is the concept of agglomeration. Businesses will seek to locate in proximity to markets and supply chains and often near other businesses operating within a similar sector. There are strong economic benefits associated with business agglomeration.

As Perth has grown rapidly, it has overcome many of the disadvantages of the geographic isolation from the eastern states. Perth has become increasingly more significant and important on a national scale. The mining boom, the burgeoning economic growth and strong relative wealth led to an ever-increasing presence of global and national businesses opening offices in Perth.

This has resulted in many new retailers entering the WA market including Aldi, Costco and new DFO investments, which have directly increased demand for distribution and logistics facilities.

Major infrastructure

Perth has historically been a well-planned city, with an efficient infrastructure network including a road network that services the outer metropolitan areas. There are effective linkages to most of the major industrial precincts and as industrial land prices increase, there will be a further push outwards for cheaper, larger lot industrial land connected to major highways. Aside from Kewdale and Forrestfield, only Latitude 32 will provide a quality intermodal infrastructure within Perth of sufficient scale to meet the demand of Perth's growth.

Table 13. Major infrastructure

Infrastructure	Description
Road networks	Major highway networks include the Kwinana Freeway, Perth-Bunbury Highway, Tonkin Highway and Albany Highway which are key access routes south. While the Mitchell Freeway, Grand Highway and Great Northern Highway are key access routes North. The Canning Highway & Stirling Highways provide connections to the port.
Rail networks	The Kewdale Primary Freight Hub forms the major freight distribution point in the metropolitan area for interstate and regional freight receipt and metropolitan freight distribution. The rail network is most important distribution network for freight movements through Fremantle and connections to inter-modal hubs such as Mundijong and enhancement of existing hubs needs to occur to facilitate significant economic multipliers.
Perth airport	Perth Airport is centrally located less than 10km to the east of the CBD and 30km from the subject site.
Sea ports	**Fremantle Port** Located about 15-20km from the Perth CBD. Accounts for 71% of state imports & about 15% of state export trade. **Kwinana Port** Located about 35-40km south of the Perth CBD and provides a secondary hub for movement of sea-freight. The development of an outer harbour at Kwinana is under consideration.

Source: Department of Planning, Lands and Heritage

There are significant investments in infrastructure underway or planned in the short to medium term. These will both enhance the functionality of the existing network while also allowing greater capacity of movement. They should also influence the desirability of various industrial locations across Perth. Some of these key investments are summarised in the following table.

Table 14. Major transport and freight infrastructure investments

Infrastructure	Value	Status	Commencement	Completion
Kwinana Freeway (4 projects)	$368 million	Construction about to commence	2018	2020
Perth to Darwin Highway	$196 million	Under construction	2016	2019
Wanneroo Road	$146 million	Construction about to commence	2018	2020
Other road infrastructure (6 projects)	$449 million	Under construction	2018	~2020
Airport Rail Link	$1.9 billion	Under construction	2017	2020
Other rail (METRONET Stage 1) projects	$1.05 billion	Committed and possible	2017	TBA

Source: Department of Infrastructure, Regional Development and Cities (2018)

Demand segments

MacroPlan has analysed the different drivers that will influence industrial land demand based upon the requirements of businesses. Some case study examples are provided in **Appendix 1** to highlight these concepts in various cities across Australia.

This section provides an evaluation framework that would be suitable in understanding optimal tenancies and composition within industrial precincts, or for identifying premium locations. There are several key drivers that will influence the segmentation of the industrial land market within Perth and Peel.

Geographic drivers

Location or geographic drivers are fundamental to the success of industrial land precincts and must be matched to appropriate pricing and tenancy types. Considerations and requirements influencing the desirability of various precincts include:

- Regional versus metropolitan
- Distance to CBD and ports
- Access to employment/labour and markets
- Land topography & environmental constraints

Business drivers

Demand for industrial land is heterogenous due to the diverse types of industrial land owners, investors and users that exist within the market, including major institutional players, developers/builders, smaller private investors and owner-occupiers.

Major investors will seek to manage industrial estates, ensuring the tenancy mix and structure is maintained and suitable to create a fully-functional precinct. Motivation will be secure rental returns and potential capital growth of the asset.

Developers and builders may look for larger tracts of lands and seek to sub-divide into smaller lots for sale. Developers and builders would be motivated by potential profit through DA success or the build phase.

Owner-occupiers will typically be looking for premises that are fit-for-purpose or for the appropriate land parcel size on which to construct a purpose-built building.

Businesses also have differing requirements depending upon the industry sector in which they operate, the size and type of the market in which they operate (e.g. domestic/international), and the phase in the life-cycle of the business itself. Some of the key requirements of businesses are shown in the following table.

Table 15. Lot size, freight and location requirements by tenant type

Infra-structure	Size	Features	Freight needs	Examples	Locational criteria
Multi-nationals	5 hectares + (up to 20 hectares or more in some cases) At least 25,000 sqm footprint	Branded sites with high amenity, landscaping etc Anchor tenants	International/ national trading	Ford, GM etc	● Gateway location ● Good access
National companies	2 to 5 hectares	Industrial Park located on primary road	Access to national routes but not necessarily ports	Woolworths, Coles, FAL, Aldi	● Good access ● Labour force
Service/support industries	Up to 1-2 hectares	Clustered around each other with low amenity and minimal office space	Limited	Small engineering component support firms i.e. machinist, panel beaters	● Access to suitable land size ● Access to arterial roads
Local service / local businesses	1,000 to 5,000 sqm sites with offices / warehouse storage component. (up to 30 ha in extent)	Often high amenity in new business parks with office at front of premises and storage at rear. Office and warehouse parks. Restricted retail, some recreation and entertainment	Limited	Flexible - printing supplies / import export of technology parts. Car repairs, building supplies and products. Business Parks	● Land as an asset ● Affordable land ● Do not require extensive fit out ● Accept lower amenity if rent is low. ● Efficient links to key suppliers
Head office companies/ technology firms	1,000 to 5,000 sqm primarily office configuration	High quality office space with landscape gardens. Often co-located with other firms in campus style buildings	Primary or secondary arterials with access to freeway	Head offices of multinational or national firms with or without operations at other sites Example: BMW Australia, Sigma Pharmaceuticals, BASF	● High amenity sites with significant exposure/signage opportunities ● Suitably skilled labour pool catchment
Bulky goods/ showroom	500 sqm up to 2 hectares	Various showroom sizes with carparking on major metropolitan roads	Limited	Harvey Norman JB Hi Fi	● Good access and visibility ● Clustering of uses ● Labour pool catchment area

Source: MacroPlan Dimasi (2018)

Table 16. Lot size, freight and location requirements by tenant type (continuation)

Infra-structure	Size	Features	Freight needs	Examples	Locational criteria
Manu-facturing	Size is varied. Around 1 hectare for small component assembly up to 10 hectares + for larger firms	Manufacturing plants often co-located with office for security / design purposes i.e. Ford Australia	Access to freeways important	National or multinational firms, motor vehicles, building parts, food processing	● Buffer zone from residential ● Need large labour pool catchment area ● Direct access to motorways and main arterials, ports and airport ● Location of accessible public transport network to grow and accommodate large vehicles
Business Parks	Approximately 80 hectares	Campus style environment with high amenity	Limited	Accommodated technology-based firms integrating research, distribution, administration, sales, etc Example: Macquarie Park or Norwest	● Sizable catchments containing knowledge-based skills ● Proximity to research, innovative firms ● Good amenity ● Outstanding transport and communication infrastructure ● Premium employment lands ● Co-locate business and administration ● Ample onsite parking ● Purpose designed building for long term tenancy
Freight and logistics	Between 1 and 10 hectares	Inter-modal facilities i.e. flexible access to rail/roads	International and national trading Good access	Freight and logistics companies Example: Enfield in Sydney	● Good access to motorways, port, rail and airport ● Service large markets ● Centrally located ● Affordable prices ● Buffer zones from residential ● Space to grow and accommodate large vehicles

Source: MacroPlan Dimasi (2018)

4.3 Case studies: Market segment opportunities

This section of the report provides a summary of case study examples of best practice industrial/employment land developments across Australia, with a focus upon the 'missing links' in Perth's industrial land market. The examples selected are summarised in the following table and the full details are provide in **Appendix 1**.

The most significant factor is that interstate markets have a greater level of institutional investment from large property trusts and investors (such as ISPT, GPT, Dexus, Stockland, Walker, Frasers Property Australia, Goodman). These institutions, with significant amounts of land banking, can help to alleviate the pressure on the industrial market and to private major facilities on long-term leases.

The lack of institutional developers is important because on the eastern seaboard a significant percentage of industrial projects are financed and built by developers based on long leases with custom building and site specifications. This provides an opportunity for the subject site to attract institutional developers to secure long-term leases.

In WA, LandCorp (or the Industrial Land Authority) has traditionally filled in that market gap, although, being a single organisation, it does not have the resources to provide the same level of active investment in each estate.

In summary, there is currently a lack of provision for industrial land supply to cater for:

- Freight and distribution hubs
- Major corporate tenants
- Large land users, national and multinational tenants
- Business parks
- Clustering of users
- Sites with critical mass to attract institutional investment
- Large built form product available for lease.

Table 17. Case study examples

Type	Precinct name	Precinct location (city)	Precinct age	Size	Lot size range	Predominant industries/uses	Examples	Ancillary/ supporting uses	Examples	Infra-structure characteristics	Planning controls	Other key features
Corporate tenants	Metroplex on Gateway	Brisbane	18 years	62 hectares	2,500 sqm - 20,000 sqm	General industry, light industry, and commercial uses	Austral Foods, Armaguard, Fisher & Paykel Australia, Johnson & Johnson, LG Electronics, Phillip Morris, Phillips Australia, Toshiba, Yokogawa Australia Pty Ltd and Adidas Australia	Retail uses	ABC Childcare Centre, Michael Hill Jeweller, Mobilecare, Master Engraving and Zac's Place (café/restaurant)	The site enjoys immediate access to the Gateway Bridge and major arterial road systems that serve south-east Queensland	Zoned General Industry Area under the Brisbane City Plan 2000, shops and offices are limited to a maximum floor space of 250sqm and must satisfy the provisions of the Centre Design Code, before being referred to Council	Metroplex is comprised of a mix of business and industrial uses that are integrated into each precinct, rather than separated by land use classification. Land was released in four stages and development of business, industrial and supportive land uses have been encouraged
Major freight/ distribution hub	Industry Park - Dandenong	Melbourne	10 years	120 hectares	2,300 sqm - 45,000 sqm	Manufacturing industries	Bunnings distribution, Onesteel, New Wave Logistics, NP Distribution	Convenience shops and ancillary offices	Arco café	Excellent road access and located in proximity to Westernport and the Port of Hastings, one of the four major commercial ports in Victoria	M1 Industry Park is in a Business Zone 3 and M2 Industry Parks is in an Industrial Zone 1, within the Greater Dandenong planning scheme	Zoning encourages integrated development
Major business park	Norwest Business Park - Bella Vista	Western Sydney	18 years	Norwest comprises 377 hectares including 221 hectares of business park, 35 hectares of lakes and parkland and 122 hectares of executive residential estates.	NA	Industrial, commercial and residential	IBM, ResMed, BASF, C&W Optus, Sigma Pharmaceuticals, Wyeth Australia, Schneider Electrics and Woolworths Limited	Retail, local services	Coles supermarket, retail, and local services	Direct access to the M2 and M7 motorways, as well as bus services	Zoned Employment Area 10(a) (Business Park) - A central precinct within the estate is zoned Business 3(a) (Retail)	Facilities and services available to tenants include a Crown Plaza Hotel, a neighbourhood shopping centre including a Coles supermarket, 35 speciality stores, food court, medical, banking, childcare and post office services as well as two petrol stations.

Type	Precinct name	Precinct location (city)	Precinct age	Size	Lot size range	Predominant industries/uses	Examples	Ancillary/ supporting uses	Examples	Infra-structure characteristics	Planning controls	Other key features
Major land bank	Swanbank Enterprise Park	Ipswich, Queensland	Develop-ment Approval Dec 2007	Total site of 2,200 hectares - 300 hectares prime Industrial and 1,400 hectares buffer and green space	5+ hectares	Targeting difficult-to-locate industries, located around existing Swanbank Powerplant	Boulder Steel/APST, Swanbank Poweplant, Swanbank Papermill, part of QLD Government Western Corridor Water Recycling system.	NA	NA	Located adjacent to the Cunningham Highway. Construction of South West Transport Corridor which will run along site's southern boundary. Co-location with regional electricity generation capacity. Trade waste management, gas, electricity, recycled water and fresh water already on tap	Master Planned Development under Ipswich City Council Planning Scheme. Recognised Industrial land precinct under SEQ Regional Plan as part of Western Corridor	Larger buffer, green space. Located in Western Corridor and rapid population growth areas (Springfield, Ripley Valley, Ipswich etc). To create 14,000 jobs
Major freight/ distributio n hub	Eastern Creek, Penrith	Penrith, Sydney	2000	Currently contains 1,500 hectares of industrial land with additional 1,000 hectares of employment land	Stage 3 serviced industrial land ranging from 6,086 sqm to 21,390 sqm	Industrial, commercial, distribution centre	Woolworths Liquor Distribution Centre, Kimberley-Clark Distribution Centre, CSR Warehouse and Distribution Centre			Direct access to the M4 and M7 motorways. Erskine Park Link Road under construction	This incorporate the State Environmental Planning Policy 59 (SEPP 59) employment lands, including Eastern Creek, Huntingwood, the Raceway and Greystanes precincts	The Planning Minister will be able to stage the future development in line with infrastructure provisions
Clustering	Australia Trade Coast	Brisbane	20 years	8,000 hectares	NA	Aviation & aerospace, building & construction, business services, food manufacturing , innovative manufacturing , retail, shipping & marine, transport & logistics	Qantas, Virgin Blue, Sunstate Cement, Raptis, Sandvik, DFO, DP World, Swire Cold Storage, NQX	Retail and local services	Direct Factory Outlet, Airport Village (including Woolworths Supermarket), Portside Wharf, Port of Brisbane Visitor Centre, Metroplex on Gateway services & facilities, Colmslie Hotel, child care centre	33 International & domestic airlines service Brisbane Airport, Airtrain is currently being constructed, The Brisbane Multimodal Terminal, The Port of Brisbane, Gateway Motorway, Airport Flyover.	Zoned Mixed use, light industry, general industry, heavy industry under Brisbane City Council	Australia Trade Coast Limited is a partnership between Queensland Government, Brisbane City Council - Brisbane Marketing, Brisbane Airport Corporation and Port of Brisbane Pty Ltd who work together to promote and develop the region as a premier location for trade and industry

Source: *MacroPlan Dimasi (2018)*

4.4 Critical success factors

From the market analysis and case studies, MacroPlan has identified nine key success factors that underpin successful, sustainable industrial precinct development. MacroPlan has also identified the opportunity that this creates for the proposed estate at Bullsbrook.

1. Strategic location in high growth area

The area needs to be accessible to port and airport facilities, regionally significant road infrastructure, major economic growth areas and major population growth areas.

Opportunity: The proposed Bullsbrook Freight and Industrial Area is well-located to benefit from the proposed growth in and around the surrounding urban expansion areas. The uses proposed at the site would complement the existing worker profile while also providing further employment and amenity opportunities. The addition of standard gauge rail access (in addition to the existing narrow gauge) would be ideal.

2. Access to enabling and supporting infrastructure

The project requires excellent road access for large vehicles (B-double at least) to support freight activity such as B-double turning, trailer parking, staff and visitor parking. Depending on the project it is also beneficial to have access to rail and sea ports and infrastructure. Access by bus (public transport) is important for workers, particularly for relatively remote locations.

Opportunity: The subject site is in proximity to a major arterial road route to the north of the state and well-located for the future Perth-to-Darwin National Highway. It has access to the rail network which makes it an ideal candidate to facilitate the changing landscape of the industrial market and cater for freight and logistics and heavy haulage vehicles. Sites east of Perth are also highly desirable for logistics companies due to easy access to the Fremantle port via major arterial roads.

The lack of water and sewer connections is a financial and timing constraint in the short to medium term and will require an integrated response that can also cater for the proposed urban expansion of Ellenbrook North and Bullsbrook South.

Access to gas infrastructure from the Dampier to Bunbury LNG pipeline offers an excellent opportunity for energy intensive uses and manufacturing.

3. Large parcels under consolidated ownership

During development, consolidated ownership allows for a coordinated development strategy to be employed. It also allows for a mix of lot sizes and flexibility in composition. It also allows for easy management and administration of issues. It provides certainty for tenants and investors in relation to development outcomes.

Opportunity: This is a key driver in having a successful estate, it minimises the consensus required to get things done and ensures product delivery. Tenants are more likely to commit to an estate if they can be guaranteed of delivery and timing. Any issues that may comprise the final delivery of lots or titles (i.e. such as multiple ownership) reduces the ability to attract tenants.

4. Environmental approvals and credentials

Several of the most successful international industrial estates have ISO 14001 these include the Byron Bay Industrial Estate (Australia), Plaine de l'Ain industrial park (France) as well as 8 TECOM Business Parks in Dubai. Corporate tenants and investors require a high level of Environmentally Sustainable Design (ESD) initiatives as evidenced by the success and tenant profile attracted to the Stockyards Industrial Estate.

ESD initiatives implemented at the Stockyards Estate were warehouse air conditioning, wash down bays, heavy duty cranes, a state of the art multi-

purpose product test centre, rain water tanks for re-use in the amenities, warehouse insulation, and sun-louvers.

Opportunity: The subject site only has manageable environmental issues and as such will reduce the time in which the finished lots can be brought to market, increasing appeal to tenants. There is also an opportunity to implement best practice ESD initiatives. This adds to the appeal of the estate and its ability to attract multinationals that have a growing awareness of their carbon footprint and social corporate responsibility.

5. Lot size mix

The lots sizes should reflect the industries being targeted and the natural competitive advantages of the precinct. Amalgamation of lots should also be an option for prospective tenants, this allows for flexibility and adaptability to the changing needs and requirements of tenants in a market that is dynamic.

Opportunity: There are several market gaps in Perth's industrial market and larger lots are underrepresented. The subject site would be best positioned in this instance to have flexible lot sizes and be dictated by market forces and end user requirements.

6. Exposure, marketing & branding

This helps build the branding and reputation of the industrial area, information included should be relevant to lot size, infrastructure available and the management details. An effective entry statement adds to the overall appeal of the estate and helps create a "sense of place".

Opportunity: With the large very development area and long-term development, there is an opportunity build a recognisable brand for the project to market the estate(s).

7. Anchor tenancy

Attracting anchor tenants creates the reputation and awareness of the area, decreases perceived risk, entices other tenants and assists in creating critical mass. Furthermore, if the industrial estate wishes to specialise or focus on industry sectors, the anchor tenant can be critical.

Opportunity: Two target anchors would be those involved in freight and logistics and heavy haulage. There is an opportunity to attract a major tenant due to being able to offer land at an affordable price and a development that is flexible to their requirements. Alternatively, a purpose-built facility leased to a major anchor is also a possibility and will help define the concept for the estate.

8. Non-industrial land uses to provide worker amenity

Industrial developments should contain dedicated lots for retail and commercial uses, depending on the size of the industrial area and location as to the feasibility of the level of this retail (e.g. food, fast food, pubs etc.). As a minimum the area should contain a deli and ATM, for larger areas other possibilities include newsagent, chemist, petrol station, crèche etc.

The area should also include bulky goods and supporting non-industrial land uses, these are support services but also operate as commercial businesses which improve worker amenity and underpin white collar co-location.

Opportunity: The subject site can evolve over time at which point it can adapt to the requirements of the broader catchment. This flexibility will enable the estate to incorporate as much or as little non-industrial uses as required.

4.5 SWOT assessment

Strengths

Perth's primary competitive advantage is its economic growth driven by the mining sector and connectivity with Asian markets. This bodes well for businesses and supports the agglomeration of resource related companies.

Perth, while isolated from the rest of Australia has strong international connectivity, with economic links to Asia. From a trade perspective, these connections are more efficient than the eastern states due to time zone and transport costs. This global connectivity should not be underestimated over the next 50 years as WA continues to source labour from these locations to service mining related growth.

The implications are that Perth can accommodate businesses and absorb investment from overseas potentially more effectively than the eastern states.

The Bullsbrook Freight and Industrial Area provides an opportunity to help service this export growth building an efficient, high-technology intermodal facility without the issues of interrupting existing operational facilities.

The very large area for development could deliver a long-term solution to meet the needs of WA's growing economy while providing land supply and keeping prices contained to facilitate economic development (ie. allowing companies to invest in their businesses, rather than paying high prices for land or rent).

Weaknesses

Th Bullsbrook Freight and Industrial Area has several existing weaknesses that will need to be resolved before any significant development can be undertaken:

- Lack of infrastructure: The Bullsbrook Freight and Industrial Area is current quite constrained through a lack of infrastructure including: no standard gauge rail (only narrow gauge); poor east-west road connectivity (through to the North-West Sub-region); lack of reticulated sewer and remote from any trunk main; lack of water supply; lack of local power supply.

- Environmental issues: This includes things such as high water table, environmentally-sensitive areas, flora and fauna.
- Long approvals process: Approvals process is long and complicated (i.e. lot creation) which again increases the cost and delays the delivery of land.

Opportunities

With opportunities in the traditional areas of Kewdale and Welshpool diminishing, the subject site is ideally located to become the next freight and logistics hub. With proximity to rail and airport facilities, the subject site can service activity in the north-west to areas such as Geraldton and the Pilbara. The site also possesses all the requirements of an intermodal freight terminal, further enhancing its appeal to the freight and logistics sector.

Transport-driven opportunities

The Bullsbrook location is well-suited to build on major transport-related opportunities such as:

1. Heavy haulage and ancillary uses
2. Freight and logistics
3. Transport related services (i.e. mechanical workshops)
4. Agriculture (movement of produce, ancillary/supporting services)
5. Mining related industries (i.e. warehouses for product testing).

1. Heavy haulage and ancillary uses

Cargo and heavy haulage relates to the transportation of heavy equipment, such as:

- Mining machinery and associated equipment
- Earthmoving machinery
- Farming machinery
- Heavy industrial components, etc.

These types of tenants require wider roads and dual road access to enable easy flow though for traffic. The types of vehicles that will need to be catered for include B-doubles, B-Triples and Quads. A facility that can

allow these vehicles to turn and move around easily saves time and hence improves their overall efficiency.

2. **Freight and logistics**

Freight and logistics relates to the transportation and storage of goods such as:

- Food and food products
- Furniture
- White goods
- Electronics

Typically, these tenants require large warehouses, in excess of 20,000sqm with additional space for large hardstand and lay down areas. They require wide roads and easily accessible entry and exit points, vehicles most common with this end user are B-doubles.

3. ***Transport-related services***

These types of tenants are the support services required for the freight and logistics sector. The types of tenants include mechanical workshops, for the repair and maintenance of vehicles, storage users such those that make and distribute pallets for easy movement of goods and specific parts distributors for larger vehicles. While these tenants may require larger workshops, some of the ancillary users may only need smaller lots.

4. ***Agriculture/rural***

This relates to any business or tenant related to agriculture. This would include things such as:

- Farming equipment
- Equipment repair and maintenance
- Fertilizer production, storage and distribution
- Storage of produce (i.e. large freezer warehouses).

These tenants depending on their part of agriculture will require various in terms of land and warehousing and as such flexibility in the estate would be required to attract this segment. The inclusion of this industry reflects

the City of Swan's role as a major producer of grapes and strawberries in WA; supplying 46.4 per cent of WA's grapes (not including those used for wine and table) ($8.3 million) and 34.5 per cent of WA's strawberries ($14.7 million)

5. ***Mining related industries***

   Its connectivity to mining projects in the Pilbara could also make the area become a testing ground for mining equipment. This is one particular sector of the industry that has been active throughout the downturn with oil and gas companies requiring purpose-built facilities to test equipment before they reach the mine site. Requirements from such tenants vary and as such flexibility in the estate for various lot sizes would be ideal for such tenants.

   These potential tenants have varying requirements; however, the majority will require lots larger than 2ha, a segment of the market which is currently undersupplied. In addition to this the vehicles associated with them are extremely large and as such supporting infrastructure for such vehicles to add ease and efficiency to businesses will be required to appeal to these types of tenants.

Cost advantages

The changing industrial environment has forced tenants to look at ways of creating a competitive advantage. One way which this can be done is by reducing fixed costs, particularly those related to occupancy of land and buildings. With the established industrial areas nearing full build-out, land prices have increased.

During the last mining boom, industrial activity was constrained due to shortage in land supply which forced land prices higher. Industrial production is a good indicator of economic growth and as such constraining the industrial market leads to constraining the growth of the State. To promote industrial activity, affordable land needs to be made available to meet those peak investment cycles. This is a key competitive advantage of an industrial estate at Bullsbrook.

The proposed Bullsbrook Freight and Industrial Area can serve three key roles:

1. Provide industrial land at an affordable level
2. Provide much needed supply and hence competition to the industrial market assisting in keeping the general cost of land at more affordable levels
3. Creating employment opportunities to promote population growth.

MacroPlan concludes that an industrial estate at the subject site would benefit the State and provide much needed industrial land to the Perth market that will create employment opportunities and encourage economic growth.

Threats

The threats that may hamper the development of the Bullsbrook Freight and Industrial Area include:

Lack of funding to resolve the infrastructure constraints

The Bullsbrook Freight and Industrial Area is not required to meet any short-term demand or meet any current pressures. That also means there is little to no urgency to resolve the infrastructure constraints associated with its development. There is a threat that this may delay investment for too long and that the necessary catalytic infrastructure may not be developed in time to meet the next demand cycle.

Global economic and geopolitical conditions

Western Australia's economy is fundamentally linked to international global conditions (commodity demand/prices, exchange rates, international investment). Arguably these international links are more relevant to the State than the national economic conditions (hence why WA has very different economic cycles to the other staters – the 'two-speed' economy).

Any prolonged global recession would therefore affect WA, potentially more so than other states. This may lead a prolonged downturn in investment in the State and a lack of demand for industrial land.

Technological change

Changes in technology are disrupting several sectors including agriculture, manufacturing, retailing and finance. If these disruptions also have an impact on sectors such as freight and logistics (through driverless trucks and automated container terminals). This may mean that existing intermodal facilities can become far more productive with the introduction of new technology and that Bullsbrook may not be required to meet demand except in the very long term.

Protracted development

Not achieving a critical mass relatively quickly could mean the Bullsbrook Freight and Industrial Area struggles to attract sufficient private investment to function as a successful estate or that any investment by the State is not recovered within a reasonable payback period.

Section 5: Jobs balance sheet

The potential uses identified for the proposed development provides significant opportunities for local employment and industrial activities to support the Bullsbrook area. These employment opportunities can be classified as:

- Direct employment generation: The initial jobs directly created by the proposed construction/development phase and other expenditure flows.
- Indirect employment generation: Additional ongoing jobs indirectly created by the proposed development.

MacroPlan has calculated the long term supported employment expected at the development once the construction phase has completed. Long term supported employment has been calculated from a review of the likely employment land mix at the subject site to the following benchmarks (following table) established from MacroPlan's experience in the industrial land market.

Table 18. Job densities by industry

Industry	Jobs /hectare
Manufacturing	33-40
Construction	33-50
Wholesale trade	20
Transport & storage	20
Support services	18

Source: MacroPlan Dimasi (2018)

Based on the above schedule and the employment land mix identified an average density of 30 jobs per net developable hectare is likely to be achieved at the proposed development. The estimated 1,395 ha of developable land which could be developed (after conservation/buffer areas and land for infrastructure are removed), suggests that the proposed development is likely to generate employment for approximately 41,850 people once fully-developed. The following table outlines the jobs generated in each stage of the development.

Table 19. Job generation – Bullsbrook Freight and Industrial Area

	Developable land (ha)	Direct employment
Short term	270	8,100
Medium term	450	13,500
Long term	675	20,250
Total	**1,395**	**41,850**

Source: MacroPlan Dimasi (2018)

The size of the potential workforce created supports the notion of strong population growth in the area, as population is driven by employment. MacroPlan believes that to achieve the population growth required to sustain strong economic growth in Western Australia, there needs to be employment opportunities created in growth areas. Therefore, an industrial estate at Bullsbrook will help achieve both population targets and strong levels of economic growth.

Section 6: Development and scenario analysis

6.1 Base case development

Given the early stage of the investigations this section makes broad assumptions on the development potential of the Bullsbrook Freight and Industrial Area as an 'order of magnitude' estimate. At this scale, MacroPlan has assumed that around 1,395 ha could be developable of the total of 2,650 ha (around 53 per cent of the gross area).

Table 20. Assumed development potential (untested)

Bullsbrook Freight and Industrial Area	Area		Comment
	Gross (ha)	Estimated net developable (ha)	
Bullsbrook South Extension A	300	210	Assumed 70% developable based on existing zoning and road connections.
Bullsbrook South Extension B	100	60	Assumed 60% developable based on zoning of adjacent sites.
North Ellenbrook (Industrial Expansion)	900	450	Assumed 50% developable based on potential environmental constraints (including high water table), infrastructure requirements.
North Ellenbrook Investigation	1,350	675	Assumed 50% developable based on potential environmental constraints (including high water table), infrastructure requirements.
Total	**2,650**	**1,395**	

Source: MacroPlan Dimasi

The long-term average take-up rate for major industrial estates in Perth has been around 10 ha per annum, although this is subject to wide variation.

The North-East Sub-regional Planning Framework indicates that demand for industrial land in the sub-region is expected to grow to 2,810ha by 2050. The most comprehensive recently-produced estimate of supply is the Economic and Employment Lands Strategy which indicated a supply of 1,458ha in 2011. This indicates an additional 1,352ha and an average take up rate of 34.7 ha per annum to 2050.

This land take-up will be distributed across several existing industrial areas in the sub-region (including Malaga, Forrestfield, Hazelmere, Hazelmere South, Midland, Midvale, Welshpool East, South Guildford, Mundaring, and Bullsbrook Townsite North – in addition to the proposed new Bullsbrook Freight and Industrial Area.

MacroPlan's base case for this assessment has assumed that there would be two logical development fronts:

- Bullsbrook South Extension A (incorporating the Bullsbrook Northern Gateway Industrial Park) develops primarily has a freight and logistics hub with some associated supporting industry (truck maintenance).
- North Ellenbrook (Industrial Expansion) develops to provide light/general industrial, service commercial and some large format retail to service the Ellenbrook and Bullsbrook urban areas.

On this basis, at peak development, the overall take-up would be around 20 ha per annum which is nearly 60 per cent of the total demand in the North-East Sub-region (approximately 34.7 ha per annum). Over the longer period however, this is likely to average around 12 to 15 ha per annum. At these rates, the Bullsbrook Freight and Industrial Area could meet future demand for around 95 to 115 years. Given these timeframes, some parts of the Bullsbrook Freight and Industrial Area will be undergoing redevelopment and intensification, while other parts are still yet to be developed.

The following table outlines the Bullsbrook Freight and Industrial Area future supply by estimated release term.

Table 21. Bullsbrook Freight and Industrial Area

Industrial estates	Estimated net developable area (ha)	Estimated number of years' supply	Development timeframe	Comments
Bullsbrook South Extension A	210	21	2020-2040	Zoned an on the market (Northern Gateway Industrial Park). Has a DCP in place for infrastructure, but businesses that have low requirements for water/sewer services can locate there prior to trunk services being available.
Bullsbrook South Extension B	60	6	2030-2050	This will essentially be an extension of the 'A' precinct and the timing will be dictated by take-up of that area.
North Ellenbrook	450	45	2030-2075	Growth staging will be tied to urban expansion (Ellenbrook) largely due to the need for major infrastructure extensions that can service both the urban and the industrial needs.
North Ellenbrook Extension	675	67.5	2050-2100+	Intermodal terminal will dictate development timeframe. Existing rural uses should be retained and protected in the meantime.
Total	**1,395**	**139.5**	**2020-2100+**	

Source: MacroPlan Dimasi

The following table indicates how each of the areas may develop. Given the timeframes involved, these uses are indicative and based on differentiating the uses in each of the precincts while also taking advantage of their specific locational and infrastructure advantages.

Table 22. Bullsbrook Freight and Industrial Area land use and release schedule

Precincts	Initial land development and uses	Growth phase development and uses (in *addition to* initial uses)	Mature development/uses (*in addition*)
Bullsbrook South Extension A & B	Freight and logistics - road Value-added industry (packaging, processing)	*Potential* for intermodal facility (small scale)	Enterprise / business park including technology and training precinct
North Ellenbrook	Small-scale service commercial and light industry	General industry	Business/office park
North Ellenbrook Extension	Mining industry autonomous vehicle 'test-bed'	Logistics- road freight and warehousing	Freight and logistics- rail intermodal with full customs and quarantine services

Source: MacroPlan Dimasi 2018

The industrial requirements will drive demand in line with other industrial areas, for this assessment MacroPlan considers Kewdale to be a potential representation of the types of major uses that could evolve in the Bullsbrook Freight and Industrial Area. The following table illustrates the proportion of each land use (by floorspace) at Kewdale as at 2015, and the potential distribution (in developable hectares). Note that as floorspace and land area are not proportional across all uses, this provides *indicative* estimates.

Table 23. Industrial land distribution, Bullsbrook Freight and Industrial Area – indicative land use based on WAPC Planning Land Use Codes

Planning Land Use Categories (PLUC)	Kewdale	Bullsbrook Freight and Industrial Area (ha)
Entertainment/Recreation/Culture	0.0%	0.0
Health/Welfare/Community Services	0.2%	2.8
Manufacturing/Processing/Fabrication	12.0%	167.2
Office/Business	15.8%	220.2
Primary/Rural	0.0%	0.0
Residential	0.0%	0.0
Other Retail	3.5%	48.8
Service Industry	6.2%	86.4
Shop/Retail	2.4%	33.4
Storage/Distribution	51.5%	717.7
Utilities/Communications	8.5%	118.5
Total	100.0%	**1,395**

Source: Department of Planning, Lands and Heritage- Land Use and Employment Survey 2015-17, MacroPlan Dimasi 2018

6.2 Development staging

The attractiveness of the Bullsbrook Freight and Industrial Area has increased and moved closer to reality, in part due to the State and new Federal Government delivery of NorthLink (as part of the Perth-to-Darwin National Highway). This has provided a significant benefit by increasing the accessibility of the site to and from the Perth metropolitan region.

The staging of the development is dependent on a comprehensive funding strategy to supplement the strategic planning assessments.

The initial stages of the project would target tenants involved in transport and logistics, heavy haulage – essentially tenants that do not require trunk water or sewerage connections and that need large areas of affordable land for primarily hard-stand uses. Along with this are opportunities for related services, such as mechanical workshops and spare part distributors to cater for the repair and maintenance of the vehicles associated with heavy haulage and logistics.

The number and size of freight and logistics tenants that are attracted to the area will then dictate the timing of the second stage of the development which is to develop an intermodal facility to optimise the available rail and road infrastructure. This could facilitate the manufacture and distribution of products across the State. The intermodal facility would be a natural progression due to the nature of the businesses in the estate, it is envisaged that there would be a cluster of transport related industries.

Once the intermodal facility is established and there is enough critical mass, the next evolution would be to a fully-functional logistics park. The increased employment base would need increased amenity in order to maintain and remain competitive. It would also contain a white-collar workforce that would facilitate the demands of businesses in the estate.

MacroPlan considers that an industrial development at the subject site could be successful if the estate is flexible and adaptable to market conditions. The ability to attract a major anchor will be enhanced by having flexible lot sizes, zoning and the ability to construct a purpose-built facility based on tenant requirements.

Attracting a multinational operator that can anchor the development would be a catalyst to attract other businesses to the proposed estate.

6.3 Low/slow scenario

Under this scenario the take up rate is reduced by 10 ha, to 10 ha per annum, which indicates 139 years of supply.

Extending the development schedule will provide more lot flexibility, allowing the estate to develop lots in line with evolving demand, rather than retrofitting after development. Furthermore, this will allow more land to be available after the completion of key infrastructure developments in the area such as the Perth to Darwin highway.

However, developing at a slower pace carries the risk of falling behind the market due to environmental issues that arise that may require moving through an extensive approvals process. In addition, if development falls behind market demand, it could see nearby estates absorb Bullsbrook Freight and Industrial Area's market share.

6.4 High/fast scenario

Under this scenario the take up rate is increased by 20 ha per annum, which reduces supply to around 70 years.

Developing the Bullsbrook Freight and Industrial Area at this faster rate would allow the estate to take advantage of the strong demand for logistics in the North-East Sub-region. This would also provide early entrants with the ability to customise lots to their requirements and acquire large lots at affordable land values. Faster development would create investment interest and, in turn, attract other tenants creating synergies.

Some businesses may hesitate to enter the market before the infrastructure is completed/nearing completion. An upgraded east-west road connection in particular, are likely to be a significant trigger to making the Bullsbrook area more attractive for industrial development.

Section 7: Conclusions and recommendations

The location requirements of industry will have an important bearing on the future demand for industrial land and the future growth of the State. There appear to be several key roles and uses which comply with the objectives of developing a master-planned estate, including:

- Local servicing including construction and manufacturing / component assembly suppliers
- Light industrial uses for smaller businesses such as engineering and mechanical workshops
- Local and regional distribution
- Major national and state level tenant
- Potential for mixed use role (medium/longer term), ancillary to other uses such as heavy haulage and warehousing
- Rural support services.

Market demand analysis

The key drivers of industrial land demand are population growth and export volumes. Growth in exports, particularly around the mining industry has a flow on effect that will see employment, freight movements and population growth increase. This in turn drives up demand for industrial land to support the expansion of warehousing and storage facilities, the need for additional intermodal terminals and other population driven industrial uses.

The Sub-regional Planning Framework indicates that demand for industrial land in the North-East is expected to grow to 2,810ha by 2050, an additional 1,352ha and an average take up rate of 34.7 ha per annum.

It is estimated that the Bullsbrook Freight and Industrial Area could achieve a take up rate of approximately 12-15 ha per annum over the longer timeframe. This could increase to 20 ha per annum during periods if two separate estates are developed simultaneously. Each estate would need to have a unique offer to not directly compete or cannibalise development.

The initial stages of the estate would target tenants involved in road-based transport and logistics, heavy haulage – uses that can be developed without major infrastructure expenditure, such as trunk water/sewer or an intermodal rail terminal. Along with this are opportunities for related services, such as mechanical workshops and spare part distributors to cater for the repair and maintenance of the vehicles associated with heavy haulage and logistics. This may include a mixture of purpose-built facilities for lease and lots for sale to perspective tenants to develop on their own.

The overall size, zoning and composition of the estate depend on the end user. As such, MacroPlan has identified a potential service market for a new industrial estate in Bullsbrook, potential service markets and triggers for the overall project.

Table 24. Land use specification

Use	Service market	Triggers	Staging (years) 0-5	5-10	10-15	15-20	20-25	25+
Freight and logistics – road	• North west WA • North metro	• Perth-Darwin Hwy • East-west road connections	Growth phase					
Freight and logistics - intermodal	• Metro urban • Interstate transport	• Intermodal terminal					Growth phase	
Value-added industry	• Sub-regional	• Industry growth in the sub-region	Growth phase					
General industry	• Business-to-business • Urban development	• Urban development (Bullsbrook East, Ellenbrook North)			Growth phase			
Light industry	• Urban development • Business-to-business	• Urban development (Bullsbrook East, Ellenbrook North)				Growth phase		
Technology + business	• Urban development • Industry • Mining services	• Employment catchment					Growth phase	
"Left field"	• Mining automation		Mining industry autonomous vehicle testing, commissioning and servicing					

Source: MacroPlan Dimasi

The industrial requirements will drive demand in line with other industrial areas, for this assessment MacroPlan considers Kewdale to be a potential representation of the types of major uses that could evolve in the Bullsbrook Freight and Industrial Area. The following table illustrates the proportion of each land use (by floorspace) at Kewdale as at 2015, and the potential distribution (in developable

hectares). Note that as floorspace and land area are not proportional across all uses, this provides *indicative* estimates.

Table 25. Industrial land distribution, Bullsbrook Freight and Industrial Area, ultimate development

Planning land use categories	Kewdale	Bullsbrook Freight and Industrial Area (ha)
Entertainment/Recreation/Culture	0.0%	0.0
Health/Welfare/Community Services	0.2%	2.8
Manufacturing/Processing/Fabrication	12.0%	167.2
Office/Business	15.8%	220.2
Primary/Rural	0.0%	0.0
Residential	0.0%	0.0
Other Retail	3.5%	48.8
Service Industry	6.2%	86.4
Shop/Retail	2.4%	33.4
Storage/Distribution	51.5%	717.7
Utilities/Communications	8.5%	118.5
Total	**100.0%**	**1,395**

Source: MacroPlan Dimasi (2018)

Jobs balance sheet

Based on the above schedule and the employment land mix identified an average density of 30 jobs per net developable hectare is likely to be achieved at the proposed development. The estimated 1,395 ha of developable land suggests that the proposed development is could generate employment for approximately 41,850 people once fully functional.

Table 26. Job generation – Bullsbrook Freight and Industrial Area

	Developable land (ha)	Employment
Short term	270	8,100
Medium term	450	13,500
Long term	675	20,250
Total	**1,395**	**41,850**

Source: MacroPlan Dimasi (2018)

Demographics analysis

Population projections

The Western Australia Planning Commission projects the City of Swan and North-East and North-West Sub-regions population to grow by an average annual 2.1, 2.2 and 3.0 per cent respectively. WA Tomorrow projections indicate residents in

the working ages (15–64) will grow by an average annual 1.6 per cent in the City of Swan and 1.6 and 2.5 per cent in the North-East and North-West sub-regions respectively.

SWOT analysis

The Bullsbrook Freight and Industrial Area has some weaknesses such as the lack of major trunk and transport infrastructure as well as competition from other proposed developments such as and Latitude 32, Meridian Park. In addition, given the long timeframes to development, the nature of industry and employment is likely to change (be 'disrupted') before the area is developed.

These weaknesses and threats are outweighed by the area's strengths. There is strong demand from the logistics industry for large custom lots with that are near major access routes, particularly in the North-East Sub-region, given the advantages of road freight connectivity to the eastern states. The site will also be able to take advantage of the Perth to Darwin Highway, population growth in the North-East Sub-region and its potential for an intermodal terminal.

Scenario analysis

Based on the SWOT analysis and identified critical success factors MacroPlan considers the base case scenario to represent the optimum rate and scale of development for the Bullsbrook Freight and Industrial Area, this scenario takes advantage of current market gaps and leaves room for the development to evolve to future industrial needs, minimising the potential for over or under development. This scenario will position the Bullsbrook Freight and Industrial Area as an attractive opportunity for the main drivers of industrial demand, the logistics, freight and warehousing industries.

Appendix 1: Case studies

Case Study: Wodonga Logic – Logistics / Transport

Logic Park is a strategically located industrial and business park located in Melbourne's north east at the intersection of the Hume Highway and Murray Valley Highway in Wodonga, 290km from the Melbourne CBD and 580km from south of Sydney.

Estate size:	567 ha
Uses/users:	Mixed
Lot sizes:	30,000sqm – 610,000sqm
Infrastructure:	Intermodal terminal, Hume Freeway, Murray Valley Highway, significant infrastructure and services (power, water, fibre optic) and more than 1.9km of internal B double compliant road infrastructure
Tenants:	Woolworths, SCT Logistics, TAFE, Northern Victoria Livestock Exchange, Fatigue management service centre and trailer interchange and BP service centre.
Summary:	Wodonga Logic takes advantage of its position on a major arterial and rail line to attract distribution businesses in much the same way as Australian Marine Complex takes advantage of its proximity to Freemantle Port to attract marine industries. Its success is largely based on it being a cluster of like businesses that are supported by the nearby road and rail (intermodal terminal) infrastructure. Lots are also flexible and can be amalgamated to suit tenant requirements. It is a distribution hub between Sydney, Melbourne and the ACT and service Regional Victoria, NSW, ACT and South Australia.

Figure 23. Wodonga Logic site plan

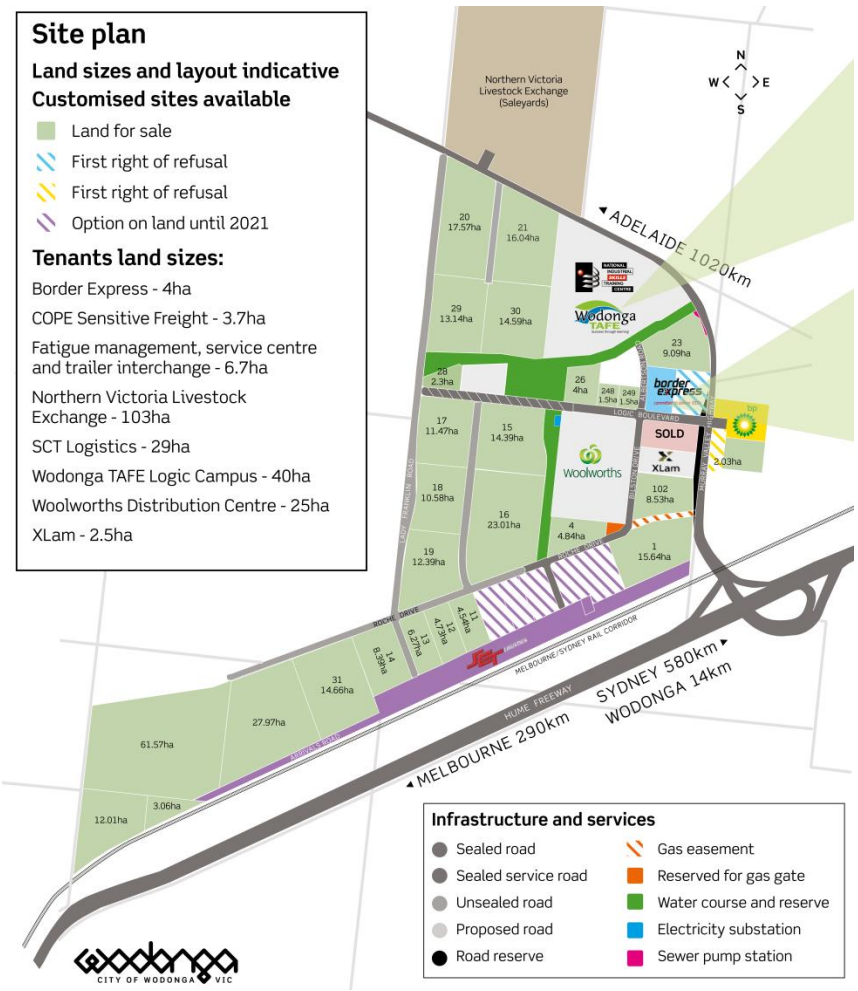


Figure 24. Wodonga Logic Park



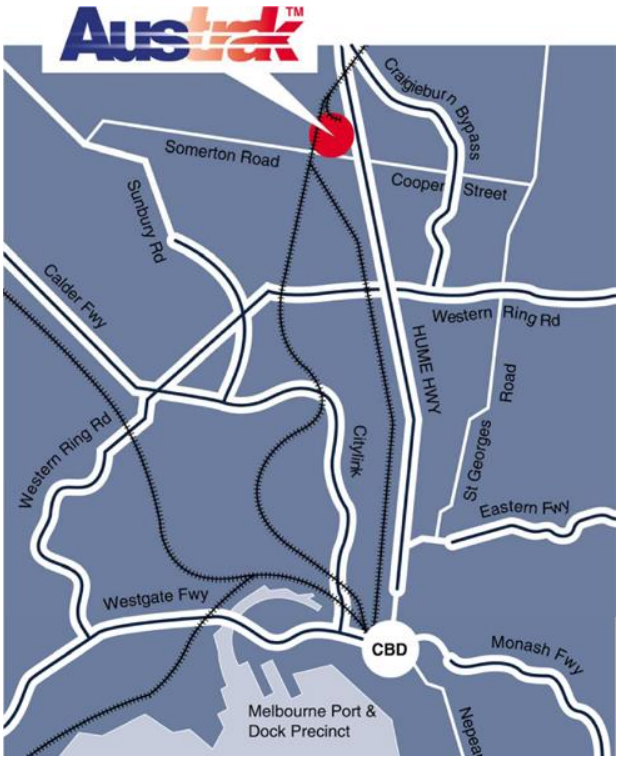
Source: Wodonga Logic

Case Study: Somerton Business Park, Somerton

The Somerton Business Park is a multi-functional regional freight hub that provides connectivity to the Port of Melbourne and to all state capital cities in Australia. It is strategically located on the Hume corridor which acts as the main corridor for all freight transported in Victoria. Somerton also acts as a port of origin and destination for shipping companies as it is fully customs bonded for both import and export containers.

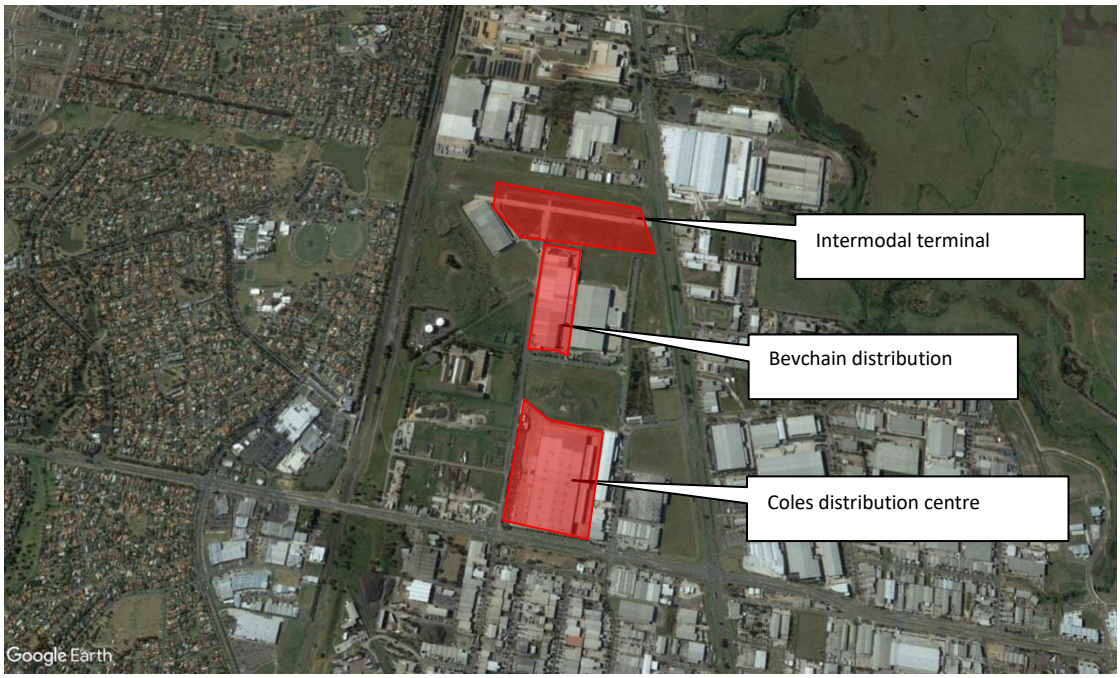
Estate size:	129ha
Distance from CBD:	23km North of Melbourne CBD
Uses/users:	Mixed Uses
Lot sizes:	N/A
Infrastructure:	Intermodal terminal connecting to Port Melbourne and interstate, direct access to the Hume Highway.
Tenants:	Coles national distribution centre, Kraft/Linfox, QUBE logistics, Boral Concrete.
Summary:	Somerton Business Park is home to the Somerton Multi-Modal Freight Terminal, it is zoned industrial zone 1 for distribution, manufacturing and storage uses and supports an on-dock rail connection at Port of Melbourne and has a 10,000 TEU capacity container park facility. Ancillary/supporting uses/businesses include recruitment services, a gymnasium, automotive services, service centre and construction services.

Figure 25. Somerton Business Park regional context



Source: Austrak

Figure 26. Somerton Business Park



Source: Google Earth

Case Study: Metroplex on Gateway

Metroplex on Gateway is one of the largest business and industrial parks in Brisbane. The primary land uses permitted throughout the site include general industry, light industry, and commercial / retail business uses. The estate has the following characteristics:

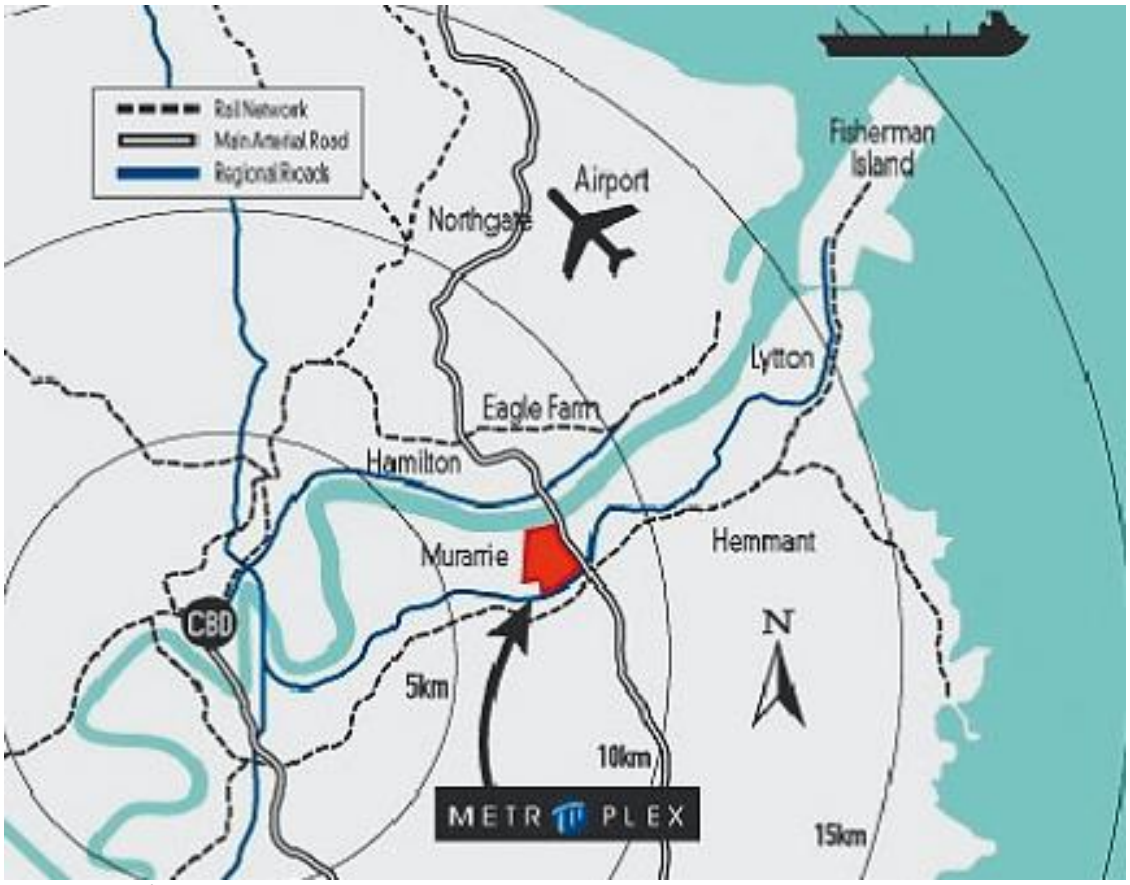
Estate size:	62 ha
Uses/users:	Mixed Business and Industrial
Lot sizes:	1,500sqm – 20,000sqm
Infrastructure:	Immediate access to Gateway Bridge and Major Arterial Road Systems
Tenants:	Austral Foods, Armaguard, Fisher & Paykel Australia, Johnson & Johnson, LG Electronics, Philip Morris, Philips Australia, Toshiba, Yokogawa Australia Pty Ltd and Adidas Australia. ABC Childcare Centre, Michael Hill Jeweller, Mobilecare, Master Engraving and Zac's Place (café/restaurant)
Summary:	The estate was successful because it had immediate access to main arterial routes. There was a variety of lot sizes and land was released in stages enabling the estate to evolve dependant on market conditions.

Figure 27. Metroplex on Gateway



Source: Metroplex on Gateway

Figure 28. Metroplex on Gateway



Source: Metroplex on Gateway

Case Study: M1 & M2 Industry Park - Dandenong

M1 and M2 Industry Parks are located approximately 30 minutes from the Melbourne CBD, situated on the intersection of Western Port Hwy, South Gippsland Hwy and Abbotts Rd.

Estate size:	120 ha
Uses/users:	Commercial and Industrial
Lot sizes:	2,340sqm – 40,797sqm
Infrastructure:	Excellent road access, proximity to the Port of Hastings,
Tenants:	Bunnings Distribution, MiTek Australia, New Wave Logistics, Hurley Transport, Loreal, BAM Wines and One Steel, Arco Cafe on site
Summary:	The estate offers both commercial and industrial uses and as such created a greater number of employment opportunities. Its proximity to the port, accessibility by road and flexible zoning and lot size mix encouraged the provision of manufacturing tenants, the storage and distribution of goods and associated uses.

Figure 29. M1 & M2 Industry Park



Source: Pellicano

Case Study: Norwest Business Park – Bella Vista

Norwest Business Park in located in the suburb of Bella Vista in Western Sydney. Facilities and services available to tenants include a Crowne Plaza Hotel, a neighbourhood shopping centre including a Coles supermarket, 35 specialty stores, food court, medical, banking, childcare and post office services as well as two petrol stations.

Estate size:	377ha (221ha of Business Park, 35ha of Lakes and 122ha of residential)
Uses/users:	Industrial uses supported by commercial and retail uses.
Lot sizes:	Various
Infrastructure:	Direct access to M2 and M7 and good public transport (Bus
Tenants:	IBM, ResMed, BASF, C&W Optus, Sigma Pharmaceuticals, Wyeth Australia, Schneider Electrics and Woolworths Limited
Summary:	Norwest is also an example of how residential uses can be accommodated close to industrial / commercial uses without compromising the viability of either use. It has developed into a unique and very successful employment-residential-commercial activity centre of a kind that is not duplicated across Australia. The ability to integrate all uses on the one site through the evolution of the estate is the reason for the success.

Figure 30. Norwest Business Park



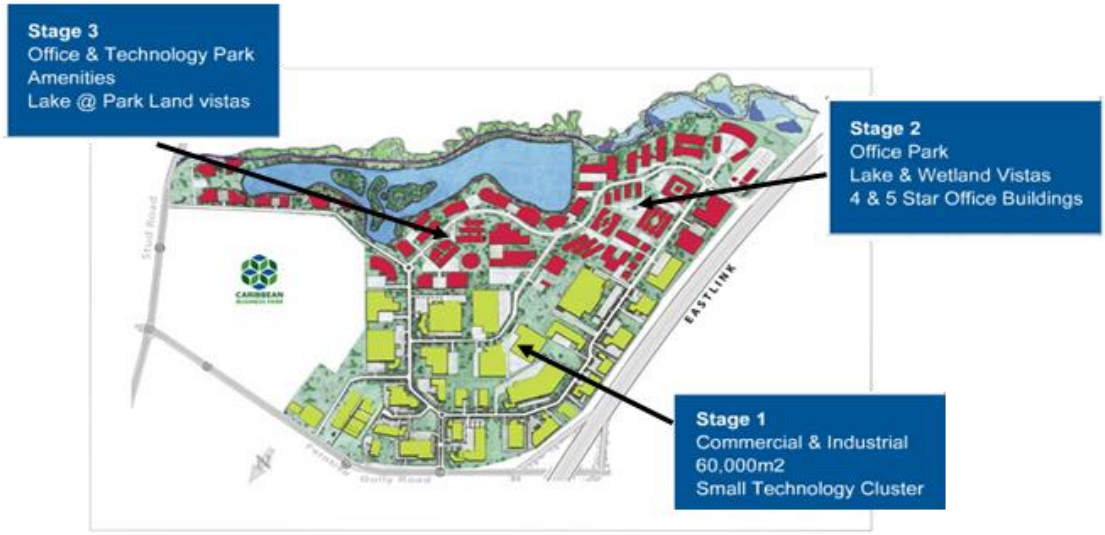
Source: Norwest Business Park

Case Study: Caribbean Business Park

Caribbean Business Park is located in Scoresby, Knox, in Melbourne, adjacent to the Scoresby Freeway. Using Eastlink (M3) Caribbean Business Park is located just 9 minutes from Ringwood, 16 minutes from Frankston and 30 minutes from Melbourne CBD.

Estate size:	230ha
Uses/users:	Commercial, Industrial and High Tech
Lot sizes:	Various
Infrastructure:	Close proximity to M3 interchange making freeway accessible. Good public transport and proximity to shopping facilities.
Tenants:	Gillette, Hallmark, Myer and Whirlpool
Summary:	The business park is zoned Business 3, which encourages the integrated development of offices and manufacturing industries and associated commercial uses. To boost the attractiveness of the precinct to potential businesses and to service the needs of businesses and employees, it was identified that there was a need to establish a limited commercial activity centre. This integration has enabled the estate to be successful.

Figure 31. Caribbean Business Park



Source: Caribbean Business Park

Figure 32. Caribbean Business Park



Source: Caribbean Business Park

Case Study: Northpoint Enterprise Park

Northpoint Enterprise Park is a strategically located industrial and business park located in Melbourne's north at the intersection of the Hume Highway and Cooper Street in Epping, 18km from the Melbourne CBD.

Estate size:	125ha
Uses/users:	Mixed
Lot sizes:	3,000sqm – 70,800sqm
Infrastructure:	Proximity to public/community facilities, Close to main arterial routes
Tenants:	BP, Porta Mouldings, Sumitomo Australia Limited, Stratco, Bowens Timber, Preston Motors, Grace Australia, Beds 'R' Us
Summary:	A master planned development which is controlled by design guidelines. It will form part of a boarder community that will ultimately employ between 20,000 and 22,000 people

Figure 33. Northpoint Enterprise Park



Source: Northpoint Enterprise Park

Case Study: Cardinia Road Employment Precinct (CREP)

The Cardinia Road employment precinct will be a multi-functional regional employment node that caters for a diverse mix of jobs. It will be a new hub for specialised business including research and development, manufacturing and production, engineering and trades related services. It will also contain a high density residential area that demands a neighbourhood level of retail facilities. This will be a fully integrated Estate, similar to Norwest Business Park.

Estate size:	353ha (186ha zoned industrial)
Distance from CBD:	50km South East of Melbourne CBD
Uses/users:	Mixed Uses
Lot sizes:	Yet to be determined (Various, dependant on End user)
Infrastructure:	Good accessibility and on site amenity
Tenants:	N/A
Summary:	CREP forms part of a 2,500ha employment corridor for the greater south east growth area. The concept was developed with the specific purpose of creating more diverse employment opportunities. It has excellent access to the metro system of freeways/highways and arterial roads. With a full diamond interchange to the Pakenham Bypass and extensive frontage to Thompsons Road which is a planned 4 lane arterial east-west connection to Dandenong and Frankston. Once full developed this integrated Estate will be a vibrant mixed use activity centre that will house approximately 19,000 employees and 4,000 residents. It will cater for a number of uses including residential and retail. It will include a campus style business park, combined showroom and workshop type uses along with industrial areas. The key success factor for this precinct is its diversity of land use and high amenity which has been

established in response to drainage and flora and fauna management plans.

Figure 34. Cardinia Road Employment Precinct



Source: Cardinia Road Employment Precinct Structure Plan

Figure 35. Metropolitan and regional context



Source: Cardinia Road Employment Precinct Structure Plan

Appendix 2: Perth industrial land supply

Perth existing supply of general industrial land

Central Sub-region

This sub-region represents the engine room of the metropolitan area in terms of generating the highest employment self-sufficiency and highest economic value associated with existing industrial areas. However, the landscape is quickly changing, as industrial land is being occupied by higher end commercial uses. Other industrial users and activities, particularly in the region close to the CBD, are being forced to relocate, as land becomes more valuable and sought after residential and offices uses.

The Central sub-region can be divided in two sectors: south and north sectors:

- The north sector (Osborne Park and Balcatta Industrial Area) has undergone substantial change from a traditional manufacturing precinct to a park environment. As these locations are now close to full capacity, fringe suburbs will increasingly play a role in meeting market needs.
  The area is also categorised by numerous bulky goods outlets and car dealerships. Traffic congestion is also an issue despite multiple access points to the Mitchell Freeway.

- The south sector (Perth Airport Zone, Hazelmere, Forrestfield, O'Connor and Canning Vale) contains a mixture of logistics and manufacturing tenants. Its proximity to the airport, major road networks, CBD and a local workforce has ensured its popularity and recent development focus. Perth's eastern region is a popular choice for national and international companies.

North-East Sub-region

The North-East Sub-region has good access to both rail and freight infrastructure, making it more attractive option to freight dependant industry. On the other hand, while the North-West Sub-region has limited transport infrastructure to service industrial land, making it less attractive to industry wishing to locate in

this sub-region, the growing population base in this sub-region means that a growing workforce will be available to employees.

In the North-East Sub-region (Freeway Industrial Park, Malaga) current road access is considered adequate for logistics companies although with population growth and new infrastructure the area will develop as an important local industrial hub. Recent land releases in the North-East Sub-region are expected to relieve some of the tightness of the market. Malaga continues to grow, although not at the same pace as seen in the North-West Sub-region.

This area is still developing and can accommodate a number of business types and at present Malaga has a mixture of small companies of which the majority are service orientated and bulky goods.

Resolution of the east-west connectivity between the North-East and North-West sub-regions would be a significant catalyst for development of the Bullsbrook Freight and Industrial Area.

North-West sub-region

As the North-East Sub-region has had limited land to facilitate industrial development, the North-West Sub-region market has been accommodating tenant demand through recent releases. The suburb of Neerabup, approximately 30 km from the Perth CBD, is being marketed as the new industrial hub in the north. The viability of the North-West Sub-region market is further enhanced by residential land release to the west, which provides a resident workforce for industrial occupiers.

This area is still developing and can accommodate a number of business types and at present Meridian Park has some extraction businesses working there Limestone) and Timber manufacturing, also some service businesses.

South-East and South-West Sub-regions

These sub-regions are already well serviced by established rail and road networks. Existing industrial development, location and accessibility are major attractors to industries opting to locate in these two sub-regions. Land availability

and the speed of approvals through the planning process will significantly influence the preference between the southern sub-regions.

South-East Sub-region

The south-east region (Forrestdale Business Park) is a well-established manufacturing and engineering precinct, although it has evolved strategically to accommodate a growing number of logistics and business park activities.

It has become a strategic link within the industrial sector due to its close proximity to the Perth CBD and its affordable land values compared to the north-west subregion.

An evolution in tenant demand has occurred in the South-East Sub-region, and recent movements into the precinct have been from storage and distribution users due to the well-established road networks and planned infrastructure improvements.

South-West Sub-region

The South-West Sub-region (Australian Marine Complex, Cockburn Commercial Park, Kwinana Industrial Area and Latitude 32), with its proximity to Fremantle Port is also a popular choice for new industry. The sector is dominated by the manufacturing / engineering industries, attracted by heavy industry located at the Kwinana industrial estate and proposed infrastructure works, including inter modal facilities and an outer harbour. The existence or imminence of major infrastructure suggests that the South-West Sub-region presently has a greater development and market potential than the North-West Sub-region.

Geographic location of existing activity

Overall, there is a shortfall in supply of well serviced and located industrial land across the Perth metropolitan area. The majority of new industrial land is located in the southern suburbs (Naval Base, Kwinana, and Flinders Precinct) primarily due to the area's established (and proposed) infrastructure, which includes:

- The extension of the Roe Highway to the Kwinana Freeway
- Improved rail linkages between Kewdale, Kwinana and Fremantle to encourage more rail usage

- An inland container terminal at Kewdale
- More efficient use of road systems for freight movements
- A new outer harbour facility at Kwinana to handle freight overflow
- Improvements to Leach Highway and associated roads leading out of Fremantle

Current available and potential future release

The table below demonstrates that with the supply of land provided through the Economic and Employment Lands Strategy, along with the development of the short to medium-term sites identified, there will be a shortfall against forecast demand for industrial land in all Metropolitan Regions with the exception of the South-East Region.

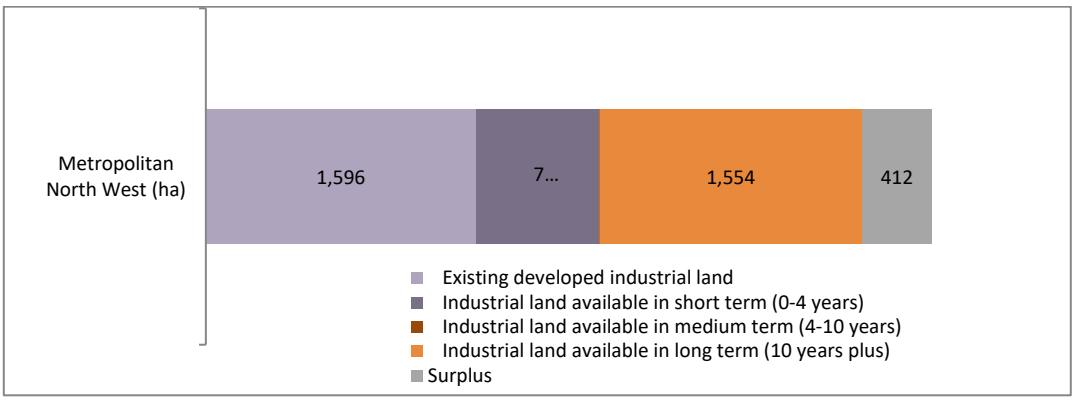
Table 27. Industrial floor space growth by Metropolitan Region

Current non-heavy industrial zoned land supply (ha)	Metropolitan North-west	Metropolitan North-east	Metropolitan South-East	Metropolitan South-West
Existing developed industrial land (as at 2015)	1,596	1,458	1,212	1,346
Industrial land available in short term (0-4 years)	728	812	597	35
Industrial land available in medium term (4-10 years)	0	749	0	1,246
Industrial land available in long term (10 years plus)	1,554	945	0	371
Shortfall/Surplus (assumes 70% of supply is developable)	412	-304	-1,128	-738
Demand at 2050	**3,466**	**4,268**	**2,937**	**3,736**

Source: Department of Planning, Lands and Heritage – Sub-regional Planning Framework 2018, Economic and Employment Lands Strategy 2014

The demand for employment land in the North West Sub-region is the 3,466 ha to 2050. Based on existing data on the available supply in the pipeline, the sub-region will encounter a surplus of 412 ha if no additional land is released to the market by 2050. The forecast take-up for the region is expected to be around an annual average of 2.2 per cent.

Figure 36. Future land supply, Metropolitan North-West Sub-region



Source: Department of Planning, Lands and Heritage – Sub-regional Planning Framework 2018, Economic and Employment Lands Strategy 2014

The following table highlights that within the Metropolitan North-West Sub-region there are no additional industrial areas identified that will have the capacity to cater for industrial land supply needs in the short term. There are only two sites becoming available in the medium term: The Pinjar South and Wangara.

Table 28. Future land supply, Metropolitan North-West Sub-region

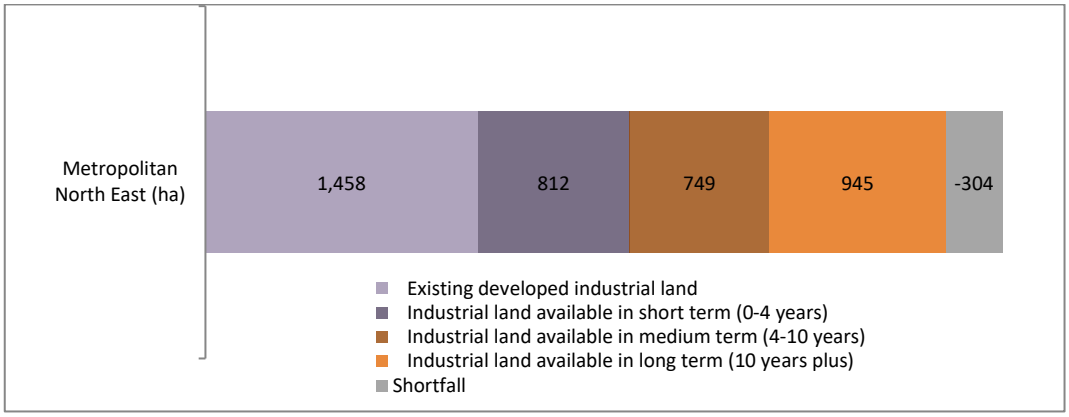
Metropolitan North

Name	Sub-regional planning framework	Gross area
► Future short term industrial sites (0-4 years)		
Metropolitan Region Scheme undeveloped industrial land	Industrial	1,040 ha
► Potential medium term non-heavy industrial sites (4-10 years)		
NA		
► Potential long term non-heavy industrial sites (strategic land bank sites) (10 years +)		
Pinjar South	Industrial investigation	390
Pinjar North	Industrial investigation	300
Nowergup	Industrial investigation	662 ha
Nowergup	Industrial investigation	1,080 ha
Jandabup	Industrial investigation	450 ha
Total gross area		**830**

Source: Department of Planning, Lands and Heritage – Sub-regional Planning Framework 2018

The forecast additional demand for industrial land in the Metropolitan North-East Sub-region is 2,810 ha by 2050, and based on existing data on the available supply in the pipeline, the region will encounter a deficit of 304 ha if no additional land is released to the market by 2050. The forecast take-up for the region is expected to be around an annual average of 3.1 per cent.

Figure 37. Future land supply, Metropolitan North-East Sub-region



Source: Department of Planning, Lands and Heritage – Sub-regional Planning Framework 2018, Economic and Employment Lands Strategy 2014

The Metropolitan North-East Sub-region has two additional industrial areas that will have the capacity to cater 812 ha of industrial land in the short term. Furthermore, five sites have been identified which have Government support for further planning investigation and to remove constraints. These sites are Wattle Grove, Bullsbrook Town site, North Ellenbrook, Hazelmere and North Ellenbrook Extension.

Table 29. Future land supply, Metropolitan North-East Sub-region

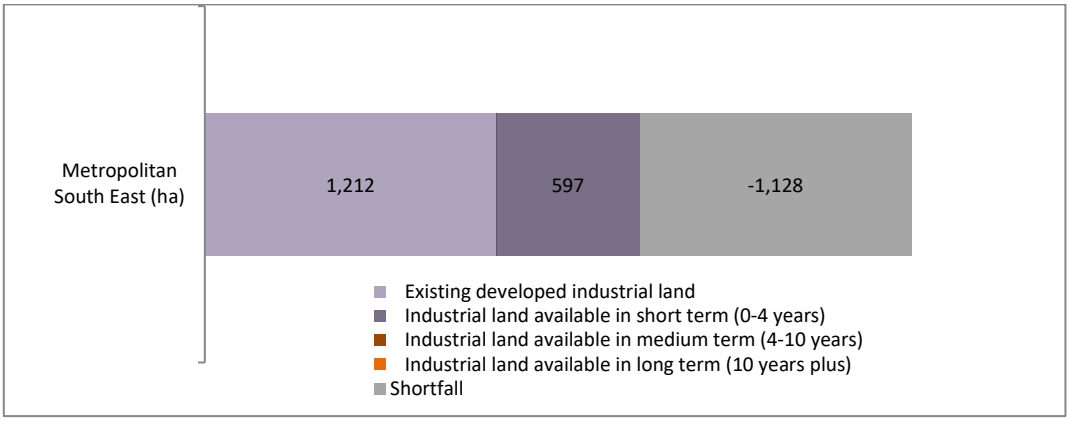
Metropolitan North-East

Name	Sub-regional planning framework	Gross area
► Future short term industrial sites (0-4 years)		
Metropolitan regional scheme undeveloped industrial land	Industrial	760 ha
Bullsbrook South A	Industrial	300 ha
Bullsbrook South B	Industrial	100 ha
► Potential medium term non-heavy industrial sites (4-10 years)		
Hazelmere South	Industrial expansion	50 ha
North Ellenbrook	Industrial expansion	900 ha
Bullsbrook Townsite Precinct (North)	Industrial expansion	110 ha
Wattle Grove	Industrial expansion	10 ha
► Potential long term non-heavy industrial sites (strategic land bank sites) (10 years +)		
North Ellenbrook Extension	Industrial investigation	1,350 ha
Total gross area		**3,580 ha**

Source: Department of Planning, Lands and Heritage – Sub-regional Planning Framework 2018,

The forecast additional demand for industrial land in the Metropolitan South-East Sub-region is 1,725 ha by 2050 and based on existing data on the available supply in the pipeline, the region will have a deficit of 1,128 ha of industrial land by 2050. The forecast take-up for the region is expected to be around an annual average of 2.6 per cent.

Figure 38. Future land supply, Metropolitan South-East Sub-region



Source: Department of Planning, Lands and Heritage – Sub-regional Planning Framework 2018, Economic and Employment Lands Strategy 2014

The Metropolitan South-East Sub-region has one additional industrial area that will have the capacity to cater 415 ha of industrial land in the short term. Furthermore, two sites (South Forrestdale and South Armadale) have been identified for development in the medium-term.

Table 30. Future land supply, Metropolitan South-East Sub-region

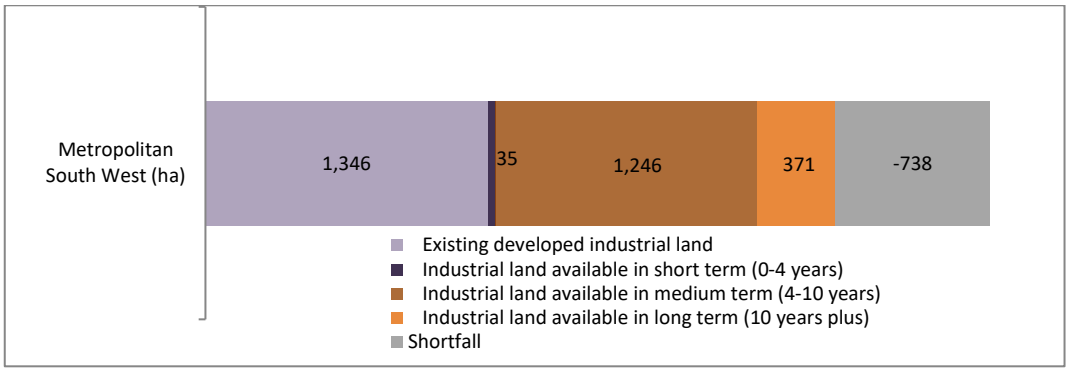
Metropolitan South-East

Name	Sub-regional planning framework	Gross Area
► Future short term industrial sites (0-4 years)		
Metropolitan regional scheme undeveloped industrial land	Industrial	593 ha
► Potential medium term non-heavy industrial sites (4-10 years)		
South Forrestdale	Industrial expansion	180 ha
South Armadale	Industrial expansion	80 ha
► Potential long term non-heavy industrial sites (strategic land bank sites) (10 years +)		
NA		
Total gross area		**853 ha**

Source: Department of Planning, Lands and Heritage – Sub-regional Planning Framework 2018

The forecast demand for industrial land in the Metropolitan South-West Sub-region is 2,390 ha by 2050, and based on existing data on the available supply in the pipeline, the region will encounter a deficit of 738 ha of industrial land by 2050. The forecast take-up for the region is expected to be around an annual average of 30 per cent.

Figure 39. Future land supply, Metropolitan South-West Sub-region



Source: Department of Planning, Lands and Heritage – Sub-regional Planning Framework 2018, Economic and Employment Lands Strategy 2014

The Metropolitan South-West Sub-region has one additional industrial area that will have the capacity to cater 593 ha of industrial land in the short term. Furthermore, two sites (Latitude 32/Postans and Latitude 32 Future investigations area) have been identified.

Table 31. Future land supply, Metropolitan South-West Sub-region

Metropolitan South-West

Name	Sub-regional planning framework	Gross Area
► Future short term industrial sites (0-4 years)		
Metropolitan regional scheme undeveloped industrial land	Industrial	593 ha
► Potential medium term non-heavy industrial sites (4-10 years)		
Latitude32/Postans	Industrial expansion	1,780 ha
► Potential long term non-heavy industrial sites (strategic land bank sites) (10 years +)		
Latitude32 - Future investigation areas	Industrial investigation	480 ha
Total gross area		**2,903 ha**

Source: Department of Planning, Lands and Heritage – Sub-regional Planning Framework 2018

Appendix 3: Indicative development staging

Demand for industrial land in North-East Sub-region

This appendix provides a summary of the historical and potential future demand for industrial land in Perth's North-East Sub-region by type of use. This includes a breakdown of demand for land uses, which was used to inform discussions with service providers:

- approximate total demand in hectares for each proposed area/zone of the District Structure Plan
- approximate lot sizes
- employment density

Table 32. Historical and potential take up rates in Perth North-East corridor

	Share of Perth metro total take-up	Net take-up (ha)	Take-up scenario based on net developable area:			
			50%	60%	65%	70%
			Gross (ha)	Gross (ha)	Gross (ha)	Gross (ha)
Historical take-up rate	16%	10.45	20.90	17.42	16.08	14.93
Accelerated demand	26%	16.98	33.96	28.30	26.13	24.26
Potential upper demand	36%	23.51	47.03	39.19	36.17	33.59

Source: based on advice from Landcorp (2018)

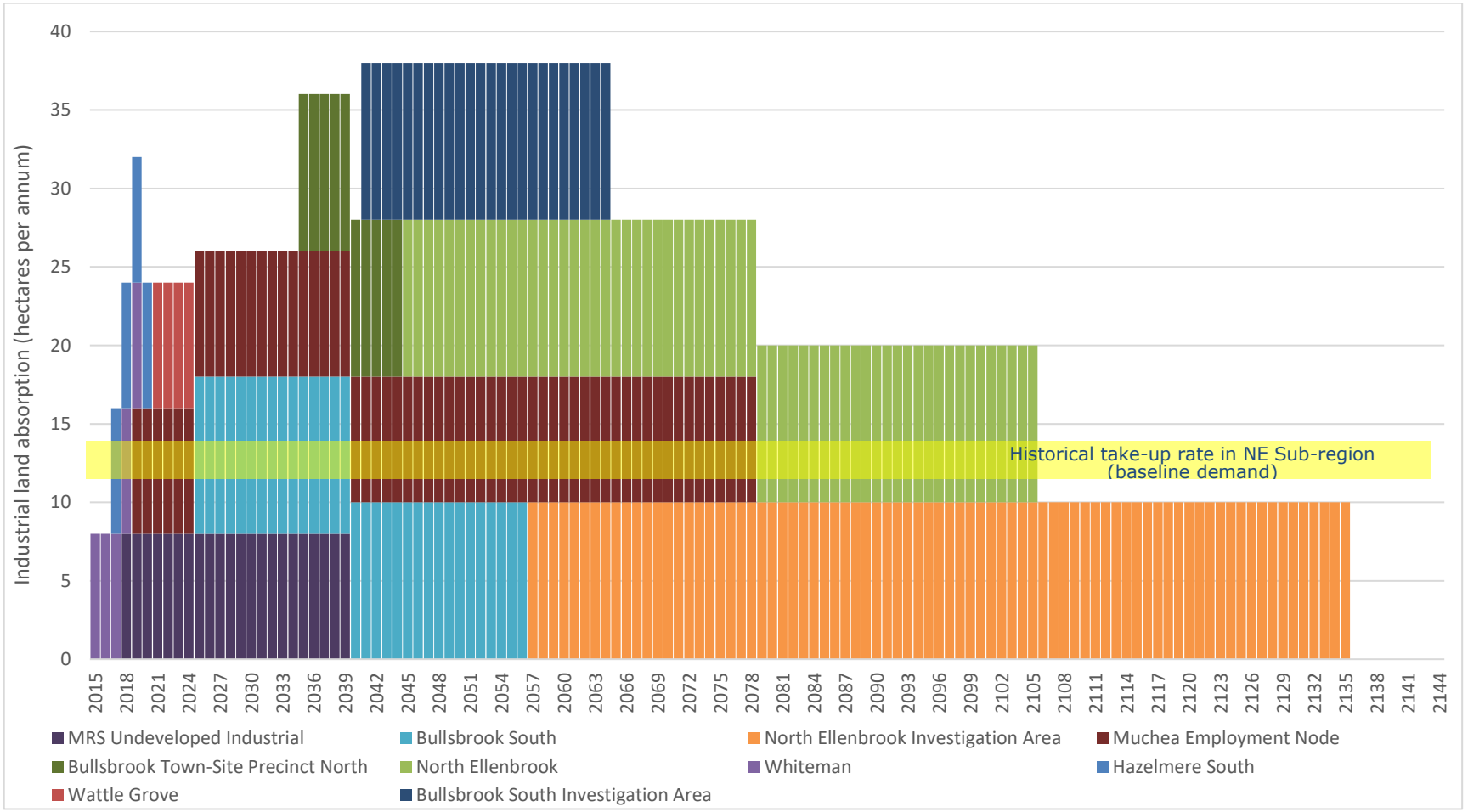
Table 33. Development rates, lot size cohorts and indicative employment

Main use	Demand		Lot size cohorts (by number of lots) m^2 based on existing established industrial areas					Employment density (jobs per net developable hectare)
	Hectares per annum (net land area)	Share of total (indicative)	<2,000	2,000 - 5,000	5,001 - 10,000	10,001 - 20,000	20,001 +	
Light industry	4 – 8	20%	45%	35%	18%	2%	0%	45
General industry	8 – 12	35%	22%	35%	32%	4%	7%	32
Freight & logistics	4 – 15	20%	0%	15%	38%	25%	22%	12
Value-added industry	4 – 10	15%	0%	30%	45%	20%	5%	20
Technology & business	8 – 12	10%	10%	30%	40%	15%	5%	30

Source: MacroPlan, based on analysis of WAPC Land Use and Employment Survey, CoreLogic RPData, and Landcorp advice

Note: the demand is based on 'active' development and sales phase for industrial estates

Figure 40. Potential timing of industrial land development (indicative) in North-East Sub-region and Muchea



Source: MacroPlan 2019, based on *indicative timing* from Landcorp and other stakeholders

Appendix 4: Employment projections

MacroPlan has prepared employment projections for the land area included in the Bullsbrook Freight and Industrial District Structure Plan. This assessment covers:

- Agree land use and employment figures and distribution with stakeholders for 2031 and 2041.
- Update report based on revised land use concepts and deliver the employment figures in a format compatible with MLUFS/ROM for 2031 and 2041 horizons.

This assessment is informed by the planning investigations and consultation with the relevant stakeholders for the area covered by the Bullsbrook Freight and Industrial District Structure Plan. The purpose of that consultation was to establish indicative planning and development timeframes for each of the industrial precincts across the North East sub-region. This provides the context for the future demand timeframe for the industrial precincts within the BFIA. The outcomes of the consultation are included in **Appendix 3** of this report.

A4.1 Methodology and assumptions

Methodology

MacroPlan's process for developing these employment projections was to:

1. Consult with stakeholders to determine through expert judgement and available quantifiable analysis, the most likely development and take-up rates for industrial land in Perth's North-east Sub-region.
2. Forecast the likely demand and development rate specific to each precinct of the Bullsbrook Freight and Industrial District Structure Plan area.
3. Determine the total area of each development precinct (A to G) and multiply by the likely developable ratio, net of land areas required for environmental, planning or infrastructure requirements.
4. Estimate the existing employment on each of the precincts using the current MLUFS projections (2019, series 1.4).

5. Determine the amount of industrial land to be developed by future Census year (2021, 2026, 2031, 2036 and 2041).
6. Calculate total industrial employment densities using data from the WAPC Land Use and Employment Survey for different types of industrial land relevant to the Bullsbrook Freight and Industrial District Structure Plan area.
7. Calculate the employment by industry from comparable areas in Perth drawing on 2016 Census data by place of employment. The areas used for this assessment include: Forrestfield, Kewdale-Welshpool, Malaga, Hazelmere, Midland and Carramar (Flynn Drive).
8. Confirm the overlap between the 2015-2017 Land Use and Employment Survey areas and the Bullsbrook Freight and Industrial District Structure Plan area as a basis for estimating the existing employment in the area.

Assumptions

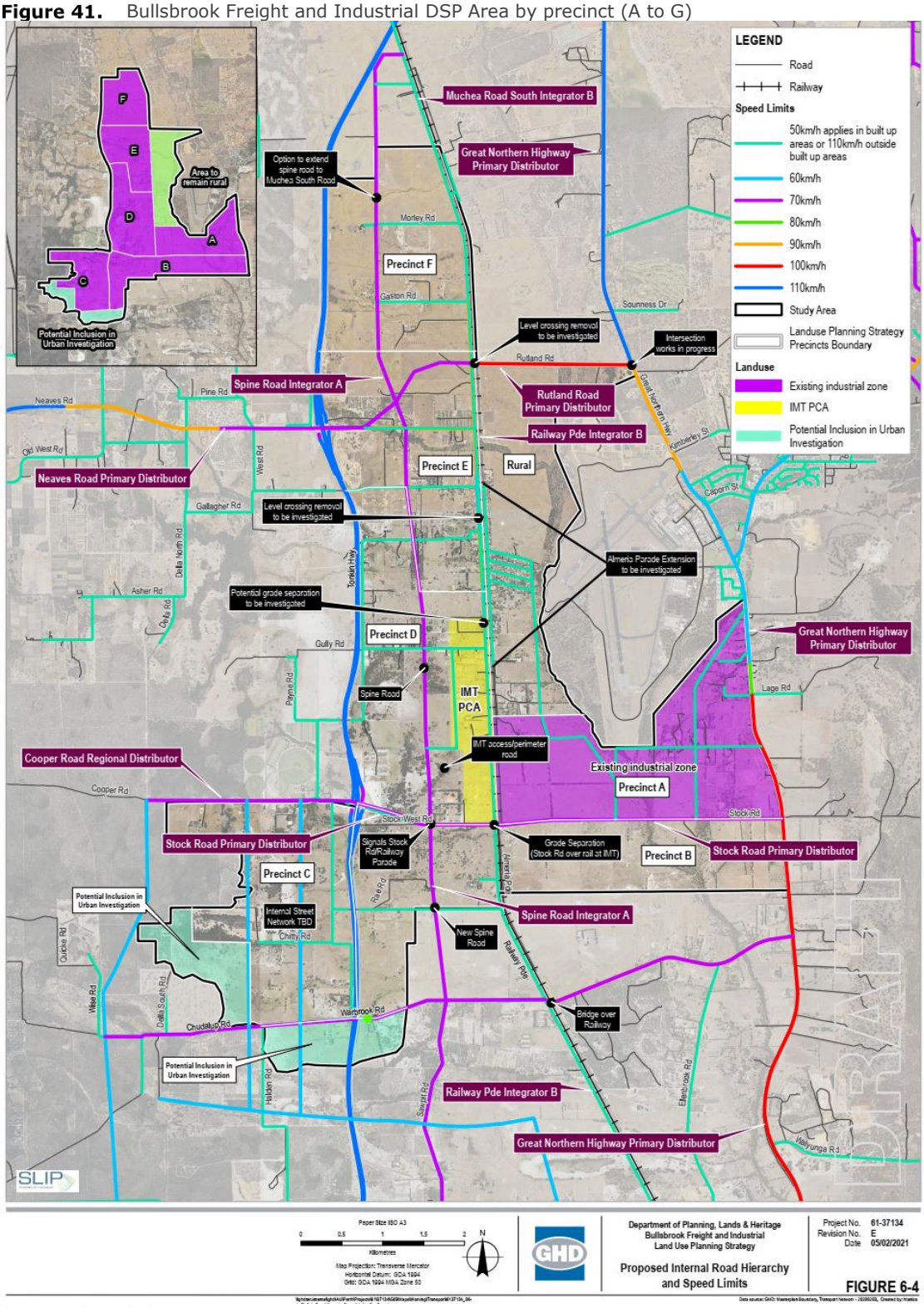
Note that the assessment makes the following assumptions:

1. The baseline employment projections are consistent with the MRS zoning and therefore consider land that is already zoned for industrial use (in this case, Bullsbrook South).
2. Land that is not currently zoned for an 'employment' use (including rural) in the MRS still has some level of employment uses although these are not significant in number. These uses are reflected in the final employment projections by industry.
3. The North-east Sub-region of Perth will have a significantly more important role in meeting the future demand for industrial land than it has had in the past. This is based on the consultation undertaken for this assessment and the build-out of other industrial areas (particularly those elsewhere in the North-East Sub-region and in the Central Sub-region).
4. Employment densities will be relatively stable over time and that new types of jobs will offset any structural changes in the economy that could mean significant reductions in employment densities for industrial precincts (ie. automated intermodal terminals).

Spatial area

The following figure indicates the precincts and labels for the study area.

Figure 41. Bullsbrook Freight and Industrial DSP Area by precinct (A to G)



Source: GHD 2021

The definition of the precincts within the Bullsbrook Freight and Industrial Area aligns with the boundaries used for the Bullsbrook Freight and Industrial District Structure Plan as well as taking into account the ROM and the STEM/MLUFS boundaries.

A4.2 Take-up of industrial land

The take-up of industrial land depends on demand and is directed to different geographical areas depending on locational factors, suitable infrastructure and the availability of suitable land. This means that the zoning the BFIA for industrial uses, is only a part of the equation.

Implicit in this assessment is the assumption that the BFIA will compete with and absorb demand from other sub-regions of Perth. The following table indicates the average absorption (take-up) rate for land in the North-east sub-region of Perth.

Table 34. Historical and potential take up rates in Perth North-East corridor

	Share of Perth metro total take-up	Net take-up (ha)	Take-up scenario based on net developable area:			
			50%	60%	65%	70%
			Gross (ha)	Gross (ha)	Gross (ha)	Gross (ha)
Historical take-up rate	16%	10.45	20.90	17.42	16.08	14.93
Accelerated demand	26%	16.98	33.96	28.30	26.13	24.26
Potential upper demand	36%	23.51	47.03	39.19	36.17	33.59

Source: MacroPlan 2018 based on advice from Landcorp (2018)

A4.3 Employment densities in industrial precints

The following table summarises the average development rates per annum and employment densities relevant to the BFIA. As the land uses will vary across the BFIA precincts, each area will have a different average employment density.

Table 35. Development rates, lot size cohorts and indicative employment

Main use	Demand		Employment density (jobs per net developable hectare)
	Hectares per annum (net land area)	Share of total demand (indicative)	
Light industry	4 – 8	20%	45
General industry	8 – 12	35%	32
Freight & logistics	4 – 15	20%	12
Value-added industry	4 – 10	15%	20
Technology & business	8 – 12	10%	30

Source: MacroPlan 2018, based on analysis of WAPC Land Use and Employment Survey, CoreLogic RPData, and Landcorp advice

Note: the demand is based on 'active' development and sales phase for industrial estates

A4.4 Baseline employment projections

This assessment has used the land development as the basis for projecting the employment within the Bullsbrook Freight and Industrial Area.

Table 36. Baseline employment by ROM zone

ROM zone	2016	2021	2026	2031	2036	2041
520	158	173	200	208	229	253
521	105	101	95	96	106	117
522	31	32	34	36	40	44
523	4	6	6	80	88	97
524	21	24	19	21	23	26
547	312	311	336	380	420	464
Total	**632**	**646**	**690**	**821**	**906**	**1,001**

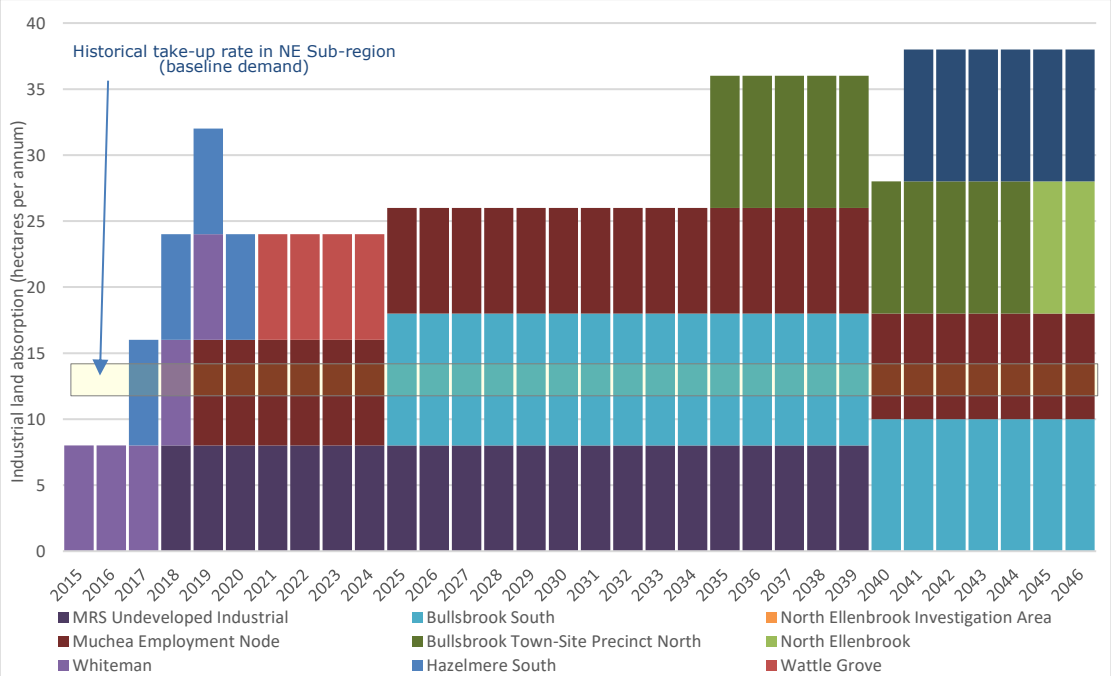
Source: DPLH Metropolitan Land Use Forecasting System 2016 v1.4 (2041 extrapolation)

A4.5 Industrial land absorption

This section of the report outlines the project take-up of industrial land in the north-west sub-region of Perth by year. These projections favour the development of land that is already zoned industrial and is available for development. This includes vacant parcels within existing developed precincts/estates (termed 'MRS Undeveloped Industrial' in the figure below) and newly developing areas that are either on the market already (such as Muchea and Bullsbrook South) or are expansions of existing industrial precincts that have proven demand (ie. Hazelmere South).

The development of the Bullsbrook Freight and Industrial land will happen within this competitive context of other land developments in order to optimise the value of existing infrastructure and servicing before new sites are developed.

Figure 42. Industrial land take-up in the north-east sub-region- projections (to 2046)



Source: MacroPlan 2019, based on stakeholder consultation

Note that Appendix A includes a more detailed description of each of the industrial precincts in the sub-region and the timing and development rate of each precinct.

A4.6 Land development forecasts by precinct

The following table indicates the forecast areas of land in the BFIA that are expected to be developed by future Census year. These are cumulative totals and therefore indicate the total land area expected to be developed at any point in time.

Table 37. Total hectares of industrial land developed in the BFIA - cumulative

Precinct	Gross land area	Developable ratio	Developable area	2016	2021	2026	2031	2036	2041	Ultimate
A1	271	65.0%	176	0	0	15	53	90	128	176
A2	244	65.0%	159	0	0	5	18	30	43	159
B1	160	65.0%	104	0	0	0	0	0	0	104
B2	153	65.0%	99	0	0	0	0	0	0	99
B3	268	65.0%	174	0	0	0	0	0	0	174
C	542	65.0%	352	0	0	0	0	0	0	352
D	298	65.0%	194	0	0	0	0	0	0	194
D1	258	65.0%	168	0	0	0	0	0	0	168
E	409	65.0%	266	0	0	0	0	0	0	266
F	414	65.0%	269	0	0	0	0	0	0	269
G	363	65.0%	236	0	0	0	0	0	0	236
Total	**3,380**	**65.0%**	**2,197**	**0**	**0**	**20**	**70**	**120**	**170**	**2,197**

Source: MacroPlan Dimasi 2019

The following table provides the forecast employment densities in each of the ROM zones. The reason for variation between zones is due to:

- The different employment nature of each precinct including general industry, freight and logistics, light industry, etc. These are based on the employment densities provided in the previous section of this report.
- Change of use over time as industrial precincts develop. For example the North Ellenbrook Industrial Precinct is planned to include a sub-precinct of light industry/service commercial which will develop at a later stage to the initial general industrial area. Therefore, ROM zone 524 is forecast to transition over time to a higher employment density.

Table 38. Employment density assumptions– jobs per hectare

Precinct	2016	2021	2026	2031	2036	2041	Ultimate
A1	22.00	22.00	22.00	22.00	22.00	22.00	22.00
A2	12.00	12.00	12.00	20.00	22.00	22.00	22.00
B1	22.00	22.00	22.00	22.00	22.00	22.00	22.00
B2	22.00	22.00	22.00	22.00	22.00	22.00	22.00
B3	32.00	32.00	32.00	35.25	35.25	35.25	35.25
C	22.00	22.00	22.00	22.00	22.00	22.00	22.00
D	22.00	22.00	22.00	22.00	22.00	22.00	22.00
D1	22.00	22.00	22.00	22.00	22.00	22.00	22.00
E	22.00	22.00	22.00	22.00	22.00	22.00	22.00
F	22.00	22.00	22.00	22.00	22.00	22.00	22.00
G	32.00	32.00	32.00	32.00	35.25	35.25	35.25
Average (unweighted)	**22.91**	**22.91**	**22.91**	**23.93**	**24.41**	**24.41**	**24.41**

Source: MacroPlan Dimasi 2019 based on employment densities from the WAPC Land Use and Employment Survey 2015-17

The following table indicates the new industrial employment in each precinct, solely as a result of the BFIDSP development. These employment numbers represent the previous two tables multiplied together (ie. hectares of land developed for industrial uses *times* the expected number of employees per hectare).

Table 39. *Industrial* employment from the BFIA (not including baseline employment)

Precinct	2016	2021	2026	2031	2036	2041	Ultimate
A1	0	0	330	1,155	1,980	2,805	3,875
A2	0	0	60	350	660	935	3,489
B1	0	0	0	0	0	0	2,288
B2	0	0	0	0	0	0	2,188
B3	0	0	0	0	0	0	6,141
C	0	0	0	0	0	0	7,751
D	0	0	0	0	0	0	4,261
D1	0	0	0	0	0	0	3,689
E	0	0	0	0	0	0	5,849
F	0	0	0	0	0	0	5,920
G	0	0	0	0	0	0	8,317
Total	**0**	**0**	**390**	**1,505**	**2,640**	**3,740**	**53,768**

Source: MacroPlan Dimasi 2019

Note: As the newly definition of zones 524 and 527 do not overlap with the industrial precincts, they are not included in the table above.

A4.7 Employment projections by industry

This section covers the employment projections for each of the precincts A to G in the BFIDSP area. This includes all the existing (largely rural) uses on site and the transition to industrial development.

The projections also include estimates for the new boundary definitions for zones 524 and 527. These do not include any planned industrial land and the employment projections for these two zones assume no change in zoning.

Table 40. Employment by industry by precinct - 2016

Ultimate	Agriculture	Mining	Manufacturing	Utilities	Construction	Wholesale	Retail	Transport	Communication	Finances	Public Admin.	Education	Health	Welfare and other	Entertainment-recreation	
Precinct / Zone	**A**	**B**	**C**	**D**	**E**	**Fw**	**Fr**	**G**	**H**	**I**	**J**	**Ke**	**Kh**	**Ko**	**L**	**Total**
A1	0	0	3	0	0	0	3	2	0	1	4	0	0	0	2	**16**
A2	0	0	1	0	0	1	0	14	0	0	0	0	0	0	0	**16**
B1	2	0	31	0	5	2	32	15	3	6	39	0	0	4	18	**156**
B2	0	0	2	0	0	0	2	1	0	0	2	0	0	0	1	**9**
B3	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	**2**
C	1	1	1	0	3	1	0	2	0	0	0	0	0	0	0	**11**
D	25	0	1	0	1	1	1	1	3	0	1	0	0	0	3	**37**
D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
E	18	0	1	0	1	1	0	0	2	0	1	0	0	0	2	**26**
F	18	0	1	0	1	1	0	0	2	0	1	0	0	0	2	**26**
G	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	**4**
524	1	1	1	0	4	1	0	3	0	0	0	0	0	0	0	**13**
527	0	0	6	0	1	0	6	3	1	1	8	0	0	1	4	**31**
Total	**66**	**4**	**49**	**0**	**17**	**11**	**45**	**42**	**11**	**9**	**55**	**0**	**1**	**5**	**32**	**348**

Source: MacroPlan 2019

Note: Totals may not add due to rounding.

Table 41. Employment by industry by precinct - 2021

Ultimate	Agriculture	Mining	Manufacturing	Utilities	Construction	Wholesale	Retail	Transport	Communication	Finances	Public Admin.	Education	Health	Welfare and other	Entertainment-recreation	
Precinct / Zone	**A**	**B**	**C**	**D**	**E**	**Fw**	**Fr**	**G**	**H**	**I**	**J**	**Ke**	**Kh**	**Ko**	**L**	**Total**
A1	0	0	3	0	0	0	3	2	0	1	4	0	0	0	2	**16**
A2	0	0	1	0	0	1	0	14	0	0	0	0	0	0	0	**16**
B1	2	0	29	0	3	2	31	16	2	5	40	0	3	4	18	**155**
B2	0	0	2	0	0	0	2	1	0	0	2	0	0	0	1	**9**
B3	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	**3**
C	1	1	1	0	3	1	0	2	0	0	0	1	0	0	0	**12**
D	22	0	1	0	1	1	1	1	4	0	1	0	0	0	3	**35**
D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
E	15	0	1	0	1	1	0	0	3	0	1	0	0	0	2	**25**
F	15	0	1	0	1	1	0	0	3	0	1	0	0	0	2	**25**
G	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	**5**
524	2	1	1	0	3	1	0	3	0	0	0	1	1	0	1	**14**
527	0	0	6	0	1	0	6	3	0	1	8	0	1	1	4	**31**
Total	**60**	**4**	**47**	**0**	**13**	**10**	**44**	**43**	**13**	**9**	**56**	**3**	**6**	**5**	**34**	**348**

Source: MacroPlan 2019

Note: Totals may not add due to rounding.

Table 42. Employment by industry by precinct - 2026

Ultimate	Agriculture	Mining	Manufacturing	Utilities	Construction	Wholesale	Retail	Transport	Communication	Finances	Public Admin.	Education	Health	Welfare and other	Entertainment-recreation	
Precinct / Zone	**A**	**B**	**C**	**D**	**E**	**Fw**	**Fr**	**G**	**H**	**I**	**J**	**Ke**	**Kh**	**Ko**	**L**	**Total**
A1	0	3	51	2	41	12	58	7	0	29	8	32	2	96	7	**347**
A2	0	12	7	0	11	7	10	24	0	5	0	0	1	0	1	**77**
B1	1	0	30	0	5	2	33	17	3	6	43	0	4	4	20	**168**
B2	0	0	2	0	0	0	2	1	0	0	3	0	0	0	1	**10**
B3	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	**3**
C	1	1	1	0	0	1	0	2	0	0	0	1	0	0	0	**9**
D	19	0	1	0	1	1	1	1	5	0	1	0	0	0	3	**33**
D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
E	14	0	0	0	1	1	0	0	4	0	1	0	0	0	2	**24**
F	14	0	0	0	1	1	0	0	4	0	1	0	0	0	2	**24**
G	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**4**
524	2	1	1	0	0	1	0	3	0	0	0	1	1	0	1	**11**
527	0	0	6	0	1	0	7	3	1	1	9	0	1	1	4	**34**
Total	**54**	**18**	**101**	**2**	**61**	**28**	**111**	**60**	**16**	**43**	**65**	**35**	**9**	**100**	**42**	**745**

Source: MacroPlan 2019

Note: Totals may not add due to rounding.

Table 43. Employment by industry by precinct - 2031

Ultimate	Agriculture	Mining	Manufacturing	Utilities	Construction	Wholesale	Retail	Transport	Communication	Finances	Public Admin.	Education	Health	Welfare and other	Entertainment-recreation	
Precinct / Zone	**A**	**B**	**C**	**D**	**E**	**Fw**	**Fr**	**G**	**H**	**I**	**J**	**Ke**	**Kh**	**Ko**	**L**	**Total**
A1	0	10	167	6	134	43	200	16	1	126	17	102	5	324	22	**1,174**
A2	0	68	36	0	65	33	59	59	0	36	0	1	4	0	7	**368**
B1	1	0	30	0	11	2	37	17	3	7	48	1	4	5	24	**190**
B2	0	0	2	0	1	0	2	1	0	0	3	0	0	0	1	**11**
B3	1	0	1	0	34	1	0	0	0	0	0	0	0	1	2	**40**
C	1	1	1	0	0	1	0	3	0	0	0	1	0	0	1	**11**
D	17	0	1	0	1	2	1	1	6	1	1	0	0	0	4	**33**
D1	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	**12**
E	12	0	1	0	1	1	1	0	4	0	1	0	0	0	3	**24**
F	12	0	1	0	1	1	1	0	4	0	1	0	0	0	3	**24**
G	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	**4**
524	2	2	1	0	1	1	1	3	0	1	0	1	1	0	1	**13**
527	0	0	6	0	2	0	7	3	1	1	10	0	1	1	5	**38**
Total	**48**	**83**	**246**	**6**	**261**	**85**	**309**	**105**	**19**	**173**	**80**	**107**	**16**	**332**	**71**	**1,942**

Source: MacroPlan 2019

Note: Totals may not add due to rounding.

Table 44. Employment by industry by precinct - 2036

Ultimate	Agriculture	Mining	Manufacturing	Utilities	Construction	Wholesale	Retail	Transport	Communication	Finances	Public Admin.	Education	Health	Welfare and other	Entertainment-recreation	
Precinct / Zone	**A**	**B**	**C**	**D**	**E**	**Fw**	**Fr**	**G**	**H**	**I**	**J**	**Ke**	**Kh**	**Ko**	**L**	**Total**
A1	0	17	285	10	230	73	341	27	1	216	25	175	9	555	37	**2,001**
A2	0	128	68	0	122	61	112	98	0	67	0	3	7	1	13	**680**
B1	2	1	33	0	13	2	40	19	3	8	53	1	5	5	26	**210**
B2	0	0	2	0	1	0	2	1	0	0	3	0	0	0	2	**13**
B3	1	0	1	0	37	1	0	0	0	0	1	0	0	1	2	**44**
C	1	2	1	0	1	1	1	3	0	1	0	1	1	0	1	**12**
D	19	0	1	0	1	2	1	1	7	1	1	0	0	0	4	**37**
D1	0	0	0	0	11	0	0	0	0	0	0	0	0	0	1	**13**
E	13	0	1	0	1	1	1	0	5	0	1	0	0	0	3	**26**
F	13	0	1	0	1	1	1	0	5	0	1	0	0	0	3	**26**
G	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	**5**
524	2	2	1	0	1	1	1	3	0	1	0	1	1	0	1	**14**
527	0	0	7	0	3	0	8	4	1	2	11	0	1	1	5	**42**
Total	**53**	**151**	**399**	**10**	**420**	**145**	**508**	**159**	**21**	**296**	**96**	**181**	**24**	**564**	**97**	**3,123**

Source: MacroPlan 2019

Note: Totals may not add due to rounding.

Table 45. Employment by industry by precinct - 2041

Ultimate	Agriculture	Mining	Manufacturing	Utilities	Construction	Wholesale	Retail	Transport	Communication	Finances	Public Admin.	Education	Health	Welfare and other	Entertainment-recreation	
Precinct / Zone	**A**	**B**	**C**	**D**	**E**	**Fw**	**Fr**	**G**	**H**	**I**	**J**	**Ke**	**Kh**	**Ko**	**L**	**Total**
A1	0	24	402	15	325	104	482	38	1	306	34	247	12	786	52	**2,828**
A2	0	182	95	0	173	86	159	133	0	95	0	4	10	1	18	**957**
B1	2	1	36	0	14	2	45	21	3	8	59	1	5	6	29	**232**
B2	0	0	2	0	1	0	3	1	0	1	4	0	0	0	2	**14**
B3	2	0	1	0	41	1	0	0	0	0	1	0	0	1	2	**49**
C	2	2	1	0	1	1	1	3	0	1	0	1	1	0	1	**13**
D	21	0	1	0	1	2	1	1	7	1	1	0	0	0	5	**41**
D1	0	0	0	0	12	0	0	0	0	0	0	0	0	0	1	**15**
E	15	0	1	0	1	1	1	1	5	0	1	0	0	0	3	**29**
F	15	0	1	0	1	1	1	1	5	0	1	0	0	0	3	**29**
G	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	**5**
524	2	2	1	0	1	1	1	4	0	1	0	1	1	0	1	**16**
527	0	0	7	0	3	0	9	4	1	2	12	0	1	1	6	**46**
Total	**58**	**212**	**549**	**15**	**574**	**202**	**701**	**208**	**23**	**415**	**112**	**255**	**31**	**796**	**121**	**4,273**

Source: MacroPlan 2019

Note: Totals may not add due to rounding.

Table 46. Employment by industry by precinct – ultimate development

Ultimate	Agriculture	Mining	Manufacturing	Utilities	Construction	Wholesale	Retail	Transport	Communication	Finances	Public Admin.	Education	Health	Welfare and other	Entertainment-recreation	
Precinct / Zone	**A**	**B**	**C**	**D**	**E**	**Fw**	**Fr**	**G**	**H**	**I**	**J**	**Ke**	**Kh**	**Ko**	**L**	**Total**
A1	0	33	554	20	449	144	664	52	2	422	45	342	17	1,086	70	**3,898**
A2	0	679	353	0	647	318	593	444	0	354	0	14	37	3	69	**3,511**
B1	4	1	419	0	526	104	183	1,103	20	32	60	1	5	12	51	**2,520**
B2	0	18	313	11	253	81	375	29	1	238	26	193	9	613	40	**2,202**
B3	12	222	1,240	97	639	857	665	1,154	134	864	63	25	14	102	102	**6,189**
C	10	2	1,297	0	1,734	346	471	3,666	56	80	3	1	1	22	75	**7,764**
D	25	0	713	0	954	191	260	2,015	38	44	3	0	0	12	45	**4,302**
D1	141	267	250	267	94	127	160	2,000	16	319	0	53	0	0	8	**3,704**
E	15	428	2,495	0	1,278	7	289	150	126	6	131	28	0	634	292	**5,878**
F	15	433	2,525	0	1,294	7	293	151	128	6	132	28	0	641	295	**5,949**
G	1	78	1,690	111	1,202	1,084	1,279	342	66	1,742	10	77	66	134	439	**8,322**
524	2	2	1	0	1	1	1	4	0	1	0	1	1	0	1	**16**
527	0	0	7	0	3	0	9	4	1	2	12	0	1	1	6	**46**
Total	**224**	**2,163**	**11,858**	**506**	**9,074**	**3,268**	**5,242**	**11,113**	**587**	**4,111**	**485**	**764**	**152**	**3,262**	**1,492**	**54,302**

Source: MacroPlan 2019

Note: Totals may not add due to rounding.



Brisbane
Level 15
111 Eagle Place
Brisbane Qld 4000
(07) 3221 8166

Gold Coast
Level 2, The Wave, 89-91 Surf Parade Broadbeach Qld 4218
PH: (07) 3221 8166

Melbourne
Level 16
330 Collins Street
Melbourne Vic 3000
(03) 9600 0500

Sydney
Level 52
19 Martin Place
Sydney NSW 2000
(02) 9221 5211

Perth
Level 1, 89 St Georges Terrace
Perth WA 6000
(08) 9225 7200

Canberra
PO Box 589,
Canberra ACT 2006
(02) 9221 5211

MacroPlanDimasi



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