

Appendix F: Biological Survey Report, Neaves Rd.



Australian Government

BUILDING OUR FUTURE



mainroads
WESTERN AUSTRALIA

NorthLinkWA

Perth-Darwin National Highway

Public Environmental Review

Perth-Darwin National Highway (Swan Valley Section)

SEPTEMBER 2015 | VOLUME I: MAIN TEXT



This document is a Public Environmental Review under the *Environmental Protection Act 1986* (WA) and a draft Public Environment Report under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).

Invitation to make a submission

The Western Australian Environmental Protection Authority (EPA) invites people to make a submission on this proposal. The environmental impact assessment process is designed to be transparent and accountable, and includes specific points for public involvement, including opportunities for public review of environmental review documents. In releasing this document for public comment, the EPA advises that no decisions have been made to allow this proposal to be implemented.

Main Roads Western Australia is proposing to construct a new section of the Perth–Darwin National Highway between Malaga and Muchea, Western Australia. The proposal is 38 km of new dual carriageway highway to the west of the Swan Valley and will connect the intersection of Tonkin Highway and Reid Highway in the south with Great Northern Highway and Brand Highway in the north.

A Public Environmental Review (PER) has been prepared by Main Roads Western Australia in accordance with the Western Australian *Environmental Protection Act 1986* and is available for a public review period of 4 weeks from 7 September 2015, closing on 6 October 2015. The PER document describes the proposal, examines the likely environmental effects and the proposed environmental management procedures associated with the proposed development.

The proposal (EPBC 2013/7042) has also been determined to be a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and will be assessed by a Public Environment Report under the EPBC Act. The controlling provisions under Part 3 of the EPBC Act are:

- Listed threatened species and communities (Sections 18 and 18A);
- Listed migratory species (Sections 20 and 20A); and
- Commonwealth land (Sections 26 and 27A).

The PER also represents a Public Environment Report under the EPBC Act and is published pursuant to Section 98(1)(c) of the EPBC Act.

The EPA is coordinating the public review period on behalf of the Commonwealth and will provide submissions on EPBC Act matters to the Department of the Environment.

Where to get copies of this document

The PER may be accessed via the proponent's website at <https://www.mainroads.wa.gov.au/BuildingRoads/Projects/UrbanProjects/Pages/NorthlinkWA.aspx>

Printed and CD copies of this document may also be obtained from:

David Morley
NorthLink WA
Phone: 08 9269 6200
Email: david.morley@northlinkwa.com.au

Hard copies of the document cost \$10 (including postage). CDs will be provided free of charge.

Why write a submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action – including any alternative approaches. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged with electronic submissions being acknowledged electronically. The proponent will be required to provide adequate responses to points

raised in submissions. In preparing its assessment report for the Minister for Environment, the EPA will consider the information in submissions, the proponent's responses and other relevant information. Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the *Freedom of Information Act 1992*, and may be quoted in full or in part in the EPA's report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining a group interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the PER or the specific proposal. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal more environmentally acceptable.

When making comments on specific elements of the PER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable; and
- suggest recommendations, safeguards or alternatives.

Points to keep in mind

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the PER;
- if you discuss different sections of the PER, keep them distinct and separate, so there is no confusion as to which section you are considering; and
- attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

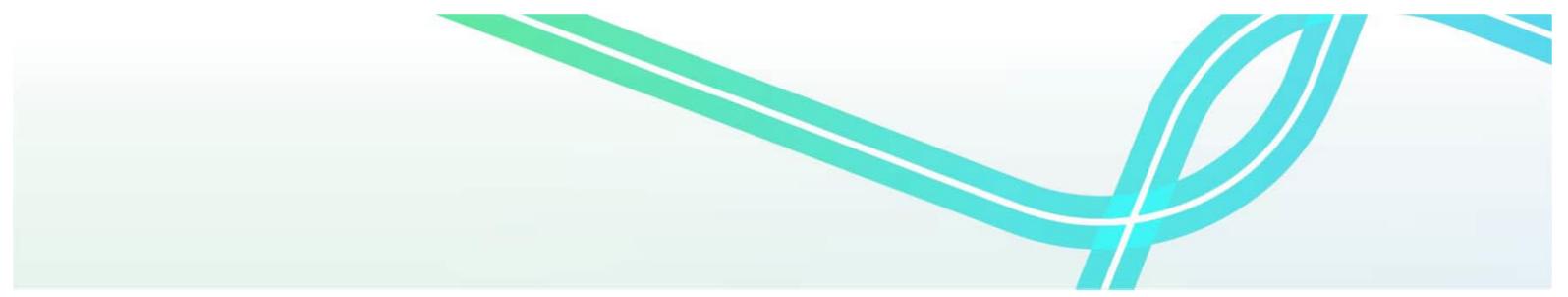
- your name;
- address;
- date; and
- whether and the reason why you want your submission to be confidential.

The closing date for submissions is: 6 October 2015.

The EPA prefers submissions to be made at <https://consultation.epa.wa.gov.au>. Alternatively, submissions can be:

- posted to: Chairman, Environmental Protection Authority, Locked Bag 10, EAST PERTH WA 6892; or
- delivered to the Environmental Protection Authority, Level 8, The Atrium, 168 St Georges Terrace, Perth.

If you have any questions on how to make a submission, please ring the Office of the Environmental Protection Authority on (08) 6145 0800.



EXECUTIVE SUMMARY

Introduction

Main Roads Western Australia (MRWA) proposes to construct a new section of the Perth–Darwin National Highway (hereafter referred to as ‘the proposal’) between Malaga and Muchea, Western Australia. The proposal is 38 km of new dual carriageway highway to the west of the Swan Valley and will connect the intersection of Tonkin Highway and Reid Highway in the south with Great Northern Highway and Brand Highway in the north.

The proposal is the culmination of decades of planning for the southern terminus of the Perth–Darwin National Highway (PDNH), a key 4,000 km road transport route linking Perth with northern Western Australia and the Northern Territory.

This document is a Public Environmental Review (PER) required under Western Australian environmental legislation and a Public Environment Report required under Commonwealth environmental legislation. It will be used by Western Australian and Commonwealth agencies as the basis for environmental assessment of the proposal.

Background and Context

The current PDNH alignment follows Great Northern Highway through the Swan Valley between Roe Highway and Muchea. However, urban growth and increased tourism between Midland and Bindoon has generated additional traffic on roads in and around the Swan Valley, including on Great Northern Highway. Traffic congestion, increased travel times and reduced amenity have resulted in the need to investigate a more contemporary solution that is able to cater for projected future traffic volumes while minimising impacts to residents, businesses and tourism in the Swan Valley.

While future urban growth will result in more development in the Swan Valley, opportunities for upgrade works along this section of Great Northern Highway are limited. With the freight task predicted to double by 2050, a fit for purpose road built to national highway standard is required.

The objectives of the proposal are to:

- Improve freight capacity, efficiency and productivity.
- Reduce urban congestion now and into the future.
- Improve road safety through the ‘Towards Zero’ initiative.
- Maximise sustainability through economic, social and environmental responsibility.
- Improve amenity for the community, tourists and road users.
- Create value through affordable infrastructure.

Overview of the Proposal

MRWA is, therefore, proposing to construct a new section of the PDNH (Figure ES1). Beginning at the intersection of Tonkin Highway and Reid Highway, the highway will travel north on a new alignment through Whiteman Park towards Gngangara Road before heading northeast through parts of the Gngangara State Forest to Ellenbrook. Skirting the western fringes of Ellenbrook, the highway will continue north



passing west of Bullsbrook before again turning northeast to cross Muchea Road South and the Midland–Geraldton railway line. The highway will connect to Great Northern Highway and Brand Highway on the eastern side of the Muchea town site.

The highway will be accessible from grade-separated interchanges at the following roads:

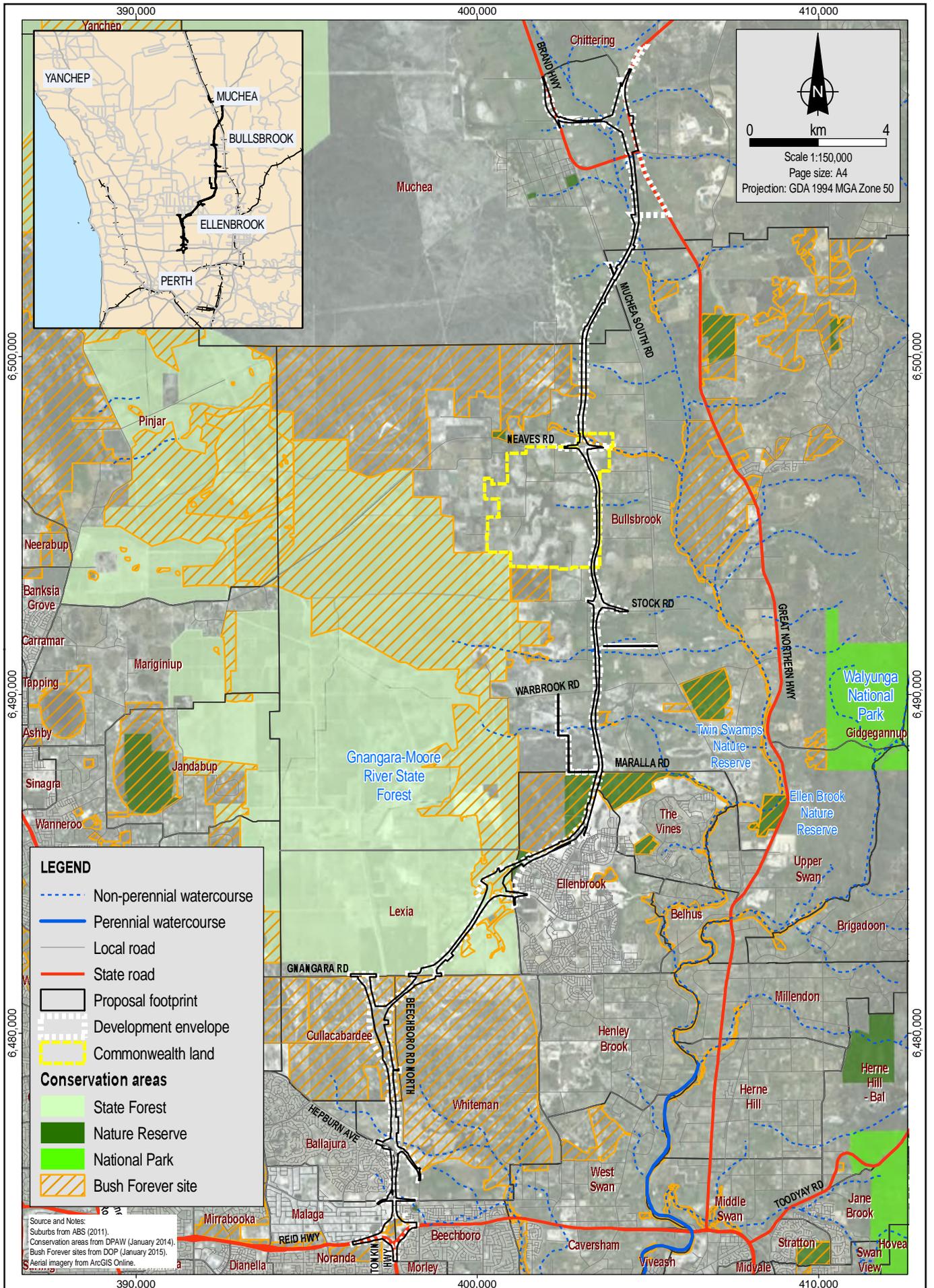
- Tonkin Highway and Reid Highway in Malaga.
- Hepburn Avenue in Malaga.
- Gnangara Road in Lexia.
- The Promenade in Ellenbrook.
- Stock Road in Bullsbrook.
- Neaves Road in Bullsbrook.
- Great Northern Highway and Brand Highway in Muchea.

The proposal's design also incorporates an interchange with a future road heading northwest from Whiteman Park, known as the East Wanneroo North–South Route. The East Wanneroo North–South Route north of Gnangara Road is currently in early planning stages and is not part of this proposal. Grade separations will be achieved using a combination of cuttings, embankments, bridges and flyovers as required.

Pedestrian and cyclist traffic will be accommodated through the provision of a Principal Shared Path alongside the new PDNH alignment between Ellenbrook and Malaga. The Principal Shared Path will be accessible from planned interchanges as well as local streets near the alignment to increase useability.

Construction of the proposal is to start in 2016–2017. While this document describes the ultimate planning design concept for the proposal, construction is likely to proceed in a staged approach. Proposal staging has not yet been decided, though it will be influenced by a number of factors including government priorities, funding availability, urban growth and traffic demand. The staging is not expected to change the overall environmental impacts described in this document.

The key characteristics of the proposal are summarised in Table ES-1.



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Projection: GDA 1994 MGA Zone 50

LEGEND

- Non-perennial watercourse
- Perennial watercourse
- Local road
- State road
- Proposal footprint
- Development envelope
- Commonwealth land

Conservation areas

- State Forest
- Nature Reserve
- National Park
- Bush Forever site

Source and Notes:
Suburbs from ABS (2011).
Conservation areas from DPAW (January 2014).
Bush Forever sites from DOP (January 2015).
Aerial imagery from ArcGIS Online.



Table ES-1 Key proposal characteristics

Element	Description
Proponent name	Main Roads Western Australia
Proposal title	Perth–Darwin National Highway
Short description	This proposal is to construct a new 38 km long section of the Perth–Darwin National Highway between Malaga and Muchea, Western Australia. It will consist of a dual carriageway highway and will connect the intersection of Tonkin Highway and Reid Highway in the south with Great Northern Highway and Brand Highway in the north.
Development envelope	Approximately 975 hectares (ha).
Proposal footprint	Disturbance for construction purposes to be no more than 746 ha.
Noise walls	<ul style="list-style-type: none"> • Noise walls constructed to a height of between 2.4 metre (m) and 5 m dependent on agreement with landholders. • Noise walls on residential boundaries to be no less than 2.4 m in height. • Noise walls on non-residential boundaries to be no less than 1.8 m in height.
Area of native vegetation cleared	<ul style="list-style-type: none"> • No more than 205 ha.
Area of conservation category wetland cleared or indirectly impacted	<ul style="list-style-type: none"> • No more than 16.0 ha.

Community Engagement and Stakeholder Consultation

MRWA is committed to utilising the knowledge, views and expertise of the community and stakeholders to guide sustainable outcomes in its decision making process as demonstrated by its Community Engagement Policy (MRWA, 2008). The key principles of this policy are respect, transparency, diversity, accountability, early engagement and leadership.

In accordance with this policy, a considerable amount of community and stakeholder engagement has been undertaken during the development of this proposal, both during historical alignment definition studies and as part of the current community and stakeholder engagement process. This has ensured that there is an agreed understanding of the local issues in relation to the proposal and that these issues have informed the proposal’s design, subject to the proposal’s constraints.

Stakeholder consultation and engagement has been facilitated through:

- Community ‘drop-in’ sessions held at various locations along the corridor as follows:
 - Morley Galleria.
 - Altone Park Shopping Centre.
 - Ballajura Library.
 - Ellenbrook Library.
 - Ellenbrook Shopping Centre.
 - Bullsbrook IGA.
 - Muchea IGA.

- Three Community Reference Groups.
- Environmental Reference Group.
- Freight and Road User Group.
- Drainage Reference Group.
- Safe Systems Working Group.
- Project Enabling Group involving and informing key government stakeholders.
- Community, business and special group meetings and briefings.
- Government agency briefing and project development sessions.
- A number of Project Newsletters.
- A 1800 Information Line.
- A project website (www.northlinkwa.com.au).
- A project email address.

A number of stakeholder issues have been raised throughout the proposal's development, including issues relating to the feasibility of various route alignments and the social, economic and environmental concerns associated with these. A Community and Stakeholder Register has been developed to capture all issues, complaints and queries raised.

The community and stakeholder engagement program has increased awareness of the proposal and enabled stakeholders to have the opportunity to inform and influence the proposal's design and management. MRWA is committed to ongoing engagement throughout the proposal's development to ensure that a sustainable outcome is achieved that minimises environmental and social impacts.

Strategic Assessment of the Proposal

The Strategic Assessment of the Perth and Peel Regions (SAPPR) is currently being undertaken under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). At a state level the SAPPR is being led by the Department of Premier and Cabinet, which is working closely with a number of state government agencies. The SAPPR will assess the impact of future development proposed under current state land use planning on Matters of National Environmental Significance (MNES) within the Perth and Peel regions in order to provide effective long-term management of key environmental issues and greater certainty to industry on those areas that can be developed.

The assessment of this proposal's environmental impacts is not being conducted as part of the SAPPR process. The timing of the SAPPR was not consistent with the timeframes required for the project to be ready for construction. However, the SAPPR does take this proposal into account given the implications of this proposal on future land use planning.

Further information on the SAPPR is available at www.dpc.wa.gov.au.

Potential Environmental Impacts and Management

As determined by the Environmental Protection Authority (EPA, 2014a), the preliminary key environmental factors for the proposal are:

- Flora and Vegetation.

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- Terrestrial Fauna.
 - Hydrological Processes and Inland Waters Environmental Quality.
 - Amenity – Noise and Vibration.
 - Rehabilitation and Decommissioning.
 - Offsets.

Tables ES-2, ES-3, ES-4, ES-5 and ES-6 summarise the key existing environmental values, potential impacts, environmental commitments, key management strategies to achieve these commitments and residual impacts for each of the preliminary key environmental factors.

To ensure that impacts are minimised and that the relevant EPA objectives can be met, MRWA has committed to achieving a number of environmental outcomes. While various management measures are proposed in this PER to achieve these desired outcomes, alternative management strategies may arise with further design, investigations and proposal planning. MRWA is committed to achieving environmental outcomes through the implementation of appropriate management measures that are relevant to specific conditions on-site, and which may vary from those described in this document. This approach is consistent with the Environmental Assessment Guideline for Recommending Environmental Conditions (EPA, 2013a).

Following the minimisation of impacts through avoidance, mitigation and management measures, there are residual impacts that require offsetting. The strategies for offsetting the residual impacts address environmental values relevant to the State as assessed by the EPA and Matters of National Environmental Significance as determined by the Commonwealth.

In addition to the preliminary key environmental factors, the following environmental aspects were also required to be considered:

- Heritage:
 - Aboriginal.
 - European.
- Amenity – including Dick Perry Reserve and Whiteman Park.

In addition to consideration of amenity impacts to Dick Perry Reserve and Whiteman Park, impacts of the proposal on conservation areas were also considered in this section.

Tables ES-7 and ES-8 and ES-9 summarise the existing values, potential impacts, proposal commitments, the key management strategies to achieve these commitments and residual impacts for Aboriginal heritage, European heritage and amenity.

Matters protected by the EPBC Act, both environmental values on Commonwealth land and impacts to MNES (i.e. threatened and migratory species), have been considered separately. Table ES-10 summarises the existing environment, potential impacts, environmental commitments, key management strategies to achieve these commitments, and residual impacts for matters protected under the EPBC Act.

Following the implementation of mitigation measures and proposed offsets, MRWA expects that the proposal will meet the EPA's objectives for each of the preliminary key environmental factors: flora and vegetation, terrestrial fauna, hydrological processes and inland waters environmental quality, amenity and rehabilitation.

Table ES-2 Flora and vegetation

EPA objective	Key environmental values ¹	Potential impacts	Management	Residual impacts	Proposed offset
<p>To maintain representation, diversity, viability and ecological function at the species, population and community level.</p>	<p>Major flora and vegetation values within and in close proximity (flora study area) to the proposal footprint:</p> <ul style="list-style-type: none"> • 485 native taxa represent a high diversity of flora on the Swan Coastal Plain (SCP). • 205.0 ha native vegetation (in degraded to pristine condition). • Two Threatened and eight Priority listed flora. • 13 significant flora of the Perth Metropolitan region. • 60 vegetation associations and five mapping units. • Four Threatened Ecological Communities (TECs) (Mound Springs SCP, Claypans of the SCP, SCP02 and SCP20a). • Five Priority Ecological Communities (PECs) (SCP21c, SCP22, SCP23b, SCP24 and Banksia Woodlands SCP). • Ecological linkages (Gaston Road, Bullsbrook; Raphael Road, Bullsbrook; Maralla Road Nature Reserve; Rocla mining lease area; Cullacabardee; Reid Highway). • Approximately 361.5 ha of Groundwater Dependent Ecosystems (GDEs) (i.e. geomorphic wetlands supporting intact native vegetation). • 14 Bush Forever sites. 	<ul style="list-style-type: none"> • Construction phase impacts: <ul style="list-style-type: none"> – Permanent loss of native vegetation. – Permanent loss of GDEs. – Permanent loss of native vegetation within Bush Forever sites. – Permanent loss of TECs and PECs. – Permanent loss of Threatened and Priority listed flora. – Spread of introduced weeds. – Spread of <i>Phytophthora</i> Dieback. – Fragmentation of native vegetation. • Operation phase impacts: <ul style="list-style-type: none"> – Spread of introduced weeds. – Spread of <i>Phytophthora</i> Dieback. – Vegetation degradation from uncontrolled access to remnant vegetation. – Increase in fires. 	<p>Avoidance:</p> <p>Mound Springs SCP TEC at Gaston Road; Claypans of the Swan Coastal Plain TEC adjacent to the existing Great Northern Highway; <i>Caladenia huegelii</i>, <i>Grevillea curviloba</i> subsp. <i>incurva</i> and <i>Darwinia foetida</i> threatened flora locations; <i>Cyathochaeta teretifolia</i> (P3), <i>Ornduffia submersa</i> (P4) and <i>Stylidium striatum</i> (P4) priority flora locations; and Bush Forever Site 13, including conservation category wetland UFI 8926.</p> <p>Environmental commitments:</p> <ul style="list-style-type: none"> • A maximum of 205.0 ha of native vegetation will be cleared. • A maximum of 128.5 ha of Bush Forever sites will be cleared. • A maximum of 49.6 ha of GDEs will be cleared. • A maximum of 4.4 ha of State listed TECs (SCP02 and SCP20a) will be cleared. • A maximum of 145.5 ha of State listed PECs (SCP21c, SCP22, SCP23b, SCP24 and Banksia Woodlands SCP) will be cleared. <p>Key management strategies that can be applied to achieve these commitments:</p> <ul style="list-style-type: none"> • Progressive clearing and revegetation will occur through the construction phase of the proposal. • An EMP will be developed and implemented prior to construction and will include measures for mitigating and managing the risk of fire, the introduction and/or spread of weeds and/or dieback and litter. The EMP will also include management and monitoring of Threatened and Priority flora, TECs and PECs, including vegetated buffers. • A detailed infrastructure plan will be developed for each stage of the development prior to construction to ensure that the proposal is designed within the approved development envelope and identifies areas of native vegetation to be retained. • Educational and induction material about the significant flora and ecological communities will be provided to contractors working on the proposal to reduce the risk of clearing outside of the proposal footprint. • No movement of plant (construction) or vehicles outside of the designated clearing line during construction. 	<ul style="list-style-type: none"> • Loss of 205.0 ha of native vegetation in degraded or better condition. • Loss of 49.6 ha of native vegetation consistent with GDEs. • Loss of 128.5 ha within Bush Forever sites. • Loss of 4.4 ha of two State TECs. • Loss of 145.5 ha of five State PECs. • Loss of 39.2 ha and 2.0 ha of critical habitat for <i>Caladenia huegelii</i> and <i>Grevillea curviloba</i> subsp. <i>incurva</i>, respectively. • High loss (known individuals) of two Priority taxa: <ul style="list-style-type: none"> – <i>Millotia tenuifolia</i> var. <i>laevis</i>: 18.8% on known individuals. – <i>Meeboldina decipiens</i> subsp. <i>decipiens</i> ms: 50% of known individuals. <p>Three fragmented ecological linkage networks (Gaston Road Bullsbrook, Raphael Road Bullsbrook and Reid Highway) will be further fragmented.</p> <p>Three large, fairly contiguous ecological linkage networks (Maralla Road Nature Reserve, Rocla mining lease area and Cullacabardee) will be fragmented.</p>	<ul style="list-style-type: none"> • Providing 673.5 ha of Black Cockatoo habitat as part of Offset Proposal 1. This offset area will be ceded to the Conservation Commission, with the intention that it will be added to conservation estate and managed in the long-term by Department of Parks and Wildlife. • Providing 78 ha of TEC SCP20a as part of Offset Proposal 1. This offset area will be ceded to the Conservation Commission, with the intention that it will be added to conservation estate and managed in the long-term by Department of Parks and Wildlife. • Providing 0.2 ha of TEC SCP02 as part of Offset Proposal 3. This will only be required where TEC SCP02 is confirmed to be present within the proposal footprint.

Table ES-3 Terrestrial fauna

EPA objective	Key environmental values ¹	Potential impacts	Management	Residual impacts	Proposed offset
<p>To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.</p>	<p>Major fauna and habitat values within and in close proximity (fauna study area) to the proposal footprint:</p> <ul style="list-style-type: none"> 159.3 ha of natural fauna habitats (Banksia Woodland, Eucalypt/Corymbia Woodland, Dampland and Wetland). A total of 97 fauna were recorded, including one fish, six amphibians, 19 reptiles, 62 birds and nine mammals. Four species of conservation significant fauna were recorded: <ul style="list-style-type: none"> Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>) (EN, S1). Forest Red-tailed Black Cockatoo (<i>Calyptorhynchus banksii naso</i>) (VU, S1). Australian Bustard (<i>Ardeotis australis</i>) (P4). Southern Brown Bandicoot (P5) (<i>Isodon obesulus fusciventer</i>). Seven species of conservation significance are considered likely to occur: <ul style="list-style-type: none"> Great Egret (<i>Ardea alba</i>) (M, S3). Cattle Egret (<i>Ardea ibis</i>) (M, S3). Rainbow Bee-eater (<i>Merops ornatus</i>) (M, S3). Western Carpet Python (<i>Morelia spilota imbricata</i>) (S4). Jewelled Sandplain Ctenotus (<i>Ctenotus gemmula</i>) (P3). Black-striped Snake (<i>Neelaps calonotos</i>) (P3). Western Brush Wallaby (<i>Macropus irma</i>) (P4). Ecological linkages important for fauna (Maralla Road Nature Reserve; Cullacabardee Nature Reserve and Reid Highway). 	<ul style="list-style-type: none"> Construction phase impacts: <ul style="list-style-type: none"> Habitat loss due to vegetation clearing. Habitat fragmentation due to vegetation clearing. Disturbance to waterbirds (including migratory species) from impacts to wetlands. Fauna mortalities primarily due to clearing activities. Feral predation of displaced fauna by Red Foxes and Cats. Accidental fire during construction activities. Light and noise as a result of machinery and construction activities. Operation phase impacts: <ul style="list-style-type: none"> Habitat fragmentation. Severing of ecological connectivity. Fauna mortalities from fauna/vehicle interactions. Feral predation by Red Foxes and Cats. Habitat degradation, edge effects, weeds, dieback, rubbish and vehicle tracks. Increased risk of bushfires due to greater human access to areas of vegetation. Light and noise as a result of vehicles along the PDNH. Altered surface and groundwater hydrology resulting in habitat degradation. 	<p>Avoidance:</p> <p>Western Swamp Tortoise critical habitat at Twin Swamps Nature Reserve, an area containing a high concentration of Black Cockatoo potential breeding trees and Mound Springs SCP TEC at Gaston Road.</p> <p>Environmental commitments:</p> <ul style="list-style-type: none"> A maximum of 201.8 ha of Carnaby's Cockatoo foraging habitat, 120.1 ha of Forest Red-tailed Black Cockatoo foraging habitat, and 120.1 ha of breeding habitat (inclusive of 737 potential breeding trees) and 58.6 ha of roosting habitat for both species will be removed. A maximum of 159.3 ha of natural fauna habitat will be removed. Ecological connectivity will be maintained across the proposal. The occurrence of fauna mortality, associated with vegetation clearing and vehicle interaction will be minimised during construction and operation. <p>Key management strategies that can be applied to achieve these commitments:</p> <ul style="list-style-type: none"> A total of 21 underpasses and two bridges are planned to be constructed in key locations along the proposal. Their effectiveness will be assessed via a monitoring program. Boundary fencing or flagging will be used to delineate extent of clearing during construction. An environmental management plan will be implemented to limit the risk of fire, spread of weeds, rubbish and vehicle tracks caused during construction. Furniture and revegetation will be used in fauna underpasses to reduce risk of predation. There will be multiple fauna underpasses in close proximity to reduce the risk of predation. A trapping and translocation program will be conducted for ground dwelling fauna in areas of native vegetation prior to clearing. Fauna spotters will be present during the clearing to help translocate any fauna and minimise any mortalities. All fauna injured during the construction period will be taken to an authorised veterinarian or wildlife carer. Limit the use of Banksia and other Black Cockatoo foraging resources as part of revegetation activities within 10 m of the road. Fauna fencing and fauna escape ramps will be installed in areas of ecological significance. 	<ul style="list-style-type: none"> Loss of 159.3 ha of natural fauna habitat Loss of Black Cockatoo habitat: <ul style="list-style-type: none"> 201.8 ha of Carnaby's Cockatoo and 120.1 ha of Forest Red-tailed Black Cockatoo foraging habitat. 58.6 ha of roosting habitat for both species. 120.1 ha of potential breeding habitat (including 737 potential breeding trees) for both species. Loss of conservation significant habitat: <ul style="list-style-type: none"> 15.5 ha Great Egret habitat. 271.2 ha Cattle Egret habitat. 367.5 ha Rainbow Bee-eater habitat. 81.7 ha Jewelled Sandplain Ctenotus habitat. 124.8 ha Black Striped-snake, Western Carpet Python and Western Brush Wallaby habitat. 19.0 ha Southern Brown Bandicoot habitat. Fragmentation to fauna habitats. However, fauna underpasses allow the maintenance of ecological connectivity. Some increase in the degradation of habitats from the spread of weeds and dieback, rubbish dumping, vehicle tracks and some edge effects. 	<p>Providing 673.5 ha of Black Cockatoo habitat as part of Offset Proposal 1. This offset area will be ceded to the Conservation Commission, with the intention that it will be added to conservation estate and managed in the long-term by Department of Parks and Wildlife.</p>

Table ES-4 Hydrological processes and inland waters environmental quality

EPA objective	Key environmental values ¹	Potential impacts	Management	Residual impacts	Proposed offset
<ul style="list-style-type: none"> To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected. To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected. 	<p>Major surface water features within and in close proximity to the proposal footprint:</p> <ul style="list-style-type: none"> Ellen Brook. Five Environmental Protection Policy (EPP) lakes (439, 440, 441, 450 and 453). Fifty-two geomorphic wetlands, including 20 conservation category wetlands (CCWs), 11 resource enhancement wetlands (REW) and 21 multiple use wetlands (MUW). Seven occurrences of Mound Springs SCP TEC. Claypans of the SCP TEC. 12.5 km of the proposal footprint occurs within the Gngara Underground Water Pollution Control Area, including 12 km within the Priority 1 area and 0.5 km within the Priority 3 area. Eight Wellhead Protection Zones (WHPZ) occur within the proposal footprint. <p>Other key values considered include Twin Swamps and Ellen Brook nature reserves (2.6 km and 5 km from the proposal footprint respectively).</p>	<p>Construction phase impacts:</p> <ul style="list-style-type: none"> Altered surface water runoff volumes from vegetation clearing. Altered surface water flow from earthworks and crossing/impounding of waterways and wetlands. Temporary changes to local groundwater levels as a result of drawdown of local aquifers during construction. Altered groundwater flow paths associated with subsurface compaction. Altered water quality, associated with: <ul style="list-style-type: none"> Liberation of sediments during ground disturbing activities. Disturbance to potential acid sulfate soils. Accidental spills and releases. <p>Operation phase impacts:</p> <ul style="list-style-type: none"> Altered surface water runoff volumes from road surface. Changes to local groundwater levels associated with infiltration basins. Altered water quality associated with road runoff and accidental spills and releases. 	<p>Avoidance:</p> <p>Mound Springs SCP TEC at Gaston Road, one CCW (UFI 8914) and three REWs (UFI 8916, UFI 8915 and UFI 8541). The interchange at Warbrook Road was relocated to Stock Road to avoid any potential impacts on Twin Swamps Nature Reserve and an additional 2.8 ha of CCW and 4.5 ha of REW within the development envelope has been avoided.</p> <p>Environmental commitments:</p> <ul style="list-style-type: none"> A maximum of 14.8 ha of CCW and 14.0 ha of REW will be removed. No adverse change in the condition of remaining wetlands, Ellen Brook, Mound Springs SCP TEC and Claypans of the SCP TEC. No adverse impact on groundwater quality or availability of the Gngara Mound. <p>Key management strategies to achieve these commitments:</p> <ul style="list-style-type: none"> An EMP will be developed and implemented prior to construction and will include measures for mitigating and managing hydrological impacts particularly in regard to the generation, storage, handling and release of pollutants, including an emergency spill response procedure. A drainage management and monitoring plan will be developed and implemented, including a groundwater monitoring procedure, to ensure impacts to Gngara Mound are being appropriately managed. Following final design and identification of appropriate water abstraction locations (where not in accordance with an existing bore/licence) an investigation into water abstraction requirements will be undertaken to understand the extent and scale of associated impacts on groundwater. A wetland management and monitoring plan will be developed and implemented, including a groundwater monitoring to ensure that impacts to wetlands (including Ellen Brook) are being appropriately managed. A detailed infrastructure plan will be prepared for each stage of the development prior to construction to ensure that the proposal is designed and constructed in accordance with the drainage strategy. Any dewatering, sourcing of construction water and interference of beds and banks will be undertaken in accordance with approved licences under the <i>Rights in Water and Irrigation Act 1914</i>. 	<p>Construction:</p> <ul style="list-style-type: none"> Complete loss of one CCW (0.9 ha) and partial loss of an additional six CCWs (13.9 ha). Partial loss of four REWs (14.0 ha). Partial loss of EPP Lake 450 (0.04 ha). Loss of ecosystem function in a portion of one CCW isolated by the proposal (1.2 ha). Minor localised alteration to ephemeral surface water flows. Temporary and localised lowering of groundwater levels. <p>Operation:</p> <ul style="list-style-type: none"> Localised and temporary increase in groundwater levels at infiltration basins, following rainfall. 	<p>Providing 32 ha of CCW as part of Offset Proposal 2.</p>

Table ES-5 Amenity (noise and vibration)

EPA objective	Key environmental values	Potential impacts	Management	Residual impacts
<p>To ensure that impacts from noise and vibration are reduced as low as reasonably practicable.</p>	<p>Noise monitoring was conducted at eight sites between Bayswater and Muchea.</p> <ul style="list-style-type: none"> Existing daytime noise levels were highest at the Stock Road West site in Bullsbrook (54.2 dB LA_{eq (Day)}) and lowest at the Cootha Court site in Ballajura. At night, the noisiest site monitored was Mitra Loop in Beechboro (52.8 dB LA_{eq (Night)}) and the quietest at sites in Cootha Court in Beechboro and Strachan Road in Bullsbrook (43.2 dB A_{eq (Night)}). It is assumed for this proposal that daytime traffic noise levels will be more than 5 dB above the night time traffic noise levels. 	<ul style="list-style-type: none"> Sleep disturbance. Hearing impairment. Community annoyance. Reduced amenity. Reduced learning capacity. Changed behaviour in the use of public areas. Hearing protection requirement. Vibration, leading to structural damage (only expected during construction). 	<p>Environmental commitments:</p> <ul style="list-style-type: none"> Construction noise will comply with the prescribed standards for noise emissions under the Environmental Protection (Noise) Regulations 1997. Operational noise will not exceed the noise limit of 60 dB LA_{eq} as prescribed in State Planning Policy 5.4 between Reid Highway and Ellenbrook. <p>Key management strategies that can be applied to achieve these commitments:</p> <ul style="list-style-type: none"> A CNVMP will be developed for any out of hour's works, prior to construction, to ensure all works are carried out in accordance with AS 2436:2010 - Guide to Noise and Vibration control on Construction, Demolition and Maintenance sites, and will include the following mitigation/management measures: <ul style="list-style-type: none"> Using equipment with low noise levels and maintaining noise control devices on equipment. Using broadband reversing alarms on construction equipment. Ensure construction vibration does not exceed 5 mm/s. Providing a 24-hour noise complaint hotline during construction. Obtaining necessary approval to work outside of normal working hours, if required. Providing public notification where receptors may be impacted by construction noise and/or vibration, particularly when works will occur outside normal working hours. Minimising the amount of night-time traffic and construction adjacent to residential areas. Conducting a dilapidation survey prior to construction. Undertaking noise and vibration monitoring during construction in response to complaints or at potentially affected locations. Using the quietest practical road surface. Constructing noise walls to a maximum height of 5 m adjacent to noise sensitive premises between Reid Highway and Ellenbrook and of a material with a surface density exceeding 15 kg/m². Should the construction of noise walls not result in achieving the noise target of 55 dB LA_{eq} at noise sensitive receptors between Hepburn Avenue and Ellenbrook, efforts will be made to achieve the noise limit of 60 dB LA_{eq}. Constructing screening walls of a maximum height of 2.4 m at noise sensitive premises north of Ellenbrook. Where the limit can't be achieved north of Ellenbrook, facade treatments will be applied to reduce indoor noise. The level of treatment provided will be determined on a case-by-case basis in consultation with affected property owners. 	<p>Noise and vibration impacts will temporarily occur during the construction phase of the proposal. With the implementation of mitigation and management measures the effects are expected to be manageable and within the requirements of the Environmental Protection (Noise) Regulations 1997.</p> <p>For brownfields areas between Reid Highway and Hepburn Avenue the proposal will achieve the noise limits of 60 dB LA_{eq} prescribed in State Planning Policy 5.4.</p> <p>For greenfields areas between Hepburn Avenue and Ellenbrook the proposal will achieve the noise target of 55 dB LA_{eq} at noise sensitive receptors where practicable, while achieving the noise limit of 60 dB LA_{eq} at remaining noise sensitive receptors where 55 dB LA_{eq} cannot be achieved.</p> <p>Mitigation measures will not achieve the 55 dB LA_{eq} target for eight rural residential properties north of Ellenbrook. Façade treatment will be provided to achieve indoor noise targets, but will not necessarily reduce external noise.</p>

Table ES-6 Rehabilitation and decommissioning

EPA objective	Key environmental values	Potential impacts	Management	Residual impacts
<p>To ensure that premises are decommissioned and rehabilitated in an ecologically sustainable manner.</p>	<ul style="list-style-type: none"> • The revegetation strategy considers the existing landscapes of the proposal footprint. • Provide a landscape consistent with the vegetation types and classes of the proposal footprint. • Provide an urban experience for road users, creating a 'journey' through the road corridor. • Provide a road corridor development with high quality urban design and aesthetic structures. • Provide a soft landscaped road alignment in keeping with the varied site context of the corridor. • Provide landscape and urban design treatments that are sustainable and maintainable. • Provide landscape and urban design treatments that provide amenity for adjoining landholders and provide management of the roadways visual impacts. 	<p>Failure to rehabilitate or poor site rehabilitation can have a number of impacts on the environment including:</p> <ul style="list-style-type: none"> • Reduction in the quality and quantity of habitats. • Reduction in ecosystem functions. • Impacts to adjacent natural vegetation and in the economic value of sites. • Contaminated water from road runoff into swales. 	<p>Environmental commitments:</p> <ul style="list-style-type: none"> • All areas of temporary disturbance will be revegetated by the re-establishment of a cover of vegetation suited to the location. • Rehabilitation of the road verge will improve the amenity of the site, the stability of unpaved surfaces and promote ecological sustainability. <p>Key management strategies to achieve these commitments:</p> <ul style="list-style-type: none"> • An EMP will be developed and implemented during construction, which includes a detailed revegetation plan, outlining a clear timeframe for mitigation and management measures, monitoring actions and completion criteria. • Retain topsoil and vegetation removed (topsoil materials must be contaminant and weed free). • Dieback hygiene procedures will be implemented. • Weed hygiene procedures will be implemented. • Unsuitable topsoil and cleared vegetation will be treated or disposed of during the clearing works. • Landscaping will be undertaken in accordance with the landscaping types and extent present in the proposal footprint (rural zone, transition zone and urban zone). • Local provenance native species that represent the floristic formations of the proposal footprint will be selected for revegetation. • Rehabilitation will be scheduled progressively where practicable. Timing of activities will, however, be dependent on optimal seasons. • Ongoing maintenance will form part of the regional Maintenance Program and will be the responsibility of the Asset Manager. 	<ul style="list-style-type: none"> • Achievement of roadside stability and minimised on-going maintenance. • Enhancement of the ecological function of vegetation immediately adjacent to the proposal footprint and assistance in conservation of local biodiversity value.

Table ES-7 Other environmental factors – Aboriginal heritage

EPA objective	Key environmental values	Potential impacts	Management	Residual impacts
<p>To ensure that historical and cultural associations, and natural heritage, are not adversely affected.¹</p>	<p>Archaeological and ethnographic heritage within the proposal footprint:</p> <p>Registered sites:</p> <ul style="list-style-type: none"> • Bennett Brook in Toto (ID 3692). • Temporary camp (ID 20058). • NOR/02 Lightning Swamp (ID 21393). • Chandala Brook (ID 21620). <p>Lodged Sites</p> <ul style="list-style-type: none"> • Ellen Brook, Upper Swan (ID 3525). <p>Newly identified sites in close proximity to the proposal footprint:</p> <ul style="list-style-type: none"> • NorthLink 14-01. • NorthLink 14-02. 	<p>Disturbance to Aboriginal heritage sites.</p> <ul style="list-style-type: none"> • Registered sites: <ul style="list-style-type: none"> – Bennett Brook in Toto (ID 3692). – Temporary camp (ID 20058). – NOR/02 Lightning Swamp (ID 21393). – Chandala Brook (ID 21620). 	<p>Environmental commitments:</p> <ul style="list-style-type: none"> • No disturbance to any Aboriginal heritage site outside of that approved under Section 18 of the AH Act. • Minimise impacts to unknown Aboriginal heritage sites. <p>Key management strategies to achieve these commitments:</p> <ul style="list-style-type: none"> • Should any ground disturbance be proposed for Registered (archaeological) sites: <ul style="list-style-type: none"> – MRWA will seek formal, written advice from the Department of Aboriginal Affairs (DAA) as to whether Ministerial consent is required under Section 18 of the <i>Aboriginal Heritage Act 1972</i> (AH Act) for the proposed works. – Consultation with the South-West Aboriginal Land and Sea Council (SWALSC) and other relevant Aboriginal people will take place. – An application will be made under Section 18 of the AH Act to use the ground on which the sites are located, where necessary. • Prior to nearby ground disturbance, sites NorthLink 14-01 and NorthLink 14-02 will be clearly delineated using physical markers and/or fencing and existing induction programmes/materials altered to alert staff in the area about the restrictions in entering or working near these heritage areas. • Monitoring by archaeologists and/or appropriately trained members of the Noongar community will take place in areas that have high potential for sites with some archaeological integrity. • MRWA will continue to consult with SWALSC and other relevant Aboriginal people on the documentation and management of Aboriginal sites. 	<ul style="list-style-type: none"> • Disturbance and clearance of Aboriginal Heritage values in proposal footprint.

1. Aboriginal heritage was not identified in the Environmental Scoping Document (ESD) by the EPA as a preliminary key environmental factor. However, heritage was identified as one of two other environmental factors that require consideration in the PER. In addition, MRWA recognises the significance of Aboriginal heritage and a survey was commissioned in this regard.

Table ES-8 Other environmental factors – European heritage

EPA objective	Key environmental values	Potential impacts	Management	Residual impacts
<p>To ensure that historical and cultural associations, and natural heritage, are not adversely affected.¹</p>	<p>Two Management Category No.5 places on the Shire of Chittering’s Heritage List were identified within the proposal footprint:</p> <ul style="list-style-type: none"> • Muchela – No. 30 Brand Highway, Muchea. • Drainage/Irrigation Channel – association with early drainage practices in the Muchea district. <p>One Place registered in the National Estate List of Classified Places (the National Trust):</p> <ul style="list-style-type: none"> • Ellenbrook Estate Area. <p>One place not listed on any statutory lists, but potentially subject to the Government Heritage Property Disposal Process:</p> <ul style="list-style-type: none"> • Forestry Department’s Divisional Headquarters and Fire Lookout. 	<p>Disturbance to European heritage values in the proposal footprint associated with:</p> <ul style="list-style-type: none"> • Muchela – No. 30 Brand Highway, Muchea. • Drainage/Irrigation Channel, Muchea South Road, Muchea. • Ellenbrook Estate Area. • Forestry Department’s Divisional Headquarters and Fire Lookout. 	<p>Environmental commitments:</p> <ul style="list-style-type: none"> • No disturbance to any European heritage site outside of the proposal. <p>Key management strategies to achieve these commitments:</p> <ul style="list-style-type: none"> • A site visit will be undertaken to enable external photographs to be taken of the Ellenbrook Estate Area, Muchela, Drainage/Irrigation Channel that may be subject to the Government Heritage Property Disposal Process (GHPDP). The site visit should enable an understanding of the nature and extent of original/historic fabric remaining on site. • Comply with the GHPDP by preparing a letter to the State Heritage Office advising of further clearance of the Ellenbrook Estate Area, Muchela, the Drainage/Irrigation Channel and the Forestry Department’s Divisional Headquarters and Fire Lookout site. • The Shire of Chittering will be advised that the proposal is occurring and that it will directly impact on two locally listed heritage places - Muchela and the Drainage/Irrigation Channel. Clarification is required on the status of these places on the Shire’s Heritage List and what process is required to enable the further clearance of this site. • The European Heritage values identified adjacent to the study area will be clearly marked on future mapping for the proposal to ensure that all construction personnel are aware of their location and the need for care during construction or with any future boundary changes. • The City of Swan, Shire of Chittering and City of Bayswater will be informed that the proposal is occurring and that it is occurring in close proximity to locally listed heritage places. 	<ul style="list-style-type: none"> • Disturbance and clearance of European Heritage values in proposal footprint.

1. European heritage was not identified in the ESD by the EPA as a preliminary key environmental factor and no specific objectives were set for this. However, heritage was identified as one of two other environmental factors that require consideration in the PER. In addition, MRWA recognises the significance of European heritage.

Table ES-9 Other environmental factors – amenity (Dick Perry Reserve, Whiteman Park and conservation areas)

EPA objective	Key environmental values	Potential impacts	Management	Residual impacts
<p>To ensure that impacts to amenity are reduced to as low as practicable.¹</p>	<ul style="list-style-type: none"> ● Proposed Dick Perry Reserve (Concept Plan for Gngara Park). ● Whiteman Park (reserved for parks and recreation). ● Conservation areas: <ul style="list-style-type: none"> – Class A Nature Reserve 46919. – Class A Nature Reserve 46920. – Gngara–Moore River State Forest No. 65. – Nine Bush Forever sites: 97, 100, 192, 198, 300, 304, 307, 399 and 480. 	<ul style="list-style-type: none"> ● Reduction in the size of Dick Perry Reserve and its potential to be utilised as recreational open space by the community. ● Loss of native vegetation, habitat fragmentation and potential fauna mortalities through Whiteman Park associated with clearing activities and vehicle movements during construction and operation. ● Loss of conservation areas. 	<ul style="list-style-type: none"> ● Construction of the proposal is likely to require changes to the Master Plan to accommodate the relocation or redesign of planned infrastructure. ● Management measures to address the continued use and viability of the reserve have been addressed through the design of the proposal and include: <ul style="list-style-type: none"> – Re-establishment of a barrier fence along the western side of the proposal to ensure access to the reserve is controlled. Gates for access for fire management activities will be established at regular intervals as agreed with DPAW. – Link walk trails with PSP at the interchanges on Gngara Road and at Ellenbrook to ensure continuity of the trails. ● Implementation of mitigation measures relevant to the specific environmental values (i.e. flora and vegetation, fauna and habitats, and wetlands) detailed in Tables ES-2, ES-3 and ES-4, including: <ul style="list-style-type: none"> – Implementation of a vehicle underpass south at crossing of Baal Street. Additionally, an access road parallel to the alignment will be constructed in this vicinity to provide access to the Cullacabardee community. – Implementation of fauna underpasses on or adjacent to Whiteman Park to facilitate fauna movement and maintain ecological connectivity. – Management measures to address habitat fragmentation have been incorporated in the UPDC of the proposal. These are discussed in more detail in Section 9.5.1. – The use of fauna spotters and a translocation program to reduce risk of fauna mortalities. ● Minimise the State Forest and Nature Reserve excision area and impact to Bush Forever sites as much as practical. 	<ul style="list-style-type: none"> ● Reduced amenity of the proposed Dick Perry Reserve and its utilisation as open space. ● Minor and localised impacts on fauna populations. ● Fragmentation of fauna habitats will increase due to the proposal. However, the inclusion of fauna underpasses allows the maintenance of ecological connectivity to the greatest practicable extent. ● Excision of 114 ha of conservation estate (including 8 ha of Class A Nature Reserve and 106 ha of State Forest). ● Loss of 128.5 ha of intact native vegetation in Bush Forever sites.

1. Amenity was not identified in the ESD by the EPA as a preliminary key environmental factor.

Table ES-10 Matters protected under the EPBC Act

Key environmental values	Potential impacts	Management	Residual impacts	Proposed offset
<p>Matters of National Environmental Significance under the EPBC Act:</p> <ul style="list-style-type: none"> Two species of conservation significant fauna were recorded: <ul style="list-style-type: none"> Carnaby's Cockatoo <i>Calyptorhynchus latirostris</i> (EN, S1). Forest Red-tailed Black Cockatoo (<i>Calyptorhynchus banksii naso</i>) (VU, S1). Six species of conservation significance are considered likely to occur: <ul style="list-style-type: none"> <i>Caladenia huegelii</i> (EN). <i>Darwinia foetida</i> (CR, EN). <i>Grevillea curviloba</i> subsp. <i>incurva</i> (EN). Great Egret (<i>Ardea alba</i>) (M, S3). Cattle Egret (<i>Ardea ibis</i>) (M, S3). Rainbow Bee-eater (<i>Merops ornatus</i>) (M, S3). Two TECs (Claypans of the SCP and Mound Springs SCP) were recorded. <p>Environmental impacts to Commonwealth land:</p> <ul style="list-style-type: none"> No conservation significant flora was recorded or is expected to occur. 1.9 ha of Wetland habitat classified as potential breeding habitat for Black Cockatoos. 26 potential breeding trees. No critical habitat exists on the Commonwealth Land for conservation significant fauna other than the Black Cockatoos. Two CCWs (0.42 ha) are present. 	<p>Matters of National Environmental Significance under the EPBC Act:</p> <ul style="list-style-type: none"> Permanent loss of TEC. Local loss of Threatened flora. For Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo: <ul style="list-style-type: none"> Loss of breeding, foraging and roosting habitat. Increased occurrence of vehicle collisions. Habitat degradation. Habitat degradation and loss for Great Egret, Cattle Egret and Rainbow Bee-eater. <p>Environmental impacts to Commonwealth land:</p> <ul style="list-style-type: none"> Clearing of Conservation Category Wetlands. Loss of fauna habitat and Black Cockatoo habitat. 	<p>Avoidance:</p> <p>Mound Springs SCP TEC at Gaston Road, Claypans of the SCP TEC adjacent to the existing Great Northern Highway, <i>Caladenia huegelii</i>, <i>Grevillea curviloba</i> subsp. <i>incurva</i> and <i>Darwinia foetida</i> threatened flora locations, Western Swamp Tortoise critical habitat at Twin Swamps Nature Reserve and an area containing a high concentration of Black Cockatoo potential breeding trees.</p> <p>Environmental commitments:</p> <ul style="list-style-type: none"> A maximum of 201.8 ha of Carnaby's Cockatoo foraging habitat, 120.1 ha of Forest Red-tailed Black Cockatoo foraging habitat, 120.1 ha of breeding habitat, 58.6 ha of roosting habitat and 737 potential breeding trees will be removed. No impact to TECs, Threatened flora and Western Swamp Tortoise critical habitat. <p>Key management strategies that can be applied to achieve these commitments for Matters of National Environmental Significance under the EPBC Act:</p> <ul style="list-style-type: none"> A management and monitoring program will be included within the EMP to ensure that the condition and structural integrity of the vegetated buffer for <i>Caladenia huegelii</i> is maintained. Additional targeted surveys will be completed prior to the construction phase to further define the population size and the extent of the known location. The targeted survey will also identify if any additional plants are located within the proposal footprint. Impacts to the loss of Black Cockatoo habitat will be offset. <p>Key management strategies that can be applied to achieve these commitments for environmental impacts to Commonwealth land include:</p> <ul style="list-style-type: none"> Implement an environmental management plan to limit spread of weeds, dieback, rubbish and vehicle tracks. Installation of drainage culverts to maintain hydrological flow. Reduction of design footprint. A wetland management and monitoring plan will be prepared and implemented. 	<p>Matters of National Environmental Significance under the EPBC Act:</p> <ul style="list-style-type: none"> Loss of 39.2 ha and 2.04 ha of Critical habitat for <i>Caladenia huegelii</i> and <i>Grevillea curviloba</i> subsp. <i>incurva</i>, respectively. No impact to Mound Springs SCP and Claypans of the SCP TECs. No impact upon the Western Swamp Tortoise or its critical habitat at Twin Swamps Nature Reserve and Ellen Brook Nature Reserve. For Black Cockatoos: <ul style="list-style-type: none"> The loss of 201.8 ha of Carnaby's Cockatoo foraging habitat, 120.1 ha of Forest Red-tailed Black Cockatoo foraging habitat, 58.6 ha roosting habitat, 120.1 ha breeding habitat and 737 suitable trees (including Commonwealth land). Increased occurrence of vehicle collision. Habitat degradation. <p>Commonwealth lands:</p> <ul style="list-style-type: none"> No significant flora or vegetation exists on the Commonwealth land within the proposal footprint. Excision of 46.4 ha of Commonwealth land. Rural land use will be maintained for disposed land with restrictive covenants. Loss of 1.9 ha of Wetland habitat (0.42 ha of CCW), classified as potential breeding habitat for Black Cockatoos¹. Loss of 26 potential breeding trees¹. 	<p>Providing 673.5 ha of Black Cockatoo habitat as part of Offset Proposal 1. This offset area will be ceded to the Conservation Commission, with the intention that it will be added to conservation estate and managed in the long-term by Department of Parks and Wildlife.</p> <p>Providing an offset for impacts to critical habitat for <i>Caladenia huegelii</i>.</p>

1. Fauna values outside of Commonwealth land are addressed separately in Table ES-3.



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C	Level 2 Spring Flora and Vegetation Assessment
D	Dieback Assessment
E	Gaston Road Threatened Ecological Community Hydrogeological Review
F	Environmental Management Plan
G	Level 2 Targeted Fauna Assessment
H	Drainage Strategy
I	Wetland Assessment
J	Position Paper – Twins Swamps Hydrology
K	Preliminary Acid Sulfate Soil Investigation
L	Position Paper – Groundwater Level Impact from Construction Dewatering and Groundwater Abstraction
M	Position Paper – Road Embankment Compaction Assessment
N	Position Paper – Ellen Brook Nature Reserve
O	Traffic Noise Assessment
P	Aboriginal Heritage Desktop Assessment
Q	Ethnographic Aboriginal Heritage Survey
R	Aboriginal Archaeological Assessment
S	European Heritage Desktop Assessment
T	Archaeological Assessment of the Forestry Department’s Divisional Headquarters
U	Historic Heritage Report – Forestry Department’s Divisional Headquarters
V	Preliminary Black Cockatoo Offset Considerations

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1 INTRODUCTION

Main Roads Western Australia (MRWA) proposes to construct a new section of the Perth–Darwin National Highway (hereafter referred to as ‘the proposal’) between Malaga and Muchea, Western Australia. The proposal is 38 km of new dual carriageway highway to the west of the Swan Valley and will connect the intersection of Tonkin Highway and Reid Highway in the south with Great Northern Highway and Brand Highway in the north.

The proposal is the culmination of decades of planning for the southern terminus of the Perth–Darwin National Highway (PDNH), a key 4,000 km road transport route linking Perth with northern Western Australia and the Northern Territory.

This document is a Public Environmental Review (PER) required under the Western Australian *Environmental Protection Act 1986* (EP Act) and a Public Environment Report required under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). It will be used by the Office of the Environmental Protection Authority (OEPA) and the Department of the Environment (DOTE) as the basis for conducting an environmental impact assessment of the proposal.

1.1 Proponent

The proponent for the proposal is MRWA and formal contact details are shown in Table 1.1.

Table 1.1 Proponent identification

Property	Details	
Proponent	Commissioner of Main Roads Main Roads Western Australia PO Box 6202 East Perth WA 6002	
Key contacts	Rob Arnott Project Director Main Roads Western Australia PO Box 6202 East Perth WA 6002 rob.arnott@mainroads.wa.gov.au	Denise True Environment and Heritage Manager NorthLink WA PO Box 4223 Victoria Park WA 6979 denise.true@northlinkwa.com.au

1.2 Background and Context

The PDNH is a key interstate road for the transport of people and goods between Perth and Darwin. Within Western Australia (WA), the route is important for transport between the southwest and the north of the State.

The current route of the PDNH starts at the intersection of Great Northern Highway with Roe Highway and Reid Highway in Midland. It follows Great Northern Highway in a northerly direction through the Swan Valley, passing through the townships of Upper Swan and Bullsbrook. At the intersection with Brand Highway in Muchea, the PDNH continues along Great Northern Highway to the northeast.



Great Northern Highway is a two-lane road built to rural highway standard. However, urban growth and increased tourism between Midland and Bindoon has generated additional traffic on roads in and around the Swan Valley, including on Great Northern Highway. Traffic congestion, increased travel times and reduced amenity have resulted in the need to investigate a more contemporary solution that is able to cater for projected future traffic volumes while minimising impacts to residents, businesses and tourism in the Swan Valley.

While future urban growth will result in more development in the Swan Valley, opportunities for upgrade works along this section of Great Northern Highway are limited. With the freight volumes predicted to double by 2050, a fit for purpose road built to national highway standard is required. The objectives for such a road are to:

- Improve freight capacity, efficiency and productivity.
- Reduce urban congestion now and into the future.
- Improve road safety through the 'Towards Zero' initiative.
- Maximise sustainability through economic, social and environmental responsibility.
- Improve amenity for the community, tourists and road users.

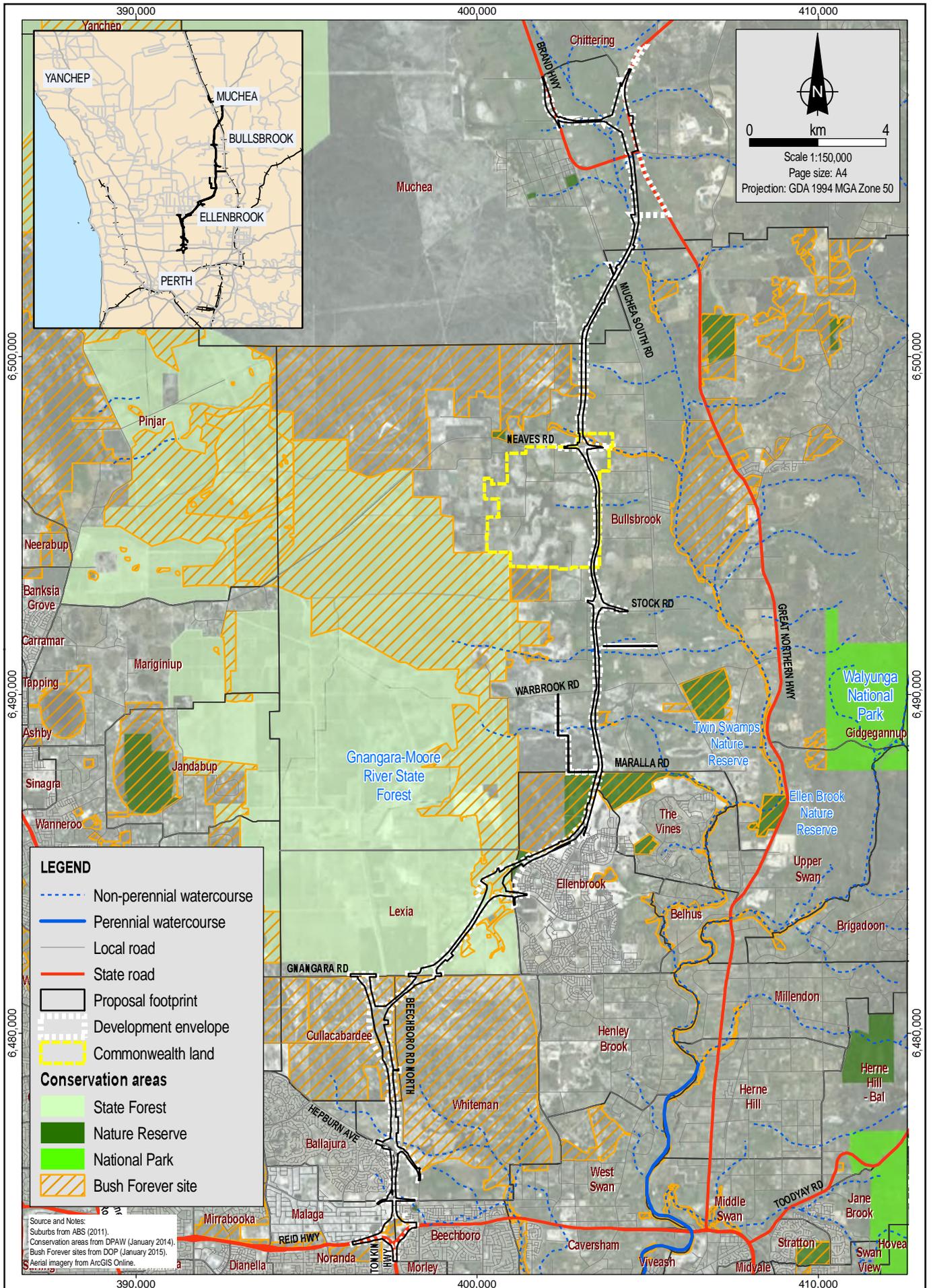
1.3 The Proposal

MRWA is proposing to construct a new section of the PDNH (Figure 1.1). Beginning at the intersection of Tonkin Highway and Reid Highway, the highway will travel north on a new alignment through Whiteman Park towards Gnangara Road before heading northeast through parts of the Gnangara State Forest to Ellenbrook. Skirting the western fringes of Ellenbrook, the highway will continue north passing west of Bullsbrook before again turning northeast to cross Muchea Road South and the Midland–Geraldton railway line. The highway will connect to Great Northern Highway and Brand Highway on the eastern side of the Muchea town site.

The highway will be accessible from grade-separated interchanges at the following roads:

- Tonkin Highway and Reid Highway in Malaga.
- Hepburn Avenue in Malaga.
- Gnangara Road in Lexia.
- The Promenade in Ellenbrook.
- Stock Road in Bullsbrook.
- Neaves Road in Bullsbrook.
- Great Northern Highway and Brand Highway in Muchea.

In addition to these planned interchanges, allowance has been made in the design to incorporate an interchange with a future road heading northwest from Whiteman Park, known as the East Wanneroo North–South Route (EWNSR). The EWNSR north of Gnangara Road is currently in early planning stages and is not part of this proposal. Grade separations will be achieved using a combination of cuttings, embankments, bridges and flyovers as required.



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LEGEND

- Non-perennial watercourse
- Perennial watercourse
- Local road
- State road
- Proposal footprint
- Development envelope
- Commonwealth land

Conservation areas

- State Forest
- Nature Reserve
- National Park
- Bush Forever site

Source and Notes:
Suburbs from ABS (2011).
Conservation areas from DPAW (January 2014).
Bush Forever sites from DOP (January 2015).
Aerial imagery from ArcGIS Online.

Pedestrian and cyclist traffic will be accommodated through the provision of a Principal Shared Path (PSP) alongside the new PDNH alignment between Ellenbrook and Malaga. The PSP will be accessible from planned interchanges as well as local streets near the alignment to increase useability.

Construction of the proposal is to start in 2016–17. While this document describes the ultimate planning design concept (UPDC) for the proposal, construction is likely to proceed in a staged approach. Staging of construction has not yet been finalised, though it will be influenced by a number of factors including government priorities, funding availability, urban growth and traffic demand. The staging is not expected to change the spatial extent or significance of the overall environmental impacts described in this document.

1.4 Key Proposal Characteristics

The key characteristics of the proposal are summarised in Table 1.2.

Table 1.2 Key proposal characteristics

Element	Description
Proponent name	Main Roads Western Australia
Proposal title	Perth–Darwin National Highway (Swan Valley Section)
Short description	This proposal is to construct a new 38 km long section of the Perth–Darwin National Highway between Malaga and Muehea, Western Australia. It will consist of a dual carriageway highway and will connect the intersection of Tonkin Highway and Reid Highway in the south with Great Northern Highway and Brand Highway in the north.
Development envelope	975 ha.
Proposal footprint	Disturbance for construction purposes to be no more than 746 ha.
Noise walls	<ul style="list-style-type: none"> • Noise walls constructed to a height of between 2.4 m and 5 m dependent on agreement with landholders. • Noise walls on residential boundaries to be no less than 2.4 m in height. • Noise walls on non-residential boundaries to be no less than 1.8 m in height.
Area of native vegetation cleared	No more than 205 ha.
Area of conservation category wetland cleared or indirectly impacted	No more than 16.0 ha.

Note: MRWA is seeking approval to construct and operate the proposal within the development envelope. The impact assessment in this PER is based on the proposal footprint, which is the area required to be disturbed based on the proposal's current design. The proposal footprint is wholly contained within the development envelope. The proposal footprint and development envelope are discussed further in Chapter 4.

1.5 Purpose of this Document

The EP Act requires proposals that may have a significant effect on the environment to be referred to the Environmental Protection Authority (EPA). The proposal was referred to the EPA in 2013 and the EPA subsequently decided that the proposal would be formally assessed. The EPA set a PER level of assessment, the highest level of assessment available under the EP Act.

The EPBC Act requires that all actions that will or may have a significant impact on a matter protected under the Act must be referred to the Minister for the Environment via the DOTE. An action must also be



referred if it will have an impact on Commonwealth land. This proposal was referred under the EPBC Act due to likely impacts to threatened flora and fauna species and because it intersects Commonwealth land. DOTE determined that the proposal is a 'controlled action', setting a Public Environment Report level of assessment.

The EPA and the DOTE have agreed to a joint assessment that requires MRWA to produce a single PER (this document) that satisfies the requirements of both assessment processes. The assessment is unable to be formally conducted under the bilateral agreement for joint assessments between WA and the Commonwealth, though the assessment will be coordinated. Broadly, the purpose of this PER is to:

- Describe the features of and activities associated with the proposal, including the development of the proposal.
- Describe the existing natural and social environment in the area where the proposal is located.
- Detail the impacts that the proposal may have on key environmental factors.
- Describe the management and mitigation measures that will be put in place to reduce the impacts of the proposal on the environment.
- Predict the environmental outcomes of the proposal.
- Invite public comment on the environmental impacts of the proposal.

This PER is divided into chapters as follows:

- Chapter 1 (this chapter) introduces the proposal and sets out the basis for this document.
- Chapter 2 provides background to the proposal.
- Chapter 3 provides details on alternative options to the proposal, and how the current proposal has been developed and refined over time.
- Chapter 4 contains a detailed description of the proposal.
- Chapter 5 describes the regulatory context – the legislation, regulations, guidelines, policies that may apply to the proposal.
- Chapter 6 describes the community and stakeholder engagement activities undertaken as part of proposal.
- Chapter 7 discusses the environmental impact assessment framework applied in the development of this PER.
- Chapter 8 focuses on terrestrial flora and vegetation and describes the existing environment, potential impacts of the proposal on this factor, management and mitigation measures and residual impacts.
- Chapter 9 focuses on fauna and describes the existing environment, potential impacts of the proposal on this factor, management and mitigation measures and residual impacts.
- Chapter 10 discusses hydrological processes and inland waters environmental quality and describes the existing environment, potential impacts of the proposal on this factor, management and mitigation measures and residual impacts.
- Chapter 11 describes potential impacts on amenity (specifically noise and vibration), management and mitigation measures and residual impacts.
- Chapter 12 describes rehabilitation and landscaping.

- 
- Chapter 13 discusses Aboriginal heritage and describes the existing environment, potential impacts of the proposal on this factor, management and mitigation measures and residual impacts.
 - Chapter 14 discusses European heritage and describes the existing environment, potential impacts of the proposal on this factor, management and mitigation measures and residual impacts.
 - Chapter 15 discusses the impact on the amenity associated with Dick Perry Reserve and Whiteman Park and conservation areas.
 - Chapter 16 describes potential impacts to matters protected under the EPBC Act.
 - Chapter 17 describes the proposed offsets for the proposal.
 - Chapter 18 concludes the main content of this document.
 - Chapter 19 contains a list of definitions, acronyms and abbreviations used in the document.
 - Chapter 20 contains a bibliography of all reference material cited throughout the document.

A number of individuals and organisations contributed to the development of this PER. Details are provided in Appendix A.

1.6 Assessment Process

Assessment of this PER will be conducted in accordance with:

- Part IV of the EP Act.
- The *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012*.
- Parts 8 and 9 of the EPBC Act.

The assessment process has been set out in the proposal's Environmental Scoping Document (ESD) (EPA, 2014a) (Appendix B) and the client service charter agreed by the OEPA, DOTE and MRWA (DOTE, 2014a).

The nominal assessment timeline is shown in Table 1.3.



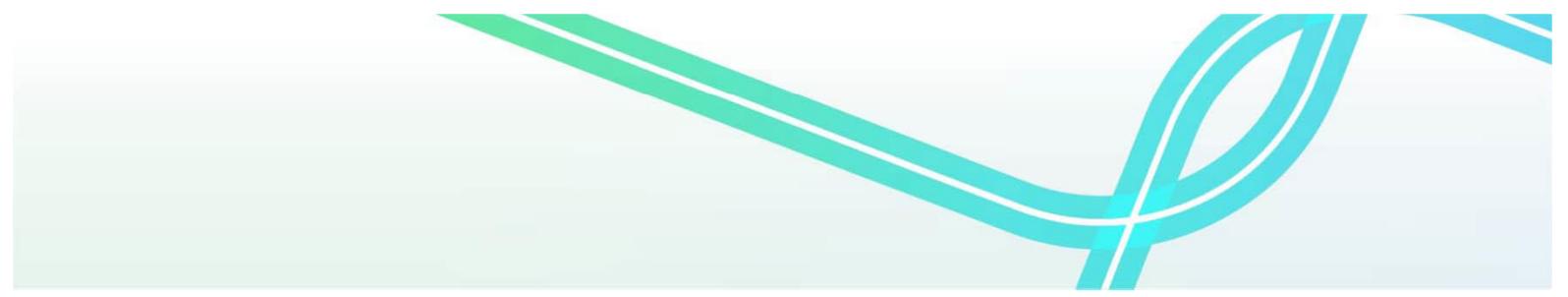
Table 1.3 Assessment timeline

Step	Nominal timing¹
EPA approves ESD	1 April 2014
MRWA submits first adequate draft of PER	30 March 2015
OEPA provides comment on first draft PER	8 May 2015
MRWA submits adequate revised draft PER	13 July 2015
OEPA reviews revised draft PER	27 July 2015
EPA authorises release of PER for public review	31 August 2015
MRWA releases approved PER for 4-week public review	7 September 2015
Public review period ends	6 October 2015
OEPA provides summary of public submissions	3 weeks
MRWA provides responses to public submissions	6 weeks
OEPA reviews MRWA responses to public submissions	4 weeks
OEPA assesses proposal on behalf of EPA	7 weeks
OEPA prepares and finalises EPA report on proposal	5 weeks
Minister for the Environment decides whether to approve proposal	After receiving EPA report

1. Dates are subject to change.



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2 PROPOSAL BACKGROUND AND JUSTIFICATION

2.1 Proposal Background

The PDNH is an important link in the State and national road network. It will enhance transport efficiencies between the Perth metropolitan area, northwest WA and the Northern Territory (MRWA, 2012a). The national highway currently follows the Great Northern Highway alignment and Roe Highway in Midland. The current road is built to rural highway standard. Urban growth in the northeast of the Perth metropolitan area, along with growth in the resources sector is anticipated to intensify traffic congestion, reducing amenity and serviceability of the existing highway route. To provide an acceptable long-term road network there is a need to plan for a new national highway route (WAPC, 2012).

The planning for the PDNH commenced in the 1980s. Since 1991, numerous studies have been undertaken by MRWA on behalf of the WA Government in relation to the development of a highway standard road from Perth's metropolitan area to regional areas in the north. The development of this road will provide appropriate road infrastructure to support increased traffic between Perth and regional areas and reduce the impacts of vehicle movements on the local residential population, while it will increase productivity and freight efficiency (MRWA, 2013a).

There has been extensive stakeholder consultation regarding a preferred route and alignment options. The focus of these preferred route alignment options has been to consider key constraints, including environmental and social aspects, and to avoid and minimise impacts where possible.

2.2 Proposal Objectives

The overall proposal objectives are to:

- **Improve freight capacity, efficiency and productivity.** Efficiency can be improved by increasing the average speed of freight along the new route. This will increase reliability by having more consistent travel times. By improving freight movements, and particularly the types of cargoes to support emerging oil and gas projects in WA, the region's competitiveness to undertake such projects in Australia will be increased. Connecting areas of supply and demand ensures the flow of goods into these areas and builds upon the region's global competitive advantage into the future (MRWA, 2013a).
- **Reduce urban congestion now and into the future.** It is estimated that traffic congestion in Perth could cost \$2.2 billion per year by 2020 (MRWA, 2013a). Reducing travel time, fuel consumption and general traffic congestion will support economic development and the productive capacity of the freight network. In addition, improving the general traffic congestion in the Swan Valley area will promote better residential and tourist opportunities and communities.
- **Improve road safety in line with the State "Towards Zero" policy.** The primary safety issue is Great Northern Highway's role as a major freight route that is within the Swan Valley tourist area and an urban environment with increasing residential development (MRWA, 2013a). Traffic safety can be improved by diverting regional traffic, including heavy freight vehicles, onto a fit for purpose highway.
- **Maximise sustainability through economic, social and environmental responsibility.** Developing detailed mitigation and management measures during the planning and development of the proposal will ensure that opportunities for environmental, social and economic enhancement within



and outside of the proposal corridor are maximised. By providing efficient freight infrastructure to the economic regions of northwest Australia, the proposal supports economic development. The northwest region accounts for approximately 30% of the nation's exports and is predicted to rise to 45 to 55% by 2025 (Department of State Development, 2012 cited in MRWA, 2013a).

- **Improve amenity for the community, tourists and road users.** Improving the general traffic congestion, in particular in the Swan Valley area, will promote better residential and tourist opportunities. Reducing impacts such as noise and pollution associated with freight vehicles will have benefits for residents and tourists. Improvement of amenities will enhance journeys and give provision for roadside facilities.
- **Create value through affordable infrastructure.** This proposal represents a significant investment and it is critical that primary benefits for road safety, freight capacity and urban congestion are realised in an affordable and socially and environmentally responsible way.

2.3 Proposal Justification

Due to the increase in demand for mineral resources, such as iron ore, and the exploration and development of oil and gas, the population and industry in the northwest of Australia has grown significantly. This increase in mining and construction activity has put a strain on existing road infrastructure (MRWA, 2013a).

As a result of urban growth, agriculture and other developments in the northeast corridor of the Perth metropolitan area, traffic congestion is expected to increase, especially around the Bullsbrook and Upper Swan town sites. This will reduce social amenity and the serviceability of the existing highway route (GHD, 2013a). As upgrading opportunities are limited along the current highway route, the development of a new route is required.

As a solution to the problem it has been proposed to construct new sections of road and to bypass the Swan Valley area. To make sure the highway is fit for purpose, it is necessary to construct a new road from the intersection of Reid Highway and Tonkin Highway to Muchea, as well as upgrade road connections and interchanges within the existing road network (MRWA, 2013a).

2.4 Policies and Strategies

The National Land Freight Strategy was formally approved and released by the Standing Council on Transport and Infrastructure (SCOTI) in September 2013. The Strategy is a partnership between the Commonwealth, State, Territory and local governments and industry to provide a streamlined, combined and multimodal transport system which is capable of moving freight around Australia efficiently (SCOTI, 2012). The PDNH is a key road link and forms part of the National Land Freight Network.

Directions 2031, the State's strategic planning document for the Perth and Peel regions, was released by the Department of Planning (DOP) on behalf of the WA Planning Commission (WAPC). The focus of this strategy is land use and key infrastructure. The PDNH contributes to Directions 2031, particularly in relation to creating a more compact city that maximises the efficiencies of road infrastructure, while mitigating and reducing road congestion (WAPC, 2010 cited in MRWA, 2013a).



2.5 Other Actions Taken or Approved in the Region Affected by the Proposal

2.5.1 Tonkin Highway Grade Separations Project (TGS)

Tonkin Highway will be upgraded between Collier Road and Reid Highway through a series of grade-separated intersections and widening of the highway. Grade separations will occur at Collier Road, Morley Drive and Benara Road. TGS connects directly to the southern extent of the proposal and consists of the following key elements:

- Upgrading Tonkin Highway between Collier Road (north of Guilford Road) and Benara Road (south of Reid Highway) to six lanes (three in each direction).
- Construction of a single-point grade separated interchange at Collier Road including associated realignment of Collier Road and modifications to local road accesses.
- Construction of a grade separated roundabout interchange at Morley Drive including associated local road modifications.
- Grade separation of Benara Road to accommodate a flyover at Tonkin Highway.

TGS is currently under environmental assessment by DOTE and DER. Construction is expected to commence in early 2016.

2.5.2 Reid Highway/Malaga Drive Interchange

The existing at-grade intersection of Reid Highway and Malaga Drive is being upgraded to a grade separated interchange. Construction commenced in May 2015 and will be completed in 2016. This interchange is immediately west of the Reid Highway/Tonkin Highway interchange of this proposal.

2.5.3 East Wanneroo North–South Route

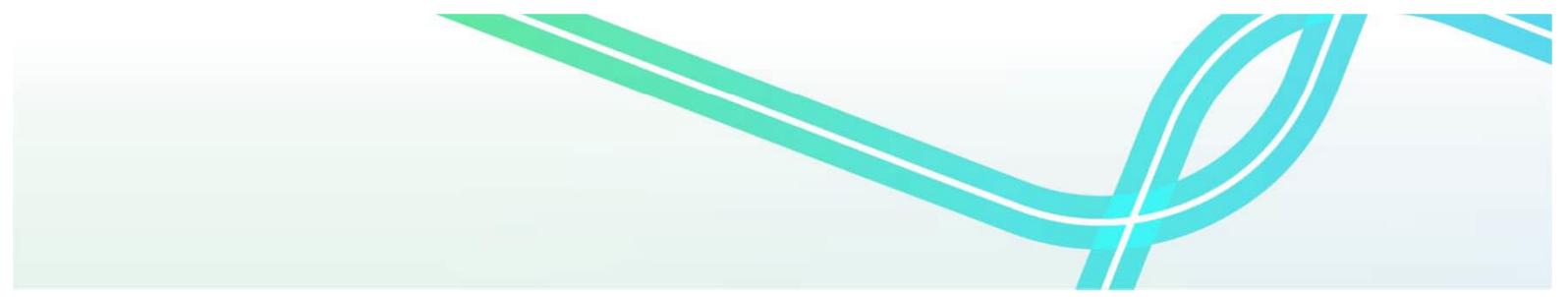
An EWNSR (to be referred to as the Whiteman to Yanchep Highway in future) is planned to connect to the PDNH immediately south of Gngara Road and will extend to Yanchep in the north, with the alignment north of Neaves Road still to be selected.

2.5.4 Muchea Employment Node

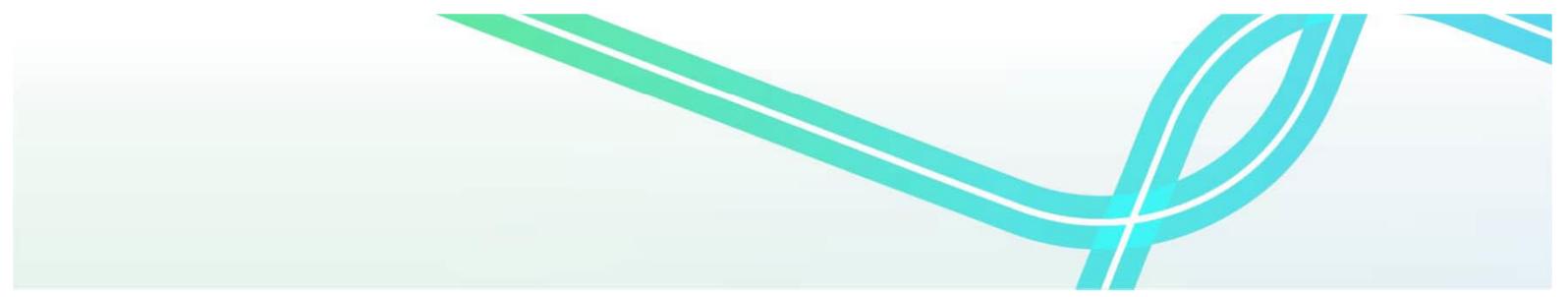
The Muchea employment node is located at the intersection of the Brand Highway and Great Northern Highway, and is an area of 1,113 ha set aside for service-based uses such as transport, livestock, fabrication, warehousing, wholesaling and general commercial use. The node is located approximately 2 km east of the Muchea town centre in the Shire of Chittering.

New development in the employment node will provide a concentration of employment opportunities for people living in and around the Shire of Chittering. Great Northern Highway and Muchea East Road divide the structure plan area into precincts.

The node was recognised as having potential as an industrial area that could take advantage of long-term transport opportunities offered by the proposed PDNH.



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3 ROUTE SELECTION DEVELOPMENT

3.1 PDNH Termination Studies

Various studies have been undertaken since 1991 to identify the route alignment for the PDNH. Several environmental assessments were undertaken as part of these studies and considered during the selection of preferred alignments.

The PDNH Termination Study – Stage 1 Report (by Travers Morgan Pty Ltd, Feilman Planning Consultants, Cossil and Webley in 1991) (MRWA, 2012b) examined a number of route options between Reid Highway and Muchea. Five route options were considered: one along the existing Great Northern Highway, two options to the west of Great Northern Highway and two options to the east of Great Northern Highway. From these, two preferred options were short listed, namely the route along the existing Great Northern Highway and a route to the east of it (MRWA, 2012b).

A northward extension of Tonkin Highway to the west of Whiteman Park and connecting to the western routes was also considered as part of the 1991 study. However, this extension was not short listed at the time as the western routes were not expected to attract sufficient traffic and construction costs were deemed to be prohibitive due to its location over the Gngangara Mound. In addition, the routes to the west would likely restrict access to Whiteman Park.

Public comment and opinion, however, was that a route further west of the Swan Valley should be investigated and the extension of Tonkin Highway from Reid Highway to Muchea was again considered in 1992. As part of this investigation, three route options were considered north of Gngangara Road (Figure 3.1):

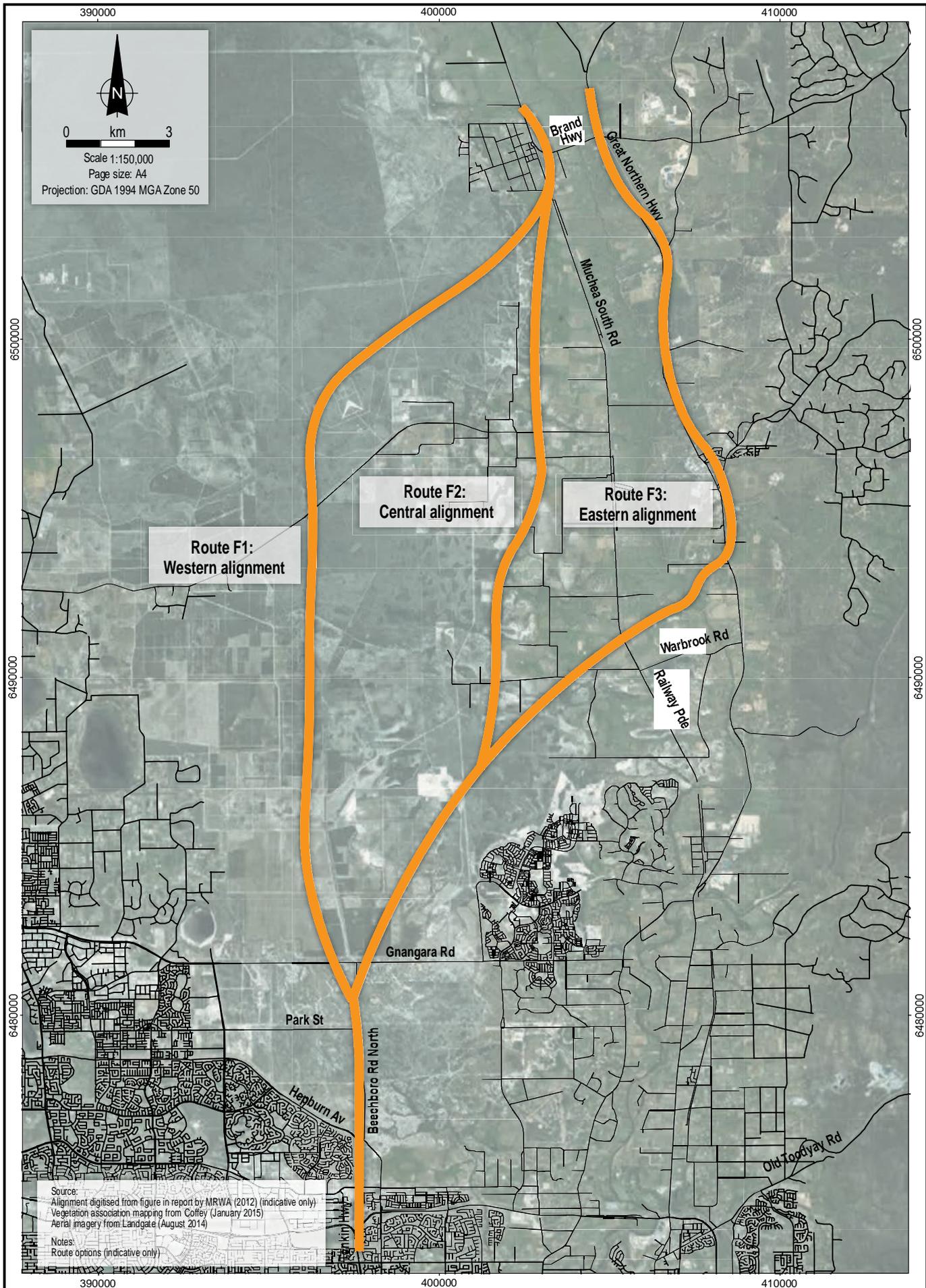
- Route F1 – A western alignment extending north from Tonkin Highway and turning east to join Brand Highway immediately south of Muchea.
- Route F2 – A central alignment that runs northeast from Gngangara Road, turning north to the west of Bullsbrook and joining Brand Highway at the same location as the western alignment.
- Route F3 – An eastern alignment that follows the central alignment from Gngangara Road but continues northeast, crossing the Midland–Geraldton railway and connecting to the existing Great Northern Highway at Bullsbrook.

A number of constraints were identified during the 1992 study, including the Dampier to Bunbury Natural Gas Pipeline, power line infrastructure, Gngangara Geophysical Observatory, Gngangara Priority 1 groundwater resource, Aboriginal heritage sites and Bush Forever sites, vegetation and surface drainage.

All three routes in the 1992 study were considered to be preferable to those previously considered, with the eastern alignment deemed to have the least impact on the above constraints. Route F2 relates closely to the general alignment of the current proposal.

In 1994, the PDNH Termination Study – Stage 2 Final Report by BSD Consultants Pty Ltd (MRWA, 2012b) was completed. Four base options were identified:

- An extension of Tonkin Highway from Reid Highway to Brand Highway in the vicinity of Muchea.
- An extension of Tonkin Highway from Reid Highway across to Great Northern Highway south of Bullsbrook, then following Great Northern Highway to Muchea.



- 
- An extension of Lord Street from Reid Highway across to Great Northern Highway south of Bullsbrook, then following the existing Great Northern Highway to Muchea.
 - An upgrade of the existing Great Northern Highway.

Seven possible route options were developed from the base options. An alignment along Lord Street and Drumpellier Drive, between Reid Highway and Maralla Road in Ellenbrook, was selected as the preferred route and was included in the Metropolitan Region Scheme (MRS) (MRWA, 2012b). This portion of the alignment is indicated in red in Option A on Figure 3.4. This decision was subsequently reviewed and amended (discussed later in Section 3.3).

3.2 PDNH – Maralla Road to Muchea

3.2.1 Alignment Selection

In December 2000 an Alignment Selection Study Report by Sinclair Knight Merz (SKM) investigated several options to enable a 500 m highway corridor to be selected between Maralla Road and a point north of Muchea (SKM, 2000). Six options were considered (Figure 3.2) with two options (Option B and Option C) shortlisted for further evaluation using a multi-criteria assessment process. The alignment options considered included:

- Option A – Far Outer Option.
- Option B – Outer Bullsbrook.
- Option C – Inner Bullsbrook.
- Option D – Inner/Outer Bullsbrook.
- Option E – Railway Parade.
- Option F – RAAF Pearce.

As discussed by SKM (2000), criteria used in the process included engineering considerations (topographical, ground conditions, utilities), flora and fauna, conservation estate, wetlands, Bush Forever sites, groundwater environmental management areas and economic aspects.

Option A, the most western route, traversed the Gngangara–Moore River State Forest before crossing the railway line just to the south of Muchea before turning northwest and rejoining Great Northern Highway south of Muchea East Road. The route was located partly over the Gngangara Mound water catchment area and impacted on significant areas of remnant vegetation, particularly Bush Forever Site 97, north of Neaves Road. This option was longer compared to the others and the additional travel distance did not satisfy the objective of minimising travel times and costs.

Option B was located approximately two kilometres to the east of Option A and extended along the outer edge of the palusplain in the drier parts of the Bassendean Sands area. This option was considered to be relatively short with lower construction costs as it avoided the waterlogged palusplain area. However, the route would affect a large number of properties and bridges that required construction at an angle and would have a higher cost and greater environmental impact.

Option C crossed a section of land managed by the Department of Defence (DOD) (known at the time as 3TU) and extended north to just south of Neaves Road and then turned northeast to join the existing Great Northern Highway north of Bullsbrook. As this option was located within the palusplain area, it would require high volumes of imported fill with higher associated construction costs. Furthermore, it would require management of traffic noise to avoid impacting on residential areas and would impact on wetlands in the area north of Maralla Road.



Option D was located along the western side of the railway line between Cunningham Road and Rutland Road, from where it turned northwest to join Option B just east of the State Forest. The route provided a relatively direct alignment for freight traffic for the northern part of the corridor, but had reasonably high costs of construction as a result of being located on the palusplain. As per Option B, construction costs associated with bridge crossings would be costly and have a greater environmental impact.

The route for Option E was similar to that of Option D, but extended along Railway Parade until approximately 3 km south of Muchea, before turning northeast to join Great Northern Highway. The route was relatively short, but impacted a large number of properties. In addition, it was considered to have adverse noise and social impacts, with a 200 m noise buffer recommended at the time. Construction of the route was determined to be costly, requiring grade separations to accommodate the existing highway and raising the level of Railway Parade to avoid seasonal waterlogging on the palusplain.

Option F was located approximately 500 m to the east of Railway Parade, between RAAF Pearce and West Bullsbrook. The route allowed for a relatively short and direct alignment, and expansion of West Bullsbrook in a westerly direction. It required construction in the waterlogged palusplain with associated high costs, as well as higher costs of construction of railway crossings at an angle. At the time, buffers for noise levels in West Bullsbrook could not be met and the route may have impacted RAAF Pearce operations.

Option B and Option C were shortlisted for further assessment through a multi criteria assessment process. Option B was preferred from a transport and engineering perspective. Neither option presented a clear advantage from an environmental perspective. Option C was preferred from an urban design perspective as it demonstrated greater flexibility to accommodate future land use planning. It further provided better integration with broader land use structure planning and was selected as the preferred option.

3.2.2 Alignment Definition

The Government of Western Australia endorsed the preferred 500 m wide corridor between Maralla Road and Muchea in January 2002. An alignment definition study was commenced in December 2003 to develop a planning design concept and a more precise road reservation based on Option C between Maralla Road and Calingiri Road at Muchea. The study included detailed environmental and heritage investigations and consultation with key stakeholders, landowners and the community (MRWA, 2012a).

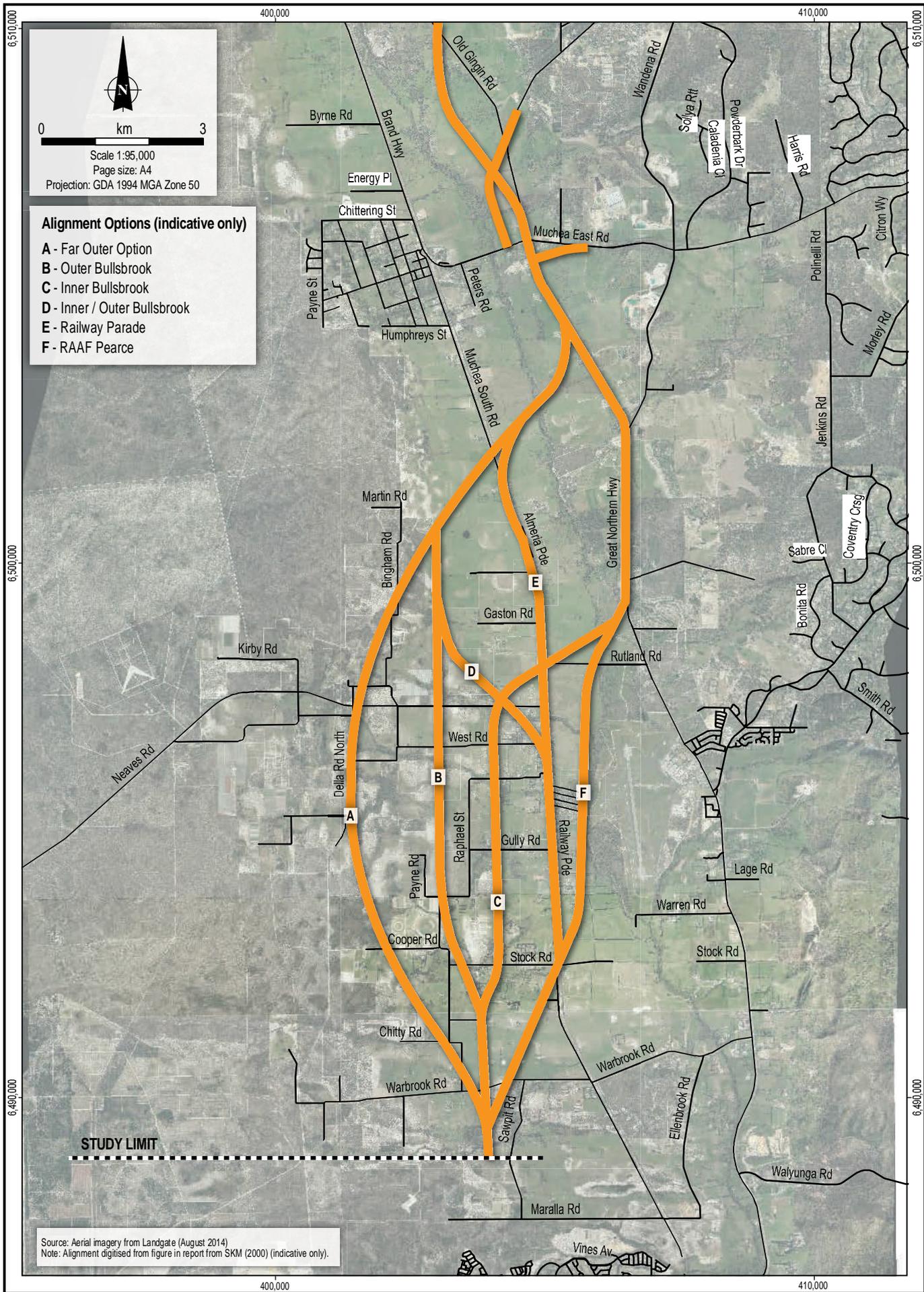
As part of the alignment definition study, an assessment of potential physical constraints on the alignment was undertaken and included topography, development, major infrastructure, DOD facilities, watercourses, wetlands, rare flora, indigenous and non-indigenous heritage sites (GHD, 2010).

In defining the alignment, impacts on the following were avoided where possible or minimised:

- Wetlands, Bush Forever sites, rare flora and trees.
- Indigenous and non-indigenous heritage sites.
- Property severance, access and water supply.

A preferred concept and reservation for the section between Maralla Road and Muchea was developed. This provided for a four-lane highway standard road within a nominal 100 m wide road reservation with potential interchanges at Warbrook Road, Neaves Road and Muchea. Provision was made for a rapid transit public transport route in the central median, drainage basins and a cycle/pedestrian facility.

Based on investigations as part of the alignment definition study, the concept alignment for the PDNH was revised to include the following key modifications:



- The DOD, which controls land owned by the Commonwealth Government south of Neaves Road, requested that an alignment further to the east be considered to minimise impact to its property. In response, an alignment along the eastern boundary of DOD land was developed that abuts Raphael Road, a shift of approximately 600 m east of the original alignment (GHD, 2013a).
- A minor westward shift of the alignment at the southern section of the DOD land to minimise impacts on an environmentally sensitive conservation category wetland at Raphael Road (WAPC, 2012) (Figure 3.3).
- Relocation of the proposed interchange at Warbrook Road to Stock Road following consultation with the City of Swan and the Department of Environment and Conservation (DEC). The DEC had at the time, indicated a preference for the interchange to be located at Stock Road to avoid any potential impacts on Twin Swamps Nature Reserve, which is covered by the Environmental Protection (Western Swamp Tortoise Habitat) Policy (GHD, 2013a).
- An eastward shift of the alignment at Gaston Road and north of Neaves Road to avoid hydrological impacts to the Mound Springs Swan Coastal Plain (SCP) Threatened Ecological Community (TEC) in the vicinity of Bingham and Gaston Roads. This shift to the east provided a 100 m buffer between the TEC and the highway reserve and would ensure that the TEC remained upstream of the PDNH (GHD, 2010).
- Realignment and reconfiguration of the interchange of the PDNH alignment, Brand Highway and Great Northern Highway at Muchea to optimise access to Muchea (WAPC, 2012).

The preferred concept and reservation (see Figure 3.3) was incorporated in the MRS by the WAPC in 2012.

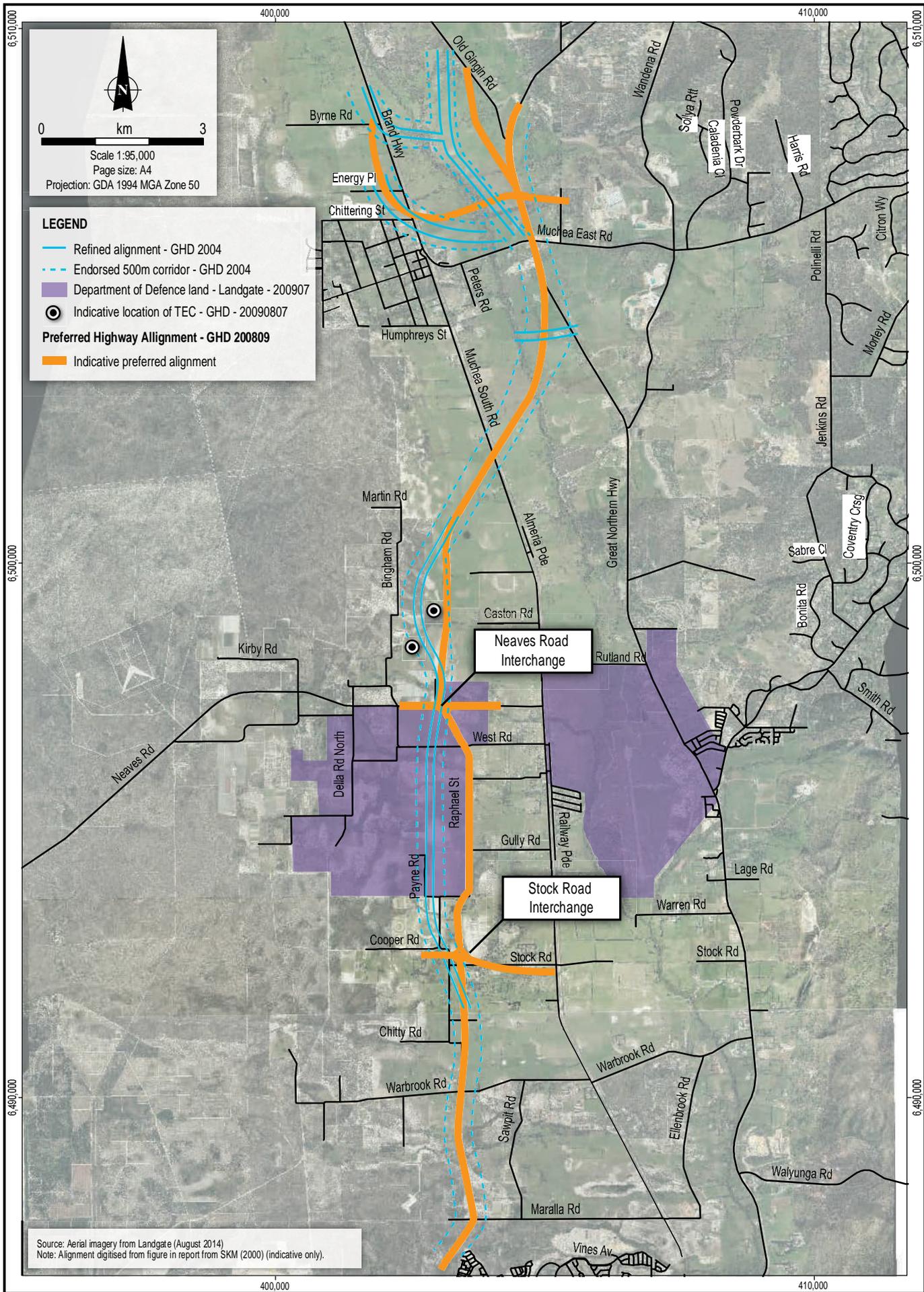
3.3 PDNH – Reid Highway to Maralla Road

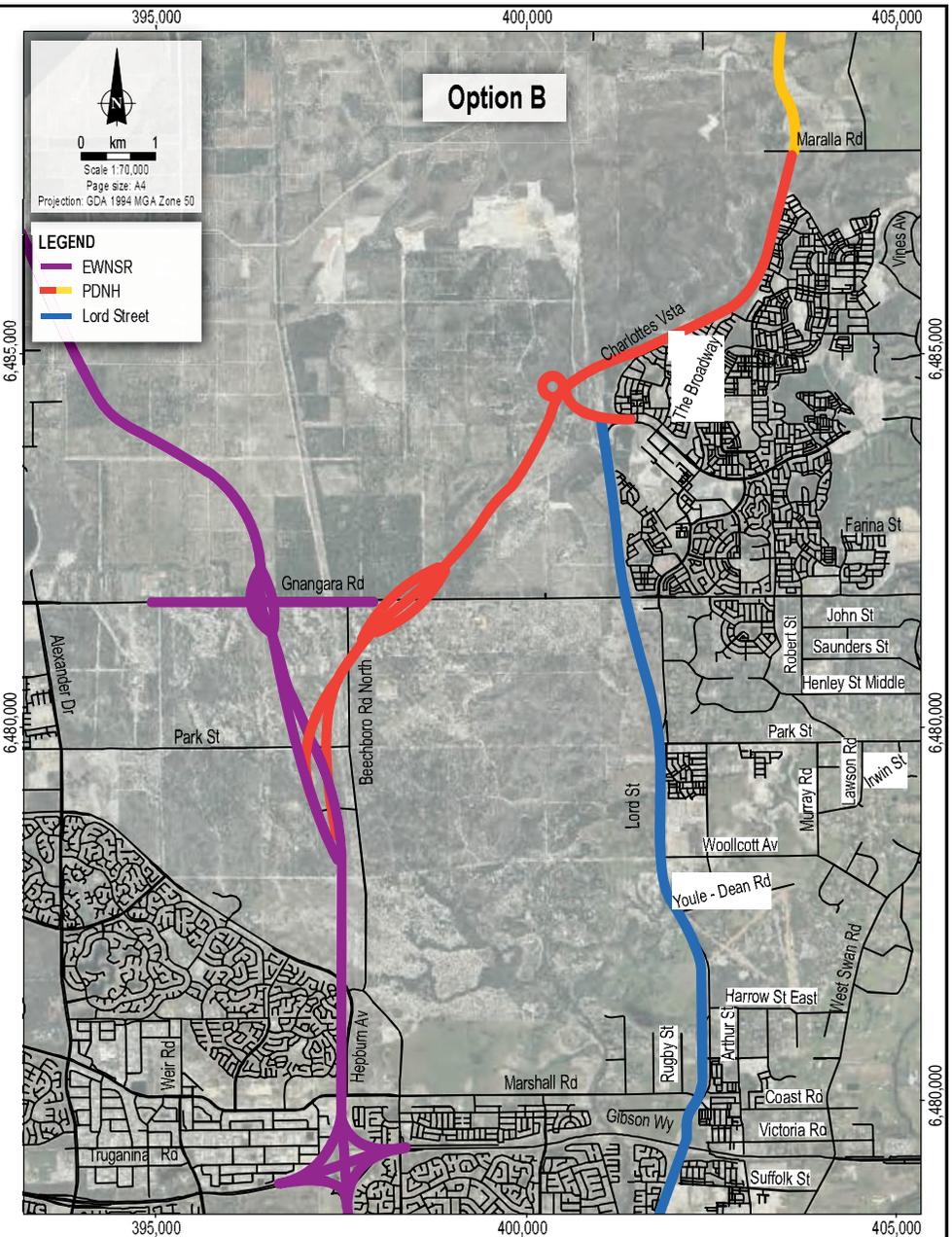
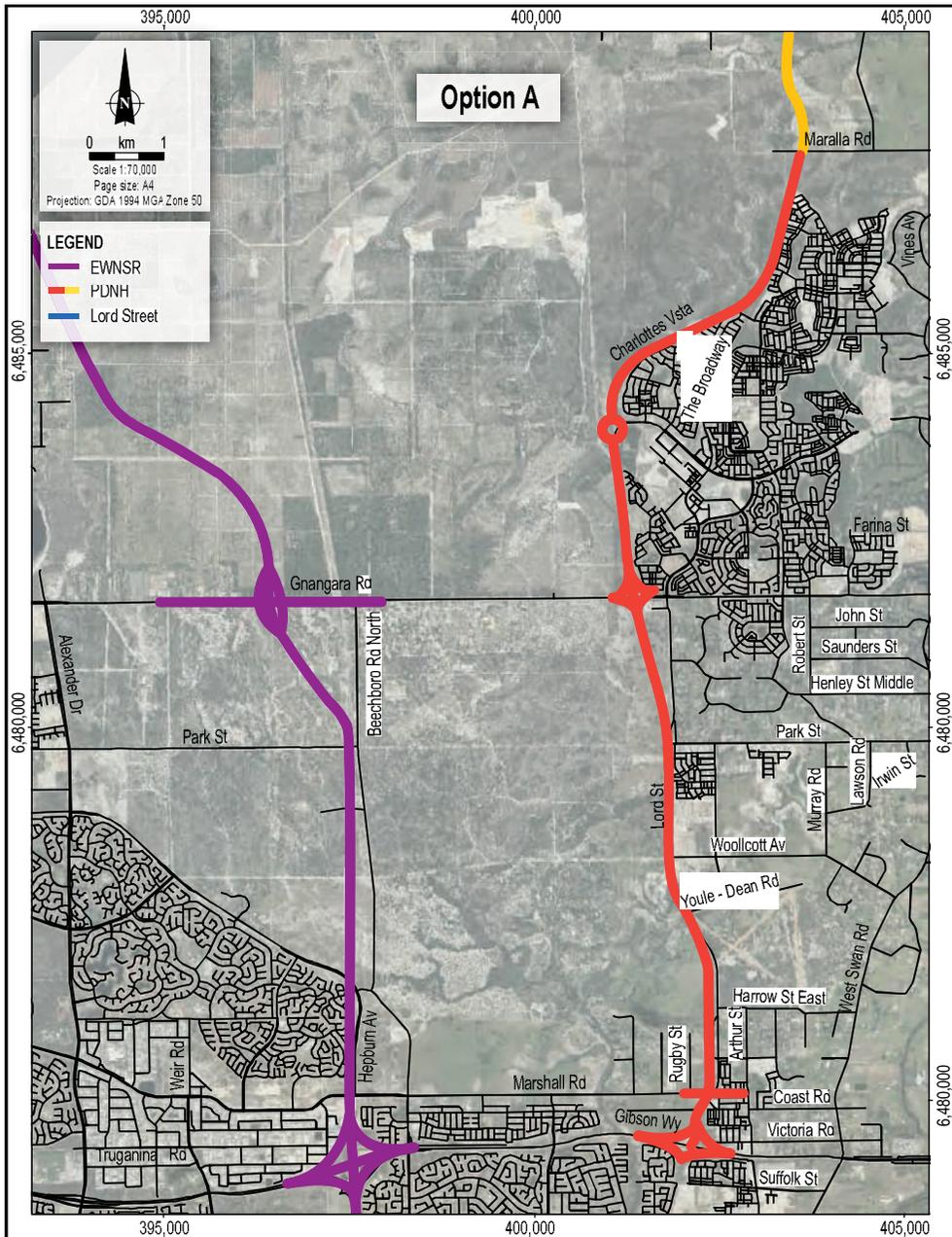
A strategic road network review was conducted by MRWA in 2012 (MRWA, 2012b) to confirm the route alignment and network configuration for the PDNH between Reid Highway and Maralla Road. The review considered environmental, social, heritage and land use constraints as well as strategic planning considerations for the area.

One key aspect considered was a separate regional road proposed to run along the western edge of the Gngangara Priority 1 Underground Water Pollution Control Area (UWPCA). This proposal, known as the EWNSR, provided an opportunity to consider a more direct connection of the PDNH to Tonkin Highway.

Three network options for this section of the PDNH were therefore considered (see Figure 3.4):

- Option A, which included the approved alignment (as endorsed by the WAPC) for the EWNSR proposal and the PDNH alignment along Drumpellier Drive and Lord Street. North of Gngangara Road the existing Drumpellier Drive was proposed to be replaced by the PDNH. Under the proposed option, PDNH would replace sections of Lord Street between Reid Highway and Gngangara Road and the existing Lord Street would become a discontinuous local road.
- Option B, which included the route alignment for the EWNSR and a western PDNH alignment running southwest to northeast on the western edge of Ellenbrook. The PDNH alignment would connect to the EWNSR south of Gngangara Road and then link with Tonkin Highway. Drumpellier Drive and Lord Street were included as four-lane local arterial roads to provide north–south connectivity to Reid Highway. Lord Street would continue south of Reid Highway as a two-lane road.
- Option B1, which was a modification of Option B, where Drumpellier Drive and Lord Street are two-lane local roads rather than four-lane local arterials.





Source: Imagery from Google Earth.
 Note: Alignment digitised from figure in report from MRWA (2012b) (indicative only).



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Main Roads WA
 Public Environmental Review
 Perth-Darwin National Highway



Indicative alignment options
 considered from Reid Highway
 to Maralla Road

Illustration No. 3.4



An environmental constraints assessment undertaken on the three options identified the following issues to be considered:

- Options B and B1 will require approximately 8 km of additional highway across the Gngangara Priority 1 Underground Water Pollution Control Area.
- Options B and B1 would increase the potential impact on a Conservation Category Wetland in Cullacabardee that is already impacted by the EWNSR, while Option A would impact on a large area of Multiple Use Wetlands south of Gngangara Road.
- Option A would impact on fewer Bush Forever sites between Reid Highway and Ellenbrook.
- All of the network options impact on a TEC north of the suburb of Ellenbrook.
- Options B and B1 would impact on the eastern portion of the Gngangara State Forest.

Modelling undertaken on these options indicated that there was a strong demand for a more direct link between the PDNH and Tonkin Highway and that Option B would provide significant transport benefits including:

- Providing a more functional transport network.
- Functioning as a more effective transport link with approximately 84% of freight traffic travelling on the PDNH north of Ellenbrook using the proposed link to Tonkin Highway.
- Improved integration with key highway infrastructure, linking to important industrial areas in Kewdale/Welshpool area.
- Having less social impact on existing and future residential areas.
- Requiring less capital expenditure.
- Achieving the lowest operating cost (MRWA, 2013a).

3.4 MRS Referral Boundary

The road reservation included in the MRS was based on the various definition studies discussed above and consisted of a corridor approximately 100 m wide and 40 km long, covering an area of approximately 963 ha.

This boundary formed the basis of the environmental referral submitted to the EPA in October 2013. Following the referral, proposal definition has led to sections of the alignment extending outside this reservation. The current development envelope therefore varies from the boundary nominated in the referral, encompassing the existing MRS road reservation as well as future proposed amendments to the MRS to allow for the construction of this proposal.

3.5 No Build Option

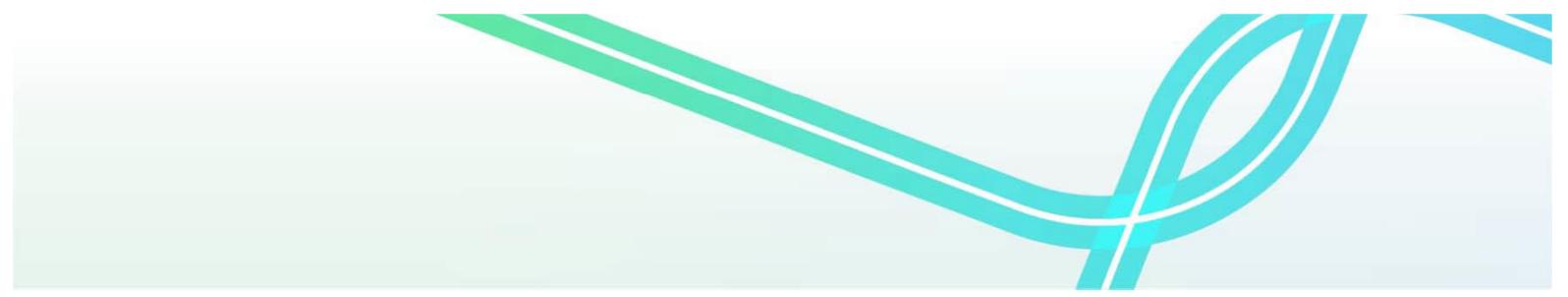
The option of not proceeding considers the consequences if the proposal is not constructed. The key consequences include:

- Lack of key transport infrastructure to support energy and resource projects in the northwest of WA to remain competitive in the global marketplace. The Australian National Land Freight Network was developed to maximise Australia's international competitiveness and consists of a network of freight corridors to the major seaports, airports and freight generating regions. The northwest of WA is the



largest single freight generating region in Australia, contributing approximately six per cent to Australia's total GDP (NLWA, 2015a).

- Separation of freight and local traffic will enhance the whole road network's safety and social amenity, which is consistent with State and metropolitan priorities and planning directions. Not proceeding with the proposal will preclude these safety and amenity benefits.
- Increasing already unacceptable congestion levels and crash statistics in the region as a result of expected traffic growth in both freight and passenger vehicles.



4 DETAILED DESCRIPTION OF PROPOSAL

4.1 Key Proposal Components

The subject of this PER is the UPDC for a new section of the PDNH between Reid Highway and Muchea. The UPDC has been sufficiently defined to describe the ultimate design of the proposal when completed. However, construction is likely to be undertaken in several stages, with the first 'design and construct' tenders being called for in 2016 or 2017. The exact staging has not yet been determined, though it will be influenced by a number of factors including government priorities, funding availability, urban growth and traffic demand.

The proposal as defined in the UPDC includes the following key components:

- Approximately 38 km of new dual carriage road.
- Grade separated interchanges with key existing roads.
- Bridges and culverts.
- Water retention basins and other drainage structures.
- A PSP within the road reservation.
- A road train assembly area (RTAA).
- A traveller's rest area.
- Landscaping and revegetation works.
- Modifications to local roads.

This PER assesses the environmental impact of the works associated with construction and operation of the proposal. Activities that generally form part of the construction phase include:

- Vegetation removal and topsoil stripping.
- Earthworks.
- Excavation of road cuttings.
- Placement of fill, compaction and embankment foundations.
- Piling and construction foundations.
- Overpass construction.
- Stormwater drainage installation.
- Pavement construction.
- Road surfacing.
- Culvert supply and installation.
- Installation of associated road furniture.
- Relocation of services.
- Modifications to local roads.

- 
- Construction of drainage basins.
 - Construction of a PSP.
 - Construction of noise and visual screen walls.
 - Use of water for construction purposes (likely to be from existing bores).
 - Traffic management.

More detail on each of the proposal components is provided in the sections below.

4.2 Route Alignment

4.2.1 Overview of Alignment

Approximately 38 km of new dual carriage road will be constructed along an alignment between Malaga and Muchea. Starting at the intersection of Tonkin Highway and Reid Highway, the road will travel north on a new alignment west of Beechboro Road through Cullacabardee. The road will turn to the northeast to pass through the northwest corner of Whiteman Park before crossing Gnangara Road and entering the Gnangara–Moore River State Forest. The road will travel through an existing road reservation forming the western boundary of Ellenbrook, turning north at Maralla Road. The alignment will then run parallel to and about 500 m west of Railway Parade as it passes through Bullsbrook, before turning northeast again to cross Railway Parade and the Midland–Geraldton railway line. South of Muchea, the road will cross Ellen Brook and join the existing Great Northern Highway at the approximate location of the existing Brand Highway and Great Northern Highway intersection (Figure 4.1).

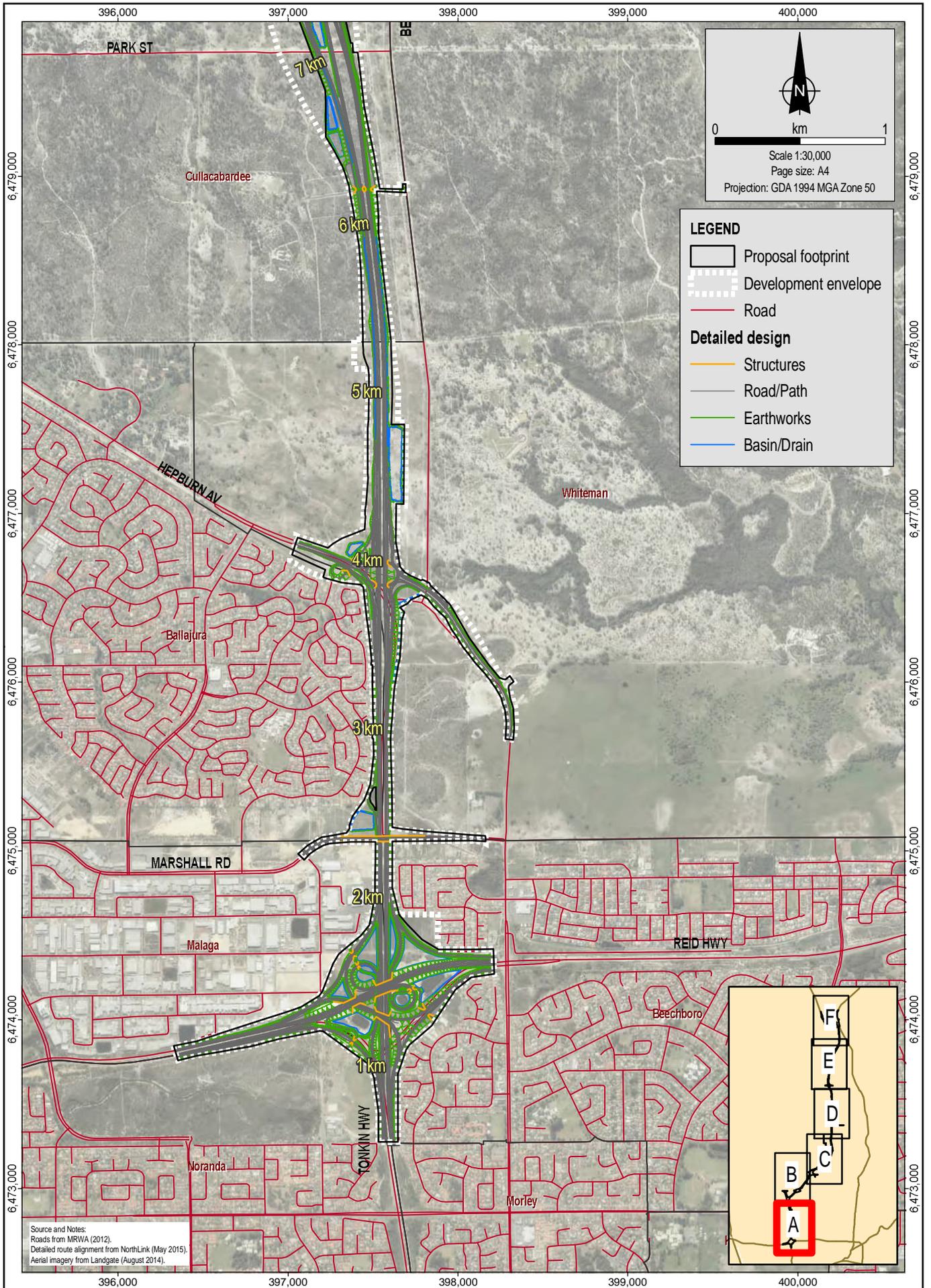
In areas of flatter terrain (e.g. north of Maralla Road), the PDNH will be built up to a height of about 1 to 2 m above the surrounding landscape. Cuttings and embankments will be required in undulating areas (e.g. around Ellenbrook). North of Maralla Road, initial construction will allow for a single carriageway with at grade intersections. The UPDC will include a dual carriageway and grade separated interchanges.

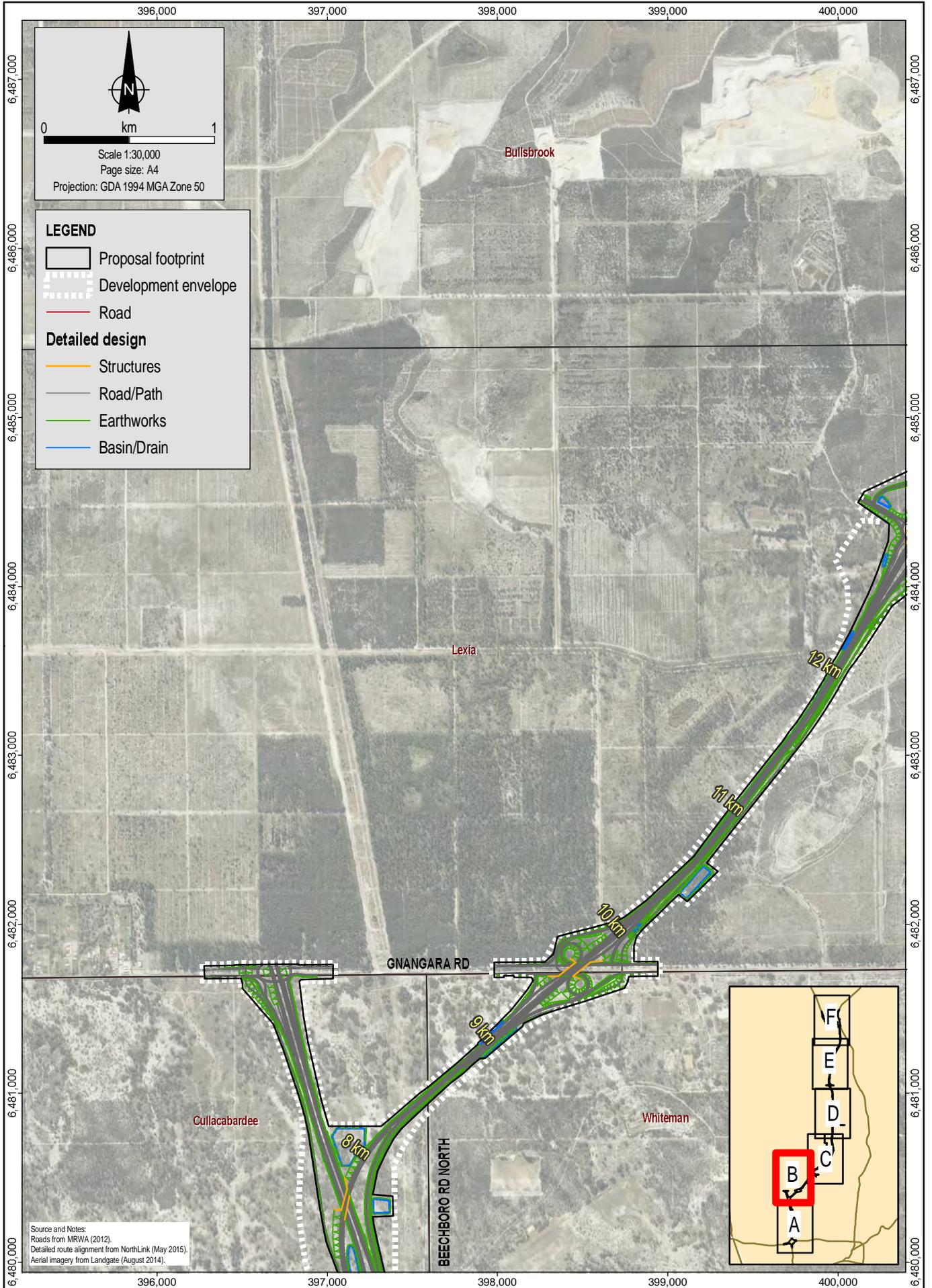
The number of traffic lanes included in the road design varies from four in each direction between Tonkin Highway/Reid Highway and Hepburn Avenue to two in each direction at the Muchea end. The final width of the road reserve will be up to approximately 100 m. The road reservation widens locally at interchanges and where additional features such as storm water retention basins are required.

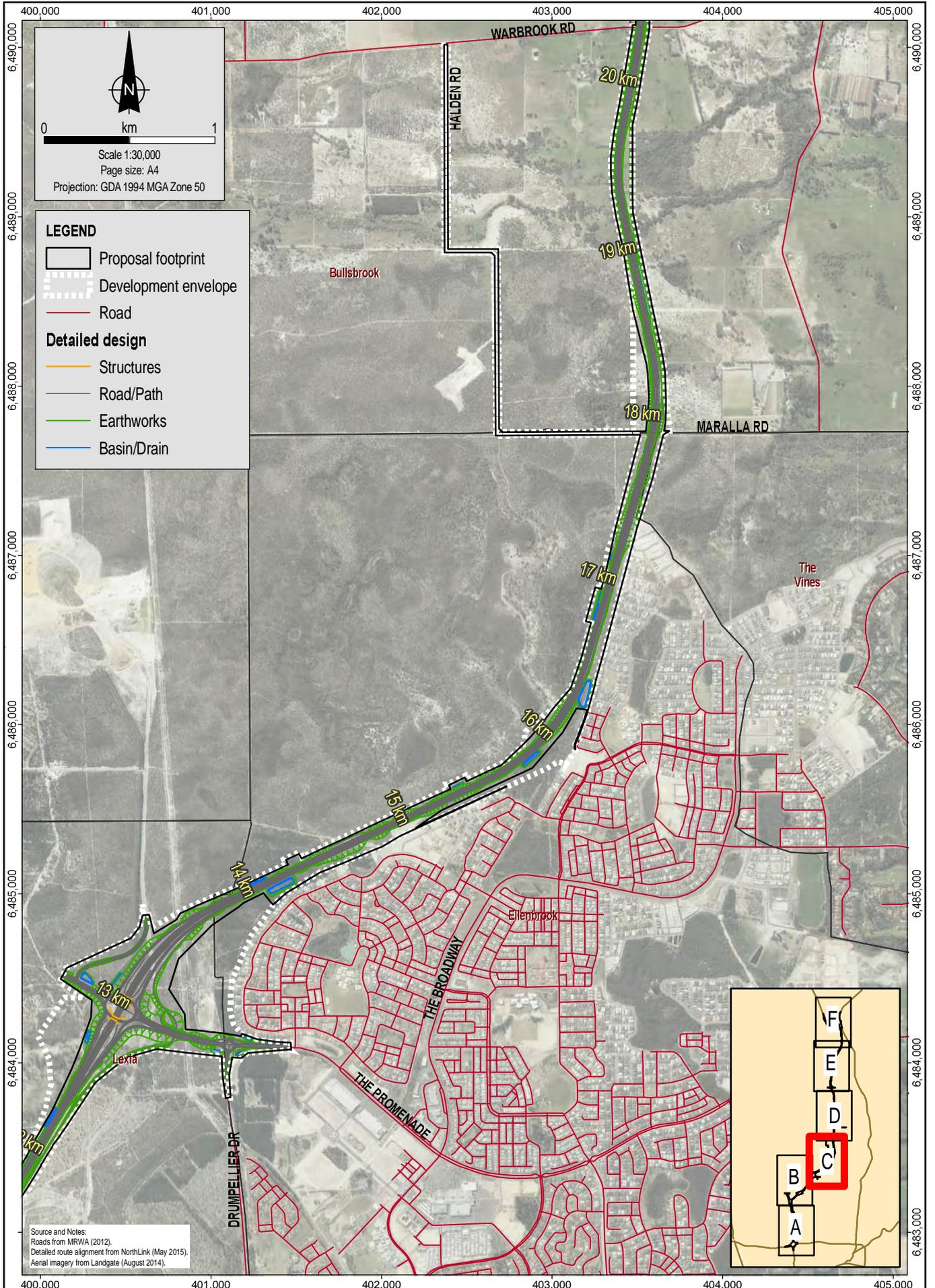
Between Tonkin Highway/Reid Highway in Malaga and Gnangara Road, a reservation of 16 m will be retained in the central median for a future dual track passenger railway. A similar reservation is intended for the future EWNSR and, accordingly, the PDNH–EWNSR interchange design makes an allowance for this. Neither railway forms part of this proposal.

In addition to the road and the central median, the final road reservation will accommodate the PSP, noise walls, landscaping and associated earthworks to support the proposal. Figure 4.2 shows a conceptual cross-section of these components.

The final proposal footprint is expected to be approximately 746 ha.







0 1 km

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Projection: GDA 1994 MGA Zone 50

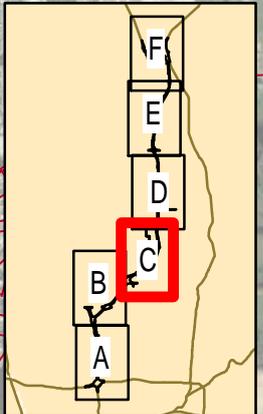
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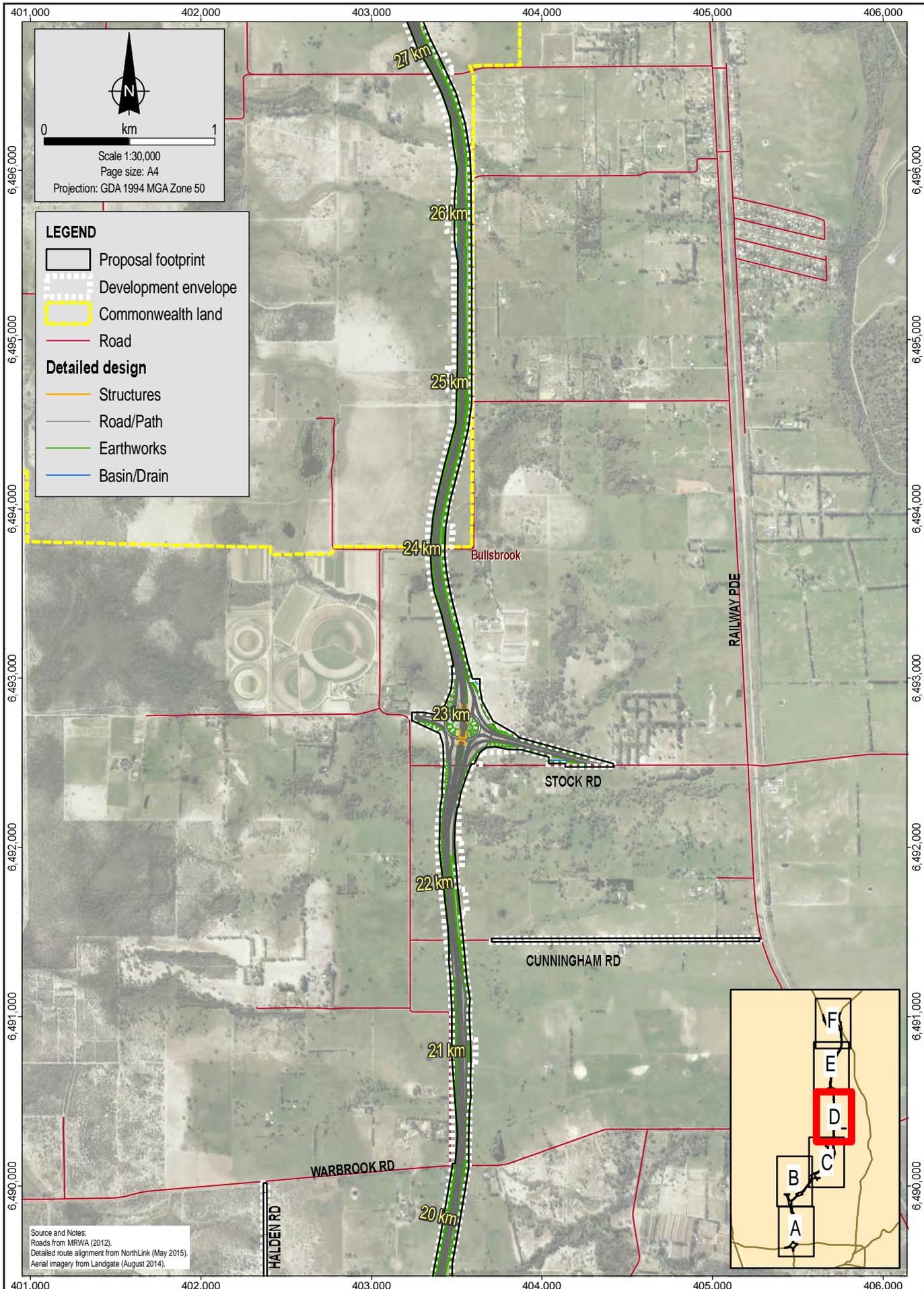
- Proposal footprint
- Development envelope
- Road

Detailed design

- Structures
- Road/Path
- Earthworks
- Basin/Drain

Source and Notes:
Roads from MRWA (2012).
Detailed route alignment from NorthLink (May 2015).
Aerial imagery from Landgate (August 2014).





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Projection: GDA 1994 MGA Zone 50

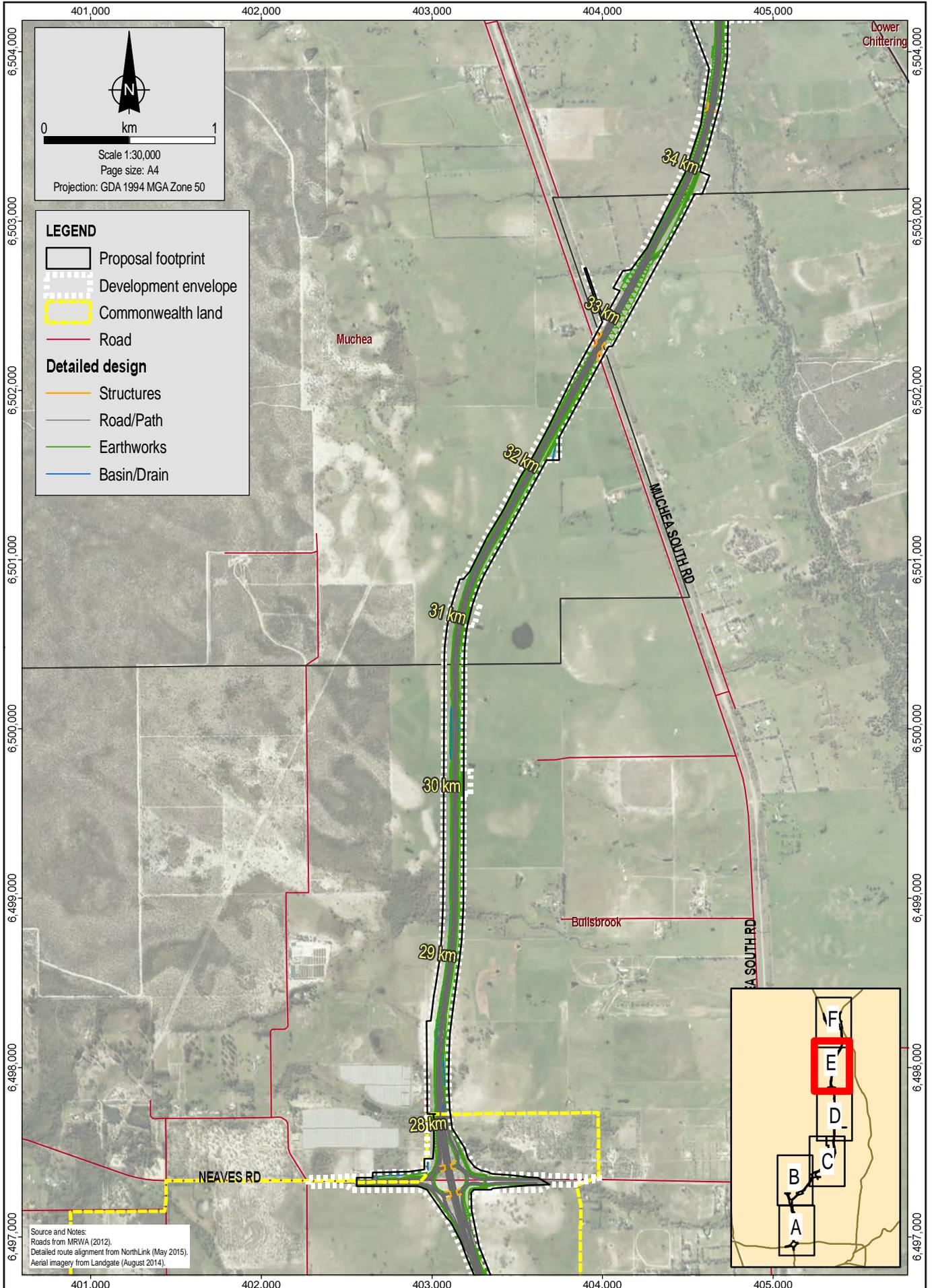
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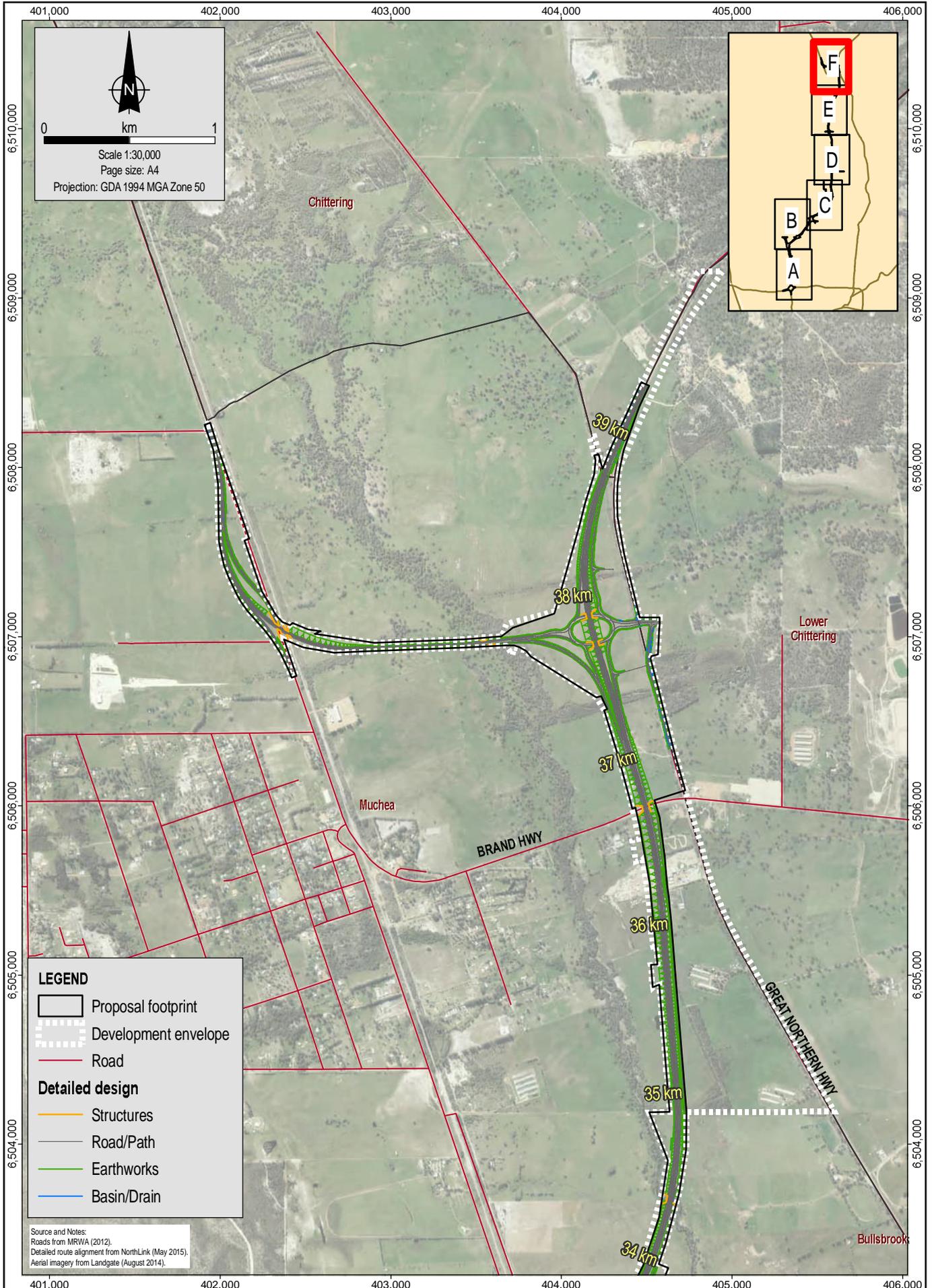
- Proposal footprint
- Development envelope
- Commonwealth land
- Road

Detailed design

- Structures
- Road/Path
- Earthworks
- Basin/Drain

Source and Notes:
Roads from MRWA (2012).
Detailed route alignment from NorthLink (May 2015).
Aerial imagery from Landgate (August 2014).







4.2.2 Alignment Changes Since Referral to Regulators

The UPDC was developed within the nominal 100 m wide road reservation (original development envelope) that formed the basis of the referral under the EPBC Act to the DOTE on 31 October 2013 (EPBC 2013/7042) and the referral to the EPA under Section 38 of the EP Act (Part IV) on 25 October 2013. This referral boundary is shown in Figure 4.3.

However, in a number of places the UPDC has resulted in the proposal being larger than the referral boundary (see Figure 4.3) in order to optimise the design. This has resulted in a redefinition of the development envelope. The additional areas required are described in Table 4.1.

The additional areas outside the referral boundary were surveyed in respect of flora, fauna, wetlands and heritage, but as no other key environmental factors were identified, it was not deemed necessary to refer these changes to the DOTE or EPA. Impacts associated with any changes have been addressed within this PER.

The component of the proposal along Reid Highway (as per the referral to the EPA and DOTE) extended from just east of Malaga Drive in Malaga to Altone Road in Beechboro. The development envelope was subsequently reduced to extend from approximately 750 m east of Malaga Drive to just west of Beechboro Road. This development envelope is approximately 975 ha and wholly contains the proposal footprint of approximately 746 ha.

The section to the east of Beechboro Road has been excluded from the development envelope as it is the subject of a previous approval (Ministerial Statement 376: Extension of Reid Highway from Beechboro Road to Great Northern Highway). Any construction works associated with the proposal along this section of Reid Highway will be undertaken in line with the conditions contained in Ministerial Statement 376.

Table 4.1 Changes in development envelope

Location	Change in development envelope	Relative impact as a result of change
Tonkin Highway	Construction of PSP to the west of Tonkin Highway requires an additional 0.12 ha, largely within the road reserve for Tonkin Highway.	The area contains low value Black Cockatoo foraging or roosting habitat and no additional potential Black Cockatoo breeding trees. This change will therefore not result in any significant increase in the impact the proposal may have on the environment.
Marshall Road overbridge	Construction of road infrastructure to the west of the Marshall overbridge resulted in an increased development envelope of approximately 1.41 ha. This additional area is within the current road reserve and will only require the upgrade of existing road infrastructure.	This area is located within a Resource Enhancement Wetland, which is 34 ha in size. This change will not result in any significant increase in the impact the proposal may have on the environment.
Northwest quadrant of the Hepburn Avenue interchange	An additional 0.85 ha was necessary to provide for a drainage basin.	This area is covered by <i>Corymbia</i> sparse mid woodland and cleared areas. The area contains low value Black Cockatoo foraging or roosting habitat and no additional potential Black Cockatoo breeding trees. This change will therefore not result in any significant increase in the impact the proposal may have on the environment.
Southeast of the Hepburn Avenue Interchange (along Beechboro Road North)	Beechboro Road North will be realigned slightly in this area to avoid impacting on a wetland. In addition, a water retention basin will be constructed in this area, which resulted in an increased development envelope of approximately 3.32 ha.	The retention basin will largely be constructed over an area that is currently an existing road. The remainder of the increased development envelope is in <i>Xanthorrhoea</i> open tall shrubland in a degraded condition. The area contains low value Black Cockatoo foraging or roosting habitat and no additional potential Black Cockatoo breeding trees. This change will not result in any significant increase in the impact the proposal may have on the environment.

Location	Change in development envelope	Relative impact as a result of change
South of Baal Street	An additional 1.07 ha was required to accommodate earthworks and batters along the western side of the alignment.	<p>This area is <i>Banksia</i> sparse low woodland (BaBm²) and <i>Corymbia</i> sparse mid woodland (CcEm²). The vegetation association BaBm² supports the following priority taxa: <i>Anigozanthos humilis</i> subsp. <i>chrysanthus</i>, <i>Hypolaena robusta</i>, and <i>Millotia tenuifolia</i> var. <i>laevis</i>. CcEm² supports the taxon <i>Millotia tenuifolia</i> var. <i>laevis</i>. The additional area required will not directly impact on any known locations of priority flora. The additional area for the development envelope is not considered to be a significant increase. The assessment of impacts associated with these vegetation associations across the proposal is addressed in detail in Chapter 8.</p> <p>The area contains moderate to high value Black Cockatoo foraging or roosting habitat and one additional potential Black Cockatoo breeding tree. This was not considered to constitute a significant increase in the impact the proposal may have on the environment, and the overall impact is addressed in Chapter 9.</p>
Baal Street	Consultation with the Cullacabardee community indicated a preference for access towards Ballajura and consequently the design makes provision for an access road to be located along the western MRS boundary of the proposal. To this end, an additional 0.75 ha of land is required at Baal Street east of the alignment.	<p>This area is <i>Banksia</i> sparse low woodland (BaBm²), which supports the following priority taxa: <i>Anigozanthos humilis</i> subsp. <i>chrysanthus</i>, <i>Hypolaena robusta</i> and <i>Millotia tenuifolia</i> var. <i>laevis</i>. The additional area required will not directly impact on any known locations of priority taxa. The additional area for the development envelope is not considered to be a significant increase in the impact the proposal may have on the environment. The assessment of impacts associated with this vegetation association across the proposal is addressed in detail in Chapter 8.</p> <p>The area contains moderate value Black Cockatoo foraging or roosting habitat and fewer than five additional potential Black Cockatoo breeding trees. This was not considered to constitute a significant increase in the impact the proposal may have on the environment, and the overall impact is addressed in Chapter 9.</p>

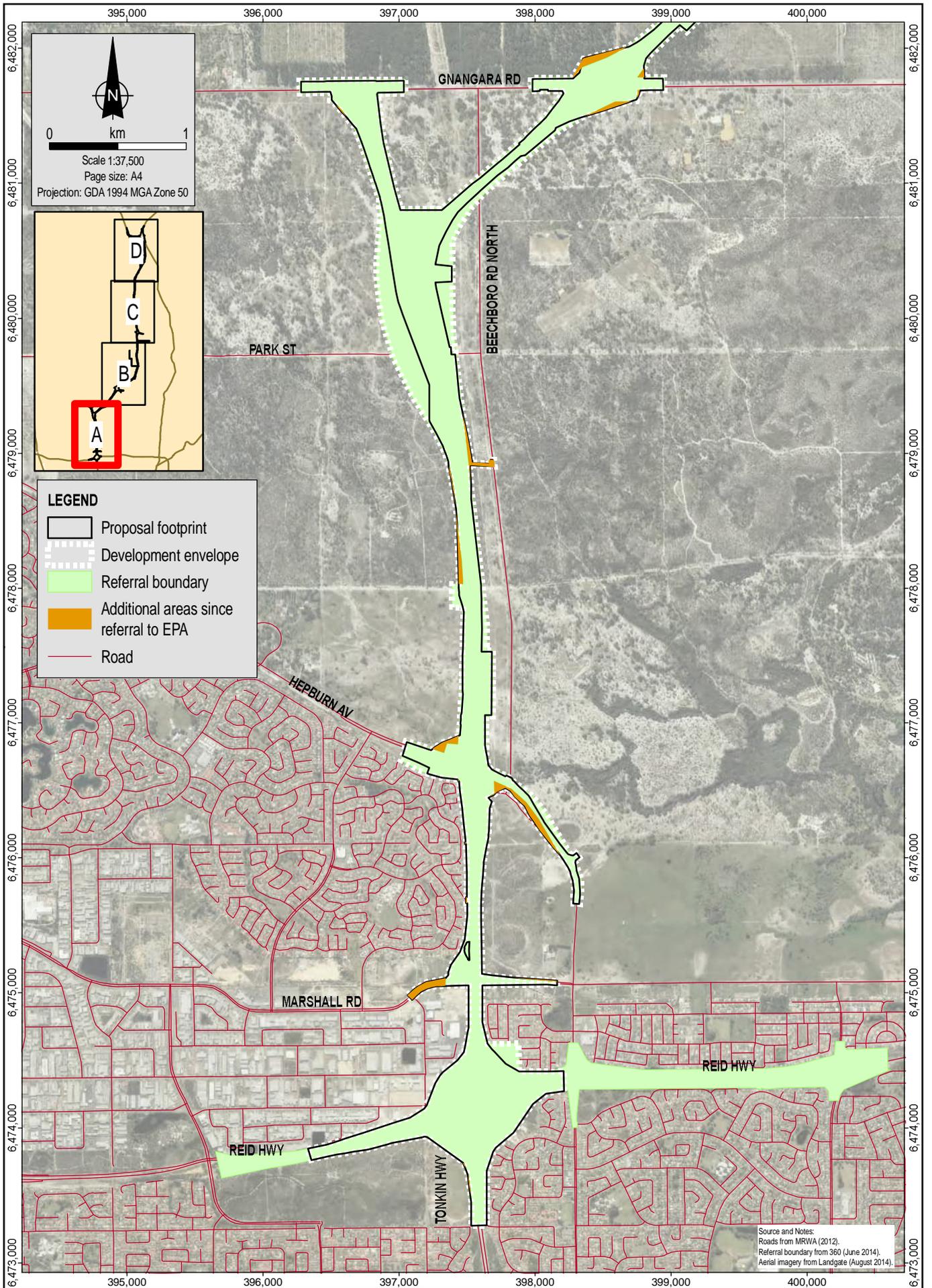
Location	Change in development envelope	Relative impact as a result of change
Gnangara Road/PDNH interchange	An additional 1.65 ha was required north of Gnangara Road, with another 0.75 ha required south of Gnangara Road as a result of the interchange design. Based on the predicted traffic volumes in 2050, an interchange configuration with a larger footprint will be required to accommodate the forecast traffic.	<p>The area north of Gnangara Road is <i>Pinus</i> mid woodland, while the area south of Gnangara Road is <i>Corymbia</i> sparse mid woodland (Cc¹). The vegetation is considered to support minimal environmental values (no threatened or priority listed taxa or ecological communities) and is in a degraded to completely degraded condition.</p> <p>This additional area north of Gnangara Road does not contain Black Cockatoo foraging or roosting habitat. The area south of Gnangara Road contains high value Black Cockatoo foraging or roosting habitat and fewer than five additional potential Black Cockatoo breeding trees. This was not considered to constitute a significant increase in the impact the proposal may have on the environment, and the overall impact is addressed in Chapter 9.</p>

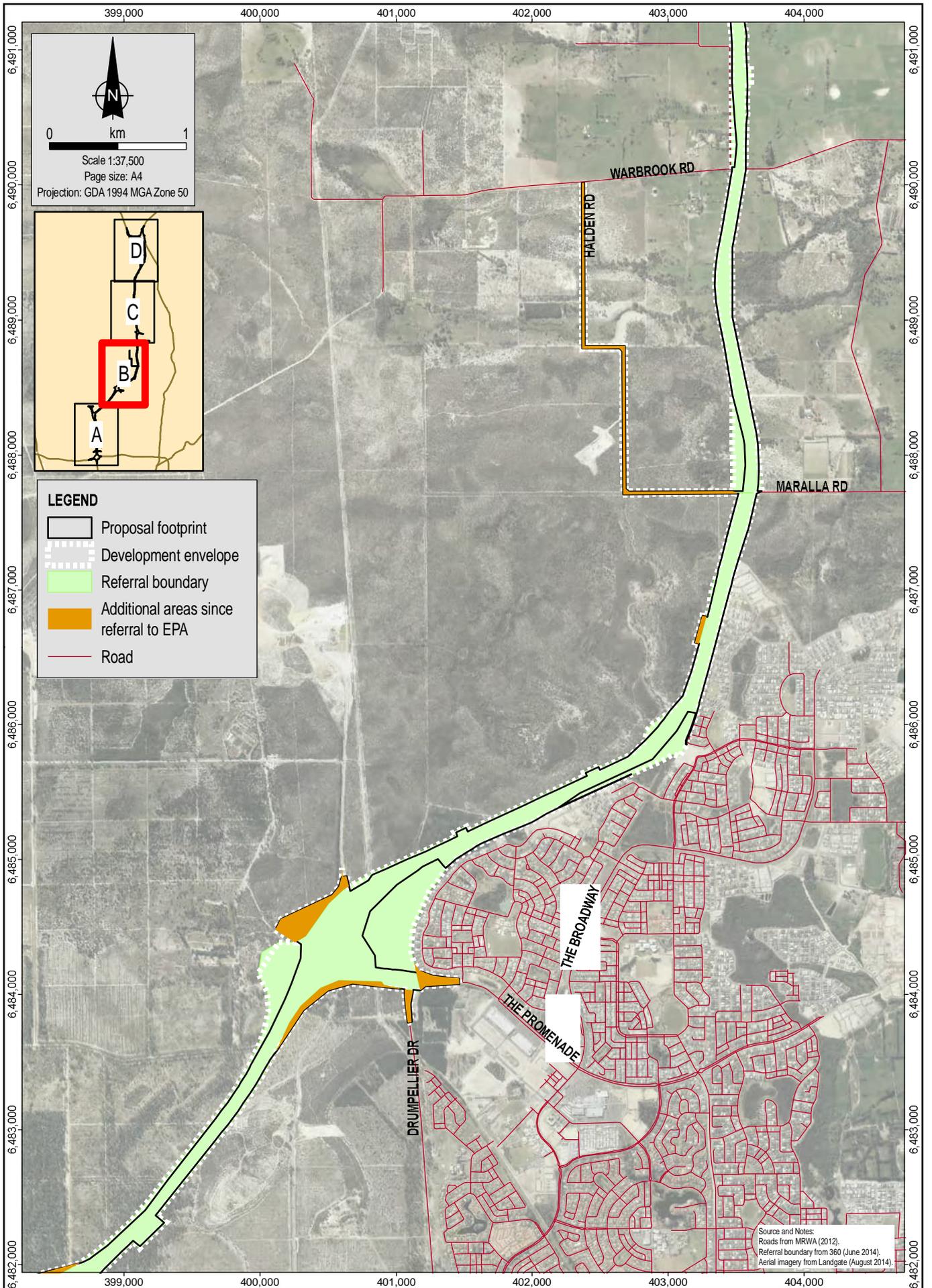
Location	Change in development envelope	Relative impact as a result of change
Interchange west of Ellenbrook	<p>It was identified that there was a need to realign the southbound exit ramp at The Promenade interchange further to the west to minimise impacts on the residential community in the area. The exit ramp will tie into a grade separated roundabout approximately 600 m to the west. This option also significantly reduced the footprint to the north of The Promenade. In association with this shift, the interchange at The Promenade was redesigned to avoid impacts on the Resource Enhancement Wetland 8541 in the southwest quadrant, which resulted in a northward shift of the interchange. This shift required an additional 6.9 ha to the northwest of the interchange. In addition, consultation with Rocla identified the need for access to a future quarry site west of The Promenade, Ellenbrook. In the original design no western link was provided at The Promenade interchange. Subsequent to consultation, the northern leg of Gaskell Avenue was designed to tie into the future Promenade western link.</p>	<p>This area is <i>Corymbia</i> sparse mid woodland (Plain on edge of Dampland) and <i>Eucalyptus</i> sparse mid woodland (Dune slopes, crests and flats). The area contains moderate to high value Black Cockatoo foraging or roosting habitat and between five and ten additional potential Black Cockatoo breeding trees. This was not considered to constitute a significant increase in the impact the proposal may have on the environment, and the overall impact is addressed in Chapter 9.</p> <p>Interchange west of Ellenbrook – an additional area of 3.69 ha was required to accommodate the PSP and earthworks south of the interchange. This area is <i>Banksia</i> sparse low woodland (BaBmMp), <i>Eucalyptus</i> sparse mid woodland (Et²) and <i>Pinus</i> mid woodland. The <i>Eucalyptus</i> sparse mid woodland supports the following threatened and priority taxa: <i>Caladenia huegelii</i>, <i>Anigozanthos humilis</i> subsp. <i>chrysanthus</i>, <i>Hypolaena robusta</i> and <i>Poranthera moorokatta</i>. The change to the interchange to facilitate the PSP will not clear any additional individuals/populations of the threatened and priority taxa.</p> <p>The area contains low to moderate value Black Cockatoo foraging or roosting habitat and less than five additional potential Black Cockatoo breeding trees. This was not considered to constitute a significant increase in the impact the proposal may have on the environment, and the overall impact is addressed in Chapter 9.</p>
Interchange west of Ellenbrook	<p>An additional area of 3.41 ha was required to accommodate the tie in with Drumpellier Drive and the Promenade.</p>	<p>This area is located in previously Cleared areas and <i>Pinus</i> mid woodland, and will not result in a significant increase in the impact the proposal may have on the environment.</p>

Location	Change in development envelope	Relative impact as a result of change
Basin west of Ellenbrook	An additional area of 0.63 ha was required for the construction of a water retention basis to the west of the most northern extent of Ellenbrook.	This area is <i>Banksia</i> sparse low woodland (Dune slopes and crests) and is located within the Priority 3 PEC SCP21c. The area contains moderate value Black Cockatoo foraging or roosting habitat and less than five additional potential Black Cockatoo breeding trees. This was not considered to constitute a significant increase in the impact the proposal may have on the environment, and the overall impact is addressed in Chapter 9.
Local roads north of Maralla Road	Construction of the proposal will require modifications to some local roads, including an upgrade to Maralla Road and Halden Road. These modifications extend over an area of 6.92 ha.	This area is <i>Banksia</i> sparse low woodland (Dune slopes and crests, and Flat plain to lower dune slopes), <i>Eucalyptus</i> sparse mid woodland (Dune rise), <i>Corymbia</i> sparse mid woodland and areas cleared for road infrastructure. This was not considered to constitute a significant increase in the impact the proposal may have on the environment, and the overall impact is addressed in Chapter 9.
Local roads north of Maralla Road	An upgrade to a portion of Cunningham Road west of Railway Parade will also be undertaken covering an area of 3.16 ha.	This area is open paddocks with remnant <i>Corymbia calophylla</i> and <i>Eucalyptus rudis</i> subsp. <i>rudis</i> and contains between five and ten additional Black Cockatoo breeding trees. This was not considered to constitute a significant increase in the impact the proposal may have on the environment, and the overall impact is addressed in Chapter 9.
Stock Road interchange	Localised increase in footprint both at the interchange to accommodate a new configuration of the interchange and make provision for heavy vehicle inspection bays. These modification to the development envelope will require 4.42 ha northwest and west of the interchange and 4.51 ha east of the interchange.	This area is <i>Corymbia</i> sparse mid woodland vegetation association and previously cleared areas. This additional area of clearance was not considered to constitute a significant increase in the impact the proposal may have on the environment.

Location	Change in development envelope	Relative impact as a result of change
Neaves Road interchange	Localised increase in footprint at the interchange to accommodate a new configuration and batters. An additional area of 0.91 ha will be required northeast of the interchange.	<p>The area is largely <i>Melaleuca</i> open low woodland and <i>Corymbia</i> sparse mid woodland. This increase in the development envelope results in part of a Conservation Category Wetland being cleared. This is in addition to three other Conservation Category Wetlands already being impacted at this interchange. This impact on wetlands is addressed in Chapter 10.</p> <p>An additional 0.83 ha will be required to the southeast and southwest of the interchange. This area is <i>Corymbia</i> sparse mid woodland vegetation association, which consists of open paddocks with remnant <i>Corymbia calophylla</i> and <i>Eucalyptus rudis</i> subsp. <i>rudis</i> over pasture species.</p> <p>The increased development envelope contains low value Black Cockatoo foraging or roosting habitat and no additional potential Black Cockatoo breeding trees. This was not considered to constitute a significant increase in the impact the proposal may have on the environment</p>
Local roads between Neaves Road and Muchea South Road	Localised increased in the development envelope to the west of the alignment to accommodate the construction of a local access road.	This is an existing cleared area 2.5 ha in size (comprising two areas of 2.14 ha and 0.36 ha, respectively), and will not result in a significant increase in the impact the proposal may have on the environment.

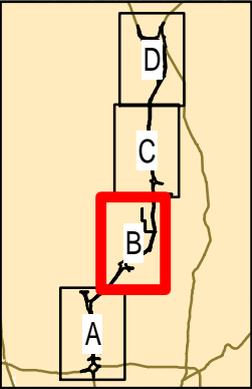
Location	Change in development envelope	Relative impact as a result of change
Interchange with Great Northern Highway and Brand Highway	Additional areas were required west of the referral boundary as a result of the interchange design. Based on the predicted traffic volumes in 2050, an interchange configuration with a larger footprint will be required. The interchange with Great Northern Highway will require an additional 17.21 ha, while the interchange with Brand Highway will require an additional 5.67 ha.	<p>The additional areas of the development envelope around Great Northern Highway are predominantly in existing cleared areas, with 0.79 ha within <i>Eucalyptus</i> sparse mid woodland (Creepline/floodplain). The area contains low value Black Cockatoo foraging or roosting habitat and between five and ten additional potential Black Cockatoo breeding trees. This was not considered to constitute a significant increase in the impact the proposal may have on the environment.</p> <p>The extended development envelope at Brand Highway is in areas previously cleared for rail and agricultural purposes, as well as open paddocks with remnant <i>Corymbia calophylla</i> and <i>Eucalyptus rudis</i> subsp. <i>rudis</i>. The amendment to the development envelope will not directly impact any threatened <i>Grevillea curviloba</i> subsp. <i>incurva</i> populations known to occur along the Brand Highway road reserve. The area contains low value Black Cockatoo foraging or roosting habitat. This increase in development envelope was not considered to constitute a significant increase in the impact the proposal may have on the environment.</p>





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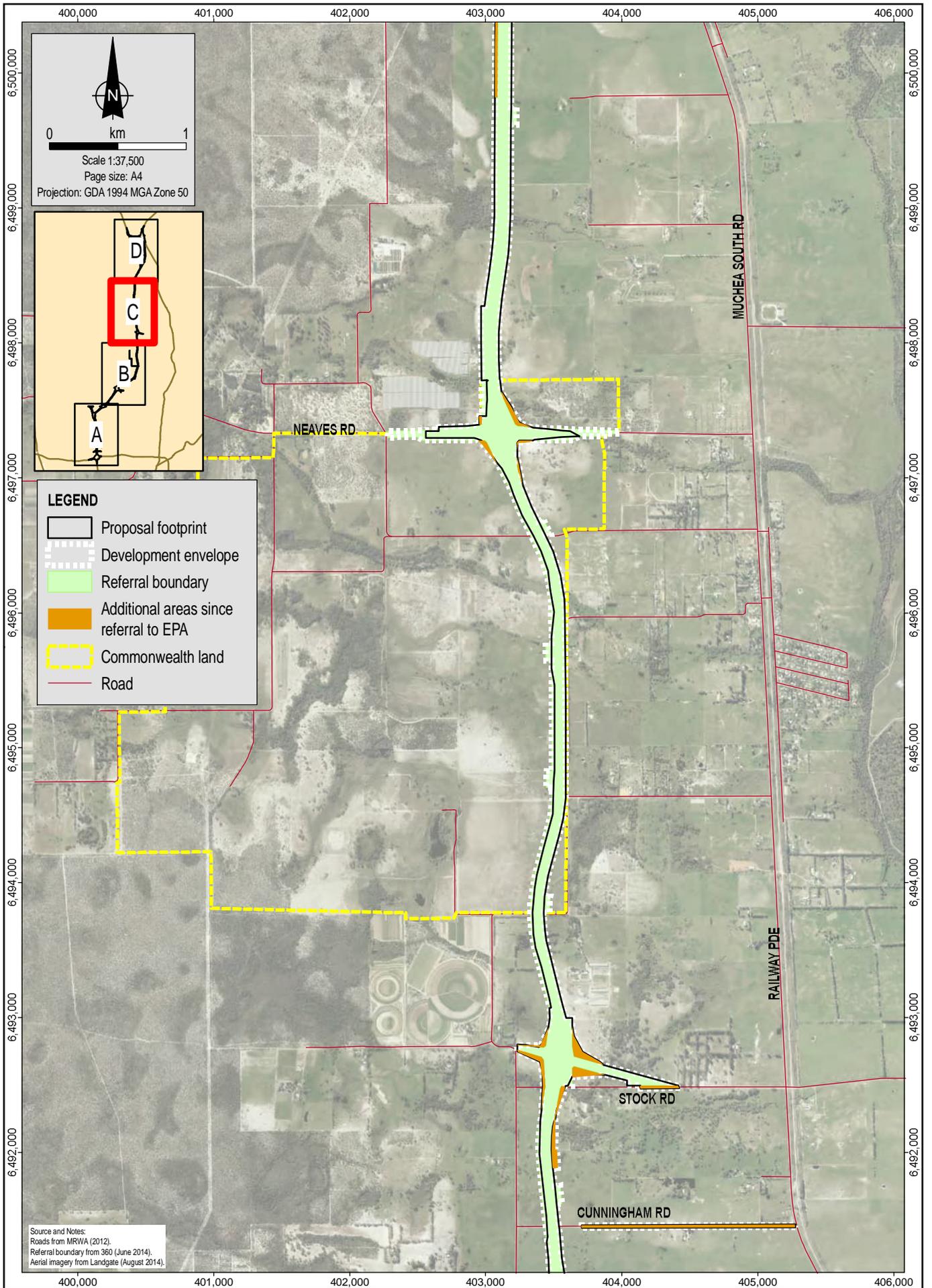
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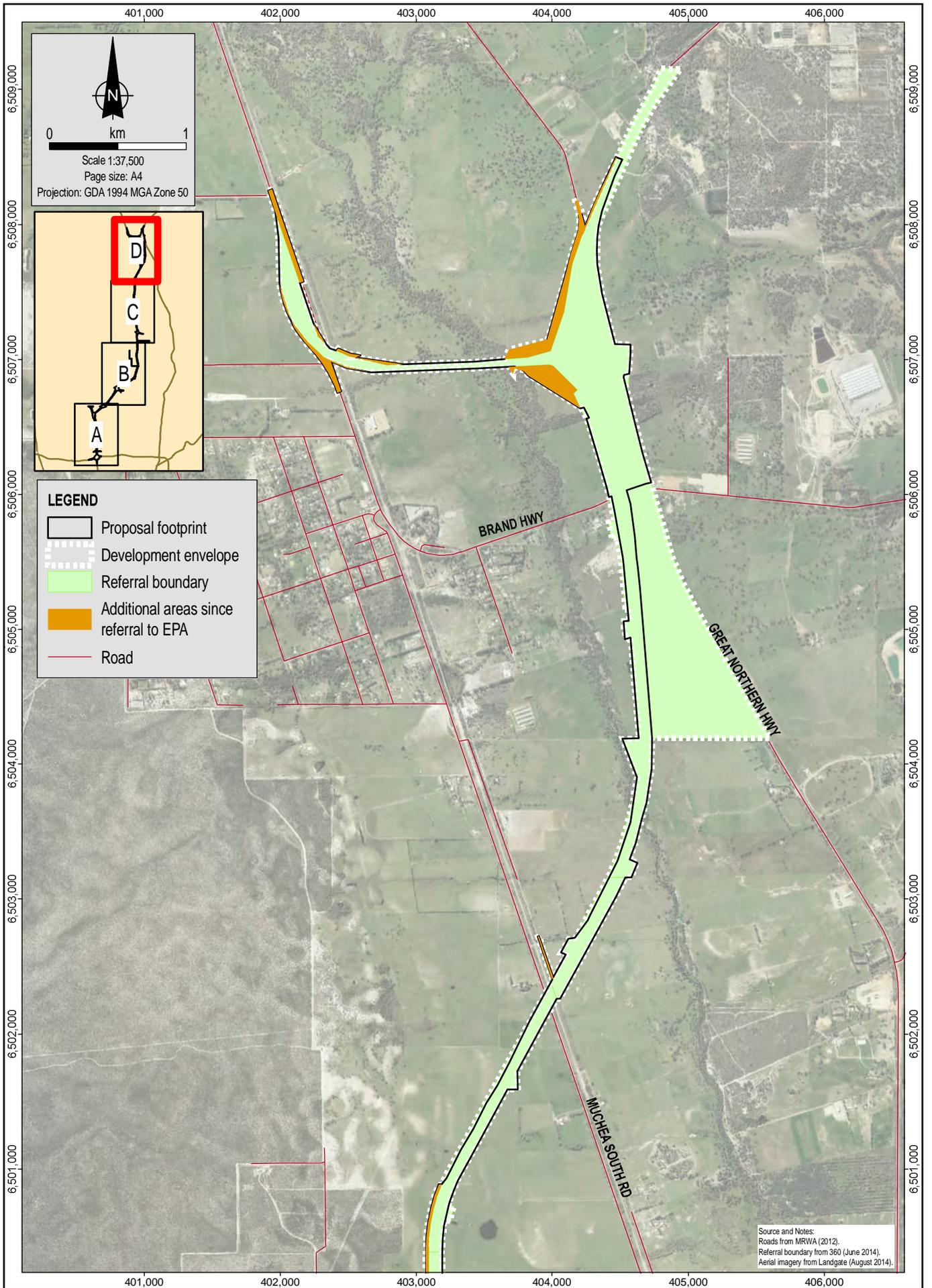


LEGEND

- Proposal footprint
- Development envelope
- Referral boundary
- Additional areas since referral to EPA
- Road

Source and Notes:
Roads from MRWA (2012).
Referral boundary from 360 (June 2014).
Aerial imagery from Landgate (August 2014).





4.2.3 Avoidance Through Design Changes

A number of changes to the design were made as a result of studies undertaken as part of the PER and issues raised by stakeholders during the consultation process. These changes resulted in avoidance of impacts to key environmental factors:

- Consultation with communities in the vicinity of Ellenbrook identified the need to provide significant distance between the alignment and residential areas between The Promenade and Maralla Road by aligning the highway as close to the western referral boundary as possible. The original design came as close as 25 m to property boundaries. The UPDC has shifted the alignment to be approximately 69 m from property boundaries.
- As part of the design the proposal was realigned along the existing Great Northern Highway to avoid impacts to the Claypans of the Swan Coastal Plain TEC, located to the east of Great Northern Highway in Muchea.
- The Mound Springs SCP TEC in the vicinity of Gaston Road has been specifically avoided through the design process.
- The location of the PSP along Hepburn Avenue, north of Marshall Road was realigned to reduce the extent of impact on a potential occurrence of TEC SCP02 (Southern wet shrublands).
- During the design, the proposal was realigned to avoid direct impacts to a population of *Caladenia huegelii* (T) in the Ellenbrook region.
- The design of the Brand Highway crossover in Muchea was designed to ensure critical habitat, including known populations, for *Grevillea curviloba* subsp. *incurva* is maintained along the road and rail reserve along Brand Highway.
- The proposal was realigned to the west of Lot 5, 189 Sawpit Road, Bullsbrook (located north of Maralla Road), which is listed as Bush Forever Site 13 (Sawpit Road Bushland, Bullsbrook) to avoid any direct impacts to the site including the conservation category wetland mapped within the Bush Forever site.
- The interchange at Warbrook Road was relocated to Stock Road, to avoid impacts to habitat for the Critically Endangered Western Swamp Tortoise at Twin Swamps Nature Reserve.
- The width of the proposal footprint was reduced between Baal Street and Gnangara Road to avoid an area containing a high concentration of potential Black Cockatoo breeding trees. The amended proposal footprint reduced the number of breeding trees to be cleared from 410 to 342 (a reduction of 68 breeding trees).
- Interchanges will be constructed at selected existing roads to enable access to suburbs and key transport routes along the alignment.
- The design allows for an interchange with the EWNSR at Cullacabardee, about 1 km southwest of the existing intersection of Gnangara Road and Beechboro Road. This interchange will be the southern terminus of the EWNSR, which will connect the PDNH to the northern suburbs of Perth. The EWNSR is in early planning stages and does not form part of this proposal.

4.3 Interchanges

The interchanges are summarised in Table 4.2.



Table 4.2 Interchanges

Interchange	Locality	Chainage ¹ (km)	Type
Tonkin Highway/Reid Highway	Malaga	0.0	Systems interchange
Hepburn Avenue	Malaga	3.9	Grade separated roundabout
East Wanneroo North–South Route	Cullacabardee	6.1 (start of Y-bifurcation)	Bifurcation (Y-interchange)
Gnangara Road and PDNH	Lexia	9.6	Parclo interchange
The Promenade	Ellenbrook	13.0	Grade separated roundabout
Stock Road	Bullsbrook	23.0	Grade separated roundabout
Neaves Road	Bullsbrook	27.8	Grade separated roundabout
Great Northern Highway/ Brand Highway	Muchea	37.9	Grade separated roundabout

1. Chainage values are approximate.

The original design proposed conventional diamond interchanges at the majority of interchanges along the alignment. Consultation with the Safe Systems Reference Group and Main Roads Technical Working Group identified the need to implement roundabout solutions at interchanges to realise safety benefits for motorists. These grade separated roundabout interchanges have a slightly increased footprint, but will likely have a decrease in fatalities and serious injuries.

Project staging may result in some interchanges being constructed first as at-grade intersections before being upgraded to grade separated interchanges at a later date.

Not all existing roads intersected by the alignment will be directly connected to the proposal. These roads are discussed in Section 4.9.

4.4 Bridges and Culverts

A number of bridges and culverts form part of the design and will be constructed. Bridges and culverts will be needed for:

- Grade separations at interchanges.
- Grade separations at non-intersecting roads.
- Facilitating pedestrian and cycling movements.
- Crossing watercourses, drainage lines and wetlands.
- Maintaining and facilitating surface water flow.
- Providing pathways for fauna movements from one side of the alignment to the other.

A summary of the main bridges and culverts required other than for grade separation at interchanges is presented in Table 4.3. Note that further engineering design work may cause bridge/culvert arrangements and locations to change.



Table 4.3 Bridges and culverts

No.	Type	Location	Chainage ¹ (km)	Length (m)	Purpose	Comment
1	Culvert	Malaga	0.29	80	Fauna underpass (1.2 m wide x 0.6 m high)	Under Beechboro Road North
2	Culvert	Malaga	3.67	1x55 1x15	Fauna underpass (1.2 m wide x 0.6 m high)	Under Reid Highway
3	Bridge	Malaga	2.33	–	Marshall Road over bridge	PDNH
4	Culvert	Hepburn Ave	4.10	1x15 1x20 1x80	Drainage and fauna underpass (0.3 m wide x 0.3 m high)	PDNH
5	Culvert	Cullacabardee	5.25	82	Fauna underpass (1.2 m wide x 1.2 m high)	PDNH
6	Culvert	Cullacabardee	5.48	80	Drainage and fauna underpass (0.3 m wide x 0.3 m high)	PDNH
7	Culvert	Cullacabardee	5.56	80	Fauna underpass (1.2 m wide x 1.2 m high)	PDNH
8	Bridge	Cullacabardee	6.19	–	PDNH over PSP/Baal Street	PDNH
9	Culvert	Cullacabardee	6.37	1x65 1x50	Fauna underpass (1.2 m wide x 1.2 m high)	PDNH
10	Culvert	Cullacabardee	8.29	65	Fauna underpass (1.2 m wide x 1.2 m high)	PDNH
11	Culvert	Cullacabardee	8.27	1x65 1x15	Fauna underpass (1.2 m wide x 1.2 m high)	EWNSR
12	Culvert	Cullacabardee	8.46	1x65 1x15	Fauna underpass (1.2 m wide x 1.2 m high)	EWNSR
13	Culvert	Ellenbrook	15.35	65	Drainage and fauna underpass (0.3 m wide x 0.3 m high)	PDNH
14	Culvert	Ellenbrook	16.60	65	Drainage and fauna underpass (0.3 m wide x 0.3 m high)	PDNH
15	Culvert	Ellenbrook	17.60	70	Fauna underpass 2x2 (3.0 m wide x 1.2 m high)	PDNH
16	Culvert	Ellenbrook	17.80	70	Fauna underpass 2x2 (3.0 m wide x 1.2 m high)	PDNH
17	Culvert	Bullsbrook	18.11	70	Fauna underpass 2x2 (3.0 m wide x 1.2 m high)	PDNH
18	Culvert	Bullsbrook	18.11	70	Fauna underpass 2x2 (3.0 m wide x 1.2 m high)	PDNH

No.	Type	Location	Chainage ¹ (km)	Length (m)	Purpose	Comment
19	Culvert	Bullsbrook	27.95	70+30 (two sections)	Drainage and fauna underpass (0.3 m wide x 0.3 m high)	PDNH
20	Culvert	Bullsbrook	28.05	85	Drainage and fauna underpass (0.3 m wide x 0.3 m high)	PDNH
21	Culvert	Bullsbrook	28.15	75	Drainage and fauna underpass (0.3 m wide x 0.3 m high)	PDNH
22	Culvert	Bullsbrook	29.25	1x40 1x12	Drainage and fauna underpass (0.3 m wide x 0.3 m high)	PDNH
23	Bridge	Bullsbrook	32.85	–	Bridge over Muchea South Road and Midland–Geraldton railway line	PDNH
24	Bridge	Bullsbrook/ Muchea	34.35	–	Bridge over Ellen Brook; fauna underpass	PDNH
25	Culvert	Muchea	37.35	80	Drainage and fauna underpass (0.3 m wide x 0.3 m high)	PDNH
26	Bridge	Muchea	2.60 (Brand Highway)	–	Pass over Ellen Brook; fauna underpass	Brand Highway
27	Bridge	Muchea	1.30 (Brand Highway)	–	Bridge over Midland–Geraldton railway line	Brand Highway

1. Chainage values are approximate.

4.5 Principal Shared Path

Pedestrian and cyclist traffic will be accommodated on a new PSP parallel to the road alignment within the proposal footprint. The PSP will connect to existing footpaths at planned interchanges as well as local roads not otherwise served directly by the proposal. Underpasses will be used at interchanges to maintain grade separation of the PSP from road ramps. Signage will be provided to assist PSP users with navigation.

4.6 Water Retention Basins

Approximately 74 water retention and infiltration basins have been included in the design along the alignment to control and capture runoff from the road and associated landscaping (Table 4.4). Retention basins vary in size and are designed to accommodate surface runoff. The annual recurrence interval (ARI) for the basins varies across the project; however, generally the infiltration basins between Reid Highway and Maralla Road have been designed to accommodate a 100 year ARI event. The detention basins have been designed to accommodate a 15 mm rainfall event (or 1 year ARI event). The exact location and size of each retention basin may change as more detailed design work is completed.



Table 4.4 Water retention and infiltration basins

Name	Type	Location	Chainage ¹ (km)	Volume (m ³)
TPR01	Infiltration	Malaga	1.10	2,010
TRP02	Infiltration	Malaga	1.07	2,980
TRP03a	Infiltration	Malaga	2.55 (Reid Highway)	4,275
TRP03b	Infiltration	Malaga	1.10	725
TRP04	Infiltration	Malaga	1.20	350
TRP07	Infiltration	Malaga	1.38	2,145
TRP08	Infiltration	Malaga	3.13 (Reid Highway)	4,940
TRP09	Infiltration	Malaga	2.50 (Reid Highway Eastbound)	615
TRP10	Infiltration	Malaga	1.53	1,445
TRP11a	Infiltration	Malaga	2.93 (Reid Highway Eastbound)	510
TRP11b	Infiltration	Malaga	1.70	480
TRP12	Infiltration	Malaga	1.68	4,550
TRP13	Infiltration	Malaga	1.73	3,980
RW01	Infiltration	Malaga	1.80 (Reid Highway Eastbound)	5,400
PDNH01	Infiltration	Ballajura	2.43	11,525
PDNH02a and PDNH02b	Infiltration	Ballajura	3.30–3.50	4,356
HEP01	Infiltration	Hepburn Ave interchange	3.78	6,410
HEP02	Infiltration	Hepburn Ave interchange	3.78	1,320
HEP03	Infiltration	Hepburn Ave interchange	4.00	2,110
HEP04	Infiltration	Hepburn Ave interchange	4.05	1,525
PDNH03	Infiltration	Cullacabardee	4.58	23,435
PDNH04	Infiltration	Cullacabardee	6.45	2,510
PDNH05	Infiltration	Cullacabardee	6.80	7,280
PDNH06	Infiltration	Cullacabardee	6.70	3,035
PDNH07	Infiltration	Cullacabardee	7.20	5,570
PDNH10	Infiltration	Cullacabardee	7.60	3,430
PDNH11	Infiltration	Cullacabardee	7.95	15,970
PDNH12	Infiltration	Cullacabardee	9.03	2,120
PDNH13	Infiltration	Cullacabardee	9.00	1,380



Name	Type	Location	Chainage ¹ (km)	Volume (m ³)
GNAN01	Infiltration	Cullacabardee/PDNH-Gnangara Rd interchange	9.45	1,830
GNAN03	Infiltration	Cullacabardee/PDNH-Gnangara Rd interchange	9.58	300
GNAN04	Infiltration	Cullacabardee/PDNH-Gnangara Rd interchange	9.68	590
GNAN05	Infiltration	Lexia/PDNH-Gnangara Rd interchange	9.68	1,365
GNAN06	Infiltration	Lexia/PDNH-Gnangara Rd interchange	9.80	1,440
GNAN07	Infiltration	Lexia/PDNH-Gnangara Rd interchange	10.05	385
PDNH14	Infiltration	Lexia	10.48	11,485
PDNH15	Infiltration	Lexia	12.18	1,545
PROM01	Infiltration	Lexia/Promenade interchange	12.70	585
PROM02	Infiltration	Lexia/Promenade interchange	12.78	7,160
PROM03	Infiltration	Lexia/Promenade interchange	13.00	585
PROM04	Infiltration	Lexia/Promenade interchange	13.00	3,880
PROM05	Infiltration	Ellenbrook/Promenade-Drumpellier Drive	1.30 (The Promenade)	735
PROM06	Infiltration	Ellenbrook/Promenade-Drumpellier Drive	1.23 (The Promenade)	375
PROM07	Infiltration	Ellenbrook/Promenade-Drumpellier Drive	1.13 (The Promenade)	455
PDNH16	Infiltration	Ellenbrook	14.05	2,120
PDNH17	Infiltration	Ellenbrook	14.18	6,365
PDNH18	Infiltration	Ellenbrook	15.35	1,555
PDNH19	Infiltration	Ellenbrook	15.80	1,630
PDNH20	Infiltration	Ellenbrook	16.28	4,895
PDNH21	Infiltration	Ellenbrook	16.80	1,770
PDNH22	Infiltration	Ellenbrook	17.10	2,280
STO05	Detention	Bullsbrook	22.47	42
STO06	Detention	Bullsbrook	22.53	40
STO07	Detention	Bullsbrook	22.69	41
STO03	Detention	Bullsbrook	22.72	52
STO08	Detention	Bullsbrook	0.42 (Cooper Road)	96

Name	Type	Location	Chainage ¹ (km)	Volume (m ³)
STO02	Detention	Bullsbrook	0.33 (Stock Road)	59
STO01	Detention	Bullsbrook	0.50 (Stock Road)	110
STO04	Detention	Bullsbrook	23.17	75
STO09	Detention	Bullsbrook	23.23	72
NEAV05	Detention	Bullsbrook	27.24	69
NEAV04	Detention	Bullsbrook	27.32	71
NEAV01	Detention	Bullsbrook	0.49 (Neaves Road West)	80
NEAV02	Detention	Bullsbrook	0.30 (Neaves Road East)	72
NEAV06	Detention	Bullsbrook	0.30 (Neaves Road East)	66
NEAV03	Detention	Bullsbrook	28.03	62
NEAV07	Detention	Bullsbrook	28.12	67
PDNH23	Detention	Muchea South Rd	32.10	400
PDNH24	Detention	Muchea South Rd	33.21	150
PDNH25	Detention	Bullsbrook	33.85	235
PDNH26	Detention	Bullsbrook	34.68	160
MUCH02	Detention	Muchea	37.43	177
MUCH01	Detention	Muchea	37.98	168

1. Chainages and volumes are approximate.

4.7 Landscaping and Revegetation Works

A substantial amount of earthworks will be required as part of construction. As the majority of the alignment will be built up above the surrounding landscape, a large volume of fill will be required to support elevated ramps, bridges and flyovers at grade separated interchanges.

In general, road verges will be landscaped and replanted and/or seeded with native tubestock. Species planted will be representative of the surrounding area (see Chapter 12) for details on revegetation).

Noise walls will be installed on the road verges at some locations to reduce noise from the road on nearby communities. Noise walls may be used in conjunction with embankments and screen walls to minimise visual impacts while maximising noise attenuation.

4.8 Road Train Assembly and Traveller's Rest Area

The proposal will also include a RTAA and traveller's rest area in the vicinity of Great Northern Highway and Brand Highway at the Muchea end of the proposal. The new RTAA will provide an alternative to Wubin and will facilitate the future use of longer combination vehicles between Muchea and Wubin. The RTAA will



improve operational efficiencies for logistics companies operating road trains into and out of Perth from the north.

The RTAA will consist of an asphalt apron approximately 5 ha in size. Assembly, breakdown and parking areas will be demarcated on the apron and rubbish bins will be provided to collect refuse. Street lighting will be installed to provide security and improve visibility at night. Other security measures will include perimeter fencing and closed-circuit television (CCTV) cameras monitored from a central off-site location.

The traveller’s rest area will improve the road side amenity and road safety for the travelling public and will include short-term parking areas and public restrooms.

4.9 Modifications to Local Roads

Construction of the proposal will require modifications to some local roads in the proposal footprint. Modifications may include severance, realignment and/or reconfiguration. Table 4.5 outlines expected modifications to local roads.

Table 4.5 Local road modifications

Road	Locality	Modification required
Marshall Road	Ballajura	Bridge over the proposal.
Beechboro Road	Cullacabardee	Severed and cul-de-sac installed on each side of the proposal. Emergency access provided to the north to Gnangara Road.
Gaskell Avenue	Lexia	Severed on the south side and reconfigured for integration with the Ellenbrook interchange on the north side.
Drumpellier Drive	Ellenbrook	Reconfigured for integration with the Ellenbrook interchange.
Maralla Road	Ellenbrook	Severed and cul-de-sac installed on each side of the proposal.
Gully Road	Bullsbrook	Severed and cul-de-sac installed on each side of the proposal.
Strachan Road	Bullsbrook	Severed and cul-de-sac installed on each side of the proposal.
Warbrook Road	Bullsbrook	Severed and cul-de-sac installed on each side of the proposal.
West Road	Bullsbrook	Severed and cul-de-sac installed on each side of the proposal.
Muchea South Road	Bullsbrook	PDNH bridge over Muchea South Road.
Brand Highway	Muchea	PDNH bridge over Brand Highway.
Brand Highway	Muchea	New Brand Highway Bridge over the proposal.



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5 REGULATORY CONTEXT

5.1 Key Legislation

This proposal will be undertaken in accordance with the requirements of both the Commonwealth and Western Australian State legislation. The two main pieces of environmental protection legislation that relate to the approval of this proposal are the Commonwealth EPBC Act and the Western Australian EP Act.

5.1.1 Commonwealth Legislation

The EPBC Act is administered by the DOTE and provides a legal framework to protect and manage flora, fauna, ecological communities, and heritage places that are of national and international importance. Approval is required under the EPBC Act if any proposed action is likely to have a significant impact on Matters of National Environmental Significance (MNES). There are currently nine MNES defined in the EPBC Act.

This proposal was referred to DOTE on 31 October 2013 (EPBC 2013/7042) and the Minister decided on 27 November 2013 that the proposal was a controlled action and on 21 January 2014 made the decision that it requires assessment through a Public Environment Report.

The Strategic Assessment of the Perth and Peel Regions (SAPPR) is currently being undertaken under the EPBC Act. At a state level the SAPPR is being led by the Department of Premier and Cabinet, which is working closely with a number of state government agencies. The SAPPR will assess the impact of future development proposed under current state land use planning on MNES within the Perth and Peel regions in order to provide effective long-term management of key environmental issues and greater certainty to industry on those areas that can be developed.

The assessment of this proposal's environmental impacts is not being conducted as part of the SAPPR process. The timing of the SAPPR was not consistent with the timeframes required for the project to be ready for construction. However, the SAPPR does take this proposal into account given the implications of this proposal on future land use planning.

Further information on the SAPPR is available at www.dpc.wa.gov.au.

5.1.2 Western Australian Legislation

The EP Act is the primary legislation that manages environmental impact assessment and environmental protection in WA and is administered by the EPA. The EP Act provides for the prevention, control and reduction of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment.

This proposal was referred to the EPA under Section 38 of the EP Act (Part IV) on 25 October 2013. The EPA set the level of assessment for the proposal as a PER on 6 January 2014, with a four-week public review period.

5.2 Other Regulatory Requirements

Other relevant Acts and Regulations relating to planning, environmental management and heritage matters have been set out in Table 5.1.

Table 5.1 Regulatory requirements

Title of Act	Title of Regulations	Title of guidelines, plans and procedures
Commonwealth		
<i>Native Title Act 1993</i>		
<i>Environment Protection and Biodiversity Conservation Act 1999</i>		<ul style="list-style-type: none"> • Matters of National Environmental Significance: Significant Impact Guidelines 1.1 EPBC Act 1999 (DOTE, 2013). • Matters of National Environmental Significance: Significant Impact Guidelines 1.2 Actions on, or impacting upon, Commonwealth Land and Actions by Commonwealth Agencies (DSEWPAC, 2013). • Carnaby’s Cockatoo (<i>Calyptorhynchus latirostris</i>) Recovery Plan (DPAW, 2013a). • Western Swamp Tortoise (<i>Pseudemydura umbrina</i>) Recovery Plan (Burbidge et al., 2010). • Survey Guidelines for Australia’s Threatened Reptiles: Guidelines for Detecting Reptiles Listed as Threatened under the <i>EPBC Act 1999</i> (DSEWPAC, 2011). • Grand Spider Orchid (<i>Caladenia huegelii</i>) Recovery Plan (DEC, 2009). • Narrow Curved-leaf Grevillea (<i>Grevillea curviloba</i> subsp. <i>incurva</i>) Interim Recovery Plan 2000-2003 (Phillimore and English, 2000). • Community of Tumulus (organic mound) springs of the Swan Coastal Plain Interim Recovery Plan No. 198 (CALM, 2006). • <i>Corymbia calophylla</i> – <i>Xanthorrhoea preissii</i> woodlands and shrublands (Swan Coastal Plain Community type 3c – Gibson et al. 1994) Interim Recovery Plan 2000-2003 (English and Blyth, 2000). • <i>Environment Protection and Biodiversity Conservation Act 1999</i> Conservation Advice for Clay Pans of the Swan Coastal Plain (TSSC, 2012).

Title of Act	Title of Regulations	Title of guidelines, plans and procedures
		<ul style="list-style-type: none"> • <i>Environment Protection and Biodiversity Conservation Act 1999</i> Environmental Offsets Policy (Government of Australia, 2012). • Department of Environment Offset Assessment Guide (DSEWPAC, 2012a). • Department of Environment How to Use the Offsets Assessment Guide (DSEWPAC, 2012b). • EPBC Act Referral Guidelines for Three Threatened Black Cockatoo Species (DSEWPAC, 2012c). • Survey Guidelines for Australia's Threatened Birds: Guidelines for Detecting Birds Listed as Threatened under the <i>EPBC Act 1999</i> (DEWHA, 2010). • Forest Black Cockatoo (Baudin's Cockatoo <i>Calyptorhynchus baudinii</i> and Forest Red-tailed Black Cockatoo <i>Calyptorhynchus banksii naso</i>) Recovery Plan 2007-2016 (Chapman, 2007).
State		
<i>Aboriginal Heritage Act 1972</i>	Aboriginal Heritage Regulations 1974	<ul style="list-style-type: none"> • EPA Guidance Statement 41: Assessment of Aboriginal Heritage (April 2004) (EPA, 2004a).
<i>Biosecurity and Agriculture Management Act 2007</i>	Biosecurity and Agriculture Management Regulations 2013	
<i>Bush Fire Act 1954</i>	Bush Fire Regulations 1954	
<i>Conservation and Land Management Act 1984</i>	Conservation and Land Management Regulations 2002 Forest Management Regulations 1993	
<i>Contaminated Sites Act 2003</i>	Contaminated Sites Regulations 2006	

Title of Act	Title of Regulations	Title of guidelines, plans and procedures
<i>Environmental Protection Act 1986</i>	Environmental Protection Regulations 1987	<ul style="list-style-type: none"> • Guidance for the Assessment of Environmental Factors No. 6 Rehabilitation of Terrestrial Ecosystems (EPA, 2006a). • Guidance for the Assessment of Environmental Factors No. 10 Level of Assessment for Proposal Affecting Natural Areas within the System 6 Region and Swan Coastal Plain Portion of the System 1 Region (EPA, 2006b). • Guidance Statement 12: Minimising Greenhouse Gases (October 2002) (EPA, 2002a). • Guidance Statement 33: Environmental Guidance for Planning and Development (May 2008) (EPA, 2008). • Guidance for the Assessment of Environmental Factors No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004b). • EPA Guidelines for preparing a Public Environmental Review 2012 (OEPA, 2012). • Environmental Impact Assessment Administrative Procedures 2012. • Guidance Statement 55: Implementing best practice in proposals submitted to the Environmental Impact Assessment Process (December 2003) (EPA, 2003). • Guidance Statement 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (June 2004) (EPA, 2004c). • Environmental Assessment Guideline 1: Defining the key characteristics of a proposal (May 2012) (EPA, 2012). • Environmental Assessment Guideline 8: Environmental factors and objectives (January 2015) (EPA, 2015a). • Environmental Assessment Guideline 9: Application of a significant framework in the environmental impact assessment processes (January 2015) (EPA, 2015b).

Title of Act	Title of Regulations	Title of guidelines, plans and procedures
		<ul style="list-style-type: none"> • Environmental Assessment Guideline 11: Recommending environmental conditions (September 2013) (EPA, 2013a). • Acid Sulfate Soils Guideline Series: Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes (DEC, 2013a). • Acid Sulfate Soils Guideline Series: Treatment and management of soils and water in acid sulfate soil landscapes (DEC, 2011). • WA Government Environmental Offset Guidelines (Government of Western Australia, 2014).
	Environmental Protection (Noise) Regulations 1997	<ul style="list-style-type: none"> • Environmental Assessment Guideline 13: Consideration of Environmental Impacts from Noise (September 2014) (EPA, 2014b).
	Environmental Protection (Clearing of Native Vegetation) Regulations 2004	
<i>Heritage of Western Australia Act 1990</i>	Heritage of Western Australia Regulations 1991	<ul style="list-style-type: none"> • State Register of Heritage Places.
<i>Land Administration Act 1997</i>	Land Administration Regulations 1998	
<i>Main Roads Act 1930</i>		
<i>Planning and Development Act 2005</i>	Planning and Development Regulations 2009	<ul style="list-style-type: none"> • Local Planning Scheme Heritage List.
<i>Rights in Water and Irrigation Act 1914</i>	Rights in Water and Irrigation Regulations 2000	
<i>Metropolitan Water Supply Sewerage and Drainage Act 1909</i>		
<i>Waterways Conservation Act 1976</i>	Waterways Conservation Regulations 1981	<ul style="list-style-type: none"> • A Guide to Managing and Restoring Wetlands in Western Australia (DEC, 2012a).
<i>Wildlife Conservation Act 1950</i>	Wildlife Conservation Regulations 1970	

5.2.1 International Agreements

The following international agreements have been considered as part of this proposal:

- China–Australia Migratory Bird Agreement (CAMBA).
- Japan–Australia Migratory Bird Agreement (JAMBA).
- Republic of Korea–Australia Migratory Bird Agreement (ROKAMBA).
- The Ramsar Convention on wetlands.

5.2.2 Policies and Position Statements

Other relevant policies, position statements and publications that have been considered in the development of this PER are listed below.

5.2.2.1 Policies

- State Planning Policy 1: State Planning Framework Policy (Government of Western Australia, 2000a).
- State Planning Policy 2: Environment and Natural Resources (Government of Western Australia, 2003).
- State Planning Policy 2.2: Gnamagara Groundwater Protection (Government of Western Australia, 2005).
- State Planning Policy 2.8: Bushland Policy for the Perth Metropolitan Region (Government of Western Australia, 2010).
- State Planning Policy 2.9: Water Resources (Government of Western Australia, 2006).
- State Planning Policy 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning (Government of Western Australia, 2009).
- WA Government Environmental Offsets Policy, 2011 (Government of Western Australia, 2011).
- Environmental Protection (Gnamagara Mound Crown Land) Policy 1992.
- Environmental Protection (Swan Coastal Plain Lakes) Policy 1992.
- WA Government Bush Forever Policy 2000.
- Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy (Government of Australia, 2012).

5.2.2.2 Environmental Protection Bulletins and Position Statements

The EPA's Environmental Protection Bulletins (and their predecessors, Position Statements) outline the views of the EPA on various matters. These Position Statements are:

- Environmental Protection Bulletin No. 1: Environmental Offsets (EPA, 2014c).
- Position Statement 2: Environmental Protection of Native Vegetation in Western Australia (EPA, 2000).
- Position Statement 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002b).
- Position Statement 4: Environmental Protection of Wetlands (EPA, 2004d).
- Position Statement 7: Principles of Environmental Protection (EPA, 2004e).

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- Environmental Protection Bulletin 20: Protection of Naturally Vegetated Areas through Planning and Development (EPA, 2013b).

5.2.2.3 Other

- EPA and DEC Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC, 2010).
- Geomorphic Wetlands Swan Coastal Plain Dataset (DPAW, last updated May 2014).
- Gngangara Groundwater Areas Allocation Plan, Water Resource Allocation and Planning Series Report No. 30 (DOW, 2009a).
- Gngangara Land Use and Water Management Strategy (WAPC and WRC, 2001a).
- Water Quality Protection Notes:
 - No. 44 – Roads Near Sensitive Water Resources (DOW, 2006a).
 - No. 36 – Protecting Public Drinking Water Source Areas (DOW, 2009b).
 - No. 6 – Vegetation buffers to sensitive water resources (DOW, 2006b).
- MRWA Environmental Guideline: Revegetation Planning and Techniques (Doc. No. 6707/031) (MRWA, 2004).
- MRWA Environmental Guideline: Vegetation Placement within the Road Reserve (Doc. No. 6707/022) (MRWA, 2013b)
- MRWA Environmental Guideline: Revegetation - Topsoil Management (Doc No. 6707/053) (MRWA, 2013c).

5.3 Decision Making Authorities and Approval Requirements

The key environmental approvals and licences required for this proposal are identified in Table 5.2. This shows the statute and agencies responsible for the approvals.

5.4 Principles of Environmental Protection

The five core principles under the EP Act have been considered throughout the development of the proposal. Each of the environmental protection principles considered are summarised in Table 5.3.



Table 5.2 Environment and heritage approvals required

Responsible agency	Statute	Approval required
Department of Aboriginal Affairs (DAA)	<i>Aboriginal Heritage Act 1972</i>	<p>Consultation will be undertaken with the South West Aboriginal Land and Sea Council, the Whadjuk Working Group and other Aboriginal informants.</p> <p>Section 18 consent is required when an Aboriginal heritage site (as defined under Section 5 of the AHA) is proposed to be disturbed.</p> <p>A Section 18 application will be submitted to the DAA during 2015 and will be assessed in parallel with this PER being assessed by DOTE and the EPA.</p>
Department of the Environment (DOTE)	<i>Environment Protection and Biodiversity Conservation Act 1999</i>	Referral under the Act is required in respect of the impact on MNES. This PER will be assessed by DOTE to obtain the necessary environmental approval.
Environmental Protection Authority (EPA)	<i>Environmental Protection Act 1986 – Part IV</i>	Referral under the Act is required if the proposal will have a significant environmental impact. This PER will be used by the EPA as part of the assessment of the proposal.
Department of Water (DOW)	<i>Rights in Water and Irrigation Act 1914 (RIWI Act)</i>	<p>Consultation will be undertaken with DOW throughout the planning process and in conjunction with water licence applications.</p> <p>A Section 5C licence to take groundwater may be required for construction purposes. An application is likely to be submitted during 2016, prior to construction and once the final design has been undertaken.</p> <p>A Section 26D licence to construct a well for dewatering may be required for construction purposes. This application will be dependent on the location of dewatering. An application is likely to be submitted during 2016, prior to construction and once the final design has been undertaken.</p>
Government of Western Australia	<i>Land Administration Act 1997</i>	<p>Development activities can only be undertaken in conservation reserves if they are consistent with the purpose for which the land was reserved. The Gngangara–Moore River State Forest (State Forest No. 65) is reserved for the purpose of State Forest and Reserves 46919 and 46920 are reserved for the purpose of conservation of flora and fauna. The proposal will intersect these three conservation estates. However, the proposal is not consistent with the current purpose of the reserved land and a proposal to excise areas of Gngangara–Moore River State Forest, Reserve 46920 and Reserve 46919 will be submitted to Parliament under Section 45(4) of the Land Administration Act. Not all land proposed to be excised will be impacted by the proposal.</p> <p>Approval will be sought from the Minister for Environment to excise land from Class A reserves under Section 45(2) of the Land Administration Act. An application in this regard has been submitted to the Conservation Commission in 2014. Approval of this application is subject to the approval of this PER by DOTE and EPA.</p>



Responsible agency	Statute	Approval required
Western Australian Planning Commission (WAPC)	<i>Planning and Development Act 2005</i> Metropolitan Region Scheme (MRS)	<p>The MRS is a town planning scheme for land use in the Perth metropolitan area.</p> <p>The MRS defines the future use of land, dividing it into broad zones and reservations. It requires local government town planning schemes to provide detailed plans for their part of the region. These schemes must be consistent with the MRS.</p> <p>It has been in operation since 1963 and provides the legal basis for planning in the Perth metropolitan region. To plan for changing needs, the Metropolitan Region Scheme map is amended frequently.</p> <p>Sections of the PDNH have progressively been included in the MRS since 1994. However, amendments to the MRS will be required to accommodate the development envelope as detailed in the PER, where necessary. An application to amend the MRS will be submitted to the WAPC during 2015 to allow for the alignment in the MRS.</p>

Table 5.3 Consideration given to environmental principles

Principle	Relevant? (yes/no)	Consideration given to principle	Relevant sections in PER
<p><i>1. The precautionary principle</i></p> <p>Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.</p> <p>In application of this precautionary principle, decisions should be guided by:</p> <p>(a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and</p> <p>(b) an assessment of the risk-weighted consequences of various options.</p>	<p>Yes</p>	<p>A wide range of comprehensive desktop and field studies to assess the impact of the proposal on environmental factors were undertaken as part of the PER. Studies included:</p> <ul style="list-style-type: none"> • Flora and vegetation. • Terrestrial fauna. • Hydrological processes and inland waters environmental quality. • Amenity (noise and vibration). • Heritage (Aboriginal and European). • Air quality. <p>Information gathered during these studies was used to inform the PER and has reduced the uncertainty surrounding the prediction of impacts for the assessment.</p> <p>MRWA has ensured that the proposal’s design (where possible) avoids serious or irreversible damage to the environment. Various studies have been undertaken since 1991 to identify the preferred alignment for the PDNH. As part of the alignment definition, potential physical constraints on the alignment were considered. These included topography, development and major infrastructure, defence facilities, watercourses, wetlands, rare flora, indigenous and non-indigenous heritage sites (GHD, 2010). A preferred design option has been recommended taking into account engineering, environmental and heritage investigations as well as consultation.</p> <p>Environmental impacts have been identified and described under each key environmental factor and mitigation and management measures have been proposed to ensure impacts are environmentally acceptable.</p>	<p>Chapters 7 to 15</p> <p>Chapters 3 and 4</p> <p>Chapters 8 to 15</p>

Principle	Relevant? (yes/no)	Consideration given to principle	Relevant sections in PER
		The precautionary principle has been applied through incorporating a drainage strategy along the length of the alignment to ensure the maintenance of hydrological flows.	
<p><i>2. The principle of intergenerational equity</i></p> <p>The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.</p>	Yes	<p>The proposal will ensure the health, diversity and productivity of the environment is maintained through the creation of an offset area to mitigate the impacts.</p> <p>The objective for the proposal's offset strategy is to achieve a net environmental benefit once the proposal has been implemented. To achieve this objective a number of different offsets are proposed to address the various residual impacts and formulate the offset package for this proposal.</p>	Chapter 17
<p><i>3. The principle of the conservation of biological diversity and ecological integrity</i></p> <p>Conservation of biological diversity and ecological integrity should be a fundamental consideration.</p>	Yes	<p>The proposal design has given consideration to avoiding areas of high biological diversity or maintaining biological diversity by minimising the impact on flora, vegetation, wetlands and fauna habitats as far as possible.</p> <p>Impacts on flora, vegetation and terrestrial fauna have been assessed and mitigation and management measures proposed.</p>	Chapters 3, 8 and 9

Principle	Relevant? (yes/no)	Consideration given to principle	Relevant sections in PER
<p><i>4. Principles relating to improved valuation, pricing and incentive mechanisms</i></p> <p>(a) Environmental factors should be included in the valuation of assets and services.</p> <p>(b) The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance and abatement.</p> <p>(c) The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste.</p> <p>(d) Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems.</p>	Yes	<p>Through the Infrastructure Sustainability Council of Australia (ISCA) framework the proposal has developed concepts through the design phase to protect the environment and the sustainability of the proposal. The proposal’s design has incorporated measures to ensure containment and abatement of pollution, particularly as part of stormwater management structures.</p> <p>The ISCA framework encourages the implementation of best-practice and innovative sustainability solutions to deliver long-term environmental, social and economic benefits.</p> <p>In addition, any waste materials that are able to be reused such as asphalt profiling, concretes and soils will be sent to a recycling depot.</p>	Chapter 10
<p><i>5. The principle of waste minimisation</i></p> <p>All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.</p>	Yes	<p>The UPDC for the proposal includes drainage design to minimise the discharge of contaminated water into the environment. Approximately 74 water retention and infiltration basins have been designed along the alignment to control and capture runoff from the road and associated landscaping. Retention basins vary in size and are designed to accommodate surface runoff.</p> <p>The Environmental Management Plan (EMP) for the proposal includes management strategies to ensure that the generation of waste during the construction phase is minimised. All activities are to be carried out with the principles of cleaner production and waste minimisation.</p>	Chapter 4

Principle	Relevant? (yes/no)	Consideration given to principle	Relevant sections in PER
<i>6. Principle of best practice</i>	Yes	<p>Mitigation and management measures proposed in this PER were based on contemporary best practice in environmental management and construction disciplines. Particularly in the design of fauna underpasses to retain habitat connectivity, as well as the design of appropriate bridge structures to minimise the impact on specific flora taxa.</p> <p>The draft Environmental Management Plan is consistent with other management plans that are currently being implemented on similar proposals elsewhere in WA.</p>	Chapter 8 and 9
<i>7. Principle of continuous improvement</i>	Yes	<p>The implementation of the Environmental Management Plan incorporates review and auditing procedures to be undertaken on a regular basis. The aim of these procedures are to continuously identify areas for improvement in environmental management procedures and performance during, particularly, the construction phase.</p>	



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6 STAKEHOLDER CONSULTATION

6.1 Stakeholder Engagement Objectives

MRWA is committed to utilising the knowledge, views and expertise of the community and stakeholders to guide sustainable outcomes in its decision making process as demonstrated by its Community Engagement Policy (MRWA, 2008). The key principles of this policy are respect, transparency, diversity, accountability, early engagement and leadership.

In accordance with this policy, a considerable amount of community and stakeholder engagement has been undertaken during the development of this proposal, both during historical alignment definition studies and as part of the current community and stakeholder engagement process. This has ensured that there is an agreed understanding of the local issues in relation to the proposal and that these issues have informed the proposal's design, subject to the proposal's constraints.

All community and stakeholder engagement has been undertaken in accordance with a Community and Stakeholder Engagement Plan to ensure alignment with MRWA policy. The objectives of the current Community and Stakeholder Engagement Plan are detailed in Table 6.1 (Estill, 2014).

Table 6.1 Engagement objectives

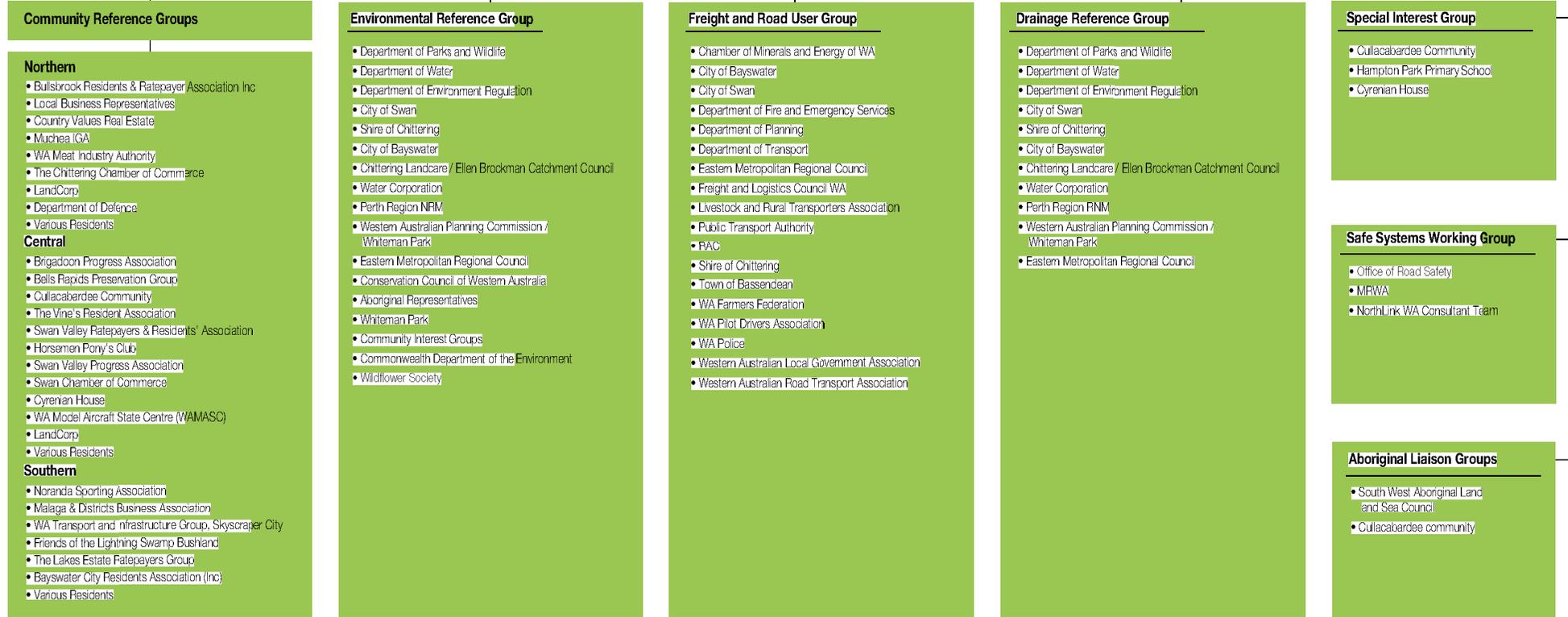
Key policy principles	Project engagement objectives
Transparent communication builds trust and reduces conflict.	Relationships with stakeholders and the community are built through timely and open communication. Commitments throughout the proposal are followed through efficiently and effectively.
Informed and diverse participation leads to meaningful input.	Processes are designed to allow for difference and a diverse range of stakeholder and community members to participate.
Meaningful community and stakeholder input increases the quality of decisions.	Input from engagement activities are incorporated into the final decision to the maximum extent possible. Decisions deliver a high value to the public.
Engagement is enabled by leadership at all levels.	Systems, culture and decision making supports quality engagement planning, delivery, evaluation and continuous improvement.
Planning and resourcing supports engagement.	Appropriate time, finances and people are allocated to projects to manage engagement activities and ensure quality outcomes.

Source: Estill (2014).

6.2 Stakeholder Engagement Activities

Engagement with stakeholders and members of the community is regarded as a critical component of the proposal. Stakeholders were identified through previous engagement processes undertaken as part of planning studies for the proposal. A database of key stakeholders has been established to record comments and any documented responses or commitments made during the process. Stakeholders include all three levels of government, landowners, residents, business owners and operators, environmental interest groups, community members, the freight industry, road users and cyclists (Estill, 2014). Figure 6.1 provides a summary of the various stakeholder engagement groups and their membership.

NORTHLINK WA
Project Team
MRWA and Consultant Team



Role:

- Representative community and interest group input
 - Identify project matters for resolution
 - Inform the resultant design
 - Act as a sounding board on relevant matters

Communities of interest (interested observers)



Stakeholder consultation and engagement has been facilitated through:

- Community ‘drop-in’ sessions held at various locations along the corridor including:
 - Morley Galleria.
 - Altone Park Shopping Centre.
 - Ballajura Library.
 - Ellenbrook Library.
 - Ellenbrook Shopping Centre.
 - Bullsbrook IGA.
 - Muchea IGA.
- Three Community Reference Groups.
- Environmental Reference Group.
- Freight and Road User Group.
- Drainage Reference Group.
- Safe Systems Working Group.
- Project Enabling Group involving and informing key government stakeholders.
- Community, business and special group meetings and briefings.
- Government agency briefing and project development sessions.
- A number of Project Newsletters.
- A 1800 Information Line.
- A project webpage (www.northlinkwa.com.au).
- A project email address.

Further meetings are scheduled between now and September for the Project Enabling Group, the Freight and Road User Group, the Environmental Reference Group and the South/Central/North Community Reference Groups. An outcomes display is also proposed for late 2015.

6.3 Issues Raised by Stakeholders

A number of issues or comments have been raised by stakeholders throughout the proposal’s development, including issues relating to the feasibility of various route alignments and the social, economic and environmental concerns associated with these. A summary of the key issues raised is provided in Table 6.2.

Table 6.2 Key stakeholder issues

Area of interest	Key issues raised	Response
Proposal planning	<ul style="list-style-type: none"> • Support for the proposal. • Doubt that the proposal will proceed. • Timing of the proposal. • Concern at the time to completion (by 2019). • The extent of the resultant proposal footprint. • Use of the former PDNH reservation along Lord St and Drumpellier Drive and potential to return it to public use at Whiteman Park. • Suggested realignment of the PDNH corridor further west to avoid the direct interface with residents of Ellenbrook. 	<ul style="list-style-type: none"> • Background to the proposal, including justification for its development is outlined in Chapter 2. • Details regarding the historic development of the proposal are in Chapter 3. • The detailed description of the proposal is in Chapter 4.
Flora	<ul style="list-style-type: none"> • Impacts on remnant native vegetation. • Loss of vegetation and trees within the road reserve. • Identification and protection of TEC and other ecological communities along the corridor. • Impacts for flora and fauna from changing surface water, runoff and drainage regimes. • Measures to identify and assess areas impacted by dieback. • Topsoil management and use of degraded topsoil or topsoil containing dieback as base level fill and covered. • Revegetation strategies. • Expand offsets to include rehabilitation of degraded land. 	<ul style="list-style-type: none"> • Impacts related to flora and vegetation are addressed in Section 8.6. • Management measures relating to dieback are included in Section 8.6. • Strategies relating to revegetation are discussed in Section 12.3. • The relevant offsets for the proposal are discussed in Chapter 17.

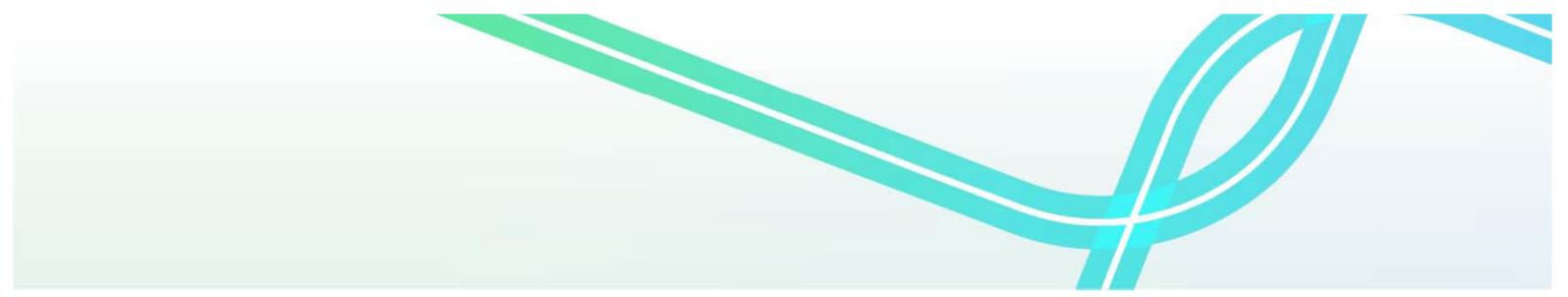
Area of interest	Key issues raised	Response
Fauna	<ul style="list-style-type: none"> ● Impacts on fauna movement corridors for terrestrial fauna and birds. ● Impacts on reptiles in the proposal area. ● Impacts on Black Cockatoos. ● Bird strikes as a result of vehicle collisions during flyover or as a result of road foraging. 	<ul style="list-style-type: none"> ● Impacts relating to fauna are addressed in Section 9.6. ● Impacts to Black Cockatoos are addressed in Sections 9.6 and 16.4.
Hydrology	<ul style="list-style-type: none"> ● Proposals for managing an extreme flood event. ● Seek local infiltration solutions generally and manage flows locally without piping it to other areas or main drains. ● Protect potable water quality by understanding and diverting stormwater away from production bores – spillage, hydrocarbons, weed management spraying etc. with provision for emergency response to allow for effective clean up. ● Recognise the long-term maintenance impacts and costs. ● Adopting the appropriate technologies and treatment options. ● Impacts for water self-sufficiency of Cyrenian House. ● Impact for the Priority One water mound. ● Impacts for Muchea residents and others reliant upon ground water as a potable water supply source. ● Protect existing bores from spills and other impacts. ● Ensure compliance with relevant water quality guidelines and standards and be informed by the Gnangara Water and Land Management Strategy. ● Maintain sheet flow characteristics in the northern section to avoid local flooding and inundation outcomes resulting from the proposal. 	<ul style="list-style-type: none"> ● Impacts to surface and groundwater are addressed in Section 10.6.

Area of interest	Key issues raised	Response
Wetlands	<ul style="list-style-type: none"> ● Impacts on historic and planned wetland rehabilitation work undertaken by volunteers. ● The potential role for community groups to play a part in identifying, restoring or even potentially managing rehabilitated wetlands. ● Need for wetland connectivity to maintain the integrity of the existing wetland network. ● Long-term protection and management of wetlands is a critical catchment management task for the future. ● Wetland protection should be a priority wherever possible. 	<ul style="list-style-type: none"> ● General impacts to wetlands are addressed in Section 10.4.6. ● Wetland vegetation is discussed in Section 8.2.
Aboriginal and European Heritage	<ul style="list-style-type: none"> ● Identification and protection and/or recognition of sites of Aboriginal or European heritage value. 	<ul style="list-style-type: none"> ● Impacts to heritage are discussed in Section 13.5 and 14.5.
Noise	<ul style="list-style-type: none"> ● Noise impact for the communities of Beechboro, Noranda, Bennett Springs, Ballajura, Ellenbrook and rural properties. ● Residential noise impacts. ● Concern about the already high noise levels and the lack of existing noise mitigation measures. ● Noise mitigation measures. 	<ul style="list-style-type: none"> ● Noise impacts are discussed in Section 11.5.

Area of interest	Key issues raised	Response
Amenity	<ul style="list-style-type: none"> ● Impact on the recreational area under the Gngara Park Management Plan. ● Concern that the sensitivities and importance of Cyrenian House facility (Rick Hamersley Centre) may not be recognised. ● Retention of kangaroos, birds and wildlife and other fauna as a valued and positive benefit of the current location of Cyrenian House with fauna movement through the site. ● Concern at the severance and other impacts for Whiteman Park. ● Concern at the introduction of a highway/freeway standard road in a rural area in the northern section. ● Visual and proximity impacts. 	<ul style="list-style-type: none"> ● Amenity impacts relating to Dick Perry Reserve and Whiteman Park are discussed in Section 15.5. ● Impacts on Cyrenian House were discussed in detail with the centre. The proposal design allows for sufficient access to the centre, as well as emergency access. ● Fauna movement corridors are addressed in Section 9.5.8. ● Visual and social impacts were not identified in the ESD as a key environmental factor and are therefore not considered further.
Social	<ul style="list-style-type: none"> ● The distance of the new highway from existing homes. ● Visual impacts. ● Crime and anti-social behaviour in residual land between noise walls and property boundaries – use of residual space. ● Concern at the loss of passing trade and commercial opportunities for Mucnea businesses and in particular the IGA store. ● Impacts for business access to GNH at the northern reconnection point near Mucnea. 	<ul style="list-style-type: none"> ● Noise and vibration impacts are discussed in Section 11.5. ● Visual and social impacts were not identified in the ESD as a key environmental factor and are therefore not considered further.



The community and stakeholder engagement program has increased awareness of the proposal and enabled stakeholders the opportunity to inform and influence the proposal's design and management. MRWA is committed to ongoing engagement throughout the proposal's development to ensure a sustainable outcome is achieved that minimises environmental and social impacts. A number of proposal design decisions were influenced by consultation with stakeholders as described in Chapter 4.



7 ENVIRONMENTAL IMPACT ASSESSMENT FRAMEWORK

7.1 Introduction

In accordance with the ESD (EPA, 2014a) (see Appendix B), a number of studies were undertaken to assist with the preparation of this PER. The preliminary key environmental factors relevant to the proposal, as set out in the ESD, are:

- Flora and Vegetation.
- Terrestrial Fauna.
- Hydrological Processes and Inland Waters Environmental Quality.
- Amenity – Noise and Vibration.
- Rehabilitation and Decommissioning.
- Offsets.

These preliminary key environmental factors are discussed in Chapters 8, 9, 10, 11, 12 and 17.

In addition to the above preliminary key environmental factors, the ESD requires the following other environmental issues to be considered:

- Heritage.
- Amenity – including Dick Perry Reserve and Whiteman Park.

These other environmental factors are discussed in Chapters 13, 14 and 15.

Matters protected under the EPBC Act, including MNES and environmental values on Commonwealth land, are discussed separately in Chapter 16.

7.2 EPA Significance Framework

The EPA determines environmental objectives for each key environmental factor and these are described in Environmental Assessment Guideline 8 – Environmental Factors and Objectives (EAG 8) (EPA, 2015a). These objectives describe the desired goal that, if met, indicates that the proposal is not expected to have a significant impact on the particular factor.

The EPA Environmental Assessment Guideline 9 – Application of a Significance Framework in the Environmental Impact Assessment (EIA) Process (EAG 9) (EPA, 2015b) describes the use of the guideline by the EPA in determining the likely significance of a proposal throughout the EIA process. This significance framework also applies to the assessment of each key environmental factor.

The EPA's framework is a 'risk-based' approach to the extent that the primary focus of the assessment is on understanding the likely 'significance' (which is similar to 'consequence' in traditional risk assessment terminology) of the environmental impacts of a proposal.

In applying the framework, two threshold levels have been determined by the EPA to describe the likely significance:

- The level at which the proposal is likely to have a significant effect on the environment. If the impact from a proposal does not exceed this level, it is considered to meet the EPA's objective for a specific



factor. Where impacts exceed this level, proposals are considered to potentially meet the EPA's objectives.

- The level at which the proposal is likely to have an unacceptable effect on the environment. If the impact from a proposal exceeds this level, it is considered unlikely to meet the EPA's objective for a specific factor.

Where impacts are determined to have a significant or unacceptable effect on the environment, mitigation and management measures are developed, which follows a hierarchical approach to manage the potential impacts:

- Avoidance: measures taken to avoid the impact altogether.
- Minimisation: measures taken to reduce duration, intensity or extent of impact.
- Rehabilitation/restoration: measures taken to repair, rehabilitate or restore degraded areas.
- Offset: measures taken to compensate for any significant residual impact.

The above framework is then applied again to demonstrate that the impact on a particular environmental factor has been reduced to a level where the proposal is likely to meet the EPA's objective.

7.3 Assessment Approach

The impact assessment approach adopted for this PER is a five-step process:

1. Identify potential impacts.
2. Assess the significance of potential impacts.
3. Establish avoidance, mitigation and management measures.
4. Assess and describe the residual impacts. Residual environmental impacts are those that remain after avoidance, mitigation and management measures have been applied.
5. Determine environmental offsets, where required, to counter-balance significant residual impacts.

The significance of impacts on an environmental factor under this approach is determined through consideration of a number of criteria, including:

- The values, sensitivity and quality of environmental factors on which the proposal is likely to have an impact.
- The extent (intensity, duration, magnitude and geographic footprint) of the likely impacts.
- The consequence of the impacts.
- The resilience of the environment to cope with the impacts.

The prediction and evaluation of the key impacts was based on knowledge of the existing environment likely to be affected, the results of specialist studies and monitoring programs, experience gained from similar projects in comparable environmental settings and professional judgement.

7.4 Reliability of Information

A number of surveys and studies were conducted in support of the PER. All studies were undertaken consistent with relevant technical guidelines, policies and legislation, and appropriate levels of rigour applied in conducting these surveys. Individuals and third-party consultants with appropriate experience and relevant expertise in the area of investigation were contracted to undertake these surveys and studies.



The supporting reports, most of which are included as appendices, discuss the reliability of the data, including the degree of certainty, assumptions, limitations of the technical data. Where appropriate, sources of authority and other information used are cited.

The development and refinement of the proposal's design over time may have resulted in minor inconsistencies between the PER and supporting study reports, for example in relation to areas and distances. The definition of terms to denote project or study areas in these studies may also differ from the terms 'proposal footprint' and 'development envelope' used in the PER. As supporting studies were reworked as needed for any significant changes during the development of the proposal, any remaining inconsistencies between the studies appended to this PER and the relevant sections of this PER have been reviewed and are not considered to affect the outcome of the impact assessment.

A peer review of the PER was undertaken to ensure that the results and findings presented complied with requirements for surveys and studies, and that the PER adhered to relevant guidelines and expectations of regulators.

7.5 Structure of Impact Assessment

The following chapters discuss the impacts to the biological and physical environment of the proposal footprint. Impacts are discussed under each key environmental factor. Each chapter describes the EPA's objectives for the factor (where relevant), the existing environment, any predicted impacts that may occur, the management strategies that will be used to mitigate the impacts and finally the residual impact.

The 746 ha proposal footprint includes 47 ha of Commonwealth land. While Chapters 8 to 15 consider the entire proposal footprint, Chapter 16 focuses only on impacts to matters protected under the EPBC Act; that is, impacts to Matters of National Environmental Significance across the entire proposal footprint, and impacts to the environment on the 47 ha of Commonwealth land within the proposal footprint.

The potential impacts, management and mitigation strategies and the residual impacts are summarised in a table at the end of each chapter.

To ensure that impacts are minimised and that the relevant EPA objectives can be met, MRWA has committed to achieving a number of environmental outcomes. While various management measures are proposed in this PER to achieve these desired outcomes, alternative management strategies may arise with further design, investigations and proposal planning. The construction of the proposal will be the subject of a competitive tender process and the cost for mitigation measures have therefore not been included in this PER. MRWA is committed to achieving environmental outcomes through the implementation of appropriate management measures that are relevant to specific conditions on-site, and which may vary from those described in this document. This approach is consistent with the Environmental Assessment Guideline for Recommending Environmental Conditions (EPA, 2013a). The environmental commitments for each key factor are detailed in the management and mitigation section of each chapter.



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8 FLORA AND VEGETATION

8.1 EPA Objectives

The EPA's objective in respect of flora and vegetation (EPA, 2015a) is to maintain representation, diversity, viability and ecological function at the species, population and community level.

8.2 Existing Environment

A detailed flora and vegetation survey was conducted in 2014 (Coffey, 2015a) (Appendix C) and built on previous survey work (GHD, 2013b; 360 Environmental 2014a). These surveys were undertaken as follows:

- GHD (2013b) – three days in September 2012.
- 360 Environmental (2014a) – nine days between 15 September and 26 November 2014.
- Coffey (2015a) – ten days in September 2014 and three days in November 2014.

The survey completed by Coffey (2015a) covered an area of approximately 3,074 ha (the 'flora study area'); which is approximately four times larger than the proposal footprint (746 ha) to provide a broader floristic context. The flora study area followed the alignment of the proposal footprint and extended to approximately 500 m from the edge of the proposal footprint in several locations south of Maralla Road. North of Maralla Road, the flora study area extended to the boundaries of the properties that the proposal footprint traverses. The flora study area was limited to properties where access was granted.

8.2.1 Flora

The 2014 spring flora and vegetation survey identified a total of 456 vascular flora species from 73 families and 234 genera. This included 357 native taxa (approximately 78% of the total) and 99 introduced taxa (Coffey, 2015a). The total number of vascular taxa recorded from the three main surveys along the proposal footprint is 485 native taxa and 149 introduced taxa. This is considered to represent a high diversity of flora on the SCP and is higher than comparable surveys in the proximity of the proposal footprint (Coffey, 2015a).

The families with the highest representation were Myrtaceae, Fabaceae, Orchidaceae, Cyperaceae, Poaceae and Asteraceae (Coffey, 2015a).

8.2.2 Conservation Significant Flora of the Region

A desktop search of Department of Parks and Wildlife (DPAW) and DOTE databases and previous biological surveys for significant taxa (Threatened and Priority Listed) occurring within and in proximity to the proposal footprint was used in association with the field studies in determining the likelihood of significant taxa occurring within the proposal footprint.

The desktop search identified 25 Threatened and 45 Priority listed (two Priority 1, nine Priority 2, 21 Priority 3 and 13 Priority 4) taxa as occurring within and in proximity to the proposal footprint (Figure 8.1 and Table 8.1).

8.2.3 Conservation Significant Flora

Three Threatened and eight Priority listed flora recorded from the flora study area (see Figure 8.1), are listed under the WC Act, the EPBC Act or protected by DPAW (Coffey, 2015a). The Threatened and Priority listed flora recorded from the flora study area include:

- 
- *Caladenia huegelii* (CR – State and EN – Commonwealth).
 - *Darwinia foetida* (EN – State and CR – Commonwealth).
 - *Grevillea curviloba* subsp. *incurva* (EN – State and Commonwealth).
 - *Millotia tenuifolia* var. *laevis* (P2).
 - *Poranthera moorokatta* (P2).
 - *Cyathochaeta teretifolia* (P3).
 - *Meeboldina decipiens* subsp. *decipiens* ms (P3).
 - *Anigozanthos humilis* subsp. *chrysanthus* (P4).
 - *Hypolaena robusta* (P4).
 - *Ornduffia submersa* (P4).
 - *Stylidium striatum* (P4).

Table 8.1 Threatened and priority listed flora occurring in proximity to the proposal footprint

Taxon	Conservation code			Generalised description of known locations	Flowering period	Closest record (km)	Likelihood of occurrence in the proposal footprint ²
	EPBC Act	WC Act ¹	DPAW				
<i>Acacia anomala</i>	VU	VU	–	Lateritic soils. Slopes.	Aug to Sep	0.04	Unlikely
<i>Acacia benthamii</i>	–	–	2	Sand. Typically on limestone breakaways.	Aug to Sep	1.2	Unlikely
<i>Acacia drummondii</i> subsp. <i>affinis</i>	–	–	3	Lateritic gravelly soils.	Jul to Aug	1.3	Unlikely
<i>Acacia oncinophylla</i> subsp. <i>oncinophylla</i>	–	–	3	Granitic soils.	Aug to Oct	6.1	Unlikely
<i>Acacia ridleyana</i>	–	–	3	Grey or yellow/brown sand, gravelly clay, granitic loam.	Aug to Dec	5.3	Unlikely
<i>Adenanthos cygnorum</i> subsp. <i>chamaephyton</i>	–	–	3	Grey sand, lateritic gravel.	Jul or Sep to Dec or Jan	0.8	Unlikely
<i>Andersonia gracilis</i>	EN	VU	–	Heath associated with <i>Banksia telmatiaea</i> on sandplains, sandy clay, gravelly loam. Winter-wet areas, near swamps	Sep to Nov	16	Unlikely
<i>Anigozanthos humilis</i> subsp. <i>chrysanthus</i>	–	–	4	Grey or yellow sand.	Jul to Oct	5.6	Unlikely
<i>Anigozanthos viridis</i> subsp. <i>terraspectans</i>	VU	VU	–	Low heath associated with <i>Banksia telmatiaea</i> on sandplains, clay loam. Winter-wet depressions.	Aug to Sep	>50	Unlikely
<i>Caladenia huegelii</i>	EN	CR	–	Grey or brown sand, clay loam.	Sep to Oct	0.03	Likely
<i>Calectasia</i> sp. Pinjar (C. Tauss 557)	–	–	1	Deep grey quartz soils. Gentle slopes, above damplands.	Oct to Nov	2.3	Unlikely
<i>Calytrix breviseta</i> subsp. <i>breviseta</i>	EN	CR	–	Sandy clay. Swampy flats.	Oct to Nov	7.3	Unlikely

Taxon	Conservation code			Generalised description of known locations	Flowering period	Closest record (km)	Likelihood of occurrence in the proposal footprint ²
	EPBC Act	WC Act ¹	DPAW				
<i>Centrolepis caespitosa</i>	EN	–	4	Brown, orange or grey clay. Salt flats, wet areas.	Oct to Dec	3.9	Possible
<i>Chamaescilla gibsonii</i>	–	–	3	Clay to sandy clay. Winter-wet flats, shallow water-filled claypans.	Sep	0.6	Possible
<i>Chamaelucium</i> sp. Gingin (N.G. Marchant 6)	EN	VU	–	Yellow undulating sand, red- brown gravel supporting open low woodland over open scrub.	May and Oct to Feb	9.2	Unlikely
<i>Conospermum densiflorum</i> subsp. <i>unicephalatum</i>	EN	EN	–	Heath with brown clay soils. Low-lying areas. Loam, loam-clay over laterite. Laterite	Sep to Nov	>50	Unlikely
<i>Conospermum undulatum</i>	VU	VU	–	Swamps with grey or yellow-orange clayey sand, peaty sand over clay	May to Oct	0.7	Possible
<i>Cyanicula ixiooides</i> subsp. <i>ixiooides</i>	–	–	4	Laterite, gravel.	Aug to Oct	3.8	Unlikely
<i>Cyathochaeta teretifolia</i>	–	–	3	Grey sand, sandy clay. Swamps, creek edges.	Jan	0	Present
<i>Darwinia foetida</i>	CR	EN	–	Grey-white sand on swampy, seasonally wet sites.	Oct to Nov	0.3	Likely
<i>Darwinia pimelioides</i>	–	–	4	Loam, sandy Loam. Granite outcrops.	Sep to Oct	4.8	Possible
<i>Diuris micrantha</i>	VU	VU	–	Herblands with brown loamy clay. Winter-wet swamps, in shallow water.	Sep to Oct	38	Unlikely
<i>Diuris purdiei</i>	EN	EN	–	Grey-black sand, moist. Winter-wet swamps.	Sep to Oct	14.5	Unlikely
<i>Drakaea elastica</i>	EN	CR	–	<i>Kunzea glabrescens</i> thickets with white or grey sand. Low-lying situations adjoining winter-wet swamps.	Oct to Nov	7	Unlikely

Taxon	Conservation code			Generalised description of known locations	Flowering period	Closest record (km)	Likelihood of occurrence in the proposal footprint ²
	EPBC Act	WC Act ¹	DPAW				
<i>Drakaea micrantha</i>	VU	EN	–	Jarrah forest with white-grey sand.	Sep to Oct	25.3	Unlikely
<i>Drosera occidentalis</i> subsp. <i>occidentalis</i>	–	–	4	Sandy & clayey soils. Swamps & wet depressions.	Nov to Dec	0.04	Likely
<i>Eleocharis keigheryi</i>	VU	VU	–	Clay, sandy loam. Emergent in freshwater: creeks, claypans.	Aug to Nov	1.9	Possible
<i>Eryngium pinnatifidum</i> subsp. <i>Palustre</i> (G.J. Keighery 13459) PN	–	–	3	Winter-wet flats. Brown sandy loam.	Nov	0	Present
<i>Eucalyptus x balanites</i>	EN	CR	–	Sandy soils with lateritic gravel.	Oct to Dec or Jan to Feb	4.7	Unlikely
<i>Eucalyptus leprophloia</i>	EN	EN	–	White or grey sand over laterite. Valley slopes.	Aug to Oct	>135	Unlikely
<i>Grevillea althoferorum</i> subsp. <i>fragilis</i>	EN	CR	–	Crests, pale brown loamy sand or grey sand over yellow sands.	Aug to Nov	4.2	Possible
<i>Grevillea corrugata</i>	EN	VU	–	Woodlands associated with Wandoo on gravelly lateritic loam. Brown – red loam, clay-loam over Laterite/granite.	?Aug to Sep	12.3	Unlikely
<i>Grevillea curviloba</i> subsp. <i>curviloba</i>	EN	CR	–	Grey sand. Winter-wet heath.	Oct	0.04	Likely
<i>Grevillea curviloba</i> subsp. <i>incurva</i>	EN	EN	–	Roadsides associated with <i>Acacia saligna</i> on sand, sandy loam. Winter-wet heath.	Aug to Sep	0.02	Likely
<i>Guichenotia tuberculata</i>	–	–	3	Sand clay over laterite, sand.	Aug to Oct	0.04	Possible
<i>Haemodorum loratum</i>	–	–	3	Grey or yellow sand, gravel.	Nov	1.9	Possible

Taxon	Conservation code			Generalised description of known locations	Flowering period	Closest record (km)	Likelihood of occurrence in the proposal footprint ²
	EPBC Act	WC Act ¹	DPAW				
<i>Hibbertia helianthemoides</i>	–	–	4	Clayey sand over sandstone or loam over quartzite. Hills and scree slopes.	Jul or Sep to Oct	7.4	Unlikely
<i>Hydrocotyle lemnoides</i>	–	–	4	Swamps.	Aug to Oct	0.04	Likely
<i>Hypolaena robusta</i>	–	–	4	White sand. Sandplains.	Sep to Oct	0	Present
<i>Isopogon drummondii</i>	–	–	3	White, grey or yellow sand, often over laterite.	Feb to Jun	5.3	Unlikely
<i>Jacksonia sericea</i>	–	–	4	Calcareous & sandy soils.	Usually Dec or Jan to Feb	0.4	Possible
<i>Lepidosperma rostratum</i>	EN	EN	–	Sedgeland on clay. Seasonal clay based open depression.	May to Jun	16.6	Unlikely
<i>Leucopogon squarrosus</i> subsp. <i>trigynus</i>	–	–	2	White, grey sand.	Jun	3.9	Possible
<i>Macarthuria keigheryi</i>	EN	EN	–	White or grey sand. Associated with Banksia woodlands.	Sep to Dec or Feb to Mar	6.7	Unlikely
<i>Meionectes tenuifolia</i>	–	–	3	Granite flats, shallow soil at margins, inundated. Grey clay.	Sep to Dec	2.1	Possible
<i>Oxymyrrhine coronata</i>	–	–	4	Yellow sand-clay-gravel over laterite.	Dec	9.9	Unlikely
<i>Persoonia rudis</i>	–	–	3	White, grey or yellow sand, often over laterite.	Sep to Dec or Jan	3.6	Possible
<i>Phlebocarya pilosissima</i> subsp. <i>pilosissima</i>	–	–	3	White or grey sand, lateritic gravel.	Aug to Oct	0.13	Possible
<i>Platysace ramosissima</i>	–	–	3	Sandy soils.	Oct to Nov	0.7	Likely

Taxon	Conservation code			Generalised description of known locations	Flowering period	Closest record (km)	Likelihood of occurrence in the proposal footprint ²
	EPBC Act	WC Act ¹	DPAW				
<i>Poranthera moorokatta</i>	–	–	2	White silica sand in open spaces between shrubs.	Sep to Oct	1	Likely
<i>Schoenus capillifolius</i>	–	–	3	Brown mud. Claypans.	Oct to Nov	3.4	Possible
<i>Schoenus griffinianus</i>	–	–	3	White sand.	Sep to Oct	6.9	Unlikely
<i>Schoenus</i> sp. Bullsbrook (J.J. Alford 915)	–	–	2	Grey peaty sand. Low-lying flats.	Oct	3.2	Possible
<i>Schoenus</i> sp. Waroona (G.J. Keighery 12235)	–	–	3	Clay or sandy clay. Winter-wet flats.	Oct to Nov	4	Possible
<i>Stachystemon</i> sp. Keysbrook (R. Archer 17/11/99)	–	–	1	Grey sand.	Oct	1.5	Possible
<i>Stenanthemum sublineare</i>	–	–	2	Littered white sand. Coastal plain.	Oct to Dec	7.8	Unlikely
<i>Stylidium aceratum</i>	–	–	2	Sandy soils. Swamp heathland.	Oct to Nov	3.2	Possible
<i>Stylidium longitubum</i>	–	–	3	Sandy clay, clay. Seasonal wetlands.	Oct to Dec	1.3	Possible
<i>Stylidium paludicola</i>	–	–	3	Peaty sand over clay. Winter wet habitats. Marri and Melaleuca woodland, Melaleuca shrubland.	Oct to Dec	1.2	Possible
<i>Stylidium squamellosum</i>	–	–	2	Brown to red-brown clay loam. Winter-wet habitats and depressions, open woodland, shrubland.	Oct to Nov	1.3	Possible
<i>Stylidium trudgenii</i>	–	–	3	Grey sand, dark grey to black sandy peat. Margins of winter-wet swamps, depressions.	Nov to Jan	0.8	Likely
<i>Synaphea grandis</i>	–	–	4	Laterite.	Oct to Nov	2	Possible

Taxon	Conservation code			Generalised description of known locations	Flowering period	Closest record (km)	Likelihood of occurrence in the proposal footprint ²
	EPBC Act	WC Act ¹	DPAW				
<i>Tetraria</i> sp. Chandala (G.J. Keighery 17055)	–	–	2	Mound spring, black peat over clay & humic sand.	Jul to Feb	4.8	Possible
<i>Thelymitra dedmaniarum</i>	EN	CR	–	Granite.	Nov to Dec or Jan	10.3	Unlikely
<i>Thelymitra stellata</i>	EN	EN		Sand, gravel, lateritic loam.	Oct to Nov	2.8	Possible
<i>Thysanotus glaucus</i>	–	–	4	White, grey or yellow sand, sandy gravel.	Oct to Dec or Jan to Mar	6.9	Unlikely
<i>Trichocline</i> sp. Treeton (B.J. Keighery & N. Gibson 564)	–	–	2	Sand over limestone, sandy clay over ironstone. Seasonally wet flats.	Dec to Jan	1.6	Possible
<i>Trithuria occidentalis</i>	EN	CR	–	Edge of shallow, winter-wet brown- grey claypans in very open shrubland of <i>Melaleuca lateritia</i> .	Oct to Nov	1.9	Possible
<i>Verticordia lindleyi</i> subsp. <i>lindleyi</i>	–	–	4	Sand, sandy clay. Winter-wet depressions.	May or Nov to Dec or Jan	0.2	Likely
<i>Verticordia serrata</i> var. <i>linearis</i>	–	–	3	White sand, gravel. Open woodland.	Sep to Oct	0.04	Likely

Source: Coffey (2015a) (Appendix C).

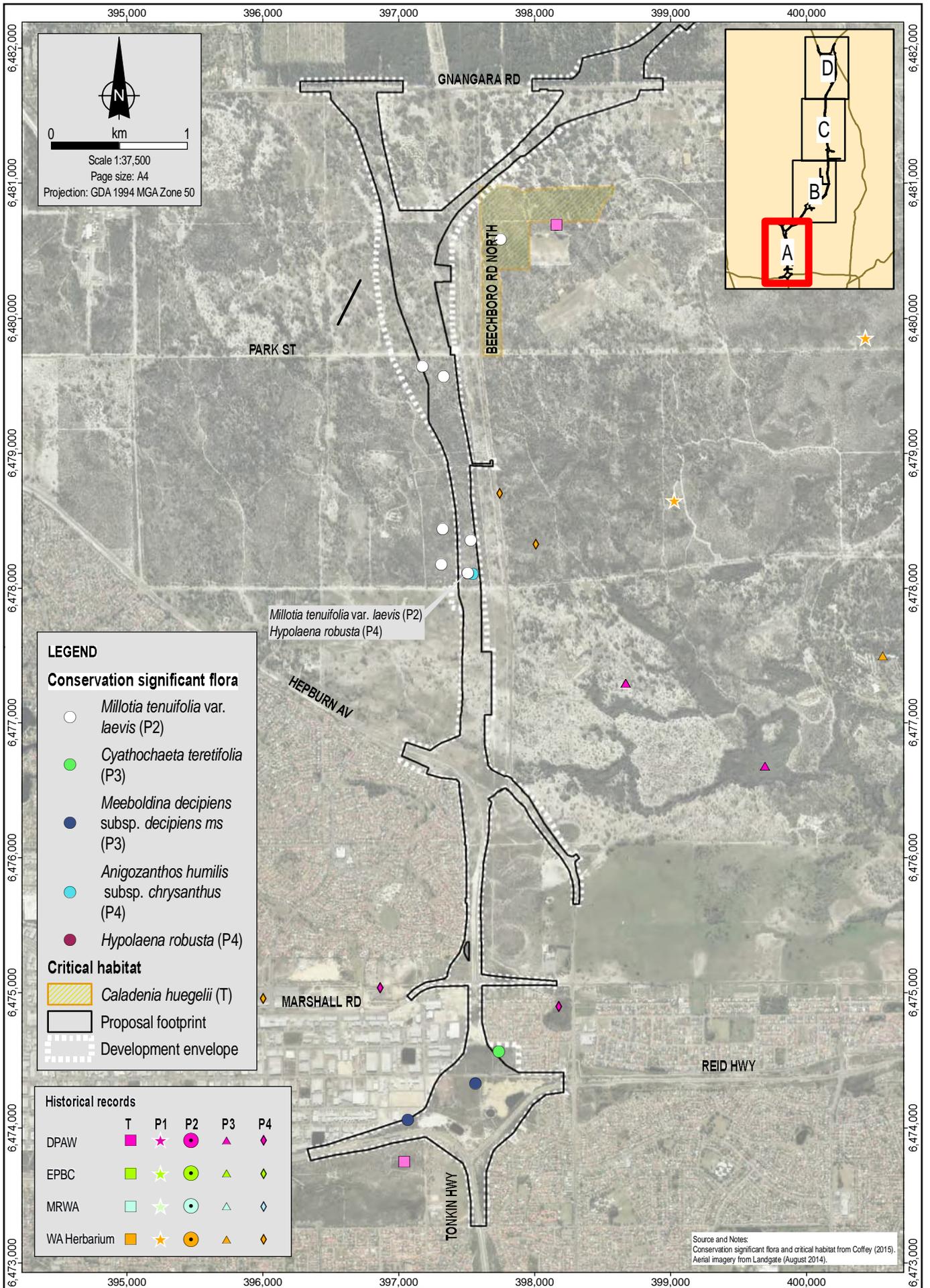
1. *Wildlife Conservation Act 1950*.

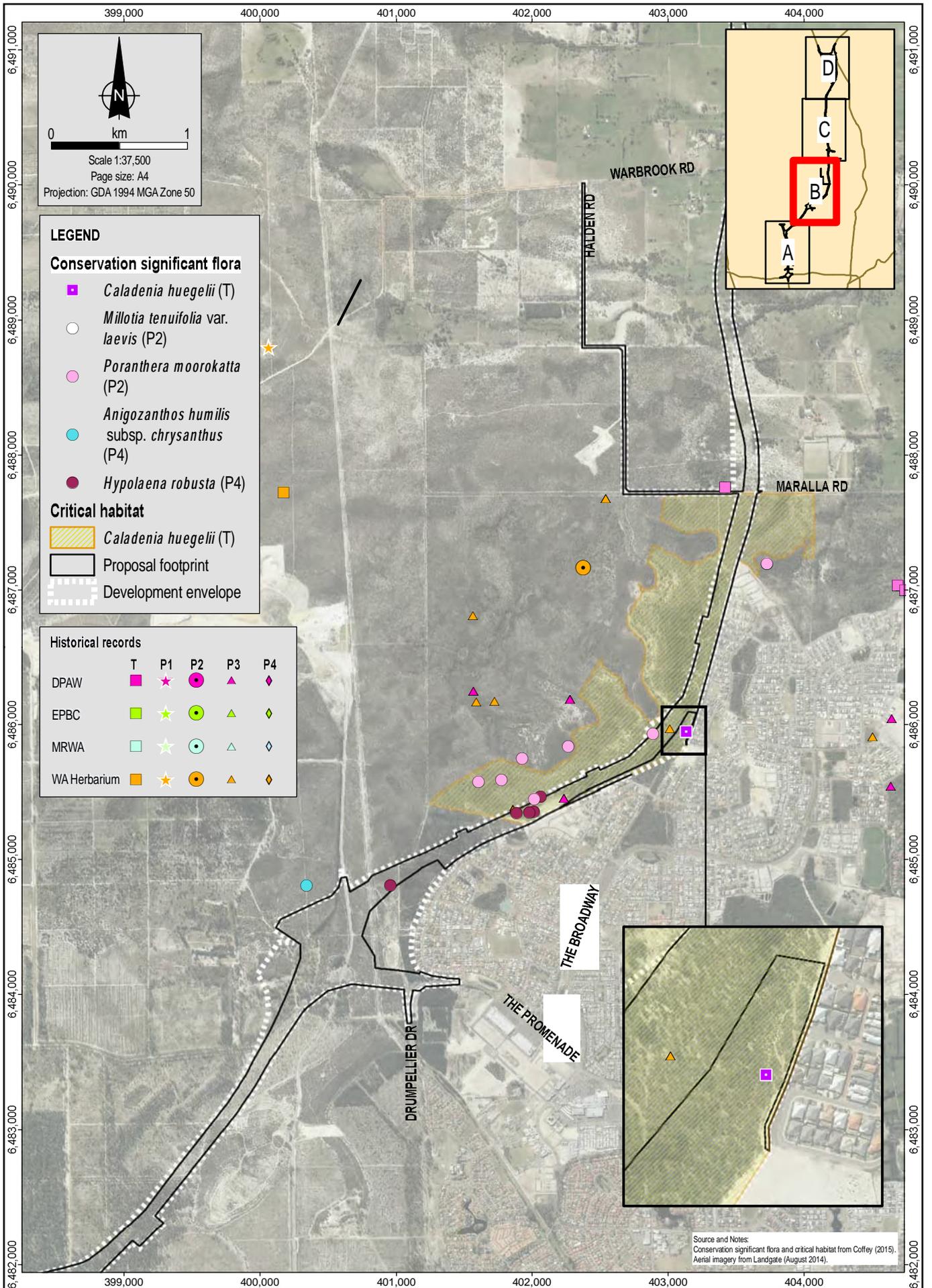
2. 'Present' = occurring within the proposal footprint based on surveys.

'Likely' = suitable habitat present and records within 1 km from the proposal footprint.

'Possible' = suitable habitat present, but records within 1 km to 5 km from the proposal footprint.

'Unlikely' = a lack of suitable habitat, and/or there are no records closer than 5 km from the proposal footprint.





Scale 1:37,500
Page size: A4
Projection: GDA 1994 MGA Zone 50

LEGEND

Conservation significant flora

- *Caladenia huegelii* (T)
- *Millotia tenuifolia* var. *laevis* (P2)
- *Poranthera moorokatta* (P2)
- *Anigozanthos humilis* subsp. *chrysanthus* (P4)
- *Hypolaena robusta* (P4)

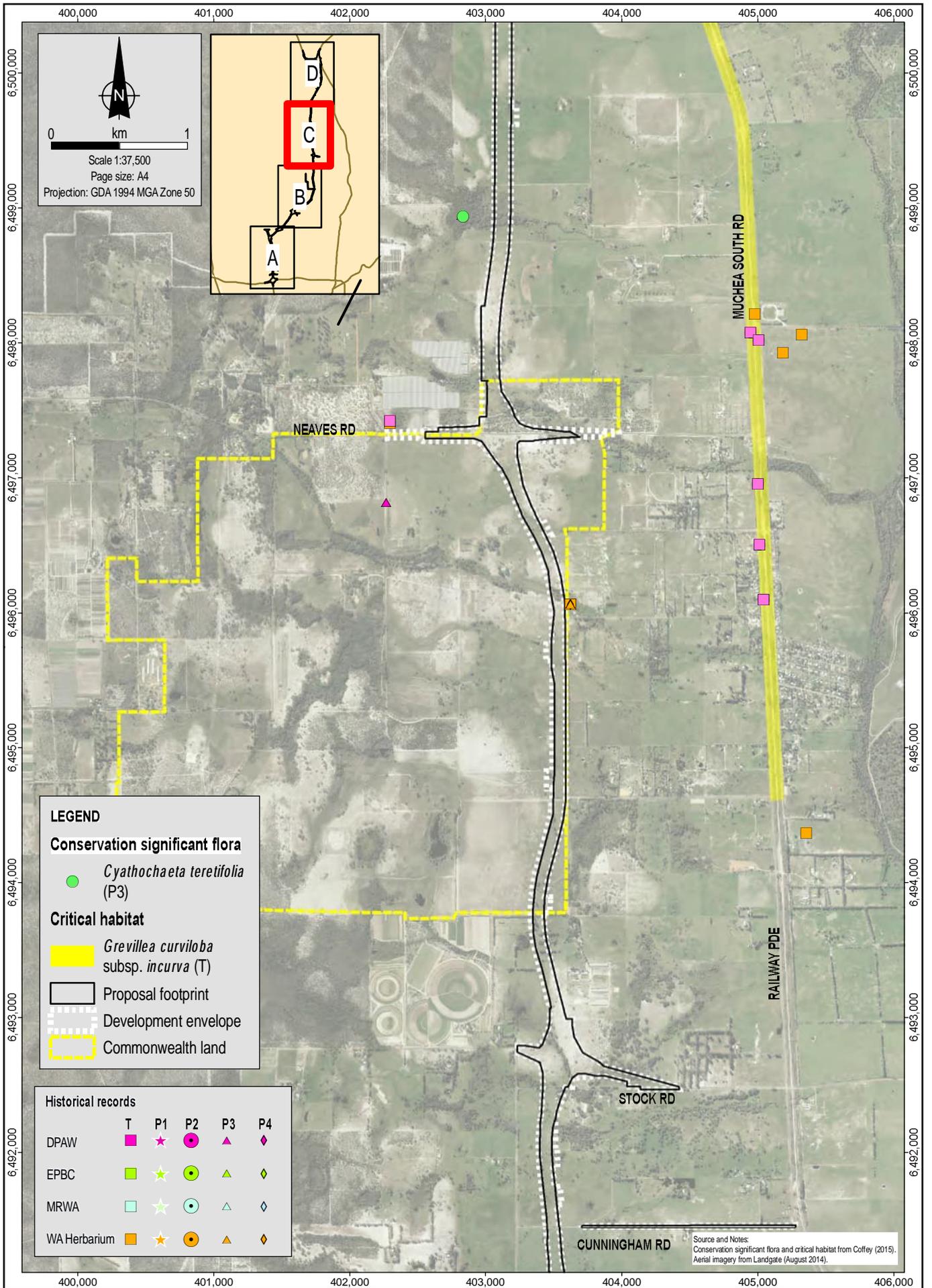
Critical habitat

- ▨ *Caladenia huegelii* (T)
- ▭ Proposal footprint
- ▭ Development envelope

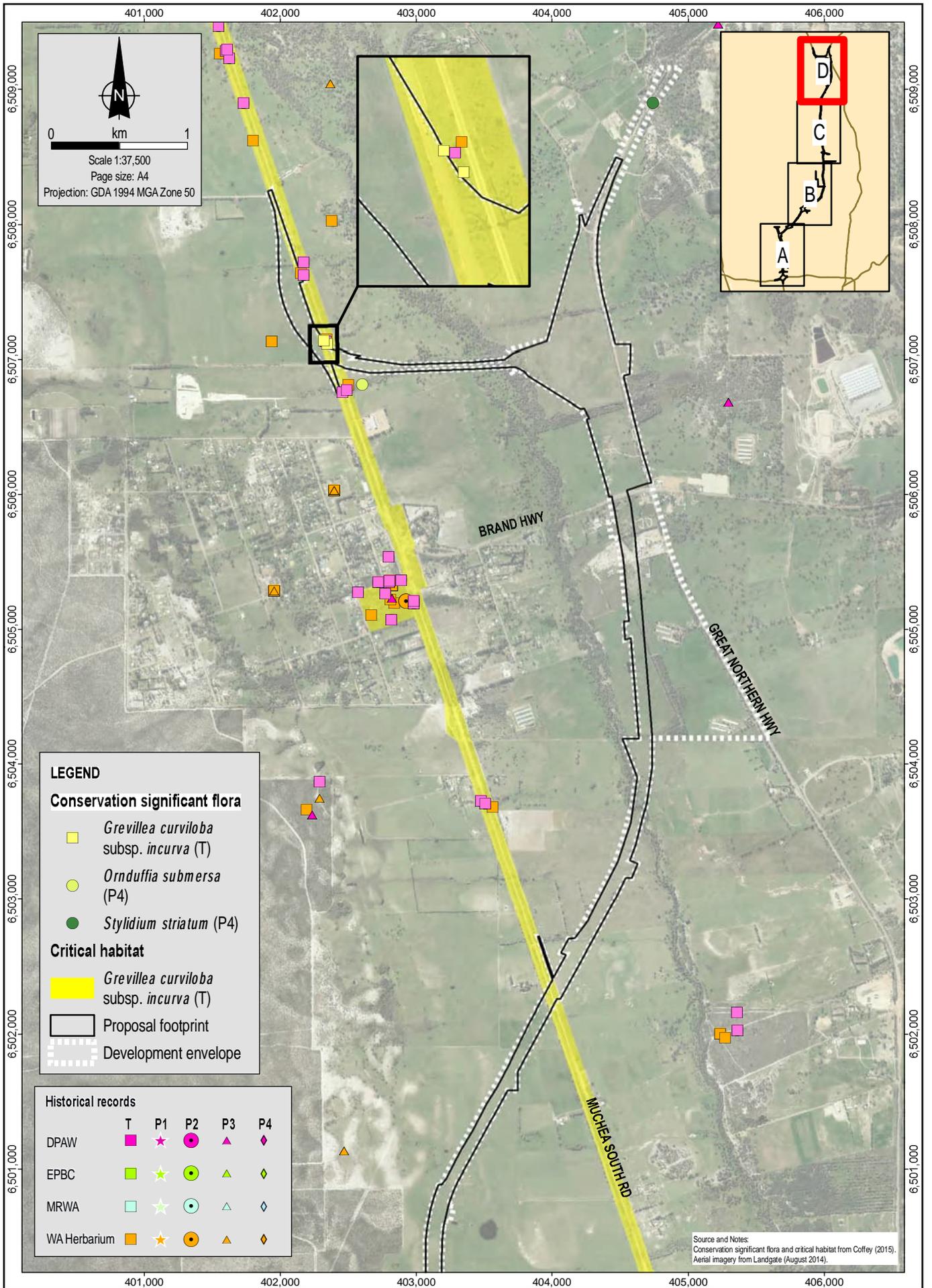
Historical records

	T	P1	P2	P3	P4
DPAW	■	★	●	▲	◆
EPBC	■	★	●	▲	◆
MRWA	■	★	●	▲	◆
WA Herbarium	■	★	●	▲	◆

Source and Notes:
Conservation significant flora and critical habitat from Coffey (2015).
Aerial imagery from Landgate (August 2014).



Source and Notes:
 Conservation significant flora and critical habitat from Coffey (2015).
 Aerial imagery from Landgate (August 2014).



8.2.4 Broad Vegetation Communities of the Region

The proposal footprint is located within the Drummond Botanical Subdistrict of the SCP subregion which is mainly comprised of Banksia low woodlands on leached sands with Melaleuca swamps on ill-drained sites with woodland of Tuart, Jarrah and Marri on less leached sands (Beard, 1990).

The Interim Biogeographic Regionalisation for Australia (IBRA) divides Australia into 89 bioregions based on major biological and geographical or geological attributes (Thackway and Cresswell, 1995). The flora study area is located within the Perth IBRA subregion (SWA02) of the Swan Coastal Plain IBRA bioregion (SWA).

The SWA IBRA bioregion is a low-lying coastal plain, mainly covered with woodlands. It is dominated by Banksia (*Banksia* spp.) or Tuart (*Eucalyptus gomphocephala*) on sandy soils with *Casuarina obesa* on outwash plains, and paperbark (*Melaleuca* spp.) in swampy areas. In the east, the plain rises to duricrusted Mesozoic sediments dominated by Jarrah (*E. marginata*) woodland (Mitchell et al., 2002).

The Perth IBRA subregion is composed of colluvial and aeolian sands, alluvial river flats and coastal limestone. Heaths and/or Tuart woodlands occur on limestone with Banksia and Jarrah-Banksia woodlands on the Quaternary marine dunes, while Marri (*Corymbia calophylla*) exist on colluvials and alluvials. The Perth IBRA subregion also includes a complex series of seasonal wetlands (adapted from Mitchell et al., 2002).

The SWA IBRA bioregion is not considered to be a bioregion with less than 10% protection (DOTE, 2014b). Both the SWA IBRA bioregion and the Perth IBRA subregion have between 10 and 15% of their current area protected within International Union for the Conservation of Nature (IUCN) Class I-IV Reserves (i.e. National Parks, Nature Reserves).

Five vegetation complexes occur across the proposal footprint (Heddle et al, 1980). The five vegetation complexes that occur and the extent remaining on the SCP are detailed in Table 8.2.

Table 8.2 Native vegetation extent remaining on the Swan Coastal Plain

Vegetation complex	Pre-European extent (ha) ¹	2013 extent (ha) ¹	Pre-European extent remaining (%) ¹	Formal protection ² (ha)	Pre-European extent within formal protection (%) ¹
Bassendean Complex-Central and South	87,392	24,206	27.70	2,244	2.57
Bassendean Complex-North Transition	17,640	16,126	91.42	11,318	64.16
Bassendean Complex-North	74,133	53,518	72.19	26,442	35.67
Southern River Complex	57,172	11,255	19.69	1,234	2.16
Yanga Complex	26,176	4,645	17.75	530	2.02

1. Pre-European extents from WALGA (2013).

2. WALGA (2013) states "formal protection includes DPAW conservation estates, Bush Forever on DPAW managed lands and Bush Forever in Regional Parks".

The National Objectives and Targets for Biodiversity Conservation 2001-2005 recognises that retention of 30% or more of the pre-clearing extent of each vegetation complex is necessary if Australia's biological diversity is to be protected (Environment Australia, 2001). In addition to the 30% retention target, the EPA has adopted a 10% level of pre-clearing extent as representing 'endangered' (EPA, 2000). The SWA IBRA



bioregion is considered a constrained area (Government of Western Australia, 2000b) and as such the retention target for the vegetation complexes on the SCP is 10%.

The Bassendean-North Transition and Bassendean-North vegetation complexes currently have greater than 30% of their pre-European extent remaining on the SCP (WALGA, 2013). The pre-European extent remaining on the SCP for the remaining three vegetation complexes are above the level of 10% (WALGA, 2013) for it to be classified as endangered (EPA, 2000).

Of the five vegetation complexes occurring within the proposal footprint, only the Bassendean-North Transition and Bassendean-North vegetation complexes have greater than 30% of their pre-European extent remaining on the SCP in formal protection. The remaining three vegetation complexes have less than 10% of their pre-European extent remaining on the SCP in formal protection.

8.2.5 Vegetation Associations

The vegetation recorded from the flora study area can be grouped into eight broad floristic formations (excluding cleared and built up areas):

- *Astartea* tall shrubland to open tall shrubland.
- *Banksia* sparse low woodland.
- *Cenchrus* grassland.
- *Corymbia* sparse mid woodland.
- *Eucalyptus* sparse mid woodland.
- *Melaleuca* open low woodland.
- *Pinus* mid woodland.
- *Xanthorrhoea* open tall shrubland.

Upon further refinement of the broad floristic formations, and with the aid of statistical analysis, review of aerial imagery and information available on the soils and landforms, the eight broad floristic formations were differentiated into 60 vegetation associations. A further six mapping units have been delineated from the flora study area. These included highly modified areas (CcEr³, Pp, Rehab, R, and Former Settlements) and cleared areas (Cl) which include infrastructure and industry/development.

The 60 vegetation associations and six mapping units are described in Table 8.3 and mapped on Figure 8.2. The floristic information collected from the sampling sites located within the flora study area is provided in Appendix C.

Table 8.3 Vegetation associations

Unit code	Broad floristic formation and site preference	Vegetation association descriptions	Extent in flora study area (ha)
As	<i>Astartea</i> tall shrubland to open tall shrubland Floodplain/Dampland	<i>Astartea scoparia</i> , <i>Kunzea glabrescens</i> tall shrubland to tall open shrubland over <i>*Holcus lanatus</i> , <i>*Bromus diandrus</i> and <i>*Vulpia bromoides</i> low grassland over <i>*Romulea rosea</i> , <i>*Hypochaeris glabra</i> and <i>*Lotus subbiflorus</i> open to isolated low herbs.	3.4 (0.1%)
AsMIEvCl	<i>Astartea</i> tall shrubland to open tall shrubland Dampland	<i>Astartea scoparia</i> , <i>Melaleuca lateritia</i> , <i>Eutaxia virgata</i> closed mid shrubland over <i>Lepidosperma striatum</i> and <i>Lepidosperma longitudinale</i> sparse tall sedgeland with occasional <i>Meeboldina</i> spp. and <i>Hypolaena exsulca</i> sparse tall rushland.	5.4 (0.2%)
Ba	<i>Banksia</i> sparse low woodland Flat plain	<i>Banksia attenuata</i> sparse low woodland and <i>Eucalyptus todtiana</i> isolated low mallee trees over <i>Melaleuca seriata</i> , <i>Eremaea pauciflora</i> var. <i>pauciflora</i> and <i>Xanthorrhoea preissii</i> sparse low shrubland over <i>Phlebocarya ciliata</i> open low herbland.	3.7 (0.1%)
BaBm ¹	<i>Banksia</i> sparse low woodland Dune slopes and crests	<i>Banksia attenuata</i> and <i>Banksia menziesii</i> low woodland to sparse low woodland over <i>Eremaea pauciflora</i> var. <i>pauciflora</i> , <i>Hibbertia hypericoides</i> , <i>Hibbertia subvaginata</i> sparse low shrubland over <i>Patersonia occidentalis</i> subsp. <i>occidentalis</i> sparse low herbland.	41.7 (1.4%)
BaBm ²	<i>Banksia</i> sparse low woodland Dune slopes and crests	<i>Banksia attenuata</i> and <i>Banksia menziesii</i> low woodland to sparse low woodland over <i>Calytrix fraseri</i> (Ellenbrook Form), <i>Verticordia nitens</i> and <i>Beaufortia elegans</i> sparse mid shrubland over <i>Alexgeorgea nitens</i> and <i>Desmocladius flexuosus</i> sparse low rushland.	147.6 (4.9%)
BaBm ³	<i>Banksia</i> sparse low woodland Flat plain to lower dune slopes	<i>Banksia attenuata</i> , <i>Banksia menziesii</i> low woodland over <i>Eremaea pauciflora</i> var. <i>pauciflora</i> , <i>Scholtzia</i> aff. <i>involutrata</i> , <i>Hibbertia hypericoides</i> open to sparse low shrubland over <i>Patersonia occidentalis</i> subsp. <i>occidentalis</i> sparse mid herbland.	41.9 (1.4%)
BaBmMp	<i>Banksia</i> sparse low woodland Flat, dampland	<i>Banksia attenuata</i> , <i>Banksia menziesii</i> and <i>Melaleuca preissiana</i> sparse low woodland over <i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i> , <i>Regelia inops</i> and <i>Banksia ilicifolia</i> sparse tall shrubland over <i>Verticordia nitens</i> and <i>Astroloma xerophyllum</i> isolated mid shrubs.	7.5 (0.2%)
Bl	<i>Banksia</i> sparse low woodland Dampland	<i>Banksia littoralis</i> sparse low woodland over <i>Hypocalymma angustifolium</i> and <i>Pericalymma crassipes</i> closed mid shrubland over <i>Meeboldina scariosa</i> sparse tall rushland.	4.8 (0.2%)

Unit code	Broad floristic formation and site preference	Vegetation association descriptions	Extent in flora study area (ha)
BIMp	<i>Melaleuca</i> open low woodland Low depression, dampland	<i>Banksia littoralis</i> and <i>Melaleuca preissiana</i> sparse low woodland over <i>Astartea scoparia</i> , <i>Pericalymma crassipes</i> and <i>Kunzea glabrescens</i> closed mid shrubland to mid shrubland over <i>Schoenus caespititius</i> open tall sedgeland.	8.2 (0.3%)
Cc/Mp	<i>Corymbia</i> sparse mid woodland Dampland	<i>Corymbia calophylla</i> and/or <i>Melaleuca preissiana</i> mid woodland over <i>Banksia littoralis</i> sparse low woodland over <i>Xanthorrhoea preissii</i> and <i>Taxandria linearifolia</i> open to sparse tall shrubland.	15.8 (0.5%)
Cc ¹	<i>Corymbia</i> sparse mid woodland	<i>Corymbia calophylla</i> isolated clumps of mid trees with occasional <i>Eucalyptus marginata</i> subsp. <i>thalassica</i> mid trees over <i>Xanthorrhoea preissii</i> sparse mid shrubland over * <i>Ehrharta calycina</i> and * <i>Briza maxima</i> sparse low grassland.	263.2 (8.7%)
Cc ²	<i>Corymbia</i> sparse mid woodland Dampland	<i>Corymbia calophylla</i> isolated mid trees over <i>Melaleuca preissiana</i> isolated low trees over <i>Xanthorrhoea preissii</i> sparse mid shrubland.	7.6 (0.3%)
Cc ³	<i>Corymbia</i> sparse mid woodland Dune slope	<i>Corymbia calophylla</i> mid woodland over <i>Banksia attenuata</i> and <i>Banksia ilicifolia</i> sparse low woodland over <i>Xanthorrhoea preissii</i> and <i>Macrozamia fraseri</i> sparse tall shrubland.	3.7 (0.1%)
Cc ⁴	<i>Corymbia</i> sparse mid woodland Dampland	<i>Corymbia calophylla</i> mid woodland over <i>Melaleuca preissiana</i> low woodland to sparse low woodland over <i>Dielsia stenostachya</i> closed mid rushland.	13.4 (0.4%)
Cc ⁵	<i>Corymbia</i> sparse mid woodland Flat plain	<i>Corymbia calophylla</i> mid woodland over <i>Xanthorrhoea preissii</i> and <i>Jacksonia furcellata</i> sparse tall shrubland over <i>Dasypogon bromeliifolius</i> , <i>Patersonia occidentalis</i> subsp. <i>occidentalis</i> , * <i>Ursinia anthemoides</i> low herbland.	45.1 (1.5%)
Cc ⁶	<i>Corymbia</i> sparse mid woodland Flat plain	<i>Corymbia calophylla</i> sparse mid woodland over <i>Banksia menziesii</i> , <i>Banksia attenuata</i> and <i>Nuytsia floribunda</i> sparse low woodland over <i>Xanthorrhoea preissii</i> sparse tall shrubland.	16.9 (0.6%)
Cc ⁷	<i>Corymbia</i> sparse mid woodland Plain on edge of dampland	<i>Corymbia calophylla</i> sparse mid woodland over <i>Banksia menziesii</i> , <i>Banksia attenuata</i> and occasional <i>Banksia ilicifolia</i> low woodland to sparse low woodland over <i>Hibbertia subvaginata</i> and <i>Petrophile linearis</i> sparse low shrubland.	4.9 (0.2%)

Unit code	Broad floristic formation and site preference	Vegetation association descriptions	Extent in flora study area (ha)
CcEm ¹	<i>Corymbia</i> sparse mid woodland Depression to low slopes	<i>Corymbia calophylla</i> and <i>Eucalyptus marginata</i> subsp. <i>thalassica</i> isolated clumps of mid trees over <i>Banksia attenuata</i> , <i>Banksia menziesii</i> and <i>Banksia ilicifolia</i> low woodland to sparse low woodland over <i>Xanthorrhoea brunonis</i> mid shrubland to open mid shrubland.	3.9 (0.1%)
CcEm ²	<i>Corymbia</i> sparse mid woodland Flat plain, gently sloping	<i>Corymbia calophylla</i> and <i>Eucalyptus marginata</i> subsp. <i>thalassica</i> mid woodland to sparse mid woodland over <i>Xanthorrhoea preissii</i> , <i>Calytrix fraseri</i> (Ellenbrook Form), <i>Verticordia nitens</i> sparse mid shrubland over <i>Hibbertia hypericoides</i> , <i>Eremaea pauciflora</i> var. <i>pauciflora</i> , <i>Scholtzia</i> aff. <i>involuta</i> open to sparse low shrubland.	92.5 (3.1%)
CcEr ¹	<i>Corymbia</i> sparse mid woodland	<i>Corymbia calophylla</i> and <i>Eucalyptus rudis</i> subsp. <i>rudis</i> isolated mid trees over <i>Astartea scoparia</i> and <i>Taxandria linearifolia</i> tall shrubland over * <i>Cenchrus clandestinus</i> and * <i>Holcus lanatus</i> closed low grassland.	9.3 (0.3%)
CcEr ²	<i>Corymbia</i> sparse mid woodland	<i>Corymbia calophylla</i> and <i>Eucalyptus rudis</i> subsp. <i>rudis</i> isolated clumps of low trees over <i>Jacksonia furcellata</i> sparse tall shrubland over * <i>Ehrharta calycina</i> , * <i>Bromus diandrus</i> and * <i>Ehrharta longiflora</i> closed mid grassland.	20.6 (0.7%)
CcMp	<i>Corymbia</i> sparse mid woodland Relatively flat, on edge of depression	<i>Corymbia calophylla</i> and <i>Melaleuca preissiana</i> sparse mid woodland over <i>Banksia attenuata</i> and <i>Banksia ilicifolia</i> sparse low woodland over <i>Kunzea glabrescens</i> open tall shrubland.	1.0 (0.1%)
CcMpMr	<i>Corymbia</i> sparse mid woodland Road and rail verge (Brand Highway)	<i>Corymbia calophylla</i> isolated clumps of mid trees over <i>Melaleuca preissiana</i> and <i>Melaleuca raphiophylla</i> isolated clumps of low trees over grassland dominated by introduced grasses.	11.1 (0.4%)
Co	<i>Melaleuca</i> open low woodland Palusplain	<i>Casuarina obesa</i> isolated low trees over <i>Melaleuca concreta</i> open tall shrubland over <i>Lepidosperma longitudinale</i> , <i>Juncus pallidus</i> , <i>Schoenus caespititius</i> open mid sedgeland.	5.2 (0.2%)
Em ¹	<i>Eucalyptus</i> sparse mid woodland Flat plain	<i>Eucalyptus marginata</i> subsp. <i>thalassica</i> isolated mid trees over <i>Melaleuca preissiana</i> and occasional <i>Banksia attenuata</i> and <i>Banksia ilicifolia</i> low woodland over <i>Xanthorrhoea preissii</i> , <i>Hypocalymma angustifolium</i> and <i>Astroloma xerophyllum</i> open to sparse mid shrubland.	7.6 (0.2%)

Unit code	Broad floristic formation and site preference	Vegetation association descriptions	Extent in flora study area (ha)
Em ²	<i>Eucalyptus</i> sparse mid woodland Low hill	<i>Eucalyptus marginata</i> subsp. <i>thalassica</i> sparse mid woodland over <i>Banksia menziesii</i> low woodland over <i>Xanthorrhoea preissii</i> sparse tall shrubland.	30.4 (1.0%)
Ep	<i>Banksia</i> sparse low woodland Flat plain	<i>Banksia</i> spp. sparse low woodland over <i>Eremaea pauciflora</i> subsp. <i>pauciflora</i> <i>Melaleuca striata</i> , <i>Beaufortia elegans</i> low shrubland over <i>Patersonia occidentalis</i> , <i>Dasyogon bromeliifolius</i> , sparse herbland.	4.8 (0.2%)
EpRi	<i>Banksia</i> sparse low woodland Dune slope	<i>Banksia</i> spp. sparse low woodland over <i>Eremaea pauciflora</i> , <i>Calytrix flavescens</i> and <i>Regelia inops</i> sparse low shrubland over <i>Patersonia occidentalis</i> , <i>Dasyogon bromeliifolius</i> and <i>Podotheca gnaphalioides</i> sparse herbland.	0.9 (0.1%)
Er ¹	<i>Eucalyptus</i> sparse mid woodland Palusplain	<i>Eucalyptus rudis</i> subsp. <i>rudis</i> and occasional <i>Corymbia calophylla</i> sparse mid woodland over <i>Astartea scoparia</i> , <i>Kunzea glabrescens</i> and <i>Aotus gracillima</i> open tall shrubland over <i>Desmocladius flexuosus</i> and <i>Dielsia stenostachya</i> isolated low rushes.	8.3 (0.3%)
Er ²	<i>Eucalyptus</i> sparse mid woodland Dampland/Palusplain	<i>Eucalyptus rudis</i> subsp. <i>rudis</i> isolated mid trees over <i>Astartea scoparia</i> , <i>Melaleuca teretifolia</i> and <i>Melaleuca lateritia</i> closed tall shrubland to open tall shrubland over <i>Lepidosperma longitundinale</i> and <i>Schoenus caespititius</i> sparse mid sedgeland.	4.8 (0.2%)
Er ³	<i>Eucalyptus</i> sparse mid woodland Dampland	<i>Eucalyptus rudis</i> subsp. <i>rudis</i> isolated mid trees over <i>Melaleuca preissiana</i> , <i>Banksia littoralis</i> and occasional <i>Melaleuca raphiophylla</i> sparse low woodland over <i>Astartea scoparia</i> , <i>Melaleuca teretifolia</i> and <i>Hypocalymma angustifolium</i> closed tall shrubland to tall shrubland.	12.8 (0.4%)
Er ⁴	<i>Eucalyptus</i> sparse mid woodland Floodplain	<i>Eucalyptus rudis</i> subsp. <i>rudis</i> open mid forest over <i>Hardenbergia comptoniana</i> open tall shrubland over <i>Pteridium esculentum</i> subsp. <i>esculentum</i> tall herbland.	3.5 (0.1%)
Er ⁵	<i>Eucalyptus</i> sparse mid woodland Creepline/floodplain	<i>Eucalyptus rudis</i> subsp. <i>rudis</i> sparse mid woodland over <i>Melaleuca preissiana</i> and <i>Melaleuca raphiophylla</i> low woodland over <i>*Zantedeschia aethiopica</i> and <i>*Rorippa nasturtium-aquaticum</i> open mid herbland.	0.9 (0.1%)

Unit code	Broad floristic formation and site preference	Vegetation association descriptions	Extent in flora study area (ha)
Er ⁶	<i>Eucalyptus</i> sparse mid woodland Creekline/floodplain	<i>Eucalyptus rudis</i> subsp. <i>rudis</i> sparse mid woodland over <i>Melaleuca raphiophylla</i> sparse low woodland over * <i>Lolium rigidum</i> , * <i>Ehrharta longiflora</i> and * <i>Cenchrus clandestinus</i> low grassland.	51.8 (1.7%)
Er ⁷	<i>Eucalyptus</i> sparse mid woodland Creekline/floodplain	<i>Eucalyptus rudis</i> subsp. <i>rudis</i> sparse mid woodland over * <i>Zantedeschia aethiopica</i> tall herbland over low grassland (dominated by introduced species).	4.4 (0.1%)
Er ⁸	<i>Eucalyptus</i> sparse mid woodland Creekline/floodplain	<i>Eucalyptus rudis</i> subsp. <i>rudis</i> , <i>Corymbia calophylla</i> sparse mid woodland over <i>Melaleuca preissiana</i> and <i>Melaleuca raphiophylla</i> isolated clumps of low trees over * <i>Holcus lanatus</i> and * <i>Cenchrus clandestinus</i> closed mid grassland.	5.5 (0.2%)
ErCo	<i>Eucalyptus</i> sparse mid woodland Floodplain	<i>Eucalyptus rudis</i> subsp. <i>rudis</i> , <i>Casuarina obesa</i> and <i>Melaleuca</i> sp. open low forest over * <i>Ehrharta longiflora</i> , * <i>Ehrharta calycina</i> and * <i>Lolium rigidum</i> low grassland over * <i>Lotus subbiflorus</i> and * <i>Moraea flaccida</i> sparse low herbland.	4.7 (0.2%)
ErMp	<i>Eucalyptus</i> sparse mid woodland Sumpland	<i>Eucalyptus rudis</i> subsp. <i>rudis</i> and <i>Melaleuca preissiana</i> sparse mid woodland over * <i>Acacia longifolia</i> subsp. <i>longifolia</i> closed tall shrubland over <i>Astartea scoparia</i> sparse mid shrubland.	11.7 (0.4%)
ErMrMc	<i>Eucalyptus</i> sparse mid woodland Floodplain	<i>Eucalyptus rudis</i> subsp. <i>rudis</i> , <i>Melaleuca raphiophylla</i> and <i>Melaleuca concreta</i> open low forest over * <i>Moraea flaccida</i> sparse mid herbland over * <i>Lolium rigidum</i> , * <i>Ehrharta longiflora</i> and * <i>Cynodon dactylon</i> mid grassland.	2.3 (0.1%)
Et ¹	<i>Eucalyptus</i> sparse mid woodland Dune rise	<i>Eucalyptus tottiana</i> isolated mid mallee trees over <i>Banksia attenuata</i> , <i>Banksia menziesii</i> and <i>Nuytsia floribunda</i> sparse low woodland over <i>Allocasuarina humilis</i> , <i>Jacksonia floribunda</i> and <i>Stirlingia latifolia</i> sparse mid shrubland.	13.8 (0.5%)

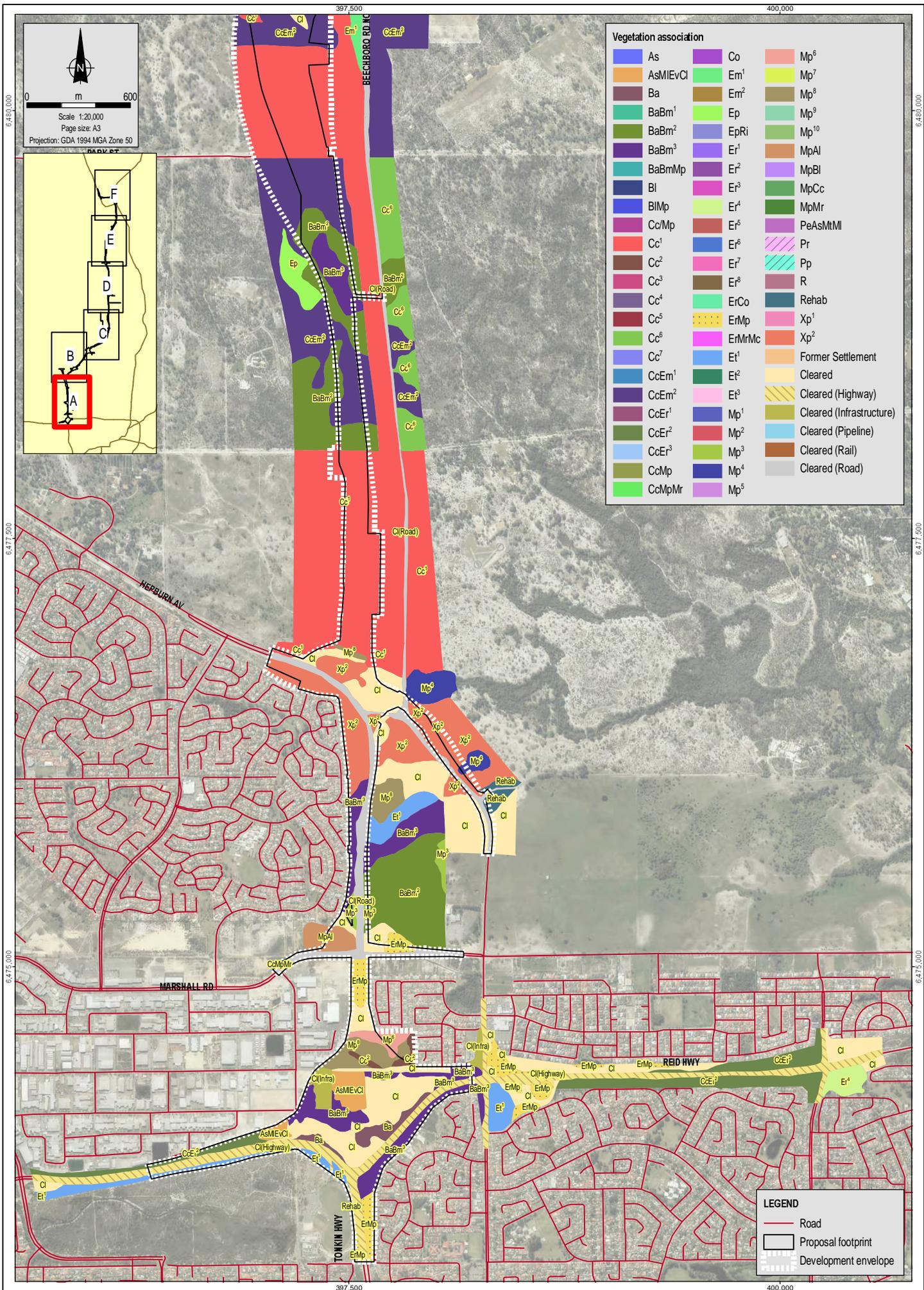
Unit code	Broad floristic formation and site preference	Vegetation association descriptions	Extent in flora study area (ha)
Et ²	<i>Eucalyptus</i> sparse mid woodland Dune slopes, crests and flats	<i>Eucalyptus tottiana</i> isolated mid mallee trees over <i>Banksia attenuata</i> , <i>Banksia menziesii</i> and <i>Nuytsia floribunda</i> sparse low woodland over <i>Verticordia nitens</i> , <i>Beaufortia elegans</i> , <i>Jacksonia floribunda</i> sparse mid shrubland.	81.9 (2.7%)
Et ³	<i>Eucalyptus</i> sparse mid woodland Dune rise	<i>Eucalyptus tottiana</i> sparse mid mallee trees over <i>Banksia attenuata</i> , <i>Banksia menziesii</i> and <i>Banksia ilicifolia</i> sparse low woodland over <i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i> and <i>Jacksonia furcellata</i> sparse tall shrubland.	20.5 (0.7%)
Mp ¹	<i>Melaleuca</i> open low woodland Mound spring	<i>Melaleuca preissiana</i> closed low forest over <i>Histiopteris incisa</i> and <i>Pteridium esculentum</i> subsp. <i>esculentum</i> sparse tall herbland over <i>Cyathochaeta teretifolia</i> open mid sedgeland.	1.5 (0.1%)
Mp ²	<i>Melaleuca</i> open low woodland Transitional dampland/dryland	<i>Melaleuca preissiana</i> isolated mid trees over <i>Banksia attenuata</i> , <i>Banksia menziesii</i> and occasional <i>Banksia ilicifolia</i> sparse low woodland over <i>Xanthorrhoea preissii</i> , <i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i> and <i>Hypocalymma angustifolium</i> mid shrubland.	8.5 (0.3%)
Mp ³	<i>Melaleuca</i> open low woodland Dampland	<i>Melaleuca preissiana</i> low woodland over <i>Astartea scoparia</i> , <i>Taxandria linearifolia</i> and <i>Aotus gracillima</i> open tall shrubland over <i>Cyathochaeta avenacea</i> and <i>Juncus pallidus</i> open tall sedgeland.	5.3 (0.2%)
Mp ⁴	<i>Melaleuca</i> open low woodland Dampland/depression	<i>Melaleuca preissiana</i> mid woodland over <i>Banksia littoralis</i> sparse low woodland over <i>Lepidosperma striatum</i> and <i>Lepidosperma longitudinale</i> closed tall sedgeland.	12.5 (0.4%)
Mp ⁵	<i>Melaleuca</i> open low woodland Depression	<i>Melaleuca preissiana</i> low open woodland over <i>Astartea scoparia</i> , <i>Eutaxia virgata</i> and <i>Hypocalymma angustifolium</i> open low shrubland over <i>Cyathochaeta avenacea</i> and <i>Lepyrodia glauca</i> open low sedgeland.	1.4 (0.1%)
Mp ⁶	<i>Melaleuca</i> open low woodland Dampland	<i>Melaleuca preissiana</i> sparse low woodland over <i>Pericalymma crassipes</i> , <i>Hypocalymma angustifolium</i> and <i>Xanthorrhoea preissii</i> open tall shrubland over <i>Lepidosperma striatum</i> and <i>Lepidosperma longitudinale</i> tall sedgeland.	2.7 (0.1%)
Mp ⁷	<i>Melaleuca</i> open low woodland	<i>Melaleuca preissiana</i> sparse to open low woodland over * <i>Zantedeschia aethiopica</i> sparse tall herbland over * <i>Cenchrus clandestinus</i> and * <i>Holcus lanatus</i> sparse mid grassland.	3.0 (0.1%)

Unit code	Broad floristic formation and site preference	Vegetation association descriptions	Extent in flora study area (ha)
Mp ⁸	<i>Melaleuca</i> open low woodland	<i>Melaleuca preissiana</i> sparse to open low woodland over <i>Xanthorrhoea preissii</i> sparse mid shrubland over <i>Lepidosperma longitudinale</i> sparse mid sedgeland.	9.4 (0.3%)
Mp ⁹	<i>Melaleuca</i> open low woodland Dampland	<i>Melaleuca preissiana</i> sparse to open low woodland over <i>Xanthorrhoea preissii</i> tall shrubland over <i>Astartea scoparia</i> and <i>Taxandria linearifolia</i> sparse mid shrubland.	0.9 (0.1%)
Mp ¹⁰	<i>Melaleuca</i> open low woodland Dampland	<i>Melaleuca preissiana</i> open low woodland to forest over <i>Juncus kraussii</i> subsp. <i>australiensis</i> sparse mid sedgeland over * <i>Cynodon dactylon</i> open low grassland.	4.6 (0.2%)
MpAl	<i>Melaleuca</i> open low woodland	<i>Melaleuca preissiana</i> and * <i>Acacia longifolia</i> subsp. <i>longifolia</i> sparse low woodland over <i>Xanthorrhoea preissii</i> sparse mid shrubland over * <i>Bromus diandrus</i> , * <i>Ehrharta calycina</i> and * <i>Avena barbata</i> tall grassland.	4.3 (0.1%)
MpBl	<i>Melaleuca</i> open low woodland Dampland	<i>Melaleuca preissiana</i> and <i>Banksia littoralis</i> open low woodland to forest over <i>Melaleuca lateritia</i> and <i>Melaleuca teretifolia</i> sparse mid shrubland over <i>Schoenus caespitius</i> sparse mid sedgeland.	5.4 (0.2%)
MpCc	<i>Melaleuca</i> open low woodland Wetland slope, depression	<i>Melaleuca preissiana</i> and <i>Corymbia calophylla</i> sparse mid woodland over <i>Astartea scoparia</i> and <i>Hypocalymma angustifolium</i> open mid shrubland.	1.3 (0.1%)
MpMr	<i>Melaleuca</i> open low woodland	<i>Melaleuca preissiana</i> and <i>Melaleuca raphiophylla</i> low (open) woodland over * <i>Zantedeschia aethiopica</i> and * <i>Typha orientalis</i> open mid herbland.	6.0 (0.2%)
PeAsMtMI	<i>Astartea</i> tall shrubland to open tall shrubland Dampland	<i>Pericalymma ellipticum</i> var. <i>floridum</i> , <i>Astartea scoparia</i> and <i>Melaleuca teretifolia</i> tall shrubland.	8.4 (0.3%)
Pr	<i>Eucalyptus</i> sparse mid woodland Dune crest	* <i>Pinus radiata</i> sparse low woodland over <i>Eucalyptus todtiana</i> isolated mid mallee trees over <i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i> and <i>Macrozamia fraseri</i> sparse tall shrubland.	8.6 (0.3%)
Xp ¹	<i>Xanthorrhoea</i> open tall shrubland	<i>Xanthorrhoea preissii</i> tall open shrubland over * <i>Ehrharta calycina</i> sparse mid grassland.	8.4 (0.3%)

Unit code	Broad floristic formation and site preference	Vegetation association descriptions	Extent in flora study area (ha)
Xp ²	<i>Xanthorrhoea</i> open tall shrubland	<i>Xanthorrhoea preissii</i> sparse mid shrubland to open tall shrubland.	35.3 (1.2%)
Other mapping units			
CcEr ³	<i>Corymbia</i> sparse mid woodland	Open paddocks with remnant <i>Corymbia calophylla</i> and <i>Eucalyptus rudis</i> subsp. <i>rudis</i> over pasture species (introduced) dominated by * <i>Cenchrus clandestinus</i> .	629.1 (20.8%)
Cl	N/A	Cleared areas, consisting of paddocks, infrastructure corridors (i.e. Roads and Highways), building envelopes (i.e. residential housing, industry etc.) and the former Ellenbrook settlement (within Rocla mine tenement). Includes mapping units Cleared (Highway), Cleared (Infrastructure), Cleared (Pipeline), Cleared (Road), Cleared (Rail) and Former Settlement.	1,105.3 (36.5%)
Pp	<i>Pinus</i> mid woodland	* <i>Pinus pinaster</i> plantation.	74.6 (2.5%)
R	<i>Corymbia</i> sparse mid woodland	<i>Corymbia calophylla</i> , <i>Eucalyptus camaldulensis</i> and <i>Eucalyptus todtiana</i> low woodland over <i>Calothamnus quadrifidus</i> and <i>Banksia nivea</i> sparse mid shrubland over * <i>Bromus diandrus</i> and * <i>Ehrharta calycina</i> sparse mid grassland over * <i>Ursinia anthemoides</i> and * <i>Hypochaeris glabra</i> sparse low herbland (Revegetation site).	31.7 (1.0%)
Rehab	N/A	Rehabilitation sites associated with Rocla mine site and other sites of rehabilitation, including road sides.	11.2 (0.4%)

Source: Coffey (2015a) (Appendix C).

* Introduced (weed) species.



Vegetation association

As	Co	Mp ⁶
AsMEVCl	Em ¹	Mp ⁷
Ba	Em ²	Mp ⁸
BaBm ¹	Ep	Mp ⁹
BaBm ²	EpRi	Mp ¹⁰
BaBm ³	Er ¹	MpAI
BaBmMp	Er ²	MpBl
Bl	Er ³	MpCc
BlMp	Er ⁴	MpMr
Cc/Mp	Er ⁵	PeAsMtM
Cc ¹	Er ⁶	Pr
Cc ²	Er ⁷	Pp
Cc ³	Er ⁸	R
Cc ⁴	ErCo	Rehab
Cc ⁵	ErMp	Xp ¹
Cc ⁶	ErMrMc	Xp ²
Cc ⁷	Et ¹	Former Settlement
CcEm ¹	Et ²	Cleared
CcEm ²	Et ³	Cleared (Highway)
CcEr ¹	Mp ¹	Cleared (Infrastructure)
CcEr ²	Mp ²	Cleared (Pipeline)
CcEr ³	Mp ³	Cleared (Rail)
CcMp	Mp ⁴	Cleared (Road)
CcMpMr	Mp ⁵	

LEGEND

	Road
	Proposal footprint
	Development envelope

Source & Notes
 Vegetation association mapping from Coffey (January 2015)
 Aerial imagery from Landgate (August 2014)

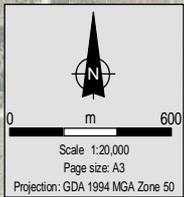


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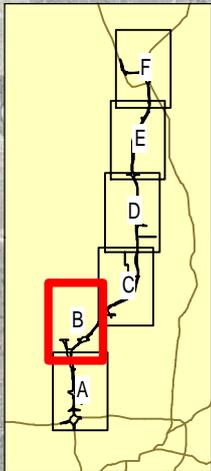
Vegetation association mapping
 Map 1 of 6

Figure No:
 8.2A



Vegetation association

As	Co	Mp ⁶
AsMI/EvCl	Em ¹	Mp ⁷
Ba	Em ²	Mp ⁸
BaBm ¹	Ep	Mp ⁹
BaBm ²	EpRi	Mp
BaBm ³	Er ¹	MpAI
BaBmMp	Er ²	MpBI
BI	Er ³	MpCc
BI/Mp	Er ⁴	MpMr
Cc/Mp	Er ⁵	PeAsMIMI
Cc ¹	Er ⁶	Pr
Cc ²	Er ⁷	Pp
Cc ³	Er ⁸	R
Cc ⁴	ErCo	Rehab
Cc ⁵	ErMp	Xp ¹
Cc ⁶	ErMrMc	Xp ²
Cc ⁷	Et ¹	Former Settlement
CcEm ¹	Et ²	Cleared
CcEm ²	Et ³	Cleared (Highway)
CcEr ¹	Mp ¹	Cleared (Infrastructure)
CcEr ²	Mp ²	Cleared (Pipeline)
CcEr ³	Mp ³	Cleared (Rail)
CcMp	Mp ⁴	Cleared (Road)
CcMpMr	Mp ⁵	



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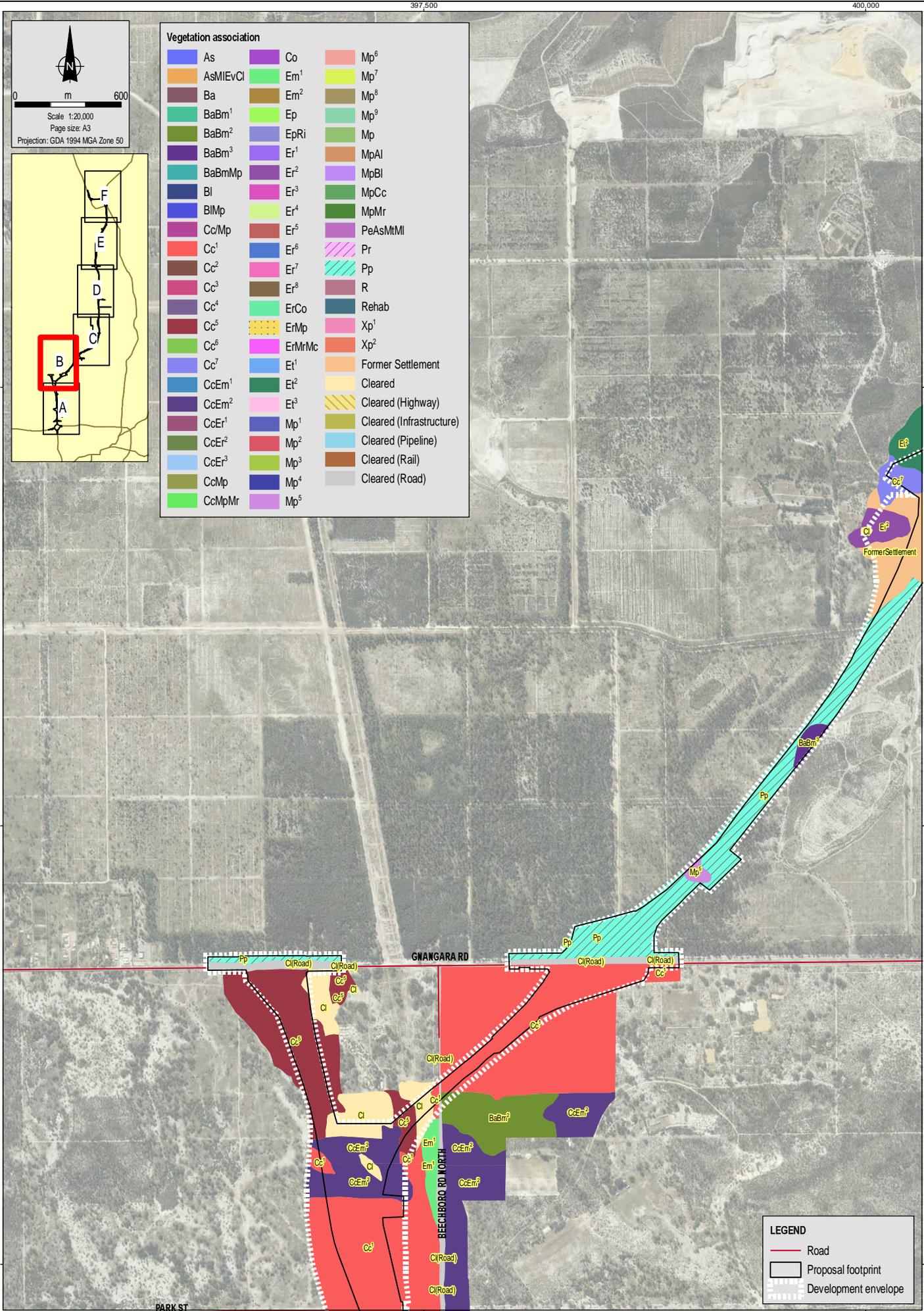
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6,482,500

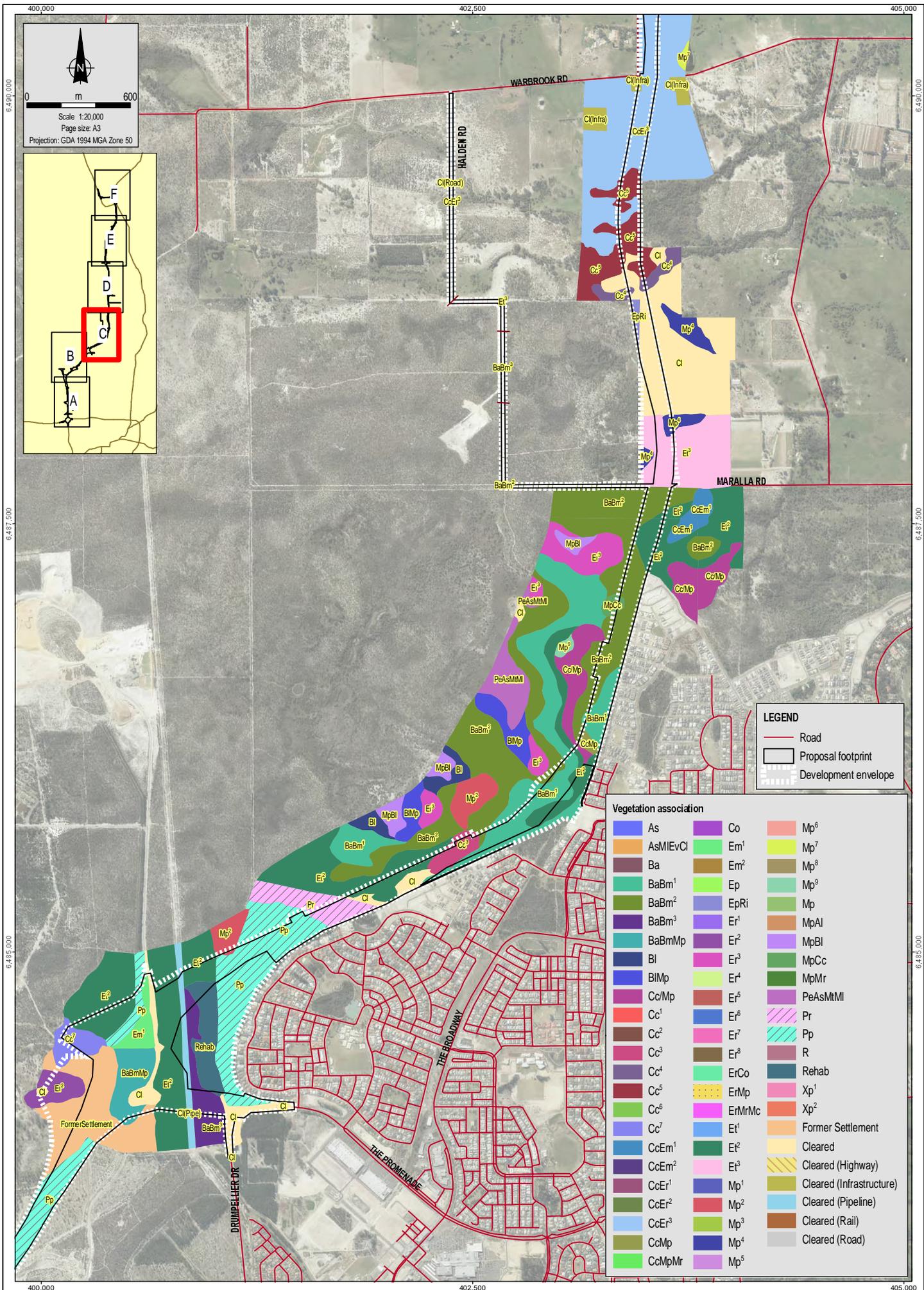
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6,480,000



LEGEND

	Road
	Proposal footprint
	Development envelope



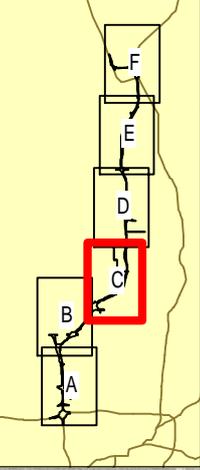
LEGEND

- Road
- Proposal footprint
- Development envelope

Vegetation association

As	Co	Mp ⁶
AsMIEVCl	Em ¹	Mp ⁷
Ba	Em ²	Mp ⁸
BaBm ¹	Ep	Mp ⁹
BaBm ²	EpRi	Mp
BaBm ³	Er ¹	MpAl
BaBmMp	Er ²	MpBl
Bl	Er ³	MpCc
BlMp	Er ⁴	MpMr
Cc/Mp	Er ⁵	PeAsMMI
Cc ¹	Er ⁶	Pr
Cc ²	Er ⁷	Pp
Cc ³	Er ⁸	R
Cc ⁴	ErCo	Rehab
Cc ⁵	ErMp	Xp ¹
Cc ⁶	ErMrMc	Xp ²
Cc ⁷	Et ¹	Former Settlement
CcEm ¹	Et ²	Cleared
CcEm ²	Et ³	Cleared (Highway)
CcEr ¹	Mp ¹	Cleared (Infrastructure)
CcEr ²	Mp ²	Cleared (Pipeline)
CcEr ³	Mp ³	Cleared (Rail)
CcMp	Mp ⁴	Cleared (Road)
CcMpMr	Mp ⁵	

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Projection: GDA 1994 MGA Zone 50



Source & Notes
Vegetation association mapping from Coffey (January 2015)
Aerial imagery from Landgate (August 2014)

NorthLinkWA

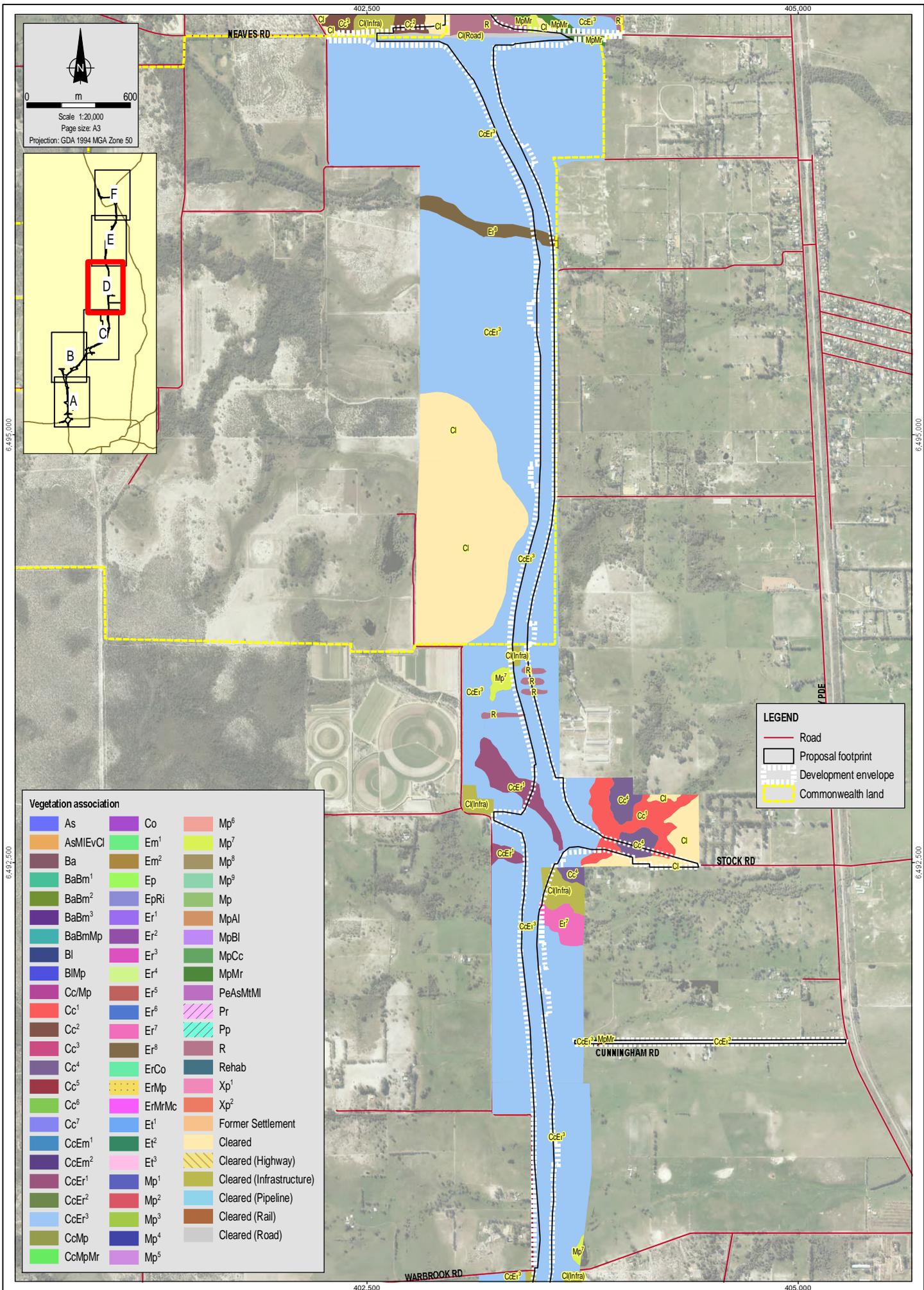
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Vegetation association mapping
Map 3 of 6

Figure No: 8.2C



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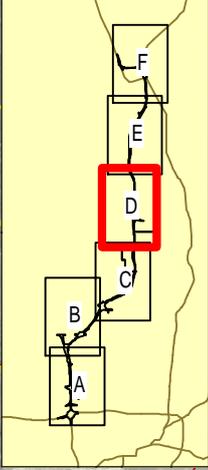
- Road
- Proposal footprint
- Development envelope
- Commonwealth land

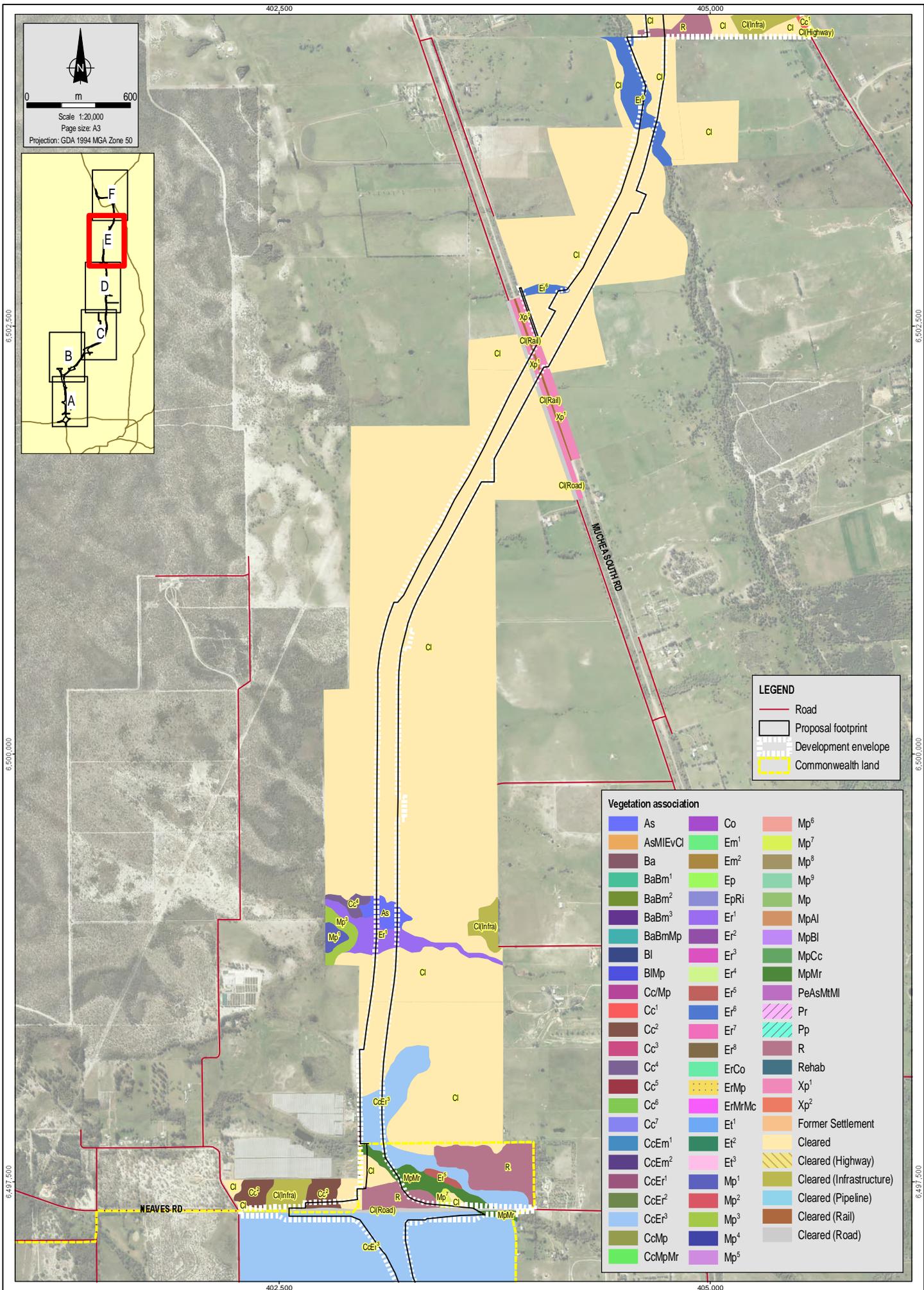
Vegetation association

As	Co	Mp ⁶
AsMIvCI	Em ¹	Mp ⁷
Ba	Em ²	Mp ⁸
BaBm ¹	Ep	Mp ⁹
BaBm ²	EpRi	Mp
BaBm ³	Er ¹	MpAl
BaBmMp	Er ²	MpBl
Bl	Er ³	MpCc
BlMp	Er ⁴	MpMr
Cc/Mp	Er ⁵	PeAsMtMI
Cc ¹	Er ⁶	Pr
Cc ²	Er ⁷	Pp
Cc ³	Er ⁸	R
Cc ⁴	ErCo	Rehab
Cc ⁵	ErMp	Xp ¹
Cc ⁶	ErMrMc	Xp ²
Cc ⁷	Et ¹	Former Settlement
CcEm ¹	Et ²	Cleared
CcEm ²	Et ³	Cleared (Highway)
CcEr ¹	Mp ¹	Cleared (Infrastructure)
CcEr ²	Mp ²	Cleared (Pipeline)
CcEr ³	Mp ³	Cleared (Rail)
CcMp	Mp ⁴	Cleared (Road)
CcMpMr	Mp ⁵	

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Projection: GDA 1994 MGA Zone 50





LEGEND

- Road
- Proposal footprint
- Development envelope
- Commonwealth land

Vegetation association

As	Co	Mp ⁶
AsMIEvCI	Em ¹	Mp ⁷
Ba	Em ²	Mp ⁸
BaBm ¹	Ep	Mp ⁹
BaBm ²	EpRi	Mp
BaBm ³	Er ¹	MpAI
BaBmMp	Er ²	MpBI
BI	Er ³	MpCc
BIMp	Er ⁴	MpMr
Cc/Mp	Er ⁵	PeAsMtMI
Cc ¹	Er ⁶	Pr
Cc ²	Er ⁷	Pp
Cc ³	Er ⁸	R
Cc ⁴	ErCo	Rehab
Cc ⁵	ErMp	Xp ¹
Cc ⁶	ErMrMc	Xp ²
Cc ⁷	Ei ¹	Former Settlement
CcEm ¹	Ei ²	Cleared
CcEm ²	Ei ³	Cleared (Highway)
CcEr ¹	Mp ¹	Cleared (Infrastructure)
CcEr ²	Mp ²	Cleared (Pipeline)
CcEr ³	Mp ³	Cleared (Rail)
CcMp	Mp ⁴	Cleared (Road)
CcMpMr	Mp ⁵	

Source & Notes
 Vegetation association mapping from Coffey (January 2015)
 Aerial imagery from Landgate (August 2014)

NorthLinkWA

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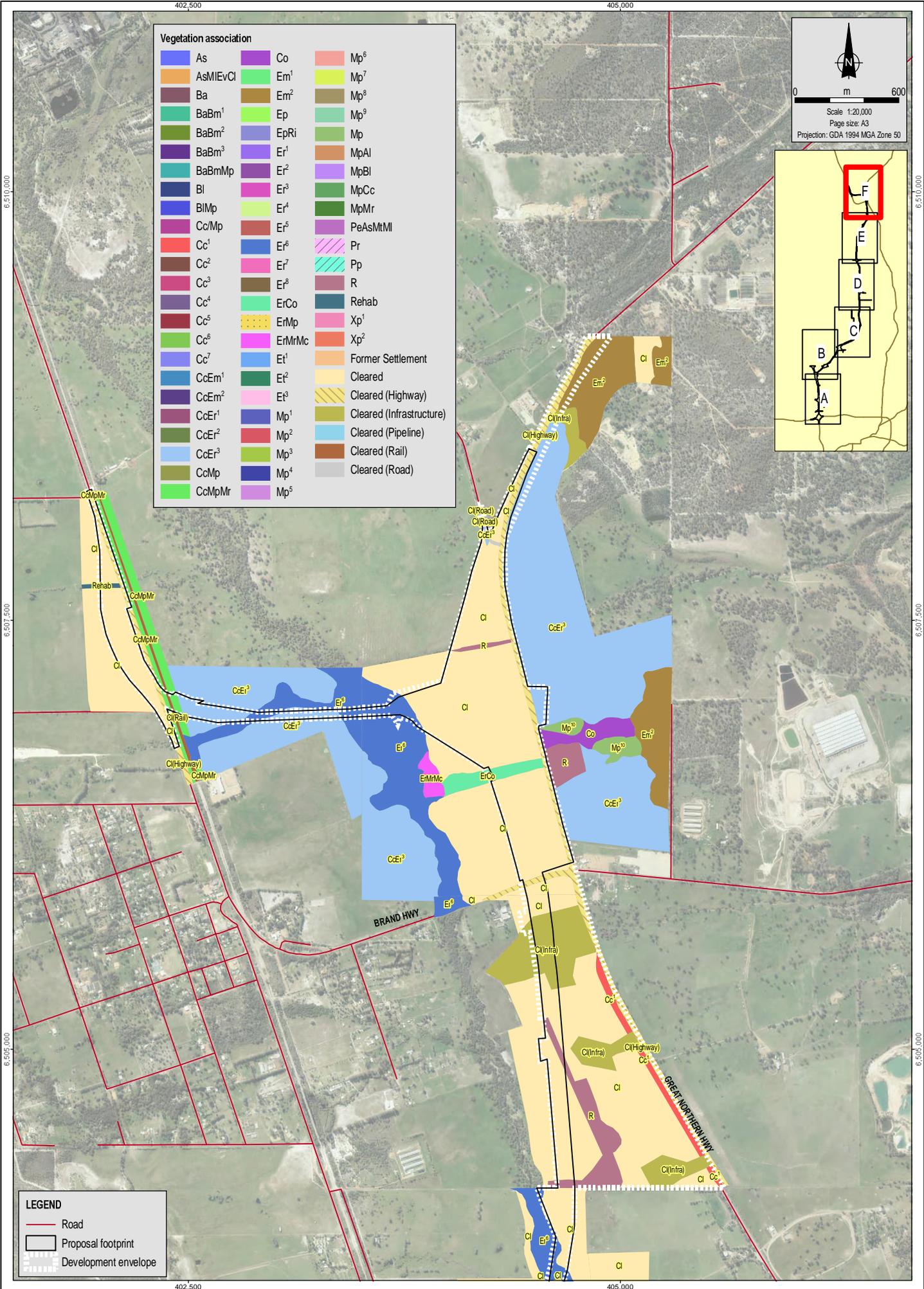
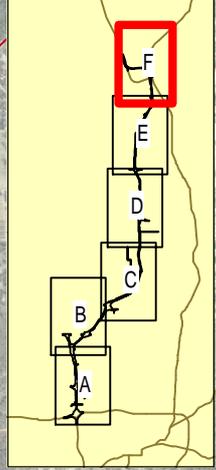
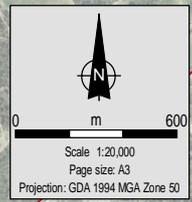
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Vegetation association mapping
Map 5 of 6

Figure No:
8.2E

Vegetation association

As	Co	Mp ⁶
AsMIvCI	Em ¹	Mp ⁷
Ba	Em ²	Mp ⁸
BaBm ¹	Ep	Mp ⁹
BaBm ²	EpRi	Mp
BaBm ³	Er ¹	MpAI
BaBmMp	Er ²	MpBI
BI	Er ³	MpCc
BlMp	Er ⁴	MpMr
Cc/Mp	Er ⁵	PeAsMtMI
Cc ¹	Er ⁶	Pr
Cc ²	Er ⁷	Pp
Cc ³	Er ⁸	R
Cc ⁴	ErCo	Rehab
Cc ⁵	ErMp	Xp ¹
Cc ⁶	ErMrMc	Xp ²
Cc ⁷	Et ¹	Former Settlement
CcEm ¹	Et ²	Cleared
CcEm ²	Et ³	Cleared (Highway)
CcEr ¹	Mp ¹	Cleared (Infrastructure)
CcEr ²	Mp ²	Cleared (Pipeline)
CcEr ³	Mp ³	Cleared (Rail)
CcMp	Mp ⁴	Cleared (Road)
CcMpMr	Mp ⁵	



LEGEND

- Road
- ▭ Proposal footprint
- ▭ Development envelope

8.2.6 Floristic Community Types

The floristic data collected from the flora study area were compared against the floristic data from Gibson et al. (1994) and the floristic data for the SCP (Keighery et al., 2012) to determine the floristic community type (FCT) representation (Appendix C).

The sites sampled within the flora study area aligned with 20 separate FCTs (Table 8.4). The location of the FCTs across the flora study area and proposal footprint is provided on Figure 8.3. SCP21c was the most represented type across the flora study area with 23 sites, followed by SCP11 with 17 sites and SCP23b with 14 sites.

Table 8.4 Floristic community type determination

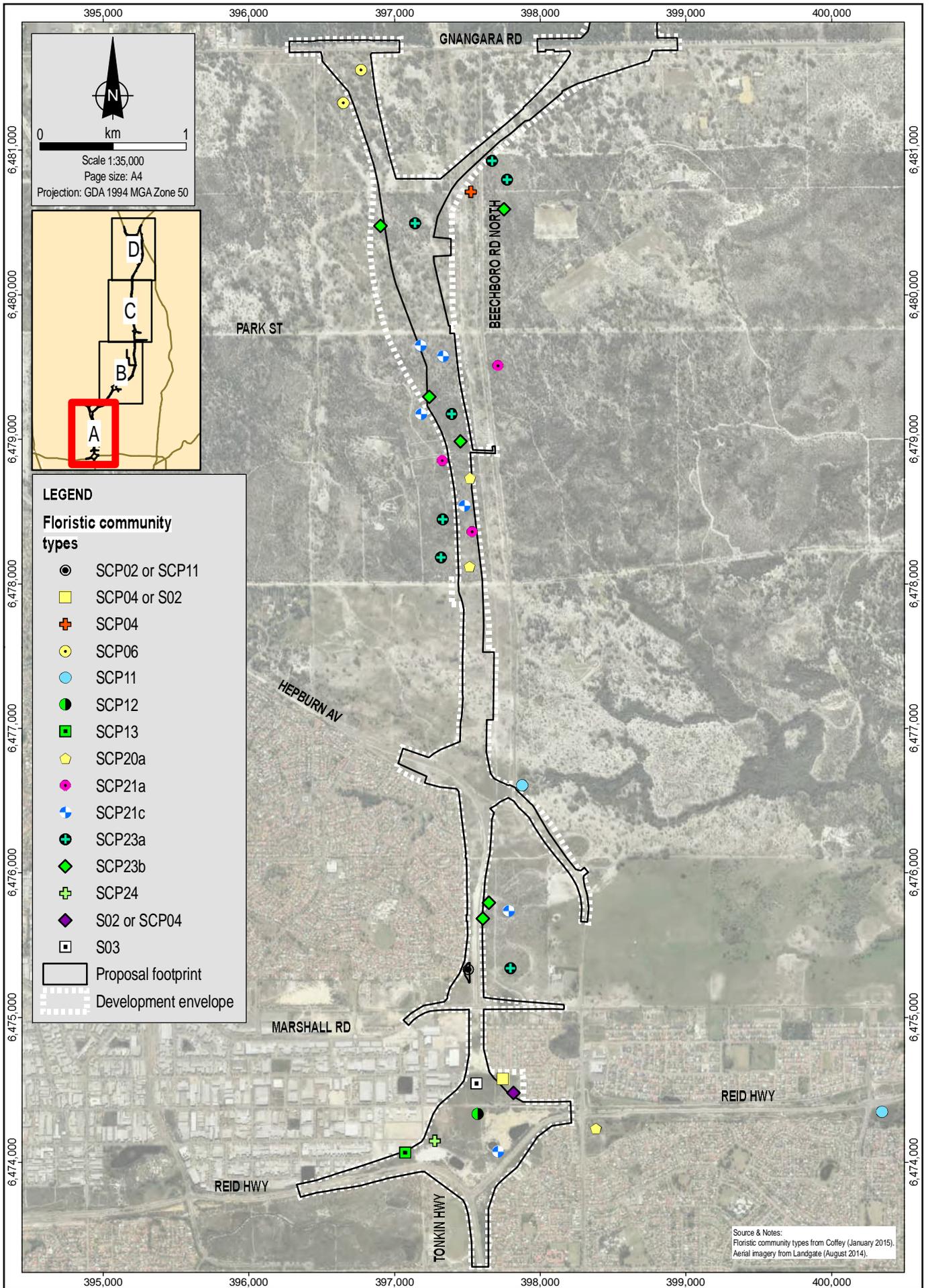
FCT	Description	State listing ¹
S02	Northern <i>Pericalymma ellipticum</i> dense low shrublands	–
S03	Wet sedgeland on sandy clays	–
S09	<i>Banksia attenuata</i> woodlands over dense low shrublands	–
SCP02	Southern wet shrublands	TEC (EN)
SCP04	<i>Melaleuca preissiana</i> damplands	–
SCP05	Mixed shrub damplands	–
SCP06	Weed dominated wetlands on heavy soils	–
SCP11	Wet forests and woodlands	–
SCP12	<i>Melaleuca teretifolia</i> and/or <i>Astartea aff. fascicularis</i> shrublands	–
SCP13	Deeper wetlands on heavy soils	–
SCP14	Deeper wetlands on sandy soils	–
SCP17	<i>Melaleuca raphiophylla</i> – <i>Gahnia trifida</i> seasonal wetlands	–
SCP20a	<i>Banksia attenuata</i> woodlands over species rich dense shrublands	TEC (EN)
SCP21a	Central <i>Banksia attenuata</i> – <i>Eucalyptus marginata</i> woodlands	–
SCP21c	Low lying <i>Banksia attenuata</i> woodlands or shrublands	PEC (3)
SCP22	<i>Banksia ilicifolia</i> woodlands	PEC (2)
SCP23a	Central <i>Banksia attenuata</i> – <i>Banksia menziesii</i> woodlands	–
SCP23b	Northern <i>Banksia attenuata</i> – <i>Banksia menziesii</i> woodlands	PEC (3)
SCP24	Northern Spearwood shrublands and woodlands	PEC (3)
SCP28	Spearwood <i>Banksia attenuata</i> or <i>Banksia attenuata</i> – <i>Eucalyptus</i> woodlands	–

1. State listing definitions:

TEC (EN): Endangered Threatened Ecological Community.

PEC (2): Priority 2 Priority Ecological Community.

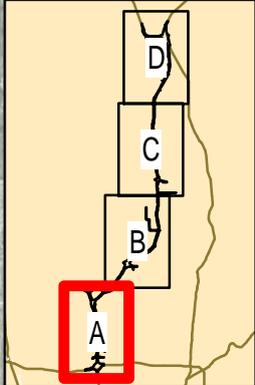
PEC (3): Priority 3 Priority Ecological Community.



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Projection: GDA 1994 MGA Zone 50



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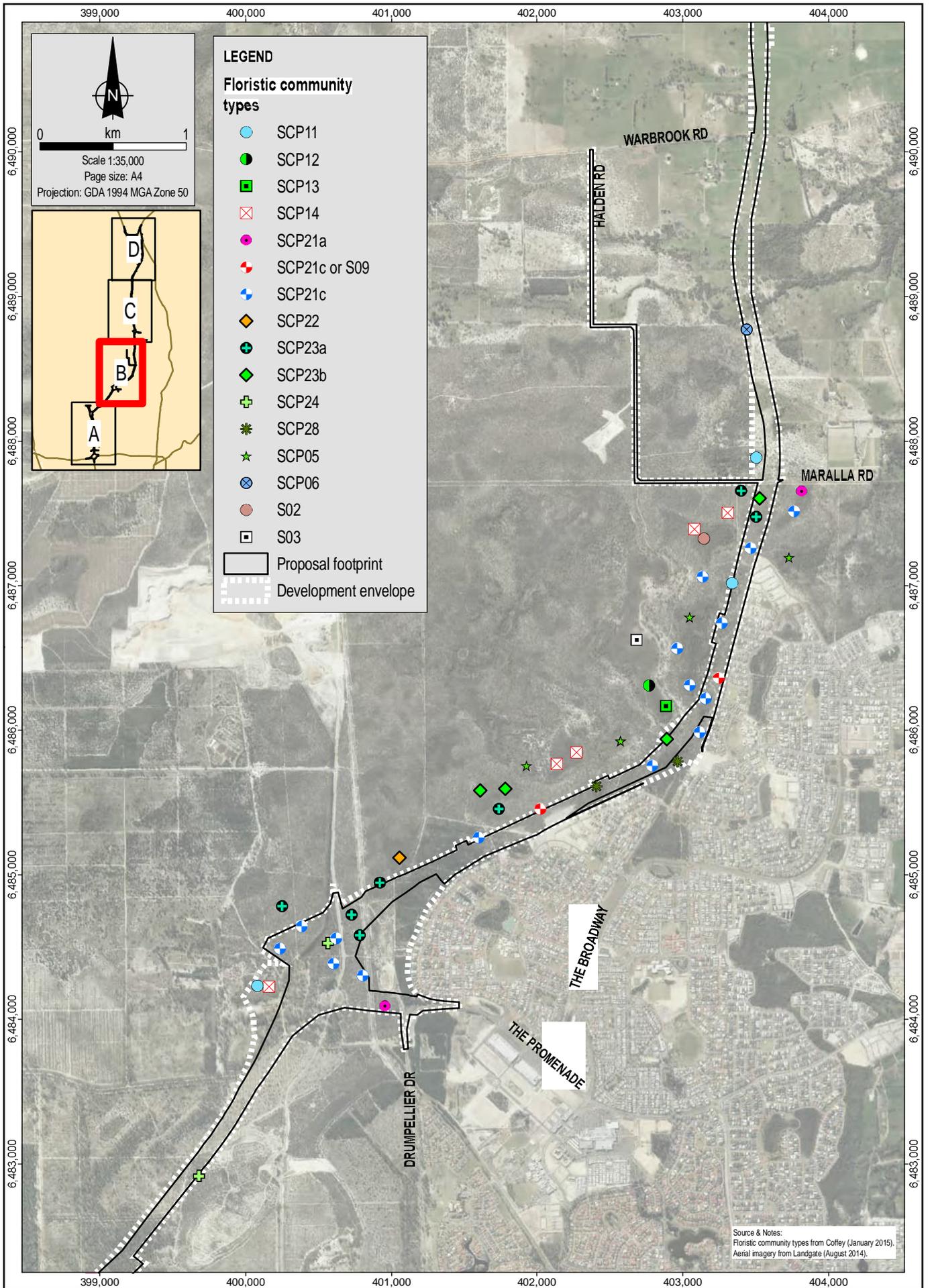
Floristic community types

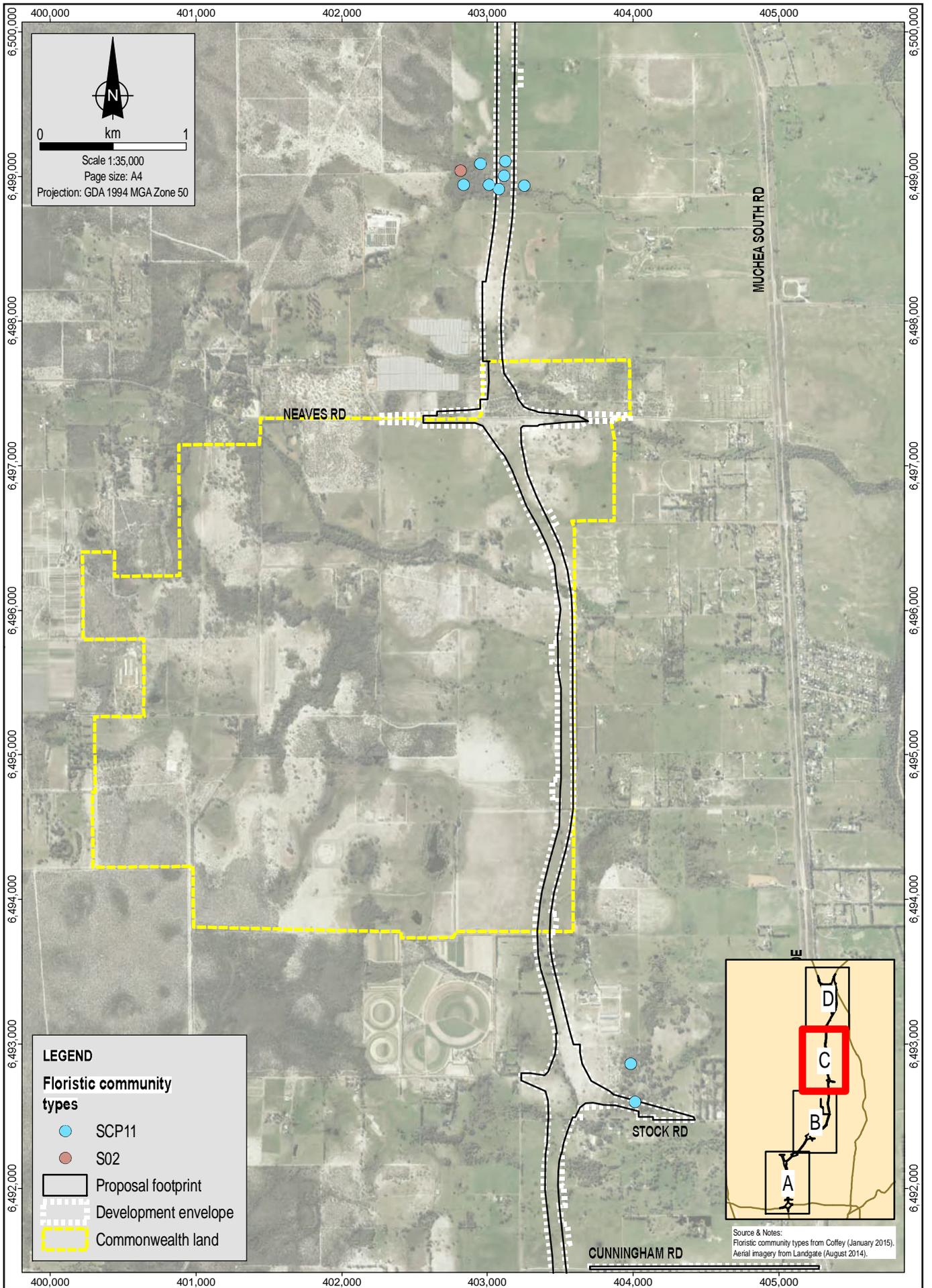
- SCP02 or SCP11
- SCP04 or S02
- ⊕ SCP04
- SCP06
- SCP11
- SCP12
- SCP13
- SCP20a
- SCP21a
- ⊕ SCP21c
- ⊕ SCP23a
- ◆ SCP23b
- ⊕ SCP24
- ◆ S02 or SCP04
- S03

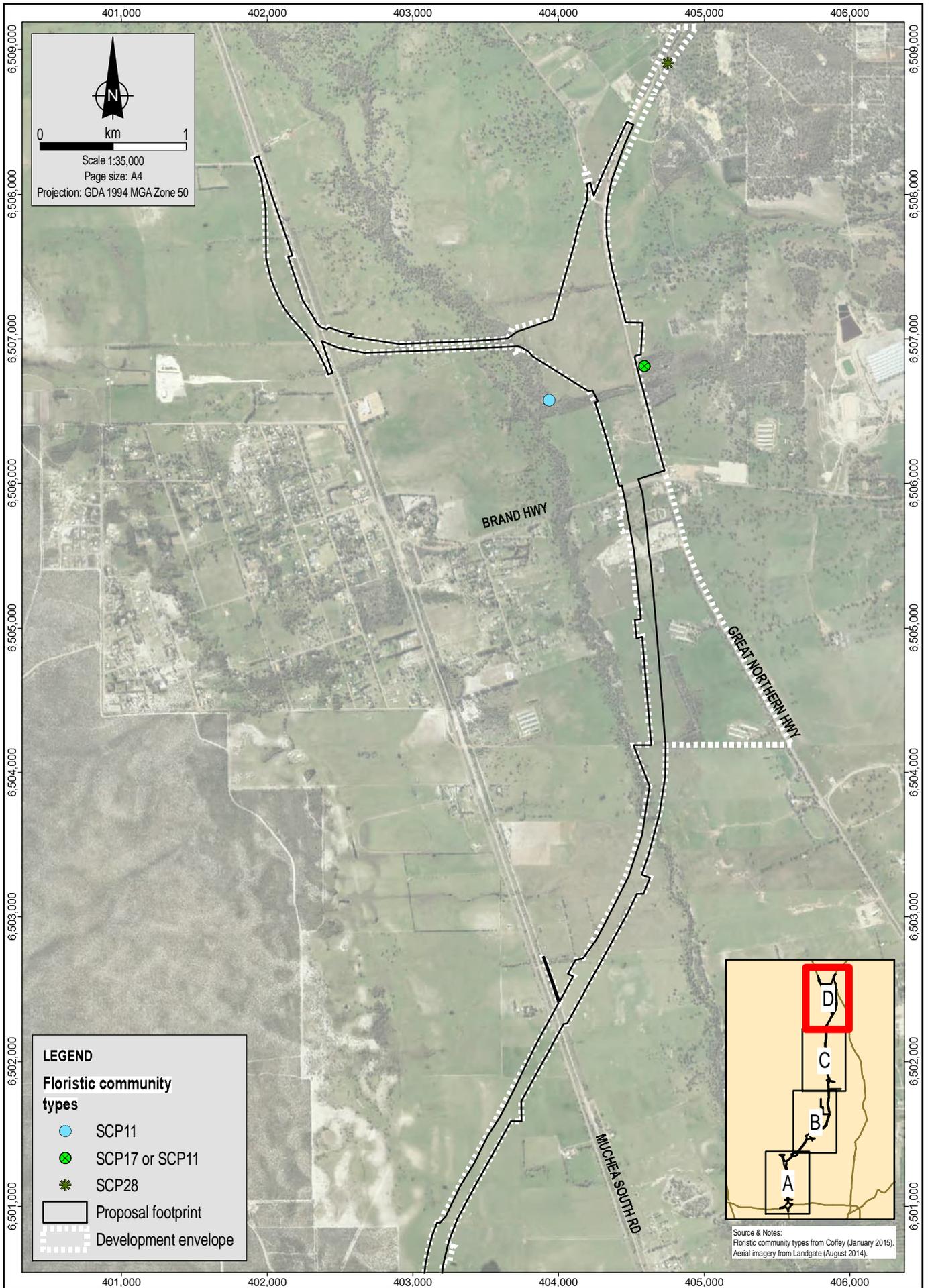
▭ Proposal footprint

▭ Development envelope

Source & Notes:
Floristic community types from Coffey (January 2015).
Aerial imagery from Landgate (August 2014).



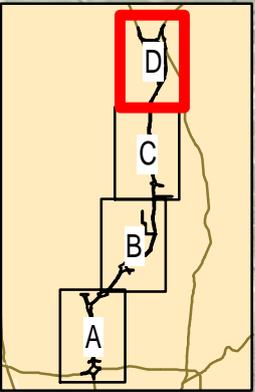




LEGEND

Floristic community types

- SCP11
- SCP17 or SCP18
- ✱ SCP28
- Proposal footprint
- Development envelope



Source & Notes:
 Floristic community types from Coffey (January 2015).
 Aerial imagery from Landgate (August 2014).

8.2.7 Threatened and Priority Ecological Communities

An ecological community is a naturally occurring group of plants, animals and other organisms interacting in a unique habitat. The complex range of interactions between the component species provides an important level of biological diversity in addition to genetics and species.

A desktop review of DPAW's Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) database (DPAW, 2015) and DOTE protected matters search tool for TECs (DOTE, 2014c) identified nine State listed TECs, five State listed PECs, and seven Commonwealth listed TECs as potentially occurring within the flora study area (Figure 8.4). The search parameters used for each search (DPAW and DOTE) are provided in Appendix C.

In addition to the known PECs and TECs, the survey and statistical analysis (Coffey, 2015a) recorded one State and Commonwealth listed TEC (Claypans of the SCP - Claypans with mid dense shrublands of *Melaleuca lateritia* over herbs or *Casuarina obesa* association) and one State PEC (*Banksia* dominated woodlands on the Swan Coastal Plain) from the flora study area (see Figure 8.4). The State (Critically Endangered) and Commonwealth (Endangered) listed TEC, Mound Springs SCP, occurs within the flora study area, and outside of the development envelope.

The location of the Commonwealth TEC, Claypans of the SCP, may represent either the Priority 1 PEC Claypans with mid dense shrublands of *Melaleuca lateritia* over herbs or the Priority 1 PEC *Casuarina obesa* association. For the purposes of this assessment, this community is considered as the Commonwealth TEC, Claypans of the SCP. One site sampled within the flora study area was considered to correspond with either FCT SCP11 or SCP17. However, based on the vegetation present and the location, this may be a misclassification due to the presence of introduced taxa (Appendix C).

The presence of *Casuarina obesa* in the upper storey may suggest the site is better placed within the Priority 1 PEC *Casuarina obesa* association. Alternatively, the presence of clay based soils and *Melaleuca lateritia* may also indicate that the site closely resembles the Priority 1 PEC Claypans with mid dense shrublands of *Melaleuca lateritia* over herbs. This PEC is also classified as Claypans of the Swan Coastal Plain under the EPBC Act and is ranked as Critically Endangered. The PEC occurs on claypans (predominantly basins) usually dominated by a shrubland of *Melaleuca lateritia* and can occur on both the coastal plain and the adjacent plateau. The claypans are characterised by aquatic (*Hydrocotyle lemnoides* – P4) and amphibious taxa (e.g. *Glossostigma diandrum*, *Villarsia capitata* and *Eleocharis keigheryi* – T).

The State TEC SCP02 was identified based on the multivariate statistical analysis. The sample site was considered to match both SCP02 and SCP11. Given the location, soil type and species representation it is unlikely to be the TEC SCP02. Further survey work is required to confirm if the site is consistent with SCP02. MRWA is committed to completing additional surveys in spring 2015, including the establishment of new quadrats and the sampling of existing quadrats, to determine the FCT. The survey design and timing will be determined in consultation with the Species and Communities Branch of DPAW. It is anticipated that further analysis on the potential TEC will be available in spring 2015. Survey results will be provided to the EPA as part of the response to submissions process to inform the EPA's assessment of the proposal.

The '*Banksia* dominated woodlands on the Swan Coastal Plain' is listed as a Priority 3 PEC. Based on the description, the relevant vegetation associations dominated by *Banksia attenuata* and *Banksia menziesii* on the SCP represent this PEC. *Banksia dominated woodlands on the Swan Coastal Plain* is also represented by TEC SCP20a and PECs SCP21c, SCP22, SCP23b and SCP24.

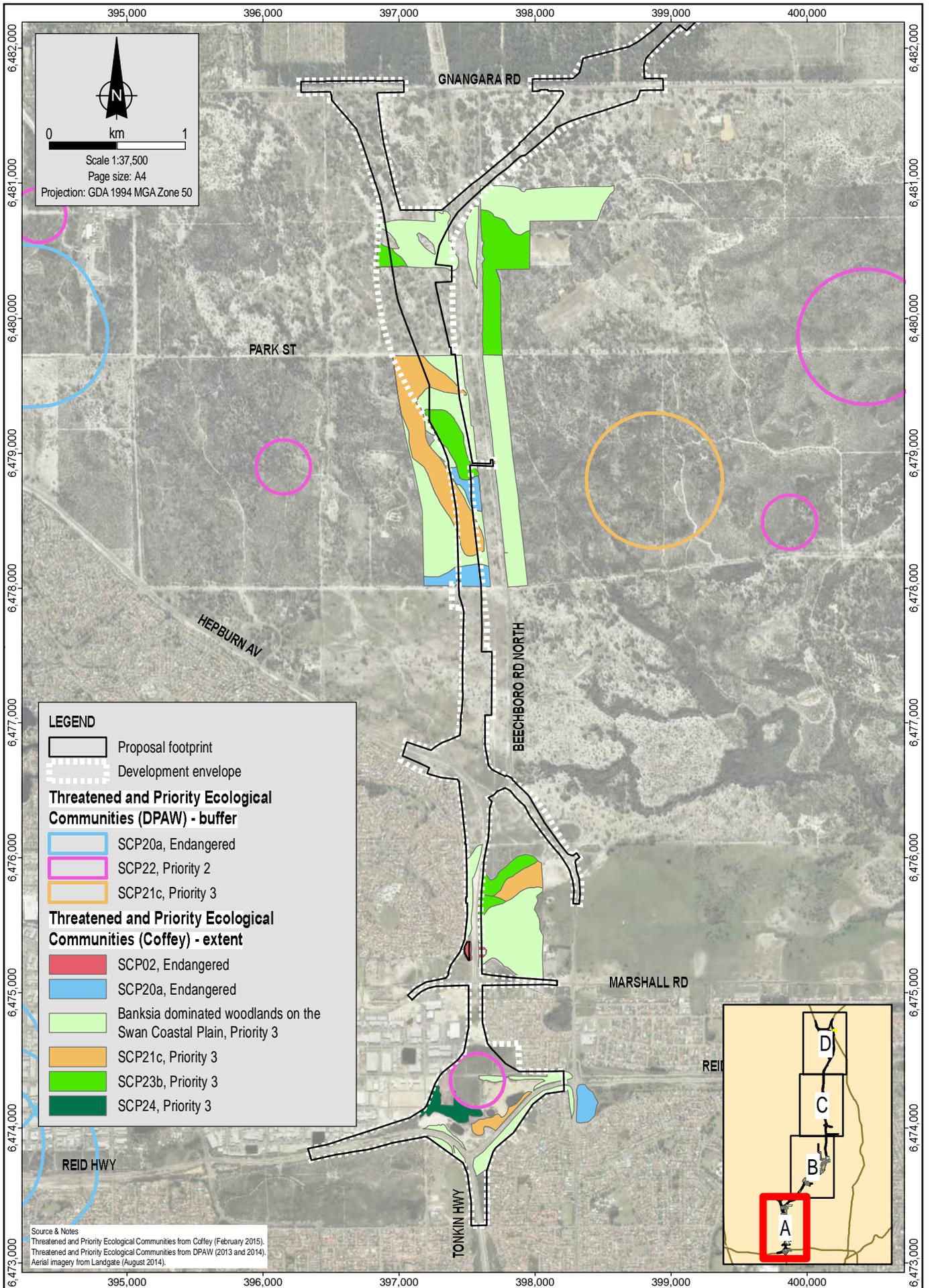
The TECs and PECs known to occur within and adjacent to the flora study area and those recorded are described in Table 8.5.

Table 8.5 TECs and PECs occurring near or within the flora study area

Community name	Community description	State conservation status	Commonwealth conservation status	Vegetation association occurrence	Indicative extent within the flora study area (ha)
Claypans of the SCP	Claypans of the SCP.	(TECs and PECs under numerous communities with clay soils)	Critically Endangered	Co and Mp ¹⁰	9.77
SCP07	Herb rich saline shrublands in clay pans.	Vulnerable	Critically Endangered	–	–
Mound Springs SCP	Communities of Organic Mound Springs, SCP TEC.	Critically Endangered	Endangered	Mp ¹	1.49
Muceha Limestone	Shrublands and woodlands on Muceha Limestone of the SCP.	Critically Endangered	Endangered	–	–
SCP20c	Shrublands and woodlands of the eastern side of the SCP.	Critically Endangered	Endangered	–	–
SCP3a	<i>Corymbia calophylla</i> – <i>Kingia australis</i> woodlands on heavy soils, SCP.	Critically Endangered	Endangered	–	–
SCP3c	<i>Corymbia calophylla</i> – <i>Xanthorrhoea preissii</i> woodlands and shrublands, SCP.	Critically Endangered	Endangered	–	–
Coastal Saltmarsh	Subtropical and Temperate Coastal Saltmarsh.	Priority 1	Vulnerable	–	–
SCP20a	<i>Banksia attenuata</i> woodland over species rich dense shrublands.	Endangered	–	BaBm ² and Et ¹	12.31
SCP20b	<i>Banksia attenuata</i> and/or <i>Eucalyptus marginata</i> woodlands of the eastern side of the SCP.	Endangered	–	–	–
SCP3b	<i>Corymbia calophylla</i> – <i>Eucalyptus marginata</i> woodlands on sandy clay soils of the southern SCP.	Vulnerable	–	–	–
SCP22	<i>Banksia ilicifolia</i> woodlands.	Priority 2	–	Mp ²	3.37

Community name	Community description	State conservation status	Commonwealth conservation status	Vegetation association occurrence	Indicative extent within the flora study area (ha)
SCP21c	Low lying <i>Banksia attenuata</i> woodlands or shrublands.	Priority 3	–	Ba, BaBm ¹ , BaBm ² , BaBm ³ , BaBmMp, Cc ⁷ , CcEm ¹ , CcEm ² , CcMp, Cc/Mp, Em ¹ , Ep, Et ² and Pr	177.95
SCP23b	Swan Coastal Plain <i>Banksia attenuata</i> – <i>Banksia menziesii</i> woodlands.	Priority 3	–	BaBm ¹ , BaBm ² , BaBm ³ , CcEm ² , Et ¹ and Et ²	57.50
Central Granite Shrublands (Com 5, Markey)	Central Northern Darling Scarp Granite Shrubland Community.	Priority 4	–	–	–
SCP02	Southern Wet Shrublands	–	Endangered	Mp ³	1.36
SCP24	Northern Spearwood shrublands and woodlands	Priority 3	–	BaBm ³ and Em ¹	8.09
<i>Banksia</i> dominated woodlands on the Swan Coastal Plain	<i>Banksia attenuata</i> and/or <i>Banksia menziesii</i> woodlands on deep sands on the SCP.	Priority 3	–	Ba, BaBm ¹ , BaBm ² , BaBm ³ , BaBmMp, Cc ³ , Cc ⁶ , Cc ⁷ , CcEm ¹ , CcEm ² , Em ¹ , Et ¹ , Et ² and Et ³	488.10

Source: Coffey (2015a) (Appendix C).



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Projection: GDA 1994 MGA Zone 50

LEGEND

- Proposal footprint
- Development envelope

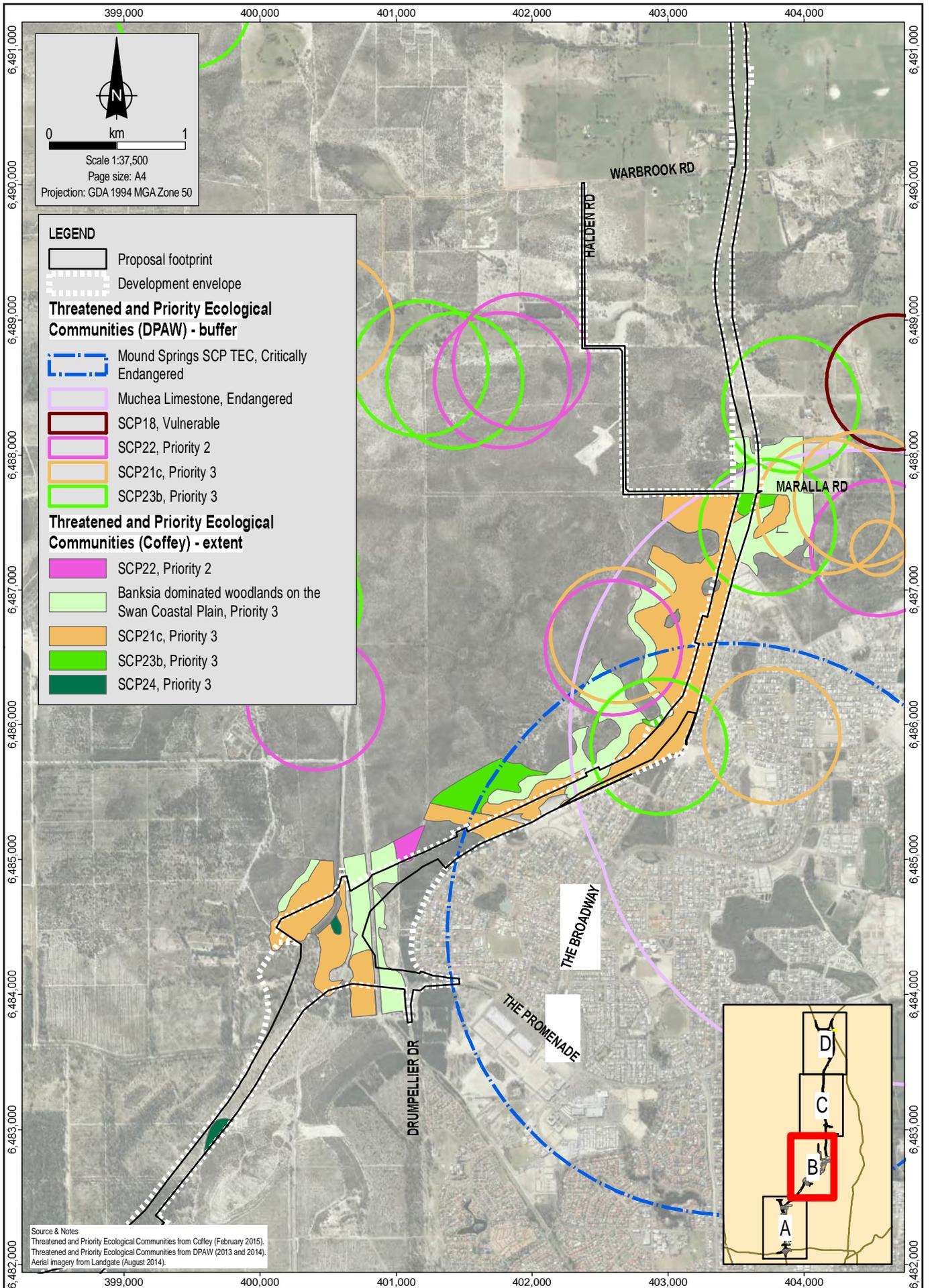
Threatened and Priority Ecological Communities (DPAW) - buffer

- SCP20a, Endangered
- SCP22, Priority 2
- SCP21c, Priority 3

Threatened and Priority Ecological Communities (Coffey) - extent

- SCP02, Endangered
- SCP20a, Endangered
- Banksia dominated woodlands on the Swan Coastal Plain, Priority 3
- SCP21c, Priority 3
- SCP23b, Priority 3
- SCP24, Priority 3

Source & Notes
Threatened and Priority Ecological Communities from Coffey (February 2015).
Threatened and Priority Ecological Communities from DPAW (2013 and 2014).
Aerial imagery from Landgate (August 2014).



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Page size: A4
Projection: GDA 1994 MGA Zone 50

LEGEND

- Proposal footprint
- Development envelope

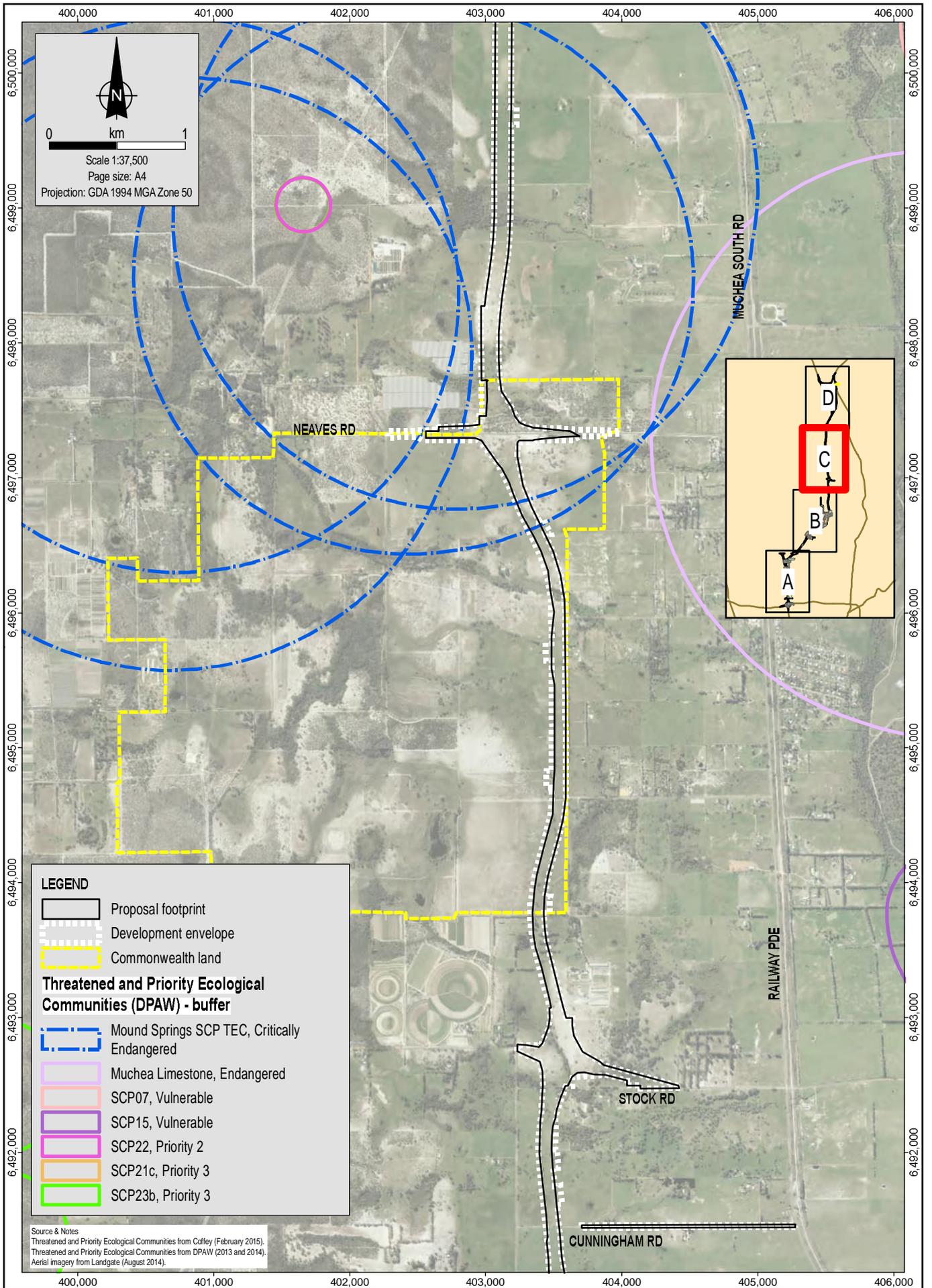
Threatened and Priority Ecological Communities (DPAW) - buffer

- Mound Springs SCP TEC, Critically Endangered
- Muchea Limestone, Endangered
- SCP18, Vulnerable
- SCP22, Priority 2
- SCP21c, Priority 3
- SCP23b, Priority 3

Threatened and Priority Ecological Communities (Coffey) - extent

- SCP22, Priority 2
- Banksia dominated woodlands on the Swan Coastal Plain, Priority 3
- SCP21c, Priority 3
- SCP23b, Priority 3
- SCP24, Priority 3

Source & Notes
Threatened and Priority Ecological Communities from Coffey (February 2015).
Threatened and Priority Ecological Communities from DPAW (2013 and 2014).
Aerial imagery from Landgate (August 2014).



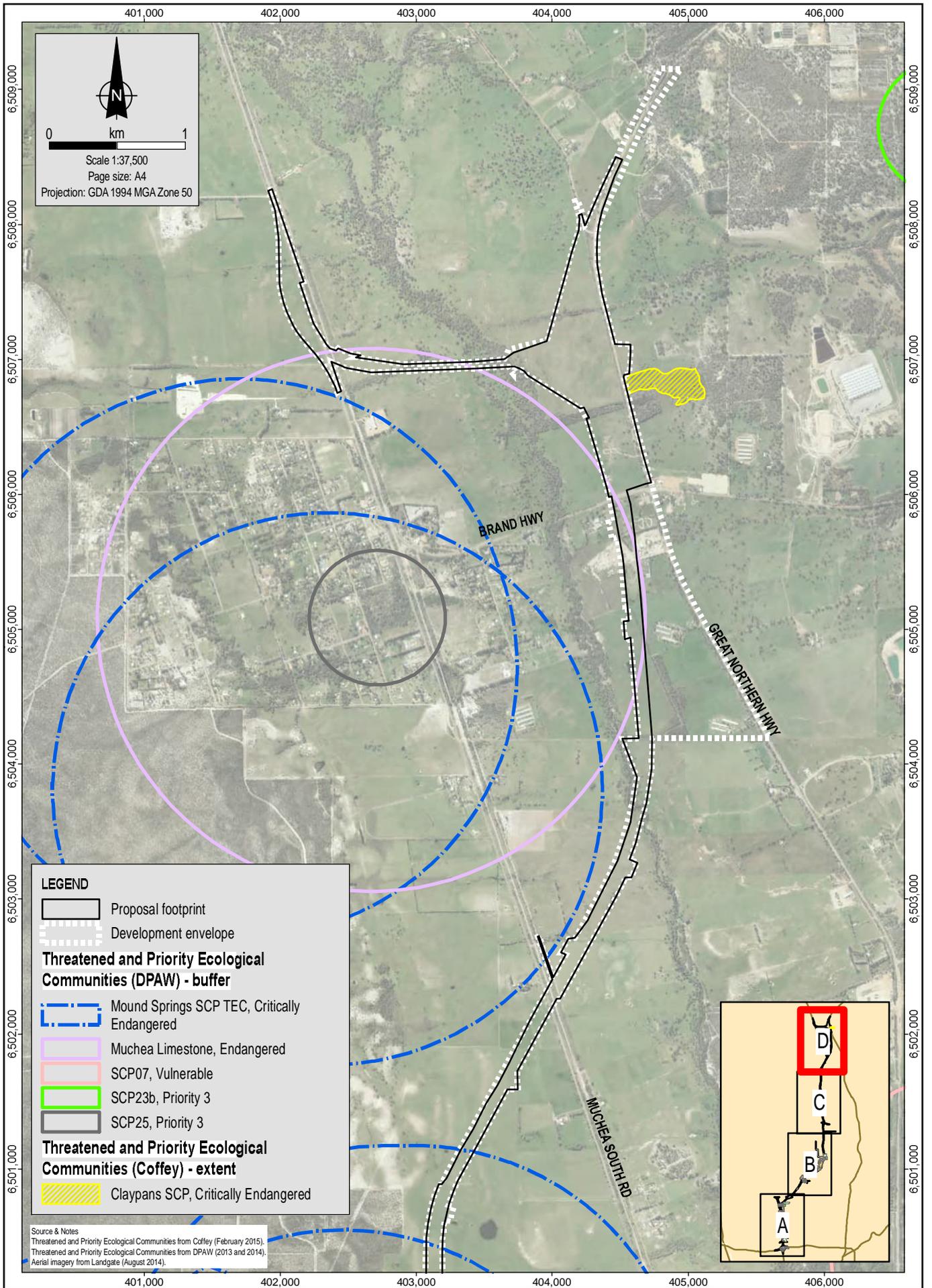
LEGEND

- Proposal footprint
- Development envelope
- Commonwealth land

Threatened and Priority Ecological Communities (DPAW) - buffer

- Mound Springs SCP TEC, Critically Endangered
- Muchea Limestone, Endangered
- SCP07, Vulnerable
- SCP15, Vulnerable
- SCP22, Priority 2
- SCP21c, Priority 3
- SCP23b, Priority 3

Source & Notes
 Threatened and Priority Ecological Communities from Coffey (February 2015).
 Threatened and Priority Ecological Communities from DPAW (2013 and 2014).
 Aerial imagery from Landgate (August 2014).

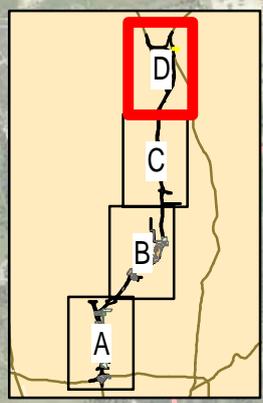


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LEGEND

- Proposal footprint
- Development envelope
- Threatened and Priority Ecological Communities (DPAW) - buffer**
- Mound Springs SCP TEC, Critically Endangered
- Muchea Limestone, Endangered
- SCP07, Vulnerable
- SCP23b, Priority 3
- SCP25, Priority 3
- Threatened and Priority Ecological Communities (Coffey) - extent**
- Claypans SCP, Critically Endangered

Source & Notes
 Threatened and Priority Ecological Communities from Coffey (February 2015).
 Threatened and Priority Ecological Communities from DPAW (2013 and 2014).
 Aerial imagery from Landgate (August 2014).



8.2.8 Vegetation Supporting Significant Flora

The vegetation associations that support habitat for conservation significant flora (Threatened and Priority listed) recorded from the study area that are considered to be locally significant for the continual survival of those significant flora are listed in Table 8.6.

Table 8.6 Locally significant vegetation associations supporting threatened and priority taxa

Vegetation association	Threatened and priority taxa present
AsMIEvCI	<i>Meeboldina decipiens</i> subsp. <i>decipiens</i> ms
BaBm ¹	<i>Poranthera moorokatta</i>
BaBm ²	<i>Anigozanthos humilis</i> subsp. <i>chrysanthus</i> , <i>Hypolaena robusta</i> and <i>Millotia tenuifolia</i> var. <i>laevis</i>
Bl	<i>Poranthera moorokatta</i>
Cc/Mp	<i>Millotia tenuifolia</i> var. <i>laevis</i> and <i>Poranthera moorokatta</i>
CcEm ²	<i>Millotia tenuifolia</i> var. <i>laevis</i>
CcMpMr	<i>Grevillea curviloba</i> subsp. <i>Incurva</i>
Em ²	<i>Stylidium striatum</i>
Er ³	<i>Poranthera moorokatta</i>
Er ⁶	<i>Ornduffia submersa</i>
Et ²	<i>Anigozanthos humilis</i> subsp. <i>chrysanthus</i> , <i>Caladenia huegelii</i> , <i>Hypolaena robusta</i> and <i>Poranthera moorokatta</i>
Mp ¹	<i>Cyathochaeta teretifolia</i>
Mp ⁶	<i>Cyathochaeta teretifolia</i>

Source: Coffey (2015a).

8.2.9 Fragmentation and Ecological Corridors

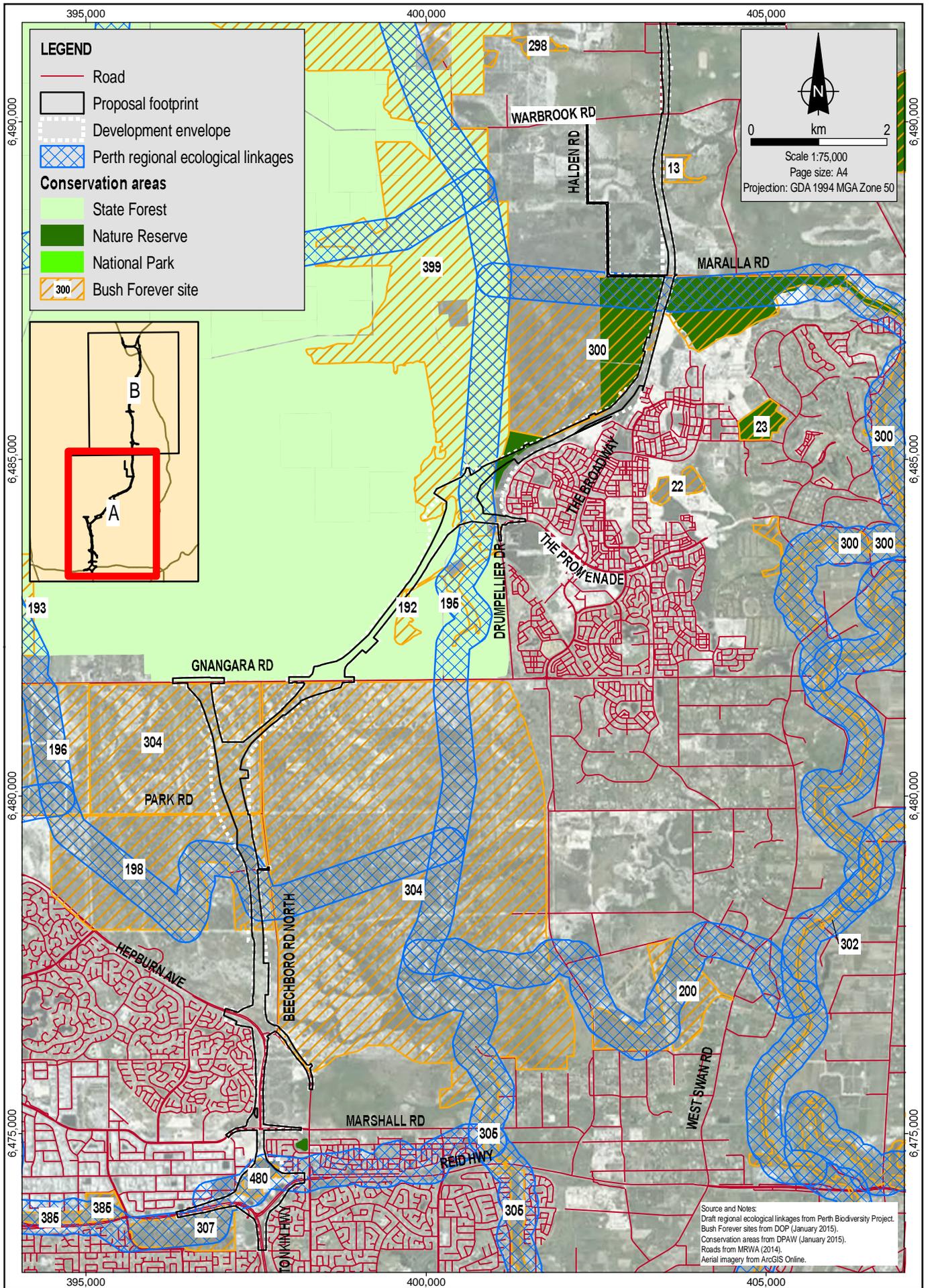
The flora study area is located within the Perth IBRA subregion, which has historically been cleared for urban and industrial development and silviculture/agriculture. The historical clearing has resulted in only 42% (or 473,176 ha) of the pre-European extent of native vegetation within the Perth IBRA subregion (1,117,757 ha) remaining intact (DPAW, 2013b). This historical clearing has placed greater emphasis on the importance of the remaining intact native vegetation and ensuring linkages are maintained to allow ecological movement, including fauna and genetic material.

A Regional Ecological Linkage Network plan produced aims to link protected regionally significant natural areas by retaining the best condition local natural areas available so they can act as linkage corridors for flora and fauna to move between regionally significant areas (WALGA, 2004). The flora study area is located across several of these key ecological linkages (Figure 8.5). Ecological linkage corridors occur at the following locations (from north to south):

- Gaston Road, Bullsbrook. This linkage corridor incorporates the known TEC Mounds Spring SCP and connects Bush Forever Site 97 in the west with Bush Forever Site 292 in the east.
- Raphael Road, Bullsbrook near the proposed Cooper Road separation. This corridor links Bush Forever Sites 6 and 399 in the west with Ellen Brook, which provides a north–south ecological corridor.



- Maralla Road Nature Reserve. This linkage corridor connects the State Forest (F 65) with Ellen Brook and represents a pinch point between the State Forest in the west and native vegetation on the eastern SCP and the Darling Scarp.
- Rocla mining lease area. A north–south ecological linkage corridor is located at the proposed Promenade grade separation in Ellenbrook. The corridor links the State Forest in the north with Whiteman Park in the south.
- Cullacabardee. The east–west corridor links Lake Jandabup and Gngara Lake in the northwest with Whiteman Park in the east.
- Reid Highway. The east–west linkage corridor connects vegetation from the coastline east towards Bennett Brook at the southern end of Whiteman Park.



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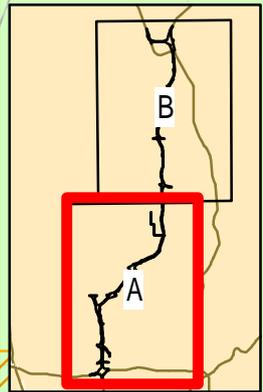
- Road
- ▭ Proposal footprint
- - - Development envelope
- ▨ Perth regional ecological linkages

Conservation areas

- ▭ State Forest
- ▭ Nature Reserve
- ▭ National Park
- ▨ 300 Bush Forever site

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Projection: GDA 1994 MGA Zone 50

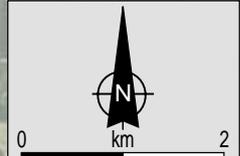


Source and Notes:
 Draft regional ecological linkages from Perth Biodiversity Project.
 Bush Forever sites from DOP (January 2015).
 Conservation areas from DPAW (January 2015).
 Roads from MRWA (2014).
 Aerial imagery from ArcGIS Online.

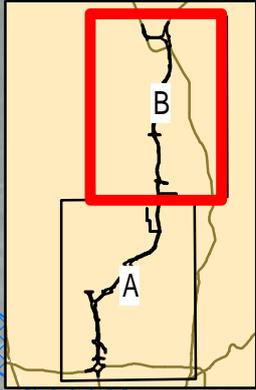
400,000

LEGEND

-  Road
-  Proposal footprint
-  Development envelope
-  Commonwealth land
-  Perth regional ecological linkages
- Conservation areas**
-  State Forest
-  Nature Reserve
-  Bush Forever site

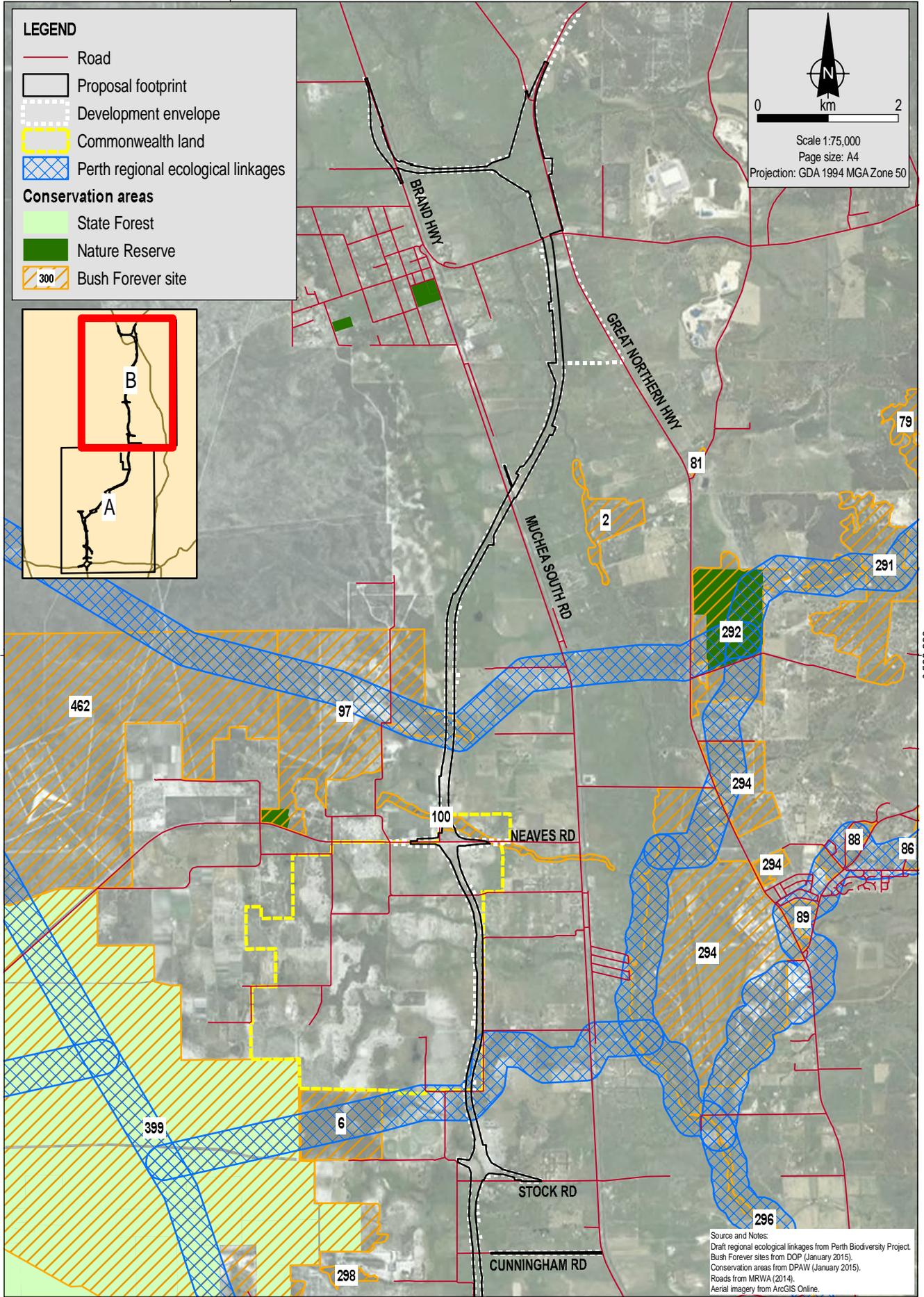


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6,500,000

6,500,000



Source and Notes:
 Draft regional ecological linkages from Perth Biodiversity Project.
 Bush Forever sites from DOP (January 2015).
 Conservation areas from DPAW (January 2015).
 Roads from MRWA (2014).
 Aerial imagery from ArcGIS Online.

400,000

8.2.10 Vegetation Condition

The condition of the vegetation located at each sampling site and additional locations throughout the flora study area was assessed according to the vegetation condition rating scale developed by Keighery (1994). Vegetation that is in degraded or better condition is considered to be intact vegetation. The condition of the vegetation is consistent with the size, connectivity and structure of the vegetation along the flora study area. For example, the fragmented vegetation located in the north of the flora study area is in degraded or worse condition due to historical clearing and grazing pressures, while in the Whitman Park, Cullacabardee and Ellenbrook areas, vegetation consists of relatively large, fairly contiguous areas, and is in good or better condition.

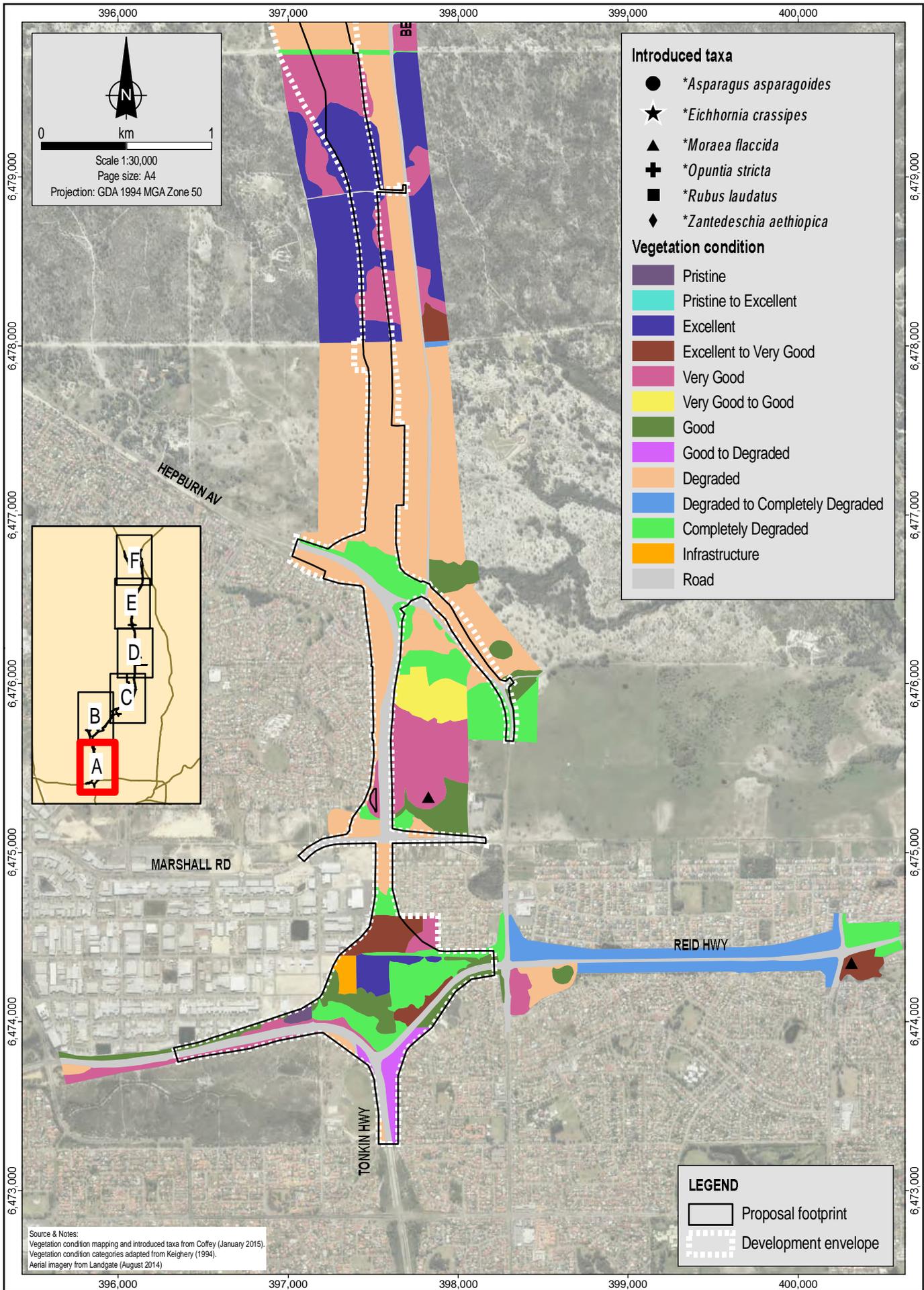
The vegetation north of Maralla Road through the palusplain zone was considered to be highly variable with large portions considered completely degraded or cleared. There were isolated pockets of vegetation considered to be in good or better condition. The vegetation south of Maralla Road was variable; however, the majority of the vegetation was considered to be in good or better condition with isolated pockets of vegetation that was considered degraded or worse and included isolated cleared areas. Isolated pockets of pristine vegetation were identified in the flora study area in the location of Ellenbrook.

The vegetation condition of the flora study area is presented in Table 8.7 and illustrated in Figure 8.6.

Table 8.7 Vegetation condition rating in the flora study area

Condition rating	Extent in flora study area	
	(ha)	(%)
Pristine	9.3	0.3
Pristine to Excellent	36.4	1.2
Excellent	226.7	7.5
Excellent to Very Good	51.2	1.7
Very Good	175.7	5.8
Very Good to Good	35.4	1.2
Good	51.0	1.7
Good to Degraded	23.4	0.8
Degraded	530.1	17.5
Degraded to Completely Degraded	138.1	4.6
Completely Degraded	1,627.9	53.8
Cleared and Infrastructure/Roads etc.	122.4	4.0
Total	3,027.8	100.0

Source: Coffey (2015a) (Appendix C).



Introduced taxa

- **Asparagus asparagoides*
- ★ **Eichhornia crassipes*
- ▲ **Moraea flaccida*
- ✚ **Opuntia stricta*
- **Rubus laudatus*
- ◆ **Zantedeschia aethiopica*

Vegetation condition

- Pristine
- Pristine to Excellent
- Excellent
- Excellent to Very Good
- Very Good
- Very Good to Good
- Good
- Good to Degraded
- Degraded
- Degraded to Completely Degraded
- Completely Degraded
- Infrastructure
- Road

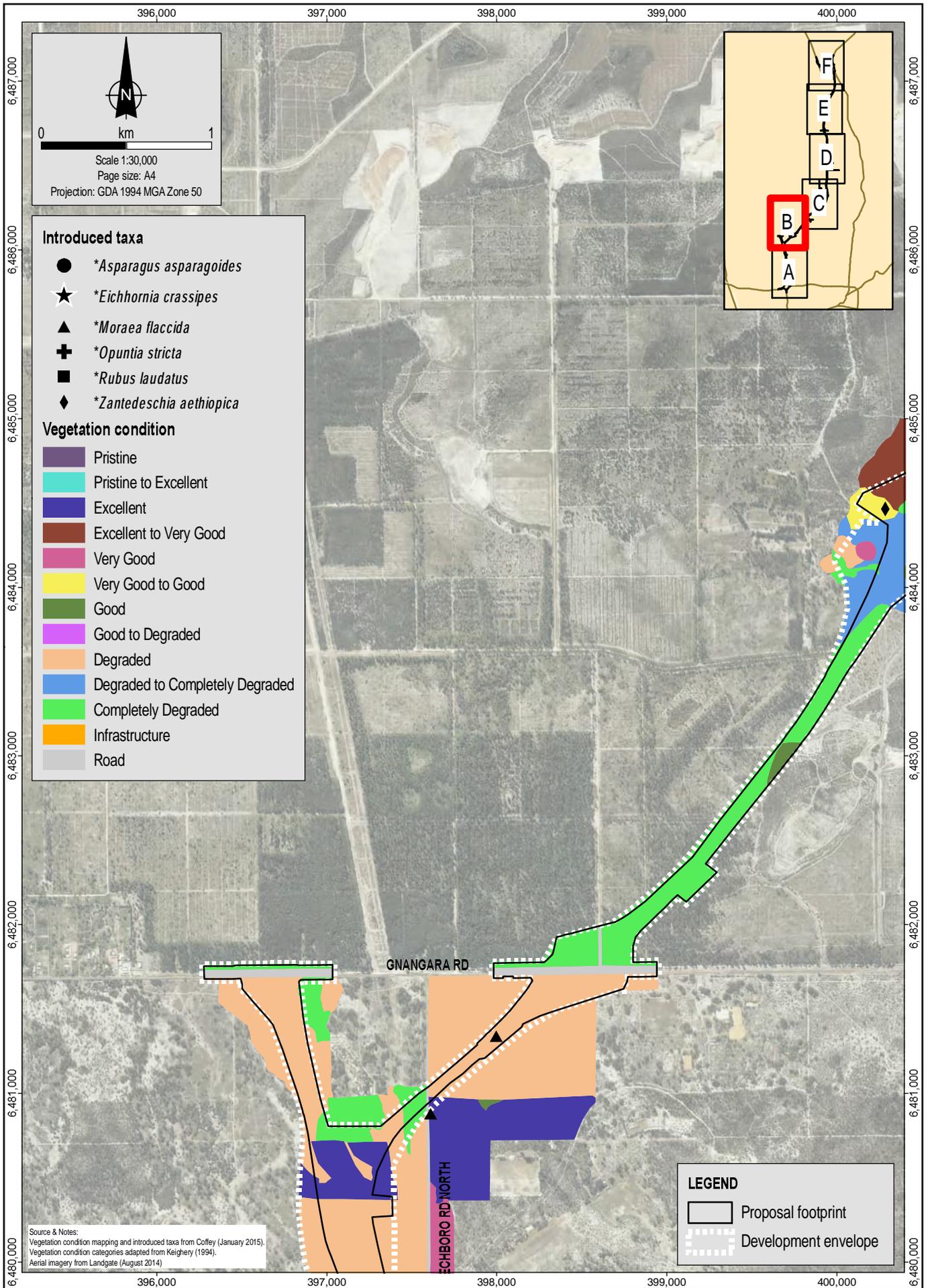
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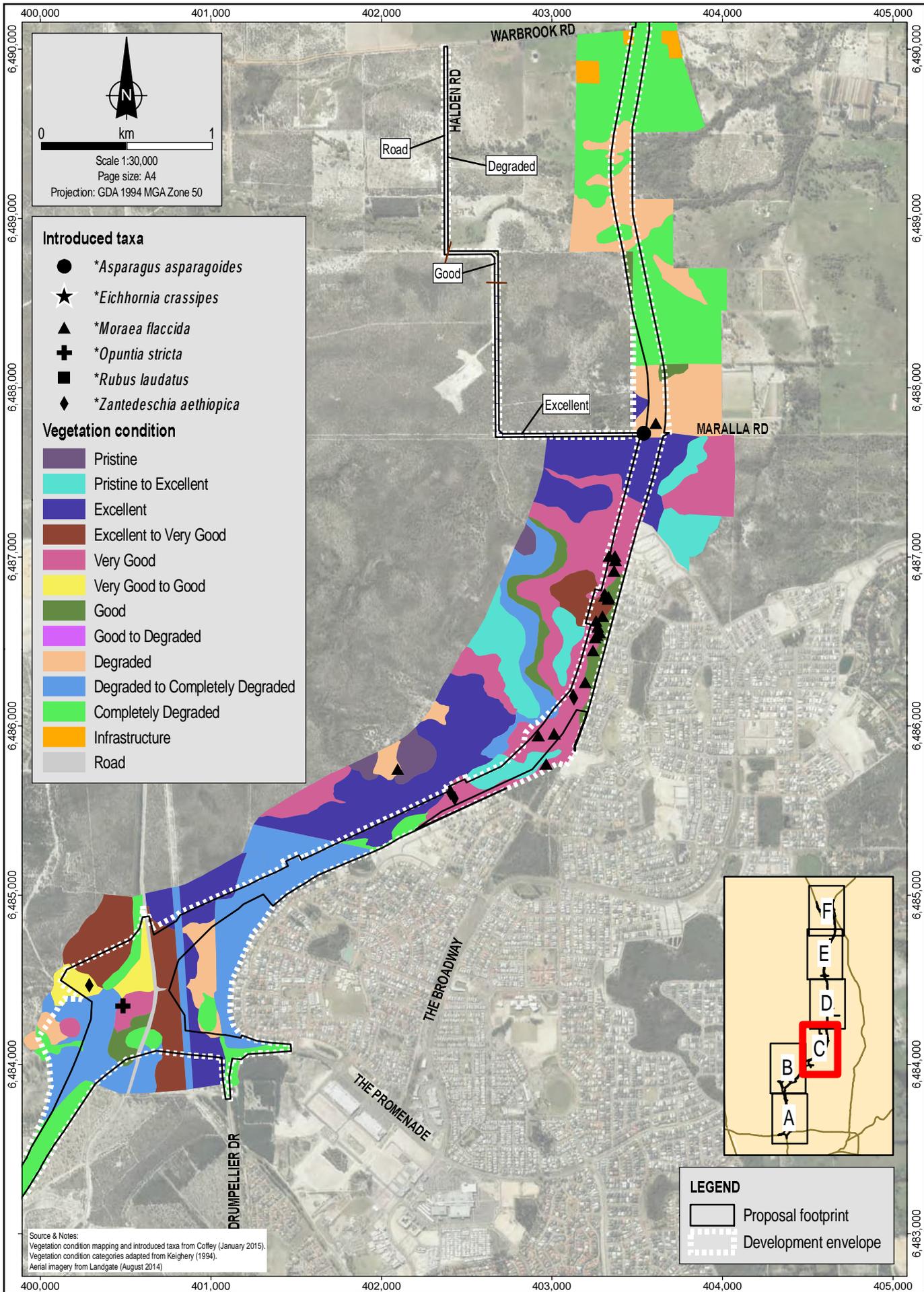
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Projection: GDA 1994 MGA Zone 50

Source & Notes:
Vegetation condition mapping and introduced taxa from Coffey (January 2015).
Vegetation condition categories adapted from Keighery (1994).
Aerial imagery from Landgate (August 2014)

LEGEND

- ▭ Proposal footprint
- ▭ Development envelope





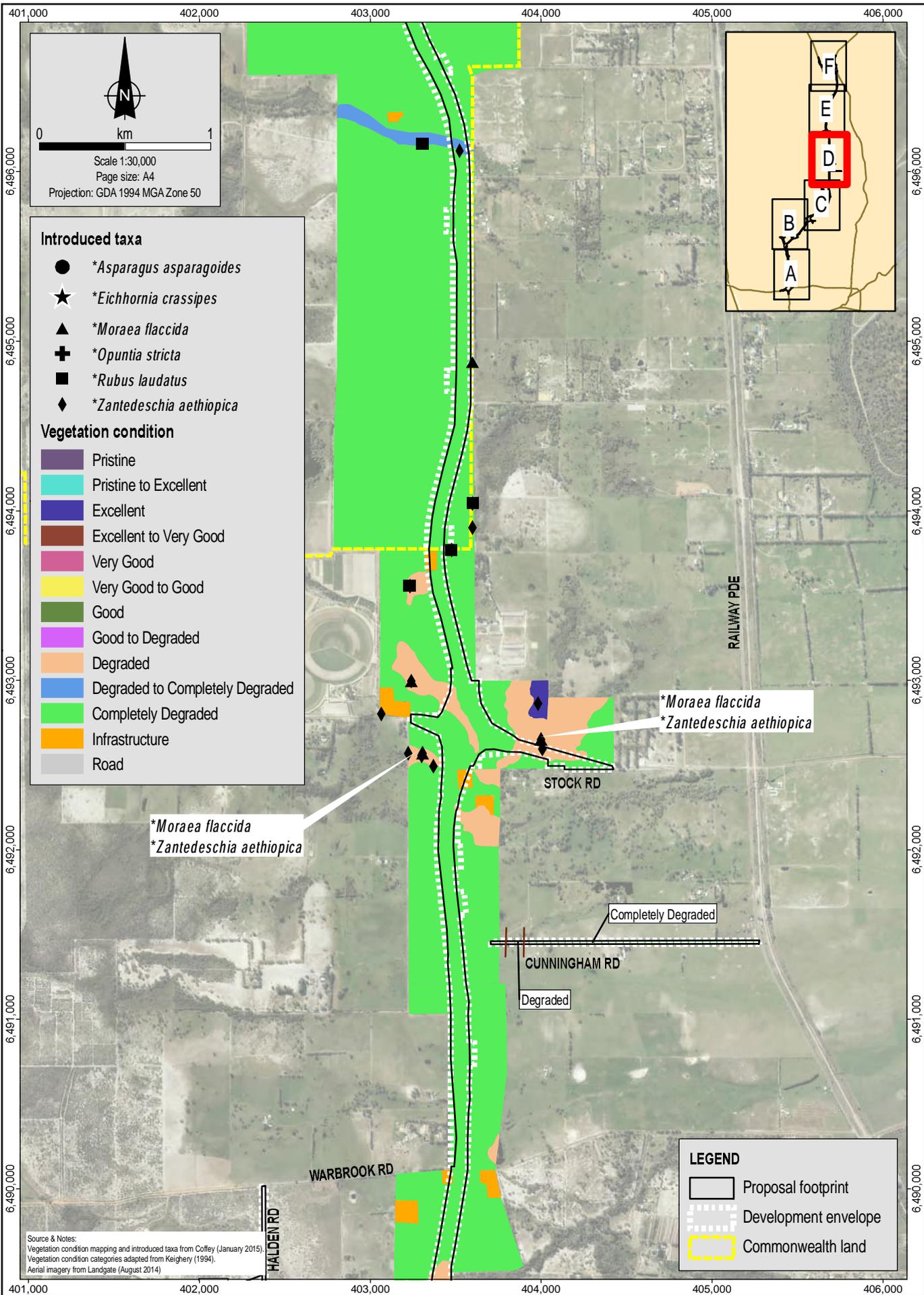
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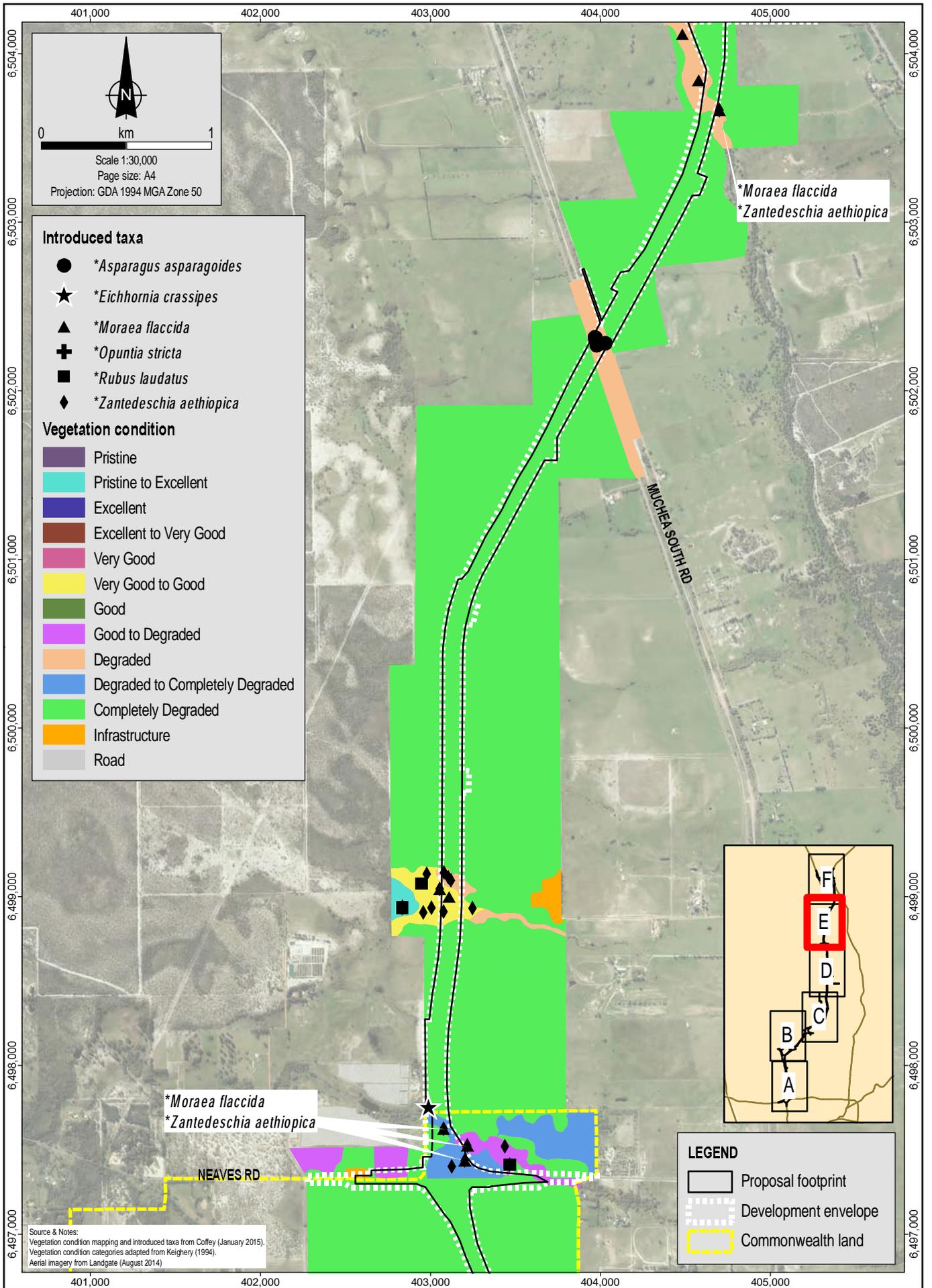
- Introduced taxa**
- **Asparagus asparagoides*
 - ★ **Eichhornia crassipes*
 - ▲ **Morea flaccida*
 - ⊕ **Opuntia stricta*
 - **Rubus laudatus*
 - ◆ **Zantedeschia aethiopica*
- Vegetation condition**
- Pristine
 - Pristine to Excellent
 - Excellent
 - Excellent to Very Good
 - Very Good
 - Very Good to Good
 - Good
 - Good to Degraded
 - Degraded
 - Degraded to Completely Degraded
 - Completely Degraded
 - Infrastructure
 - Road

Source & Notes:
Vegetation condition mapping and introduced taxa from Coffey (January 2015).
Vegetation condition categories adapted from Keighery (1994).
Aerial imagery from Landgate (August 2014)

LEGEND

- ▭ Proposal footprint
- ▭ Development envelope



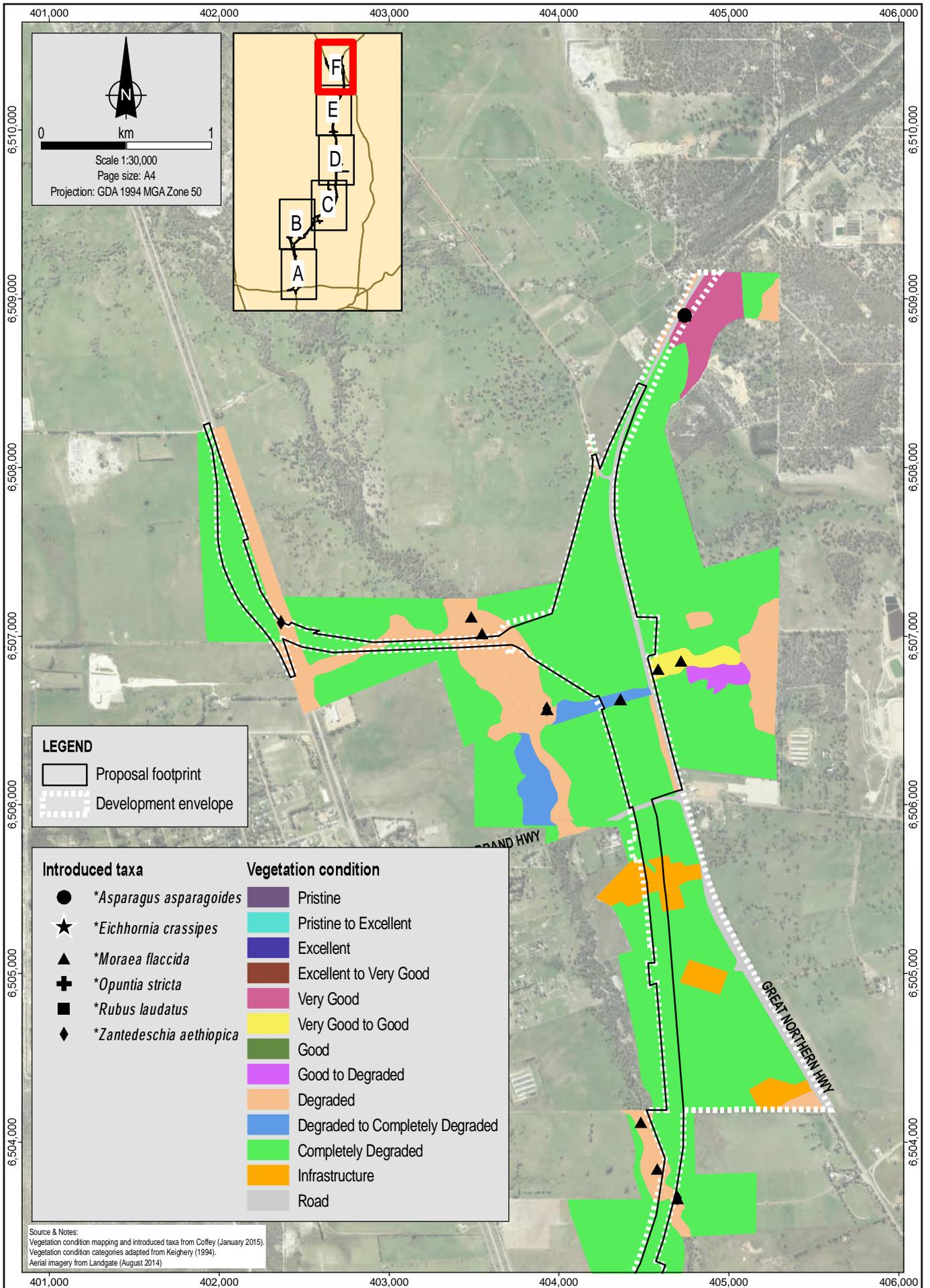


- Introduced taxa**
- **Asparagus asparagoides*
 - ★ **Eichhornia crassipes*
 - ▲ **Moraea flaccida*
 - ✚ **Opuntia stricta*
 - **Rubus laudatus*
 - ◆ **Zantedeschia aethiopica*
- Vegetation condition**
- Pristine
 - Pristine to Excellent
 - Excellent
 - Excellent to Very Good
 - Very Good
 - Very Good to Good
 - Good
 - Good to Degraded
 - Degraded
 - Degraded to Completely Degraded
 - Completely Degraded
 - Infrastructure
 - Road

LEGEND

- ▭ Proposal footprint
- ▭ Development envelope
- ▭ Commonwealth land

Source & Notes:
 Vegetation condition mapping and introduced taxa from Coffey (January 2015).
 Vegetation condition categories adapted from Keighery (1994).
 Aerial imagery from Landgate (August 2014)





8.2.11 Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDEs) are ecosystems that require access to groundwater to meet all or some of their water requirements in order to maintain communities of plants and animals, the ecological processes they support and the ecosystem services they provide (Richardson et al., 2011).

The vegetation associations recorded from the geomorphic wetlands (see Figure 8.2) and Ellen Brook are considered to be GDEs due to the presence of groundwater or surface water dependent flora. As such, there is approximately 361.5 ha of GDEs (geomorphic wetlands supporting intact native vegetation) within the flora study area, of which 49.6 ha is located within the proposal footprint (Figure 8.7).

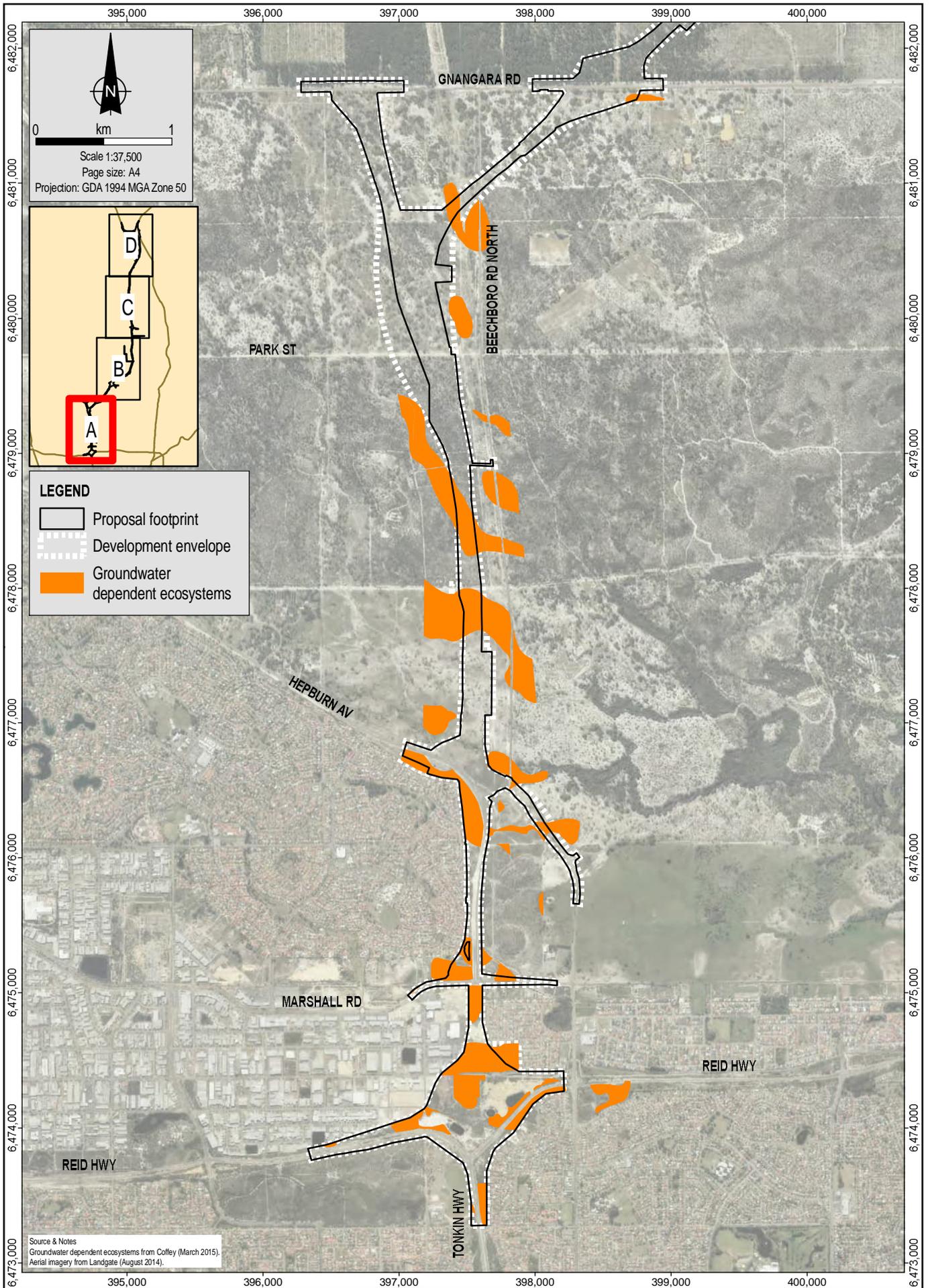
Species recorded from the flora study area (Coffey, 2015a) that are considered to be either groundwater dependent or maintained by surface water runoff are listed in Table 8.8 (360 Environmental, 2014b; Syrinx, 2011).

Banksia ilicifolia has been shown to display the greatest susceptibility and lowest net recovery to groundwater abstraction (Groom et al., 2000), while plants with shallow roots (i.e. sumpland sedges) are dependent on moisture in the vadose zone. Stratigraphic changes which affect the vadose zone will impact on the health and survival of these species (e.g. *Hypocalymma angustifolium*) (360 Environmental, 2014b).

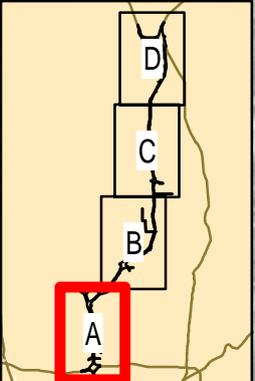
Table 8.8 Groundwater dependent flora

Taxa	Hydrological classification
<i>Astartea scoparia</i>	Subsurface – perched
<i>Banksia ilicifolia</i>	Groundwater dependent (obligate)
<i>Banksia littoralis</i>	Groundwater dependent (obligate)
<i>Baumea articulata</i>	Groundwater or surface water (obligate)
<i>Baumea juncea</i>	Groundwater or surface water (obligate)
<i>Corymbia calophylla</i>	Groundwater dependent (facultative)
<i>Eucalyptus rudis</i>	Groundwater dependent (obligate)
<i>Eucalyptus todtiana</i>	Groundwater dependent (facultative)
<i>Hypocalymma angustifolium</i>	Vadose (saturated) zone
<i>Meeboldina scariosa</i>	Groundwater or surface water (obligate)
<i>Melaleuca lateritia</i>	Groundwater dependent (obligate)
<i>Melaleuca preissiana</i>	Groundwater dependent (obligate)
<i>Melaleuca raphiophylla</i>	Groundwater dependent (obligate)
<i>Melaleuca teretifolia</i>	Groundwater dependent (obligate)
<i>Scholtzia involucrata</i>	Vadose (saturated) zone
<i>Stirlingia latifolia</i>	Vadose (saturated) zone
<i>Taxandria linearifolia</i>	Groundwater dependent (obligate)

Sources: 360 Environmental (2014b) and Syrinx (2011).



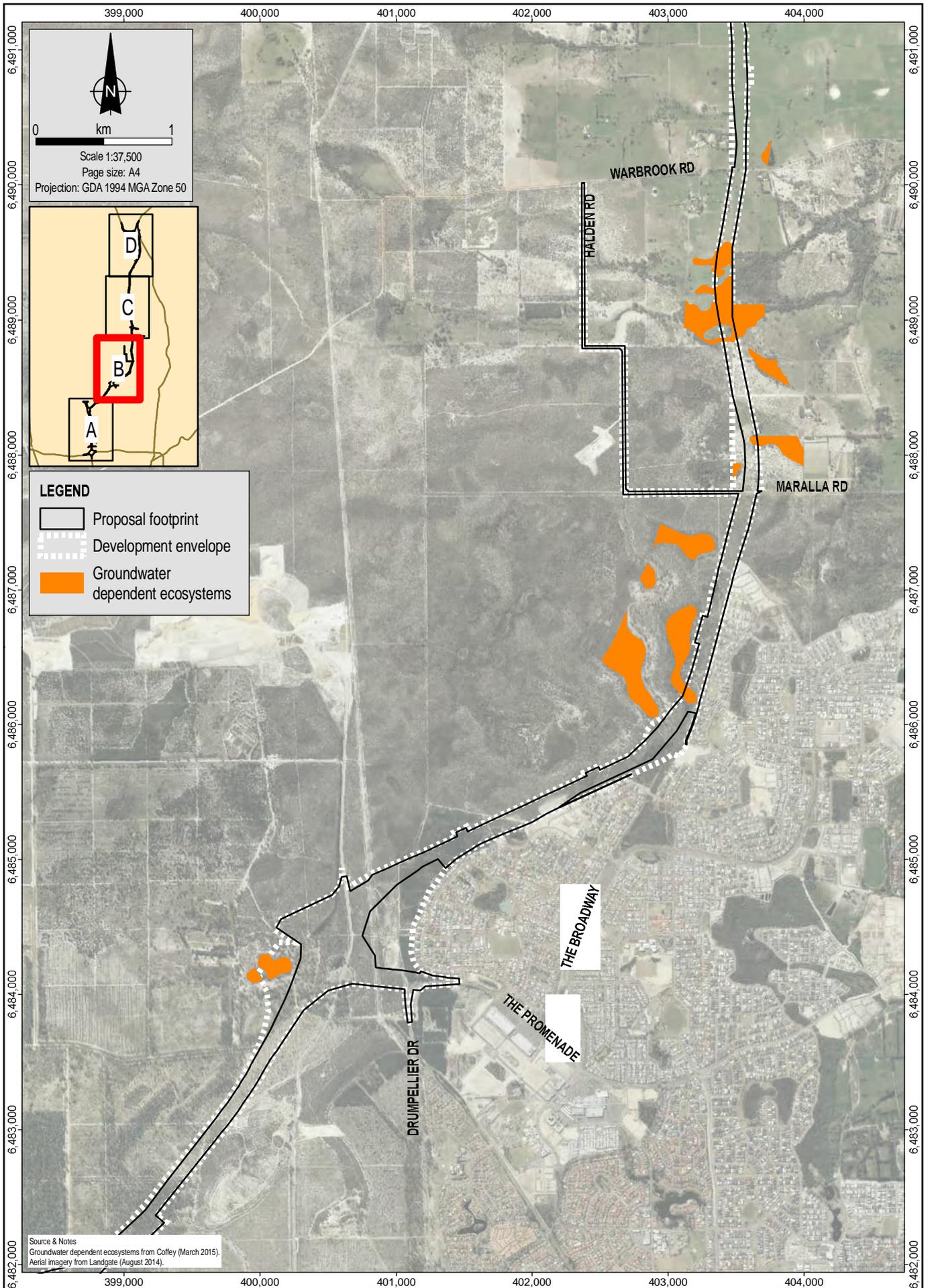
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LEGEND

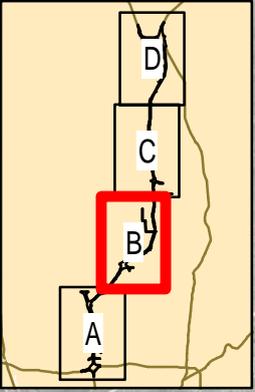
- Proposal footprint
- Development envelope
- Groundwater dependent ecosystems

Source & Notes
 Groundwater dependent ecosystems from Coffey (March 2015).
 Aerial imagery from Landgate (August 2014).



0 km 1

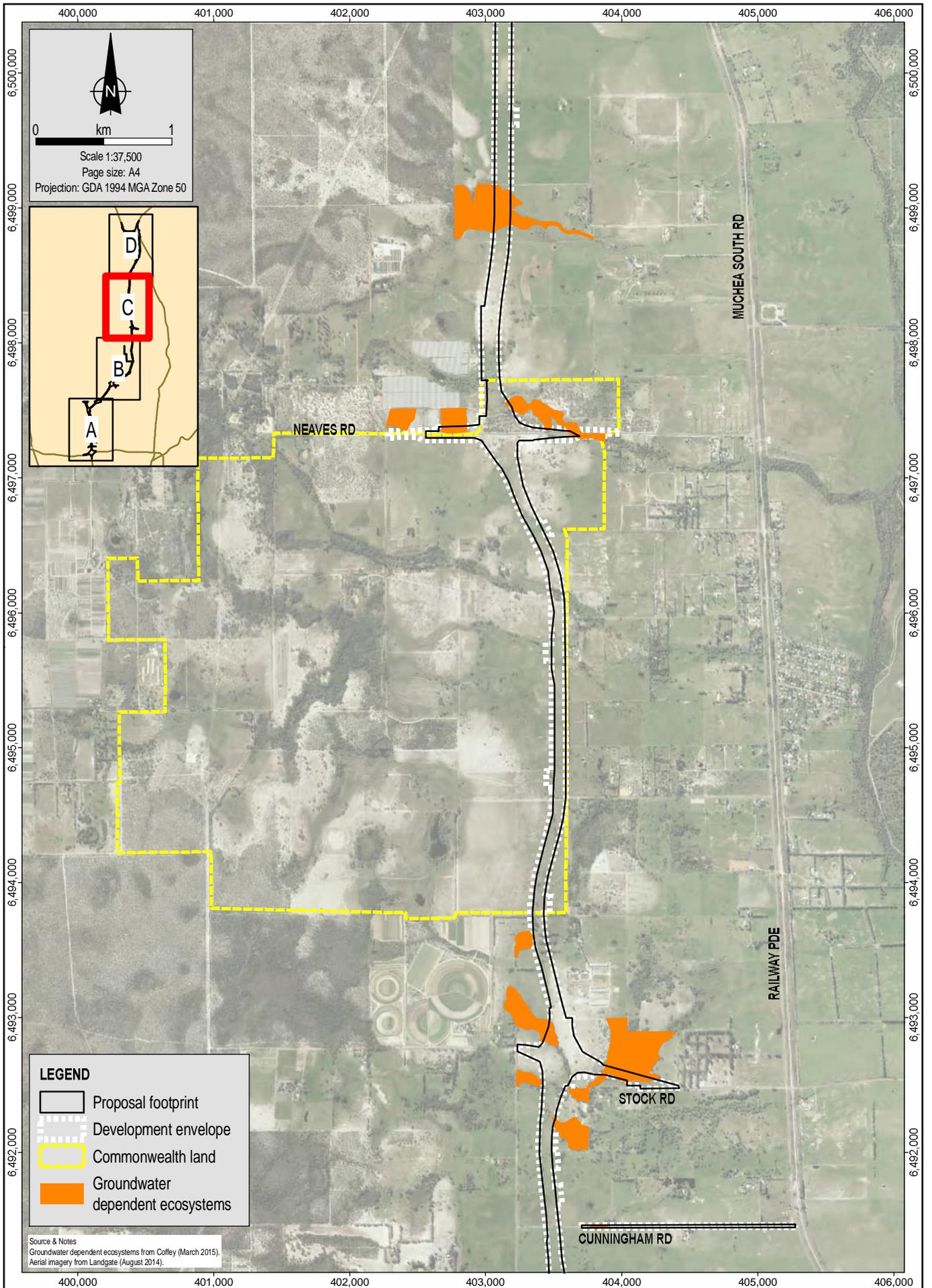
Scale 1:37,500
Page size: A4
Projection: GDA 1994 MGA Zone 50



LEGEND

- Proposal footprint
- Development envelope
- Groundwater dependent ecosystems

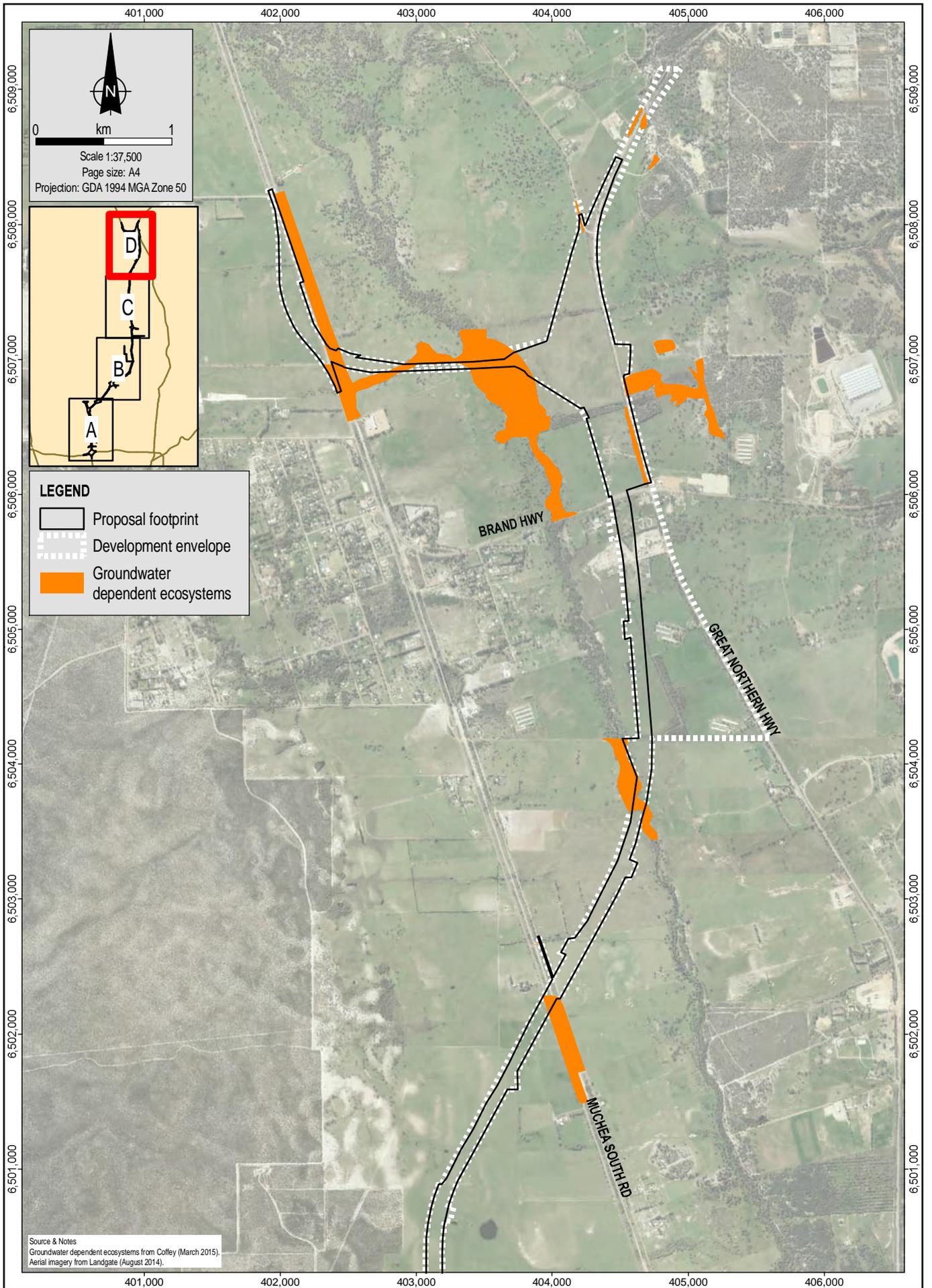
Source & Notes
Groundwater dependent ecosystems from Coffey (March 2015).
Aerial imagery from Landgate (August 2014).



LEGEND

- Proposal footprint
- Development envelope
- Commonwealth land
- Groundwater dependent ecosystems

Source & Notes
 Groundwater dependent ecosystems from Coffey (March 2015).
 Aerial imagery from Landgate (August 2014).



8.2.12 Bush Forever Sites

The Bush Forever Strategy aim was to protect, where achievable, a target of at least 10% of each of the original 26 vegetation complexes of the SCP portion of the Perth Metropolitan Region (PMR) (Government of Western Australia, 2000b). There are now 290 Bush Forever Sites making up approximately 51,200 ha of regionally significant bushland.

There are 14 Bush Forever sites located within or adjacent (within 1 km) to the proposal (Figure 8.5). Nine of these sites are located within the proposal footprint, and five are located within 1 km of the proposal footprint:

- Within the proposal footprint:
 - Site 97: Kirby Road Bushland, Bullsbrook.
 - Site 100: Neaves Road Creek, Bullsbrook.
 - Site 192: Wetherell Road Bushland, Lexia/Ellenbrook.
 - Site 198: Beechboro Road Bushland, Cullacabardee/Ballajura.
 - Site 300: Maralla Road Bushland, Ellenbrook/Upper Swan.
 - Site 304: Whiteman Park, Whiteman/West Swan.
 - Site 307: Lightning Swamp and Adjacent Bushland, Noranda.
 - Site 399: Melaleuca Park and Adjacent Bushland, Bullsbrook/Lexia.
 - Site 480: Victoria Road Bushland, Malaga/Beechboro.
- Adjacent (within 1 km) to the proposal footprint:
 - Site 2: North East Ellen Brook Bushland, Bullsbrook.
 - Site 6: Cooper Road Water Reserve and Adjacent Bushland, Bullsbrook.
 - Site 13: Sawpit Road Bushland, Bullsbrook.
 - Site 195: Wetherell Road Bushland, Lexia/Ellenbrook.
 - Site 385: Reid Highway Bushland, Mirrabooka/Malaga.

8.2.13 Introduced Flora

A total of 99 introduced taxa were recorded from the flora study area (Coffey, 2015a). Of the 99 taxa recorded, four were considered to be Weeds of National Significance (WONS) and an additional two taxa were declared pests under Section 22 of the *Biosecurity and Agricultural Management Act 2007* (BAM Act). Water Hyacinth (**Eichhornia crassipes*) is prohibited under Section 12 of the BAM Act:

- **Asparagus asparagoides* (Bridal Creeper) – WONS and declared pest.
- **Eichhornia crassipes* (Water Hyacinth) – WONS and prohibited.
- **Moraea flaccida* (One-leaf Cape Tulip) – declared pest.
- **Opuntia stricta* (Prickly Pear) – WONS and declared pest.
- **Rubus laudatus* (Blackberry) – WONS and declared pest.
- **Zantedeschia aethiopica* (Arum Lily) – declared pest.



The WONS and declared pests were recorded from numerous locations throughout the proposal footprint (see Figure 8.6). An additional 11 weeds were ranked as high priority for eradication or control within the DPAW (2013c) weed prioritisation process (Appendix C).

8.2.14 *Phytophthora* Dieback

Phytophthora Dieback (Dieback) is a soil borne pathogen with a range of hosts in the southwest of WA. Dieback predominantly occurs in members of the Proteaceae (Banksia), Ericaceae (heath), Myrtaceae (myrtle), Xanthorrhoeaceae (grass tree) and Fabaceae (pea) plant families. While some plant species are resistant, others are susceptible to the disease caused by the pathogen resulting in chlorosis, dieback and usually death (Wills and Keighery, 1994).

Dieback is listed as a Priority 1 threat¹ by the EPA and a Key Threatening Process under the EPBC Act. It is considered to be the third greatest threat to biodiversity in WA after salinity and climate change (EPA, 2007).

A Dieback assessment was undertaken within and adjacent to the proposal footprint (Terratree, 2014). The methods and approach undertaken are detailed further in Appendix D.

In total 725.3 ha was assessed with 67.56% of the area determined to be excluded (unmappable) from the Dieback assessment, 25.78% infested, 4.15% uninfested and 2.51% uninterpretable (Figure 8.8).

The majority of the proposal footprint and surrounding area was considered to be excluded due to the lack of native vegetation in good or better condition with sufficient disease indicator species to sample. The mappable areas of the proposal footprint were a mosaic of mainly infested and uninfested vegetation. While there were some areas of protectable uninfested vegetation within the proposal footprint, adjacent areas in the Ellenbrook area between Maralla Road and Gngangara Road were of more importance due to the longer term viability of keeping the area dieback free and protectable.

¹ A Priority 1 threat represents a top environmental issue identified by the EPA during the State of the Environment reporting (EPA, 2007).

