EPA Referral Supporting Documentation

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Great Northern Highway/ Apple Street/ Coondaree Parade Intersection Upgrade

May 2020

EOS# 1802

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EXECUTIVE SUMMARY

Main Roads Western Australia (Main Roads) is proposing to upgrade the Great Northern Highway (GNH)/ Apple Street/ Coondaree Parade intersection (the Intersection) (the Proposal). The Intersection upgrade is required to accommodate increased traffic flows predicted in Upper Swan due to the planning of a new residential development by Satterley and improve access to the Apple Street Road Train Assembly Area (RTAA). The Proposal is an Australian Government priorty project under the Urban Congestion Funding Program, that was publically announced by the Australian Government in late 2019.

Currently the Intersection is an un-signalised, offset, four-way intersection that does not have sufficient capacity for the predicted future traffic flows resulting from the surrounding residential and industrial uses. The increase in vehicles at the Intersection will constrain freight movements, increase travel time delays and reduce productivity and road safety.

Main Roads is referring the Proposal to the Environment Protection Authority (EPA) for a decision on assessment under Section 38 of the *Environmental Protection Act 1986*. The purpose of this document is to provide information to support the decision on assessment of the Proposal.

The proposed upgrades to the Intersection, will be developed within an 18 ha Development Envelope and includes:

- construction of a 4-legged roundabout at the the Intersection;
- widening of the GNH carriageway between 14.4–15.2 SLK to a dual lane on both the northbound and southbound approaches;
- construction of a new entrance on Apple Street to the RTAA;
- construction of a new access road between the service station on GNH and the Apple Street RTAA;
- providing improved pedestrian and cycling infrastructure; and
- drainage upgrades along GNH in the north-western portion of the Development Envelope.

The proposed design will ensure the roundabout and approaches are suitable for articulated trucks and the transportation of high-wide loads. The design to be issued for tender was finalised in April 2020.

Environmental impact studies undertaken for the Proposal have considered and assessed potential impacts at both local and regional scales. The results of these assessments have informed the design of the Proposal, the impact assessment and development of mitigation measures.

Extensive consultation has been undertaken with key staholders, with the Proposal being widely supported by all parties.

The Proposal's predicted outcomes have been considered in relation to the environmental principles and the EPA's environmental objectives for each key environmental factor. A summary of potential impacts, proposed mitigation and outcomes for the identified preliminary key environmental factors of the Proposal is provided in Table ES 1.

Table ES 1: Summary of the potential impacts, proposed mitigation and predicted outcome

Terrestrial Fauna	
EPA objective	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.
Policy and guidance	**EPA Policy and Guidance** • EPA Statement of Environmental Principles, Factors and Objectives (EPA 2020). • EPA Instructions on how to prepare an Environmental Review Document (EPA 2018b). • EPA Environmental Factor Guideline: Terrestrial Fauna (EPA 2016b).

	• EPA Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna (EPA 2016c). • EPA Technical Guidance: Terrestrial Fauna Surveys (EPA 2016d). • EPA Technical Guidance: Sampling of Short Range Endemic Invertebrate Fauna (EPA 2016[12]). • Environment Protection (Western Swamp Tortoise Habitat) Policy 2011 **Other policy and guidance** • Government of Western Australia WA Environmental Offsets Policy (GoWA 2011). • Government of Western Australia WA Environmental Offsets Guidelines (GoWA 2014)
Potential impacts	**Direct impacts:** • Loss of conservation significant fauna habitat from clearing. • Loss of conservation significant fauna individuals from clearing or other interactions. **Indirect impacts:** • Degradation/alteration of fauna habitat from altered groundwater and hydrological regimes; • Habitat degradation associated with construction activity including fire, transmission of weeds; introduction/spread of dieback, dust and increased abundance of introduced fauna species; • Discharge of polluting substances; • Disturbance from the possible displacement of fauna in trenches and sumps associated with construction activities.
Mitigation	**Avoidance** • Modification of the Development Envelope to avoid direct impacts to Ellen Brook Nature Reserve. • Installation of gross pollutant traps (GPTs) to improve water quality entering Ellen Brook. • Table drain maintenance on GNH to limit water from attracting Western Swamp Tortoise (WST) individuals into the road reserve. • Retention and modification of the sump to the south of Apple Street to facilitate maintenance of existing drainage flows in the Development Envelope. • Preventing introduction of new invasive weeds and pathogens into the Development Envelope through the Hygiene Management Plan (HMP) and Construction Environmental Management Plan (CEMP) • Clearing activities will be undertaken in late winter/ early spring to reduce the likelihood of WST occurring within the Development Envelope. **Minimisation** • Clearing will be restricted to the Development Envelope to avoid over clearing. • Implementation of a Western Swamp Tortoise Management Plan (WSTMP) to reduce likelihood of potential direct and indirect impacts to WST. • Development and implementation of a CEMP to implement best practice for aspects including, but not limited to, fauna management, spill response, weed management, fire management, waste management, dust suppression and hazardous materials storage. **Rehabilitation** • The sump and other suitable areas of road reserve will be revegetated post construction, with locally endemic species.
Outcomes	**Residual impact** • Potential impacts to conservation significant fauna, including the WST is not considered significant due to the minor disturbance, water quality improvements and the overall environmental management measures proposed to minimise potential impacts. **Offset** • As residual impacts are not considered significant, offsets are not required for this factor. **Summary**

	• The footprint selected for the Proposal minimises impacts to fauna and, with implementation of proposed mitigation measures, the EPA's objective for fauna will be met.

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Document Control

Report Compilation & Review	Name and Position	Document Revision	Date
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Reviewer:	Paul West Senior Environment Officer	Rev B	30 April 2020
Reviewer:	Martine Scheltema Manager Environment	Rev C	8 May 2020
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1 INTRODUCTION

Great Northern Highway (GNH) is a national freight route with high volumes of light and heavy vehicles. The GNH, Apple Street and Coondaree Parade intersection (the Intersection) in Upper Swan is the primary access point for local residents and businesses and is currently close to its maximum utilisation rate. Currently, the Intersection is an un-signalised,offset, four-way intersection that does not have sufficient capacity for the predicted future traffic flows resulting from the surrounding residential and industrial land uses. The predicted increase in vehicles at the Intersection will constrain freight movements, resulting in increased travel time delays, reduced productivity and increased road safety risks.

Main Roads Western Australia (Main Roads) is proposing to upgrade the Intersection (the Proposal), see Figure 1-1, to accommodate increased traffic flows expected in Upper Swan, which will be further exacerbated due to planned residential developments in the area. The design for the roundabout and approaches will accommodate articulated trucks and the transportation of high-wide loads.

It is intended that the construction of the Proposal will not only address projected congestion issues but also improve road user safety at the Intersection. The Proposal will be constructed within an 18 hectare (ha) Development Envelope and includes:

- construction of a 4-legged roundabout at the Intersection;
- widening of the GNH carriageway between 14.4–15.2 SLK, to a dual lane on both the northbound and southbound approaches;
- construction of a new entrance on Apple Street to the Road Train Assembly Area (RTAA);
- construction of a new access road between the service station on GNH and the Apple Street RTAA;
- provision of improved pedestrian and cycling infrastructure; and
- drainage upgrades on GNH in the north west extent of the Development Envelope.

The conceptual disturbance footprint encompasses a 16.38 hectare (ha) area within the 18 ha Development Envelope (Figure 1-2). The Proposal will require the removal of 3.05 ha of native vegetation and a further 4.48 ha of vegetation that was planted by Main Roads in the 1980s (Figure 1-2). The remaining 8.85 ha within the conceptual disturbance footprint is in cleared areas.

The Proposal design has been developed in close consultation with the Department of Biodiversity, Conservation and Attraction (DBCA) given the proximity to the Ellen Brook Nature Reserve, which contains habitat for the Critically Endangered, *Pseudemydura umbrina* (Western Swamp Tortoise [WST]). Main Roads has worked closely with DBCA to identify opportunities for a net benefit to WST conservation resulting from the construction of the Proposal.

Main Roads is also working closely with Water Corporation and City of Swan, both whom have construction activities proposed in the Upper Swan region over the next two years. Main Roads and City of Swan have provided in-principle support to deliver components of Water Corporation's sewer infrastructure to reduce the potential for cummulative impacts on sensitive environmental receivers, like WST habitat.

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Source: Aerial image: Skyview. Development Envelope: Main Roads 04/2020.
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Source: Aerial image: Skyview. Development Envelope: Main Roads 04/2020. Vegetation: Main Roads Site Inspection (2020)
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1.1 Purpose of this Document

Main Roads is referring the GNH/ Apple Street/ Coondaree Parade Intersection Upgrade Proposal to the Environmental Protection Authority (EPA) for a decision on assessment under Section 38 of the *Environmental Protection Act 1986* (EP Act). The purpose of this document is to support that referral. This document provides information on the Proposal activities, potential environmental impacts and proposed mitigation measures associated with construction and operation of the Proposal.

This document has been prepared in accordance with Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016 (EPA 2016) and Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual (EPA 2018).

1.2 Proposal Description

The Proposal is located in the City of Swan, Upper Swan Region of Western Australia (Figure 1-1). Main Roads is proposing to reconstruct the the Intersection within a 18 ha Development Envelope. The Proposal will provide a new roundabout at the interection, two new accesses into the Apple Street RTAA and upgrade of drainage infrastructure adjacent to Ellen Brook Nature Reserve (Figure 1-2).

The Proposal will involve the clearing of up to 3.05 ha of native vegetation and 4.48 ha of non-native vegetation, planted by Main Roads in the 1980s, within the 18 ha Development Envelope. The remaining 8.85 ha required for construction of the Proposal will occur on cleared land.

1.3 The Proponent

The Commissioner of Main Roads Western Australia is the Proponent for this Proposal. The Proponent details are outlined in Table 1-1.

Table 1-1: Proponent identification details

Item	Details
Proponent	Commissioner of Main Roads Western Australia
ABN/CAN	50 860 676 021
Address	PO Box 6202 East Perth WA 6002
Contact	Martine Scheltema Manager Environment Main Roads Western Australia Telephone: 9323 4614 Email: martine.scheltema@mainroads.wa.gov.au

1.4 Environmental Impact Assessment Process

1.4.1 *Environmental Protection Act 1986*, Part IV Environmental Impact Assessment

The Proposal will be referred under Part IV of the EP Act, which is the primary legislation governing environmental protection and impact assessment in Western Australia. Division 1 of Part IV of the EP Act provides for the referral and assessment of significant and strategic proposals.

Although Main Roads does not believe the impacts of this Proposal are significant, Main Roads has decided to refer the Proposal under Part IV of the EP Act given the Proposal is within the *Environment Protection (Western Swamp Tortoise Habitat) Policy 2011* (EPP) Boundary.

1.4.2 Environmental Protection and Biodiversity Conservation Act 1999

A proposed action that may have a significant impact on a Matter of National Environmental Significance (MNES) requires approval from the Commonwealth under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Impacts associated with the implementation of

this Proposal are not expected to be significant and; therefore, Main Roads does not intend to refer the Proposal to the Department of Agriculture, Water and the Environment (DAWE) under the EPBC Act. Further details on potential MNES within the Development Envelope are provided in Section 7.

1.4.3 Other Approvals and Regulation

Following primary environmental approval of the Proposal under Part IV of the EP Act, additional regulatory approvals will be required to develop and operate the Proposal. These are summarised in Table 1-2.

Table 1-2: Summary of Other Regulatory Approvals Required

Item	Type of Approval	Regulatory Agency	Legalisation Regulating the Activity
Interference with bed and banks of a watercourse (clearing of vegetation and construction works)	Application for a permit to authorise interference or obstruction of the bed and banks of a watercourse	Department of Water and Environmental Regulation (DWER)	*Rights in Water and Irrigation Act 1914* (RIWI Act)
Sourcing of construction water	Licence to take^	DWER	RIWI Act
Land acquisition	Administration of State Land Transfer of private land	Department of Planning, Lands and Heritage (DPLH)	*Land Administration Act 1997*
Development Application	Application to undertake road construction outside of dedicated road reserve	Western Australian Planning Commission (WAPC) of DPLH	*Planning and Development Act 2005*
Clearing of Native Vegetation	Application for a permit to approve clearing of native vegetation*	DWER	Part V of the EP Act

* Required if not assessed by EPA
^ Only required if agreement to access and use landowner water sources not reached.

Planning Approvals

Land within the Development Envelope as presented in Figure 1-3, will be acquired by Main Roads and dedicated as a road reserve pursuant to s. 28 (1) of the *Land Administration Act 1997*. Land acquisition boundaries within the Development Envelope will be formalised following finalisation of the design, to minimise the required purchase area. A Development Application will subsequently be submitted to undertake road construction activities outside of the Metropolitan Region Scheme.

Native title

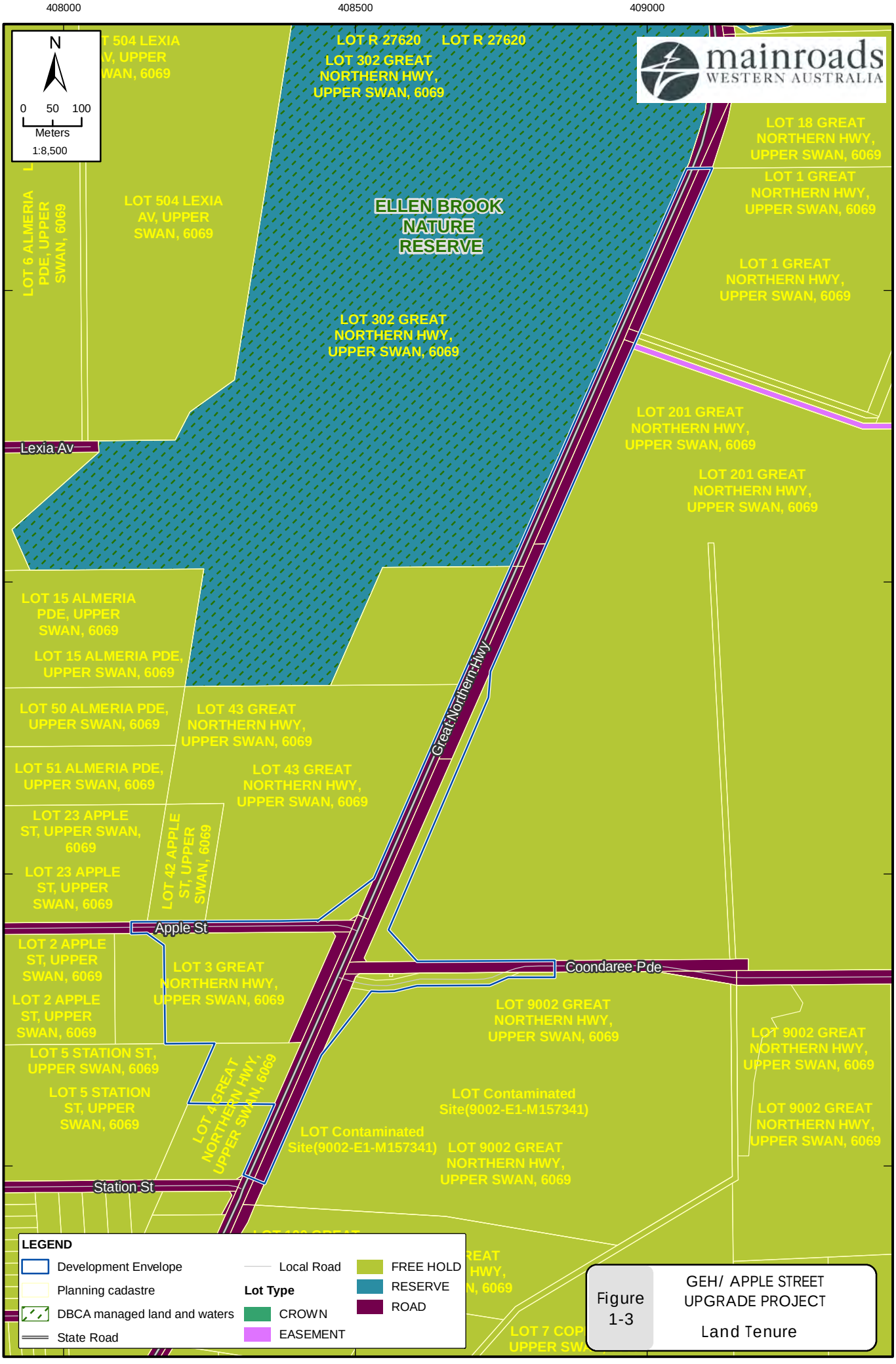
The Proposal is within the Whudjuk Peoples Indigenous Land Use Agreement Area. All land to be purchased for the Proposal is Freehold hand. There is no Native Title extant within the Development Envelope.

1.4.4 Decision Making Authorities

The authorities listed in Table 1-3 have been identified as decision making authorities for the Proposal.

Table 1-3: Decision making authorities for the Proposal

Decision Making Authority	Relevant Legislation
Minister for Aboriginal Affairs	*Aboriginal Heritage Act 1972*
Minister for Lands	*Land Administration Act 1997*
Minister for Planning	*Planning and Development Act 2005*
Western Australian Planning Commission	*Planning and Development Act 2005*
Chief Executive Officer (CEO) of DWER	RIWI Act



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Source: Aerial image: Skyview. Development Envelope: Main Roads 04/2020. Cadastre: Landgate (04/2020)
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1.5 Exclusions

1.5.1 Operation and maintenance of road and drainage infrastructure

The road and drainage infrastructure in Main Roads road reserve will be maintained by Main Roads. The City of Swan will continue to maintain the associated local road infrastructure on Apple Street and Coondaree Parade.

1.5.2 Bullsbrook to Ellenbrook Water Corporation Project

Water Corporation is planning to install a new sewer main from Bullsbrook to Ellenbrook which will extend from Bullsbrook in the north, along the western side of GNH and then align westbound towards Ellenbrook along Apple Street. Main Roads has provided in principle agreement that it will construct and cap the sewer main for Water Corporation where it intersects with the Intersection upgrade to reduce cumulative impacts to WST from multiple construction projects in the Upper Swan Region. Main Roads will undertake these construction works on behalf of Water Corporation, using environmental and other relevant approvals obtained by Water Corporation.

2 THE PROPOSAL

2.1 Proposal Justification

The Intersection in Upper Swan is the primary access point for local residents and businesses and is currently close to its maximum utilisation rate. The current un-signalised offset four-way intersection does not have sufficient capacity for the future traffic flows from the surrounding residential and industrial uses. An increase in vehicles at the Intersection will constrain freight movements, resulting in time delays, reduced productivity and increased road safety risks.

Maintaining efficient traffic flows on GNH is particularly important as the highway is a key freight route, with approximately 30% of vehicles on GNH categorised as heavy vehicles (Main Roads n.d).

Satterley's Clementine Development, Upper Swan is a substantial, proposed residential development, bound by Apple Street in the north, Railway Parade on the east and Ellen Brook to the west and south. Construction of the Proposal is critical to allow for safe and efficient traffic flows to be maintained along GNH with increased traffic volumes on Apple Street from the Satterley's proposed housing development.

The Federal, State and local governments have all committed funding to supplement the financial contribution made by Satterley. Whilst the design of the Proposal has been managed by Satterley in close consultation with Main Roads, the construction and ongoing maintenance of the road infrastructure will be managed by Main Roads.

2.2 Key Proposal Characteristics

The Proposal will require the removal up to 3.05 ha of native vegetation and 4.48 ha of non-native, planted vegetation within the Development Envelope. The remaining 8.85 ha (54%) of the conceptual disturbance footprint consists of cleared land. The conceptual disturbance footprint for the Proposal includes the Intersection upgrade, an access road between the RTAA and petrol station and drainage maintenance works requested by DBCA.

The drainage design has been developed in consultation with DBCA to specifically maintain existing flow directions whilst reducing the volumes of ponded water adjacent to the Ellen Brook Nature Reserve. Main Roads incorporated Gross Pollutant Trap (GTPs) into the design for the Proposal to improve water quality entering the Ellen Brook Nature Reserve.

In accordance with EPA instructions (EPA 2018b), a summary and key characteristics of the Proposal have been outlined in Table 2-1 and Table 2-2 respectively, and the conceptual disturbance footprint presented in Figure 1-2.

The construction and operational elements of the Proposal are discussed in more detail in Section 2.3.

Table 2-1: Key Proposal Characteristics

Item	Details
Proposal Title	Great Northern Highway/ Apple Street/ Coondaree Parade Intersection Upgrade
Proponent Name	Commissioner of Main Roads Western Australia
Short description	Upgrade the Intersection to a four-legged roundabout and improve accessibility to the Apple Street Road Train Assembly Area to promote future freight efficiency and public safety in the Upper Swan region.

Table 2-2: Local and proposed extent of physical elements

Element	Location	Proposed extent
Physical elements		
GNH/ Apple Street Coondaree Parade Roundabout and associated infrastructure	Figure 1-2	Clearing or disturbance within a 18 ha Development Envelope of: • up to 3.05 ha of native vegetation; and • up to 4.48 ha of non-native, planted vegetation.

2.3 Proposal Stages

2.3.1 Design

Main Roads', Metropolitan Project Delivery team received the Proposal design from Satterley, following its progression to the 85% design phase. The design was reviewed in consultation with Environment Branch and Road Traffic & Engineering Branch and finalisation is anticipated in mid-May 2020.

The proposed design for the Proposal will include but is not limited to, the following key components:

- Dual carriageway, four legged roundabout offset between GNH, Apple Street and Coondaree Parade. The roundabout will have a radius of 30 metres to account for heavy vehicles
- GNH dual carriageway on approaches to the roundabout northbound and southbound.
- Pavement is a combination of full depth asphalt and granular pavement.
- Relocation and installation of services.
- Cyclist lane on GNH approach and departure south of the roundabout.
- Relocation of the Apple Street entrance to the RTAA
- Construction of a new access road between the GNH petrol station, immediately south west of the Development Envelopment, and the RTAA.
- Significant road drainage including, pit and pipe, table drains and sump reshaping/ improvement.
- Western Power street lighting
- GPT installation

The drainage design for the Proposal has undergone a number of changes to incorporate DBCA comments. Additional table drain maintenance to the north of the Intersection was added to the Proposal upon request from DBCA.

2.3.2 Construction

Vegetation clearing for the Proposal is likely to be undertaken separately to construction, in late Winter to early Spring of 2020. Main Roads also intends to arrange all required service relocations prior to the contractor taking possession of site for construction. Construction is currently planned to commence late 2020 for a period of approximately six months.

It is anticipated that the Contractor will opt to contra-flow traffic to enable the roundabout to be constructed one half at a time. This will reduce the construction footprint of the works, as side tracks will not be required to maintain traffic flow on GNH. Under this preferred construction methodology, the northbound and southbound carriageway will undergo the following construction steps:

- Removal of redundant kerbing, signs and drainage infrastructure.
- Embankment construction and sump reconstruction.
- Drainage and GPT installation.
- Construction of pavement (design details the use of both full depth asphalt and granular pavement).
- Installation of finishing features such as line marking, signage, new kerbing and electrical components.

Laydown areas for vehicles, material storage and site compounds will be restricted to previously disturbed areas.

The construction of the GNH/ Apple Street/ Coodaree Parade roundabout will be managed by a Construction Environmental Management Plan (CEMP) as discussed further in Section 5.

2.4 Alternative Options Considered

Five options were considered and assessed on the basis of road safety, traffic movements, environmental impacts and pedestrian access.

The preferred option (Option 2) performs well in all traffic modelling scenarios, and provides better environmental outcome by reducing cumulative impacts on adjacent sensitive environmental receivers.

The alternatives options considered for the Proposal are provided in Table 2-3.

Table 2-3: Alternatives considered for the Proposal

Options	Details	Environmental Impacts
Option 1 Signalised Intersection	This option is a four-leg signalised intersection. The Intersection has been designed for double diamond phasing. A signalised intersection generally has high impact angles compared to other treatments. This results in higher severity crashes. This option was ultimately not selected as a roundabout showed significantly better resulting in traffic modelling.	This option had a similar footprint to the existing intersection and would have retained the existing sump. Traffic modelling demonstrated poor serviceability and safety concerns that were unacceptable.
Option 2 (current Proposal) Dual lane roundabout with heavy vehicle access through RTAA	The Option 2 is the Proposal design, which includes a dual-lane roundabout. Main Roads have assessed this as providing the optimal performance from a capacity and safety perspective.	This option requires minor expansion of the existing road reserve and has the greatest safety and serviceability benefits, whilst limiting the potential for cumulative environmental impacts.
Option 3: Single Lane Roundabout	Option 3 utilises a large diameter roundabout to provide continuous flow at the Intersection. To accommodate heavy vehicles the roundabout has a 60 m diameter pavement marked outer central island. The option did not perform well with projected 2031 traffic volumes and further assessment was not progressed.	This option although having a reduced footprint, would likely have required expansion to a dual-lane roundabout according to traffic projections. This option had the potential to result in cumulative environmental impacts.
Option 4: Staggered T-Junction with Traffic Signals	Option 4 formalises the existing intersection arrangement and provides channelization. Both Apple Street and Coondaree Parade have been realigned	This option would require a small disturbance footprint outside of the existing road formation. The poor

	further north and south respectively. This results in separation of the Intersections of 60 metres (m). This option was not selected as a roundabout showed significantly better resulting in traffic modelling.	serviceability to heavy vehicles and safety implications made this option unsuitable.
Option 5: Staggered T-Junction with Traffic Signals and Acceleration Lanes	Option 5 is a modification of the staggered T intersection, providing acceleration lanes to ensure consistent flow. This treatment has been implemented in several industrial areas of Perth's south. However, due to the proximity of Apple Street and Coondaree Parade and the associated channelization, vehicles are unable to travel from Apple Street to Coondaree Parade or vice versa. This may cause drivers to attempt unsafe manoeuvres and; was therefore, not considered by Main Roads for further assessment.	This option would have the smallest footprint of all the designs assessed. This option had considerable design/safety concerns that were considered unacceptable.

2.5 Planning History

In early 2016 Satterley commenced consultation with Main to upgrade the Intersection. A preliminary design was provided to Main Roads in May 2018, followed by an amended 85% design in February 2019.

In mid-2019, Main Roads agreed to have increased involvement in the detailed design and to manage the construction of the Proposal. In March 2020, Main Roads reassessed and modelled the roundabout against alternate intersection configurations and determined that the Intersection design selected by Satterley was appropriate as it maximises long term road efficiency and safety objectives. The design was refined to minimise impacts on vegetation, reduce the requirement for land purchasing and improve drainage flow and quality into Ellen Brook Nature Reserve.

3 STAKEHOLDER CONSULTATION

Main Roads has undertaken extensive stakeholder consultation for the Proposal. Consultation will continue with key stakeholders throughout the assessment and construction phases of the Proposal. Activities undertaken to date include:

- Identification and, if possible, resolution of issues that affect stakeholders.
- Undertaking face-to-face and written consultation with stakeholders.
- Maintaining regular consultation with key funding bodies.
- Keeping regulators informed with detailed design and environment management.
- Establishing and maintaining relationships with relevant local groups such as 'Friends of' groups, other service providers and local government.

Specific consultation with key stakeholders and response to issues are identified in Table 3-1.

3.1 Key stakeholders

Main Roads has identified the following stakeholders for the Proposal:

- BGC Brikmakers
- City of Swan
- DWER
- DAWE
- DBCA
- DPLH
- EPA Services
- Friends of Western Swamp Tortoise
- Satterley
- Water Corporation
- Western Swamp Tortoise Recovery Team
- Whadjuk Traditional Owners

Table 3-1: Summary of Stakeholder Consultation

Stakeholder	Date	Consultation type/topics discussed	Outcome
Satterley	Ongoing, monthly meetings held from mid-2019 until present.	Funding agreements, design amendments and stakeholder liaison.	Funding Deed of Agreement to be formalised by mid-2020. Design to be finalised late-April 2020.
DBCA – Threatened Species and Communities	18 June 2019	General introduction to the Proposal and request for any further assessment and management requirements.	Threatened Species and Communities Branch deferred to the DBCA Swan Coastal District Office.
DBCA – Swan Coastal District	24 July 2019	Initial meeting held with DBCA Planning Officer, Michael Roberts to discuss the design and potential impact to WST.	DBCA District Office provided general support of the Proposal. An opportunity to review drainage design was requested and a site inspection with WST specialist Gerald Kuchling was recommended.
DPLH	26 August 2019	Main Roads requested information from DPLH regarding whether Proposal activities would impact Registered Aboriginal Site Place ID 3525: Ellen Brook Upper Swan.	Works may impact Registered Aboriginal Site Place ID 3525: Ellen Brook Upper Swan. No further consultation is required, as Main Roads will undertake Proposal activities in accordance with an existing Section 18 consent for impacts to Site Place ID 3525 for road reconstruction and upgrade to GNH in Upper Swan.
DBCA – Swan Coastal District Office	5 September 2019	Site investigation to discuss design and environment management with regard to WST.	Hydrologist recommended a number of drainage design amendments. Gerald Kuchling provided recommendation for WST management pre- and during construction.
Water Corporation	Ongoing monthly meetings, commencing 3 October 2019 until present.	Interaction between Main Roads and Water Corporation projects during design and delivery stages.	In-principle support that MRWA will install portions of Water Corporation's sewer from the 'Wastewater pipeline from Bullsbrook to Ellenbrook' project. A collaborative community liaison approach will be implemented between both parties during development and construction.
EPA	11 October 2019	General introduction to the Proposal and discussion on referral of the Proposal to the EPA.	Decision made to refer the Proposal to the EPA in second quarter of 2020.
Water Corporation and City of Swan	Ongoing, monthly meetings between the three parties commencing 10 December 2019 until present.	City of Swan was invited to attend the monthly meetings with Water Corporation due to their proposed works in Upper Swan on GNH/Stock Road.	Funding Deed of Agreement to be formalised by mid-2020 with City of Swan, as they are a key stakeholder funding part of the Proposal. Agreed to have a combined community engagement approach between Main Roads, City of Swan and Water Corporation to reduce resident confusion during design and delivery stages.
BGC Brikmakers	5 February 2020.	Partly funding works due to inclusion of driveway entrance upgrade.	BGC Brikmakers previously approached Main Roads in 2016 to discuss a driveway upgrade. Progress update on the Proposal by Main Roads Managing Director in February and the Funding Deed of Agreement to be formalised by mid-2020.

Stakeholder	Date	Consultation type/topics discussed	Outcome
Water Corporation, City of Swan and Satterley	18 February 2020	Community liaison strategy	Agreed to have a combined community engagement approach between Main Roads, City of Swan, Satterley and Water Corporation to reduce resident confusion and disruption.
Friends of WST	16 March 2020	Consultation session to discuss the Proposal and to address any concerns of the group.	General support of the Proposal from the group, with particular interest in the proposed drainage improvements. There was general acknowledgement that an upgrade to the Intersection was required.
WST Recovery Team	17 March 2020	Consultation session to discuss the Proposal and to address any concerns of the group.	The group raised no concerns regarding the Proposal. There was general support for the Proposal and interest in the opportunities for improved water quality entering Ellen Brook Nature Reserve and training of a WST conservation detection dog.
Vibe Petroleum	26 March 2020 and 1 April 2020	Teleconference and follow up letter regarding closure of a petrol station access and proposed new access road with the RTAA	Consultation is ongoing as a memorandum of understanding will be to be signed regarding access road roles and responsibilities for ongoing maintenance.

3.1.1 Department of Biodiversity, Conservation and Attractions

Main Roads advised DBCA's Threatened Species and Communities Branch of the Proposal in June 2019 and sought advice on the environmental assessment and management with regards to WST. The Branch deferred advice to the District Office and Land Use Planning sections of DBCA.

Subsequently, a meeting was held with DBCA Planning Officer, Michael Roberts to discuss the design and potential impact to WST. Following this meeting DBCA provided general support for the Proposal as the road works were not adjacent to the fenced portion of Ellen Brook Nature Reserve and that Main Roads intended to maintain the existing drainage regime. DBCA requested that Main Roads continue to provide updates on the progress of the drainage design and that further consultation be undertaken with WST specialist, Gerald Kuchling.

Consultation progressed with DBCA's Swan Coastal District Office land use planners, hydrologist and WST specialist Gerald Kuchling with a site visit on 5 September 2019. The outcomes of the site visit resulted in the inclusion of table drain maintenance, increasing the Development Envelopein the northern extent of the Proposal, revisions to the 85% drainage design and several management recommendation during construction. All recommendations were incorporated into the design and WST Management Plan.

3.1.2 Western Swamp Tortoise Recovery Team

Main Roads representative met with the WST Recovery Team on 17 March 2020 and presented the Proposal to the Chair of the WST Recovery Team, representatives from DBCA Threatened Species and Communities and DBCA Regional Office, and WST specialist Gerald Kuchling. The drainage design, previous DBCA consultation, WST detection survey methodology and proposed environmental management during construction was discussed in detail.

The WST Recovery Team was supportive of the potential advances in the training and utilisation of a local conservation, detection dog to survey for WST prior to clearing and construction commencing. DBCA provided forthcoming support in obtaining the required animal ethics approvals and was keen to assist where required.

There were no objections raised by the WST Recovery Team and they will continue to be informed of progress on the detection surveys prior to works commencing.

3.1.3 Friends of Western Swamp Tortoise

Main Roads representatives met with the Friends of WST group on 16 March 2020 and presented to the Chair, Treasurer, Vice President and a number of other interested members.

The primary interest of the Friends of WST Group was that the table drain to the north of the Development Envelope was re-established and appropriately maintained in the future. The Friends of WST were supportive of the Proposal and the community/ safety benefits it would bring. Main Roads inclusion of GPTs in an effort to improve water quality entering Ellen Brook Nature Reserve from road run-off, was also supported.

The group was endorsed the Proposal and the environmental management proposed. No further recommendations were provided to Main Roads representatives.

3.1.4 Water Corporation

Water Corporation has been frequently consulted during the design phase of the project due to the Water Corporation proposed sewer main installation works that may occur within the Development Envelope. Main Roads and Water Corporation have been sharing design information to ensure that new proposed works for both parties do not conflict.

Environmental factors associated with both works were discussed during the development stage and Main Roads has provided in principle agreement that it will construct and cap the sewer main where it intersects with the roundabout construction activities. This should avoid digging up recently installed infrastructure, reduce unnecessary expenditure and have positive environmental outcomes

reducing cumulative impacts.

3.1.5 City of Swan

City of Swan is the Local Government Authority within which the Proposal is located. Main Roads has undertaken frequent consultation with City of Swan to ensure that their adjacent works on Apple Street, Railway Parade and Stock Road are staged to minimise impacts to the local community.

City of Swan will also be involved in the assessment of the Development Application.

3.1.6 Satterley

Satterley is a key stakeholder for the Proposal and has been involved in the Proposal since inception. Satterley is in the planning stages of a large residential development in Upper Swan. The projected increase in vehicle movements round the Intersection as a result of the development, is a key driver for this Proposal. Satterley is partially funding the design and construction of the Proposal.

4 ENVIRONMENTAL PRINCIPLES AND FACTORS

4.1 Principles

Section 4A of the *Environmental Protection Act 1986* (EP Act) establishes the objectives and principles of the EP Act. In accordance with the EPA's Statement of Environmental Principles, Factors and Objectives (EPA 2020 [3]), this section describes how each of the five principles of the EP Act has been applied to the Proposal (Table 4-1).

Table 4-1: *Environmental Protection Act 1986* Principles

No.	Principle	Consideration of Principle in the Proposal
1	The precautionary principle *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.* *In the application of the precautionary principle, decision should be guided by:* *careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and an assessment of the risk-weighted consequences of various options.*	Comprehensive desktop and field studies have been undertaken within and adjacent to the Development Envelope. Studies includes: - Flora and vegetation. - Terrestrial fauna. Potential impacts have been identified and described under each key environmental factor. Information gathered during these studies has reduced the uncertainty surrounding prediction of impacts for the assessment. Mitigation and management measures have been proposed to ensure potential impacts to the environment are significantly reduced. Main Roads has ensured that the Proposal's design (where possible) avoids serious or irreversible damage to the environment.
2	The principle of intergenerational equity *The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.*	The Proposal will ensure the health, diversity and productivity of the environment is maintained through retaining as much habitat as possible.
3	The principle of the conservation of biological diversity and ecological integrity *Conservation of biological diversity and ecological integrity should be a fundamental consideration.*	There are patches of limited biological diversity and ecological integrity within and adjacent the Proposal. Main Roads has sought to preserve as much of the remnant biodiversity as possible by avoiding areas of native vegetation and mature trees where practicable.
4	Principles relating to improved valuation, pricing and incentive mechanisms *Environmental factors should be included in the valuation of assets and services* *The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance or abatement* *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 wastes* *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*	Main Roads acknowledges the need for improved valuation, pricing and incentive mechanisms and endeavours to pursue these principles when appropriate. For example, environmental factors have determined the location and design of the Intersection upgrade within the Development Envelope, with a strong focus on reducing the direct and indirect impacts and improving water quality. Potential impacts on terrestrial fauna have been assessed and mitigation and management measures proposed. Main Roads accepts that the cost of the Proposal must include environmental impact mitigation, management and maintenance activities. These requirements will be incorporated into the overall Proposal costs.
5	The principle of waste minimisation	Management strategies will be implemented to ensure that generation of waste during the construction phase is minimised. All activities shall

No.	Principle	Consideration of Principle in the Proposal
	All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	be carried out with the principles of cleaner production and waste minimisation.

4.2 Identification of Preliminary Key Environmental Factors

Environmental factors are those parts of the environment that may be impacted by an aspect of a proposal. The EPA has 14 environmental factors, organised into five themes: Sea, Land, Water, Air and People.

The preliminary Key Environmental Factors and EPA objectives are provided in Table 4-2. The key environmental factor for this Proposal is Terrestrial fauna due to the potential impacts to WST. The relevance of each factor to the Proposal has been summarised and the significant environmental factors that require further consideration identified.

No other environmental factors established by the EPA for the purposes of environmental impact assessment were considered by the Proponent to be significant for the Proposal. Discussion on why the remaining environmental factors are not singificant to the Proposal are discussed in Section 5.

Table 4-2: Assessment of environmental factors

Principle	Factor	Objective	Relevance to Proposal	Significant impact to Environmental Factor
Sea	Benthic Communities and Habitats	To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.	The Proposal is not located adjacent or nearby coastal areas.	No significant impacts.
	Coastal Processes	To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected.	The Proposal is not located adjacent or nearby coastal areas.	No significant impacts.
	Marine Environmental Quality	To maintain the quality of water, sediment and biota so that environmental values are protected.	The Proposal is not located adjacent or nearby coastal areas.	No significant impacts.
	Marine Fauna	To protect marine fauna so that biological diversity and ecological integrity are maintained.	The Proposal is not located adjacent or nearby coastal areas.	No significant impacts.
Land	Flora and Vegetation	To protect flora and vegetation so that biological diversity and ecological integrity are maintained.	Almost the entire Development Envelope has been previously cleared, containing degraded condition vegetation.	Not a significant impact. Refer to Section 6.
	Landforms	To maintain the variety and integrity of significant physical landforms so that environmental values are protected.	The Proposal will involve shallow earthworks and will not impact on high value landforms.	No significant impacts.
	Subterranean Fauna	To protect subterranean fauna so that biological diversity and ecological integrity are maintained.	The Proposal will involve shallow earthworks. All dewatering will be short term and localised, which is not expected to cause significant impacts to subterranean fauna.	No significant impacts.

Principle	Factor	Objective	Relevance to Proposal	Significant impact to Environmental Factor
	Terrestrial Environmental Quality	To maintain the quality of land and soils so that environmental values are protected.	The Proposal will involve shallow earthworks with localise short term dewatering unlikely to impact acid sulfate soils (ASS) or contaminated site.	Not a significant impact. Refer to Section 6.
	Terrestrial Fauna	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.	Construction has the potential to impacts to WST due to proximity to Ellen Brook Nature Reserve and Proposal locality within the Environmental Protection Policy (EPP) boundary. No direct or indirect impacts expected.	Proposal has the potential to impact WST. Potential impact on WST not considered significant. Refer to Section 5.
Water	Inland Waters	To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.	Wetlands and river systems are present within the Development Envelope however, there will be no alterations to existing drainage.	Proposal is adjacent to wetland/ river systems however no significant impact is anticipated. Refer to Section 6.
Air	Air Quality	To maintain air quality and minimise emissions so that environmental values are protected.	The Proposal will result in minor air (dust, vehicle) emissions during construction. The Proposal operations will not result in significant air emissions.	Emissions will be managed using standard management practices during construction. No significant impacts.
	Greenhouse Gas Emissions	To reduce net greenhouse gas emissions in order to minimise the risk of environmental harm associated with climate change.	The Proposal operations will not result in significant air emissions.	Emissions will be managed using standard management practices during construction. No significant impacts.
People	Social Surroundings	To protect social surroundings from significant harm.	The Development Envelope is located in a residential area and has Aboriginal Heritage values. Works are isolated to previously disturbed areas	Impact to Aboriginal heritage is not likely. Disturbance through noise and amenity issues are not a significant impact. Refer to Section 6.
	Human Health	To protect human health from significant harm.	No human health impacts expected. No radiation emissions.	No significant impact.

5 ENVIRONMENTAL FACTOR - TERRESTRIAL FAUNA

This section describes terrestrial fauna and fauna habitat that occur within the Development Envelope, provides an assessment of the potential impacts of the Proposal to conservation significant fauna listed under the BC Act and EPBC Act, including proposed mitigation measures and the predicted outcome for this key environmental factor.

Fauna species listed under the EPBC Act as threatened or migratory are also addressed in Section 7.

5.1 EPA Objective

The EPA's objective for terrestrial fauna is to protect terrestrial fauna so that biological diversity and ecological integrity are maintained (EPA 2016b).

5.2 Policy and guidance

The following policies and guidance are relevant to the Terrestrial Fauna factor:

- EPA Statement of Environmental Principles, Factors and Objectives (EPA 2020).
- EPA Instructions on how to prepare an Environmental Review Document (EPA 2018b).
- EPA Environmental Factor Guideline: Terrestrial Fauna (EPA 2016b).
- EPA Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna (EPA 2016c).
- EPA Technical Guidance: Terrestrial Fauna Surveys (EPA 2016d).
- Survey Guidelines for Australia's Threatened Birds (DEWHA 2010).
- Environment Protection (Western Swamp Tortoise Habitat) Policy 2011 (EPA 2011).

Other policy and guidance:

- Government of Western Australia WA Environmental Offsets Policy (GoWA 2011).
- Government of Western Australia WA Environmental Offsets Guidelines (GoWA 2014)

5.3 Receiving environment

5.3.1 Fauna studies

In November 2019, Main Roads (2020) completed a reconnaissance flora and vegetation assessment and a fauna habitat and targeted Black Cockatoo habitat assessment within the Development Envelope. The area surveyed was expanded in April 2020 to account for changes in the Proposal scope. Database searches of Threatened and Priority Fauna (within 5 km of the Development Envelope) were used to inform the desktop assessment and field survey for the Main Roads (2020) assessment.

Details relating to the Main Roads biological assessment are outlined in Table 5-1.

Table 5-1: Terrestrial Fauna Investigations Undertaken for the Purpose of this Proposal

Survey/Report Name	Survey Type and Timing
Main Roads (2020) ***GNH and Apple Street Intersection: Flora, Vegetation, Fauna habitat and Black Cockatoo Assessment***	**Survey Area:** Development Envelope comprising 18 hectares **Type:** Fauna habitat and Black Cockatoo Habitat Assessment to delineate fauna habitat types, record potential foraging and breeding habitat for Black Cockatoos. **Timing:** Fieldwork undertaken by a qualified ecologist on 29 November 2019 and 7 April 2020

5.3.2 Fauna Habitat

Regional context

The Proposal is located on the Swan Coastal Plain, defined by a low lying coastal plain, mainly covered with woodlands (Mitchell et al. 2002). The Swan Coastal Plain is characterised by a Mediterranean climate with hot and dry summers, and cool, moist winters with relatively high rainfall which has lead to a diverse range of vegetation, from coastal dunes and sandplains to Banksia and Eucalypt woodlands. This subregion contains areas of high biodiversity value and provides some key habitat types for fauna.

This bioregion also contains a number of Wetlands of National significance including the Ellen Brook Swamps System (SWA007WA) (The Ellen Brook) which is located adjacent to the Development Envelope (Figure 5-1). The Ellen Brook is a natural, ephemeral waterway that contains the largest catchment area in the Swan-Canning subcatchments on the Swan Coastal Plain.

The Swan Coastal Plain is heavily developed with approximately 80% of it cleared. Some of the remaining areas of vegetation have a high conservation value, containing rare and endangered flora and fauna such as the WST.

Local context

Four broad fauna habitats, along with completely cleared areas, are present in the Development Envelope (Main Roads 2020). The fauna habitat types provide low habitat value for native fauna. Almost the entire Development Envelope has been previously cleared, see Figure 5-2. All habitats recorded were considered to be widespread, common and of limited significance. High value fauna habitat, particularly for conservation significant fauna species, occurs in Ellen Brook Nature Reserve located immediately west from the Development Envelope. Fauna habitat types are defined in Table 5-2 and Figure 5-1.

Table 5-2: Fauna habitat types in the Development Envelope

Fauna habitat type	Description	Value to conservation significant fauna	Related vegetation types	Mapped extent in Development Envelope (ha)
Open Eucalypt Woodland	Planted *Eucalyptus camaldulensis* (River Red Gum) trees with occasional *Casaurina obesa* (Swamp Sheoak), *Corymbia calophylla* (Marri) and *Eucalyptus rudis* (Flooded Gum) trees over a ground storey dominated by introduced grasses mostly along roadside constructed drainage lines.	Provides low quality habitat to Black Cockatoos	VT1, VT2, VT, Planted A	5.9
Isolated Trees	*Acacia saligna* and Swamp Sheoak isolated trees over weeds.	No value	VT4, Planted B	0.6
Grasslands/Degraded Areas	Introduced grassed along roadsides.	No value	Introduced Grasses	2.65
Drainage Sump	Constructed drainage sump.	Potential habitat for WST	Drainage Sump	0.1
Cleared	Cleared areas.	No value	Cleared	8.75
Total				18

Source: Adapted from Main Roads (2020)

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Source: Aerial image: Skyview. Development Envelope: Main Roads 04/2020. Fauna: Main Roads Site Inspection (2020)
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Source: Aerial image: Skyview March 1965. Development Envelope: Main Roads 04/2020l

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5.3.3 Fauna Diversity

A total of 221 species from 78 families were identified from the desktop assessment as potentially occuring within 5 km of the Development Envelope (Main Roads 2020). This comprised 18 mammals (15 native), 137 birds (132 native), 40 reptiles and nine amphibians.

The fauna habitat present in the Development Envelope are highly degraded and fragmented; therefore, these habitats are not expected to contain high levels of fauna diversity.

5.3.4 Conservation Significant Fauna

A total 33 conservation signfiicant fauna species have been recorded within 5 km of the Development Envelope. Of these, two were considered likely to occur (Forest Red-tailed Black Cockatoo [FRTBC] and Carnaby's Cockatoo), three species were considered to possibly occur (WST, Quenda and Peregrine Falcon) and the remaining were considered unlikely to occur due to a lack of suitable habitat and nearby records (Main Roads 2020).

No conservation significant fauna have been observed in the Development Envelope however, foraging evidence in the form of chewed Marri nuts from FRTBC has been recorded in the Development Envelope (Main Roads 2020).

A summary of the likelihood of occurrence of key conservation significant species, identified as either likely or possibly occuring within the Development Envelope is presented in Table 5-3.

All conservation significant fauna records (including MNES) are presented in the Main Roads (2020) assessment.

Table 5-3: Conservation significant fauna

Species	Status		Habitat	Likelihood of Occurrence in the Development Envelope
	EPBC Act	WA		
Birds				
Carnaby's Cockatoo (*Calyptorhynchus latirostris*)	EN	T	Forages in proteaceous heath and shrubland, Eucalypt woodlands and introduced pine plantations. Nests in hollows in large Eucalypts. Almost the entire Development Envelope has been previously cleared with the Development Envelope now containing poor quality foraging habitat. No trees with potentially suitable hollows were recorded within the Development Envelope.	**Likely** – Records from the vicinity and potential habitat present.
Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*)	VU	VU	Eucalypt forests of Jarrah, Marri and Karri, with recent movement into Perth suburbs.	**Likely** – Records from the vicinity and foraging evidence was observed in the Development Envelope.
Peregrine Falcon (*Falco peregrinus*)	-	OS	Occupies a wide range of habitats including woodlands, wetlands, open country and built up areas. This species breeds primarily on ledges in cliffs, granite outcrops, quarries and tall buildings. It feeds mostly on other birds but also feeds on rabbits and other moderate sized mammals.	**Possible** – May overfly the area on occasion, but unlikely to contain important habitat for the species. Species unlikely to be reliant on the habitats in the Development Envelope for foraging or breeding.
Mammals				

Species	Status		Habitat	Likelihood of Occurrence in the Development Envelope
	EPBC Act	WA		
Quenda (Southern Brown Bandicoot) (*Isoodon obesulus*)	-	P4	Variety of forest, woodland, shrubland and heath communities, but prefer areas of denser vegetation, including wetland fringes and heathland.	**Possible** – Previous record within the Development Envelope, however this is likely to represent a transient individual rather than a resident as preferred habitat for the species not present.
Reptiles				
Western Swamp Tortoise (*Pseudemydura umbrina*)	CR	CR	Inhabits shallow, ephemeral, winter-wet swamps on clay or sand over clay soils with nearby suitable aestivating refuges.	**Possible** – The Development Envelope is adjacent to the Ellen Brook Nature Reserve population. A man-made sump provides possible short term habitat for individuals, however there are no natural habitat types in the Development Envelope that are likely to support this species.

*CR = Critically Endangered; EN = Endangered; VU = Vulnerable; T= Threatened; P = Priority species, OS = Other specially protected fauna. Source: Adapted from Main Roads (2020)

Western Swamp Tortoise (*Pseudemydura umbrina*)

The WST is listed as Critically Endangered under the BC Act and the EPBC Act. It is also listed as Critically Endangered on the Internation Union for Conservation of Nature (IUCN) Red List of Threatened Species under criteria A1c, B1+2c, C1+2b and D (Biota 2020). The species inhabits ephemeral, winter- and spring-inundated swamps on clay, or sand over clay soils, with suitable aestivation areas nearby (Biota 2020)

Scattered population records range from eastern parts of the Swan Coastal Plain, from Guildford in the south to Bullsbrook in the north (Biota 2020); and unconfirmed sightings reported from as far north as Mogumber and as far south as Donnybrook (Biota 2020). The WST is restricted to two naturally occurring populations on the north-eastern fringe of the Perth metropolitan area at Ellen Brook and Twin Swamps Nature Reserves (Figure 5-3).

The Proposal is located in the southern most extend of the EPP Boundary, with the Ellen Brook Nature Reserve abutting the western boundary of the Development Envelope.

The suitable habitats for the WST are unique to the Ellen Brook Nature Reserve and are not common in the Swan Coastal Plain. There is one habitat type that may be used by this species within the Development Envelope (Main Roads 2020) being the drainage sump comprising 0.1 ha.

This species was not observed during the field survey by Main Roads (2020), however it is known to occur within the adjacent Ellen Brook Nature Reserve. WST escapees from the reserve could possibly occur and may utilise the habitat provided by the drainage sump. However, there are no habitat types within the Development Envelope that are likely to support this species.

Quenda, Southwestern Brown Bandicoot (*Isoodon obesulus*)

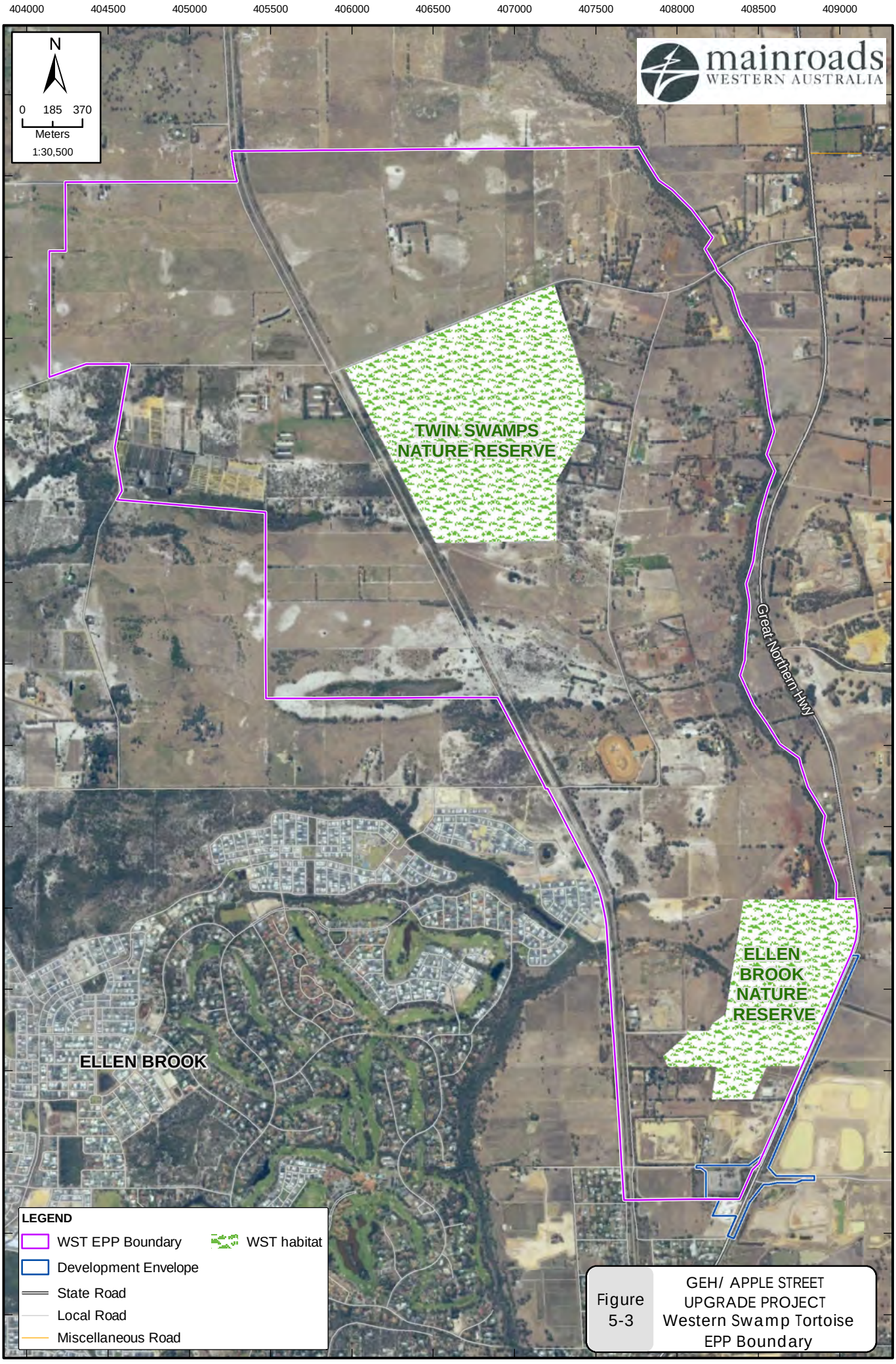
The Quenda, or Southwestern Brown Bandicoot (*Isoodon obesulus*), is listed as Priority 4 on the DBCA Priority List. It once occurred throughout south west Western Australia; however, now has a widely but patchy distribution, from around Guilderton to east of Esperance and inland to Hyden in *Eucalyptus marginata* (Jarrah) and *E. diversicolour* (Karri) forests and adjacent coastal vegetation complexes. The species prefers low, dense (cover up to 1 m high), scrubby, often swampy habitats, and often feeds in adjacent forest and woodland that is burnt on a regular basis and in areas of pasture and cropland lying close to dense cover. Populations inhabiting Jarrah and *E. wandoo* (Wandoo) forests usually associated with watercourses. On the Swan Coastal Plain it is often associated with wetlands with dense vegetation where they feed on fruit, seeds, insects and fungi (DEC 2012).

This species was not observered during the field survey, however, one historical record has been identified in the Development Envelope from DBCA database and NatureMap searches (DBCA 2019a, DBCA 2019b). The Development Envelope does not contain the preferred habitat for this species due to the lack of dense understorey cover of more than 1 m, and absence of adjacent forest and woodland that is burnt at a regular basis. The previous record in the Development Envelope is likely to represent an individual moving through the area rather than a resident, as preferred habitat for this species is not present.

Peregrine Falcon (Falco peregrinus)

The Peregrine Falcon is listed as Other Specially Protected Fauna under the BC Act. It occupies a wide range of habitats including woodlands, wetlands, open country and built up areas. This species breeds primarily on ledges in cliffs, granite outcrops, quarries and tall buildings. It feeds almost entirely on other birds. It also eats rabbits and other moderately sized mammals, bats and reptiles (DAWE 2020).

This species was not observed during the field survey by Main Roads (2020). This species may overfly the area on occasion, but is unlikely to be reliant on the habitats in the Development Envelope for foraging or breeding.



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Source: Aerial image: Skyview. Development Envelope: Main Roads 04/2020. Fauna: Main Roads Site Inspection (2020)
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Black Cockatoos

The Development Envelope falls within known (and predicted) distributions of Carnaby's Cockatoo, FRTBC and Baudin's Cockatoo (Black Cockatoos) as described in the *EPBC Act Referral Guidelines for Three Threatened Black Cockatoo Species* (the Referral Guidelines; DSEWPaC 2012). Due to the presence of potential habitat and nearby records of sightings, Carnaby's Cockatoo and FRTBC are considered likely to occur in the Development Envelope (Main Roads (2020), while Baudin's Cockatoo was considered unlikely to occur due to the Proposal location and a lack of records within 5 km. Carnaby's Cockatoo is a seasonal visitor to the Swan Coastal Plain, which provides important foraging and roosting habitat during the non-breeding season. The FRTBC has a traditional range within the Jarrah Forest and Warren bioregions, where it breeds. In recent years, the FRTBC has expanded its distribution onto the Swan Coastal Plain.

The Swan Coastal Plain is generally more important to Black Cockatoos as a feeding ground with only small areas supporting breeding to the north of Perth (DoEE 2017a, EPA 2019). Foraging habitat is defined as areas including plants of species known to support foraging within the range of each Black Cockatoo species. While a broader range of species utilised for foraging (including introduced species such as **Pinus* spp.), Marri and Jarrah woodlands are particularly important to the FRTBC, the Banksia woodlands and proteaceous heath are commonly utilised by Carnaby's Cockatoo (DSEWPaC 2012, EPA 2019).

Black Cockatoos breed in large hollow-bearing trees, generally within woodlands or forests. The size of the tree can be a good indication of the hollow bearing potential of the tree. Trees of suitable diameter at breast height are potentially important for maintaining breeding in the long term, through maintaining the integrity of the habitat and allowing trees to provide future nest hollows. Maintaining the long term supply of trees of a size to provide suitable nest hollows is particularly important in woodland stands that are known to support Black Cockatoo breeding (DSEWPaC 2012).

The vegetation in the Eucalypt Woodland habitat in the Development Envelope may provide potential habitat for Black Cockatoos. No observations of Black Cockatoos were recorded in the Main Roads (2020) assessment.

Black Cockatoo Foraging and Roosting Habitat

There is approximately 5.9 ha of potential, poor quality foraging habitat for Black Cockatoos in the Development Envelope, within the Open Eucalypt Woodland habitat (Main Roads 2020) (Table 5-2, Figure 5-4). Vegetation mapped as potential foraging habitat includes areas containing River Red Gum and Marri which are known dietary items for Black Cockatoos (DSEWPaC 2012). The River Red Gum in this habitat type are unlikely to be a foraging species for Carnaby's Cockatoo, preference is likely to be given to more suitable species such as Marri (DoEE 2017a). The River Red Gum, Marri and Flooded Gum may provide a potential foraging resource for the FRTBC (DSEWPaC 2012). Marri nuts with chew marks indicative of FRTBC were recorded within the Development Envelope in the Main Roads (2020) assessment.

The potential foraging habitat was assessed as poor quality due to the low density of foraging species, with foraging habitat consisting mostly of isolated trees over weeds and the presence of food sources generally limited to one stratum (canopy).

There are no known roosting sites within or adjacent to the Development Envelope.

Forty-nine trees (including introduced Eucalypts and Marri) with a Diameter at Breast Height (DBH) greater than 500 milimetres (mm) were recorded (Main Roads 2020).

Black Cockatoo Breeding Habitat

Almost the entire Development Envelope has been previously cleared. Accordingly, nearly all the trees within the project area are not considered old enough to form adequate sized hollows for Black Cockatoos. It is considered that three trees located south of the Intersection could potentially be old enough (>120 years) to contain hollows. An inspection of these trees did not identify any hollows present.

Although the Development Envelope does not contain trees old enough to contain hollows, 49 trees

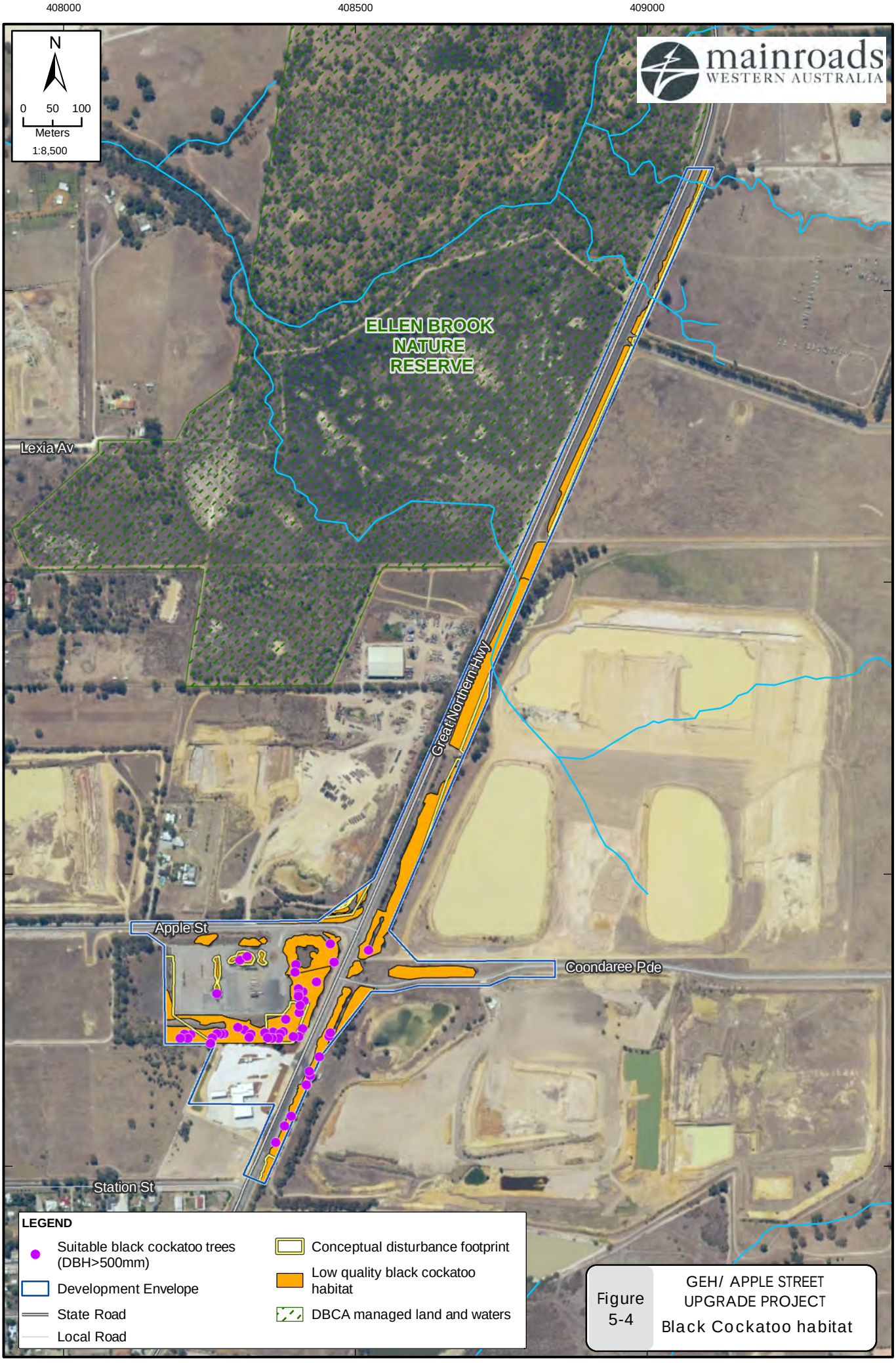
were recorded as having a Diameter at Breast Height (DBH) greater than 500 milimetres (mm) (Suitable DBH Trees). These Suitable DBH Trees are located within the Open Eucalypt Woodland habitat type, consisting of five Marri, one Flooded Gum and 43 River Red Gum trees. None of these Suitable DBH trees contained any hollows suitable for Black Cockatoo breeding (Main Roads 2020). The location of these trees are displayed in Figure 5-4.

5.3.5 Ecological Linkages

The objective of ecological linkages is to facilitate the movement of wildlife and connect significant vegetation, habitat and landscape features with continuous corridors of native vegetation (COW 2018). The northern end of the Development Envelope intersects a regionally significant fragmented bushland/wetland linkage between Ellen Brook Nature Reserve and Walyunga National Park (Figure 5-5).

No road works will occur within the linkage corridor. The Proposal will not fragment this linkage, with the Proposal considered to have a net environmental benefit.

Potential impacts to ecological linkages are not discussed further in this document.



Document Path: Y:\Metropolitan Region\Environment\Project Files\Great Northern Highway Apple St Intersection - Roundabout\Maps, GIS, Design\Mxds\GNH Apple Street_BC Habitat_RevA.mxd
Source: Aerial image: Skyview. Development Envelope: Main Roads 04/2020. Fauna: Main Roads Site Inspection (2020)
Created by: DWhite

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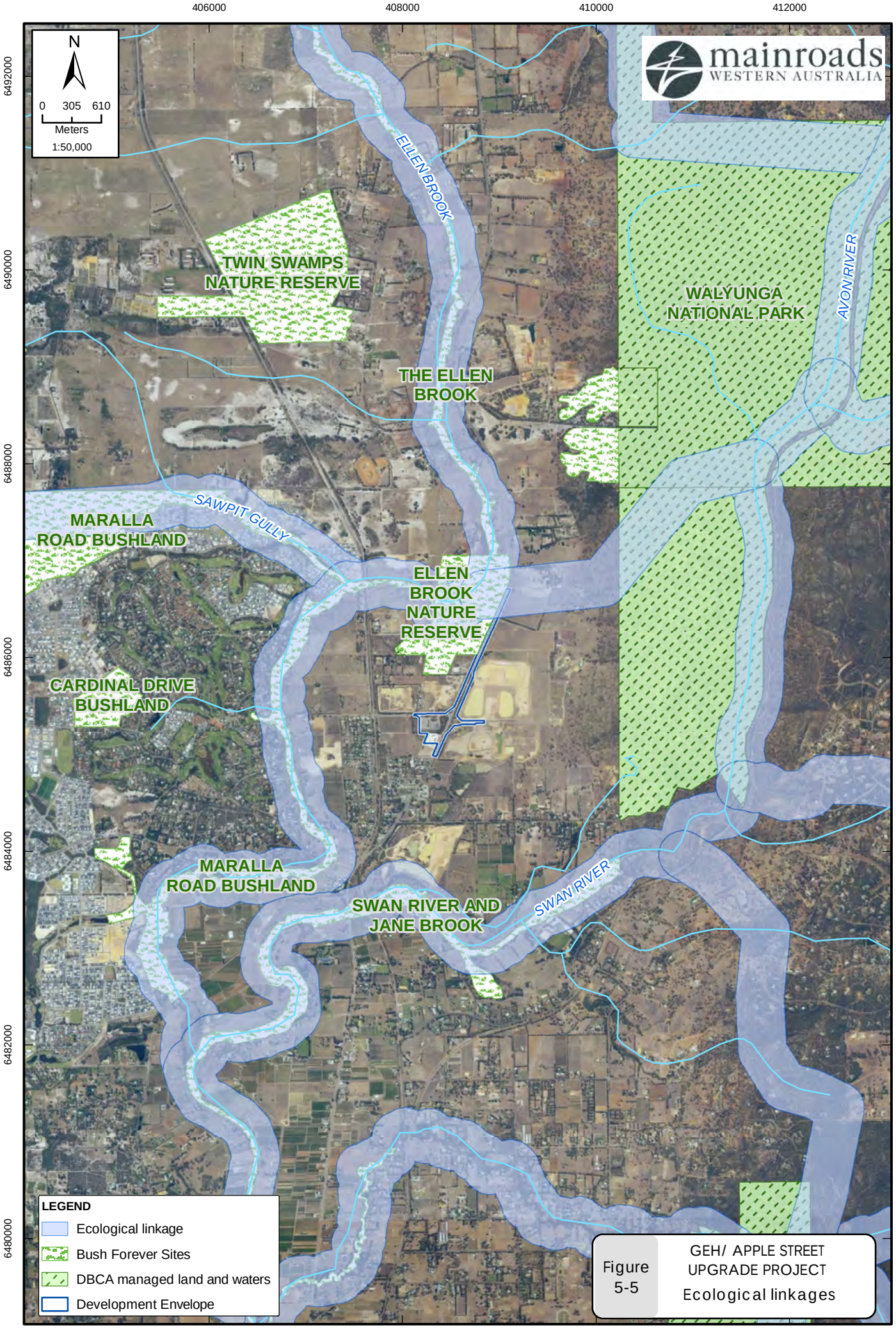

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Source: Aerial image: Skyview. Development Envelope: Main Roads 04/2020. Fauna: Main Roads Site Inspection (2020)
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5.4 Potential impacts

5.4.1 Direct impacts

Implementation of the Proposal has the potential to result in the following direct impacts to terrestrial fauna:

- Loss of conservation significant fauna habitat
- Loss of conservation significant fauna individuals.

5.4.2 Indirect impacts

Implementation of the Proposal has the potential to result in the following indirect impacts to terrestrial fauna:

- Degradation/alteration of fauna habitat from altered groundwater and hydrological regimes;
- Habitat degradation associated with construction activity including fire, transmission of weeds; introduction/spread of dieback, dust and increased abundance of introduced fauna species;
- Discharge of polluting substances;
- Disturbance from the possible displacement of fauna in trenches and sumps associated with construction activities.

5.5 Assessment of impacts

5.5.1 Direct impacts

Loss of fauna habitat

Clearing for the Proposal will result in the loss of up to 3.05 ha of native vegetation and 7.63 of four mapped fauna habitat types. This includes the removal of up to 4.51 ha of poor quality Black Cockatoo foraging habitat and up to 31 Suitable DBH Trees (Table 5-4).

Table 5-4: Proposed clearing of fauna habitat types within the Development Envelope

Habitat type	Habitat value to conservation significant fauna	Extent in Development Envelope (ha)	Proposed to be cleared (ha)	% Fauna habitat type loss	Remaining in the Development Envelope
Open Eucalypt Woodland	Limited Black Cockatoo habitat	5.9	4.51	76.4%	1.39
Isolated Trees	None	0.6	0.6	100%	0
Grasslands/Degraded Areas	None	2.65	2.42	91.3%	0.23
Drainage Sump	Possible WST habitat	0.1	0.1	0%*	0.1
Cleared	None	8.75	8.75	100%	0

* Although 0.1 ha of unvegetated, drainage sump habitat will be removed, the new sump that is equivalent in size, will be located immediately south of the existing sump and therefore there is no net loss in possible WST habitat.

Fauna habitat provides limited value for a range of conservation listed fauna species. The total loss of potential habitat for individual conservation listed fauna species that have been recorded, or have the potential to occur, and the significance of the impact of that habitat loss is described in Table 5-5.

Table 5-5: Potential Impact Proposal may have on Conservation Significant Fauna.

Species	Conservation status		Likelihood of occurrence	Proposed to be cleared (ha)	Significance of Proposal
	EPBC Act	WA			
Black Cockatoos (Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo)	EN/VU	T/VU	Likely	4.51	**Low impact.** The Proposal will result in the: - removal of up to 4.51 ha of low quality potential Black Cockatoo foraging habitat - removal of 31 suitable DBH trees for Black Cockatoos, none containing hollows. There is poor quality foraging habitat within the Development Envelope. The presence of Red River Gum, Flooded Gum and Marri are known dietary items for Black Cockatoos; however, there is a low density of foraging species present, and only Marri would be the preferred foraging species for Carnaby's Cockatoo. The clearing of up to 4.51 ha of potential habitat is not expected to result in a significant impact to the species based on; - the representation of appropriate habitat in adjacent and nearby conservation areas including Ellen Brook Nature Reserve and Walyunga National Park; - 18 Suitable DBH Trees remaining in the Development Envelope; - no known roosting habitat within the Development Envelope; - the low density of foraging species present in the Development Envelope; and - the habitat present in the Development Envelope is not critical to the survival of the species at a local or regional scale.
Peregrine Falcon (*Falco peregrinus*)	-	OS	Possible	7.63	**Low impact.** This species may overfly the Development Envelope on occasion, however the Peregrine Falcon is unlikely to be reliant on the habitat types in the Development Envelope for foraging or breeding. The species is widespread, highly mobile and is expected to occur outside of the Development Envelope. Given that this species is highly mobile and not likely to be dependent on any of the habitat types for foraging or breeding, it is not expected that the Proposal will have a significant impact on this species.
Quenda (Southern Brown Bandicoot) (*Isoodon obesulus*)	-	P4	Possible	0.0	**Low impact.** There is effectively no remnant vegetation, and a lack of dense understorey cover in the Development Envelope, that has the potential to be utilised by Quenda. The species is widespread and is expected to occur outside of the Development Envelope. Given the narrow linear nature of the Proposal, the lack of preferred habitat in the Development Envelope, the proximity of the Development Envelope to larger areas of similar or better quality habitat, and the presence of other records in the vicinity

Species	Conservation status		Likelihood of occurrence	Proposed to be cleared (ha)	Significance of Proposal
	EPBC Act	WA			
					of the Proposal, it is not expected that the Proposal will have a significant impact on this species.
Western Swamp Tortoise (*Pseudemydura umbrina*)	CR	CR	Possible	0.1	**Low impact.** The Proposal will result in the relocation of up to 0.1 ha of potential habitat for WST. The Development Envelope contains 0.1 ha of potential habitat in the drainage sump on the south west corner of the Intersection. The Proposal requires that the sump be modified to account for the new intersection however; the sump will not be removed completely. While the drainage sump contains potential habitat, none of the habitat types in the Development Envelope are likely to support this species. The Proposal has the potential to temporarily disturb WST habitat associated with the drainage sump modification in the Development Envelope.

Loss of fauna individuals

Injury and mortality of fauna can result from construction and operation activities that have the potential to decrease local fauna abundance, particularly WST individuals that may be attracted to the ponding of water in drainage lines adjacent to GNH during periods when the fenced habitat in Ellen Brook Nature Reserve is comparibly dry. This includes fauna being injured/killed by collisions with earthmoving equipment and/or vehicles during construction works or operation.

Main Roads will effectively manage this risk by timing clearing for the Proposal when WST individuals are unlikely to seek santuary outside the fenced area of Ellen Brook Nature Reserve. WST are not expected to inhabit the construction area after clearing as leafy habitat will not be present. Furthermore, a pre-clearing and pre-construction detection survey will be completed over the final construction footprint to identify WST in the construction footprint prior to works commencing.

5.5.2 Indirect Impacts

Degradation/alteration of fauna habitat from altered groundwater and hydrological regimes

The removal of vegetation and excavations for the construction of roads and drainage infrastructure may have a minor short term affect on local surface water flows. Without appropriate management, earthworks could potentially cause sedimentation in the adjacent fauna habitat of Ellen Brook Nature Reserve. To reduce the likelihood of this occurring, the construction activities will be undertaken in dry conditions where possible.

The sump located south of the the Intersection has been designed to capture and direct water into the road side table drain to allow for discharge into a tribuatory of Ellen Brook immediately north of the fenced portion of Ellen Brook Nature Reserve. The sump has been designed to have the capacity to handle road run-off during peak events (1:10 average recurrence interval [ARI] rainfall event). The drainage flow has not been altered with the Proposal and the maintenance to the table drain on the western side of GNH in the northern extent of the Development Envelope will result in more efficient surface flows in this area.

The incorporation of appropriate stormwater design for the Proposal is expected to reduce the risk of altered groundwater and hydrological regimes as the existing local surface flow directions and hydrological regimes has been maintained, as per DBCA request. This will be effective in having little to no adverse impacts to fauna habitat within the Development Envelope, nor in Ellen Brook Nature Reserve, as there are no changes in the existing surface hydrology of the areas adjoining Ellen Brook Nature Reserve.

Habitat degradation - fire, weeds, dieback, dust and introduced fauna

Construction activities and vehicle movements have the potential to increase dust, spread weeds and cause fire, all of which may result in the degradation of fauna habitat. Dust and fire will be managed throughout the construction contract through standard construction management and is not considered likely to have potential impacts on WST habitat.

The introduction of dieback and/ or weeds into the fauna habitat adjacent to the Development Envelope may cause the degradation of fauna habitat values in Ellen Brook Nature Reserve. Construction/fill material will not be brought into the road reserve immediately adjacent to Ellen Brook Nature Reserve. The risks associated with weed and dieback as considered low, however, these risks will be effectively managed during construction by Main Roads through a Hygiene Management Plan.

Vegetation clearing can increase access of feral predators to fauna habitats such as Ellen Brook Nature Reserve. As there is no clearing of native vegetation proposed adjacent to Ellen Brook Nature Reserve, the Proposal is not expected to affect the impact feral predation has on local populations of fauna.

The potential residual impacts from the Proposal to terrestrial fauna are not expected to be locally or regionally significant.

The discharge of polluting substances during construction

The contamination of surface water and groundwater during construction has the potential to degrade WST habitat in Ellen Brook Nature Reserve. The potential for contamination during construction is limited to isolated areas of chemical storage and small quantities of hydrocarbons where machinery or generators are working. Where possible, the storage of chemicals will be isolated to sealed areas, such as the RTAA and will be appropriately bunded to reduce the potential risks of contamination

Main Roads has incorporated the installation of GPTs into the drainage design for the proposal to manage risk associated with the operation of the road network. Installation of other measures such as bunding and spill management procedures will be considered as approproate during construction.

The environment management proposed will be effective in reducing the risk of surface run off or any hydocarbon spillages from GNH into Ellen Brook Nature Reserve.

Disturbance from the possible displacement of fauna in trenches and sumps associated with construction activities

The Development Envelope is partially within the EPP boundary for the WST and within 300 m of the start of the fenced habitat for WST in Ellen Brook Nature Reserve. The proposed drainage works are adjacent to a known turtle access pathway into Ellenbrook Nature Reserve (Plate 1) which, without management, may result in displacement of individuals during construction activities in adjacent trenches or sump.

The presence of water in excavated areas has the potential to attract tortoises searching for inundated habitat, which may then become trapped. Main Roads will effectively manage these risks, in consultation with DBCA, by undertaking searches prior to commencement of clearing and again prior to construction; specifically prior to works occurring in trenches that were required to be left open overnight and prior to infilling for any trenches or excavated areas. Any individuals identified within the Development Envelope will be relocated in consultation with DBCA.

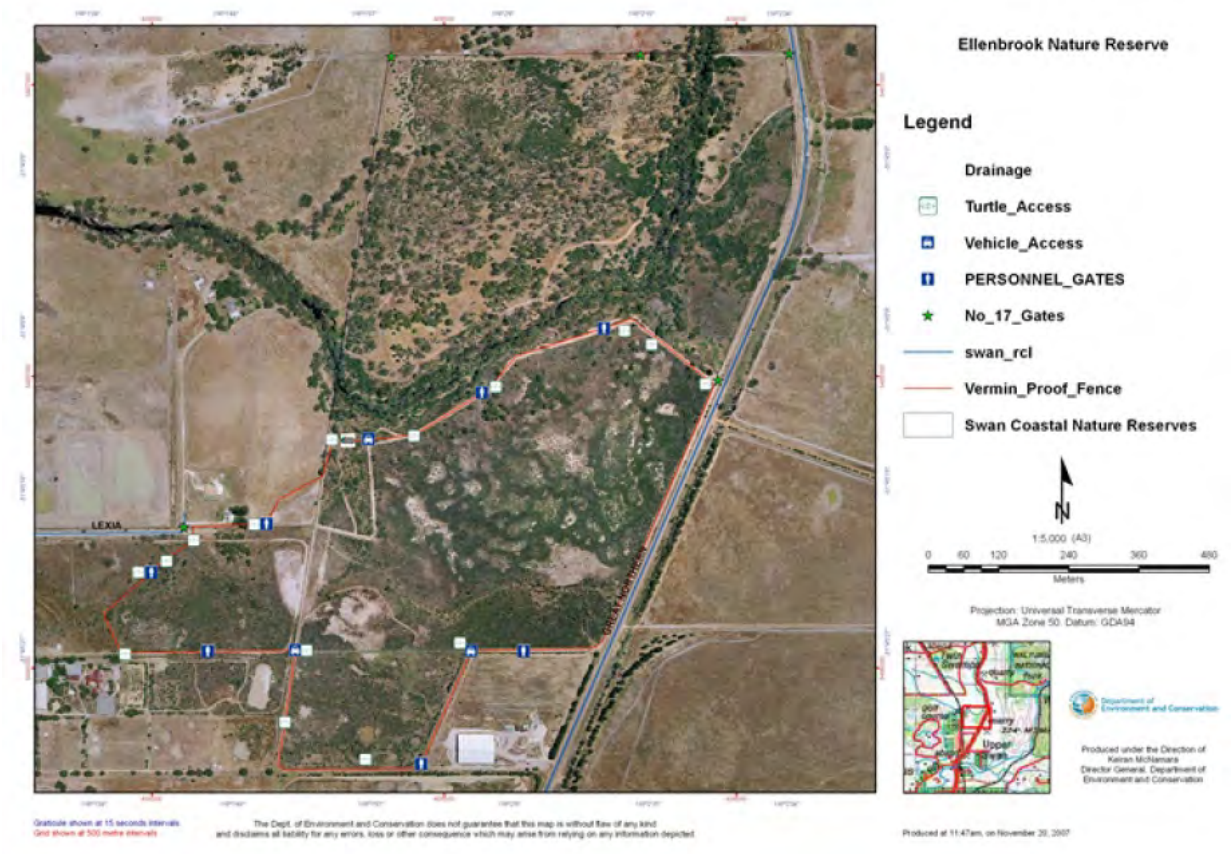

Plate 1: Western Swamp Tortoise access locations in Ellen Brook Nature Reserve

5.6 Mitigation

The key value for terrestrial fauna is the presence of WST habitat adjacent to the Development Envelope in Ellen Brook Nature Reserve. The proposed design has been modified to avoid impacts to WST, including changes to surface hydrology from the Proposal. Extensive consultation has been undertaken to ensure the Proposal delivers a net environmental benefit for the species and minimises the extent of the conceptual disturbance footprint where possible.

Key mitigation measures for the Proposal include:

- The incorporation of appropriate drainage design to maintain existing surface water flows and hydrology into Ellen Brook Nature Reserve.
- Installation of GPTs to manage the potential long term effects of road run-off into Ellen Brook Nature Reserve.
- Appropriate management measures such as bunding and spill management procedures during construction to reduce the risk of surface run off or any hydrocarbon spillages from GNH into Ellen Brook Nature Reserve.
- Implementation of the following management plans for the Proposal during construction:
  - Construction Environmental Management Plan (CEMP) to effectively manage potential impacts for:
    - habitat degradation associated with construction activity including fire, transmission of weeds, introduction/ spread of dieback, dust and increased abundance of introduced fauna species.
    - loss of WST individuals.
    - discharge of polluting substances during construction.
  - Hygiene Management Plan (HMP) to manage the introduction/ spread of dieback into Ellen Brook Nature Reserve.
  - Western Swamp Tortoise Management Plan (WSTMP) to manage the risk of mortality of WST during construction works.

Within the support and encouragement from the Western Swamp Tortoise Recovery Team, Main Roads is actively progressing the training of a conservation detection dog to identify WST in the construction footprint pre-clearing and pre-construction. Should the detection dog not be fit for purpose in time for the Proposal, Main Roads will seek a pre-clearance survey from a suitably qualified fauna expert.

The mitigation and management measures detailed in Table 5-6 will be implemented throughout construction to ensure potential environmental impacts on values are minimised.

5.6.1 Construction Environmental Management Plan

The Proposal will be managed through the implementation of a CEMP during construction. The CEMP will be developed in consultation with DBCA to minimise the risk of any adverse impacts to WST and the surrounding environment. The CEMP will stipulate contractual compliance requirements and operational controls for aspects such as clearing methods, fauna management, induction requirements, incident response and auditing. It will also incorporate all aspects of a WST Management Plan that has been prepared by Biota for the Proposal. The CEMP will be reviewed by DBCA representatives and incorporated into the tender package for the works.

5.6.2 Hygiene Management Plan

Main Roads will effectively manage the risk of weeds and the spread/ introduction of dieback through the implementation of a HMP. The HMP will present weed and dieback management actions to ensure potential indirect impacts to adjacent Ellen Brook Nature Reserve can be appropriately managed. Environmental aspects of the Proposal to be addressed in this HMP include, but not limited to:

- Construction vehicle access within the Development Envelope and surrounding local area
- clearing of vegetation
- introduction of construction materials

- disturbance of topsoil during clearing activities.

5.6.3 Western Swamp Tortoise Management Plan

The key values for terrestrial fauna is the WST habitat contained within the fenced area of Ellen Brook Nature Reserve. The design has been revised in consultation with relevant stakeholders to avoid any degradation of habitat within Ellen Brook Nature Reserve. This includes the following managment measures:

- Clearing of native vegetation to be undertaken during late winter to early spring period (June-September), when tortoises are mostly likely to be within the flooded wetland areas within the fences area of Ellen Brook Nature Reserve. In drier months, tortoises are more likely to search for alternative inundated areas and could potentially attempt to access the open drainage channel in the road reserve.
- Searches to be undertaken by a suitably qualified individual for WST within the Development Envelope within two (2) weeks prior to clearing areas being completed, prior to construction activities commence and prior to works (including infilling) occurring in trenches that were required to be left open overnight.
- DBCA is to be notified of any tortoises found during daily inspections, with DBCA relocating any individuals identified.

This WSTMP also includes provisions for ongoing maintenance following the completion of this Proposal to ensure the efficacy of the road side drainage is maintained.

Table 5-6: Application of mitigation hierarchy for terrestrial fauna

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Loss of fauna habitat.	The Development Envelope has been modified during the design phase to avoid direct impacts to Ellen Brook Nature Reserve by having the Proposal elements only within the Main Roads road reserve.	Clearing will be restricted to the Development Envelope to avoid over-clearing and to minimise indirect impacts to adjacent fauna habitat.	Terrestrial fauna habitat lost by modification to the sump will be replaced through revegetation following the completion of the project.	Loss of up to 7.63 of low value fauna habitat including: - 4.51 ha of Black Cockatoo poor quality foraging habitat - Relocation of 0.1 of WST potential habitat associated with a sump. After the mitigation hierarchy has been applied, Main Roads considers that the direct removal of 7.63 ha of fauna habitat is not locally significant to terrestrial fauna. No offsets are proposed as the residual impact is not expected to be significant at a local or regional scale.
Loss of individual fauna.	The Proposal design has been modified to: - include the installation of GPTs to improve water quality within Ellen Brook; - include table drain maintenance to limited ponding of surface water in GNH road reserve, adjacent to Ellen Brook Nature Reserve; and - restrict Proposal activities to within Main Roads tenure to reduce the risk of impact WST individuals in Ellen Brook Nature Reserve during ground disturbance.	Main Roads will implement a WSTMP during construction. This includes, but not limited to, undertaking a pre-clearing and pre-construction survey in consultation with DBCA to identify any WST individuals within the Development Envelope prior to works commencing. A CEMP will also be implemented by Main Roads during construction and will include, but not limited to, the following measures: - Progressive clearing to allow fauna to migrate away from clearing activities or machinery movement. - Enforcement of speed limits will reduce risk to fauna.	Not applicable.	Vehicle movements has the potential to result in mortality for fauna. These impacts affect individuals and may cause a significant impact on species. After the mitigation hierarchy has been applied, Main Roads considers that construction of the Proposal can be appropriately managed to address this impact and; therefore, no significant impacts to terrestrial fauna are expected.
Degradation/alteration of fauna habitat from altered groundwater and hydrological regimes.	The Proposal has maintained the existing local hydrological regimes by retaining and modifying the sump located south west of GNH. The sump at the Apple Street and GNH intersection has been designed to:	The sumps located south of Apple Street will continue to capture and detain road runoff for infiltration and evaporation in the sumps.	Not applicable.	There are no residual impacts as the incorporation of appropriate stormwater design for the Proposal will maintain existing local surface flow directions and GPTs will improve water quality. Ellen Brook Nature Reserve will be able to continue to receive surface water flows following

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
	- capture and direct water into the road side table drain to allow for discharge into a tributary of Ellen Brook and into a sump immediately north of a fenced portion of Ellen Brook Nature Reserve. - have an increased capacity to handle road run-off during peak events (1:10 average recurrence interval [ARI] rainfall event) for the new extent of the designed sealed road surface Drainage has been designed to ensure that there is no change to the hydrological regime entering Ellen Brook Nature Reserve, and water quality has been improve through the installation of GPTs.			significant rainfall events, as requested by DBCA, and will continue to maintain its important ecological value. Main Roads considers that the potential impacts can be managed, and the residual impact will not be significant. This Proposal can be managed to meet the EPA's objective for this factor and no offsets are proposed.
The discharge of polluting substances during construction.	The Proposal design includes the installation of GPTs to reduce the risk of polluted surface run off and hydrocarbon spillages from GNH into Ellen Brook Nature Reserve.	A CEMP will be implemented by Main Roads during construction to ensure that any hydrocarbon storage facilities and all associated connections will be constructed within appropriately bunded areas away from Ellen Brook Nature Reserve. Management measures will also include the implementation of spill management procedures during construction.	Not applicable.	Main Roads considers the Proposal can be appropriately managed to address this impact and; therefore, no offsets are proposed.
Habitat degradation associated with construction activity including fire, transmission of weeds; introduction/spread of dieback, dust and increased abundance of introduced fauna species.	Weeds are currently established in the Development Envelope. The CEMP and HMP will require all earth moving machinery and equipment to be clean on entry to the site, to prevent the introduction of new invasive weed species adjacent to Ellen Brook Nature Reserve.	A CEMP will be implemented during construction and will include measures to ensure: - dust suppression to minimise disturbance to fauna habitats; and - use of domestic waste facilities to minimise fauna (and feral animal) access - roadkill (that may attract introduced predators) will be removed from trafficable areas	Not applicable.	Main Roads considers the Proposal can be managed to address any potential increase or spread of weeds, dust and increased abundance of introduced fauna species; and no significant residual impact on terrestrial fauna is anticipated. Main Roads considers the Proposal can be appropriately managed to address this impact and; therefore, no offsets are proposed

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
		- fire prevention and control.		
Disturbance from the possible displacement of fauna in trenches and sumps associated with construction activities.	Clearing associated with the Proposal will be undertaken in late winter/ early spring, to reduce the likelihood of WST occurring within the Development Envelope. Where possible, trenches that may act as a trap for WST will not be left open overnight during construction.	Main Roads will implement a WSTMP during construction. This includes undertaking a pre-clearing and pre-construction survey in consultation with DBCA to identify any WST individuals within the Development Envelope. Searches will be undertaken prior to works occurring in trenches that were required to be left open overnight, including prior to infilling for any trenches. The WSTMP will also include contingency actions for any individuals found in the Development Envelope.	Not applicable	Main Roads anticipates no significant residual impact on terrestrial fauna with respect to this potential impact and considers that the Proposal can be appropriately managed to address this impact. As such, no offsets are proposed.

5.7 Predicted outcome

The key terrestrial fauna values identified in the Development Envelope include:

- Four fauna habitat types (Open Eucalypt Woodland, Isolated Trees, Grasslands/Degraded Areas, Drainage Sump) with no significant features
- Possible presence of five conservation significant fauna species.

The predicted outcomes of the Proposal in relation to terrestrial fauna include;

- Loss of up to 7.63 ha of limited value fauna habitat, including;
  - 4.51 ha of poor quality Black Cockatoo habitat;
  - 31 Suitable DBH Trees; and
  - 0.1 ha of potential WST habitat will be relocated immediately south of the current sump.
- potential injury and/ or mortality of fauna during clearing activities and construction of the Proposal; and
- indirect impacts relating to the risk of degradation/ alteration of fauna habitat from altered groundwater and hydrological regimes, and habitat degradation from construction activity including fire, weeds, introduction/ spread of dieback, dust and increased abundance of introduced fauna species.

Main Road recognises the Development Envelope is located immediately adjacent to Ellen Brook Nature Reserve which contains core habitat for the Critically Endangered WST. To minimise impacts to the present values, Main Roads has undertaken extensive consultation with stakeholders to design the Proposal and ensure there is a net ecological benefit to Ellen Brook Nature Reserve and the WST. This includes the following:

- Modification of the conceptual disturbance footprint to the Main Roads road reserve, and where possible, reducing of the area of fauna habitat being removed in the Development Envelope whilst retaining critical road safety objectives.
- Design modifications to include the installation of GPTs to reduce the potential for pollutants entering Ellen Brook and the association Ellen Brook Nature Reserve.
- Table drain maintenance on the western side of GNH adjacent to Ellen Brook Nature Reserve to ensure no ponding of surface water that has the potential to attract WST into the road reserve.
- Retention of the sump and maintaining existing local hydrological regimes in the road reserve, as requested by DBCA.
- Implementation of other appropriate measures such as bunding and spill management procedures during construction to reduce the risk of surface run off or any hydrocarbon spillages from GNH into Ellen Brook Nature Reserve.

Main Roads plans to implement a HMP, WSTMP and a CEMP to manage construction activities and any residual, potential impacts. This includes searches for the WST within the Development Envelope within the two (2) weeks prior to clearing activities commencing, prior to construction and prior to works occurring (including inflling) in trenches that were required to be left open overnight.

Through the implementation of the EPA's mitigation hierarchy (Section 5.6), the residual impacts of the Proposal to terrestrial fauna are considered low. Main Roads considers that the measures proposed during construction will further reduce risks. As such, the EPA's objective for terrestrial fauna will be met and biological diversity and ecological integrity will be maintained.

6 OTHER ENVIRONMENTAL FACTORS OR MATTERS

No other environmental factors established by the EPA for the purposes of environmental impact assessment were considered by Main Roads to be significant for the Proposal, as presented in Table 6-1.

Table 6-1: Assessment of Other Environmental Factors Relevant to the Proposal

Environmental Factor	EPA Objective	Existing Environment	Potential impacts	Proposed Management
Flora and Vegetation	'To protect flora and vegetation so that biological diversity and ecological integrity are maintained.'	The flora and vegetation assessment undertaken by Main Roads (2020) identified four vegetation types ranging from Degraded to Completely Degraded condition, with the majority of vegetation in Completely Degraded condition. The vegetation has been subject to high levels of disturbance associated with historical clearing, pre-1960s. All of the vegetation in the Development Envelope has been previously cleared and the native vegetation consists of regrowth amongst introduced species. The Development Envelope does not contain any Threatened or Priority flora or ecological communities.	The Proposal may result in the clearing of up 3.05 ha of native vegetation in Degraded and Completely Degraded condition. No significant residual impacts to flora and vegetation from the Proposal are expected.	The CEMP will define techniques to minimise direct and indirect impacts during construction to the surrounding environment. Included will be measures to minimise the risk of over-clearing, such as clear demarcation of clearing areas and Proposal extents. Development of a HMP including standard hygiene measures are to be implemented to ensure Dieback and weeds are not introduced and/or spread to adjacent vegetation.
Inland Waters	'To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.'	The portion of the Development Envelope relating to the Intersection upgrade intersects with a Multiple Use Wetland. The table drain maintenance portion of the works, intersects with Conservation Category Wetland "Martyn Reserve Wetland' and a tributary that directly feeds into Ellen Brook. The Development Envelope and surrounding local area is significantly disturbed from historic (pre-1960s) broad scale clearing for agriculture and more recent clay mine operations commencing in the 1980s. The hydrological regime of the area is already highly modified.	The hydrological flows within the road reserve will be maintained to reflect the existing direction as requested by DBCA. Currently there is no system in place to capture pollutants from road runoff prior to entering Ellen Brook Nature Reserve, which includes Ellen Brook and Martyn Reserve Wetland. The Proposal is likely to improve water quality entering this sensitive environmental receiver and therefore aligns with EPA objective to maintain hydrological regimes and water quality.	Main Roads has committed to install up to three GPTs to improve water quality in the sump in the south west corner of the Development Envelope and road run-off entering Ellen Brook Nature Reserve. Measures to prevent release of hazardous materials and sediment into adjacent waterways and groundwater will be managed through the CEMP.

Environmental Factor	EPA Objective	Existing Environment	Potential impacts	Proposed Management
Social Surroundings	'To protect social surroundings from significant harm.'	The Development Envelope is located within a rural area that has mining and industrial land uses, mixed with residential properties to the south west. The buffer of one Aboriginal heritage site intercepts the Development Envelope (Ellenbrook Upper Swan [ID 3525]). The Department of Planning, Lands and Heritage (DPLH) have advised that the Development Envelope falls within the buffer boundary of the site only, not the cultural boundary. As such, the works are not expected to impact the site.	The Proposal may result in minor short term impacts to visual amenity during construction. No residual social impacts are expected from the Proposal.	Dust and air quality will be managed through standard management actions and will be stipulated to the contractor in the CEMP.
Terrestrial environmental quality	'To maintain the quality of land and soils so that environmental values are protected.'	The Development Envelope is adjacent to an area mapped as having a high to moderate risk of acid sulfate soils (ASS) occurring. Wet or waterlogged soils are present within the Development Envelope, which is likely due to clay soil types observed in the surrounding environment. ASS is not expected within the Development Envelope. Lot 9002 (1452 GNH, Upper Swan 6069) is classified as "possibly contaminated – further assessment required". This lot has not been formally assessed by DWER. A Preliminary Site Investigation (PSI) was undertaken by Site Environment and Remediation Services in July 2018. The investigation identified stockpiles and a compound with asbestos containing material (ACM).	Excavations will be less than 3 m and are unlikely to require dewatering as initial geotechnical investigations indicate the water table is significantly lower than 3 m. Any potential dewatering will be localised to install pits and lighting infrastructure and short term in nature (less than 72 hours). Apart from this, the Proposal will largely be in fill and therefore any unknown ASS is unlikely to be disturbed. The potentially contaminated materials associated with Lot 9002 are more than 200 m from the Development Envelope and will not be disturbed during works.	Main Roads has a low impact ASS Management Plan that can be utilised to manage any unanticipated ASS encountered during construction. No impact to any contaminated sites are anticipated. Management measures will be included in the CEMP in the event that an unknown contaminated site is identified during construction.

7 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

7.1 Controlled Action Provisions

The EPBC Act provides a legal framework for the protection of MNES. The EPBC Act requires that all actions that will or may have a significant impact on a MNES must be referred to the Minister for the Environment via DAWE. Protected matters under the EPBC Act include listed threatened species and ecological communities; and migratory species protected under international agreements that occur within the Development Envelope.

7.2 Policy and Guidelines

MNES are listed and protected under the following legislation and guidelines:

- EPBC Act
- Environment Protection and Biodiversity Conservation Regulations 2000.
- Significant Impact Guidelines (No.1.1): Matters of National Environmental Significance (DotE 2013).

7.3 Summary of Existing Environmental Values and Potential Impact on MNES

A number of desktop and targeted field surveys have been completed for the Proposal to assess the presence of MNES and trigger the requirement for referral under the EPBC Act. These have been summarised in Table 7-1.

The potential impacts to MNES from the Proposal as it relates to the EPBC Act have been determined through:

- a review of previous terrestrial fauna surveys and investigations within the Development Envelope, including desktop findings and field-based identification and mapping of fauna habitat types; and
- spatial analysis of fauna habitats and species records to determine potential impacts on species recorded or likely to occur in the Development Envelope.

The significance and management of potential impacts on MNES have been assessed in the context of:

- the policy and guidelines outlined in Section 7.2;
- the application of the mitigation hierarchy including avoidance, minimisation, rehabilitation and offset measures to the design and implementation of the Proposal;
- a review of approved conservation advice and/or Recovery Plans, where available, for each relevant MNES, specifically, whether a population is an important population, whether available habitat in the Development Envelope is critical habitat for the local population or species; and
- ensuring the outcomes align with Recovery Plan or conservation advice actions for matters identified to have a potential impact from the Proposed Action.

The Proposed Action has not been referred to DAWE as the Proposal is considered by the Proponent to not be a Controlled Action under s. 75 of the EPBC Act. Based on the low risk of impacts to MNES, specifically WST as listed as Critically Endangered under the EPBC Act, that will result from implementation of the Proposal, Main Roads considers that referral of the Proposal to DAWE is not warranted.

Table 7-1: Matters of National Environmental Significance within the Proposal Area

REGIONAL SCHEME DESCRIPTION	IMPACT OF PROPOSAL
Listed Threatened Ecological Communities	None. No EPBC listed TECs have been recorded within the Development Envelope during flora and vegetation surveys.
Listed Threatened Flora	No EPBC Act listed flora were identified during detailed and targeted field surveys within the Development Envelope.
Listed Threatened Fauna	Direct loss of habitat for the following EPBC Act listed fauna species known to occur within the Proposal Area (see Section 5.5.1). - 4.51 ha of potential Carnaby's Cockatoo (*Calyptorhynchus latirostris*) (Endangered) habitat. - 4.51 ha of potential FRTBC (*Calyptorhynchus banksii naso*) (Vulnerable) habitat. - 31 Black Cockatoo Suitable DBH Trees (none contain hollows or are suitable for breeding). - 0.1 ha of potential WST habitat in the sump to the south of Apple Street will be relocated. The proposed drainage modifications and construction works adjacent to Ellen Brook Nature Reserve, which contains known critical habitat for WST (Critically Endangered), presents a risk to the species at a local and regional scale.

7.4 Mitigation Measures

Mitigation measures to address potential impacts on MNES are outlined in Section 5.6 and will also be detailed in the CEMP.

7.5 Summary of Assessment of Level of Significant of Impact on MNES

A range of guidance exists to direct the protection and conservation of MNES, this includes measures for minimising further impacts from Proposals and broader conservation initiatives.

This section describes how the Proposed Action has had regard to, and is not inconsistent with, relevant recovery plans, conservation advices and threat abatement plans for MNES. Broader conservation initiatives are typically the focus of organisations with those responsibilities and capabilities and; therefore, not considered further in this section. Table 7-2 assesses the threats on MNES by the proposal in relation to each of the recovery plans.

The relevant plans and guidance documents for WST are;

- EPA Environmental Protection (Western Swamp Tortose Habitat) Policy 2011 (EP Policy) (EPA 2012); and
- Western Swamp Tortoise (*Pseudemydura umbrina*) Recovery Plan (Burbridge et al. 2010).

The two Threat Abatement Plans relevant to this species are;

- Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (DoEE 2017b); and
- Threat abatement plan for predation by the European red fox (DEWHA 2008).

A review of the EP Policy (EPA 2012) has been in process from 12 Febuary 2020. In accordance with s. 36(1)(a) of the EP Act, the Minister for Environment directed the EPA to defer the completion of the review of EP Policy (EPA 2012) until the science informing the review of the WST (*Pseudemydura umbrina*) Recovery Plan is made available. The review is to be completed by 30 November 2022. This document has adopted the approved EP Policy for WST.

The relevant plans and guidance documents for Black Cockatoos are;

- *EPBC Act Referral Guidelines for Three Threatened Black Cockatoo Species* (DSEWPAC 2012);
- Approved Conservation Advice for *Calyptorhynchus banksii naso* (Forest Red-tailed Black

Cockatoo) (DEWHA 2009);

- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan (DPaW 2013); and
- Forest Black Cockatoo (Baudin's Cockatoo *Calyptorhynchus baudinii* and Forest Red-Tailed Black Cockatoo *Calyptorhynchus Banksii Naso*) Recovery Plan (DEC 2008)

There are no threat abatement plans relevant to Black Cockatoos. The Proposal is not expected to exacerbate threats to MNES or be contrary to conservation advice.

Table 7-2: Relevant Recovery Plans, Threat Abatement Plans and Conservation Advice for MNES

EPBC Act Listed	No.	Plan/Conservation Advice and Threats	Response
Black Cockatoos	**DPaW (2013), 'Carnaby's Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan'**		
	1a	Loss of breeding habitat	The Development Envelope does not contain trees with suitable breeding hollows for Black Cockatoos. There are 49 Suitable DBH trees present in the Development Envelope, none contain hollows. The Proposal is not considered to be inconsistent with the recovery plan.
	2a	Loss of non-breeding, foraging and night roosting habitat	The Proposal is not considered to be inconsistent with the recovery plan.
	3a	Tree health	Activities associated with the Proposal are not anticipated to exacerbate this threat. The existing road has uncontrolled public access. A HMP will be implemented during construction phase to reduce the risk of introducing and or spreading *Phytopthora* Dieback into Ellen Brook Nature Reserve. The Proposal is not considered to be inconsistent with the recovery plan.
	4a	Illegal shooting	The Proposal is not expected to exacerbate this threat. No firearms are permitted during construction within the Development Envelope.
	5a	Illegal taking	The Proposal is not expected to exacerbate this threat due to the absence of trees with hollows or Known Nesting Trees in the Development Envelope. Main Roads will also manage the risks associated with native fauna during construction by implementing management practices to negate any risk by illegal taking during the construction period.
	6a	Collisions with motor vehicles	Although the Proposal has the potential to exacerbate this threat, the risk of this impact occurring after the mitigation hierarchy has been applied (refer to Section 5.6) is considered to be low during construction.
	DEWHA (2009), 'Approved Conservation Advice for Calyptorhynchus banksii naso (Forest Red-tailed Black Cockatoo)'		
	1b	Illegal shooting	The Proposal will not exacerbate this threat. The Proposal is not considered to be inconsistent with the recovery plan. Refer to 4a above which also applies for FRTBC. The Proposal is not considered to be inconsistent with the recovery plan.
	2b	Habitat loss	Refer to 1a above which also applies to FRTBC. Up to 5.9 ha of vegetation in the Development Envelope is poor quality foraging habitat for Black Cockatoo species of which approximately 4.51 ha will be removed by the Proposal. There is no roosting habitat available, or known known roosting sites have been recorded in the Development Envelope. The Proposal has been modified to reduce vegetation clearing (and associated fauna habitat) where possible. The Proposal is not considered to be inconsistent with the recovery plan.

EPBC Act Listed	No.	Plan/Conservation Advice and Threats	Response
	3b	Nest hollow shortage	There are no Known Nesting trees, or any Suitable DBH trees that contain hollows suitable for breeding by Black Cockatoos in the Development Envelope. The Proposal will not exacerbate this threat and; therefore, is not considered to be inconsistent with the recovery plan.
	4b	Competition from other species	The Proposal is not expected to increase competition for nesting hollows or foraging habitat from other species (Galahs, parrots, etc.) as there are no hollows are known to occur in the Development Envelope. The Proposal is not considered to be inconsistent with the recovery plan.
	5b	Injury or death from *Apis mellifera* (European Honeybees)	There are no Known Nesting Trees within the Development Envelope for FRTBC. The loss of up to 31 Suitable DBH Trees without suitable hollows in the Development Envelope is not expected to result in displacement of nesting FRTBC by bees. The Proposal will not exacerbate this threat and; therefore, is not considered to be inconsistent with the recovery plan.
	DEC (2008), 'Forest Black Cockatoo (Baudin's Cockatoo Calyptorhynchus baudinii and Forest Red-Tailed Black Cockatoo Calyptorhynchus Banksii Naso) Recovery Plan'		
	1c	Killing by illegal shooting	The Proposal will not exacerbate this threat. Refer to 1b above.
	2c	Feral honeybees	Refer to 5b above.
	3c	Habitat loss	The Proposal is unlikely to exacerbate this threat given the poor quality habitat in the Development Envelope, which does not contain any Suitable DBH Trees with hollows for breeding and the large areas of high quality, intact vegetation remaining in nearby nature reserves. Refer to item 2b above on the Approved Conservation Advice for Forest Red-tailed Black Cockatoos.
	4c	Nest hollow shortage	Refer to 3b above. The proposal will not significantly exacerbate this threat.
	5c	Nest hollow competition	Refer to 4b above.
Western Swamp Tortoise	**EPA (2012), 'Environmental Protection (Western Swamp Tortoise Habitat) Policy**		
	1d	the application of fertilisers and pesticides;	Not applicable to activities associated with the Proposal.
	2d	the disposal of liquid and solid wastes;	Not applicable to activities associated with the Proposal.
	3d	the discharge of polluting substances;	The Proposal will not exacerbate this threat. GPTs will be installed including implementation of other appropriate measures such as bunding and spill management procedures during construction to reduce the risk of surface run off or any hydrocarbon spillages from GNH into Ellen Brook Nature Reserve. A CEMP will be implemented by Main Roads during construction to manage construction risks. After the mitigation hierarchy has been applied, the Proposal is not expected to be inconsistent with the EP Policy.

EPBC Act Listed	No.	Plan/Conservation Advice and Threats	Response
	4d	the extraction of basic raw materials;	Not applicable to activities associated with the Proposal.
	5d	the construction of drainage systems;	The Proposal will not exacerbate this threat. The Proposal involves the improvement of drainage infrastructure adjacent to Ellen Brook Nature Reserve. The sump located south of Apple Street will continue to capture and retain road runoff for infiltration and evaporation in the sumps. Drainage design has also ensured that there is no change to drainage regime into Ellen Brook Nature Reserve as requested by DBCA. As such, the Proposal will provide a net benefit to the WST by improving the current drainage and water quality into Ellen Brook Nature Reserve. The Proposal is not expected to be inconsistent with the EP Policy.
	6d	the placement of fill;	Not applicable to activities associated with the Proposal.
	7d	the abstraction of groundwater;	Not applicable to activities associated with the Proposal.
	8d	the clearing of vegetation; and	The Development Envelope has been modified during the design phase to avoid direct impacts to Ellen Brook Nature Reserve by having the Proposal elements only within the Main Roads road reserve. The Proposal does not clear any habitat critical to the survival of the species within Ellen Brook Nature Reserve. The Proposal is not expected to be inconsistent with the EP Policy.
	9d	the lighting of unauthorised fires.	Not applicable to activities associated with the Proposal.
	Burbridge et al. (2010), 'Western swamp tortoise (*Pseudemydura umbrina*) recovery plan'		
	1e	Water quantity and quality	The Proposal will not exacerbate this threat. Refer to 5d above. The Proposal is not expected to be inconsistent with the Recovery Plan.
	2e	Predator control	The Proposal will not exacerbate this threat. The fox-proof fence that surrounds Ellen Brook Nature Reserve that protects the high quality tortoise habitat will not be removed or altered by the Proposal. As such, the Proposal is not expected to be inconsistent with the Recovery Plan.
	3e	Fire	The Proposal will not exacerbate this threat. On-ground management measures during construction will actively manage threatening processes including fire, this will include the implementation of a CEMP that outlines fire presentation and control measures. As such, the Proposal is not expected to be inconsistent with the Recovery Plan.
	4e	Effects of adjacent land use	Not applicable to activities associated with the Proposal.
	DEWHA 2008, 'Threat abatement plan for predation by the European red fox'		

EPBC Act Listed	No.	Plan/Conservation Advice and Threats	Response
	1f	Red fox	This Threat Abatement Plan identifies localised fox control measures. Red fox (*Vulpes vulpes*) have not been recorded in the Development Envelope, therefore are not relevant to the Proposal.
	DoEE (2017b) Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)		
	1g	Feral Pigs	This Threat Abatement Plan sets out a suggested series of actions and strategies to manage the impacts of feral pigs. Feral pigs (*Sus scrofa*) have not been recorded in the Development Envelope, therefore are not relevant to the Proposal.

7.6 Significance of direct impacts to Black Cockatoos

Table 7-3 assesses the proposed action against referral triggers identified in the *EPBC Act referral guidelines for three threatened Black Cockatoo species* (DSEWPAC 2012) to determine the risk of significant impact. The Proposal is not expected to result in significant impacts to Black Cockatoos.

Table 7-3: EPBC Act Referral Guidelines Significance Impact Criteria

Significance impact criteria	Assessment of impacts to Black Cockatoos
Clearing of any known nesting tree.	There are 49 Suitable DBH Trees, none containing suitable hollows, present in the Development Envelope, of which 31 are proposed to be removed. There are also no known Black Cockatoo breeding sites recorded in the Development Envelope. As such, the clearing of 31 Suitable DBH Trees will not result in a significant impact to Black Cockatoos relating to this criterion.
Clearing or degradation of any part of a vegetation community known to contain breeding habitat.	There is no known breeding habitat within the Development Envelope. A total of 49 Suitable DBH trees (trees with a DBH greater than 500 mm) is present in the Development Envelope. Of these trees, 31 Suitable DBH Trees, none containing hollows, will be removed for the Proposal. The clearing of 31 Suitable DBH trees for the Proposal will not result in a significant impact to Black Cockatoos relating to this criterion
Clearing of more than 1 ha of quality foraging habitat.	Up to 4.51 ha of poor quality habitat for Black Cockatoos will be cleared within the Development Envelope. The Proposal will not clear more than 1 ha of quality foraging habitat,
Clearing or degradation of a known night roosting tree.	No known night roosting trees have been recorded within the Development Envelope. As such, the Proposal will not result in the clearing of any known roosting trees and is not at variance with this criterion.
Creation of a new gap of more than 4 km between patches of habitat suitable for breeding, foraging or roosting.	The Proposal is a linear development that also involves the construction of a roundabout. The Proposal does not intersect any large remnant patches of vegetation, and there is no breeding habitat for Black Cockatoos available in the Development Envelope. The Proposal will not create a new gap of more than 4 km between patches of suitable for breeding, foraging or roosting and; therefore, will not be at variance with this criterion.

An assessment of the Proposal on Black Cockatoos was undertaken with reference to the Significant Impact Guidelines (DoE 2013). The Proposal's impacts on 4.51 poor quality foraging and breeding habitat are not considered to be significant given the small scale of the the Proposal, and the presence and abundance of better quality breeding and foraging habitat within 5 km from the Proposal. The assessment had regard to the following significant of impact criteria:

- Potential to cause a long-term decrease in the size of a population
- Potential to reduce the area of occupancy of the species
- Potential for fragmentation of an existing population into two or more populations
- Potential to adversely affect habitat critical to the survival of a species
- Potential to disrupt the breeding cycle of a population
- Potential to modify, destroy, remove isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- Potential for the establishment of invasive species in the endangered species' habitat that are harmful to the endangered species
- Potential for the introduction of disease that may cause the species to decline
- Potential interference with the recovery of the species

Based on scale and nature of the Proposal, it was assessed that the Proposal is not likely to have a significant impact to Black Cockatoos.

7.7 Significance of direct impacts to Western Swamp Tortoise

Table 7-4 assesses the proposed action against referral triggers identified to determine the risk of significant impact to WST. The Proposal is not expected to result in significant impacts to WST.

Table 7-4: Assessment of impacts to Western Swamp Tortoise

Significance impact criteria	Assessment of impacts to Western Swamp Tortoise
Potential to cause a long-term decrease in the size of a population	The Proposal is located adjacent to Ellen Brook Nature Reserve, an 'A Class' Reserve, vested with the Conservation Commission of Western Australia. Ellen Brook Nature Reserve comprises an area of approximately 80 ha and contains WST core habitat of seasonal wetlands (Holocene Swamp Deposits) (GoWA 2000). The Proposal will result in the relocation of 0.1 ha of potential habitat within a man made sump that may be used by the WST given the location to Ellen Brook Nature Reserve. However, as there will be no clearing of core habitat represented in Ellen Brook Nature Reserve, it is not expected that the Proposal will result in a long-term decrease in the size of an important population for the species.
Potential to reduce the area of occupancy of the species	The Proposal will not reduce the area of occupancy of WST. The Proposal is located adjacent to Ellen Brook Nature Reserve which contains core habitat for WST. None of this habitat is proposed to be cleared by the Proposal. On this basis, is it not expected that the Proposal will significantly reduce the area of occupancy for WSTs.
Potential for fragmentation of an existing population into two or more populations	The Proposal will not result in the fragmentation of an existing population. As such, the Proposal will not present a barrier to movement between these reserves.
Potential to adversely affect habitat critical to the survival of a species	Habitat critical to survival for WST is outlined below (Burbidge et al. 2010): - *all land within the 'fox-proof' fences at Twin Swamps Nature Reserve (Reserve number A27621, centroid coordinates 31°43'18"S, 116°00'58"E) and Ellen Brook Nature Reserve (Reserves A27620 and A42126, centroid coordinates 31°45'19"S, 116°02'04"E) and all land within Mogumber Nature Reserve (centroid coordinates approximately 31°05'45"S, 116°01'45"E) (digitised boundaries are available from DEC) and the south-east portion of Moore River Nature Reserve where clay soils occur (centroid approximately 31°11'48"S, 115°40'20"E,* - *land to the west of Ellen Brook Nature Reserve that contains Western Swamp Tortoise habitat and which is earmarked for purchase for inclusion into the reserve; this includes Lot 505 and the eastern part of Lot 15,* - *land within surface water catchments extending outside the three above nature reserves,* - *any land where a wild population (not scattered individuals) of P. umbrina is detected in the future, and* - *land targeted in this recovery plan for Western Swamp Tortoise reintroduction, namely land at the northern end of Perth Airport (centroid coordinates approximately 31°55'34"S, 115°58'53"E), which is Commonwealth land leased to Westralia Airports Corporation, zoned for conservation in the Perth International Airport Master Plan and Environmental Strategy.* The Proposal is located within the EPP boundary and will remove up to 0.1 ha of drainage sump habitat, that will be reinstated to the south of the existing sump. However, the Proposal will replace the sump immediately south of the existing sump and involves drainage upgrades that will improve water quality into Ellen Brook Nature Reserve, providing a net benefit to the species. In addition, drainage maintenance on the western side of GNH will prevent ponding of water and reduce attraction of WST individuals to man-made drainage structures. As such, the Proposal will not adversely impact habitat critical to the survival for WST and; therefore, the Proposal is not expected to have a significant impact on available habitat or affect habitat critical to the survival for the species.
Potential to disrupt the breeding cycle of a population	The impacts from the Proposal are not expected to disrupt the breeding cycle of the species, given the net environmental benefit provided by the Proposal by improving water quality into Ellen Brook Nature Reserve.

Significance impact criteria	Assessment of impacts to Western Swamp Tortoise
Potential to modify, destroy, remove isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Development Envelope is located immediately adjacent to Ellen Brook Nature Reserve. Given the linear nature of the Proposal, and the net environmental benefit to the species from improving water quality into Ellen brook Nature Reserve as part of the Proposal; it is not expected that the removal of up to 0.1 ha of drainage habitat will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
Potential for the establishment of invasive species in the endangered species' habitat that are harmful to the endangered species	The Proposal will not introduce any invasive species that are not already present in the surrounding local area.
Potential for the introduction of disease that may cause the species to decline	Without appropriate hygiene practices, the Proposal has the potential to inadvertently introduce dieback (*Phytophthora cinnamomi*) into the adjacent remnant vegetation in Ellen Brook Nature Reserve which could lead to the decline in vegetation health. Disturbance from the Proposal is not expected to introduce new plant diseases to the adjacent remnant vegetation in the Ellen Brook Nature Reserve as Main Roads will implement a HMP to mitigate these risks.
Potential interference with the recovery of the species	The recovery plan objective for WST is to decrease the chance of extinction of the species by creating at least three wild naturally recruiting populations, increasing the total number of mature individuals in the wild to more than 50 and conducting a translocation at a fourth site (Burbidge et al. 2010). The Proposal will improve water quality into the Ellen Brook Nature Reserve, which will benefit the resident WST population residing in this reserve. The Proposal does not pose a risk to the recovery of the species.

8 HOLISTIC IMPACT ASSESSMENT

In order to achieve a holistic view of how impacts may impact the wider receiving environment or specific species, the Environmental Impact Assessment process needs to consider the connections and interactions between ecosystems, communities, populations and the wider environment. This requires consideration of the impacts of the Proposal in a regional context as well as at the local scale.

Currently the GNH/ Apple Street/ Coondaree Parade intersection is an un-signalised and offset, four-way intersection that does not have sufficient capacity for the future traffic flows resulting from the surrounding residential and industrial uses. The proposal will improve productivity and increase road safety. The Proposal design will operate efficiently well into the future, reducing the likelihood reworks and cumulative impacts on sensitive receivers.

The preliminary environmental and social impact studies undertaken for the Proposal have considered and assessed potential impacts at both local and regional scales and the results have informed the impact assessment and development of mitigation measures. Biological survey work has been undertaken with assistance from DBCA to inform the environmental values in the Development Envelope and potential impacts of the Proposal. This information has assisted in reducing the Conceptual Footprint to avoid impacts to fauna habitat and improve water quality in local surrounds.

The Proposal's predicted outcomes have been considered in relation to the environmental principles (see Section 4.1) and the EPA's environmental objectives for terrestrial fauna.

Main Roads considers that significant measures have been undertaken to reduce the Proposal's impacts, improve water quality exiting the road reserve and design of the Intersection to avoid or minimise impacts on WST. In addition to this the commitment to develop and implement a WSTMP, HMP and CEMP, will ensure that the EPA's objectives for each key environmental factor will be met.

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10 APPENDICES

Appendix	Title
Appendix A	Great Northern Highway/ Apple Street/ Coondaree Parade Environmental Inspection Report
Appendix B	Western Swamp Tortoise Management Plan

Appendix A: Great Northern Highway/ Apple Street/ Coondaree Parade Environmental Inspection Report

Flora, Vegetation, Fauna Habitat and Black Cockatoo Assessment

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Great Northern Highway and Apple Street Intersection

April 2020

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Amendments

Report Compilation & Review	Name and Position	Document Revision	Date
Author:	Amy Dalton Environment Officer	Rev A	17/04/20
Reviewer:	Jordan Tindiglia Senior Environment Officer	Rev B	23/04/20
Author:	Amy Dalton Environment Officer	Rev 0	29/04/20

1 INTRODUCTION

Main Roads is proposing to upgrade the Great Northern Highway and Apple Street intersection between SLK 14.3 to 16.2 in the City of Swan (Figure 1). The intersection upgrade has been proposed to accommodate increased traffic flows expected in the Upper Swan area due to planned residential developments.

On the 29 November 2019 Main Roads conducted a site inspection of a survey area, comprising 18 ha. A follow-up site inspection of the survey area was undertaken on 7 April 2020. The purpose of the site inspections were to assess the biological values of the survey area.

2 SCOPE

The scope of works included a flora and vegetation survey, fauna habitat assessment and a black cockatoo habitat assessment. Specifically, the scope included:

- A desktop assessment to identify biological features and constraints that may occur within, or near to the survey area
- A vegetation and flora survey to describe and map vegetation types, assess vegetation condition, record vascular flora present at the time of survey and map locations of any Threatened or Priority ecological communities and flora
- A fauna habitat assessment to broadly map the fauna habitat types
- A Black Cockatoo habitat assessment to identify and map black cockatoo foraging, breeding and roosting habitat in accordance with Commonwealth guidelines

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3 SURVEY METHOD

3.1 Desktop Assessment

A desktop assessment was undertaken prior to conducting the field assessment to identify the possible occurrences of Threatened and Priority flora, ecological communities and fauna based on known distribution and habitat types. All desktop searches were undertaken using a 5 km radial buffer of the survey area (study area). The desktop assessment included a review of:

- The Department of Biodiversity, Conservation and Attractions (DBCA) NatureMap database (DBCA 2019a)
- The DBCA Threatened and Priority Ecological Communities (TECs and PECs), flora and fauna databases (DBCA 2019b)
- The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (PMST) (DotEE 2019a).

3.2 Flora and Vegetation

A reconnaissance flora and vegetation survey was undertaken by a Main Roads ecologist and environmental scientist in November 2019 and April 2020. The survey methodology was undertaken with reference to standards set out in the Technical Guidance – Vegetation Surveys for Environmental Impact Assessment (EPA 2016).

The survey area was traversed on foot to record changes in vegetation structure and type. Site selection for vegetation mapping was determined from aerial photographs and based on differences in structure and species composition of the communities present within the survey area.

The following actions were undertaken during the survey:

- Traversed survey area by foot
- Inspected and noted various vegetation types within the survey area
- Sampled vascular plant taxa within relevé sites and opportunistically
- Recorded detailed site notes (soil types and geology within the survey area)
- Mapped vegetation types and condition
- Undertook targeted searches for significant flora species
- Took representative site photos.

In addition to the data collected on site, prior to conducting the field assessment, a previous survey report from an assessment conducted in the area by Strategen (2019) was reviewed and the vegetation types mapped were used inform the vegetation mapping boundaries for this assessment.

3.2.1 Vegetation Types

Aerial photography interpretation and field notes taken during the survey were used to develop vegetation type mapping polygon boundaries over the survey area. The polygon boundaries were then digitised using Geographic Information System (GIS) software.

Vegetation type (VT) descriptions (though floristic in origin) have been adapted from the National Vegetation Information System (NVIS) Australian Vegetation Attribute Manual Version 7.0 (NVIS Technical Working Group 2017), a system of describing structural vegetation units (based on dominant taxa). This model follows nationally agreed guidelines to describe and represent

vegetation types, so that comparable and consistent data is produced nation-wide. For the purposes of this report, a VT is considered equivalent to a NVIS sub-association as described in the NVIS Australian Vegetation Attribute Manual Version 7.0 (NVIS Technical Working Group 2017).

3.2.2 Vegetation Condition

The vegetation condition was assessed and mapped in accordance with the vegetation condition rating scale for the South West and Interzone Botanical Provinces of Western Australia (IBRA) (devised by Keighery (1994) and adapted by EPA (2016a)).

3.2.3 Significant flora

Targeted searches for significant flora identified in the desktop assessment were undertaken during the field survey via meandering traverses. Post-survey, the evaluation of the likelihood of occurrence of significant flora within the survey area was completed based on presence of suitable habitat, survey effort and existing known records.

3.3 Fauna Habitat Assessment

The fauna habitat assessment was completed concurrently with the vegetation and flora survey. Fauna habitat delineation and mapping was based upon interpretation of aerial photography and landforms, along with the vegetation descriptions and mapping undertaken during the site assessment. The evaluation of the likelihood of occurrence of significant fauna within the survey area was completed based on presence of suitable habitat and existing known records.

3.4 Black Cockatoo Habitat Assessment

The Black Cockatoo assessment was conducted in accordance with Black Cockatoo Referral Guidelines (DSEWPaC 2012). The Black Cockatoo Assessment focused on the three Black Cockatoo species: Carnaby's Cockatoo (*Calyptorhynchus latirostris*) and Baudin's Cockatoo (*Calyptorhynchus baudinii*), both listed as Endangered under the EPBC Act and the *Biodiversity Conservation Act 2016* (BC Act) and the Forest Red-tailed Black Cockatoo (FRTBC) (*Calyptorhynchus banksii naso*) which is listed as Vulnerable under the EPBC Act and BC Act. These three species have modelled distributions that include the survey area.

The Black Cockatoo habitat assessment involved visual and aural assessment of the survey area to identify breeding habitat (presence/absence of actual and potential future breeding trees), foraging habitat, roosting areas, current activity and any other signs of use by Black Cockatoos.

3.4.1 Foraging

The location and extent of suitable Black Cockatoo foraging habitat was identified and mapped for the survey area, based on the vegetation types and presence/absence of tree and shrub species known to be important dietary items for Black Cockatoos e.g. *Corymbia calophylla* (Marri) and *Banksia* spp.

3.4.2 Breeding

Suitable breeding habitat for Black Cockatoos, as defined by DSEWPaC (2012) was recorded and electronically logged using a GPS. Any tree meeting the following criteria was recorded:

- Native trees or planted *Eucalyptus* sp.
- Diameter at breast height (DBH) >500 mm (300 mm for Wandoo and Salmon Gum)

Trees were placed in the following size class categories:

- A = 500 -1000 mm DBH
- B = 1000 – 2000 mm DBH
- C = >2000 mm DBH.

The presence of hollows was assessed by on-ground assessment with size, number and evidence of usage recorded.

The Black Cockatoo assessment also involved recording evidence of feeding (chewed cones, seed and nut material) and any opportunistic observations of Black Cockatoos in the survey area.

3.5 Limitations

Table 1 displays the evaluation of the flora and vegetation assessment against a range of potential limitations that may have an effect on that assessment. Based on this evaluation, the assessment has not been subject to constraints that would affect the thoroughness of the assessment and the conclusions reached.

Table 1. Flora and vegetation survey potential limitations and constraints

Potential Limitation	Impact on Assessment	Comment
Sources of information and availability of contextual information.	**Not a constraint.**	The survey has been undertaken on the Swan Coastal Plain which has been well studied and documented with ample literature available. The available resources were adequate to complete the survey.
Competency / experience levels of the team carrying out the survey, including experience in the bioregion surveyed.	**Not a constraint.**	All survey personnel have the appropriate training in sampling and identifying the flora of the region.
Scope (i.e. what life forms, etc., were sampled).	**Not a constraint.**	Due to the highly degraded nature and uniform distribution of vegetation within the survey area, most life forms are likely to have been sampled adequately during the time of the survey.
Proportion of flora recorded and or/collected, any identification issues.		The proportion of flora surveyed was adequate. The entire survey area was traversed and flora species were recorded systematically.
Appropriate area fully surveyed (effort and extent).	**Not a constraint**	The information collected during the survey was sufficient to assess the vegetation that was present during the time of the survey. The survey area was traversed on foot and all differences in vegetation structure were recorded appropriately.
Access restrictions within the survey area.	**Not a constraint.**	Existing roads and tracks enabled adequate access to survey the vegetation and fauna habitats within the survey area. Where access was not available by car, the area was easily traversed by foot.

Potential Limitation	Impact on Assessment	Comment
Survey timing, rainfall, season of survey.	**Not a constraint.**	Flora and vegetation surveys are normally conducted following winter rainfall in the South-West Province, ideally during spring (EPA 2016). The field assessment was conducted in November, within the optimum survey timing for the region and April. As such, this is not considered a limiting factor as the data collected during the survey was adequate to determine the vegetation values in the survey area.
Disturbance that may have affected the results of the survey such as fire, flood or clearing.	**Not a constraint.**	The survey area and regional surrounds have been subject to disturbance over a significant period of time. Given the wide range of this disturbance, this is not considered to be a limitation within the survey area.

4 RESULTS

4.1 Flora and Vegetation

4.1.1 Desktop Assessment Results

A total of 559 native vascular plant taxa from 86 plant families have been recorded in the study area (DBCA 2019a; DBCA 2019b; DotEE 2019a).

Threatened and Priority Flora

The desktop assessment identified the presence/potential presence of 20 Threatened flora and 22 DBCA Priority flora species in the study area using the PMST (DotEE 2019a), NatureMap (2019a) and DBCA (2019b) database results (Figure 2).

A likelihood of occurrence assessment of species identified as potentially occurring was undertaken and all of the species were identified as unlikely to occur in the survey area (Appendix A).

Threatened and Priority Ecological Communities

A search of Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) within the study area was undertaken as part of the desktop assessment using the PMST (DotEE 2019a) and DBCA (DBCA 2019b) database results (Figure 3, Figure 2).

DBCA data indicates the buffers of two TECs intercepting the survey area in its northern section (Figure 3):

- Herb rich shrublands in clay pans (SCP08)
- *Corymbia calophylla – Xanthorrhoea preissii* woodlands and shrublands of the Swan Coastal Plain (SCP3c)

The TECs and PECs identified from the desktop assessment are presented in Table 2.

Table 2. TECs and PECs identified in the database searches (5 km buffer)

Name	Conservation Status		Source
	BC Act, DBCA Priority Listing	EPBC Act	
Banksia Woodlands of the Swan Coastal Plain ecological community TEC	-	Endangered	DBCA PMST
Corymbia calophylla – Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain (3c) TEC	Critically Endangered	Endangered	DBCA PMST
Shrublands and Woodlands on Muchea Limestone TEC	-	Endangered	DBCA PMST
Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain ecological TEC	-	Critically Endangered	PMST
Banksia ilicifolia Woodlands (22) PEC*	Priority 3	Endangered	DBCA
Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain) TEC	Endangered		DBCA
Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain (15) TEC	Vulnerable		DBCA
Herb rich shrublands in clay pans (08) TEC	Vulnerable	Critically Endangered	DBCA
Low lying *Banksia attenuata* woodlands or shrublands (21c) PEC*	Priority 3	Endangered	DBCA
Shrublands on calcareous silts of the Swan Coastal Plain (18) TEC	Vulnerable	-	DBCA
Swan Coastal Plain *Banksia attenuata – Banksia menziesii* woodlands (23b) PEC*	Priority 3	Endangered	DBCA

* Can be a component of the Banksia Woodlands of the Swan Coastal Plain TEC

4.1.2 Field Assessment Results

Native Flora

A total of 10 native flora species from 5 families and 8 genera were recorded in the survey area from relevé sites and opportunistic recordings (Appendix B). Releve data from the survey area is provided in Appendix C.

Two of the species recorded, ^*Eucalyptus camaldulensis* and ^*Casuarina obesa* are native species planted in the survey area.

The small number of native flora taxa collected from the survey area (10 taxa) is considered low for the Swan Coastal Plain (Gibson *et al.* 1994), which is reflective of the high level of disturbance and historical clearing resulting in a lack of native remnant vegetation.

Introduced Species

A total of seven introduced species were recorded in the survey area, including:

- **Acacia iteaphylla* (Flinders Range Wattle)
- **Avena barbata* (Wild Oats)
- **Eragrostis curvula* (African Lovegrass)
- **Gomphocarpus fruticosus* (Cotton Bush)
- **Hyparrhenia hirta* (Tambookie Grass)
- **Trifolium arvense* (Hare's-Foot Clover)
- *Watsonia meriana (Bulbil Watsonia)

One of the species recorded, **Gomphocarpus fruticosus* (Cotton Bush) is a Declared pest species pursuant to section 22 of the *Biosecurity and Agriculture Management Act* 2007 (BAM Act). This species was recorded from two locations in the survey area (Table 3, Figure 5).

Table 3. Declared Weed Species Recorded in the Survey Area

Species	Easting	Northing	No. of Plants Recorded
**Gomphocarpus fruticosus* (Cotton Bush)	408634	6485647	1
**Gomphocarpus fruticosus* (Cotton Bush)	408626	6485626	2

Threatened and Priority Flora

DBCA data indicates previous records of *Eleocharis keigheryi* (Vulnerable; EPBC Act and BC Act) and *Trithuria occidentalis* (Endangered; EPBC Act, Critically Endangered; BC Act) adjacent to the survey area within Ellenbrook Nature Reserve (DBCA 2019b) (Figure 2).

Eleocharis keigheryi grows in small clumps in a substrate of clay or sandy loam. This species is emergent in freshwater creeks and claypans. Associated species include *Melaleuca lateritia* and herbs such as *Wurmbea* spp, *Tribonanthes* spp. and *Leptocarpus* spp. (DEWHA 2008a). The survey area contains an artificially constructed drainage sump and constructed roadside drainage lines which are highly degraded and lack native understorey species. The survey area does not contain habitat suitable for this species and as such, this species was considered unlikely to occur.

Trithuria occidentalis is known from one population in Ellenbrook. This species grows partly submerged on the edge of shallow, winter-wet claypans in very open shrubland of *Melaleuca lateritia* and numerous annual herbs (DEWHA 2008b). Due to the highly modified state of the vegetation in the survey area, and the lack of suitable habitat for this species, *Trithuria occidentalis* was considered unlikely to occur.

Due to the lack of native vegetation and the highly degraded state of remnant vegetation it is considered unlikely that the survey area provides suitable habitat for any Threatened or Priority flora species. Based on known distribution and habitat types, it is considered unlikely that any of the remaining Threatened and Priority flora species identified in the desktop assessment occur in the survey area (Appendix A).

During the field survey, the survey area was traversed by foot and no Threatened flora species listed under the EPBC Act and BC Act or any DBCA Priority listed flora species were recorded.

Vegetation Types

The survey area contains approximately 9.16 ha of vegetation. The vegetation in the survey area comprised mostly introduced grassland, dominated by **Hyparrhenia hirta, *Avena barbata* and**Eragrostis curvula* (2.65 ha; 14.7%) (Table 4, Figure 4).

All of the native vegetation in the survey area (4.23 ha) has been subject to historical clearing and the remnant native vegetation remaining (in VT1, VT2, VT3 and VT4) consists of native regrowth amongst planted vegetation and weeds, associated with roadside constructed drainage lines. Four vegetation types were recorded in the survey area, along with planted areas, a constructed drainage sump and areas cleared for roads and tracks (Table 4, Figure 4).

Table 4. Vegetation Types in the Survey Area

Vegetation Type	Description	Extent in the Survey Area (ha)	Percentage of Survey Area (%)
VT1	Planted ^*Eucalyptus camaldulensis* with regrowth scattered *Corymbia calophylla* mid open woodland over *Acacia saligna* mid open shrubland over *Typha orientalis, *Hyparrhenia hirta* mid grassland.	1.97	10.90
VT2	Planted ^*Eucalyptus camaldulensis* and ^*Casuarina obesa* with regrowth *Eucalyptus rudis* isolated trees over *Melaleuca rhaphiophylla, Melaleuca teretifolia* open shrubland over of *Typha orientalis, *Hyparrhenia hirta, *Avena barbata, *Eragrostis curvula* mid grassland.	0.79	4.37
VT3	Planted ^*Eucalyptus camaldulensis* with regrowth *Eucalyptus rudis* scattered trees over an open shrubland of *Melaleuca rhaphiophylla, Melaleuca teretifolia* over *Typha orientalis, *Hyparrhenia hirta, *Avena barbata, *Eragrostis curvula* mid grassland.	1.04	5.76
VT4	*Acacia saligna* tall isolated shrubs over introduced grasses.	0.43	2.39
Planted A	Planted ^*Eucalyptus camaldulensis* isolated trees over weeds.	2.11	11.70
Planted B	Planted ^*Casuarina obesa* isolated trees over weeds.	0.17	0.93
Introduced grasses	**Hyparrhenia hirta, *Avena barbata* and **Eragrostis curvula* mid closed grassland.	2.65	14.7
Drainage Sump	Constructed drainage sump.	0.10	0.54
Cleared	Roads/tracks.	8.75	48.6
Total		**18**	**100**

^ planted native species, *introduced species

Vegetation Condition

The entire survey area has been historically cleared and subject to high levels of disturbance associated with the construction of roads and industry in the area. The vegetation condition was assessed using the condition scale for the South West adapted from Keighery 1994 (EPA 2016). Vegetation Condition ranged from Degraded to Completely Degraded, with the majority of the vegetation in Completely Degraded condition (39%, 7.02 ha) due to the high levels of disturbance associated with historical clearing along with the lack of native, intact vegetation and the dominance of weeds (Figure 5, Table 5). All of the vegetation in the survey area has been previously cleared and the remnant native vegetation consists of regrowth amongst planted vegetation and weeds.

Table 5. Vegetation Condition in the Survey Area

Condition Rating	Condition Extent in Survey Area (ha)	Percentage of Survey Area (%)
Degraded	2.13	11.80
Completely Degraded	7.02	39
Waterbody	0.10	0.54
Cleared	8.75	48.60
Total	**18**	**100**

Vegetation of Conservation Significance

None of the TECs or PECs identified in the desktop assessment are considered representative of any of the vegetation types in the survey area. The native vegetation in the survey area has been historically cleared and retains little to no native vegetation structure. As such, no TECs or PECs are considered to occur in the survey area.

The desktop assessment identified two TECs intercepting the survey area from DBCA data (2019b), 'Herb rich shrublands in clay pans (Community Type SCP08) and '*Corymbia calophylla – Xanthorrhoea preissii* woodlands and shrublands of the Swan Coastal Plain (Community Type 3c) (Table 2, Figure 3). The two TECs in relation to the survey area are discussed below.

Herb rich shrublands in clay pans (Community Type SCP08)

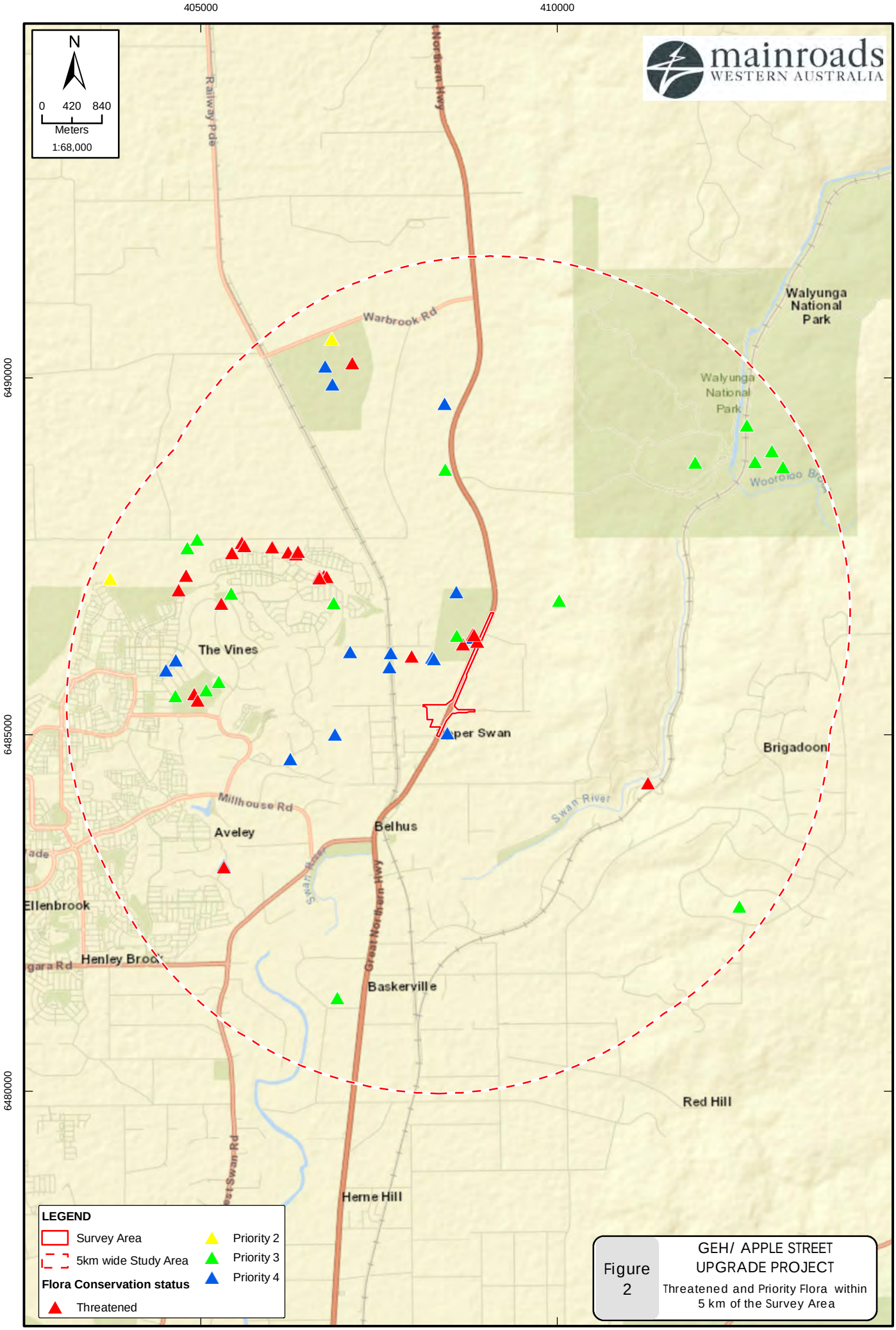
This vegetation community type occurs in low lying flats with a clay impeding layer allowing seasonal inundation. This TEC is dominated by one or more of the shrubs: *Viminaria juncea, Melaleuca viminea, M. lateritia, Kunzea micrantha* or *K. recurva* with occasional emergents of *Eucalyptus wandoo.* Species such as *Hypocalymma angustifolium*, *Acacia lasiocarpa* var. *bracteolata* long peduncle variant (G. J. Keighery 5026) and *Verticordia huegelii* occur at moderate frequencies. Typical herbs include *Centrolepis aristata, Chorizandra enodis, Drosera menziesii* subsp. *menziesii, Drosera rosulata* and *Hyalosperma cotula* (TSSC 2012).

The survey area does not contain any clay pan areas. None of the vegetation types in the survey area are considered representative of this community and as such, this TEC is not considered to occur in the survey area.

Corymbia calophylla – Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain (Community Type 3c)

This community is located on heavy soils of the eastern side of the Swan Coastal Plain between Bullsbrook and Capel. Dominant species in the community are the trees *Corymbia calophylla* and occasionally *Eucalyptus wandoo*; the shrubs *Xanthorrhoea preissii, Acacia pulchella, Banksia dallanneyi, Gompholobium marginatum* and *Hypocalymma angustifolium* and the herbs *Burchardia congesta, Cyathochaeta avenacea* and *Neurachne alopecuroidea* (TSSC 2017).

None of the vegetation types identified in the survey area resemble the description of this community type. VT2 contains regrowth of scattered *Corymbia calophylla* trees which is a key dominant species for the TEC. However, this vegetation type is highly modified and does not contain any of the other key dominant species for this TEC (TSSC 2017). This VT is dominated by planted trees and a weedy understorey. As none of the vegetation is representative of the TEC, this TEC is not considered to occur in the survey area.



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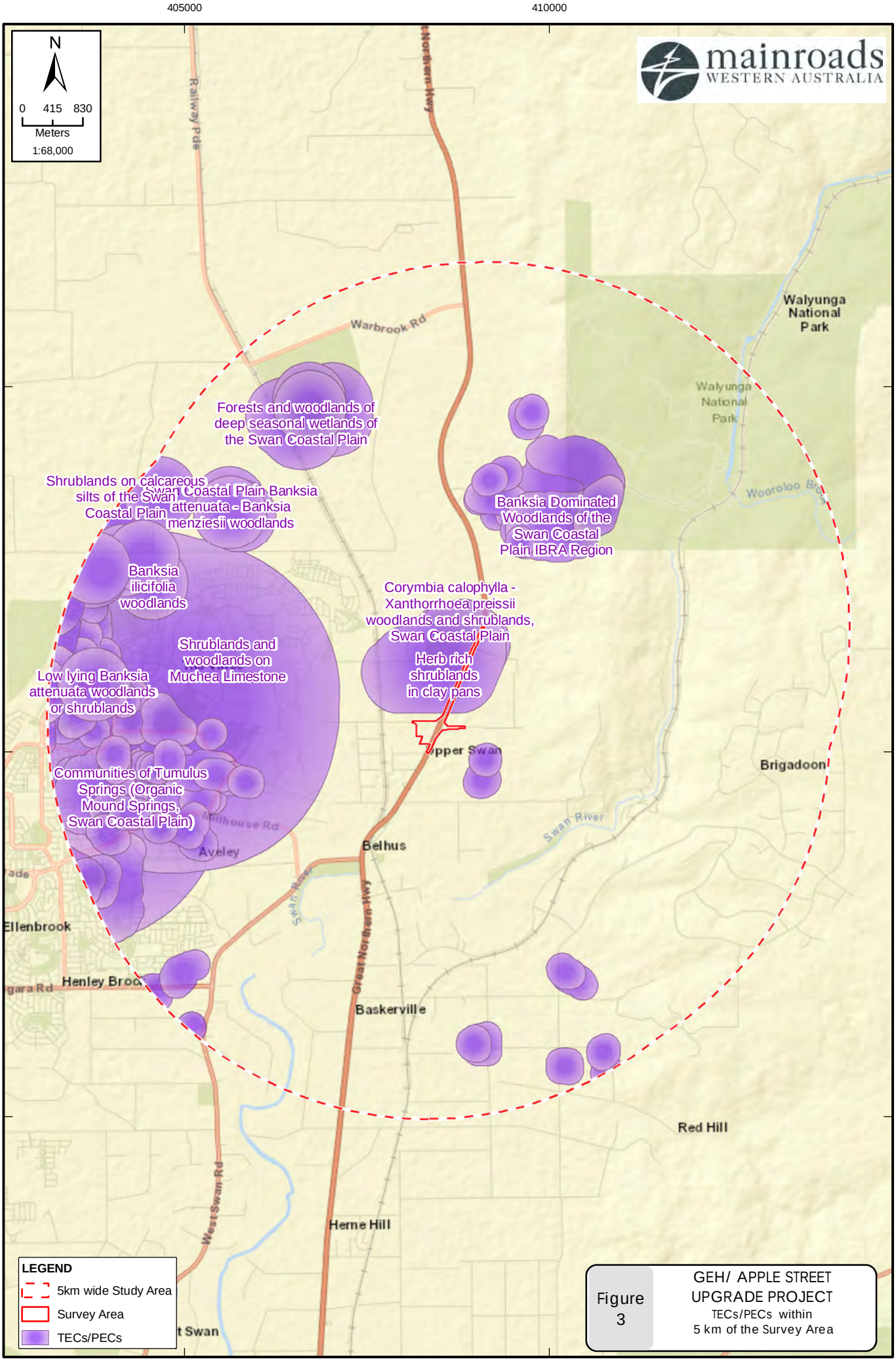

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4.2 Fauna

4.2.1 Desktop Assessment Results

A total of 221 species from 78 families were identified in the desktop assessment as occurring within the regional area (DBCA 2019a, DBCA 2019c, DotEE 2019a). This comprised 18 mammals (15 native), 137 birds (132 native), 40 reptiles and nine amphibians.

Significant Fauna Likelihood

The desktop assessment identified significant fauna species potentially occurring in the survey area (Figure 6, Appendix D). A total of 33 significant species retrieved from the database searches are considered as either Likely, Possibly or Unlikely to occur in the survey area based on species distributions and the habitats identified in the field survey.

A total of two species are considered Likely to occur in the survey area; FRTBC and Carnaby's Cockatoo. The survey area falls within known (and predicted) distributions of Carnaby's Cockatoo, FRTBC and Baudin's Cockatoo (DSEWPAC 2012). The survey area is not within a known breeding or roosting area for Black Cockatoos (DotEE 2017, Peck et al. 2019). DBCA (2020) data indicates nearby records of sightings of Carnaby's Cockatoo and FRTBC approximately 200 m to the west and 1.5 km to the south west of the survey area, respectively. Due to the presence of potential habitat and nearby records of sightings, Carnaby's Cockatoo and FRTBC are considered likely to occur, while Baudin's Cockatoo was considered unlikely to occur due to project location and a lack of records within 5 km of the survey area. These species will be further discussed in Section 4.2.2.

Three species, *Isoodon obesulus fusciventer* (Quenda, Southern Brown Bandicoot), *Falco Peregrinus* (Peregrine Falcon) and *Pseudemydura umbrina* (Western Swamp Tortoise) are considered to possibly occur. These species will be further discussed in Section 4.2.2.

The remaining potentially occurring species identified in the database searches are considered unlikely to occur due to a lack of suitable habitat and nearby records.

It is important to note, that the PMST is not entirely based on point records, but also on broader information, for example bioclimatic distribution models whereas NatureMap and DBCA data is. Consequently, the results of the PMST are in some cases less accurate, particularly at a local scale. As a result, the PMST will include species that do not occur in the search area because for example, there is no habitat or they are now known to be locally extinct. Many fauna are not distributed evenly across the landscape, are more abundant in some places than others are, and are consequently more detectable (Currie 2007). Some small, common ground-dwelling reptile and mammal species tend to be habitat specific, and many bird species can occur as regular migrants, occasional visitors or vagrants.

4.2.2 Field Assessment Results

Fauna Habitat

Four broad fauna habitats were mapped in the survey area. The habitat types provide low habitat value for native fauna. The remaining areas consist of Cleared areas, which provide little to no habitat for native fauna species. The Cleared areas comprise the majority of the survey area (48.6%, 8.79 ha). All fauna habitats are mapped in Figure 7 and described in Table 6.

These habitats differed primarily in landform, geology and vegetation structure of the upper stratum. No tree hollows suitable for vertebrate fauna were recorded in any of the habitat types.

The habitat types in the survey area were assessed on their extents and levels of significance according to the following criteria:

- Distribution: those habitats widespread and common within the surrounding regions were categorised as 'widespread'; otherwise they were categorised as being of 'limited extent'
- Significance: those habitats considered important to species of conservation significance or distinct fauna assemblages are deemed 'significant'; otherwise they were categorised as being of 'limited significance'.

All habitats recorded in the survey area are considered to be widespread, common and of limited significance.

Table 6. Fauna Habitat Types and Extent in the Survey Area

Fauna Habitat	Corresponding Vegetation Type	Extent of habitat in survey area (ha)	Percentage in the survey area (%)
Open Eucalypt Woodland	VT1, VT2, VT3, Planted A	5.9	32.80
Isolated Trees	VT4, Planted B	0.6	3.32
Drainage Sump	Drainage Sump	0.10	0.54
Grasslands/Degraded Areas	Introduced Grasses	2.65	14.7
Cleared	Cleared	8.75	48.6
Total		**18**	**100**

Open Eucalypt Woodland

This habitat consists of 5.9 ha of planted *Eucalyptus camaldulensis* (River Red Gum) trees with occasional *Casuarina obesa* (Swamp Sheoak), Marri and *Eucalyptus rudis* (Flooded Gum) trees over a ground storey dominated by introduced grass species mostly along roadside constructed drainage. The condition of this habitat ranges from Degraded to Completely Degraded. This habitat type may provide poor quality foraging habitat for Black Cockatoos.

This habitat lacks understorey vegetation and has minimal woody debris and leaf litter, providing limited food and shelter resources for small reptile, bird and mammal species. As this habitat occurs as isolated, fragmented patches throughout the survey area, fauna movement may be limited, particularly for the less mobile groups such as small reptiles and mammals. This habitat provides low value to native fauna.

Isolated Trees

This habitat consists of Acacia Isolated Trees (0.43 ha) and Swamp Sheoak Isolated Trees (0.17 ha). The condition of this habitat is Completely Degraded. These areas lack any native understorey and are highly fragmented and isolated. This habitat provides no to limited food and shelter resources to fauna, and movement is limited particularly for the less mobile groups such as reptiles and mammals. This habitat provides low value to native fauna.

Drainage Sump

This habitat type consists of a constructed drainage sump comprising 0.10 ha. This constructed drainage sump may provide potential habitat for the Western Swamp Tortoise. However, this habitat type is isolated within the survey area and is highly disturbed. This habitat may provide water resources for bird and ground dwelling vertebrate species, however, is considered to provide low value to native fauna.

Grassland/Degraded Areas

This habitat type consists of 2.33 ha of introduced grasses mostly along the roadside. In these areas, native vegetation is entirely cleared and the condition of the habitat is completely degraded. As this habitat is highly fragmented, and provides very little in the way of food and shelter resources, it has little to no value for native fauna species.

Significant Fauna

No significant fauna species were recorded in the survey area during the field assessment.

The desktop assessment identified a total of 33 significant fauna species potentially occurring in the survey area. Two species are considered likely to occur in the survey area; Carnaby's Cockatoo and FRTBC. Three species are considered as possibly occurring; the Western Swamp Tortoise, Peregrine Falcon and the Quenda.

Significant fauna species considered as either Likely or Possibly occurring are discussed further below.

Quenda, Southern Brown Bandicoot (Isoodon obesulus fusciventer)

The Quenda is listed as Priority 4 under the DBCA Priority List. It once occurred throughout southwest Western Australia; it now occurs from Guilderton southwards on the Swan Coastal Plain, including the Perth Metropolitan area, in *Eucalyptus marginata* (Jarrah) and Karri (*Eucalyptus diversicolor*) forests and adjacent coastal vegetation complexes. The species inhabits scrubby, often swampy, vegetation with dense cover up to about 1 m high. The species is patchily distributed in suitable habitat, with populations inhabiting Jarrah and *Eucalyptus wandoo* (Wandoo) forests usually associated with watercourses. On the Swan Coastal Plain it is often associated with wetlands with dense vegetation where they feed on fruit, seeds, insects and fungi (DEC 2012a).

The DBCA database and NatureMap search identified this species as potentially occurring in the regional area (DBCA 2019a, DBCA 2019b) with one previous record located within the survey area. This species is considered to possibly occur, as while there is a previous record of this species occurring within the survey area, the survey area lacks dense understorey vegetation, which is preferred habitat for this species. The previous record within the survey area is likely to represent an individual transiting through the area rather than a resident population, as preferred habitat for the species is not present.

Peregrine Falcon (Falco peregrinus)

The Peregrine Falcon is listed as Other Specially Protected Fauna under the BC Act and occurs throughout Australia. It occupies a wide range of habitats including woodlands, wetlands, open country and built up areas. This species breeds primarily on ledges in cliffs, granite outcrops, quarries and tall buildings. It feeds almost entirely on other birds. It also eats rabbits and other moderate sized mammals, bats and reptiles (DAWE 2020).

The NatureMap search identified this species as occurring in the regional area (DBCA 2019a). This species may overfly the area on occasion, but is unlikely to be reliant on the habitats in the survey area for foraging or breeding.

Western Swamp Tortoise (Pseudemydura umbrina)

The Western Swamp Tortoise is listed as Endangered under the EPBC Act and Critically Endangered under the BC Act. It once occurred in ephemeral swamps on the clay soils on the Swan Coastal

Plain between Mogumber in the north to Donnybrook in the south. Currently there are only two known wild populations near Perth, with two successfully translocated populations approximately 80 km further north. The species inhabits shallow, ephemeral, winter-wet swamps on clay or sand over clay soils with nearby suitable aestivating refuges (DAWE 2020).

The DBCA database, NatureMap and PMST search identified this species as potentially occurring in the regional area (DBCA 2019a, DBCA 2019b), with records identified adjacent to the survey area in Ellenbrook Nature Reserve. The survey area is also within the Environmental Protection Policy (EPP) boundary for the species. Suitable habitat for the Western Swamp Tortoise is unique to Ellen Brook Nature Reserve and is not common on the Swan Coastal Plain. This species is considered to possibly occur, due to the presence of potential habitat in the survey area within the drainage sump and the proximity to a known population in Ellenbrook Nature Reserve. However, there are no habitat types that are likely to support this species in the survey area.

Black Cockatoos

The DBCA database searches, NatureMap and PMST identified two species of Black Cockatoos as occurring in the surrounding area; Carnaby's Cockatoo and FRTBC (Appendix D).

The survey area falls within known (and predicted) distributions of Carnaby's Cockatoo, FRTBC and Baudin's Cockatoo (DSEWPAC 2012), but outside the known breeding and foraging range of Baudin's Cockatoo. Due to the presence of potential habitat and nearby records of sightings, Carnaby's Cockatoo and FRTBC are considered likely to occur, while Baudin's Cockatoo was considered unlikely to occur due to project location and a lack of records within 5 km of the survey area.

Carnaby's Cockatoo is a seasonal visitor to the Swan Coastal Plain, which provides important foraging and roosting habitat during the non-breeding season. The FRTBC has a traditional range within the Jarrah Forest and Warren bioregions, where it breeds. In recent years, the FRTBC has expanded its distribution onto the Swan Coastal Plain (Johnstone et al. 2013).

The Swan Coastal Plain is generally more important to Black Cockatoos as a feeding ground and only small areas support breeding to the north of Perth (DotEE 2017, EPA 2019). Foraging habitat is defined as areas including plants of species known to support foraging within the range of each Black Cockatoo species. While a broader range of species utilised for foraging (including introduced species such as **Pinus* spp.), Marri and Jarrah woodlands are particularly important to the FRTBC, the Banksia woodlands and proteaceous heath are commonly utilised by Carnaby's Cockatoo (DSEWPaC 2012, EPA 2019).

Black Cockatoos breed in large hollow-bearing trees, generally within woodlands or forests. The size of the tree can be a good indication of the hollow bearing potential of the tree. Trees of suitable diameter at breast height are potentially important for maintaining breeding in the long term, through maintaining the integrity of the habitat and allowing trees to provide future nest hollows. Maintaining the long term supply of trees of a size to provide suitable nest hollows is particularly important in woodland stands that are known to support Black Cockatoo breeding (DSEWPaC 2012).

Flocks of Black Cockatoos show fidelity to night roosts to access nearby high quality feeding sites. Roosting habitat is considered a tree where there are recorded or recent evidence of night roosting (DSEWPaC 2012). Night roosts are usually located in the tallest trees in an area and within close proximity (within 6 km) to both a high quality food supply and water supply.

The vegetation in the Eucalypt Woodland habitat in the survey area may provide potential habitat for Black Cockatoos.

Foraging Habitat

There is approximately 5.9 ha of potential poor quality foraging habitat for Black Cockatoos in the survey area in the Open Eucalypt Woodland habitat (Table 6, Figure 7). Vegetation mapped as potential foraging habitat includes areas containing River Red Gum and Marri, which are known dietary items for Black Cockatoos (DSEWPaC 2012). The River Red Gum in this habitat type are unlikely to be a foraging species for Carnaby's Cockatoo or Baudin's Cockatoo (DotEE 2017), preference is likely to be given to more suitable species such as Marri. The River Red Gum, Marri and Flooded Gum may provide a potential foraging resource for the FRTBC (DSEWPaC 2012).

Foraging evidence by way of chewed Marri nuts from FRTBC were recorded in the survey area (Plate 1). No observations of any of Black Cockatoo species were recorded during the survey.

The potential foraging habitat is considered poor quality due to the low density of foraging species, with foraging habitat consisting mostly of isolated trees over weeds and the presence of food sources generally limited to only one stratum (canopy).

Plate 1. Evidence of Black Cockatoo foraging in the survey area

Breeding Habitat

There are no known breeding sites within or adjacent to the survey area. The survey area contains 49 potential breeding trees within the Open Eucalypt Woodland habitat type. These trees had a DBH of more than 500 mm and comprised of five Marri, one Flooded Gum and 43 River Red Gum trees. None of the trees recorded contained any hollows suitable for Black Cockatoo breeding. The locations of these potential breeding trees are displayed in Figure 7 and presented in Appendix E.

Roosting Habitat

There are no known roosting sites within or adjacent to the survey area. No confirmed roost sites have been identified within 5 km of the survey area. One unconfirmed roost site, 'WS11' is located approximately 4 km from the survey area (Peck et al. 2019). Tall trees (including introduced Eucalypts and Marri) with a DBH greater than 500 mm may be large enough to provide potential roosting habitat for Black Cockatoos (DSEWPaC 2012).

Black Cockatoos will usually search for foraging resources within 6 km of a roost site. Roost sites are usually within an area of high quality foraging habitat and water sources (DSEWPaC 2012, DotEE 2017). While high quality foraging habitat is not present within the survey area, high quality food sources for Black Cockatoos may occur nearby reserves, including Walyunga National Park which is approximately 3 km to the north east of the survey area. As such, the potential breeding trees within the survey area may provide potential roosting habitat for Black Cockatoos, although preference for roosting habitat is likely to be given to areas adjacent to high quality foraging habitat and permanent water sources.

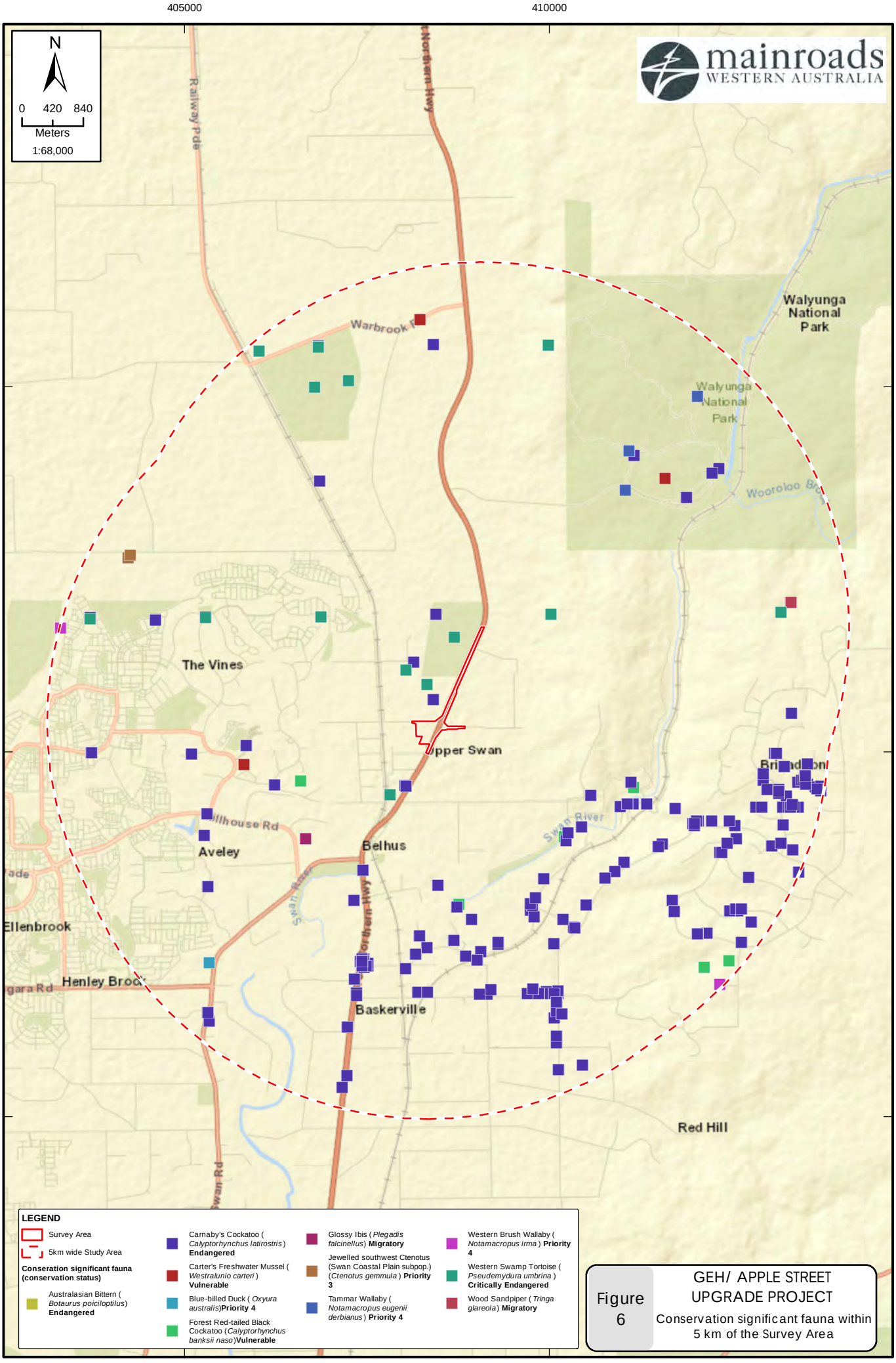

Figure 6

GEH/ APPLE STREET UPGRADE PROJECT

Conservation significant fauna within 5 km of the Survey Area

Document Path: Y:\Metropolitan Region\Environment\Project Files\Great Northern Highway Apple St Intersection - Roundabout\Maps, GIS, Design\Mxds\GNH Apple Street_Desktop_Fauna_5km_RevA.mxd

Source: Aerial image: Skyview. Development Envelope: Main Roads 04/2020. Database: DBCA (2020)

Created by: DWhite

April 2020

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Document Path: Y:\Metropolitan Region\Environment\Project Files\Great Northern Highway Apple St Intersection - Roundabout\Maps, GIS, Design\Mxds\GNH Apple Street_FaunaHabitat_RevA.mxd
Source: Aerial image: Skyview. Development Envelope: Main Roads 04/2020. Fauna: Main Roads Site Inspection (2020)
Created by: DWhite

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5 CONCLUSION

5.1 Flora and Vegetation

The flora and vegetation survey conducted in November 2019 and April 2020 was consistent with the requirements of a reconnaissance flora and vegetation survey as specified in the Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016).

A total of 10 native flora species from 5 families and 8 genera were recorded in the survey area, which is considered low for the Swan Coastal Plain and is likely a result of historical clearing and the highly degraded state of the vegetation. Two of the species recorded, ^*Eucalyptus camaldulensis* and ^*Casuarina obesa* are native species planted in the survey area. Six introduced taxa were recorded within the survey area. One of the species recorded, **Gomphocarpus fruticosus* (Cotton Bush) is a Declared pest species pursuant to section 22 of the BAM Act. This species was recorded from two locations in the survey area.

During the field survey, no Threatened or Priority flora species were recorded. The desktop survey identified 20 Threatened and 22 Priority flora species that have been recorded in the study area. No Threatened or Priority flora species were considered likely to occur due to the highly degraded state of the remnant vegetation and the lack of suitable habitat in the survey area.

The survey area contains approximately 9.16 ha of vegetation. The majority of the vegetation comprises mostly introduced grasses consisting of **Hyparrhenia hirta, *Avena barbata* and *Eragrostis curvula*.

All of the native vegetation within the survey area has been subject to high levels of disturbance and all of the remnant native vegetation consists of native regrowth amongst planted vegetation and weeds, associated with roadside constructed drainage. Due to the high levels of disturbance and clearing associated with the construction of roads and industry in the area, the vegetation condition ranged from Degraded to Completely Degraded.

None of the vegetation types within the survey area were considered to be conservation significant or represent any known TECs or PECs.

5.2 Fauna

Four broad habitats were identified and delineated from the survey area. These fauna habitat types are considered to provide low habitat value for native fauna species, due to the degraded condition of the vegetation, the lack of understory vegetation and the highly fragmented landscape. All habitats recorded in the survey area are considered to be widespread, common and of limited significance.

No significant fauna species were recorded in the survey area during the field assessment. The desktop assessment identified a total of 33 significant fauna species potentially occurring in the survey area. Two species are considered likely to occur in the survey area; Carnaby's Cockatoo and FRTBC. Three species are considered as possibly occurring; the Western Swamp Tortoise, Peregrine Falcon and the Quenda.

The Black Cockatoo habitat assessment identified that the survey area contains approximately 5.9 ha of poor quality foraging habitat for Black Cockatoos within the Open Eucalypt Woodland habitat. The potential foraging habitat was considered poor quality due to the low density of

foraging species, with foraging habitat consisting mostly of isolated trees over weeds and the presence of food sources being limited only one stratum (canopy). Foraging evidence by way of chewed Marri nuts from FRTBC were recorded in the survey area. No observations of any Black Cockatoo species were recorded during the survey.

The survey area contains five Marri, one Flooded Gum and 43 River Red Gum trees that are >500 mm DBH and are considered potential breeding trees. No observable hollows were identified in any of the trees. There are no known breeding or roosting records within or directly adjacent to the survey area (DBCA 2019c, DBCA 2020, Peck et al. 2019). The survey area and immediate surrounds are unlikely to provide sufficient food resources to maintain breeding pairs of the FRTBC as high quality Marri and Jarrah forest is not present. The survey area is not within the modelled distribution for Carnaby's Cockatoo breeding, with breeding typically occurring further east and north (DSEWPaC 2012). Additionally, while trees within the survey area may provide potential roosting habitat for Black Cockatoos, preference for roosting habitat is likely to be given to areas adjacent to high quality foraging habitat and permanent water sources.

The survey area does not contain significant habitat for Black Cockatoos. Black Cockatoos are nomadic and are not wholly dependent on the habitats existing in the survey area for foraging or breeding, given the degraded state of potential foraging habitat and potential breeding habitat types.

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7 APPENDICES

Appendix	Title
Appendix A	Threatened and Priority Flora Likelihood of Occurrence Assessment
Appendix B	Flora Species List
Appendix C	Relevé Data
Appendix D	Significant Fauna Likelihood of Occurrence Assessment
Appendix E	Black Cockatoo Potential Breeding Trees in the Survey Area

Appendix A. Threatened and Priority Flora Likelihood of Occurrence Assessment

Taxon	Status*		Habitat	Flowering Period	Database Source	Likelihood
	EPBC Act	WA				
Andersonia gracilis	EN	T	White/grey sand, sandy clay, gravelly loam. Winter-wet areas, near swamps supporting low open heath vegetation with species such as *Calothamnus hirsutus, Verticordia densiflora* and *Kunzea recurva* over sedges (DAWE 2020; Western Australian Herbarium 1998-).	September to November	PMST	**Unlikely –** No suitable habitat or nearby records.
Anigozanthos viridis subsp. terraspectans	VU	T	Grey sand, clay loam. Winter-wet depressions where it grow on grey sandy clay loam, or grey sand, in low post-fire regenerating heath. IT is associated with *Banksia leptophylla, Verticordia densiflora, Conostylis* spp. and sedges (DAWE 2020; Western Australian Herbarium 1998-).	August to September	PMST	**Unlikely –** No suitable habitat or nearby records.
Anthocercis gracilis	VU	T	Grows on steep granite slopes along the Darling Scarp in shallow, humus rich sandy or loamy soils (DAWE 2020; Western Australian Herbarium 1998-).	September to October	PMST	**Unlikely –** No suitable habitat or nearby records.
Caladenia huegelii	EN	T	Well drained, deep sandy soils in low mixed woodlands of *Banksia attenuata, B. menziesii, B. ilicifolia, Allocasuarina fraseriana* and *Eucalyptus marginata* (DAWE 2020; Western Australian Herbarium 1998-).	September - October	DBCA, NatureMap, PMST	**Unlikely –** Previous records approximately 3 km from the survey area, however no suitable habitat present.
Chamelaucium sp. Gingin (N.G. Marchant 6)	EN	T	White/yellow sand supporting open low woodland with *Eucalyptus todtiana, Banksia attenuata* and *Hibbertia* sp. Confined to the_Chittering/Gingin area (DAWE 2020; Western Australian Herbarium 1998-).	September to December	PMST	**Unlikely –** No suitable habitat or nearby records.
Darwinia foetida	CR	T	Known from three populations in swampy, seasonally wet habitat in the Muchea area. Found under *Regelia inops* and *Kunzea recurva* tall shrubland over *Hypocalymma angustifolium* low shrubland or low *Melaleuca* spp. shrubland (DAWE 2020; Western Australian Herbarium 1998-).	October to November	PMST	**Unlikely –** No suitable habitat or nearby records.
Diplolaena andrewsii	EN	T	Loam, clay. Granite outcrops and hillsides. Found in *Corymbia calophylla, E. wandoo* woodlands amongst *Hakea trifurcata, Trymalium ledifolium, Xanthorrhoea preissii, Acacia pulchella* and *Thelymitra dedmaniarum* (DAWE 2020; Western Australian Herbarium 1998-).	July to October	NatureMap	**Unlikely –** No suitable habitat.

Taxon	Status*		Habitat	Flowering Period	Database Source	Likelihood
	EPBC Act	WA				
Diuris micrantha	VU	T	Brown loamy clay. Winter wet swamps, in shallow water (DAWE 2020; Western Australian Herbarium 1998-).	August to October	PMST	**Unlikely –** No suitable habitat or nearby records.
Diuris purdiei	EN	T	Sand to sandy clay soils, in areas subject to winter inundation and amongst native sedges and dense heath with scattered emergent *Melaleuca preissiana, Corymbia calophylla, E. marginata* and *Nuytsia floribunda* (DAWE 2020; Western Australian Herbarium 1998-).	September to October	PMST	**Unlikely –** No suitable habitat or nearby records.
Drakaea elastica	EN	T	Grows in bare patches of sand within otherwise dense vegetation in low lying areas alongside winter wet swamps, typically in *Banksia menziesii, B. attenuata* and *B. ilicifolia* woodland or *Kunzea glabrescens* thicket vegetation (DAWE 2020; Western Australian Herbarium 1998-).	October to November	PMST	**Unlikely –** No suitable habitat or nearby records.
Eleocharis keigheryi	VU	T	Grows in small clumps in a substrate of clay or sandy loam. This species is emergent in freshwater creeks and claypans. Associated species include *Melaleuca lateritia* and herbs such as *Wurmbea* spp, *Tribonanthes* spp. and *Leptocarpus* spp. (DEWHA 2008a).	August to November	DBCA, NatureMap, PMST	**Unlikely –** Nearby records within Ellenbrook Nature Reserve, however no suitable habitat present.
Eucalyptus x balanites	VU	T	Light coloured sandy soils with surface laterite. It grow in gently sloping heathlands; open low Mallee woodland or heathland (DAWE 2020; Western Australian Herbarium 1998-).	October to December or January to February	PMST	**Unlikely –** No suitable habitat or nearby records.
Grevillea christineae	EN	T	Outcropping granite. Associated species include *E. loxophleba* and *E. wandoo* over *Acacia acuminata, Allocasuarina campestris* and *Melaleuca radula* with *Drosera* spp. and *Tribonanthes* spp. understorey (DAWE 2020; Western Australian Herbarium 1998-).	September	DBCA, NatureMap, PMST	**Unlikely –** Previous record approximately 2.5 km from the survey area, however no suitable habitat present.
Grevillea curviloba subsp. *curviloba*	EN	T	Winer wet, deep peaty grey sands over limestone at depth and occurs with winter wet heath including shrubs *Acacia saligna, Melaleuca huegelii* and *M. systena* (DAWE 2020; Western Australian Herbarium 1998-).	October	DBCA, NatureMap, PMST	**Unlikely –** Previous record approximately 2.5 km from the survey area, however no suitable habitat present.
Grevillea curviloba subsp. *incurva*	EN	T	Confined to an area between Muchea and Badgingarra in Western Australia. Open heath in winter wet areas on sand over limestone, or over ironstone (DAWE 2020; Western Australian Herbarium 1998-).	August to September	DBCA, NatureMap, PMST	**Unlikely –** Previous record approximately 3.5 km from the survey area, however no suitable habitat present.

Taxon	Status*		Habitat	Flowering Period	Database Source	Likelihood
	EPBC Act	WA				
Lepidosperma rostratum	EN	T	Peaty sand and clay amongst low heath, in winter-swamps. Grows in association with *Banksia telmatiaea* and *Calothamnus hirsutus* (DAWE 2020; Western Australian Herbarium 1998-).	June to August	PMST	**Unlikely –** No suitable habitat or nearby records.
Synaphea sp. *Fairbridge Farm* (D. Papenfus 696)	CR	T	Grey, clayey sand with lateritic pebbles in low woodland areas near winter flats. Associated species include *Kennedia prostrata*, *Xanthorrhoea preissii, Conostylis* sp. and *Synaphea stenoloba*. Two subpopulations occur in seasonally wet *Pericalymma ellipticum* dominated shrubland, with *Leptospermum* sp., *Lechenaultia biloba, Mesomelaena tetragona, Adenanthos meisneri, Hypocalymma angustifolium* and *Allocasuarina humilis* (DAWE 2020; Western Australian Herbarium 1998-).	September to November	PMST	**Unlikely –** No suitable habitat or nearby records.
Thelymitra dedmaniarum	EN	T	Grows in *Eucalyptus wandoo* and *E. accedens* woodlands on red brown sandy loam soil associated with dolerite and granite outcrops. Associated species include *Acacia pulchella, A. saligna, Calothamnus quadrifidus, Melaleuca radula* and *Hakea lissocarpha* (DAWE 2020; Western Australian Herbarium 1998-).	October through to December or January	PMST	**Unlikely –** No suitable habitat or nearby records.
Thelymitra stellata	EN	T	Gravelly loam among low heath and scrub in *Eucalyptus marginata* and *E. wandoo* woodlands and in low heath or lateritic hill tops (DAWE 2020; Western Australian Herbarium 1998-).	September to November	PMST	**Unlikely –** No suitable habitat or nearby records.
Trithuria occidentalis	EN	T	Grows partly submerged on the edge of shallow, winter-wet claypans in very open shrublands of *Melaleuca lateritica* and numerous annual herbs (DAWE 2020; Western Australian Herbarium 1998-).	October	DBCA, NatureMap, PMST	**Unlikely** – Nearby records within Ellenbrook Nature Reserve, however no suitable habitat present.
Millotia tenuifolia var. *laevis*	-	P2	Granite or laterite soils (Western Australian Herbarium 1998-).	September to October	DBCA, NatureMap	**Unlikely –** Previous record approximately 4.5 km from the survey area and no suitable habitat present.

Taxon	Status*		Habitat	Flowering Period	Database Source	Likelihood
	EPBC Act	WA				
Poranthera moorokatta	-	P2	Flat to very slight depression on a broad flat dampland floor. Soil surface light grey to grey, set clay with some coarse sand (Western Australian Herbarium 1998-). Ellenbrook population occurring with *Astartea* aff. *fascicularis, Banksia littoralis, Calothamnus lateralis, Centrolepis aristata, Melaleuca preissiana, Pericalymma ellipticum* var. *ellipticum* and *Phyllangium paradoxum* in a shallow dampland on mixed grey and white sand with scattered leaf litter (Barrett 2012).	September to November	DBCA, NatureMap	**Unlikely –** Previous record approximately 5 km from the survey area and no suitable habitat.
Schoenus sp. *Bullsbrook* (J.J. Alford 915)	-	P2	Low lying flat, grey peaty sand over clay (Western Australian Herbarium 1998-).	October to November	NatureMap	**Unlikely –** No suitable habitat or nearby records.
Acacia oncinophylla subsp. *oncinophylla*	-	P3	Granitic soils (Western Australian Herbarium 1998-).	August to October	DBCA, NatureMap	**Unlikely –** Previous record approximately 5 km from the survey area and no suitable habitat.
Adenanthos cygnorum subsp. *chamaephyton*	-	P3	Grey sand, lateritic gravel. Low woodland with *Banksia* spp. and *Eucalyptus marginata* (Western Australian Herbarium 1998-).	July or September to December or January	DBCA, NatureMap	**Unlikely –** Previous record approximately 2 km from the survey area and no suitable habitat.
Beaufortia purpurea	-	P3	Lateritic or granitic soils. Rocky slopes (Western Australian Herbarium 1998-).	October to December or January to February	DBCA, NatureMap	**Unlikely –** Previous record approximately 5 km from the survey area and no suitable habitat.
Chamaescilla gibsonii	-	P3	Clay to sandy clay. Winter wet flats, shallow water filled claypans (Western Australian Herbarium 1998-).	September	NatureMap	**Unlikely –** No suitable habitat or nearby records.
Cyathochaeta teretifolia	-	P3	Grey sand, sandy clay. Swamps, creek edges (Western Australian Herbarium 1998-).	November	DBCA, NatureMap	**Unlikely –** Previous record approximately 3 km from the survey area and no suitable habitat.
Haemodorum loratum	-	P3	Grey or yellow sand, gravel (Western Australian Herbarium 1998-).	November	DBCA, NatureMap	**Unlikely –** Previous record approximately 3 km from the survey area and no suitable habitat.

Taxon	Status*		Habitat	Flowering Period	Database Source	Likelihood
	EPBC Act	WA				
Halgania corymbosa	-	P3	Gravelly soils, soils over granite (Western Australian Herbarium 1998-).	August to November	DBCA, NatureMap	**Unlikely –** Previous record approximately 1 km from the survey area, however no suitable habitat and not recorded in the field assessment.
Lasiopetalum glutinosum subsp. *glutinosum*	-	P3	Open woodland dominated by *Corymbia calophylla, Eucalyptus marginata, Banksia menziesii* and *B. attenuata* and in open low scrub over heath on steep slopes of lateritic grave, clay or sandy loam near granite outcrops and creeklines (Western Australian Herbarium 1998-).	September to December	DBCA	**Unlikely –** Previous record approximately 4 km from the survey area and no suitable habitat.
Meionectes tenuifolia	-	P3	Sand or clay. Wetlands and Swamps (Western Australian Herbarium 1998-).	September to December	DBCA, NatureMap	**Unlikely –** Previous record approximately 3 km from the survey area and no suitable habitat.
Pithocarpa corymbulosa	-	P3	Gravely or sandy loam. Amongst granite outcrops (Western Australian Herbarium 1998-).	January to April	DBCA, NatureMap	**Unlikely –** Previous record approximately 5 km from the survey area and no suitable habitat.
Schoenus capillifolius	-	P3	Brown mud. Claypans (Western Australian Herbarium 1998-).	October to November	DBCA, NatureMap	**Unlikely –** Previous record approximately <1 km from the survey area in Ellenbrook Nature Reserve and no suitable habitat.
Schoenus sp. *Waroona* (G.J. Keighery 12235)	-	P3	Clay or sandy clay. Winter-wet flats (Western Australian Herbarium 1998-).	October to November	DBCA, NatureMap	**Unlikely –** Previous record approximately 4 km from the survey area and no suitable habitat.
Stylidium paludicola	-	P3	Winter-wet flats; brown sandy-clay (Western Australian Herbarium 1998-).	October to December	DBCA, NatureMap	**Unlikely –** Previous record approximately 4 km from the survey area and no suitable habitat.

Taxon	Status*		Habitat	Flowering Period	Database Source	Likelihood
	EPBC Act	WA				
Tetratheca pilifera	-	P3	Gravelly soils (Western Australian Herbarium 1998-).	August to October	DBCA, NatureMap	**Unlikely –** Previous record approximately 4 km from the survey area and no suitable habitat.
Cyanicula ixioides subsp. *ixioides*	-	P4	Laterite, gravel (Western Australian Herbarium 1998-).	August to October	DBCA, NatureMap	**Unlikely –** Previous record approximately 2 km from the survey area and no suitable habitat.
Hydrocotyle lemnoides	-	P4	Swamps (Western Australian Herbarium 1998-).	August to October	DBCA, NatureMap	**Unlikely –** Previous record approximately 1 km from the survey area and no suitable habitat.
Persoonia sulcata	-	P4	*Eucalyptus wandoo* woodlands. Lateritic or granitic soils (Western Australian Herbarium 1998-).	September to November	DBCA, NatureMap	**Unlikely** – Historical record < 100 m from the survey area recorded in 1980, however this population is likely extinct as this area has now been cleared for clay mining. No suitable habitat present.
Schoenus natans	-	P4	Winter-wet depressions (Western Australian Herbarium 1998-).	October	DBCA, NatureMap	**Unlikely** - Nearby records within Ellenbrook Nature Reserve, however no suitable habitat.
Stylidium longitubum	-	P4	Sandy clay, clay. Seasonal wetlands (Western Australian Herbarium 1998-).	October to December	DBCA, NatureMap	**Unlikely** - Nearby records within Ellenbrook Nature Reserve, however no suitable habitat.

*CR = Critically Endangered; EN = Endangered; VU = Vulnerable; T = Threatened; P = Priority species.

Appendix B. Flora Species List

Family	Species
Apocynaceae	**Gomphocarpus fruticosus*
Casuarinaceae	*^Casuarina obesa*
Fabaceae	**Acacia iteaphylla*
	Acacia pulchella
	Acacia saligna
	**Trifolium arvense*
	Viminaria juncea
Iridaceae	**Watsonia meriana*
Juncaceae	*Juncus pallidus*
Myrtaceae	*Corymbia calophylla*
	^Eucalyptus camaldulensis
	Eucalyptus rudis
	Melaleuca rhaphiophylla
	Melaleuca teretifolia
Poaceae	**Avena barbata*
	**Eragrostis curvula*
	**Hyparrhenia hirta*
Proteaceae	*Hakea sp.*
Typhaceae	*Typha orientalis*

*introduced species, ^Native planted species

Appendix C. Relevé Data

Site	**R01**	Type	Relevé
Date	29/11/2019		
MGA Zone: 50	408391 E 6485365 S		

Soil/Landform	Brown clay/drainage sump
Bare Open Ground	20
Vegetation	*Eucalyptus camaldulensis* planted trees with *Corymbia calophylla regrowth* (VT1)
Veg Condition	Degraded
Disturbance type	Historical clearing, weeds, constructed drainage sump
Fire Age	>5

Species	Cover (%)	Height (cm)
^*Eucalyptus camaldulensis*	60	800
Corymbia calophylla	5	400
Acacia saligna	+	200
Typha orientalis	2	80
**Hyparrhenia hirta*	40	60
**Avena barbata*	30	50

Site	**R02**	Type	Relevé
Date	29/12/2019		
MGA Zone: 50	408459 E 6485249 S		

Soil/Landform	Clay; Plain
Bare Open Ground	40
Vegetation	^*Eucalyptus camaldulensis* planted trees over weeds (Planted A)
Veg Condition	Completely Degraded
Disturbance type	Historical clearing, weeds
Fire Age	>5

Species	Cover (%)	Height (cm)
^*Eucalyptus camaldulensis*	60	600
**Hyparrhenia hirta*	20	60
**Eragrostis curvula*	10	60
**Avena barbata*	40	40

Site	**R03**	Type	Relevé
Date	29/12/2019		
MGA Zone: 50	408581 E 6485531 N		

Soil/Landform	Clay; drainage line
Bare Open Ground	20
Vegetation	^*Casuarina obesa* planted trees over weeds (Planted B)
Veg Condition	Completely Degraded
Disturbance type	Weeds, historical clearing
Fire Age	>5

Species	Cover (%)	Height (cm)
^*Casuarina obesa*	80	500
**Eragrostis curvula*	60	50

Site	**R04**	Type	Relevé
Date	29/12/2019		
MGA Zone: 50	408707 E 6485821 S		

Soil/Landform	Clay; drainage line
Bare Open Ground	20
Vegetation	^*Eucalyptus camaldulensis* planted trees and ^*Casuarina obesa* over *Melaleuca rhaphiophylla* open shrubland (VT2)
Veg Condition	Degraded
Disturbance type	Historical clearing, weeds
Fire Age	>5

Species	Cover (%)	Height (cm)
^*Eucalyptus camaldulensis*	20	500
^*Casuarina obesa*	5	300
Melaleuca rhaphiophylla	1	200
Acacia saligna	+	200
Acacia pulchella	+	40
**Avena barbata*	80	50
**Eragrostis curvula*	5	50

Site	**R05**	Type	Relevé
Date	29/12/2019	Aspect	NE
MGA Zone: 50	408909 E 6486271 S		

Soil/Landform	Clay; drainage line
Bare Open Ground	30
Vegetation	^*Eucalyptus camaldulensis, Eucalyptus rudis* isolated trees over *Melaleuca rhaphiophylla* open shrubland over *Typha orientalis* and **Eragrostis curvula* weedy grassland (VT3).
Veg Condition	Good
Disturbance type	Fire
Fire Age	>5

Species	Cover (%)	Height (cm)
^*Eucalyptus camaldulensis*	30	800
Eucalyptus rudis	5	500
Melaleuca teretifolia	2	300
Typha orientalis	10	110
**Avena barbata*	80	60
**Eragrostis curvula*	10	60

Appendix D. Significant Fauna Likelihood of Occurrence Assessment

Species	Status*		Habitat	Database Source	Likelihood
	EPBC Act	WA			
Mammals					
Black-flanked Rock-Wallaby (*Petrogale lateralis lateralis*)	EN	EN	Preference for rocky habitats, particularly those with caves, crevices and overhangs (DAWE 2020).	DBCA	**Unlikely** – Locally extinct apart from reintroduction programs. Records from the vicinity, however, no suitable habitat and fragmented landscape within the survey area.
Chuditch, Western Quoll (*Dasyurus geoffroii*)	VU	VU	Now primarily restricted to Jarrah Forest and Woodland, with smaller numbers in other Eucalypt Woodland Mallee (DAWE 2020).	NatureMap DBCA	**Unlikely** – Record from the vicinity, however no suitable habitat and fragmented landscape within the survey area.
Greater Bilby (*Macrotis lagotis*)	VU	VU	Remaining populations occupy three major vegetation types, namely: open tussock grassland in plains and alluvial areas (DAWE 2020).	NatureMap DBCA	**Unlikely** – Locally extinct, no suitable habitat and fragmented landscape within the survey area.
Quenda (Southern Brown Bandicoot) (*Isoodon obesulus fusciventer*)	-	P4	Variety of forest, woodland, shrubland and heath communities, but prefer areas of denser vegetation, including wetland fringes and heathland (DEC 2012a).	NatureMap DBCA	**Possible** – Previous record within the survey area, however this is likely to represent an individual transiting through the area rather than a resident population as preferred habitat for the species not present.
Tammar Wallaby (*Macropus eugenii*)	-	P4	Dense, low vegetation for daytime shelter and open grassy areas for feeding. This species inhabits coastal scrub, heath, dry sclerophyll forest and thickets in Mallee and Woodland (DEC 2012b).	DBCA	**Unlikely** – Locally extinct apart from reintroduction programs. No suitable habitat and fragmented landscape within the survey area.
Water Rat, Rakali (*Hydromys chrysogaster*)	-	P4	Variety of permanent freshwater bodies, ranging from subalpine streams to lakes, creeks and farm dams. Also on sheltered coastal beaches, mangroves and offshore islands (DEC 2012c).	DBCA	**Unlikely** – Nearest record approximately 5 km away, no suitable habitat and fragmented landscape within the survey area.
Western Brush Wallaby (*Macropus irma*)	-	P4	Optimum habitat includes open forest or woodland, particularly favouring open, seasonally wet flats with low grasses and open scrubby thickets. It is also found in some areas of Mallee and Heathland and is uncommon in Karri forest (DEC 2012d).	DBCA	**Unlikely** – Records from the vicinity, however, no suitable habitat and fragmented landscape within the survey area.
Birds					

Species	Status*		Habitat	Database Source	Likelihood
	EPBC Act	WA			
Australiasian Bittern (*Botaurus poiciloptilus*)	EN	EN	Freshwater wetlands with dense reed beds of *Baumea* spp. or *Typha* spp. for breeding and roosting and more open sedgelands and grassed areas for foraging (DotEE 2019c).	PMST	**Unlikely** – No suitable habitat within the survey area. May overfly the area on occasion, but would not use the habitat in the survey area.
Blue-billed Duck (*Oxyura australis*)	-	P4	The blue-billed duck is almost entirely aquatic and is seldom seen on land. Non-breeding flocks congregate on large, deep open freshwater dams and lake in autumn. During breeding season this species prefers deep, freshwater swamps, with dense vegetation (BirdLife Australia 2004).	NatureMap,	**Unlikely** – No suitable habitat within the survey area. May overfly the area on occasion, but would not use the habitat in the survey area.
Baudin's Black Cockatoo (*Calyptorhynchus baudinii*)	EN	T	Occurs in temperate forest and woodland dominated by Jarrah and Marri and *E. diversicolor* (Karri). This species nests in hollows of mature eucalypts, particularly Marri, Karri, *E. wandoo* (Wandoo), *E. gomphocephala* (Tuart) and *E. megacarpa* (Bullich). Mainly feeds on Marri (DSEWPaC 2012, DAWE 2020).	Not identified in the desktop searches. Survey Area within modelled distribution (DAWE 2020)	**Unlikely** – while the survey area is within the modelled distribution for this species, no records within 5 km of the survey area were identified from the desktop searches.
Carnaby's Cockatoo (*Calyptorhynchus latirostris*)	EN	T	Forages in proteaceous heath and shrubland, Eucalypt woodlands and introduced pine plantations. Nests in hollows in large Eucalypts (DSEWPaC 2012, DAWE 2020).	NatureMap DBCA	**Likely** – Records from the vicinity and potential habitat present.
Cattle Egret (*Ardea ibis*)	Mi	Mi	Found in grasslands, woodland and wetlands, not uncommon in arid areas. Breeding population at Wyndham, Western Australia. It uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora. They have sometimes been observed in swamps with tall emergent vegetation (BirdLife Australia 2020).	PMST	**Unlikely** – No suitable habitat within the survey area. May overfly the area on occasion, but would not use the habitat in the survey area.

Species	Status*		Habitat	Database Source	Likelihood
	EPBC Act	WA			
Common Greenshank *(Tringa nebularia*)	Mi	Mi	Found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. It occurs in sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass. Habitats include embankments, harbours, river estuaries, deltas and lagoons and are recorded less often in round tidal pools, rock-flats and rock platforms. The species uses both permanent and ephemeral terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and saltflats (DAWE 2020).	PMST	**Unlikely** – No suitable habitat within the survey area. May overfly the area on occasion, but would not use the habitat in the survey area.
Common Sandpiper (*Actictis hypoleucos*)	Mi	Mi	The species utilises a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around muddy margins or rocky shores and rarely on mudflats. The Common Sandpiper has been recorded in estuaries and deltas of streams, as well as on banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties. The species is often associated with mangroves, and sometimes found in areas of mud littered with rocks or snags (DAWE 2020).	PMST	**Unlikely** – No suitable habitat within the survey area. May overfly the area on occasion, but would not use the habitat in the survey area.
Curlew Sandpiper (*Calidris ferruginea*)	CR	Mi	Curlew Sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. Forage on mudflats and nearby shallow water (DAWE 2020).	PMST	**Unlikely** – No suitable habitat within the survey area. May overfly the area on occasion, but would not use the habitat in the survey area.
Eastern Curlew, Far Eastern Curlew (*Numenius madagascariensis*)	CR	Mi	Most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass (DAWE 2020).	PMST	**Unlikely** – No suitable habitat within the survey area. May overfly the area on occasion, but would not use the habitat in the survey area.

Species	Status*		Habitat	Database Source	Likelihood
	EPBC Act	WA			
Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*)	VU	VU	Eucalypt forests of Jarrah, Marri and Karri, with recent movement into Perth suburbs (DAWE 2020).	NatureMap DBCA	**Likely** – Records from the vicinity and foraging evidence was observed in the survey area.
Fork-tailed Swift (*Apus pacificus*)	Mi	Mi	Aerial over most habitats (DAWE 2020).	PMST	**Unlikely** - This species is highly mobile and known to occur occasionally in the region, but is a scarce visitor and would only overfly the survey area.
Glossy Ibis (*Plegadis falcinellus*)	Mi	Mi	Shallow margins of freshwater wetlands and adjacent flats, river pools, flooded samphire and sewage ponds (DAWE 2020).	NatureMap DBCA	**Unlikely** – No suitable habitat within the survey area. May overfly the area on occasion, but would not use the habitat in the survey area.
Grey Wagtail (*Motacilla cinerea*)	Mi	Mi	Inhabits fast flowing streams and rivers (BirdLife Australia 2017).	PMST	**Unlikely** – No confirmed sightings of this species on the Swan Coastal Plain (DotEE 2015).
Great Egret (*Ardea alba*)	Mi	Mi	Varied inland and coastal wetlands. It frequents river margins, lakes shores, marshes, flood-plains, oxbows, streams, damp meadows, rice-fields, drainage ditches, aquaculture ponds, reservoirs and sewage works, inland, and the shallows of salt-lakes saltpans, mudflats, coastal swamps, mangroves, saltmarshes, seagrass flats, offshore coral reefs, lagoons and estuaries when in coastal locations (BirdLife Australia 2016a).	PMST	**Unlikely** – May overfly the area on occasion, but unlikely to use the habitat in the survey area.
Hooded Plover (*Thinornis rubricollis*)	Mi	Mi	This species primarily inhabits sandy, open beaches. In Western Australia this species also inhabits inland and coastal salt lakes (BirdLife Australia 2016b).	PMST	**Unlikely** – No suitable habitat and no nearby records.
Osprey (*Pandion haliaetus*)	Mi	Mi	This species occurs in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. They are found in coastal areas but occasionally travel inland along major rivers (DAWE 2020).	PMST	**Unlikely** – No suitable habitat and no nearby records.

Species	Status*		Habitat	Database Source	Likelihood
	EPBC Act	WA			
Painted Snipe (*Rostratula benghalensis*)	EN	Mi	Inhabits shallow terrestrial frewshwater wetlands, including temporary and permanent lakes, swamps and claypans. Habitat requirements may be quite specific: shallow wetlands with areas of bare wet mud and both upper and canopy cover nearby (DAWE 2020).	PMST	**Unlikely** – No suitable habitat and no nearby records.
Pectoral Sandpiper (*Calidris melanotos*)	Mi	Mi	Prefers shallow fresh to saline wetlands. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. The species has also been recorded in swamp overgrown with lignum (DAWE 2020).	PMST	**Unlikely** – No suitable habitat and no nearby records.
Peregrine Falcon (*Falco peregrinus*)	-	OS	A wide range of habitats, including woodlands to open grasslands and coastal cliffs (DAWE 2020).	NatureMap	**Possible** – May overfly the area on occasion, but unlikely to be reliant on the habitats in the survey area.
Rainbow Bee-eater (*Merops ornatus*)	Mi	Mi	The Rainbow Bee-eater occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation. Aerial over most habitats (DAWE 2020).	PMST	**Unlikely** – May overfly the area on occasion, but survey area unlikely to contain important habitat for the species.
Sharp-tailed Sandpiper (*Calidris acuminata*)	Mi	Mi	Muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation (DAWE 2020).	PMST	**Unlikely** – No suitable habitat and no nearby records.
White-bellied Sea Eagle (*Haliaeetus leucogaster*)	Mi	Mi	Coastal habitats and around terrestrial wetlands in tropical and temperate regions of Australia. Habitat characterised by the presence of large areas of open water. Aerial over a variety of terrestrial habitats (DAWE 2020).	PMST	**Unlikely** – May overfly the area on occasion, but survey area unlikely to contain important habitat for the species.
Wood Sandpiper (*Tringa glareola*)	Mi	Mi	Well vegetated, shallow, freshwater wetlands, such as swamps, billabongs, lakes, pools and waterholes (DAWE 2020).	DBCA	**Unlikely** – No suitable habitat and no nearby records.
Reptiles					
Black-striped Snake, Black-striped Burrowing Stripe (*Neelaps calonotos*)	-	P3	Coastal dunes and Banksia/Eucalypt woodlands (Gaikhorst et al. 2018).	NatureMap DBCA	**Unlikely** – Records in the vicinity, however no suitable habitat.

Species	Status*		Habitat	Database Source	Likelihood
	EPBC Act	WA			
Jewelled Ctenotus (*Ctenotus gemmula*)	-	P3	White sand plains, mainly in semi arid and sub-humid zones (Storr et al. 1999).	DBCA	**Unlikely** – Records in the vicinity, however no suitable habitat.
Western Swamp Tortoise (*Pseudemydura umbrina*)	CR	CR	Inhabits shallow, ephemeral, winter-wet swamps on clay or sand over clay soils with nearby suitable aestivating refuges (DAWE 2020).	NatureMap DBCA PMST	**Possible** – The survey area is adjacent to the Ellenbrook Nature Reserve population.

*CR = Critically Endangered; EN = Endangered; VU = Vulnerable; CD = Conservation Dependent; Mi = Migratory; OS = Other specially protected species; P = Priority species.

Appendix E. Black Cockatoo Potential Breeding Trees in the Survey Area

Tree No.	Species	Size Class	No. of Hollows	Easting	Northing
1	River Red Gum	A	0	408457	6485381
2	River Red Gum	A	0	408463	6485349
3	River Red Gum	A	0	408454	6485223
4	River Red Gum	A	0	408457	6485228
5	River Red Gum	A	0	408438	6485187
6	River Red Gum	A	0	408422	6485154
7	River Red Gum	A	0	408421	6485162
8	River Red Gum	A	0	408416	6485139
9	River Red Gum	A	0	408390	6485086
10	River Red Gum	A	0	408378	6485069
11	River Red Gum	A	0	408363	6485041
12	River Red Gum	A	0	408522	6485370
13	Marri	A	0	408398	6485345
14	Marri	A	0	408396	6485332
15	River Red Gum	A	0	408410	6485299
16	River Red Gum	A	0	408412	6485283
17	River Red Gum	A	0	408403	6485262
18	River Red Gum	A	0	408409	6485235
19	River Red Gum	A	0	408403	6485221
20	River Red Gum	A	0	408394	6485221
21	Marri	A	0	408359	6485230
22	River Red Gum	B	0	408344	6485228
23	Marri	B	0	408310	6485233
24	River Red Gum	A	0	408298	6485237
25	River Red Gum	B	0	408218	6485225
26	River Red Gum	A	0	408207	6485226
27	River Red Gum	A	0	408433	6485315
28	River Red Gum	A	0	408402	6485304
29	River Red Gum	A	0	408402	6485293
30	River Red Gum	A	0	408402	6485290
31	River Red Gum	A	0	408405	6485275
32	River Red Gum	A	0	408381	6485251
33	River Red Gum	A	0	408376	6485230

Tree No.	Species	Size Class	No. of Hollows	Easting	Northing
34	River Red Gum	A	0	408371	6485226
35	River Red Gum	B	0	408368	6485219
36	River Red Gum	A	0	408357	6485219
37	River Red Gum	A	0	408349	6485219
38	River Red Gum	A	0	408321	6485226
39	River Red Gum	A	0	408318	6485220
40	Flooded Gum	B	0	408275	6485227
41	River Red Gum	A	0	408269	6485226
42	River Red Gum	A	0	408263	6485227
43	River Red Gum	A	0	408254	6485219
44	River Red Gum	A	0	408213	6485219
45	River Red Gum	A	0	408200	6485218
46	Marri	B	0	408252	6485210
47	River Red Gum	A	0	408302	6485353
48	River Red Gum	A	0	408314	6485359
49	River Red Gum	A	0	408262	6485295

Appendix B: Western Swamp Tortoise Management Plan

Biota Environmental Sciences

Great Northern Highway - Apple Street Upgrade Western Swamp Tortoise Management Plan

Prepared for Main Roads Western Australia

May 2020

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Western Swamp Tortoise Management Plan

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1.0 Introduction

1.1 Project Background

Main Roads Western Australia (Main Roads) is proposing to construct a roundabout at the Great Northern Highway and Apple Street Intersection, Upper Swan, Perth (the project) (Figure 1.1). The project will accommodate a predicted increase in traffic flows in the local area associated with development of the Upper Swan subdivision. The Critically Endangered Western Swamp Tortoise (*Pseudemydura umbrina*) occurs adjacent to the project in Ellen Brook Nature Reserve. This Western Swamp Tortoise Management Plan (WSTMP) is a species-specific management plan that has been prepared to manage any potential risks associated with the project to the Western Swamp Tortoise.

The works associated with the project include:

- development of a four-legged roundabout between Great Northern Highway, Apple Street and Coondaree Parade;
- construction of a new entrance to the Road Train Assembly Area (RTAA) on Great Northern Highway;
- duplication of the Great Northern Hwy carriageway on immediate approach to, and departure from, the roundabout;
- providing improved pedestrian and cycling infrastructure;
- construction of a new access road between the new Petrol Station on Great Northern Highway and the Apple Street RTAA; and
- installation of drainage upgrades to the north of the project along Great Northern Highway.

Currently, stormwater drainage within the Great Northern Highway road reserve includes an open sump at the Great Northern Highway and Apple Street intersection, an open drain located parallel with Great Northern Highway that allows drainage into a tributary of Ellen Brook, and a sump immediately north of the Ellen Brook Nature Reserve. The proposed works will improve the movement and quality of water in the open drain alongside Great Northern Highway.

1.2 Scope and Role of this Management Plan

The project, including associated drainage works, falls within the area covered by the *Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011* (EPP). The purpose of the EPP is *"to protect habitat suitable for the long-term survival of wild populations of the Western Swamp Tortoise".* In particular, Sections 9b and 9d(I and ii) of the EPP require:

> Section 9b: "*each landowner in the policy area, and each public authority, managing land in the policy area in a manner that minimises or avoids impacts from activities that might degrade the western swamp tortoise habitat."*; and
>
> Section 9d: *"each public authority, including the Authority but not a Minister of the Crown, ensuring that each of its decisions or actions that could impact on the beneficial uses –*
>
> *(i) is compatible with the protection of the beneficial uses; and*
>
> *(ii) minimises or avoids impacts from activities that might degrade the western swamp tortoise habitat."*

This WSTMP outlines project design, construction and operational management measures to minimise impacts on individuals and habitat of the Western Swamp Tortoise at Ellen Brook Nature Reserve and adjoining areas, as identified within the EPP area.

Monitoring procedures are also detailed to measure the effectiveness of management measures, and to provide feedback for improvements to the WSTMP. The management actions incorporated into this WSTMP relate to managing the potential impacts resulting from implementation of the project. Management actions relating to broader threatening processes

affecting Western Swamp Tortoise at Ellen Brook Nature Reserve, such as a drier climate and introduced predators, are not addressed within this plan. Similarly, this WSTMP is spatially limited to the management area outlined in Section 2.1, and does not consider populations of Western Swamp Tortoise and their habitat outside of this area, including the Twin Swamps Nature Reserve, located 3.6 km to the north of the project area (Figure 1.1).

Figure 1.1: Location map.

1.3 Relevant Legislation and Policy

The Western Swamp Tortoise is protected under both the State *Biodiversity Conservation Act 2016* (BC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Listing under the EPBC Act also means that the Western Swamp Tortoise is classed as a Matter of National Environmental Significance.

There are several additional policies, management plans and guidance documents relevant to Western Swamp Tortoises and their habitat, including:

- *Guidance for the Assessment of Environmental Factors: Protection of the Western Swamp Tortoise Habitat, Upper Swan/Bullsbrook* EPA Guidance Statement No. 7 (EPA 2006);
- *Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011;* and
- *Western Swamp Tortoise (Pseudemydura umbrina) Recovery Plan* (Burbidge et al. 2010) (the third revision of this plan was published by the Department of Biodiversity, Conservation and Attractions (DBCA; at the time, Department of Environment and Conservation) in 2010).

1.4 Definitions

The following definitions apply to terms used in this WSTMP:

Ground disturbance:	Any construction ground disturbing activity that results in the removal of native vegetation and/or the disturbance of topsoil.
Design:	Project design phase and related investigations; all project-related activities prior to substantial commencement of earthworks.
Construction:	Substantial commencement of project earthworks through to operations phase.
Project envelope:	The maximum works area for the upgrade of the intersection and roundabout construction.
Operations:	Operations will commence from the practical completion of the works and the opening of the new roundabout to traffic.

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2.0 Management Context

2.1 Management Area

The management area covered by this WSTMP is the extent of the Apple Street and Great Northern Highway intersection project area (Figure 2.1). The scope of this WSTMP also considers any potential indirect impacts on Western Swamp Tortoise habitat in the Ellen Brook Nature Reserve to the northwest of the management area.

2.2 Background on the Western Swamp Tortoise

The Western Swamp Tortoise (*Pseudemydura umbrina*) is one of Australia's most endangered reptiles, known only from four discrete locations in the Perth region and a total population of 100-200 individuals (Burbidge et al. 2010).

2.2.1 Distribution and Habitat

The former distribution of the Western Swamp Tortoise is not well understood. There are scattered records from eastern parts of the Swan Coastal Plain, from Guildford in the south to Bullsbrook in the north (Burbidge et al. 2010). However, unconfirmed sightings have been reported from as far north as Mogumber and as far south as Donnybrook (Burbidge 1967). The majority of land in this area is urbanised or otherwise cleared, and the Western Swamp Tortoise is now restricted to two naturally occurring populations on the north-eastern fringe of the Perth metropolitan area at Ellen Brook and Twin Swamps Nature Reserves. In addition, translocated populations now exist at Mogumber and Moore River Nature Reserves, approximately 100 km to the north of Perth (Burbidge et al. 2010).

The species inhabits ephemeral, winter- and spring-inundated swamps on clay, or sand over clay soils, with suitable aestivation areas nearby (Burbidge et al. 2010).

2.2.2 Ecology

Western Swamp Tortoises can be found in the water when swamps are inundated, usually from June or July to November. The species is carnivorous, feeding on small animals such as insect larvae, tadpoles, and small crustaceans. They begin to feed when water temperatures are above 14^{0}C, and their food intake increases as water temperatures increase and prey becomes more abundant (Burbidge et al. 2010). During this period, fat reserves are built up for aestivation and egg development occurs in females (Burbidge et al. 2010). Eggs are laid prior to aestivation in November and December, in an underground nest (Burbidge 1981). The eggs hatch the following winter, with hatching triggered by early winter rains causing a drop in incubation temperature (Burbidge et al. 2010). However, incubation temperature does not appear to affect hatching sex ratios (Kuchling unpublished, cited in Burbidge et al. 2010).

As swamps dry out and water temperatures rise above 28^{0}C (usually in November), the tortoises leave the water to aestivate over summer and autumn. Tortoises aestivate under leaf litter and fallen branches, or in holes in the ground. Such holes include naturally-occurring cracks or holes in the substrate, old holes dug by other species, or holes left by rotting tree trunks (Burbidge 1967, 1981, Burbidge et al. 2010). Active management efforts within reserves has included the creation of artificial aestivation holes at some sites to encourage aestivation underground to improve survival during bushfires (Burbidge et al. 2010).

Western Swamp Tortoises are not territorial, though homing behaviour does indicate that individuals have home ranges (Burbidge et al. 2010). Individuals have been recorded making movements of 450-600 m in 1-2 days, and individuals from Twin Swamps have been recorded over 1 km outside the nature reserve boundary, suggesting that in the past, individuals moved between suitable swamps (Burbidge et al. 2010).

The species is relatively slow-growing, with growth and maturation of juveniles varying depending on environmental conditions. Age to maturity consequently varies also, and has been recorded ranging from 6.5 to 18 years (Kuchling unpublished, Burbidge 1981).

Figure 2.1: Management area for this WSTMP.

2.2.3 Threats

The historical decline of the Western Swamp Tortoise is likely to be largely attributable to habitat loss, as the majority of its former range is now urbanised or otherwise cleared land. Contemporary threatening processes outlined within the recovery plan for the species (Burbidge et al. 2010) include:

- habitat loss or degradation through land clearing or clay mining;
- predation by introduced species such as the Fox (*Vulpes vulpes*);
- wildfires and inappropriate fire regimes, as tortoises aestivating under leaf litter, shrubs and logs are susceptible to being killed by fire;
- climate change, as the quality of the remaining habitat will decline if the climate becomes drier; and
- urbanisation of the land surrounding the Ellen Brook and Twin Swamps Nature.

2.2.4 Conservation Status

The species is listed as Critically Endangered under both the state *Biodiversity Conservation Act 2016* and the EPBC Act. It is also listed as Critically Endangered on the IUCN Red List of Threatened Species under criteria A1c, B1+2c, C1+2b and D.

2.3 Potential Impacts

2.3.1 Policy Framework

Section 11 of the *Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011* outlines activities that may result in degradation of Western Swamp Tortoise habitat. These include, but are not limited to:

1. application of fertilisers and pesticides;
2. disposal of liquid and solid wastes;
3. discharge of polluting substances;
4. extraction of basic raw materials;
5. construction of drainage systems;
6. placement of fill;
7. abstraction of groundwater;
8. clearing of vegetation; and
9. lighting of unauthorised fires.

The majority of these activities are not relevant to the project, with the most relevant being the construction of drainage systems, the clearing of vegetation during construction, and the potential for discharge of polluting substances during operations (Section 2.3.2).

2.3.2 Relevant Potential Impacts

Several potential impacts associated with the project may affect Western Swamp Tortoise individuals or their habitat. These include possible direct impacts within the project area comprising:

- direct loss of aestivating individuals during ground disturbance;
- inadvertent trapping of individuals in trenches and sumps during construction; and
- direct loss of wandering individuals to construction traffic or plant and equipment strike.

Indirect impacts may also potentially arise from the project, affecting Western Swamp Tortoise habitat within Ellen Brook Nature Reserve outside of the project area, comprising:

- a risk of bushfire being ignited as a result of the construction activities and spreading outside of the project area;

- habitat degradation as a result of nutrient and/or pollutant run-off into Ellen Brook Nature Reserve; and
- habitat alteration as a result of changes to drainage regimes into Ellen Brook Nature Reserve.

The majority of the potential direct and indirect impacts for this project relate to habitat degradation due to changes in run-off quality or surface hydrology regimes remaining as operational risks after the project construction is complete. These potential impacts will be mitigated primarily through project design measures (Section 3.0).

3.0 Project Design Measures

3.1 Project Area

All project design will be restricted to within the project area for the project, and no works of any kind will be located within, or directly adjoining, Ellen Brook Nature Reserve.

Ground disturbance limits will be delineated on all design drawings and will be restricted to the works area shown in red on Figure 2.1.

3.2 Drainage Design

Main Roads has undertaken extensive consultation with DBCA regarding the drainage design for the project, including on-site assessments, and has incorporated the feedback received into the final drainage design.

The existing sump at the Great Northern Highway and Apple Street intersection is designed to capture and direct water into the road side table drain alongside Great Northern Highway that ultimately discharges into a tributary of Ellen Brook and a sump immediately north of the fenced portion of Ellen Brook Nature Reserve.

Main Roads proposes to design the drainage treatments for the project such that they:

- maintain existing surface flow directions and hydrological regime;
- capture and detain road runoff for infiltration and evaporation within sumps; and
- do not result in changes to the existing surface hydrology of the areas adjoining Ellen Brook Nature Reserve.

The design for the project increases the overall capacity of the Apple Street sump (see Figure 2.1).

The proposed design will ensure:

- there is appropriate capacity in the sump to handle increased road run-off during peak events for the new extent of designed sealed road surface (i.e. designed to compensate a 1:10 average recurrence interval (ARI) rainfall event); and
- there are no changes to the existing surface hydrology direction and flow patterns of the areas adjoining Ellen Brook Nature Reserve.

3.3 Design Management Actions and Responsibilities

Table 3.1 below provides a summary of management measures to be implemented during the project design phase, including identification of management responsibilities.

Table 3.1: Summary of design phase management actions, responsibilities and frequency.

Potential Impact	Mitigation	Responsibility	Frequency
• Direct loss of aestivating individuals during ground disturbance.	3.1 Project area restricted to Main Roads tenure outside of Ellen Brook Nature Reserve	Main Roads Design Engineer	Once
• Presence of standing water immediately outside of Ellen Brook Nature Reserve attracting individuals outside of management area	3.2 Design drainage channel to prevent ponding and promote movement of water into sumps	Main Roads Design Engineer	Ongoing
• Habitat degradation as a result of nutrient and/or pollutant run-off into Ellen Brook Nature Reserve. • Habitat alteration as a result of changes to drainage regimes into Ellen Brook Nature Reserve.	3.3 All sumps to be sited south of Apple Street on design drawings.	Main Roads Design Engineer	Once
	3.4 Drainage design to ensure no change to drainage regime into Ellen Brook Nature Reserve, and the designed to compensate a 1:10 average recurrence interval (ARI) rainfall event, to the satisfaction of DBCA.	Main Roads Design Engineer	Once

4.0 Construction Management Measures

4.1 Timing of Ground Disturbance

Western Swamp Tortoises are generally found in the Ellen Brook Nature Reserve ephemeral wetland habitat when it is well inundated, which is usually between June and November (Section 2.2.2). When these wetland areas dry out, individuals leave water to find places to aestivate.

To minimise the risk of tortoises moving into the project area to aestivate and potentially being injured by construction activities, ground disturbance for the project will be undertaken between June and September.

4.2 Pre-Construction Search and Relocation

The timing of ground disturbance is expected to significantly reduce the mortality risk to tortoises in the project area during construction (Section 4.1). However, to further reduce the risk of injuring or killing individuals, the project area will be searched within two weeks prior to clearing commencing to confirm that no tortoises are present.

Any tortoises that are located during these searches will be relocated in consultation with DBCA.

4.3 Sump and Trenching Management

The presence of water in excavated areas has the potential to attract tortoises searching for inundated habitat, which may then become trapped. An experienced ecologist will search the existing sump and drains within the project area for tortoises prior to the commencement of construction, and relocate any individuals present in consultation with DBCA.

Tortoises (and other animals) may also become trapped in new excavations created during construction. To mitigate this risk, any trenches or excavated areas will only be left open for the minimum time required, and trenches will not be left open overnight unless essential. If this is required, trenches will be searched each morning by suitably trained environmental personnel to ensure no tortoises are present prior to works recommencing. If any tortoises are detected, they will be relocated in consultation with DBCA. This will also trigger a management action for fencing to be erected around the excavated area in question to exclude tortoises. Any fencing required under these circumstances will be sufficient to exclude small juvenile tortoises from the area and will be designed in consultation with DBCA.

Prior to infilling, all trenches and excavated areas will also be checked for tortoises and any other native fauna by suitably trained environmental personnel. Any tortoises (or other native fauna) found will again be relocated to suitable habitat within the Ellen Brook Nature Reserve in consultation with DBCA.

4.4 Habitat Protection and Drainage Management

The following management measures will be employed during construction to minimise the risks of indirect habitat degradation outside of the project area:

1. Ground disturbance limits shown on final design drawings will be surveyed onsite and delineated with bunting, temporary fencing or signage to ensure no earthworks inadvertently exceed the spatial limits of the final design.
2. All drainage treatments and sumps will be constructed in accordance with the project final design, following the design criteria set out in Section 3.2 of this WSTMP.

3. Storage of hydrocarbons onsite during construction will be minimised to the extent that is practicable. All hydrocarbons that are stored onsite will be appropriately bunded, and spill trays will be used for all refuelling activities.
4. All plant and equipment will be inspected weekly during the course of construction for any potential leaks of fuel or lubricants, to minimise the risk of inadvertent discharge of pollutants.
5. All solid and liquid waste will be disposed of off-site following appropriate procedures and regulations, including the *Environmental Protection (Unauthorised Discharges) Regulations 2004* and Main Roads' own waste management procedures.
6. Bushfire risk reduction measures will apply throughout construction, comprising:
   a. parking vehicles and machinery on cleared areas away from vegetation;
   b. provision of appropriate disposal units on-site for cigarettes and ensuring all personnel on-site are aware of the dangers of incorrectly disposing of cigarettes;
   c. adherence to total fire bans and other advisories issued by the Department of Fire and Emergency Services (DFES); and
   d. onsite fire response procedures to be put in place in consultation with DBCA and DFES to respond in the event of an onsite fire.

4.5 Construction Workforce Management

Project construction personnel will be made aware of the potential presence of Western Swamp Tortoise within the project area and of the potential to impact Western Swamp Tortoise habitat in the nearby reserve. All personnel will be required to undertake a site induction, which will include a section on the Western Swamp Tortoise and the presence of Western Swamp Tortoise habitat in the area.

The induction will also set out Main Roads' requirements for all onsite personnel with regard to the Western Swamp Tortoise, including:

1. No personnel or vehicles are to access Ellen Brook Nature Reserve;
2. All chemicals and potential pollutants are to be disposed of according to correct procedures and regulations, and not to be discharged into Ellen Brook Nature Reserve or surrounds under any circumstances (Section 4.4);
3. Any inadvertent spills of potential contaminants are to be immediately reported to the construction site supervisor, and a containment and clean up contingency response implemented;
4. All sightings of Western Swamp Tortoises are to be reported to the site supervisor who will contact the DBCA Swan Coastal Plain office (9303 7700);
5. Bushfire risk management measures required of all personnel during construction (as set out in Section 4.4); and
6. Contacts for the Wildcare Helpline (9474 9055) should any injured tortoises, or other native wildlife, be found.

4.6 Construction Management Actions and Responsibilities

Table 4.1 below provides a summary of management measures to be implemented during the project construction phase, including identification of management responsibilities.

Table 4.1: Summary of construction phase management actions, responsibilities and frequency.

Potential Impact	Mitigation		Responsibility	Frequency
• Direct loss of aestivating individuals during ground disturbance. • Inadvertent trapping of individuals in trenches and sumps during construction. • Direct loss of wandering individuals to construction traffic or plant and equipment strike.	4.1	Ground disturbance to be undertaken during late winter to early spring period (June-September), when tortoises are mostly restricted to the flooded wetland areas, and therefore unlikely to be present within the development area.	Main Roads, Construction contractor	Throughout construction
	4.2	Searches to be undertaken for Western Swamp Tortoise in the project area within the two weeks prior to clearing activities being completed.	Main Roads, DBCA	Once
	4.3	Any tortoises found during pre-clearing searches to be relocated in consultation with DBCA.	DBCA, Main Roads	If required
	4.4	No ground disturbance to be undertaken outside of the project area specified during design phase	Main Roads, Construction contractor	Throughout construction
	4.5	Trenches and other excavations not to be left open overnight unless essential.	Main Roads, Construction contractor	Throughout construction
	4.6	If it is essential that trenches and other excavations are left open overnight, then inspection for any tortoises are to be conducted the following morning prior to work commencing in that location.	Construction contractor, Environmental personnel	Daily, when required
	4.7	Any tortoises found during daily inspections to be relocated in consultation with DBCA.	Construction contractor, Environmental personnel, DBCA	If required
	4.8	No personnel or vehicles to access Ellen Brook Nature Reserve.	All onsite personnel	Throughout construction
	4.9	Prepare and deliver induction to all onsite personnel on the relevance of Western Swamp Tortoise to the project, setting set out management requirements for all personnel.	Main Roads, Construction contractor, Environmental personnel	Prior to construction
	4.10	Any injured tortoises (or other wildlife) to be reported to Wildcare Helpline – (08) 9474 9055, and to DBCA Swan Coastal District (Owen Donovan – e-mail owen.donovan@dbca.wa.gov.au or phone 9688 6000).	Site supervisor, Environmental personnel	If required
	4.11	Any sightings of Western Swamp Tortoise to be reported to DBCA Swan Coastal District office - 9303 7700.	Site supervisor, Environmental personnel	If required
• Habitat degradation as a result of nutrient and/or pollutant run-off into Ellen Brook Nature Reserve.	4.12	Construct drainage treatments and sumps as specified in final design.	Construction contractor	Once
	4.13	Containment and clean-up contingency procedures to be implemented to manage any inadvertent spills of pollutants.	Main Roads, Construction contractor	If required
• Risk of bushfire being ignited as a result of construction activities and spreading outside of the project area	4.14	Fire risk reduction and response measures to be implemented, as outlined in Section 4.4.	Contractor	Prior to construction and throughout construction
	4.15	Requirements of environmental induction to be followed by all onsite personnel.	Contractor, all onsite personnel	Throughout construction

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5.0 Monitoring and Operational Management

5.1 Ongoing Maintenance and Drainage Management

The project is expected to improve drainage conditions immediately adjacent to Ellen Brook Nature Reserve.

Inspection and maintenance of the road and associated infrastructure, including drainage infrastructure, will be required on an ongoing basis. This will include assessments of the efficacy of drainage treatments and any obstructions or changes to capacity (e.g. from sediment build up). All onsite management actions applicable to construction work as detailed in Section 4.0 will also be applicable to any ongoing maintenance works required as part of the ongoing operation of the project.

5.2 Operations Management Actions and Responsibilities

Table 5.1 below provides a summary of management measures and monitoring to be implemented during the project operations phase, detailing responsibility and timing.

Table 5.1: Summary of operations phase management actions, responsibilities and frequency.

Potential Impact	Mitigation	Responsibility	Frequency
• Habitat degradation as a result of nutrient and/or pollutant run-off into Ellen Brook Nature Reserve. • Habitat alteration as a result of changes to drainage regimes into Ellen Brook Nature Reserve.	5.1 Periodic on-site inspections of drainage infrastructure to ensure that it is operating effectively and not altering the drainage regime into Ellen Brook Nature Reserve.	Main Roads	Annual (and within one week of a 1 in 10 year ARI event)
	5.2 All management actions applicable to construction (Section 4.0) to be implemented during any maintenance works.	Main Roads, Maintenance contractor	As required
	5.3 Drainage channel to be cleared out to promote movement of water into sumps	Main Roads	As required
	5.4 Gross pollutant traps to be installed to improve water quality of any run-off into Ellen Brook Nature Reserve	Main Roads	Once
	5.5 Maintenance and/or modification of drainage infrastructure to be undertaken in consultation with DBCA to restore drainage regime should monitoring indicate that the development has resulted in alterations to drainage regime.	Main Roads, DBCA	If required

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6.0 Reporting and Review Process

6.1 Pre-construction Search Reporting

Main Roads and DBCA will jointly undertake a pre-construction site inspection to search for any Western Swamp Tortoises within the project area (Section 4.2). The outcomes of this exercise will be documented in a memorandum for the reference of both agencies.

6.2 Reporting

This proposal is expected to take 4-6 months to complete.

Main Roads will be reporting against the content of this WSTMP, outlining the implementation and effectiveness of management actions and any incidents/non-conformance reported, along with corrective actions taken. The report will be provided to DBCA.

6.3 Incident Reporting

Environmental incidents affecting, or potentially affecting, Western Swamp Tortoises or their habitat will be reported both internally according to Main Roads' internal environmental incident reporting procedures, and externally to DBCA.

6.4 Revision of this WSTMP

Given the scale (intersection upgrade and drainage improvements), length (4-6 months) and nature (drainage upgrades that are expected to improve stormwater quality) of the project, no formal review of the WSTMP is planned.

The WSTMP will be amended as appropriate following an incident investigation or to maintain consistency with DBCA issued permits and licences.

6.5 Stakeholder Consultation

Main Roads has undertaken extensive consultation with DBCA regarding this development. In particular, advice has been sought regarding optimal seasonal timing for clearing and construction works, minimising the likelihood of tortoises being present within the project area during clearing and construction, and the design of the drainage infrastructure associated with the development to minimise the risk of drainage into Ellen Brook Nature Reserve being altered (see also Section 3.2). Main Roads will continue to consult with DBCA during the construction of this project.

6.6 Summary of Reporting Actions and Responsibilities

Table 6.1 below provides a summary of reporting, review and consultation processes relevant to this WSTMP.

Table 6.1: Summary of reporting and review management actions, responsibilities and frequency.

Management Action	Responsibility	Frequency
6.1 Memorandum report on pre-construction search of project area for any potential Western Swamp Tortoise present.	Ecologist	Once, prior to construction
6.2 Prepare and submit report to DBCA on implementation and effectiveness of management actions, along with any incidents or non-compliance and corrective actions	Main Roads	Following construction
6.3 Consult with relevant stakeholders in regard to Western Swamp Tortoise monitoring and management	Main Roads, DBCA	As required
6.4 Environmental incidents affecting or with the potential to affect Western Swamp Tortoises or their habitat to be reported to DBCA.	Main Roads	As required

7.0 References

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