Great Northern Highway
Muchea to Wubin Upgrade - Stage 2

MAIN ROADS WESTERN AUSTRALIA

EPBC 2017/8035 Bindoon Bypass
EPBC Act | Construction Environmental Management Plan

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Current Issue

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Prepared by	Reviewed by	Reviewed by	Approved by
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Issue summary

Revision	Date	Issue description	Distribution
1	22-10-2020	Draft	Cross Discipline Review / Technical Review / PAG Review
2	30-10-2020	Draft	Issued to DAWE for comment
3	09-12-2020	Draft	PAG Review
4	11-12-2020	Final	Issued to DAWE

Declaration of Accuracy

I declare that:

1. To the best of my knowledge, all the information contained in, or accompanying this Construction Environmental Management Plan for EPBC 2017/8035 is complete, current and correct.
2. I am duly authorised to sign this declaration on behalf of the approval holder.
3. I am aware that:
    a. Section 490 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) makes it an offence for an approval holder to provide information in response to an approval condition where the person is reckless as to whether the information is false or misleading.
    b. Section 491 of the EPBC Act makes it an offence for a person to provide information or documents to specified persons who are known by the person to be performing a duty or carrying out a function under the EPBC Act or the Environment Protection and Biodiversity Conservation Regulations 2000 (Cth) where the person knows the information or document is false or misleading.
    c. The above offences are punishable on conviction by imprisonment, a fine or both.

Signed

_____

Full Name (please print)

_____

Organisation (please print)

_____

Date ____/____/____

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Glossary

Abbreviation	Description
°C	Degrees Celsius
APV	Avian Polyomavirus
BCE	Bamford Consulting Ecologists
BFDV	Beak and Feather Disease Virus
Black Cockatoos	The two species of Black Cockatoos recorded from the Development Envelope being Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) and The Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*)
BoM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
CoE	Clean on Entry
DAWE	Department of Agriculture, Water and the Environment
Declared Plant	A potentially harmful plant regulated under the *Biosecurity and Agriculture Management Act 2007* (WA).
Development Envelope	the maximum area within which the proposal footprint will be located
DoEE	Department of the Environment and Energy
DoW	Department of Water
DPaW	Department of Parks and Wildlife
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
footprint	the location where the physical proposal elements occur
GNH	Great Northern Highway
ha	hectare
km	kilometre
m	metre
Main Roads	Main Roads Western Australia
MNES	Matters of National Environmental Significance
mm	Millimetre
TEC	Threatened Ecological Communities
WA	Western Australia
BC Act	Biodiversity Conservation (Act)
WoNS	Weeds of National Significance

1. Introduction

On 1 September 2017, Main Roads Western Australia (Main Roads) referred the Bindoon Bypass proposal to the Department of Agriculture, Water and the Environment (DAWE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (EPBC Reference 2017/8035). The referral was determined to be a Controlled Action with the controlling provision being "listed threatened species and communities". In particular, it was considered that there was potential for significant impacts to:

- Black Cockatoos, in particular Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*);
- Chuditch (*Dasyurus geoffroii*);
- Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community (TEC; hereafter referred to as the 'Banksia Woodlands TEC'); and
- eight flora species listed as Threatened under the EPBC Act:
    - Bindoon Starbush (*Asterolasia nivea*)
    - Fine-leaved Darwinia (*Darwinia acerosa*)
    - Muchea Bell (*Darwinia foetida*)
    - Glossy-leafed Hammer Orchid (*Drakaea elastica*)
    - Gingin Wax (*Chamelaucium* sp. Gingin—NG Marchant 6)
    - *Grevillea corrugata*
    - Spiral Bush (*Spirogardnera rubescens*)
    - Star Sun-orchid (*Thelymitra stellata*)

Field surveys undertaken for the Bindoon Bypass recorded the presence of Carnaby's Black Cockatoo, the Forest Red-tailed Black Cockatoo and the Banksia Woodlands TEC within the Development Envelope (FVC 2019; BCE 2018). While no direct observations of the Chuditch were made, there is anecdotal evidence of the species being present and suitable habitat was identified. None of the flora species listed above were recorded during the field surveys, despite extensive and targeted searches (FVC 2019).

1.1 Purpose and Scope of this Construction Environmental Management Plan

This Construction Environmental Management Plan (CEMP) has been prepared to support DAWE's assessment of EPBC 2017/8035 under the EPBC Act. This CEMP has been developed in accordance with DAWE's Environmental Management Plan Guidelines (Department of the Environment and Energy [DoEE – now DAWE] 2014).

The purpose of this CEMP is to outline the actions required to avoid, mitigate and manage impacts from construction activities to the relevant listed threatened species and communities, in line with the management measures described in the *Bindoon Bypass Environmental Review Document and Preliminary Documentation* (Version 7) dated 17/05/2020.

The scope of this CEMP is limited to project construction and revegetation activities with the potential to directly or indirectly impact on Banksia Woodlands, Carnaby's Black Cockatoo, the Forest Red-tailed Black Cockatoo and the Chuditch. As no flora species listed as Threatened under the EPBC Act were identified within or adjacent to Development Envelope no specific measures for these species are included.

1.2 Objectives

The objectives of this CEMP are to:

- avoid clearing beyond approved limits of the Banksia Woodlands TEC, potential Gingin Wax habitat, Black Cockatoo habitat or Chuditch habitat;
- avoid clearing of more than 10 trees with hollows previously used by Black Cockatoos, as identified in BCE (2017, 2018, 2019);
- achieve performance targets and completion criteria for rehabilitation of Black Cockatoo habitat and Banksia Woodlands TEC; and
- maintain ecological connectivity across the Development Envelope.

Performance targets and completion criteria supporting these objectives are detailed in **Section 3**.

1.3 Project Description

Main Roads proposes to construct a bypass around Bindoon town and Bindoon Hill (hereafter referred to as the Bindoon Bypass, or the Proposal), located within the Shire of Chittering approximately 70 km north east of Perth and approximately 13 km north of Muchea, Western Australia (**Figure 1**). The Bindoon Bypass will divert from the existing GNH at the Chittering Roadhouse, running to the west of Bindoon and re-joining the GNH north of Calingiri Road. This will involve the construction of 47 km of new highway. The Bindoon Bypass will be constructed in stages based on the expected traffic volumes. The initial stage (Interim Stage) will consist of single carriageway (two lanes) with a number of overtaking lanes for both north-bound and south-bound traffic as well as stopping facilities. The second stage (Ultimate Stage) will build on the work done in the Interim Stage to accommodate higher numbers of road users, comprising an upgrade to dual carriageway (four lanes) between Chittering Roadhouse and Bindoon-Moora Road. Upgrades to local roads, rail crossings and intersections may also be required, as well as relocation of services, fencing of the road reserve and construction of driveway accesses for landowners.

The proposed works include:

- approximately 36 km of new dual carriageway and approximately 11 km of new single carriageway road;
- grade separated interchanges with existing roads;
- at-grade intersections with existing roads;
- a crossing at the Brockman River consisting of a bridge and culverts;
- travellers' rest areas;
- landscaping and revegetation works;
- new service roads; and
- modifications to local roads.

Activities that generally form part of the construction phase include:

- vegetation removal and topsoil stripping;
- fencing;
- earthworks, including excavation of road cuttings, material extraction from borrow pits, placement and compaction of fill and embankment foundations;
- piling and construction of foundations;
- bridge construction;
- stormwater drainage installation;

- pavement construction;
- road surfacing;
- culvert supply and installation;
- installation of associated road furniture;
- relocation of services;
- modifications to local roads;
- construction of drainage basins;
- use of water for construction purposes; and
- landscaping and revegetation.

1.4 Project Schedule

The planned project schedule for the proposed works is currently as detailed in **Table 1-1**. These dates are subject to change depending on a number of factors and will be updated accordingly.

Table 1-1: Planned Project Schedule

Activity	Current Schedule
Commencement of Construction	Quarter 3 2021
Construction Completed	2023
Commencement of Operations	2023

1.5 Environmental Setting

1.5.1 Climate

The Bindoon area has a warm, temperate climate with hot summers and cool, wet winters. The closest Bureau of Meteorology (BoM) rainfall recording station is Gingin Aero (site number 9178). That station records the average maximum temperature range as 18.3 degrees Celsius (°C) in July to 33.2 °C in January and February, and the average minimum temperature range as 6.3 °C in July to 17 °C in February (BoM 2018). The average annual rainfall recorded at Gingin Aero is 632.5 mm, with the majority falling over the winter months. July also records the highest average monthly rainfall of 125.8 mm. The highest recorded month of rainfall was 236.4 mm in June 2005 (BoM 2018).

1.5.2 Flora and Vegetation

No flora species listed as threatened under the EPBC Act have been recorded within the Development Envelope during the field surveys despite extensive searching during targeted surveys undertaken for all Threatened species that may occur within the Development Envelope. Eleven species listed on the WA Department of Biodiversity, Conservation and Attraction's (DBCA) Priority Flora list were recorded in the Development Envelope (FVC 2019).

Vegetation within the study area has broadly been characterised as Banksia low woodland, Jarrah-Marri woodland, Marri woodland, Bullich and Blackbutt (FVC 2018). The flora and vegetation surveys identified and mapped 12 vegetation associations (FVC 2019):

- *Banksia* spp. sparse woodland (Vegetation Association BaXpAn);
- *Banksia attenuata* sparse woodland (Vegetation Association BaXpUa);
- *Kunzea glabrescens* shrubland (Vegetation Association BmKgHg);

- *Eucalyptus marginata* and *Banksia sessilis* sparse woodland (Vegetation Association EmBsHh);
- *Eucalyptus marginata* sparse woodland (Vegetation Association EmXpAn);
- *Eucalyptus marginata* and *Corymbia calophylla* low sparse woodland (Vegetation Association EmXpHh);
- *Eucalyptus rudis* and *Melaleuca preissiana* sparse woodland (Vegetation Association ErXpBm);
- *Eucalyptus todtiana*, *Banksia attenuata* and *Banksia menziesii* low sparse woodland (Vegetation Association EtBeAn);
- *Eucalyptus todtiana* and *Banksia* spp. low sparse woodland (Vegetation Association EtEpAn);
- *Eucalyptus wandoo* and *Casuarina obesa* sparse woodland (Vegetation Association EwBeNa);
- *Eucalyptus wandoo* sparse woodland (Vegetation Association EwXpHh); and
- *Melaleuca viminea* shrubland (Vegetation Association MvJspLs).

Vegetation condition ranges from Completely Degraded to Excellent, with the majority of the study area being Completely Degraded to Degraded due to the large amount of cleared land and pasture. Whilst cleared land and pasture do support occasional trees or stands of trees, the absence of understorey reduces the quality of the vegetation and the value that the vegetation presents as habitat for native fauna.

The Banksia Woodlands of the Swan Coastal Plan TEC (Banksia Woodlands TEC) occurs across the Development Envelope (**Figure 2**). Five vegetation associations are considered to represent this TEC: BaXpAn, BaXpUa, EmXpAn, EtBeAn and EtEpAn (FVC 2019). Within the Development Envelope, 307.5 ha of Banksia Woodlands TEC has been mapped with the condition ranging from Degraded to Excellent (FVC, 2019).

1.5.3 Weeds and Disease

Weeds

A total of 30 introduced (weed) species were recorded during the flora and vegetation surveys (FVC 2019). The number of weeds identified is not unexpected, given that the Development Envelope and surrounding area includes large areas of paddock that are used for grazing of stock (and therefore seeded with pasture grasses and other species such as clover), cropping and horticulture

Of the weed species identified, one species is a Declared Plant under the *Biosecurity and Agriculture Management Act 2007*: *Chondrilla juncea* (Skeleton Weed). Skeleton Weed is a category C2 plant (eradication required) in the Shires of Chittering and Gingin, and other areas of the State, and is the subject of a Department of Agriculture eradication program. No Weeds of National Significance (WoNS) were recorded within the Development Envelope or the study area.

Phytophthora Dieback

Phytophthora Dieback is caused by a soil borne pathogen that occurs in areas receiving more than 400 mm annual rainfall. A dieback (*Phytophthora cinnamomi*) assessment was undertaken between March and April 2018 (Terratree, 2018). The majority of the native vegetation present within and surrounding the Development Envelope was mapped as uninfested though there are a number of areas identified as Dieback infested between Mooliabeenee Road and Cook Road (**Figure 3**). Dieback was predominately found to be present on lower slopes and in areas that showed evidence of ground disturbance activities.

1.5.4 Fauna

Fauna Habitats

Ten fauna habitats occur within the Development Envelope as follows:

- Banksia woodland;
- Banksia woodland with scattered Marri and/or Jarrah;
- Marri-Jarrah woodland;
- Marri-Jarrah woodland with little to no remnant understorey;
- Wandoo woodland (with or without understorey);
- Heath;
- Waterways or wetlands/damplands;
- Paddocks with large remnant trees;
- Paddocks; and
- Plantations.

Fauna habitat within and adjacent to the Development Envelope has been significantly fragmented due to clearing for agriculture (BCE 2017). Review of aerial photography indicates fragmentation is greatest near the southern interchange and along the northern third of the Development Envelope, where the alignment turns to the east to re-join the existing GNH. Habitat fragmentation in the surrounding area appears to be more significant to the east of the Development Envelope. Large areas of remnant native vegetation occur immediately west of the Development Envelope, particularly in the vicinity of Cook Road.

Areas of native vegetation, and therefore fauna habitat, extend across the Development Envelope at Cook Road, Barn Road, Gray Road and south of Teatree Road. These areas align with the ecological linkages identified by the Shire of Chittering (2010).

Conservation Significant Mammals

Two sightings of the Brush Wallaby were recorded by BCE (2018), though the species was not detected by the motion camera traps. These opportunistic sightings were in Banksia woodland habitat north of Mooliabeenee Road, and Marri-Jarrah woodland habitat north of Teatree Road. BCE (2018) concluded that the species is likely present at low levels of abundance in all large areas of native vegetation in the region.

No other conservation significant species were directly recorded during the 2016 and 2017 surveys; however, there were indirect records of the Water-rat (scats or possible foraging signs) along the Hay Flat Road drainage line. Residents around Chittering-Needonga Lakes have considered the species locally extinct for the last 20 years, though there are recent records along Gingin Brook near the town of Gingin (BCE 2017).

Motion-sensitive camera surveys did not record any evidence of the Chuditch, Quenda or Brush-tailed Phascogale. This does not necessarily indicate that the species are not present: they may occur in very low levels of abundance (BCE 2018). There is anecdotal evidence of Chuditch in the Bindoon area and historic records for the Brush-tailed Phascogale (BCE 2018). Quenda are known to occur at Bullsbrook and south of Muchea, though their range may not extend as far north as the Development Envelope (BCE 2018).

Black Cockatoos

The field surveys undertaken by BCE (2017, 2018, 2019) recorded considerable evidence of foraging by Forest Red-tailed Black Cockatoos in the southern two thirds of the study area, with 113 individual records of foraging activity. Evidence of foraging by Carnaby's Black Cockatoos was spread more evenly across the entire study area, with 115 individual records of foraging activity noted by BCE (2019).

Foraging habitat for both Carnaby's Black Cockatoo and the Forest Red-tailed Black Cockatoo occurs across the Development Envelope(**Figure 4** and **Figure 5**). For the Forest Red-tailed Black Cockatoo, 68.5% of the mapped habitat was determined to consist of habitat with Low or Negligible foraging value while for Carnaby's Black Cockatoo 60% of the mapped habitat was recorded as Low or Negligible (BCE 2019). Only 2.7% and 6.2% of the foraging habitat was recorded as High value for the Forest Red-tailed Black Cockatoo and Carnaby's Black Cockatoo respectively. In general, the Development Envelope provides Moderate value foraging habitat for both species of Black Cockatoo (BCE 2019).

During field surveys of the Development Envelope and surrounds, 1,352 tree hollows were recorded that are suitable for use by Black Cockatoos (BCE 2019) with a further 83 identified with evidence of chew marks around hollow entrances, indicating these are likely to be used for breeding (**Figure 6**).

1.5.5 Hydrology

Surface Water

The Development Envelope traverses three river catchments: Brockman River, Gingin Brook and Ellen Brook. The majority of the Development Envelope is in the Brockman River catchment, with smaller sections in the Gingin Brook and Ellen Brook catchment areas. Within these river catchments the Development Envelope crosses two surface water features: Brockman River (and its tributaries, the most significant of these being Udumung Brook) and Lennard Brook. The Brockman River that runs sub-parallel to most of the proposed alignment is a tributary of the Avon River and ultimately the Swan River which flows through the centre of the Perth metropolitan area. Gingin Brook is a tributary of the Moore River located west of the project area. Both river systems provide economic and environmental benefits in their catchments for tourism, agriculture and groundwater-dependent ecosystems.

Water flows in the Brockman sub-catchments are generally in an easterly direction relative to the north-south section of the proposed alignment. Flow is typically in a westerly direction relative to the alignment, where the alignment runs approximately west-east. Water flows in the Gingin Brook sub-catchments are generally in a westerly direction.

Groundwater

Four aquifers are present within the Bindoon region (DoW 2015):

- an unconfined surficial aquifer on the Swan Coastal Plain;
- a fractured rock aquifer east of the Darling Fault;
- the Mirrabooka semi-confined aquifer west of the Darling Fault; and
- the semi-confined Leederville-Parmelia aquifer.

The surficial aquifer comprises colluvium and lateritised soil profiles, including a combination of colluvial and lateritic clays, sands, ferricrete and gravels that are intersected by alluvial deposits associated with natural drainage lines. The aquifer is thin and often unsaturated (DoW 2015).

The fractured rock aquifer comprises fractured and weathered crystalline bedrock with small groundwater storage capacity (DoW 2015). Low groundwater yields can be obtained from the base of the weathered zone in the saprolite, generally around 25 m depth; however, water-bearing fractures in the granitic rock are widely spaced and springs can occur below the laterite (Commander 2003).

The Mirrabooka aquifer is comprised of the Lancelin Formation, which includes variably lateritised glauconitic sands and clays, and the Osborne Formation, which includes glauconitic siltstone, claystone, shale and sandstone, where the Kardinya Shale Member acts as a basal aquitard (Commander 2003; Geological Survey of Western Australia 1978). The aquifer is hydraulically connected to the surficial aquifer and is recharged in the north of the Perth Basin (Commander 2003). The Mirrabooka aquifer contributes to the summer flows in the headwaters of the Gingin Brook and maintains summer flows in the Moore River (DoW 2015).

The Leederville-Parmelia aquifer is an interconnected aquifer of the Leederville Formation and Parmelia Group, comprising sandstone and shale aquitards. It is semi-confined and recharged by the Gnangara mound approximately 15 km west of Bindoon, before becoming confined to the south of the Gingin proclaimed groundwater area (DoW 2015). The Leederville-Parmelia aquifer is also referred to as a 'shallow artesian aquifer' and is used for public water supply (Commander 2003). Similar to the Mirrabooka aquifer, the Leederville-Parmelia contributes to the baseflow of the Gingin Brook and is important for maintaining summer flow in the Moore River (DoW 2015).

2. Potential Environmental Impacts and Risks

2.1 Threats to Listed Threatened Species and Communities

Threats to Carnaby's Black Cockatoo, the Forest Red-tailed Black Cockatoo, Chuditch and Banksia woodlands TEC are defined in their respective recovery plans and conservation advice.

The Recovery Plans for Carnaby's Black Cockatoo (Department of Parks and Wildlife 2013) and the Forest Red-tailed Black Cockatoo (Chapman 2008) identified the following threats common to both species:

- loss of habitat due to clearing or degradation;
- competition for nest sites (including with other bird species and feral honeybees) and nest hollow shortage;
- collisions with motor vehicles; and
- illegal shooting and poaching.

In addition, the recovery plan for the Carnaby's Black Cockatoo identified disease, such as beak and feather disease virus (BFDV), avian polyomavirus (APV) and chlamydophilosis, may also pose a threat to the species (Department of Parks and Wildlife 2013).

The National Recovery Plan for the Chuditch (Department of Environment and Conservation 2012) outlines the current major threats to the species as:

- land clearing, particularly of riparian vegetation, and the removal of suitable den logs and den sites from Chuditch habitat;
- predation by, and competition from, foxes and feral cats; and
- deliberate and accidental mortality from poisoning, trapping, illegal shooting, and road kills.

The main ongoing threats to the Banksia Woodlands TEC as listed in the conservation advice (Threatened Species Scientific Committee 2016), include the following:

- clearing and fragmentation;
- dieback diseases (especially those caused by *Phytophthora* species);
- invasive species;
- fire regime change (particularly increased fire frequency; prescribed burning during late autumn to late spring when plants are in active growth, flowering and seed development and animals are active);
- hydrological degradation (groundwater abstraction, eutrophication, soil acidification); and
- loss of keystone Banksia species and fragmenting of nectar/pollen nutritional networks e.g. loss of *Banksia ilicifoia* in water drawdown areas.

2.2 Potential Impacts

2.2.1 Black Cockatoos

Table 2-1 details the potential impacts to Black Cockatoos as a result of clearing for construction of the Bindoon Bypass. Revegetation activities at the completion of construction will include planting and/or seeding with species known to provide foraging and future breeding habitat for Black Cockatoos.

Table 2-1: Impact to Black Cockatoos

Habitat	Maximum Clearing Required
Trees with hollows showing evidence of use	10
Trees with suitable hollows	117
Foraging and breeding habitat for Carnaby's Black Cockatoo	204.8 ha
Foraging and breeding habitat for the Forest Red-tailed Black Cockatoo	168 ha

The quality of foraging habitat for Black Cockatoos may also be impacted by the introduction or spread of weeds and disease due to construction activities. Vegetation health may also be adversely affected from increased dust deposition during construction or through accidental fires originating from construction activities.

During both construction and operation of the road, there is a possibility of collisions between Black Cockatoos and vehicles resulting in injury or death of the bird.

2.2.2 Chuditch

Up to 54.4 ha of habitat that is suitable for the Chuditch will be cleared for construction of the Bindoon Bypass. **Table 2-2** details the clearing by vegetation quality.

Table 2-2: Condition of Suitable Chuditch Habitat to be Cleared

Condition	Area (ha)
Completely Degraded – Degraded	15.3
Degraded	2.0
Good	10.5
Good – Very Good	6.2
Very Good	14.0
Very Good – Excellent	6.4

Should Chuditch be present within or in the vicinity of the Development Envelope, other potential impacts include:

- fragmentation of habitat and loss of connectivity;
- habitat degradation due to introduction or spread of weed or dieback; and
- fauna mortality from vehicle strikes.

2.2.3 Banksia Woodlands TEC

Up to 60 ha of the Banksia Woodlands TEC will be cleared for construction of the Bindoon Bypass. Landscaping activities will include revegetation with Banksia woodlands TEC species. **Table 2-3** details the clearing by vegetation quality.

Table 2-3: Condition of Banksia woodland TEC to be Cleared

Vegetation Quality	Maximum Cleared (ha)
Degraded – Good	4.0
Good – Very Good	21.2
Very Good	11.6
Very Good – Excellent	14.0
Excellent	9.2

Other potential impacts to the Banksia Woodlands TEC are:

- changes to Banksia Woodlands TEC vegetation health as a result of changes to groundwater levels;
- reduced biodiversity due to introduction and/or spread of weeds; and
- loss of Banksia Woodlands TEC due to the spread or introduction of *Phytophthora* dieback.

2.3 Risk Assessment

An environmental risk assessment has been undertaken for the Bindoon Bypass. The risk assessment is a live document that will continue to be revisited on receipt of approvals, in response to changes in scope or as a result of environmental incident. The outcomes of the risk assessment are presented in **Table 2-4**. The assessment framework and definitions for Likelihood and Consequence are provided in **Appendix A**.

Table 2-4: Risk Assessment

Management Objective / Desired Outcome	Impact and Risk (Event or Circumstance)	Relevant Management Measures/Actions	Residual Risk		
			Likelihood	Consequence	Residual Risk Rating
To avoid impacts to Black Cockatoo habitat beyond that approved.	Clearing of more than the approved amount of habitat or clearing of habitat outside of approved areas.	• Area to be cleared will be accurately pegged/marked on the ground. • Additional areas required for construction such as laydown areas, stockpile areas and vehicle turn around, will be located in cleared areas or areas of non-native vegetation. • Revegetation of cleared areas more than 10 m from the road with species mixes which include Carnaby's Black Cockatoo breeding and foraging species.	Unlikely	High	Medium
	Clearing of more than the approved number of 10 trees with hollows previously used by Black Cockatoos or 117 hollows suitable for use by Black Cockatoos	• Installation of safety barriers to avoid clearing of trees with suitable/used hollows. • Additional areas required for construction such as laydown areas, stockpile areas and vehicle turn around located in cleared areas or areas that do not contain potential breeding trees.	Unlikely	Minor	Low

	Introduction or spread of weeds and disease impacting on vegetation health or condition from plant and machinery	• Weed and hygiene control measures will be in place during construction including:
		  ▸ verifying all plant and machinery as clean prior to arrival at site;
		  ▸ segregating stripped topsoil according to its weed and disease status; and
		  ▸ clean on entry/exit protocols for areas at risk from weed/disease introduction or spread.
			Possible	High	Medium

	Introduction or spread of weeds and disease impacting on vegetation health or condition from unauthorised site access	• The site will be controlled as a construction site with no unauthorised access permitted.	Rare	High	Low
	Reduced vegetation health due to construction dust emissions.	• Dust suppression will be used on all cleared areas during construction activities. • Vehicle speed on site will be limited for safety of construction personnel and this will consequently reduce dust lift off.	Rare	Moderate	Low
	Damage to habitat from accidental fires resulting from construction activities.	• All hot works will be undertaken in accordance with Contractor's safety procedures which will be approved and reviewed by Main Roads Environmental Management Representative prior to works. • All vehicles, plant and equipment to be fitted with fire extinguishers and restricted to designated cleared areas. • Fire danger ratings and Shire vehicle movement bans will be observed and the requirements of these implemented.	Rare	Moderate	Low
	Injury or death caused by vehicle strikes.	• Revegetation designs do not include foraging or breeding plant species within 10 m of the road. • Wildlife hazard signage installed and maintained in areas at high risk of cockatoo-vehicle collisions. • Vehicle speed will be limited during construction and this will subsequently allow drivers more time to react to fauna on the road. • A list of local wildlife rescue organisations and carers will be maintained on site. This will allow efficient identification of an appropriate destination to which to transfer injured cockatoo.	Rare	High	Low

Management Objective / Desired Outcome	Impact and Risk (Event or Circumstance)	Relevant Management Measures/Actions	Residual Risk		
			Likelihood	Consequence	Residual Risk Rating
To avoid impacts to Banksia Woodlands TEC beyond that approved.	Clearing of more than the approved extent of 60 ha	• Area to be cleared will be accurately pegged/marked on the ground. • Additional areas required for construction such as laydown areas, stockpile areas and vehicle turn around will be located in cleared areas or areas of non-native vegetation. • Revegetation of cleared areas more than 10 m from the road with species mixes which are representative to the Eucalypt Woodlands TEC.	Unlikely	High	Medium

	Introduction or spread of weeds and disease impacting on vegetation health or condition.	• Weed and hygiene control measures will be in place during construction including:
		  ▸ verifying all plant and machinery as clean prior to arrival at site;
		  ▸ segregating stripped topsoil according to its weed and disease status; and
		  ▸ clean on entry/exit protocols for areas at risk from weed/disease introduction or spread.
			Possible	High	Medium

	Reduced vegetation health due to construction dust emissions.	• Dust suppression will be used on all cleared areas during construction activities. • Vehicle speed on site will be limited due to safety reasons which will consequently reduce dust lift-off.	Rare	Moderate	Low
	Damage to Banksia Woodlands TEC from accidental fires resulting from construction activities.	• All hot works will be undertaken in accordance with contractor safety procedures. • All vehicles, plant and equipment to be fitted with fire extinguishers and restricted and to designated cleared areas. • Fire danger ratings and Shire vehicle movement bans will be observed and the requirements of these implemented.	Rare	Moderate	Low
	Reduced vegetation health due to groundwater drawdown in areas adjacent to construction water sources	• All groundwater abstraction undertaken in line with appropriate licences and management plans approved under the *Rights in Water and Irrigation Act 1914*.	Unlikely	Moderate	Low
To achieve performance targets and completion criteria for rehabilitation of Carnaby's Black Cockatoo habitat and Banksia Woodlands TEC.	Revegetation fails to achieve completion criteria.	• Planting / seeding occurs at optimal time of year to promote seedling survival and seed germination. • Revegetation species mixes will be formulated to replicate the surrounding native vegetation. • Local provenance seed/seedling to be used in revegetation.	Unlikely	High	Medium
	Insufficient funds available to implement this CEMP.	• Project funding cost estimates include environmental management requirements.	Rare	Major	Medium
	Weed control measures fail to achieve performance targets.	• Review weed control methods used to confirm they are appropriate for the target species. • Implement alternative methods of weed control.	Rare	Moderate	Low
	Stochastic events (wildfire/drought/flood) prejudice rehabilitation outcomes.	• Support emergency response organisations (e.g. assistance with firefighting) during construction. • Road design allows for easy access for emergency services to high risk areas (e.g. large areas of vegetation).	Unlikely	High	Medium
To maintain ecological connectivity across the Development Envelope	Fauna underpasses not used by target species	• Fauna underpasses designed in accordance with Main Roads guidance (Design of Fauna Underpasses). This guidance takes into consideration current experience across Australia in relation to use of underpasses by various fauna species.	Possible	High	Medium

Management Objective / Desired Outcome	Impact and Risk (Event or Circumstance)	Relevant Management Measures/Actions	Residual Risk		
			Likelihood	Consequence	Residual Risk Rating
	Revegetation fails to achieve completion criteria.	• Planting / seeding occurs at optimal time of year to promote seedling survival and seed germination. • Revegetation species mixes will be formulated to replicate the surrounding native vegetation. • Local provenance seed/seedling to be used in revegetation.	Unlikely	High	Medium

3. Environmental Management

3.1 Implementation

Table 3-1 details the management measures to be put in place to achieve the outcomes identified in the risk assessment. The table also shows each management measure identified in the risk assessment, the implementation timing of these, their completion criteria and the monitoring record to show when each completion criteria is met.

Table 3-1: Environmental Management Implementation Schedule

Management Objective	Management Measure	Performance Target/Completion Criteria	Timing	Monitoring/ Reporting Activity	Corrective Action Trigger(s)	Corrective Action	Corrective Action Responsibility
Vegetation Clearing							
To avoid impacts to Black Cockatoo habitat beyond that approved To avoid injury or mortality of Black Cockatoos during vegetation clearing and construction	Trees with hollows previously used by or suitable for Black Cockatoos within the Development Envelope but not within the clearing footprint will be clearly marked as no-go zones and access to these areas restricted. No-go zones will include a 10 m buffer from the trunk of the tree unless this is not achievable due to the proximity of the clearing footprint. Where a 10 m buffer is not achievable, the maximum buffer achievable between the tree and the clearing footprint will be implemented.	Drawings showing environmental no-go areas provided to the Construction Contractor Representative All environmental no-go areas clearly marked with flagging on site	Contract award and prior to start of clearing. Prior to start of clearing	Record of provision of drawings showing environmental no-go areas Initial site inspection prior to clearing to confirm no-go zones are in place. Site inspections to confirm no-go zones remain in place and have not been entered. Incident reports	Clearing within a No-go area	Incorrectly cleared areas must be included in the landscape design for the project within 6 months of completion of clearing for revegetation with Black Cockatoo habitat species Clearing in the direct vicinity will cease immediately if trigger is met. Clearing will not recommence until no-go areas have been reviewed and confirmed to be in place correctly, and Main Roads Superintendent provides approval to recommence.	Construction Contractor Environmental Management Representative Main Roads Superintendent
	If clearing of Black Cockatoo habitat is to occur between 1 July and 28 February, all potential nesting trees identified by BCE (2017, 2018, 2019) within the area to be cleared will be inspected by a suitably qualified person to determine if any hollows are being used by Black Cockatoos	Survey of trees with hollows used by or suitable for use by Black Cockatoos undertaken within 7 days prior to clearing events	Within 7 days prior to clearing events that occur between 1 July and 28 February	Pre-clearing inspection for hollows that are being used, or are capable of being utilised signed off my Main Roads Superintendent. Maintain a register of nesting trees	Clearing event undertaken without pre-clearing survey. Survey undertaken more than 7 days prior to clearing	Contractor to provide evidence that a suitably qualified person is engaged to conduct surveys prior to subsequent clearing events Contractor to provide evidence that surveys are scheduled within 7 days prior to subsequent clearing events Unanticipated clearing event delays will be risk assessed against survey findings.	Construction Contractor Environmental Management Representative
	If any hollows within the clearing footprint are identified as being in use by Black Cockatoos, the hollow bearing tree and a 10 m buffer will be marked as a No-Go area. Clearing of the tree will not be undertaken until a suitably qualified person has verified that the hollow is no longer being used	No clearing of trees used by Black Cockatoo All trees currently being used by Black Cockatoos are marked with flagging as no-go areas with a 10 m exclusion zone	Black Cockatoo breeding season and following survey of area to be cleared	Surveys undertaken by suitably qualified person to confirm hollow is no longer being used by Carnaby's Black Cockatoo Maintain a register of nesting trees	Clearing of a tree with a hollow currently used by a Black Cockatoo Suitably qualified person has not confirmed the tree is no longer being used by Black Cockatoo before it is cleared	Immediate inspection of felled tree (e.g. with hollow currently in use) to determine survivability of Black Cockatoo (if present) Incorrectly cleared areas must be included in the landscape design for the project and marked for revegetation with Black Cockatoo habitat species Clearing activities are immediately ceased in the vicinity of the unmarked trees and relevant trees are correctly flagged before clearing activities recommence If a tree currently utilised by the species is felled, clearing in the direct	Construction Contractor Environment Management Representative

Management Objective	Management Measure	Performance Target/Completion Criteria	Timing	Monitoring/ Reporting Activity	Corrective Action Trigger(s)	Corrective Action	Corrective Action Responsibility
						vicinity will cease immediately if trigger is met Clearing will not recommence until no-go areas have been reviewed and confirmed to be in place correctly, and Main Roads Superintendent provides approval to recommence	
To avoid injury or mortality of Chuditch during vegetation clearing and construction	Capture and relocation of fauna in areas of native vegetation undertaken by a suitably qualified person prior to clearing. Fauna trapping and relocation will be conducted in accordance with the DBCA's standard operating procedures <https://www.dpaw.wa.gov.au/plants-and-animals/96-monitoring/standards/99-standard-operating-procedures> The trapping program will include: • Cage traps suitable for Chuditch • On days over 35°C or in extreme rain events, traps will be closed after checking in the morning and re-opening in the late afternoon, to avoid capture during the day • Relocation of fauna found to a suitable habitat nearby • Trapping until no conservation significant species are caught for two consecutive nights or otherwise determined by a fauna expert	Capture and relocation of fauna undertaken prior to clearing in all areas of native vegetation.	Prior to vegetation clearing	Records of fauna capture and relocation	Clearing commenced without capture and relocation of fauna having been undertaken	Clearing activities are immediately ceased and additional trapping/relocation undertaken. If practicable, move to areas where capture and relocation of fauna has been completed while additional trapping is undertaken. Suitably qualified person to conduct a walkover of the clearing area to encourage fauna to disperse.	Construction Contractor Environment Management Representative
	Fauna spotters engaged during clearing activities supervise the dispersal and/or capture and relocation of fauna detected ahead of clearing machinery	Fauna spotters engaged for all clearing activities	Vegetation clearing	Daily reports from fauna spotters	Fauna spotter not present during clearing of native vegetation	Clearing activities are immediately ceased and clearing of native vegetation will not resume until a fauna spotter is in attendance. Cleared areas checked for injured fauna	Construction Contractor Environment Management Representative

Management Objective	Management Measure	Performance Target/Completion Criteria	Timing	Monitoring/ Reporting Activity	Corrective Action Trigger(s)	Corrective Action	Corrective Action Responsibility
To avoid impacts to Black Cockatoo habitat beyond that approved To avoid impacts to Banksia woodlands TEC beyond that approved	All clearing areas will be clearly marked with flagging and approved by the Main Roads Superintendent prior to clearing commencing so that there is no clearing of Black Cockatoo habitat or Banksia woodlands TEC outside of the approval boundary.	All areas to be cleared will be marked with flagging on site	Prior to start of clearing	Site inspections	More than 60 ha of Banksia Woodlands TEC will be cleared. More than 204.8 ha of Carnaby's Black Cockatoo foraging habitat will be cleared. More than 168 ha of Forest Red-tailed Black Cockatoo foraging habitat will be cleared.	Incorrectly cleared areas must be included in the landscape design for the project and marked for revegetation with Black Cockatoo habitat species Clearing activities are immediately ceased and clearing of native vegetation will not resume until additional approval has been granted for the extra clearing required	Construction Contractor Environment Management Representative
	Additional areas required for construction such as laydown areas, stockpile areas and vehicle turn around, will be located in areas cleared for permanent works or areas that do not contain Black Cockatoo habitat or Banksia woodlands TEC. Clearing will be avoided for any temporary construction activities.	Areas for ancillary services located in cleared areas or areas that do not contain Black Cockatoo habitat or Banksia woodlands TEC.	During construction	Construction site plan showing all ancillary areas not located on land containing Black Cockatoo habitat or Banksia woodlands TEC. Site inspections	Areas required for construction such as laydown areas etc are proposed to be located within areas of native vegetation	Main Roads Superintendent is required to provide approval for clearing of native vegetation for construction laydown etc. and approval must only be given if there are no other practicable options. Incorrectly cleared areas must be included in the landscape design within six months of completion of clearing for revegetation with Black Cockatoo foraging habitat species and/or Banksia species as appropriate	Main Roads Superintendent Construction Contractor Environment Management Representative
	Vegetation to be retained will be marked with flagging on site	All vegetation to be retained will be marked with flagging on site	Prior to start of clearing	Site inspections	Clearing within an area of vegetation to be retained	Incorrectly cleared areas must be included in the landscape design for the project within 6 months of completion of clearing for revegetation with Black Cockatoo habitat species Clearing in the direct vicinity will cease immediately if trigger is met. Clearing will not recommence until no-go areas have been reviewed and confirmed to be in place correctly, and Main Roads Superintendent provides approval to recommence	Construction Contractor Environmental Management Representative Main Roads Superintendent
To avoid and mitigate impacts to potential habitat for Gingin Wax (*Chamelaucium* sp. Gingin)	In areas of habitat suitable for Gingin Wax (**Figure 7**), topsoil will be stripped separately to other areas and retained for later use in revegetation. The topsoil stockpile will be clearly marked with the species name and location the topsoil was taken from.	Topsoil from within the area identified in **Figure 7** is retained for use in landscaping and revegetation.	During clearing and topsoil removal.	Site inspections Topsoil management records	Topsoil from within the area identified in **Figure 7** is not stockpiled separately but mixed with topsoil from surrounding areas.	Incident investigation and report undertaken within 1 week. Investigations to identify the location of stockpile(s) containing topsoil from the area identified in **Figure 7**. These stockpiles will be clearly marked with the species name and identified as to be used in landscaping and	Construction Contractor Environmental Management Representative

Management Objective	Management Measure	Performance Target/Completion Criteria	Timing	Monitoring/ Reporting Activity	Corrective Action Trigger(s)	Corrective Action	Corrective Action Responsibility
						revegetation of areas within potential Gingin Wax habitat.	
Vehicle interaction with fauna							
To avoid injury or mortality of Black Cockatoos or Chuditch during vegetation clearing and construction	Where trees that are known to be Black Cockatoo habitat are retained but are located within 10 m of the edge of the road seal the risk of fauna strike will be assessed to determine if wildlife hazard signage is required. Fauna warning signs will be installed in areas where native vegetation occurs next to the roadside on either side of the road.	Black Cockatoo habitat retained within 10 m of the edge of the seal of the road will be risk assessed and wildlife hazard signage installed as required. Fauna warning signs installed where native vegetation occurs on either side of the road.	During construction	Risk assessment Site inspection of signage installed at completion of construction	Black Cockatoo habitat is retained within 10 m of the edge of the road seal and is not risk assessed to determine whether wildlife hazard signage is required No fauna warning signs in an area where native vegetation occurs on either side of the road	Risk assess areas where signage not installed and install wildlife hazard signage if required	Construction Contractor Environment Management Representative
	Speed limits between 40 – 80 km/hr will be applied throughout the construction site for safety purposes which will consequently reduce the risk of fauna strikes during construction	No incidents of speeding within the construction site boundary	During construction	Visual monitoring by all construction personnel.	Exceedance of site speed limits are observed	Offenders will be asked to immediately reduce speed Refresher training will be conducted within 1 week	Construction Contractor Environmental Management Representative
	A list of local wildlife rescue organisations and carers will be maintained on site to contact immediately in the event of fauna injury	A list of local wildlife rescue organisations and carers to be on site at all times	During construction	Site inspections	A list of local wildlife rescue organizations and carers is not on site Wildlife rescue specialists not contacted immediately on discovery of an injured Black Cockatoo or Chuditch	A list of local wildlife rescue organizations and carers is to be maintained on site immediately Refresher training will be conducted within 1 week	Construction Contractor Environmental Management Representative
Habitat Connectivity							
To maintain ecological connectivity across the Development Envelope	Fauna underpasses to be included in areas that align with ecological linkages identified by the Shire of Chittering's local biodiversity strategy (Shire of Chittering 2010).	Underpasses constructed in locations identified on design drawings issued for construction	During construction	Monthly progress reporting Closeout and handover inspection	Fauna underpasses (or alternatively, overpasses) not constructed as per the design drawings	Investigation to determine if under/overpass can be constructed in an alternative location Review of locations of constructed fauna under/overpasses to determine if important linkages have been maintained	Main Roads Project Manager

Management Objective	Management Measure	Performance Target/Completion Criteria	Timing	Monitoring/ Reporting Activity	Corrective Action Trigger(s)	Corrective Action	Corrective Action Responsibility
Fire							
To avoid impacts to Black Cockatoo habitat beyond that approved To avoid impacts to Banksia woodlands TEC beyond that approved	All hot works will be undertaken in accordance with contractor safety procedures, which will be reviewed by Main Roads Environment Management Representative prior to works.	No ignitions / fires started as a result of hot works No impact on MNES as a result of ignitions/fires originating from work areas	During hot works such as welding	Site inspections to confirm required controls are in place Training records for project personnel involved in hot works	Hot work procedures not correctly implemented/followed Ignition/ fire started as a result of hot works	Incident investigation and report undertaken within 1 week. Impacted areas included in revegetation plans within 2 weeks Refresher training will be conducted within 1 week	Construction Contractor Environmental Management Representative
	All vehicles, plant and equipment to be fitted with appropriate exhaust system shielding and restricted to designated cleared areas	No ignitions / fires started as a result of hot vehicles exhausts, plant or equipment No impact on Black Cockatoo habitat or Eucalypt Woodlands TEC as a result of ignitions/fires originating from work areas	All activities	Incident reports related to fires	Fire originating from work area(s)	Incident investigation and report undertaken within 1 week. Impacted areas included in revegetation plans within 2 weeks Refresher training will be conducted within 1 week	Construction Contractor Environmental Management Representative
	Fire danger ratings and Shire vehicle movement bans will be observed and the requirements of these implemented	No operation of vehicles, plant or equipment in contravention of Fire danger ratings and Shire vehicle movement bans	All activities outside of cleared areas	Pre-start and Toolbox meeting agenda items and/or minutes	Fire originating from work area(s)	Incident investigation and report undertaken within 1 week. Impacted areas included in revegetation plans within 2 weeks Refresher training will be conducted within 1 week	Construction Contractor Environmental Management Representative
Erosion and Dust Emissions							
To avoid impacts to Black Cockatoo habitat beyond that approved To avoid impacts to Banksia woodlands TEC beyond that approved	Dust suppression (e.g. water carts) and/or surface stabilization measures (e.g. hydromulch) will be used to protect loose surfaces or cleared areas. Dust generating activities suspended during periods of high wind conditions	No visual dust plumes generated by construction activities	Post clearing and during construction	Site inspections include visual monitoring for dust generation	Reports of visible dust plumes by project personnel Complaints from community or other stakeholders	Increased application rate/frequency for dust suppression methods (e.g water carts) will be implemented effective immediately of trigger being realised	Construction Contractor Environmental Management Representative
To achieve performance targets and completion criteria for Black Cockatoo and Banksia woodlands TEC	Reduced speed limits (40 - 80 km/hr) will be enforced within the construction site boundary	No incidents of speeding within the construction site boundary	During construction	Incident reports Adherence to speed limit enforced on site	Reported exceedance of site speed limits	Refresher training will be conducted within 1 week Instances of speeding are identified and offenders will be asked to immediately reduce speed Repeat offenders (ie. caught speeding more than 2 times) will undergo further refresher training.	Construction Contractor Environmental Management Representative

Management Objective	Management Measure	Performance Target/Completion Criteria	Timing	Monitoring/ Reporting Activity	Corrective Action Trigger(s)	Corrective Action	Corrective Action Responsibility
	Temporary construction drainage within or adjacent to Carnaby's Black Cockatoo habitat or Banksia woodlands TEC will be designed and constructed such that it does not result in scouring or erosion within these vegetated areas	No evidence of erosion from construction activities within Black Cockatoo habitat or Banksia woodlands TEC	Prior to and during construction	Site inspections. Annual revegetation monitoring	Erosion identified in Black Cockatoo habitat or Banksia woodlands TEC areas	Review drainage to identify whether there are any failure points, and repair/address any failure points identified within 2 weeks	Construction Contractor Environmental Management Representative
Construction Water Abstraction							
To avoid impacts to Black Cockatoo habitat beyond that approved To avoid impacts to Banksia woodlands TEC beyond that approved	Water abstraction for construction purposes will be operated so as not to reduce groundwater levels below groundwater dependent banksia communities more than 0.5 m below existing groundwater levels.	Groundwater drawdown 0.5m or less in Banksia woodland monitoring sites.	During construction	Monitoring in accordance with the groundwater operating strategy required under RIWI Act approval for the abstraction. Monitoring of groundwater levels in areas of Banksia woodland that are within 100m of bores	Groundwater drawdown of more than 0.5m in Banksia woodland monitoring sites	Abstraction from the bore in question is suspended until groundwater levels recover. Rate of abstraction reviewed to determine if a lower rate which does not reduce groundwater levels more than 0.5m in Banksia woodland monitoring sites is feasible.	Construction Contractor Environmental Management Representative
Brockman River Crossing – ASS							
To avoid impacts to Black Cockatoo and Chuditch habitat beyond that approved	Undertake ASS investigation of the Brockman River Crossing location.	ASS investigation undertaken prior to start of construction within the Brockman River floodplain.	Prior to construction within the Brockman River floodplain.	Start-up audit Construction Hold Point for Brockman River crossing construction	ASS investigation not undertaken prior to start of construction within the Brockman River floodplain	Construction activities are immediately ceased within the Brockman River floodplain until ASS survey is undertaken, results known and construction method updated as required in order to manage and PASS or AASS risks. Field readings from already disturbed areas to identify PASS/AASS risk and management measures (such as covering with clean fill or neutralisation) put in place if required	Construction Contractor Environmental Management Representative
	Should AASS or PASS be identified from the investigation, management measures consistent with the *Treatment and management of soil and water in acid sulfate soil landscapes* (DER 2015b) will be implanted. This will include: • Minimising the disturbance footprint in PASS or AASS areas to that required for construction, such as excluding PASS/AASS areas from topsoil stripping. • Neutralising PASS/AASS soil and stockpiles with lime	No statistically significant change in surface water quality downstream of the Brockman River crossing when compared to baseline conditions.	All construction activities within the Brockman River floodplain	Water quality monitoring during construction Monthly reporting	Water quality monitoring shows increased levels of salinity, metals or hydrocarbons or decreased pH downstream of the Brockman River crossing	Review of results from downstream monitoring site against upstream (control) site to determine if change is a result of construction activities. If applicable, review ASS procedures and treatment infrastructure to confirm neutralisation dosing rate is effective and all PASS/AASS material is being treated Investigation to identify cause of change	Construction Contractor Environmental Management Representative

Management Objective	Management Measure	Performance Target/Completion Criteria	Timing	Monitoring/ Reporting Activity	Corrective Action Trigger(s)	Corrective Action	Corrective Action Responsibility
	• Selecting construction methods to reduce the need for soil excavation or dewatering • Neutralising acidic dewatering effluent						
Construction Near Waterways							
To avoid impacts to Black Cockatoo and Chuditch habitat beyond that approved To avoid impacts to Banksia woodlands TEC beyond that approved	Fuels and chemicals will be stored in secure bunded areas in the construction compound and at least 50 m from drainage lines. Individual substances will be stored in accordance with the relevant material safety data sheet (MSDS) specifications and Australian Standard (AS) 1940:2017 (*The Storage And Handling Of Flammable And Combustible Liquids*).	All fuels and chemicals stored in accordance with MSDS and/or Australian Standard requirements	All construction activities	Start-up audit/inspection Site inspections	Chemicals identified during site inspections that are not stored as required Chemicals/fuels stored within 50 m of watercourse	Non-compliant vessels/containers will be moved into storage areas with appropriate containment. Chemical/fuel storage areas mover so they are more than 50 m from a water course	Construction Contractor Environmental Management Representative
	All construction areas will be equipped with appropriately stocked spill kits near construction works such that they are readily accessible should a spill occur.	Spill kits in place at all construction areas Spill kits are stock with appropriate materials relevant to the works being undertaken and the site conditions	All construction activities	Site inspections	Site inspection identifies missing or inappropriate spill kits	Supply appropriately equipped spill kit to worksite	Construction Contractor Environmental Management Representative
	Where possible, no refuelling will be undertaken within 50 m of watercourses/waterbodies. The only exception to this will be immobile plant (eg generators or pumps) or large plant (eg piling crane) where it is impractical to move the plant away from the watercourse for refuelling. In this situations, drip trays will be used and spill kits will be on hand.	No refuelling within 50 m of watercourses/waterbodies, not including the exceptions noted	All construction activities	Site inspections Incident reporting	Incident reporting or site inspections identify that refuelling has occurred within 50 m of watercourse or waterbody	Issue raised at the next toolbox meeting Review site signage and install additional signage if required	Construction Contractor Environmental Management Representative
	Where construction in or near waterways is undertaken while water is present in the watercourse, silt curtains and/or silt fences (or equivalent) will be used to contain and/or filter high turbidity water generated during construction and prevent sediment from reaching the waterway	silt curtains and/or silt fences (or equivalent) in place to manage high turbidity water	All construction activities	Site inspections	High turbidity water observed downstream of silt curtain and/or silt fences (or equivalent)	Review placement and condition of silt curtain and/or silt fences (or equivalent) Replace silt curtain and/or silt fences (or equivalent) if identified to be damaged/faulty	Construction Contractor Environmental Management Representative

Management Objective	Management Measure	Performance Target/Completion Criteria	Timing	Monitoring/ Reporting Activity	Corrective Action Trigger(s)	Corrective Action	Corrective Action Responsibility
Weeds and Disease							
To avoid impacts to Black Cockatoo and Chuditch habitat beyond that approved To avoid impacts to Banksia woodlands TEC beyond that approved To maintain ecological connectivity across the Development Envelope	Declared Plants within the construction site boundary will be treated according to their Control Codes and advice from the Department of Primary Industries and Regional Development.	No new occurrence or spread of Declared Plants within the construction site boundary during construction activities	All construction activities	Site inspections Annual revegetation monitoring	New occurrence or spread of a Declared Plant identified	Application of weed eradication techniques for the weed species Review of Clean on Entry (CoE) process	Construction Contractor Environmental Management Representative
	All plant and machinery will be inspected by the contractor prior to entry at the work site and be confirmed to be clean and free of vegetation and soil material	All plant and machinery will be verified clean on arrival at site	All construction activities	Records verifying plant and machinery arriving on site is clean	Plant and machinery arriving on site without verification that it is clean of soil and vegetative matter	Refresher training will be conducted	Construction Contractor Environmental Management Representative
	CoE procedures will be implemented on site (refer to the Dieback Management Strategy – **Appendix B**)	No breach of CoE protocols	For the duration of the approval	Entry and/or exit records for CoE points Site inspections	Breach of CoE protocol	Refresher training will be conducted within 2 weeks	Construction Contractor Environmental Management Representative
	Topsoil from areas infected or potentially infected with *Phytophthora* dieback shall be segregated and not used in non-infected areas. Dieback free soil may be used in any area, but topsoil taken from Uninterpretable areas may only be used in Uninterpretable or Dieback infested areas (refer to the Dieback Management Strategy – **Appendix B**)	No topsoil potentially infected with *Phytophthora* dieback used for revegetation in non-infected areas	During revegetation activities	Site inspections Topsoil management records	Topsoil from areas identified as potentially infected used during revegetation works	Engage a *Phytopthora* dieback specialist within 2 weeks to assess potentially infected area and implement corrective actions as advised within 1 month	Construction Contractor Environmental Management Representative
	Temporary construction drainage will be designed and constructed such that surface water runoff from dieback infested areas is not allowed to drain into protectable areas or areas that have not been assessed for the presence of Dieback (refer to the Dieback Management Strategy – **Appendix B)**	No movement of water from construction areas in dieback infested areas into protectable areas or areas that have not been assessed for the presence of Dieback	All construction activities	Site inspections Inspection of drainage structures following rainfall events	Failure of construction drainage in dieback infested areas	Repair drainage structures as soon as conditions allow access to the location Engage a *Phytopthora* dieback specialist within 2 weeks to assess potentially infected area and implement corrective actions as advised within 1 month	Construction Contractor Environmental Management Representative
Revegetation							
To achieve performance targets and completion criteria for Black Cockatoo and Banksia woodlands TEC	Revegetation will commence in the autumn/winter following completion of construction works within designated revegetation areas and corridors to maintain ecological linkages	Revegetation commenced within a year following the completion of construction Revegetation works will occur within the optimum time of year (May-June)	Post construction	Site inspections during revegetation works Annual site inspections until completion criteria have been achieved	Cleared areas not revegetated as soon as practicable	Revegetation of cleared areas to commence as soon as practicable Review scheduling to ensure all future revegetation activities are included	Construction Contractor Environmental Management Representative.

Management Objective	Management Measure	Performance Target/Completion Criteria	Timing	Monitoring/ Reporting Activity	Corrective Action Trigger(s)	Corrective Action	Corrective Action Responsibility
To avoid and mitigate impacts to potential habitat for Gingin Wax (*Chamelaucium* sp. Gingin) To maintain ecological connectivity across the Development Envelope	All rubbish and surplus materials are removed from site at the completion of revegetation	No rubbish will remain on site after construction is completed Materials not required for revegetation are not to remain on site after construction is completed. After revegetation works, all remaining materials will be removed from the site.	Within a year of the end of construction OR Within a year following completion of revegetation	Contract completion inspection	Rubbish or surplus materials observed during the contract completion inspection	Rubbish or surplus materials are removed and disposed of immediately.	Contractor Environmental Management Representative
	Compacted areas will be ripped prior to seeding / planting to provide an area of seed / seedling establishment and improve infiltration	All compacted areas are deep ripped prior to seeding / planting	At the start of revegetation activities. Within a year of the end of construction OR Within a year following completion of revegetation	Site inspections during seeding/planting	Compacted areas are not deep ripped prior to seeding / planting	Affected revegetation areas will be inspected annually with infill planting and reseeding being undertaken as required to meet revegetation completion criteria	Construction Contractor Environmental Management Representative
	Plant species which are known to provide habitat for the Black Cockatoos will not be planted within 10 m of the edge of the road seal	No foraging, nesting or roosting plant species for Black Cockatoos planted within 10 m of the edge of seal	During drafting of revegetation plans, which will initially occur prior to contract award	Site inspections during seeding/planting	Black Cockatoo preferred plant species planted within 10 m of the edge of the road seal	Black Cockatoo preferred plant species within 10 m of the edge of the road seal will be removed within 2 days and will be replanted further than 10 m from the edge of the road seal	Construction Contractor Environmental Management Representative
	Species mixes used in revegetation will aim to provide the following ecological services: • provide foraging and potential breeding habitat for Black Cockatoos in locations more than 10 m from the edge of the seal; and • support fauna movement within the road reserve and between patches of existing native vegetation outside of the Development Envelope.	Species mixes will be specified in the Main Roads Revegetation and Landscaping Specifications developed for the contractor	During drafting of revegetation plans, which will initially occur prior to contract award	Site inspections during seeding/planting	Species mix used during revegetation does not comply with the landscape design and/or provide habitat for the Carnaby's Black Cockatoo	Approval is obtained from the Main Roads Environment Representative to use alternative species that continue to achieve revegetation completion criteria If the Main Roads Environment Representative does not approve alternative species mix non-compliant species must be removed and correct species used	Construction Contractor Environmental Management Representative
		Revegetation will meet the following completion criteria within five years of completion, as verified by a suitable qualified person: • minimum of 60% of number of native species across rehabilitation site when compared to all the reference sites.	During revegetation	Annual revegetation surveys (in Spring) will be undertaken until completion criteria have been achieved	Revegetation surveys show that revegetation completion criteria are not being maintained	If vegetation density or vegetation cover is not achieved infill planting will be undertaken between May and June If minimum weed cover is not achieved weed eradication techniques will be applied within 3 months of becoming aware that an area of revegetation no longer meets the completion criteria	Main Roads Environment Representative

Management Objective	Management Measure	Performance Target/Completion Criteria	Timing	Monitoring/ Reporting Activity	Corrective Action Trigger(s)	Corrective Action	Corrective Action Responsibility
		• all common tree species identified at reference sites present in revegetation • minimum of 50% of number of Black Cockatoo habitat species when compared to all the reference sites. • minimum of 50% of number of Banksia species in revegetation of areas adjacent to Banksia woodlands TEC when compared to all reference sites within Banksia woodland TEC. • minimum of 50% native species foliage cover. • weeds are manageable and not likely to outcompete revegetation • greater than 50% of plant species are at least 5 years old.					
	Topsoil from areas infected or potentially infected with *Phytophthora* dieback shall be segregated and not used in non-infected areas. Dieback free soil may be used in any area, but topsoil taken from Uninterpretable areas may only be used in Uninterpretable or Dieback infested areas (refer to the Dieback Management Strategy - **Appendix B**)	No topsoil potentially infected with *Phytophthora* dieback used for revegetation in non-infected areas	During revegetation activities	Site inspections Topsoil management records	Topsoil from areas identified as potentially infected used during revegetation works	Engage a *Phytophthora* dieback specialist within 2 weeks to assess potentially infected area and implement corrective actions as advised within 1 month	Construction Contractor Environmental Management Representative
	Topsoil taken from the area identified in **Figure 7** to be used in landscaping and revegetation of areas within potential habitat for Gingin Wax	All topsoil taken from the area identified in **Figure 7** used in landscaping and revegetation of areas of potential habitat for the species	During landscaping and revegetation activities	Site inspections Topsoil management records	Topsoil from the area identified in **Figure 7** used in landscaping and revegetation of areas outside of potential habitat for the species	Investigation to confirm if topsoil recovered from the area identified in **Figure 7** was used in landscaping and revegetation of areas of potential habitat for Gingin Wax and if the recovered topsoil was greater than required for these areas Review of locations outside of identified potential habitat to determine if these could be suitable for Gingin Wax	Construction Contractor Environmental Management Representative

Management Objective	Management Measure	Performance Target/Completion Criteria	Timing	Monitoring/ Reporting Activity	Corrective Action Trigger(s)	Corrective Action	Corrective Action Responsibility
Access Controls							
To achieve performance targets and completion criteria for Black Cockatoo and Banksia woodlands TEC	No-go areas are clearly marked on site	No intrusion into no-go areas No-go areas are clearly marked on site	Prior to clearing	Intrusion into no-go area	Site inspections prior to and following clearing to confirm no-go areas are appropriately flagged / fenced Monthly site inspections Any intrusion into no-go areas or damage to fencing/ flagging is raised as an incident All no-go areas will be reviewed within 2 days to ensure exclusions are still in place Conduct refresher training within 1 week	No-go area inspected immediately for damage to TEC or Black Cockatoo habitat If clearing has occurred, the area is to be included in the landscape design within 2 weeks	Construction Contractor Environmental Management Representative Main Roads Superintendent
	Road reserve will be fenced to prevent stock accessing vegetation within the road reserve from adjacent farms.	100% of fencing between road reserve and private property installed Fences remain in good condition (no signs of damage) No access to road reserves by stock No unauthorised access by humans during construction	At completion of construction	Contract Completion inspection	Stock reported in road reserve after installation of fence Evidence of unauthorised access to the construction site by humans. Damaged fencing	Clearing in the direct vicinity will cease immediately if trigger is met. Clearing will not recommence until no-go areas have been reviewed and confirmed to be in place correctly, and Main Roads Superintendent provides approval to recommence	Construction Contractor Representative Main Roads Superintendent
	Notify adjacent landowners of existing fence removal so stock can be relocated and do not have access to vegetation in the road reserve	All property owners notified of fence removal at least 2 weeks prior to commencing removal of the fence Stock is confirmed to not be within paddock prior to fence removal.	Prior to fence removal	Communication records Site inspections	Stock reported in road reserve after existing fence removed and before installation of replacement fence Stock found to still be in the paddock prior to fence removal.	Landowners notified immediately and stock removed from road reserve. Landowners notified immediately and stock removed from paddock so that fence can be removed.	Construction Contractor Environmental Management Representative

3.2 Monitoring Program

A number of monitoring and reporting activities will be undertaken to ensure management measures are being implemented and completion criteria is being met. Monitoring activities are mapped to each management measure in **Table 3-1**. **Table 3-2** describes the monitoring in more detail, including relevant monitoring guidelines or methods; and responsible people.

Table 3-2: Monitoring Schedule

Monitoring Activity	Parameter Measured	Items Addressed	Applicable Method / Guideline	Responsibility
Weekly site inspection	Compliance with CEMP requirements	• Confirm environmental no-go areas are clearly marked on site • Confirm that clearing outside of approved area or in excess of approved limits has not or will not occur • Confirm areas required for temporary construction activities, such as laydown, are only located on previously cleared areas • Confirm no new occurrences of declared plants within the construction site boundary • Confirm no new occurrences of WoNS or Environmental Weeds within the construction site boundary • Confirm no breach of CoE procedures • Confirm list of wildlife rescue organization contact details is on site • Confirm no visual dust plumes • Confirm hot works procedures are in place and correctly implemented • Confirm no erosion or scouring within vegetation that is to be retained, within no-go areas or outside the approval boundary • Confirm paddocks where fencing has been removed are free of stock • Have previous weed control measures been effective and is follow-up treatment required to eliminate the weeds? • Have weed control measures been implemented as per this CEMP	Visual inspection to confirm that management measures in the CEMP are being implemented correctly.	Construction Contractor Environmental Management Representative
Weekly site inspection during seeding/planting	Revegetation progress	• Revegetation must begin within one year of commencement of the action within all areas identified for revegetation, within one year of the completion of construction • Confirm all revegetation is occurring within winter • Confirm all compacted areas are deep ripped prior to seeding/planting • Confirm no foraging, nesting or roosting plant species for Black Cockatoo are planted within 10 m of the edge of the seal • Confirm all species used for revegetation are as per the Main Roads Revegetation and Landscape Specifications and any alternative species have been approved and provide CBC habitat. • Is the revegetation species mix and density as per the management measures in this CEMP?	Visual inspection by a suitable qualified person to confirm that revegetation is occurring/has occurred in accordance with the Main Roads Revegetation and Landscape Specifications	Construction Contractor Environmental Management Representative
Annual revegetation monitoring	Revegetation progress	• Confirm that revegetated areas are tracking towards achieving completion criteria as verified by a suitable qualified person • Identify areas that require further infill planting, based on commitments made in this CEMP • Identify areas that require further weed controls, based upon commitments made in this CEMP • Confirm completion criteria is being achieved	Visual inspection to confirm that revegetation is occurring/has occurred in accordance with the Main Roads Revegetation and Landscape Specifications and this CEMP	Main Roads Environment Management Representative

Monitoring Activity	Parameter Measured	Items Addressed	Applicable Method / Guideline	Responsibility
Pre-clearing surveys for hollows being used by Black Cockatoos	Presence of hollows being used by Black Cockatoo	• Confirm all actual or potential nesting trees are free of hollows that are being used by Black Cockatoo before clearing begins • Confirm that Black Cockatoo are no longer using hollows before clearing begins • Maintain a register of nesting trees	Suitably qualified person with experience in hollow identification to visually inspect all potential nesting trees within the clearing area and record spatial co-ordinates for any trees identified with hollows that are being utilised, or are capable of being utilised, by Black Cockatoos. Monitoring will be conducted in line with best practice and monitoring methods used will be consistent with advice contained within the Black Cockatoo Recovery Plan (DPAW, 2013). Note: no-go areas are areas of vegetation that are not approved to be cleared, these include trees with hollows that are being used by or are suitable for Black Cockatoos, conservation significant flora and all areas outside of the approval boundary. These areas are identified on the engineering drawings issued for construction.	Suitably qualified person
Follow up weed monitoring	Weed control	• Confirm no new occurrence or spread of Declared Plants within the construction site boundary during construction activities • Confirm no new occurrence or spread of WoNS or environmental weeds within the construction site boundary • Confirm all plant and machinery will be verified clean on arrival at site • Confirm no breach of CoE protocols	Monthly site inspections Annual revegetation monitoring Records verifying plant and machinery arriving on site is clean CoE records/logs	Construction Contractor Environmental Management Representative
Water quality downstream of the Brockman River crossing	Water quality of the Brockman River	• Confirm no statistically significant change in water quality of the Brockman River resulting from construction activities	Establish water quality monitoring sites upstream and downstream of the crossing location Weekly sampling of surface water at these sites during in river works. Field readings for pH and EC to be taken during sampling. Lab analysis of samples for EC, TSS, TN, TP, aluminium, cadmium, chromium, copper, nickel, lead, zinc and polycyclic aromatic hydrocarbons Review downstream results against upstream control site	Construction Contractor Environmental Management Representative

3.3 Managing Uncertainty

This CEMP has been developed based on a number of different data and information sources. This data and information has informed the risk assessments and management actions contained within this CEMP and as a result any limitations or uncertainties with this data or information may impact the accuracy of this CEMP. **Table 3-3** contains measures for managing this uncertainty so that the CEMP continues to be based on the most up to date and relevant data and information.

Table 3-3: Measures for Managing Uncertainty

Data / Information Source	Limitations / Uncertainty	Risk Presented by Limitation / Uncertainty	Risk Management Measures
Road Alignment Design	Concept level of design only.	Unforeseen/additional impact to MNES Design changes result in alignment moving outside of approved areas.	Design changes reviewed against requirements of this CEMP, MNES occurrences and statutory conditions of approval
Ecological Surveys (FVC 2017, 2018, 2019; BCE 2017, 2018, 2019)	High level of certainty. No significant limitations. Assessments undertaken in line with relevant guidelines and approved methods.	N/A	N/A
Phytophthora Dieback Assessment (Terratree 2018)	Dieback surveys undertaken 2+ years in advance of commencement of construction.	Extent of dieback infested areas may change between the time of the survey and start of construction.	Boundaries of Dieback infested areas checked by a qualified Dieback interpreter prior to commencement of construction.

4. CEMP Implementation

4.1 Roles and Responsibilities

All project personnel, including sub-contractors/sub-consultants, are responsible for complying with applicable Commonwealth and State legislation, local government requirements and the conditions of all licences, permits and approvals relevant to the Bindoon Bypass. Specific responsibilities in relation to this CEMP are provided in **Table 4-1**.

Table 4-1: CEMP Roles and Responsibilities

Role	CEMP Responsibilities
Main Roads Project Manager	• The overall management and control of the CEMP. • Reviewing and approving the CEMP. • Ensuring that the necessary transfer of risk and obligations to the contractor (arising from the CEMP) are carried to the construction contract • Assisting with implementation of the CEMP and sub-plans. • Providing the necessary resources to ensure the CEMP is properly implemented. • Ensuring all personnel are inducted into the project's environmental requirements prior to commencement of works on-site. • Ensuring suppliers are made aware of the environmental objectives pertaining to them through conditions of contract. • Taking strategic actions to continuously improve the CEMP. • Participating in incident investigations. • Management, implementation, monitoring and compliance of the CEMP and any approval conditions, including construction supervision and performance of all staff, contractors and subcontractors. • Reviewing CEMP performance and implementation of correction actions, or stop work procedures, in the event of breaches of CEMP conditions, that may lead to serious impacts on local communities, or affect the reputation of the project. • Representing the project at community meetings.
Main Roads Superintendent	• Confirming all environmental requirements are implemented as outlined in the CEMP as required to avoid and minimise actual or potential environmental harm on-site. • Assisting the Environmental Management Representative to develop and maintain the various registers and checklists. • Supporting the Environmental Management Representative to plan and implement environmental requirements. • Reporting activity that has resulted, or has the potential to result, in an environmental incident immediately to the Environmental Management Representative. • Participating in incident investigations.

Role	CEMP Responsibilities
	• Monitoring construction activities to ensure that identified and appropriate control measures are effective and in compliance with the CEMP. • Managing CEMP performance and implementation of correction actions, or stop work procedures, in the event of breaches of CEMP conditions, that may lead to serious impacts on local communities, or affect the reputation of the project. • Ensuring that all construction personnel and subcontractors are informed of the intent of the CEMP and are made aware of the required measures for environmental a compliance and performance. • Ensuring effective communication and dissemination of the content and requirements of the CEMP to contractors and subcontractors. • During construction, maintain traffic safety along access roads, with special emphasis on high trafficked areas.
Main Roads Environmental Management Representative	• Reviewing the CEMP. • Developing sub-plans and monitoring programs required under this CEMP. • Being the primary contact point in relation to the environmental performance of the construction phase. • Managing procedures and practices for receiving and responding to complaints and inquiries in relation to the environmental performance. • Reporting any activity that has resulted in, or has the potential to result in an environmental incident immediately to the Project Manager, Construction Manager and other relevant personnel. • Considering and advising on matters specified in the conditions of licences and approvals relating to the environmental performance and impacts of the proposal. • Requiring reasonable steps to be taken to avoid or minimise unintended or adverse environmental impacts, and failing the effectiveness of such steps, to direct that relevant actions be ceased immediately should an adverse impact on the environment is likely to occur. • Identifying environmental competence requirements for all staff and ensure delivery of environmental training to personnel within the team. • Acting as main point of contact between the regulatory authorities and the proposal on environmental issues. • Providing advice and liaison with the construction teams to ensure that environmental risks are identified and appropriate controls are developed and included within method statements. • Assisting in the development and delivery of environmental training for site personnel and subcontractors. • Environmental auditing of subcontractors and suppliers. • Managing the environmental monitoring program once construction has been completed.

Role	CEMP Responsibilities
Construction Contractor Representative	• Assisting with implementation of the CEMP for construction related activities. • Providing the necessary resources to ensure the CEMP is properly implemented. • Making sure all personnel are inducted into the proposal's environmental requirements prior to commencement of works on-site. • Participating in incident investigations. • Management, implementation, monitoring and compliance of the CEMP and any approval conditions
Construction Contractor Environmental Management Representative	• Implementation of the CEMP on-site • Coordinating and managing all the environmental activities during the construction phase. • Being the primary contact point in relation to the environmental performance of the construction phase. • Managing procedures and practices for receiving and responding to complaints and inquiries in relation to the environmental performance. • Reporting any activity that has resulted in, or has the potential to result in an environmental incident immediately to the Main Roads Superintendent and other relevant personnel. • Requiring reasonable steps to be taken to avoid or minimise unintended or adverse environmental impacts, and failing the effectiveness of such steps, to direct that relevant actions be ceased immediately should an adverse impact on the environment is likely to occur. • Identify environmental competence requirements for all staff and ensure delivery of environmental training to personnel within the team. • Assistance in the development and delivery of environmental training for site personnel and subcontractors. • Management of the construction contractor's environmental monitoring, inspection and audit program in so far as it relates to construction activities.

4.2 Environmental Training

An environment and heritage induction will be carried out for all visitors, personnel, contractors and sub-consultants who are required to work on the Project. This induction details the responsibilities of all project personnel, contractors and sub-consultants under this CEMP and outlines environmental requirements that personnel need to be aware of when undertaking work activities in accordance with this CEMP.

All personnel will be required to sign an attendance form on completion of the induction. Attendance at these inductions is recorded in the training register for the Project.

Daily pre-start meetings will be conducted to inform project personnel of specific environmental issues related to the day's work. These meetings are to also include visitors and sub-consultants who are on site. In addition, toolbox meetings will be held with all project personnel to provide environmental awareness training and to disseminate any relevant outcomes of environmental inspection and audits, including areas for improvement or positive achievements.

Specialised training will be provided to relevant personnel and will include spill prevention, control and containment/clean up; erosion and sediment control; and environmental emergency response.

4.3 Inspections, Audits and Reporting

4.3.1 Contractor Inspections and Audits

The Construction Contractor will undertake monthly inspection of the entire worksite against this CEMP for the duration of construction works. Where any 'High' or 'Severe' risks are identified, inspections in the areas to which these apply will be undertaken on a weekly basis.

An audit against this CEMP will be undertaken by the Construction Contractor within five weeks of commencement of work and every three months thereafter.

Main Roads will conduct environment and heritage audits of the construction contract area on a six monthly basis during the construction phase.

4.3.2 Incident Reporting

Environmental incident categories and reporting timeframes are outlined in the 'Main Roads Environmental Incident and Investigation Report Form'. This form provides a guide for classifying the severity of an environment or heritage incident and the required reporting timeframe to be adhered to.

The following is a summary of the Main Roads Environmental Guideline: *Environmental Incidents: Reporting, Investigation and Management*.

In this instance that an environmental incident occurs:

- Immediate remedial action to be undertaken: where safe to do so the observer of an incident should undertake any immediate actions to stop, control or contain the incident to prevent further damage;
- Determine the environmental incident category (i.e. minor, significant or major): environmental incidents are to be categorised as per the Environmental Incident Category table accompanying the 'Main Roads Environmental Incident and Investigation Report Form';
- Notify management: notification requirements for environmental incidents are listed on the 'Main Roads Environmental Incident and Investigation Report Form';
- Assessment and investigation;
- Complete an incident report: the 'Main Roads Environmental Incident and Investigation Report Form' will be used to record environmental incidents associated with the Project;
- Corrective and preventative actions – the Contractor will track the progress of agreed corrective and preventative actions; and
- All environmental incidents are to be reported to the Superintendent and filed by the Contractor.

Corrective actions may also arise from audits, inspections and management reviews. Corrective actions are to be reviewed and endorsed by Main Roads before the action is implemented. Audits will follow to confirm satisfactory completion of the corrective action.

4.4 Review

4.4.1 Risk Review

The environmental risk assessment will be reviewed periodically to confirm it remains relevant and captures all risks to Black Cockatoo, Banksia woodlands TEC and Chuditch. Additional review triggers are:

- changes to project/CEMP scope;
- following significant environmental incidents;
- implementation of corrective actions or contingency management measures; or
- when new information with regards to the relevant MNES becomes available.

4.4.2 CEMP Review

The CEMP will be reviewed and updated as required. Each review will include an evaluation of the effectiveness of the plan and incorporate new data / information pertinent to the management of the relevant MNES. Triggers for review are as follows:

- annual review from the approval date of the CEMP;
- following significant environmental incidents;
- anticipated changes to scope;
- in response to community or stakeholder complaints;
- identification of non-compliance with environmental approval conditions;
- if monitoring results, inspections and/or audits indicate performance targets or completion criteria may not be achieved or maintained; or
- when monitoring results, inspections and/or audits indicate completion criteria have been achieved.

The CEMP will be updated by the Main Roads Environmental Management Representative or a suitably qualified delegate and approved by the Main Roads Project Director.

Changes to the CEMP will be communicated to all project personnel, contractors and sub-consultants via the regular pre-start and toolbox meetings.

5. Data Management

Records will be kept in order to demonstrate compliance with this CEMP. These records include, but are not limited to, the following:

- risk assessments;
- audit results and reports, including the timing, location and spatial delineation of clearing, and periodic reconciliation against approved disturbance limits;
- monthly and weekly inspection results;
- environmental incident reports;
- monitoring data, results and reports;
- records of revegetation activities including dates, location and area of revegetation, species mixes used and quantities;
- induction records;
- pre-start and toolbox meeting minutes; and
- correspondence between Main Roads, construction contractors and/or regulators relating to the requirements of this CEMP.

The Main Roads Site Superintendent and the Construction Contractor Representative are responsible for establishing and maintaining electronic and hardcopy filing systems for the above information. Once construction is completed, all documents that were kept on site during construction will be transferred to Main Roads head office as part of site demobilisation.

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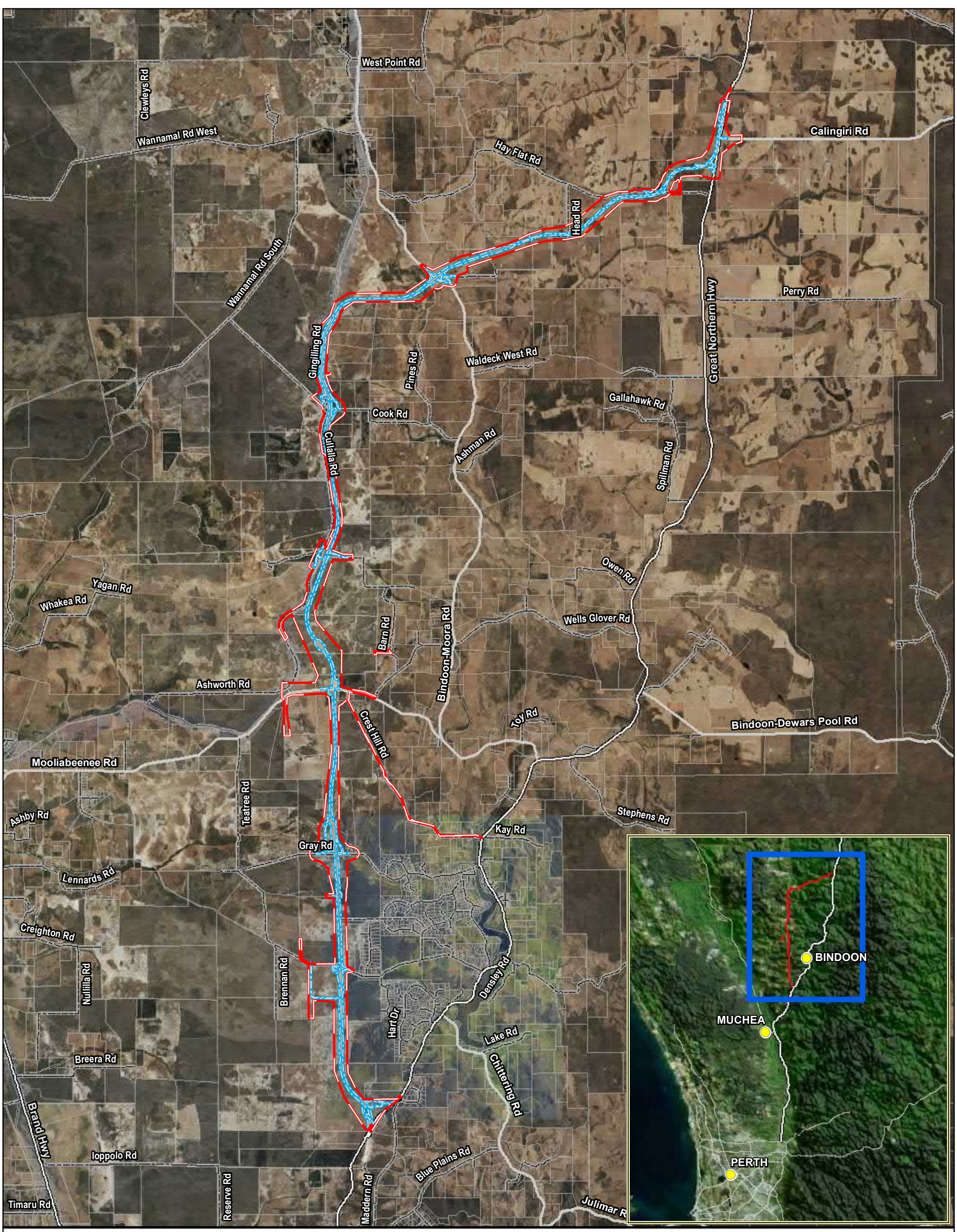
Figures



Legend

- Development Envelope
- Development Footprint
- Highway
- Major Road
- Minor Road
- Cadastral Boundary

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Metres

Scale at A3 1:120,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Project
Great Northern Highway
Bindoon Bypass South
Environmental Review Document

Figure: 1 - Proposal Location

Drawing No	Issue
GNH-CN12-EA-PER-00001 F1-1	1

Task	Drawing Status / Other
EDR	Draft

Date	By	Chkd	Appd
30/05/2019	BG	LB	TJ

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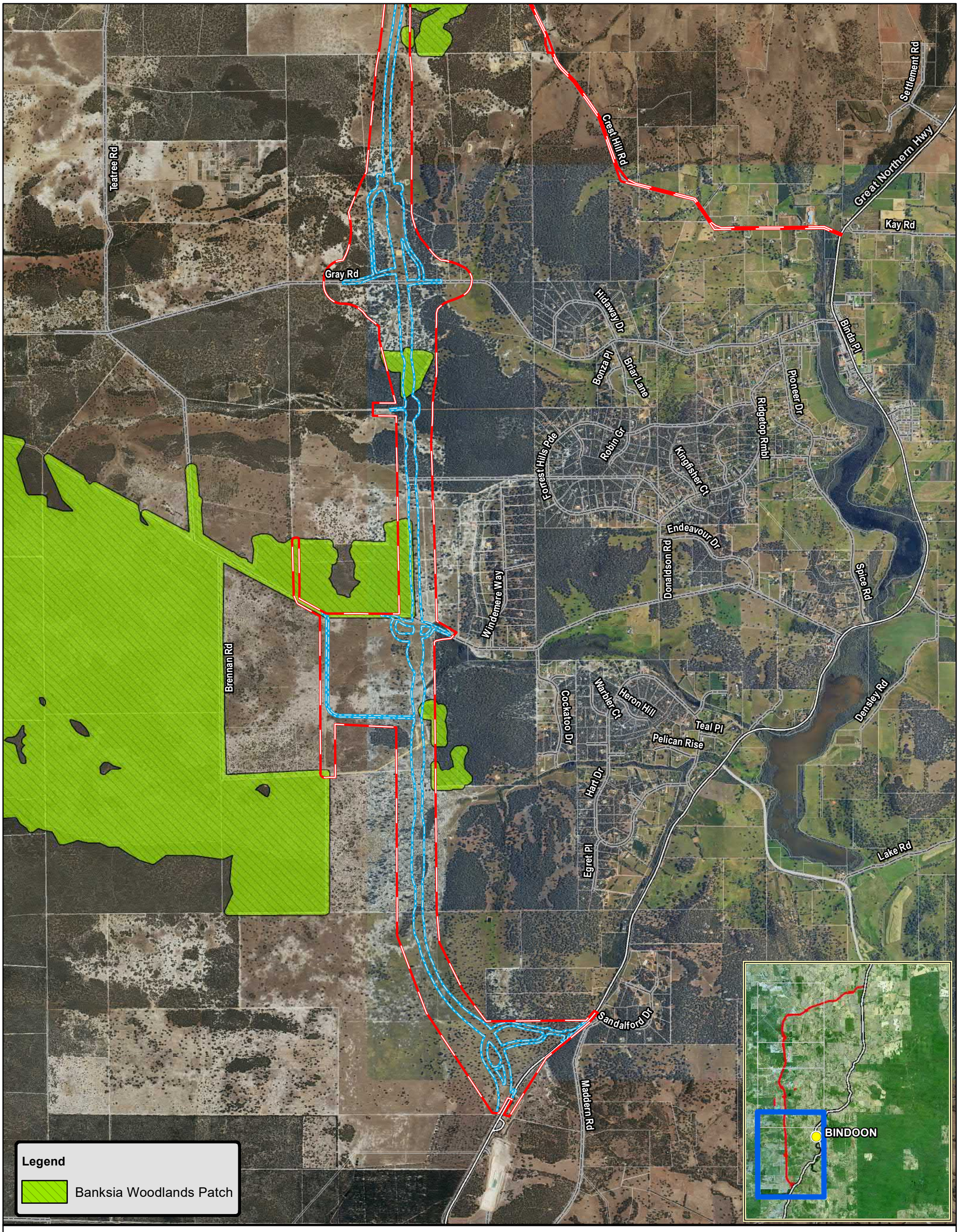

Legend

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Scale at A3 1:40,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
Environmental Review Document
Project

Figure 2: Banksia Woodlands of the Swan Coastal Plain TEC (Source: FVC 2018a)

Drawing No	Issue
GNH-CN12-EA-PER-0001 4-8	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
13/03/2020	BG	LB	TJ

MXD Location: \\Jacobs.com\PERProjects\PBIFi\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-8.mxd

Cook Rd
Ashman Rd
Bindoon-Moora Rd
Kinkella Rd
Cullalla Rd
Barn Rd
Bridges Rd
Wells Glover Rd
Ashworth Rd
Mooliabeenee Rd
Crest Hill Rd
Teatree Rd
BINDOON

Legend

Banksia Woodlands Patch

Legend

Development Envelope
Development Footprint
Cadastral Boundary
Highway
Major Road
Minor Road

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Project

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Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
13/03/2020	BG	LB	TJ

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-8.mxd

Hay Flat Rd
Wannamal Rd South
Kangaroo Gully Rd
Gingilling Rd
Cullalla Rd
Pines Rd
Waldeck West Rd
Cook Rd
Ashman Rd
BINDOON

Legend

Banksia Woodlands Patch

Legend

Development Envelope
Development Footprint
Cadastral Boundary
Major Road
Minor Road

0 480 960
Metres

Coordinate System: GDA 1994 MGA Zone 50

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GNH-CN12-EA-PER-0001 4-8	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
13/03/2020	BG	LB	TJ

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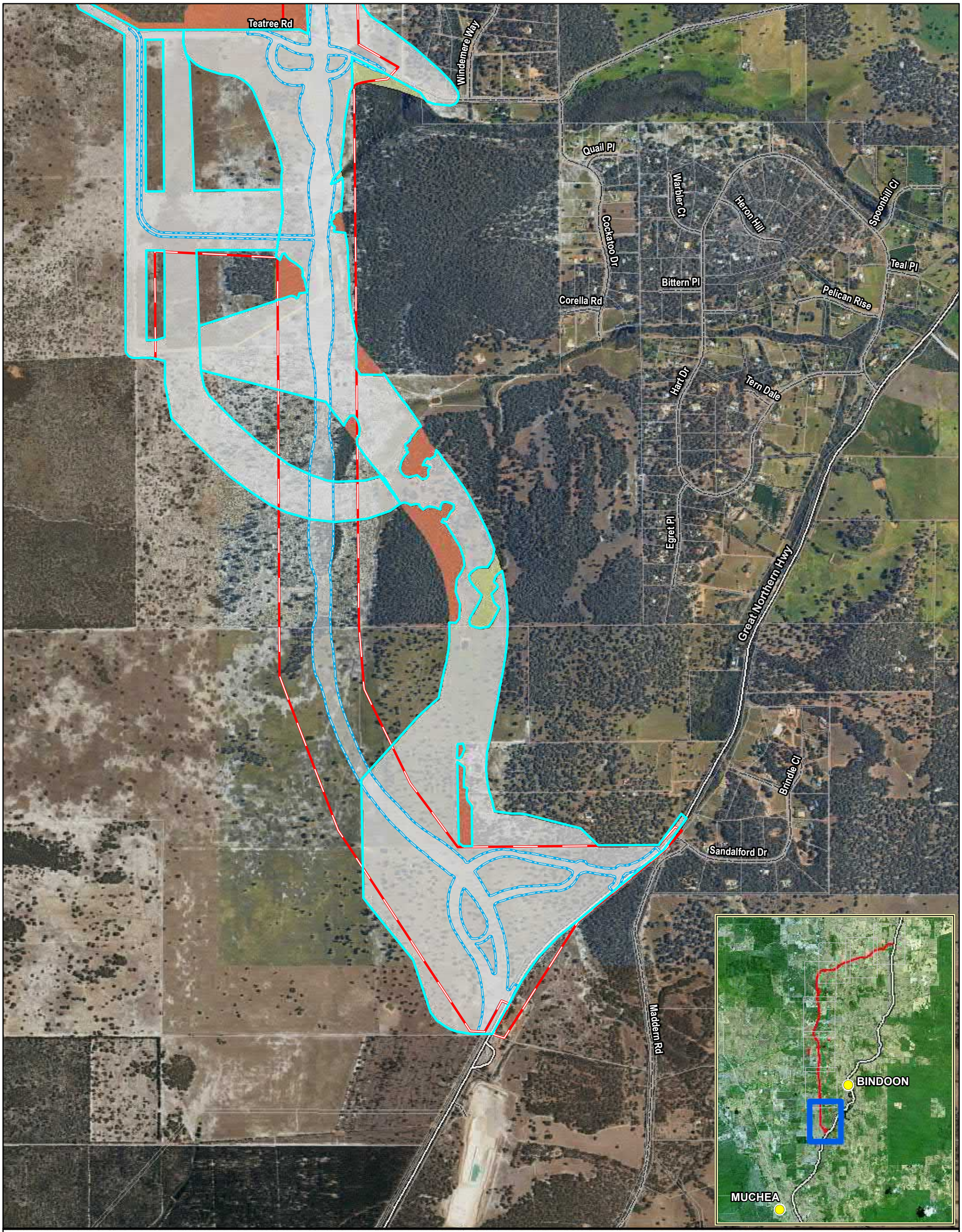

Legend

- Development Envelope
- Development Footprint
- Highway
- Major Road
- Minor Road
- Cadastral Boundary

Dieback Assessment Mapping (Terratree)

- Uninfested
- Uninterpretable
- Not Assessed

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Metres

Scale at A3 **1:20,000**

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway Bindoon Bypass Environmental Review Document
Project

Figure 3: Dieback Mapping (Source: Terratree 2018)

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-10	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
22/08/2019	BG	LB	TJ

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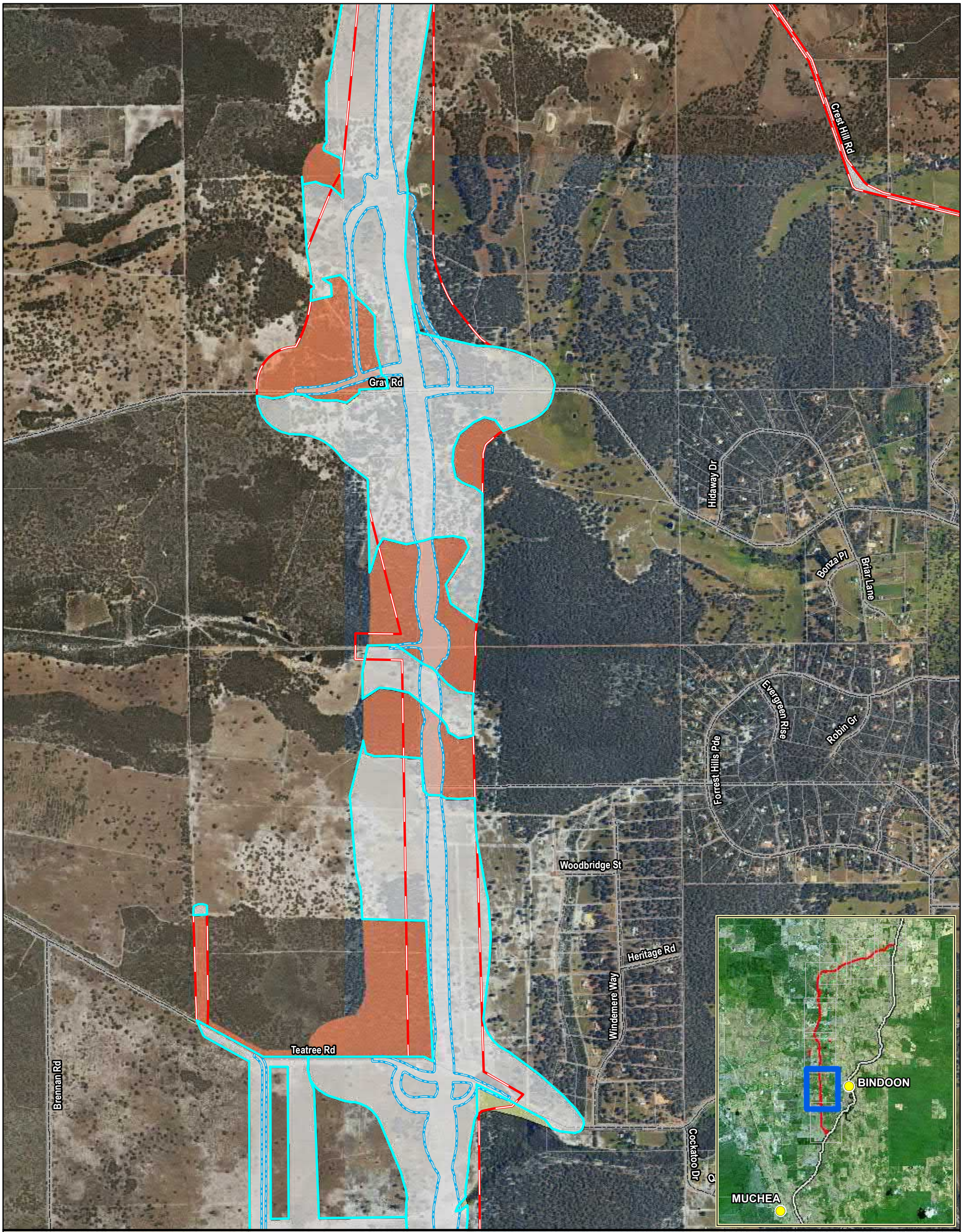

Legend

- Development Envelope
- Development Footprint
- Minor Road
- Cadastral Boundary

Dieback Assessment Mapping (Terratree)

- Uninfested
- Uninterpretable
- Not Assessed

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Metres

Scale at A3 **1:20,000**

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Project
Great Northern Highway
Bindoon Bypass
Environmental Review Document

Figure 3: Dieback Mapping (Source: Terratree 2018)

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-10	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
22/08/2019	BG	LB	TJ

MXD Location: \\Jacobs.com\PERProjects\PBIFI\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-10.mxd

Cullalla Rd
Barn Rd
Ashworth Rd
Mooliabeenee Rd
Wells Glover Rd
Crest Hill Rd
BINDOON
MUCHEA

Legend

- Development Envelope
- Development Footprint
- Major Road
- Minor Road
- Cadastral Boundary

Dieback Assessment Mapping (Terratree)

- Infested
- Uninfested
- Uninterpretable
- Not Assessed

Joint Venture Partners:

Arup Pty Ltd
Level 14 Exchange Tower
2 The Esplanade
Perth WA 6000
Tel +61 8 9327 8300 Fax +61 8 9481 1334
www.arup.com

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
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www.jacobs.com

0 240 480
Metres

Scale at A3 **1:20,000**

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Project
Great Northern Highway
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Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-10	1

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ERD	Draft

Date	By	Chkd	Appd
22/08/2019	BG	LB	TJ

MXD Location: \\Jacobs.com\PERProjects\PBIFI\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-10.mxd

Cullala Rd

Barn Rd

BINDOON

MUCHEA

Legend

- Development Envelope
- Development Footprint
- Minor Road
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Dieback Assessment Mapping (Terratree)

- Infested
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0 240 480
Metres

Scale at A3
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Coordinate System: GDA 1994 MGA Zone 50

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Great Northern Highway
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Figure 3: Dieback Mapping (Source: Terratree 2018)

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Task No	Drawing Status / Other
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22/08/2019	BG	LB	TJ

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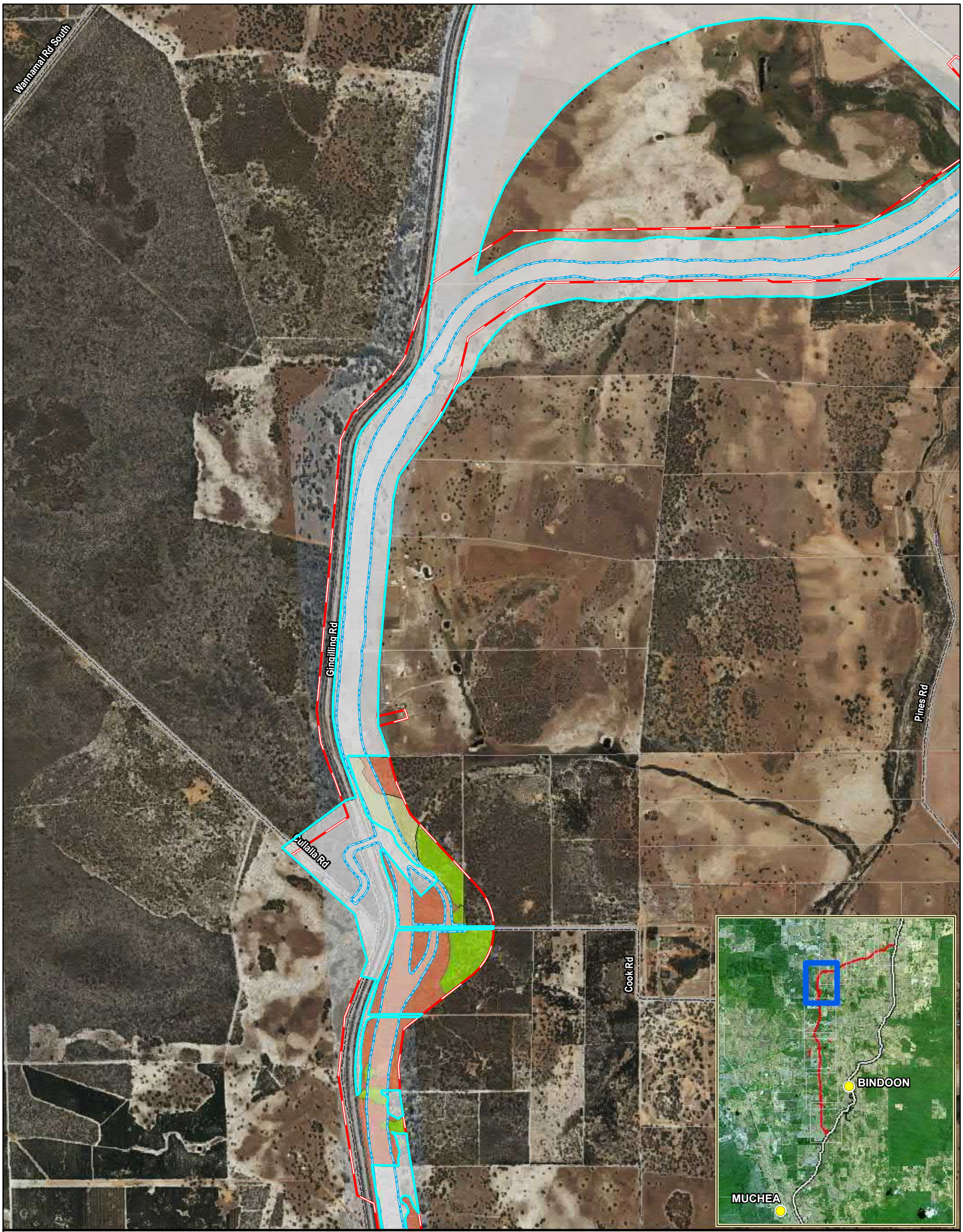

Legend

- Development Envelope
- Development Footprint
- Major Road
- Minor Road
- Cadastral Boundary

Dieback Assessment Mapping (Terratree)

- Infested
- Uninfested
- Uninterpretable
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0 240 480
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Scale at A3 1:20,000

Coordinate System: GDA 1994 MGA Zone 50

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Figure 3: Dieback Mapping (Source: Terratree 2018)

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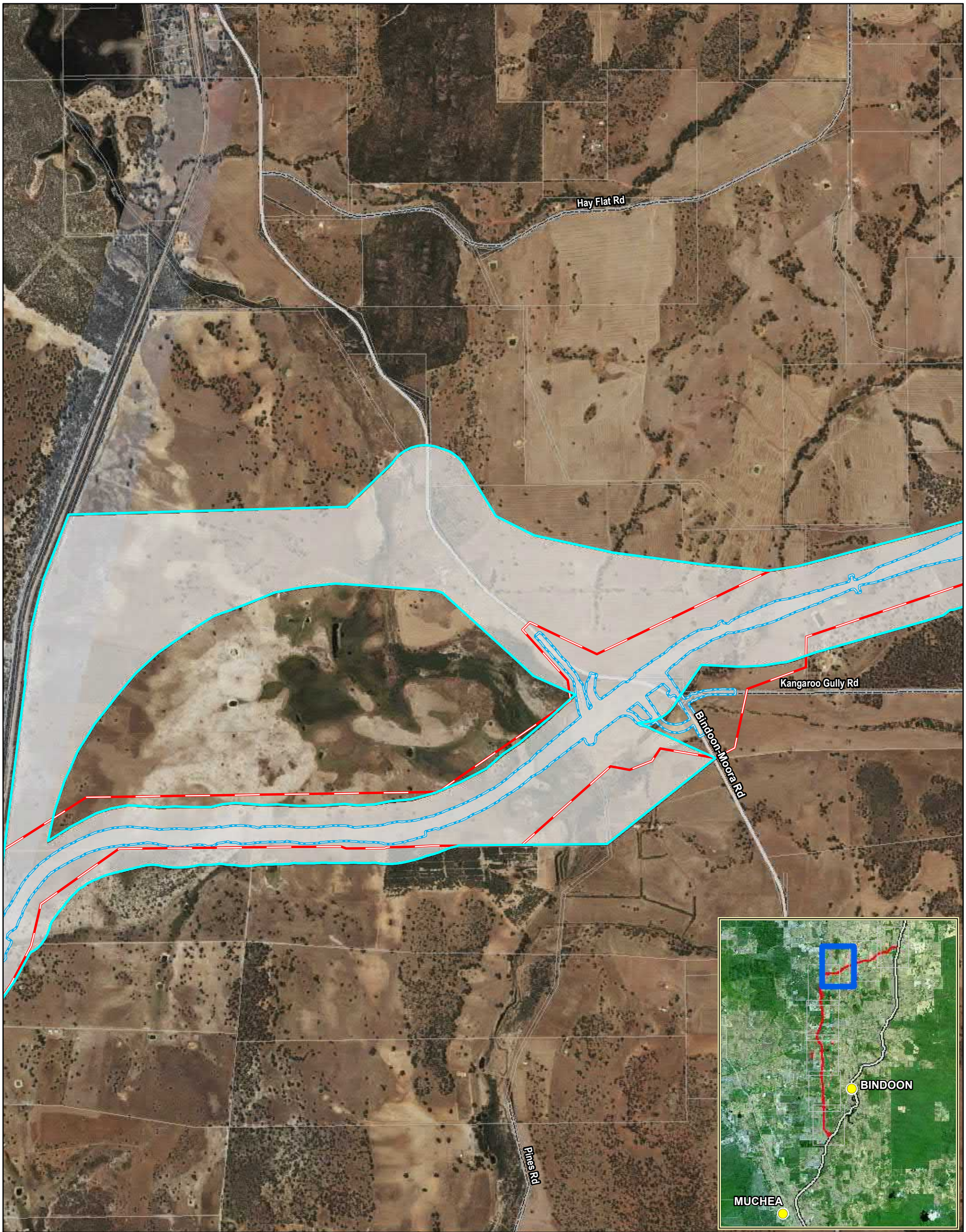

Legend

- Development Envelope
- Development Footprint
- Major Road
- Minor Road
- Cadastral Boundary

Dieback Assessment Mapping (Terratree)

- Not Assessed

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0 240 480
Metres

Scale at A3 **1:20,000**

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Main Roads Western Australia
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Great Northern Highway
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Figure 3: Dieback Mapping (Source: Terratree 2018)

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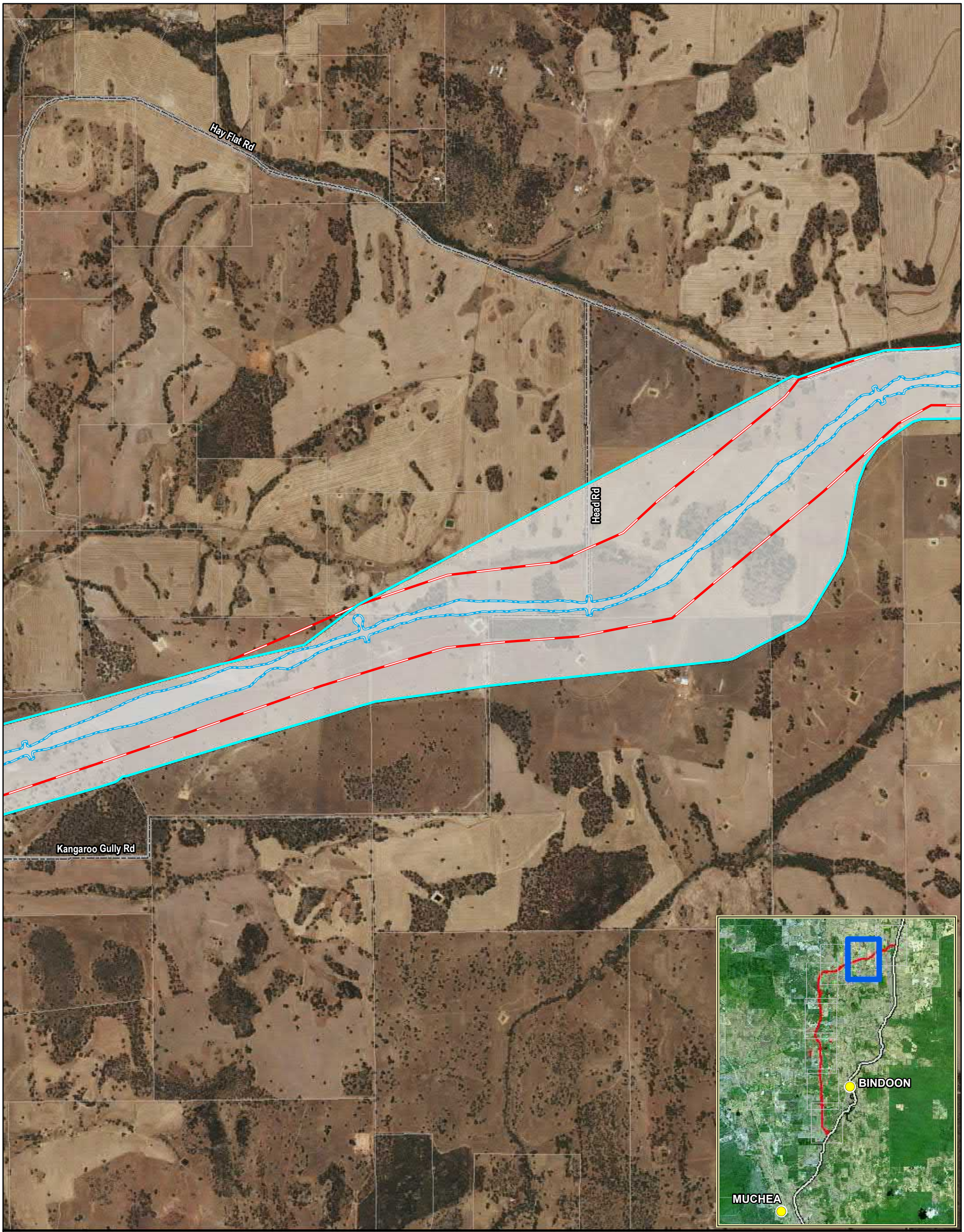

Legend

- Development Envelope
- Development Footprint
- Minor Road
- Cadastral Boundary

Dieback Assessment Mapping (Terratree)

- Not Assessed

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Metres

Scale at A3
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Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
Environmental Review Document
Project

Figure 3: Dieback Mapping (Source: Terratree 2018)

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Task No	Drawing Status / Other
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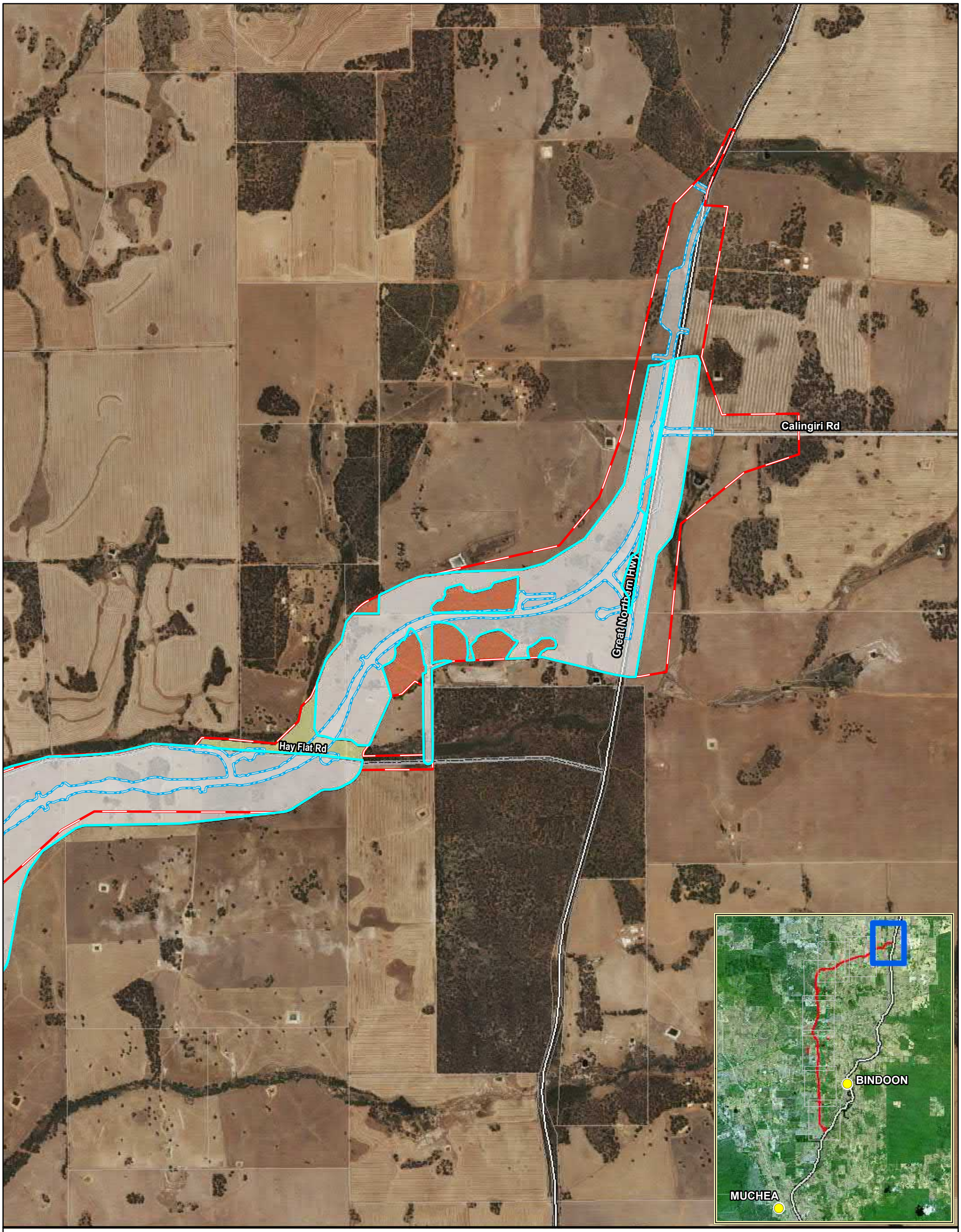

Legend

- Development Envelope
- Development Footprint
- Highway
- Major Road
- Minor Road
- Cadastral Boundary

Dieback Assessment Mapping (Terratree)

- Uninfested
- Uninterpretable
- Not Assessed

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0 240 480
Metres

Scale at A3 **1:20,000**

Coordinate System: GDA 1994 MGA Zone 50

Client: **Main Roads Western Australia**

Project: **Great Northern Highway Bindoon Bypass Environmental Review Document**

Figure 3: Dieback Mapping (Source: Terratree 2018)

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-10	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
22/08/2019	BG	LB	TJ

MXD Location: \\Jacobs.com\PERProjects\PBIFI\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-10.mxd

Cockatoo Dr
Heron Hill
Teal Pl
Bittern Pl
Pelican Rise
Corella Rd
Hart Dr
Tern Dale
Egret Pl
Great Northern Hwy
Brindle Cl
Sandalford Dr
Maddern Rd
BINDOON

Legend

- Development Envelope
- Development Footprint
- Highway
- Major Road
- Minor Road
- Cadastral Boundary

CBC Habitat (FVC)

Foraging Vales

- 0 - Nil
- 0 - Nil (Extrapolated)
- 1 - Negligible
- 1 - Negligible (Extrapolated)
- 2 - Low
- 3 - Low-Moderate
- 3 - Low-Moderate (Extrapolated)
- 4 - Moderate
- 5 - Moderate - High

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www.jacobs.com

0 240 480
Metres

Scale at A3 **1:20,000**

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
Environmental Review Document
Project

Figure 4: Carnaby's Black Cockatoo Habitat Foraging Value

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-14	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
13/08/2019	BG	LB	TJ

MXD Location: \\Jacobs.com\PERProjects\PBIFI\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-14.mxd

Robin Gr
Forrest Hills Pde
Woodbridge St
Heritage Rd
Windemere Way
Teatree Rd
Brennan Rd
Quail Pl
Warbler Ct
Cockatoo Dr
Bittern Pl
Corella Rd
Hart Dr
Egret Pl
BINDOON

Legend

- Development Envelope
- Development Footprint
- Highway
- Minor Road
- Cadastral Boundary

CBC Habitat (FVC)

Foraging Vales

- 0 - Nil
- 0 - Nil (Extrapolated)
- 1 - Negligible
- 1 - Negligible (Extrapolated)
- 2 - Low
- 2 - Low (Extrapolated)
- 3 - Low-Moderate
- 3 - Low-Moderate (Extrapolated)
- 4 - Moderate
- 5 - Moderate - High
- 6 - High

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0 240 480
Metres

Scale at A3 **1:20,000**

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia

Client

Project

Great Northern Highway
Bindoon Bypass
Environmental Review Document

Figure 4: Carnaby's Black Cockatoo Habitat Foraging Value

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-14	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
13/08/2019	BG	LB	TJ

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-14.mxd

Gray Rd
Crest Hill Rd
Hidaway Dr
Bonza Pl
Briar Lane
Evergreen Rise
Robin Gr
Forrest Hills Pde
Woodbridge St
Heritage Rd
Windemere Way
Teatree Rd
Brennan Rd
BINDOON

Legend

- Development Envelope
- Development Footprint
- Minor Road
- Cadastral Boundary

CBC Habitat (FVC)
Foraging Vales

- 0 - Nil
- 0 - Nil (Extrapolated)
- 1 - Negligible
- 1 - Negligible (Extrapolated)
- 2 - Low
- 2 - Low (Extrapolated)
- 3 - Low-Moderate
- 3 - Low-Moderate (Extrapolated)
- 4 - Moderate
- 4 - Moderate (Extrapolated)
- 5 - Moderate - High
- 6 - High

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0 240 480
Metres

Scale at A3 **1:20,000**

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
Environmental Review Document
Project

Figure 4: Carnaby's Black Cockatoo Habitat Foraging Value

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-14	1

Task No	Drawing Status / Other
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Date	By	Chkd	Appd
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MXD Location: \\Jacobs.com\PERProjects\PBIFI\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-14.mxd

Mooliabeenee Rd

Crest Hill Rd

Gray Rd

Teatree Rd

BINDOON

Legend

- Development Envelope
- Development Footprint
- Major Road
- Minor Road
- Cadastral Boundary

CBC Habitat (FVC)

Foraging Vales

- 0 - Nil
- 0 - Nil (Extrapolated)
- 1 - Negligible
- 2 - Low
- 2 - Low (Extrapolated)
- 3 - Low-Moderate
- 4 - Moderate
- 4 - Moderate (Extrapolated)
- 5 - Moderate - High
- 6 - High

Joint Venture Partners:

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0 240 480
Metres

Scale at A3 1:20,000

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Main Roads Western Australia
Client

Great Northern Highway
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Figure 4: Carnaby's Black Cockatoo Habitat Foraging Value

Drawing No	Issue
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Curlalla Rd

Barn Rd

Ashworth Rd

Mooliabeenee Rd

Wells Glover Rd

Crest Hill Rd

BINDOON

Legend

- Development Envelope
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- Major Road
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CBC Habitat (FVC)

Foraging Vales

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- 4 - Moderate (Extrapolated)
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Drawing No	Issue
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Barn Rd
Cullalla Rd
Wells Glover Rd
Mooliabeenee Rd
Bindoon-Moora Rd
Crest Hill Rd
Atkinson Rd
BINDOON

Legend

- Development Envelope
- Development Footprint
- Major Road
- Minor Road
- Cadastral Boundary

CBC Habitat (FVC)

Foraging Vales

- 0 - Nil
- 0 - Nil (Extrapolated)
- 1 - Negligible
- 2 - Low
- 2 - Low (Extrapolated)
- 3 - Low-Moderate
- 4 - Moderate
- 4 - Moderate (Extrapolated)
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Moolilabeenee Rd
Atkinson Rd
Bindoon-Moora Rd
Toy Rd
Settlement Rd
Crest Hill Rd
Kay Rd
Great Northern Hwy
Fishers Rd
Hidaway Dr
Cammeray Cl
Gray Rd
Clune Rd
Needoonga Pl
Bonza Pl
Briar Lane
Ridgetop Rmbl
Pioneer Dr
Forrest Hills Pde
Lakeside Gr
Evergreen Rise
Robin Gr
Orchard Rd
Kingfisher Ct
BINDOON

Legend

- Development Envelope
- Highway
- Major Road
- Minor Road
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CBC Habitat (FVC)
Foraging Vales

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0 240 480
Metres

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Figure 4: Carnaby's Black Cockatoo Habitat Foraging Value

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Kinkella Rd
Cullalla Rd
Bam Rd
Wells Glover Rd
Mooliabeenee Rd
Ashworth Rd
Crest Hill Rd
BINDOON

Legend

- Development Envelope
- Development Footprint
- Major Road
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CBC Habitat (FVC)

Foraging Vales

- 0 - Nil
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- 2 - Low (Extrapolated)
- 3 - Low-Moderate
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- 4 - Moderate (Extrapolated)

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Metres

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Client

Project
Great Northern Highway
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Figure 4: Carnaby's Black Cockatoo Habitat Foraging Value

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Cullalla Rd

Barn Rd

Kinkella Rd

BINDOON

Legend

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- Development Footprint
- Minor Road
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CBC Habitat (FVC)

Foraging Vales

- 0 - Nil
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- 2 - Low (Extrapolated)
- 3 - Low-Moderate
- 4 - Moderate

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Client

Project
Great Northern Highway
Bindoon Bypass
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Figure 4: Carnaby's Black Cockatoo Habitat Foraging Value

Drawing No	Issue
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Task No	Drawing Status / Other
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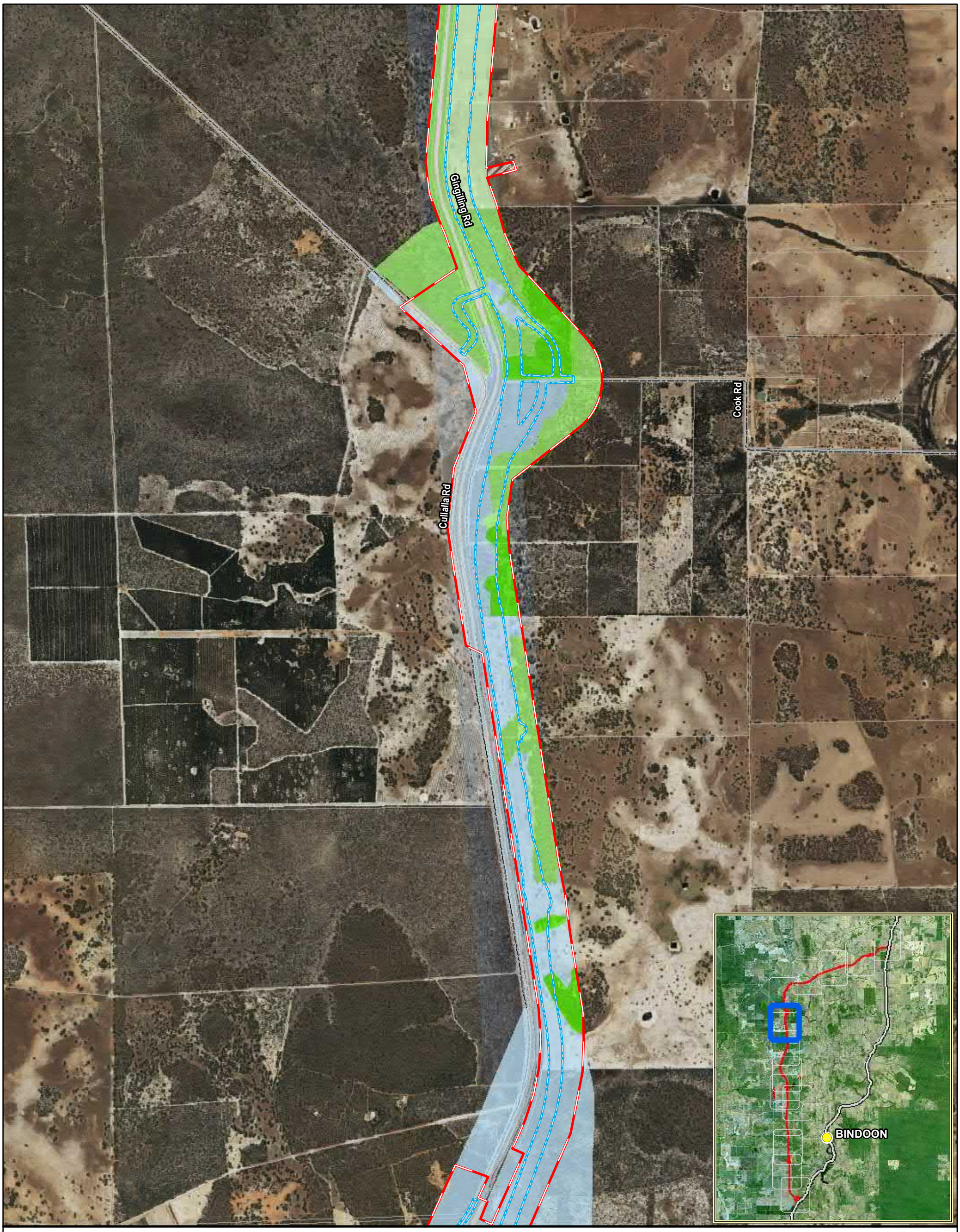

Legend

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- Development Footprint
- Minor Road
- Cadastral Boundary

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Foraging Vales

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0 240 480
Metres

Scale at A3 **1:20,000**

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia

Client

Project

Great Northern Highway
Bindoon Bypass
Environmental Review Document

Figure 4: Carnaby's Black Cockatoo Habitat Foraging Value

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-14	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
13/08/2019	BG	LB	TJ

MXD Location: \\Jacobs.com\PERProjects\PBIFI\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-14.mxd

Wannamal Rd South

Gingilling Rd

Cullalla Rd

BINDOON

Legend

- Development Envelope
- Development Footprint
- Minor Road
- Cadastral Boundary

CBC Habitat (FVC)

Foraging Vales

- 0 - Nil
- 0 - Nil (Extrapolated)
- 1 - Negligible
- 2 - Low
- 2 - Low (Extrapolated)
- 3 - Low-Moderate
- 4 - Moderate

Joint Venture Partners:

Arup Pty Ltd
Level 14 Exchange Tower
2 The Esplanade
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Date	By	Chkd	Appd
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MXD Location: \\Jacobs.com\PERProjects\PBIFI\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-14.mxd

Hay Flat Rd

Kangaroo Gully Rd

Bindoon-Moora Rd

Pines Rd

BINDOON

Legend

- Development Envelope
- Development Footprint
- Major Road
- Minor Road
- Cadastral Boundary

CBC Habitat (FVC)

Foraging Vales

- 0 - Nil
- 1 - Negligible
- 2 - Low
- 2 - Low (Extrapolated)
- 3 - Low-Moderate
- 5 - Moderate - High

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Figure 4: Carnaby's Black Cockatoo Habitat Foraging Value

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GNH-CN12-EA-PER-00001 - F4-14	1

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ERD	Draft

Date	By	Chkd	Appd
13/08/2019	BG	LB	TJ

MXD Location: \\Jacobs.com\PERProjects\PBIFI\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-14.mxd

Hay Flat Rd

Head Rd

Kangaroo Gully Rd

Bindoon-Moora Rd

BINDOON

Legend

- Development Envelope
- Development Footprint
- Major Road
- Minor Road
- Cadastral Boundary

CBC Habitat (FVC)
Foraging Vales

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- 2 - Low
- 2 - Low (Extrapolated)
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Hay Flat Rd

Head Rd

BINDOON

Legend

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- Minor Road
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CBC Habitat (FVC)

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Calingiri Rd

Great Northern Hwy

Hay Flat Rd

BINDOON

Legend

- Development Envelope
- Development Footprint
- Highway
- Major Road
- Minor Road
- Cadastral Boundary

CBC Habitat (FVC)

Foraging Vales

- 0 - Nil
- 0 - Nil (Extrapolated)
- 1 - Negligible
- 1 - Negligible (Extrapolated)
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- 2 - Low (Extrapolated)
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ERD	Draft

Date	By	Chkd	Appd
13/08/2019	BG	LB	TJ

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Cockatoo Dr
Heron Hill
Teal Pl
Bittern Pl
Pelican Rise
Corella Rd
Hart Dr
Tern Dale
Egret Pl
Great Northern Hwy
Brindle Cl
Sandalford Dr
Maddern Rd
BINDOON

Legend

- Development Envelope
- Development Footprint
- Highway
- Major Road
- Minor Road
- Cadastral Boundary
- RTBC Roost Sites

RTBC Habitat (FVC)
Foraging Vales
- 1 - Negligible
- 3 - Low-Moderate
- 4 - Moderate
- 5 - Moderate - High

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Main Roads Western Australia
Client

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Great Northern Highway
Bindoon Bypass
Environmental Review Document

Figure 5: Forest Red-tailed Black Cockatoo Habitat Foraging Value

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-15	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
30/05/2019	BG	LB	TJ

MXD Location: \\ausyd0-app023\ArcGISServer\WA_PB50732_GNH\ERD Figures\GNH-CN12-EA-PER-0001-F4-15.mxd

Robin Gr
Forrest Hills Pde
Woodbridge St
Heritage Rd
Windemere Way
Teatree Rd
Brennan Rd
Quail Pl
Warbler Ct
Cockatoo Dr
Bittern Pl
Corella Rd
Harr Dr
Egret Pl
BINDOON

Legend

- Development Envelope
- Development Footprint
- Highway
- Minor Road
- Cadastral Boundary
- RTBC Roost Sites

RTBC Habitat (FVC) Foraging Vales

- 0 - Nil
- 1 - Negligible
- 2 - Low
- 3 - Low-Moderate
- 4 - Moderate
- 5 - Moderate - High
- 6 - High

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Figure 5: Forest Red-tailed Black Cockatoo Habitat Foraging Value

Drawing No	Issue
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ERD	Draft

Date	By	Chkd	Appd
30/05/2019	BG	LB	TJ

MXD Location: \\ausyd0-app023\ArcGISServer\WA_PB50732_GNH\ERD Figures\GNH-CN12-EA-PER-0001-F4-15.mxd

Gray Rd
Crest Hill Rd
Hidaway Dr
Bonza Pl
Briar Lane
Evergreen Rise
Robin Gr
Forrest Hills Pde
Woodbridge St
Heritage Rd
Windemere Way
Teatree Rd
Brennan Rd
BINDOON

Legend

- Development Envelope
- Development Footprint
- Minor Road
- Cadastral Boundary
- RTBC Roost Sites

RTBC Habitat (FVC) Foraging Vales

- 0 - Nil
- 1 - Negligible
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- 5 - Moderate - High
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Figure 5: Forest Red-tailed Black Cockatoo Habitat Foraging Value

Drawing No	Issue
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Task No	Drawing Status / Other
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Date	By	Chkd	Appd
30/05/2019	BG	LB	TJ

MXD Location: \\ausyd0-app023\ArcGISServer\WA_PB50732_GNH\ERD Figures\GNH-CN12-EA-PER-0001-F4-15.mxd

Mooliabeenee Rd

Crest Hill Rd

Gray Rd

Teatree Rd

BINDOON

Legend

- Development Envelope
- Development Footprint
- Major Road
- Minor Road
- Cadastral Boundary
- RTBC Roost Sites

RTBC Habitat (FVC)

Foraging Vales

- 0 - Nil
- 1 - Negligible
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Main Roads Western Australia
Client

Project
Great Northern Highway
Bindoon Bypass
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Figure 5: Forest Red-tailed Black Cockatoo Habitat Foraging Value

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-15	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
30/05/2019	BG	LB	TJ

MXD Location: \\ausyd0-app023\ArcGISServer\WA_PB50732_GNH\ERD Figures\GNH-CN12-EA-PER-0001-F4-15.mxd

Cullalla Rd

Barn Rd

Wells Glover Rd

Mooliabeenee Rd

Ashworth Rd

Crest Hill Rd

BINDOON

Legend

- Development Envelope
- Development Footprint
- Major Road
- Minor Road
- Cadastral Boundary
- RTBC Roost Sites

RTBC Habitat (FVC)
Foraging Vales

- 0 - Nil
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Figure 5: Forest Red-tailed Black Cockatoo Habitat Foraging Value

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Task No	Drawing Status / Other
ERD	Draft

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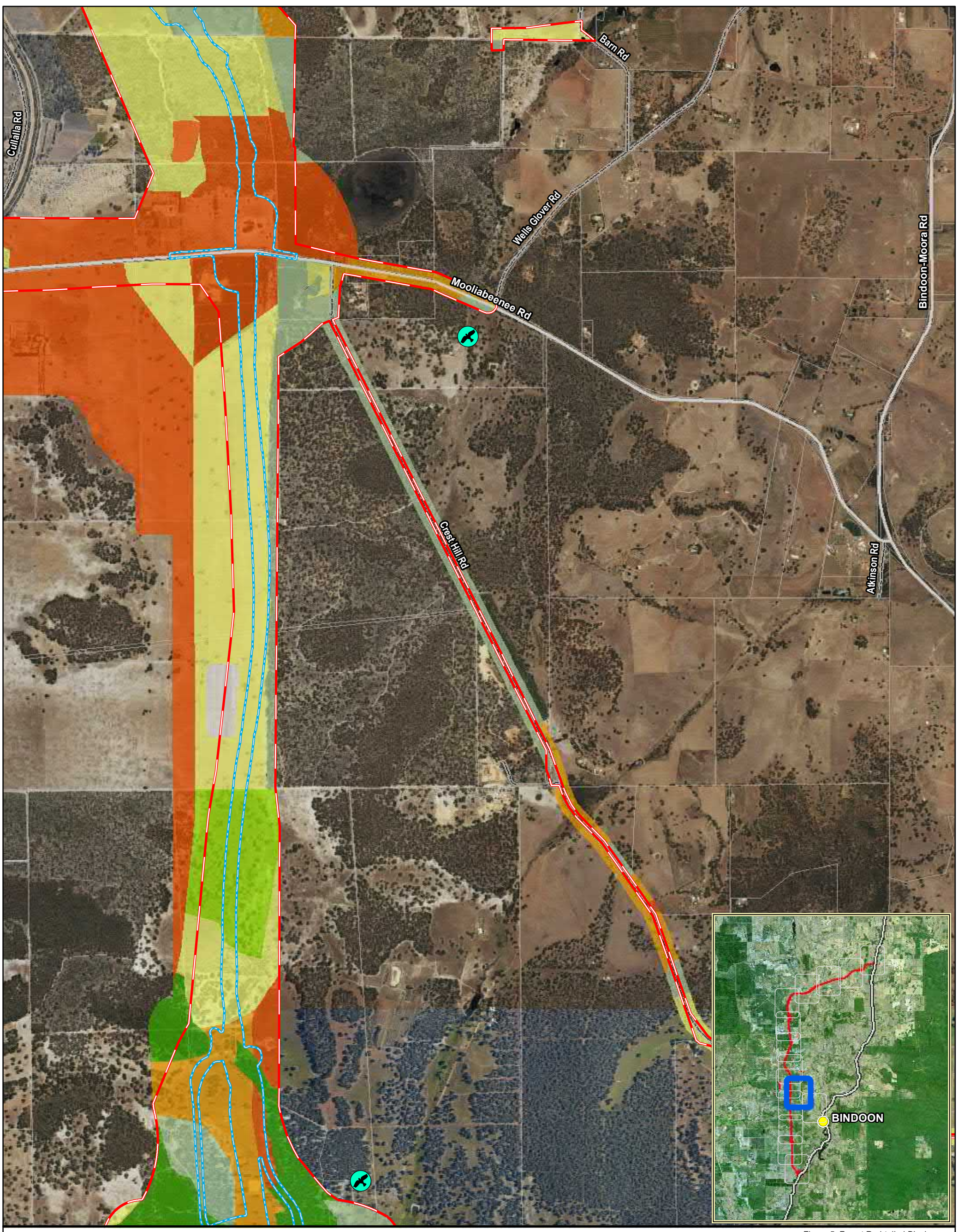
MXD Location: \\ausyd0-app023\ArcGISServer\WA_PB50732_GNH\ERD Figures\GNH-CN12-EA-PER-0001-F4-15.mxd



Legend

- Development Envelope
- Development Footprint
- Major Road
- Minor Road
- Cadastral Boundary
- RTBC Roost Sites

RTBC Habitat (FVC)
Foraging Vales

- 0 - Nil
- 1 - Negligible
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- 3 - Low-Moderate
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- 5 - Moderate - High
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MXD Location: \\ausyd0-app023\ArcGISServer\WA_PB50732_GNH\ERD Figures\GNH-CN12-EA-PER-0001-F4-15.mxd

Moolibeenee Rd
Atkinson Rd
Bindoon-Moora Rd
Toy Rd
Settlement Rd
Crest Hill Rd
Kay Rd
Great Northern Hwy
Fishers Rd
Hidaway Dr
Gammeray Cl
Gray Rd
Clune Rd
Needoonga Pl
Bonza Pl
Briar Lane
Ridgetop Rmbl
Pioneer Dr
Forrest Hills Pde
Lakeside Gr
Evergreen Rise
Robin Gr
Orchard Rd
Kingfisher Ct
BINDOON

Legend

- Development Envelope
- Highway
- Major Road
- Minor Road
- Cadastral Boundary

RTBC Habitat (FVC) Foraging Vales

- 1 - Negligible
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MXD Location: \\ausyd0-app023\ArcGISServer\WA_PB50732_GNH\ERD Figures\GNH-CN12-EA-PER-0001-F4-15.mxd

Kinkella Rd
Cullalla Rd
Bam Rd
Wells Glover Rd
Mooliabeenee Rd
Ashworth Rd
Crest Hill Rd
BINDOON

Legend

- Development Envelope
- Development Footprint
- Major Road
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RTBC Habitat (FVC)
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Cullalla Rd

Barn Rd

Kinkella Rd

BINDOON

Legend

- Development Envelope
- Development Footprint
- Minor Road
- Cadastral Boundary

RTBC Habitat (FVC)
Foraging Vales

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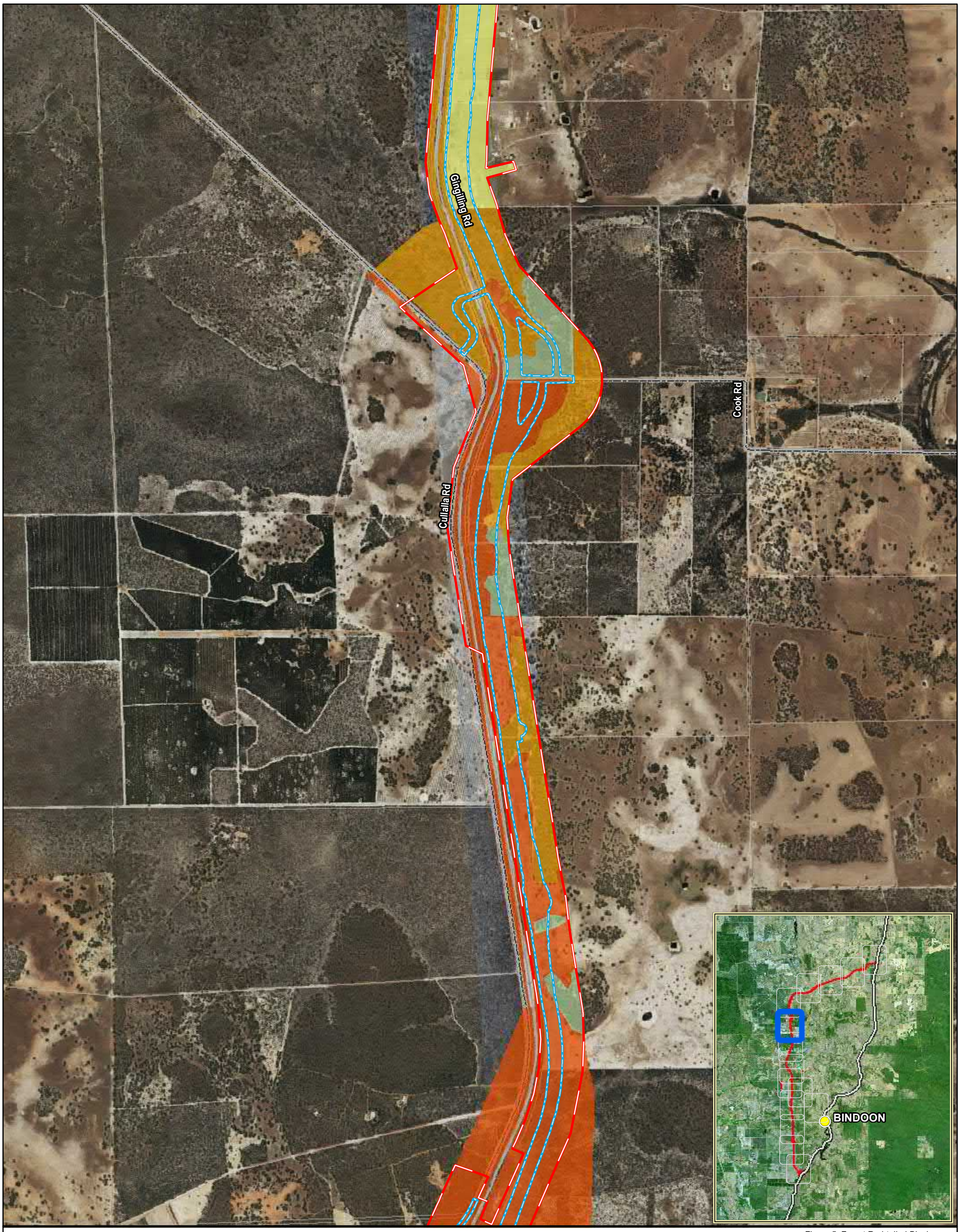

Legend

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RTBC Habitat (FVC)
Foraging Vales
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Wannamal Rd South

Gingilling Rd

Cullalla Rd

BINDOON

Legend

- Development Envelope
- Development Footprint
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- Cadastral Boundary

RTBC Habitat (FVC)
Foraging Vales

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Hay Flat Rd

Kangaroo Gully Rd

Bindoon-Moora Rd

Pines Rd

BINDOON

Legend

- Development Envelope
- Development Footprint
- Major Road
- Minor Road
- Cadastral Boundary

RTBC Habitat (FVC) Foraging Vales

- 0 - Nil
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www.jacobs.com

Main Roads Western Australia

Client

Project

Great Northern Highway
Bindoon Bypass
Environmental Review Document

Figure 5: Forest Red-tailed Black Cockatoo Habitat Foraging Value

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-15	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
30/05/2019	BG	LB	TJ

MXD Location: \\ausyd0-app023\ArcGISServer\WA_PB50732_GNH\ERD Figures\GNH-CN12-EA-PER-0001-F4-15.mxd

Hay Flat Rd

Head Rd

Kangaroo Gully Rd

Bindoon-Moora Rd

BINDOON

Legend

- Development Envelope
- Development Footprint
- Major Road
- Minor Road
- Cadastral Boundary

RTBC Habitat (FVC) Foraging Vales

- 0 - Nil
- 1 - Negligible
- 2 - Low
- 3 - Low-Moderate
- 4 - Moderate
- 5 - Moderate - High

Joint Venture Partners:

Arup Pty Ltd
Level 14 Exchange Tower
2 The Esplanade
Perth WA 6000
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www.arup.com

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0 240 480
Metres

Scale at A3 1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
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Figure 5: Forest Red-tailed Black Cockatoo Habitat Foraging Value

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-15	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
30/05/2019	BG	LB	TJ

MXD Location: \\ausyd0-app023\ArcGISServer\WA_PB50732_GNH\ERD Figures\GNH-CN12-EA-PER-0001-F4-15.mxd

Hay Flat Rd

Head Rd

BINDOON

Legend

- Development Envelope
- Development Footprint
- Minor Road
- Cadastral Boundary

RTBC Habitat (FVC)

Foraging Vales

- 1 - Negligible
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- 3 - Low-Moderate
- 4 - Moderate
- 5 - Moderate - High

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0 240 480
Metres

Scale at A3 **1:20,000**

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Project
Great Northern Highway
Bindoon Bypass
Environmental Review Document

Figure 5: Forest Red-tailed Black Cockatoo Habitat Foraging Value

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-15	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
30/05/2019	BG	LB	TJ

MXD Location: \\ausyd0-app023\ArcGISServer\WA_PB50732_GNH\ERD Figures\GNH-CN12-EA-PER-0001-F4-15.mxd

Calingiri Rd

Great Northern Hwy

Hay Flat Rd

BINDOON

Legend

- Development Envelope
- Development Footprint
- Highway
- Major Road
- Minor Road
- Cadastral Boundary

RTBC Habitat (FVC) Foraging Vales

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0 240 480

Metres

Scale at A3 **1:20,000**

Coordinate System: GDA 1994 MGA Zone 50

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Figure 5: Forest Red-tailed Black Cockatoo Habitat Foraging Value

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GNH-CN12-EA-PER-00001 - F4-15	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
30/05/2019	BG	LB	TJ

MXD Location: \\ausyd0-app023\ArcGISServer\WA_PB50732_GNH\ERD Figures\GNH-CN12-EA-PER-0001-F4-15.mxd

Cockatoo Dr
Heron Hill
Teal Pl
Bittern Pl
Pelican Rise
Corella Rd
Hart Dr
Tern Dale
Egret Pl
Great Northern Hwy
Brindle Cl
Sandalford Dr
Maddern Rd
BINDOON
Landgate / SLIP

Black Cockatoo Trees (FVC) - Outside Development Footprint

- Hollow currently in Use
- Hollow with Evidence of Use (Previously Used Hollow)
- Suitable Hollow

Black Cockatoo Trees (FVC) - Within Development Footprint

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- Suitable Hollow

- Development Envelope
- Development Footprint
- Highway
- Major Road
- Minor Road
- Cadastral Boundary

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Metres

Scale at A3 1:20,000

Coordinate System: GDA 1994 MGA Zone 50

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Client

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 6 Page 1 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

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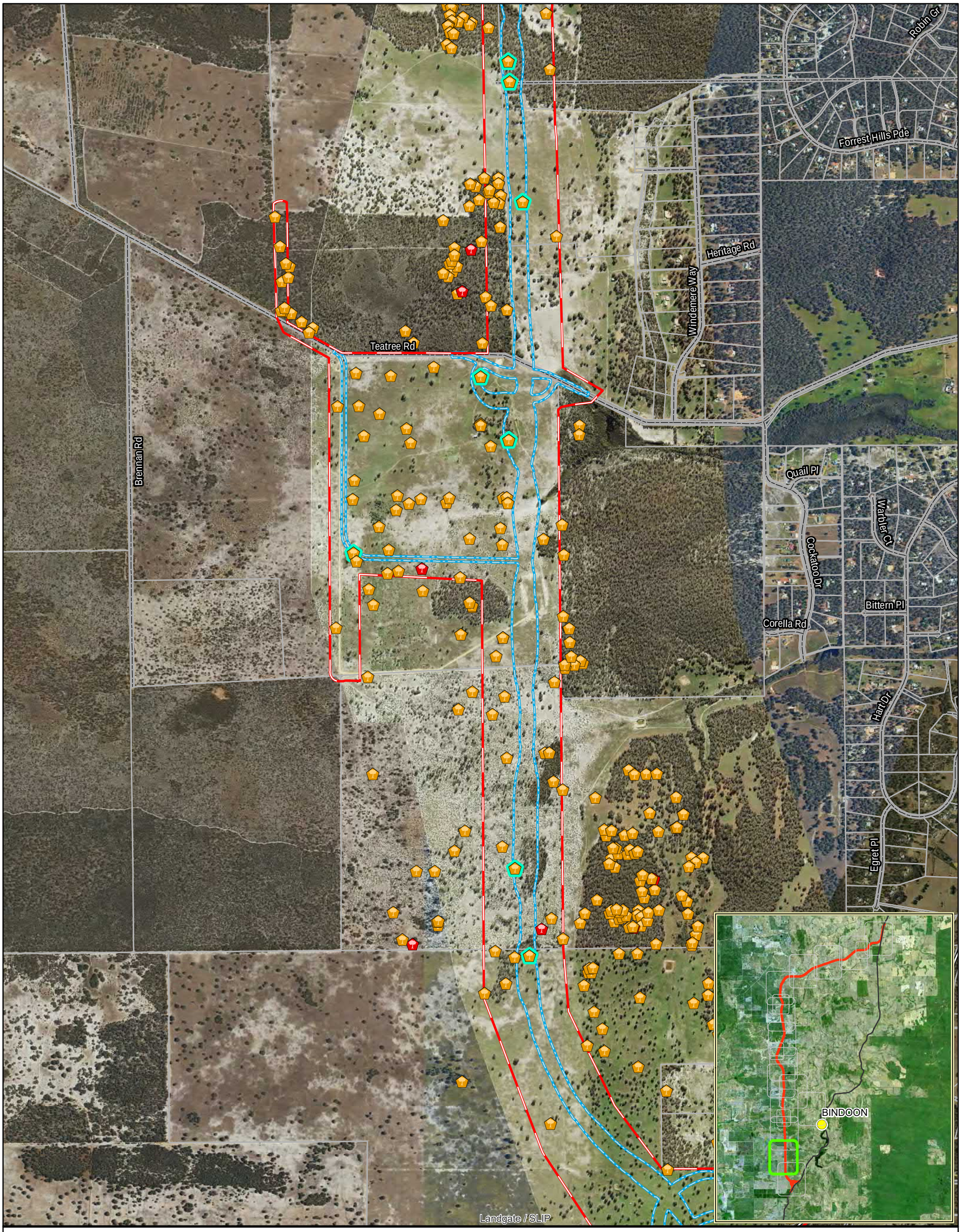

Black Cockatoo Trees (FVC) - Outside Development Footprint

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Black Cockatoo Trees (FVC) - Within Development Footprint

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0 240 480 Metres

Scale at A3 **1:20,000**

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
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Great Northern Highway
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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 6 Page 2 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

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Gray Rd
Crest Hill Rd
Hidaway Dr
Bonza Pl
Briar Lane
Evergreen Rise
Robin Gr
Forrest Hills Pde
Heritage Rd
Windemere Way
Teatree Rd
Brennan Rd
Landgate / SLIP
BINDOON

Black Cockatoo Trees (FVC) - Outside Development Footprint

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- Suitable Hollow

Black Cockatoo Trees (FVC) - Within Development Footprint

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0 240 480 Metres

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Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
Environmental Review Document
Project

Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 6 Page 3 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

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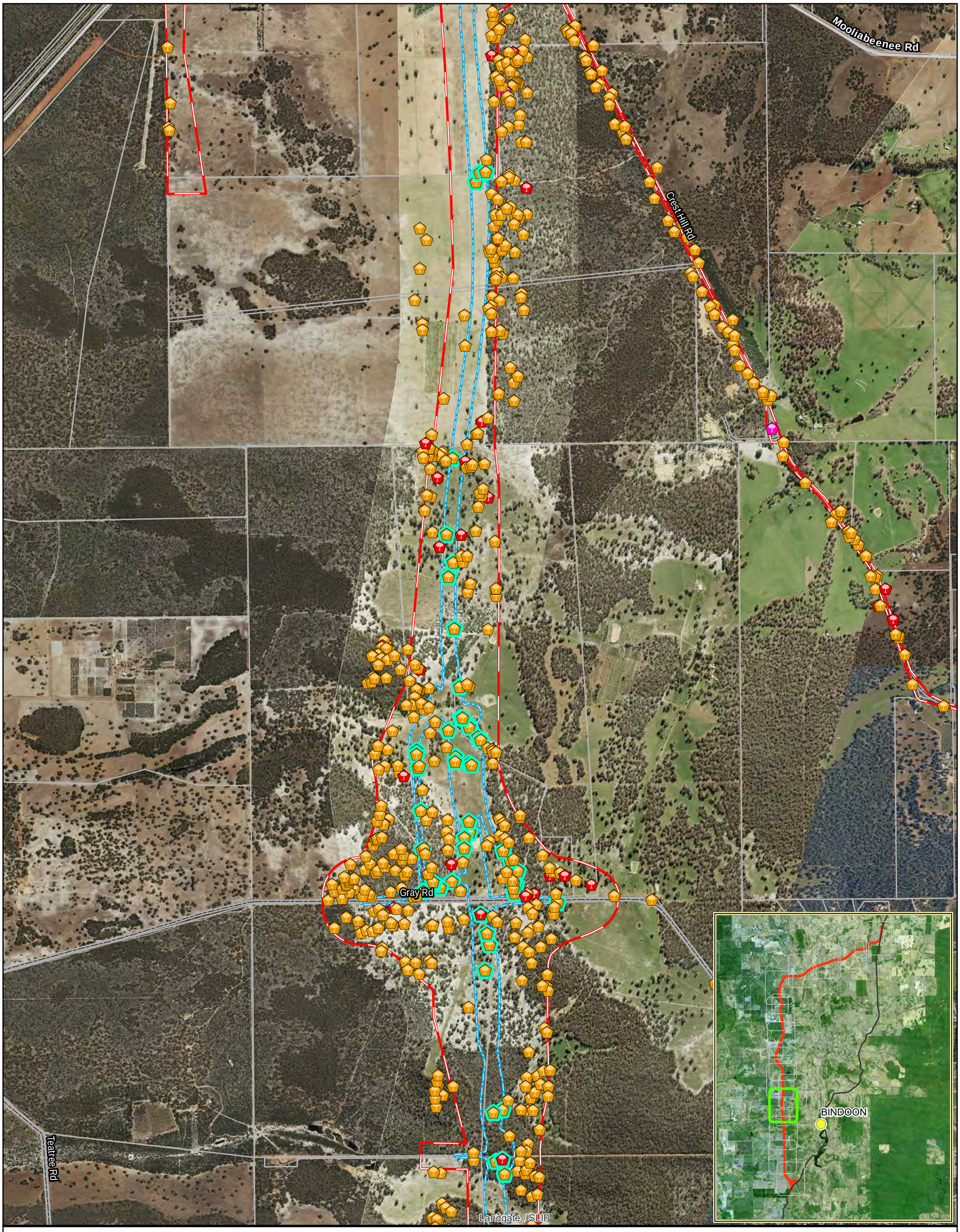

Black Cockatoo Trees (FVC) - Outside Development Footprint

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Black Cockatoo Trees (FVC) - Within Development Footprint

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- Development Footprint
- Highway
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Metres

Scale at A3 1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
Environmental Review Document
Project

Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 6 Page 4 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

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Cullalla Rd
Barn Rd
Ashworth Rd
Mooliabeenee Rd
Wells Glover Rd
Crest Hill Rd
BINDOON
Landgate / SLIP

Black Cockatoo Trees (FVC) - Outside Development Footprint

- Hollow currently in Use
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- Suitable Hollow

Black Cockatoo Trees (FVC) - Within Development Footprint

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0 240 480
Metres

Scale at A3 1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 6 Page 5 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

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Cullalla Rd
Barn Rd
Wells Glover Rd
Mooliabeenee Rd
Bindoon-Moora Rd
Crest Hill Rd
Atkinson Rd
BINDOON
Landgate / SLIP

Black Cockatoo Trees (FVC) - Outside Development Footprint

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- Development Footprint
- Highway
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- Minor Road
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Scale at A3
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Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

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Bindoon Bypass
Environmental Review Document

Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 6 Page 6 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

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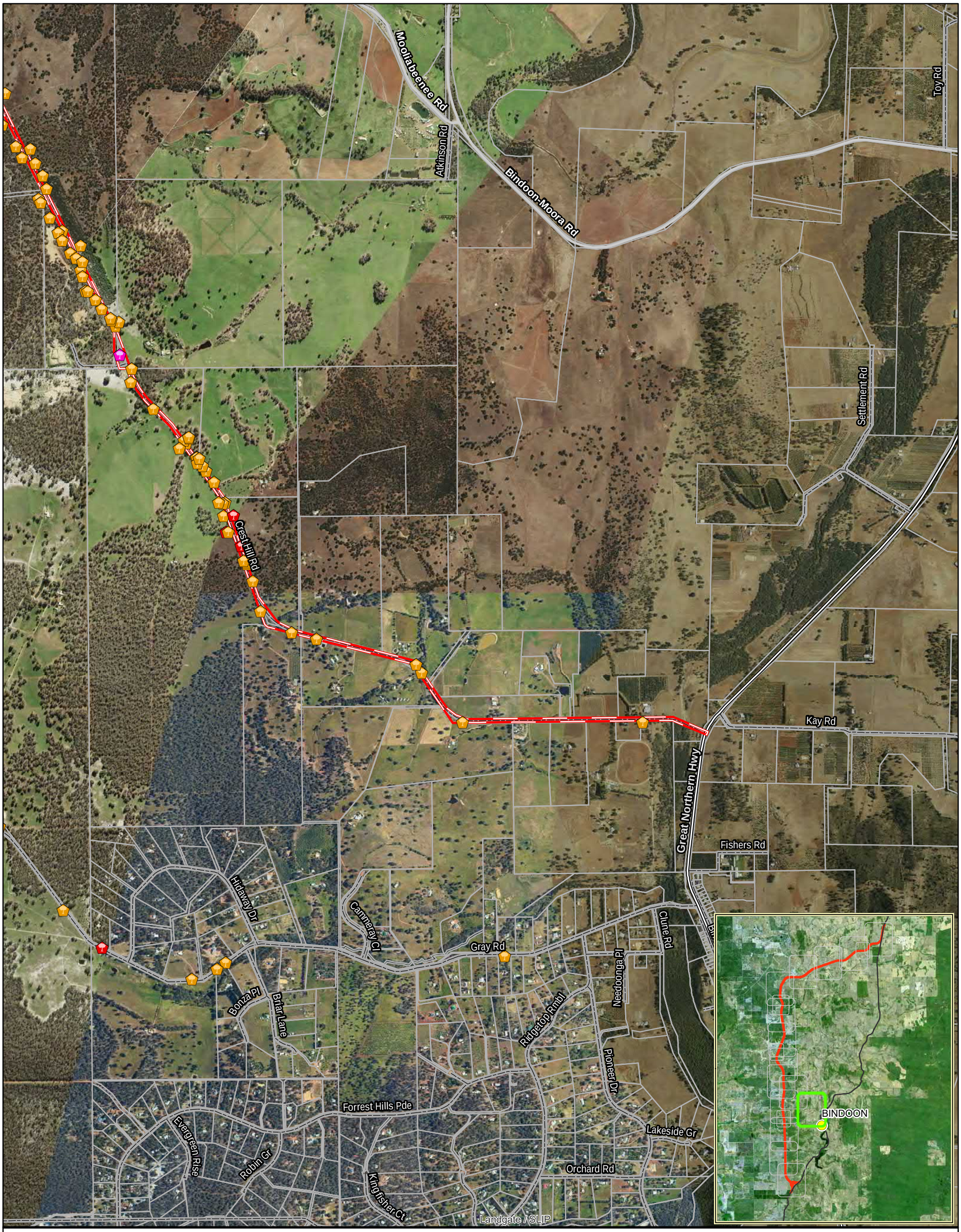

Black Cockatoo Trees (FVC) - Outside Development Footprint

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 6 Page 7 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

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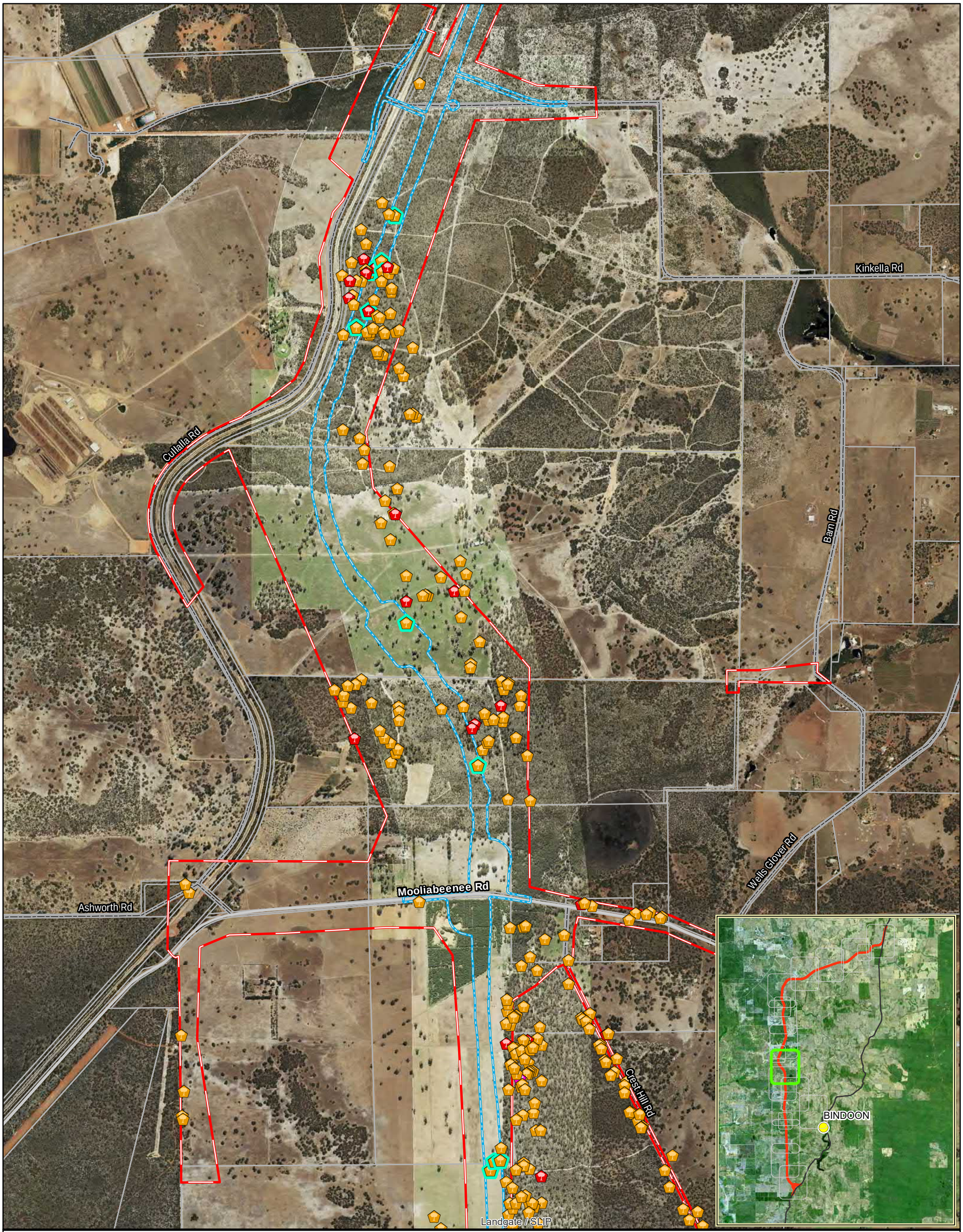

Black Cockatoo Trees (FVC) - Outside Development Footprint

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0 240 480
Metres

Scale at A3
1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Project
Great Northern Highway
Bindoon Bypass
Environmental Review Document

Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 6 Page 8 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

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Cullalla Rd

Barn Rd

Kinkella Rd

Landgate / SLIP

BINDOON

Black Cockatoo Trees (FVC) - Outside Development Footprint

- Hollow currently in Use
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0 240 480
Metres

Scale at A3 1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
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Project

Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 6 Page 9 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

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Gingilling Rd

Cullalla Rd

Cook Rd

BINDOON

Landgate / SLIP

Black Cockatoo Trees (FVC) - Outside Development Footprint

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Black Cockatoo Trees (FVC) - Within Development Footprint

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Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 6 Page 10 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

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Black Cockatoo Trees (FVC) - Outside Development Footprint

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 6 Page 11 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

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Hay Flat Rd

Kangaroo Gully Rd

Bindoon-Moora Rd

Pines Rd

BINDOON

Landgate / SLIP

Black Cockatoo Trees (FVC) - Outside Development Footprint

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0 240 480
Metres

Scale at A3 **1:20,000**

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

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Environmental Review Document
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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 6 Page 12 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
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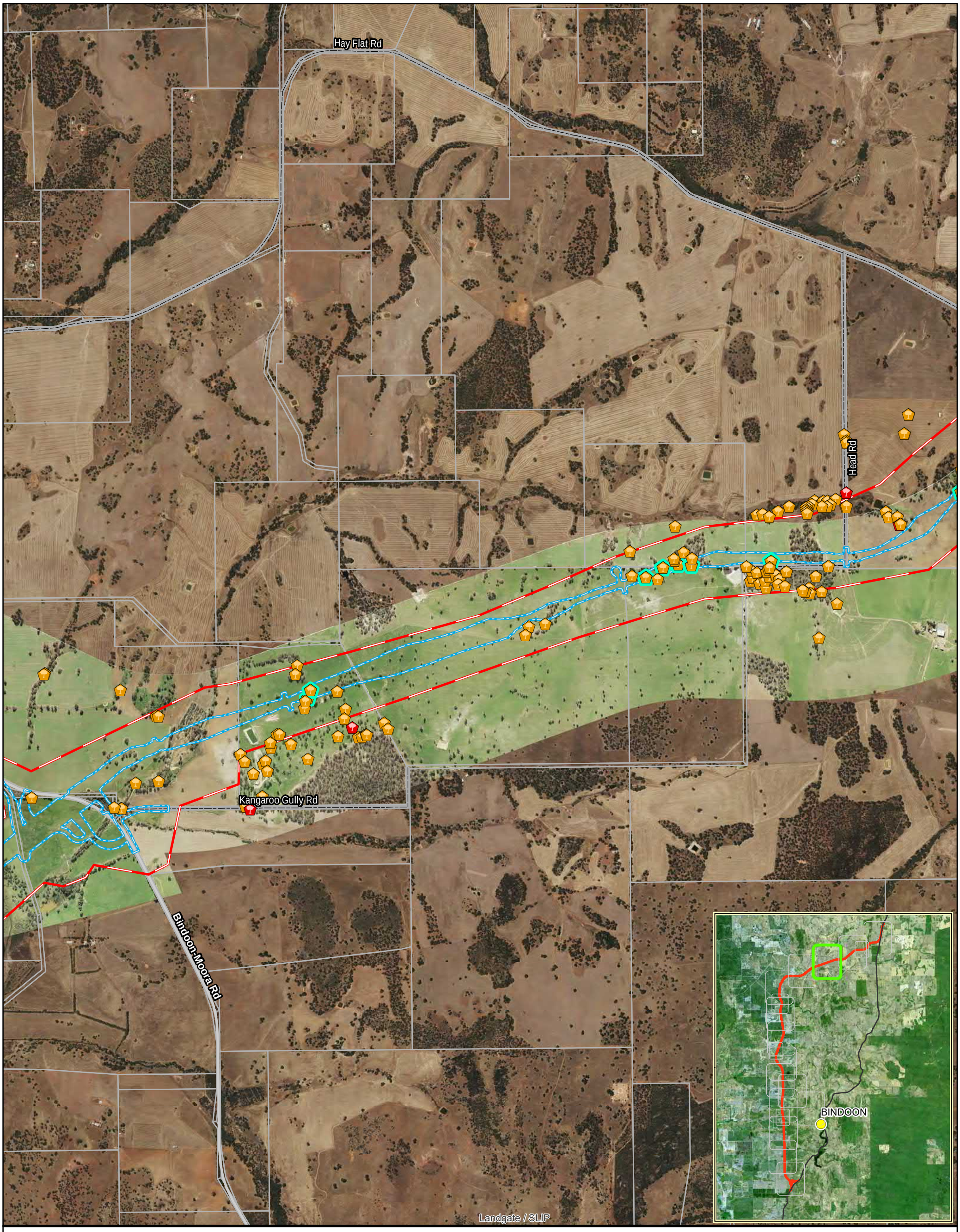

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0 240 480
Metres

Scale at A3 1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia

Client

Project

Great Northern Highway
Bindoon Bypass
Environmental Review Document

Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-13a.mxd

Hay Flat Rd

Head Rd

BINDOON

Landgate / SLIP

Black Cockatoo Trees (FVC) - Outside Development Footprint

- Hollow currently in Use
- Hollow with Evidence of Use (Previously Used Hollow)
- Suitable Hollow

Black Cockatoo Trees (FVC) - Within Development Footprint

- Hollow with Evidence of Use (Previously Used Hollow)
- Suitable Hollow

- Development Envelope
- Development Footprint
- Highway
- Major Road
- Minor Road
- Cadastral Boundary

Joint Venture Partners:

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0 240 480
Metres

Scale at A3
1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
Environmental Review Document
Project

Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 6 Page 14 of 16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-13a.mxd

Hay Flat Rd

BINDOON

Landgate / SLIP

Black Cockatoo Trees (FVC) - Outside Development Footprint

- Hollow currently in Use
- Hollow with Evidence of Use (Previously Used Hollow)
- Suitable Hollow

Black Cockatoo Trees (FVC) - Within Development Footprint

- Hollow with Evidence of Use (Previously Used Hollow)
- Suitable Hollow

- Development Envelope
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0 120 240
Metres

Scale at A3
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Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia

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Project

Great Northern Highway
Bindoon Bypass
Environmental Review Document

Black Cockatoo Habitat –Trees with Suitable or Used Hollows

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Drawing No	Issue
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Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

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Calingiri Rd

Great Northern Hwy

Hay Flat Rd

BINDOON

Landgate / SLIP

Black Cockatoo Trees (FVC) - Outside Development Footprint

- Hollow currently in Use
- Hollow with Evidence of Use (Previously Used Hollow)
- Suitable Hollow

Black Cockatoo Trees (FVC) - Within Development Footprint

- Hollow with Evidence of Use (Previously Used Hollow)
- Suitable Hollow

- Development Envelope
- Development Footprint
- Highway
- Major Road
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- Cadastral Boundary

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Scale at A3
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Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia

Client

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Great Northern Highway
Bindoon Bypass
Environmental Review Document

Black Cockatoo Habitat –Trees with Suitable or Used Hollows

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GNH-CN12-EA-PER-00001 - F4-13	2

Task No	Drawing Status / Other
ERD	Final

Date	By	Chkd	Appd
30/10/2020	JR	--	--

MXD Location: \\Jacobs.com\PERProjects\PBIFI\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-13a.mxd

1.4 ha

18.6 ha

4.6 ha

10.4 ha

Legend

- Development Envelope
- Disturbance Footprint
- Gingin-Wax Suitable Habitat: Extent of Clearing
- Gingin-Wax Suitable Habitat

Data Source: Main Roads WA, Landgate

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0 60 120
Metres

Scale at A3
1:5,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
Environmental Review Document
Project

Figure 7: Potential Habitat for Gingin Wax

Drawing No	Issue
GNH-CN12-EA-GD-0114	A

Task No	Drawing Status / Other
GNH-XXXX	Draft / Other Info

Date	By	Chkd	Appd
7/12/2020	SP	XX	XX

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\GNH-CN12-E-EA-GD-0114-A.mxd

Appendix A. Risk Assessment Framework

A.1 Risk framework

		Consequence				
		Minor	**Moderate**	**High**	**Major**	**Critical**
Likelihood	**Highly Likely**	**Medium**	**High**	**High**	**Severe**	**Severe**
	Likely	**Low**	**Medium**	**High**	**High**	**Severe**
	Possible	**Low**	**Medium**	**Medium**	**High**	**Severe**
	Unlikely	**Low**	**Low**	**Medium**	**High**	**High**
	Rare	**Low**	**Low**	**Low**	**Medium**	**High**

A.2 Likelihood and consequence

Likelihood – Qualitative measure of likelihood (how likely is it that this event/circumstances will occur after management actions have been put in place/are being implemented)	
Highly likely	Is expected to occur in most circumstances
Likely	Will probably occur during the life of the project
Possible	Might occur during the life of the project
Unlikely	Could occur but considered unlikely or doubtful
Rare	May occur in exceptional circumstances
Consequence – Qualitative measure of consequences (what will be the consequence/result if the issue does occur)	
Minor	Minor risk of failure to achieve the plan's objectives. Results in short term delays to achieving plan objectives, implementing low cost, well characterised corrective actions.
Moderate	Moderate risk of failure to achieve the plan's objectives. Results in short term delays to achieving plan objectives, implementing well characterised, high cost/effort corrective actions.
High	High risk of failure to achieve the plan's objectives. Results in medium-long term delays to achieving plan objectives, implementing uncertain, high cost/effort corrective actions.
Major	The plan's objectives are unlikely to be achieved, with significant legislative, technical, ecological and/or administrative barriers to attainment that have no evidenced mitigation strategies.
Critical	The plan's objectives are unable to be achieved, with no evidenced mitigation strategies.

Appendix B. Dieback Management Strategy

Terratree

Phytophthora Dieback Management Strategy for the Proposed Bindoon Bypass

Prepared for Jacobs Arup Joint Venture

Ref: T18009

ecological assessment
& management

Terratree Pty Ltd

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Document Control

Revision	Details	Date	Author	Reviewer
Draft	Draft for Internal Review	06/07/2018	J. Grehan	G. Maslen
Rev A	Draft for Submission to Client	06.07/2018	J. Grehan	P. Rokich
Rev B	Revision addressing client's comments	27/07/18	J. Grehan	P. Rokich
Rev C	Final	27/08/2018	J. Grehan	P. Rokich

Author: Joseph Grehan

Principal Ecologist

DISCLAIMER

This document is prepared in accordance with and subject to an agreement between Terratree Pty Ltd ("Terratree") and the client for whom it has been prepared ("Jacobs -Arup Joint Venture") and is restricted to those issues that have been raised by the client in its engagement of Terratree and prepared using the standard of skill and care ordinarily exercised by Environmental Scientists in the preparation of such documents.

Any organisation or person that relies on or uses this document for purposes or reasons other than those agreed by Terratree and the client without first obtaining the prior written consent of Terratree, does so entirely at their own risk and Terratree denies all liability in tort, contract or otherwise for any loss, damage or injury of any kind whatsoever (whether in negligence or otherwise) that may be suffered as a consequence of relying on this document for any purpose other than that agreed with the client.

Terratree Pty Ltd

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1 Executive Summary

The Jacobs Arup Joint Venture commissioned Terratree Pty Ltd (Terratree) to prepare a Dieback Hygiene Management Strategy (DHMS) for Bindoon Bypass project near the town of Bindoon, Western Australia (hereafter referred to as the 'project area') for their client, Main Roads WA (**Figure 1**).

In order to avoid potentially devastating impacts on biodiversity, it's imperative that appropriate hygiene management practices be implemented during both the investigations and construction phases of the project. This will help to minimise the risk of spreading Dieback both within the project area itself, but also into areas adjacent to, or down-gradient of mapped infestations or high risk uninterpretable and excluded areas.

Therefore the purpose of the DHMS is to:

1. Inform design so as to minimise the risk of spreading the Dieback into adjacent and receiving environments down-gradient of the project area; and
2. To provide management guidelines for contractors and staff accessing the project area during the pre-construction phase.

Disease boundaries will need to be rechecked prior to the construction phase, and a specific Dieback management plan developed for construction. The Dieback management plan will need to address the risk associated with soil and surface water movement within project area to manage the risk of vectoring Dieback into protectable areas adjacent to, and down-gradient of the project area.

Although the likelihood of the pathogen residing in soil within cleared (excluded) upland areas with annual rainfall between 600mm-700mm is low, a precautionary approach to hygiene management is recommended. The risk of transporting infected soil increases during wet conditions when soil and vegetative material can easily adhere to vehicles and machinery. Clean-down requirements are considerably less onerous during dry soil conditions because soil and vegetative material does not adhere as readily to vehicles and machinery and is less likely to be transported.

In addition to the pathogen being spread within the disturbance area, the potential also exists for the pathogen to be introduced into adjacent and down-gradient receiving areas. This can occur if drainage lines within or adjacent to the project area become contaminated with the pathogen, or infected soil is transported off-site into uninfested areas.

In the context of the Bindoon Bypass project, introduction and non-autonomous spread of the pathogen could occur in areas if the disease risk has not been assessed and is not managed appropriately during both wet and dry soil conditions.

As the geographic area of the proposed disturbance activity increases so does the likelihood of introducing or spreading Dieback. Mini-catchments (the catchment area of a first order stream) should be used to define areas of risk because this is the unit of area impacted when Dieback is introduced into an area.

The project design should carefully consider the potential impacts of surface water drainage in terms of spreading Dieback. Surface water traversing infested areas should not be directed into protectable areas within a mini catchment. Effluent entering an infested area should be retained in sumps within the infested area and not allowed to drain into protectable areas or areas that have not been assessed for the presence of Dieback.

Soil movement is a major consideration when managing Dieback in construction projects. The basic principle is to only move soil to areas of equal or greater risk, in terms of the likelihood of the pathogen being present and potential impacts to biodiversity.

As 2320.30ha (71.28%) of the assessment area was mapped as 'excluded' a hygiene management plan for the construction phase of the project should include a risk assessment of these areas. The assessment should

examine the likelihood of the pathogen being present in excluded areas, and the potential consequences to biodiversity should soil be moved from one location to another.

If staff and contractors are adequately informed and the Clean on Entry strategy is followed, then the risk of introducing or spreading the pathogen in protectable areas will be minimised.

Terratree makes the following recommendations to ensure the Dieback management strategy for the Bindoon Bypass project is correctly implemented:

- Provide Green Card training to personnel including environmental managers, supervisors and key staff members to ensure compliance with the Dieback management strategy;
- Prevent access to low lying areas;
- Provide clear instruction to staff and contractors about hygiene requirements when entering protectable areas; and
- Conduct inspections of machinery and vehicles to ensure that they are free of soil and vegetative materials.

1 Introduction

The Jacobs Arup Joint Venture commissioned Terratree Pty Ltd (Terratree) to prepare a Dieback Hygiene Management Strategy (DHMS) for Bindoon Bypass project near the town of Bindoon, Western Australia (hereafter referred to as the 'project area') for their client, Main Roads WA (**Figure 1**).

In order to avoid potentially devastating impacts on biodiversity, it's imperative that appropriate hygiene management practices be implemented during both the investigations and construction phases of the project. This will help to minimise the risk of spreading Dieback both within the project area itself, but also into areas adjacent to, or down-gradient of mapped infestations or high risk uninterpretable and excluded areas.

Therefore the purpose of the DHMS is to:

1. Inform design so as to minimise the risk of spreading the Dieback into adjacent and receiving environments down-gradient of the project area; and
2. To provide management guidelines for contractors and staff accessing the project area during the pre-construction phase.

Disease boundaries will need to be rechecked prior to the construction phase, and a specific Dieback management plan developed for construction. The Dieback management plan will need to address the risk associated with soil and surface water movement within project area to manage the risk of vectoring Dieback into protectable areas adjacent to, and down-gradient of the project area.

1.1 Project Location and Description

The project area is located near Bindoon in the Shire of Chittering, WA, approximately 84km north of the city of Perth. More specifically, the proposed bypass leaves Great Northern Highway around 25km north of Bindoon and reconnects with the highway approximately 8km south of the town. The project is approximately 1.5km east of the Muchea Uninfested High Value Hotspot as identified on the Dieback Information Delivery Management System (DIDMS).

The construction of the proposed bypass road will require clearing of native vegetation and management of the risks associated with the possible presence of the plant pathogen *Phytophthora cinnamomi* (and other less pathogenic *Phytophthora* species). To effectively manage the risk to biodiversity associated with Dieback, occurrence of the pathogen has been mapped, and protectable areas identified, which enables the development of this DHMS.

1.2 Background

The Dieback field assessment was conducted between March - April 2018 and was undertaken by Department of Biodiversity Conservation and Attractions (DBCA) registered Dieback Interpreters Joseph Grehan, Kelby Jennings and Environmental Scientist Patrick Maher.

In accordance with the Dieback Interpreter Guidelines (DPaW 2015), the comprehensive assessment consisted of a visual assessment of native vegetation within the assessment area and collection of soil and tissue samples of recently dead disease indicator species for diagnostic testing. The assessment area was comprehensively assessed with a particular focus on high-risk areas including tracks, firebreaks, disturbed areas and watercourses.

In total, 17 soil and tissue samples were taken from recently dead and dying disease indicator species. The samples were submitted to the VHS laboratory for diagnostic baiting and recorded three positive results for *Phytophthora cinnamomi* and one positive result for *Phytophthora pseudocryptogea. P. pseudocryptogea* was recently described in 2015 as a *Phytophthora* species that is part of the *P. cryptogea* species complex (Safaiefarahani *et al*. 2015). While there is limited research on the pathogenicity of *P. pseudocryptogea,* recent research suggests that *P. pseudocryptogea* has the capacity to kill or considerably reduce the biomass of several native species including *Acacia, Callistemon* and *Eucalyptus* species as well as Blackberry and Potato species (CSIRO, 2018). Other recent research has suggested that *P. pseudocryptogea* is not pathogenic to *Corymbia calophylla* trees (Croeser 2017).

Disease expression was good in infested areas with multiple disease Indicator Species Deaths (ISDs) as well as disease pattern, chronology and obvious changes to the vegetation structure, composition and cover. Dieback was predominantly found to be present on lower slopes and in areas that showed evidence of ground disturbance activities. As the area receives an annual average rainfall of 670mm, Dieback can survive in upland areas and is therefore not confined to lower slopes and gullies.

In total, 27.15ha (0.83%) of the assessment area is mapped as infested. Disease expression was good in infested areas with multiple ISDs, as well as disease pattern, chronology and obvious changes to the vegetation structure, composition and cover. Primary disease indicator species included *Banksia attenuata, B. menziesii, B. prionotes, B.sessilis, B. squarrosa* and *Xanthorrhoea preissii.* Secondary disease indicator, which are used to support a diagnosis made using primary indicators, included *Adenanthos cyngorum, Jacksonia floribunda, Stirlingia latifolia, Macrozamia riedlei.*

A total of 402.57ha, or 12.37%, of the study area is uninfested. This has been determined through a combination of visual evidence and sampling, with 13 of the 17 samples providing a negative result. Uninfested areas are characterised as being in 'very good' to 'excellent' condition, Uninfested areas showed little evidence of Dieback in terms of ISDs, disease pattern and chronology, or significant structural and compositional change. All the uninfested areas were impacted by drought and some areas were possibly impacted by other pathogenic fungi.

Only 33.55ha, or 1.09%, of the overall assessment area was categorised as uninterpretable. Uninterpretable vegetation occurs along a drainage lines or surrounding wetland areas and is dominated by resistant species including *Melaleuca preissiana, M. raphiophylla*, *Regelia inops*, *Kunzea glabrescens* and *Eucalyptus rudis*.

2320.30ha (71.28%) of the assessment area was mapped as 'excluded'. Areas of pasture, or pasture with small remnants of native vegetation, as well as planted drainage lines have been 'excluded' from the assessment as they cannot be categorised due to the lack of susceptible native vegetation. Vegetation condition in these areas is predominantly 'degraded' with a few pockets of vegetation in 'good' condition (Keighery *et al*. 1994) . The table below presents a breakdown and of the different occurrence categories, and the percentage of the overall assessment area each category covers.

Table 1: Dieback Occurrence Area Statement

Type	Area (ha)	Area (%)
Infested	27.15	0.83
Uninfested	402.57	12.37
Uninterpretable	35.55	1.09
Excluded	2320.30	71.28
Not Assessed	469.69	14.43
Total	**3255.26**	**100**

1.3 Regulatory Context

Phytophthora Dieback management is required under several regulatory mechanisms, including:

- *Environmental Protection Act* (1986) Part V S.50A "Serious Environmental Harm" provisions;
- Projects being assessed under the *Environmental Protection Act* (1986) which require Department of Biodiversity, Conservation and Attraction (DBCA) and/or Department of Mines and Petroleum (DMP) to comment on Dieback management and provide these agencies with the right to impose conditions to new approvals; and
- All operations – *Phytophthora* Dieback is listed as a Key Threatening Process with the Federal Government under the *Environment Protection and Biodiversity Conservation Act* (1999).

2 Potential Impacts and Risk Assessment

2.1 Potential Impacts

Potential impacts to biodiversity as a result of the spread of Dieback include the following:

1. Significant decline in species richness;
2. Altered vegetation structure with the loss of keystone species such as Banksias;
3. Temporary or permanent decline in vegetation cover which can lead to erosion and loss of nutrients;
4. Loss of fauna foraging habitat, particularly Proteaceous genera including Banksia, Hakea, Isopogon and Petrophile; and
5. Potential loss of threatened flora species if they occur within the affected areas and are susceptible to Dieback.

Water-gaining sites are at a higher risk of being infested with *P. cinnamomi* as flagellated zoospores can travel through water or moist substrate. It is possible however, for the pathogen to survive as stromata, or thick walled chlamydospores, in resistant plant species in upland areas during summer, and reproduce when conditions become more favourable for survival (Crone 2012).

Non-autonomous spread of Dieback can occur if the disease occurrence has not been managed appropriately. Without hygiene control measures, there is a high risk of Dieback being spread into uninfested areas of native vegetation during ground disturbance activities. If Dieback is spread into uninfested areas, the pathogen will have a significant impact on biodiversity. Susceptible species will become infected and die, with flow-on effects impacting ecosystem function and resilience.

The risk of transporting infected soil increases significantly during wet conditions when soil and vegetative material can easily adhere to vehicles and machinery. In dry conditions, the risk of transporting infected soil is reduced but not eliminated.

In addition to the pathogen being spread within the disturbance area, the potential also exists for the pathogen to be introduced into adjacent and down-gradient receiving areas. This can occur if drainage lines within or adjacent to the project area become contaminated with the pathogen, or infected soil is transported off-site into uninfested areas.

In the context of the Bindoon Bypass project, introduction and non-autonomous spread of the pathogen could occur in areas if the disease risk has not been assessed and is not managed appropriately during both wet and dry soil conditions.

2.2 Protectable Areas

In accordance with the Dieback Interpreters Guidelines (DPaW 2015), 'Protectable Areas' are defined as areas of native vegetation that meet the following criteria:

- Have been determined to be free of the *Phytophthora* spp. pathogen by a registered Dieback Interpreter (all susceptible indicator plant species are healthy, and no plant disease symptoms normally attributed to *Phytophthora* Dieback are evident);
- Are situated in areas receiving more than 600mm rainfall a year or those that are water-gaining sites (for example, granite outcrops, impeded drainage or engineering works which aggregate rainfall) in the 400-600mm a year rainfall range;
- Consists of areas where human vectors are controllable (e.g. not an open road, private property); and

- Are positioned in the landscape and are of sufficient size such that a qualified Interpreter judges that the pathogen will not autonomously engulf them in the short term (a period of a few decades); or
- Includes areas of high conservation and/or socio-economic value (for example, a small uninfested area with a known population of a susceptible species of Threatened flora). (DPaW 2015, page 113).

Further to this definition, protectable areas may also include uninterpretable areas. Uninterpretable areas that meet the protocols for identifying Protectable Areas (CALM 2004) are managed as being both infested and uninfested so that the pathogen is neither imported into, nor exported from, these areas.

Figures 2-7 show the protectable areas within the project area including uninfested and uninterpretable areas. Some uninfested and uninterpretable areas have been determined to be unprotectable due to their size and/or landscape position.

2.3 Risk Assessment Methodology

The Dieback risk assessment is a qualitative two-tier process. 'Likelihood' assesses risk in terms of the *Phytophthora* pathogen being spread as a result of a particular activity, depending on where and when that activity occurs.

The 'consequences' are assessed in terms of potential impacts to biodiversity and ecological function if the pathogen is introduced into a protectable area. Definitions of the 'likelihood' and 'consequence' categories are presented in **Tables 6** & **7.** The risk rating is determined by inputting both the likelihood and consequence ratings into the risk matrix for the three different soil moisture categories: wet, moist and dry **(Table 8)**.

The level of risk is determined by the soil moisture conditions at the time the activity is being undertaken in protectable areas in conjunction with the likelihood and consequence ratings. The risks associated with the introduction of *P. cinnamomi* are higher than with other *Phytophthora* species because of its virulence and destructive potential for native vegetation.

Table 2 below presents a risk assessment of the likelihood and consequences of potential impacts as a result of introducing Phytophthora into protectable areas and the residual risk after management startegies are implemented.

2.4 Risk Assessment Activities

The primary risk during the pre-construction phase of the project is associated with vehicles and machinery accessing protectable areas and transporting soil and vegetative materials into these areas from infested or high-risk areas such as gullies and creek lines. The likelihood of this occurring significantly increases as soil moisture increases. **Table 8** (**Appendix 2**) presents the risk associated with the three different categories of soil moisture: wet, moist and dry.

The other significant risk associated with the investigations phase of the project is that vehicles and machinery, such as drill rigs, will arrive on site dirty and import infected soil or vegetative materials into protectable areas from another site,

The importation of raw materials also poses a significant risk of introducing the pathogen into protectable areas. Raw materials include anything in which *Phytophthora* can survive and be transported in a viable form. Raw material can include Basic Raw Material (BRM), soil, mulch, vegetative material and/or seedlings for revegetation.

Table 2: Risk assessment of the likelihood and consequences of potential impacts as a result of introducing Phytophthora into protectable areas and the residual risk after management startegies are implemented under dry, moist and wet soil conditions.

Aspect	Impact(s)	Likelihood	Consequences	Level of Risk	Management Strategies and Phase 1. Pre-construction 2. Construction 3. Operation	Residual risk after management strategies implemented Likelihood	Consequences	Residual Risk
Phytophthora cinnamomi is introduced into protectable areas	Significant impact to vegetation diversity, structure and ecological function	Likely	Major (Many susceptible species)	Dry: High	Map Dieback occurrence in the native vegetation within the project area (completed) and ensure that vehicles and machinery are 'clean on entry 'to protectable areas	Unlikely	Major (Many susceptible species)	Dry: Moderate
				Moist: High				Moist: Moderate
				Wet: High				Wet: High
Introduction of other *Phytophthora* spp. Into protectable areas	Localised impacts to vegetation diversity, structure and ecological function	Likely	Moderate	Dry: Moderate	Map Dieback occurrence in the native vegetation within the project area (completed) and ensure that vehicles and machinery are 'clean on entry 'to protectable areas	Unlikely	Moderate	Dry: Low
				Moist: High				Moist: Moderate
				Wet: High				Wet: Moderate
Phytophthora spp spread through water runoff	Significant impact to vegetation diversity, structure and ecological function	Likely	Major (Many susceptible species)	Dry: High	Install drainage system to direct surface flow off construction areas to detention basins and then either: 6. Treat the water with Phytoclean to kill the pathogen if present; or 7. Discharge the water into Excluded or Infested areas to ensure that infected water is not vectored into Protectable areas down-	Unlikely	Major (Many susceptible species)	Dry: Moderate
				Moist: High				Moist: Moderate
				Wet: High				Wet: High
				Wet: High				Wet: High

					gradient of the detention basin.			

3 Environmental Objectives and Performance Indicators

The objective of the Dieback Management Startegy is to define management actions and responsibilities to prevent the non-autonomous spread of Dieback within and outside of the project area and during the pre-construction phase.

.The overarching objectives are to:

- Prevent *Phytophthora* Dieback being introduced into protectable areas within the project area;
- Protect biodiversity from Dieback; and
- Prevent unauthorised access to the project area.

The environmental objectives and performance indicators for this management plan are presented in **Table 3**.

Table 3: Environmental Objectives and Performance Indicators

Reference No.	Management Objective	Target	Performance Indicator
DB 01	Prevent *Phytophthora* Dieback from being introduced into the project area	No new infestations recorded within the project area (depending on the ability to map Dieback occurrence due to disease expression)	No breaches of hygiene requirements
DB 02	Education and training	▪ Ensure that personnel and contractors are aware of the risks associated with Dieback and adhere to the hygiene control measures outlined in this plan ▪ Have supervisors and environmental personnel undertake Green Card training https://www.dwg.org.au/green-card	▪ Dieback will be included as a component of the induction package. ▪ Green Card training to key staff as required

4 Management Strategy

4.1 Hygiene Management Principles

The Dieback Management Hierarchy of Control diagram below illustrates efficient prioritisation in Dieback management. Dieback cannot be effectively managed unless disease occurrence mapping is current and clearly identifies protectable areas. Undertaking ground disturbance activities during dry soil conditions will greatly reduce the risk of spreading a Dieback and reduce the time taken to ensure vehicles and machinery

are clean of soil and vegetative materials.

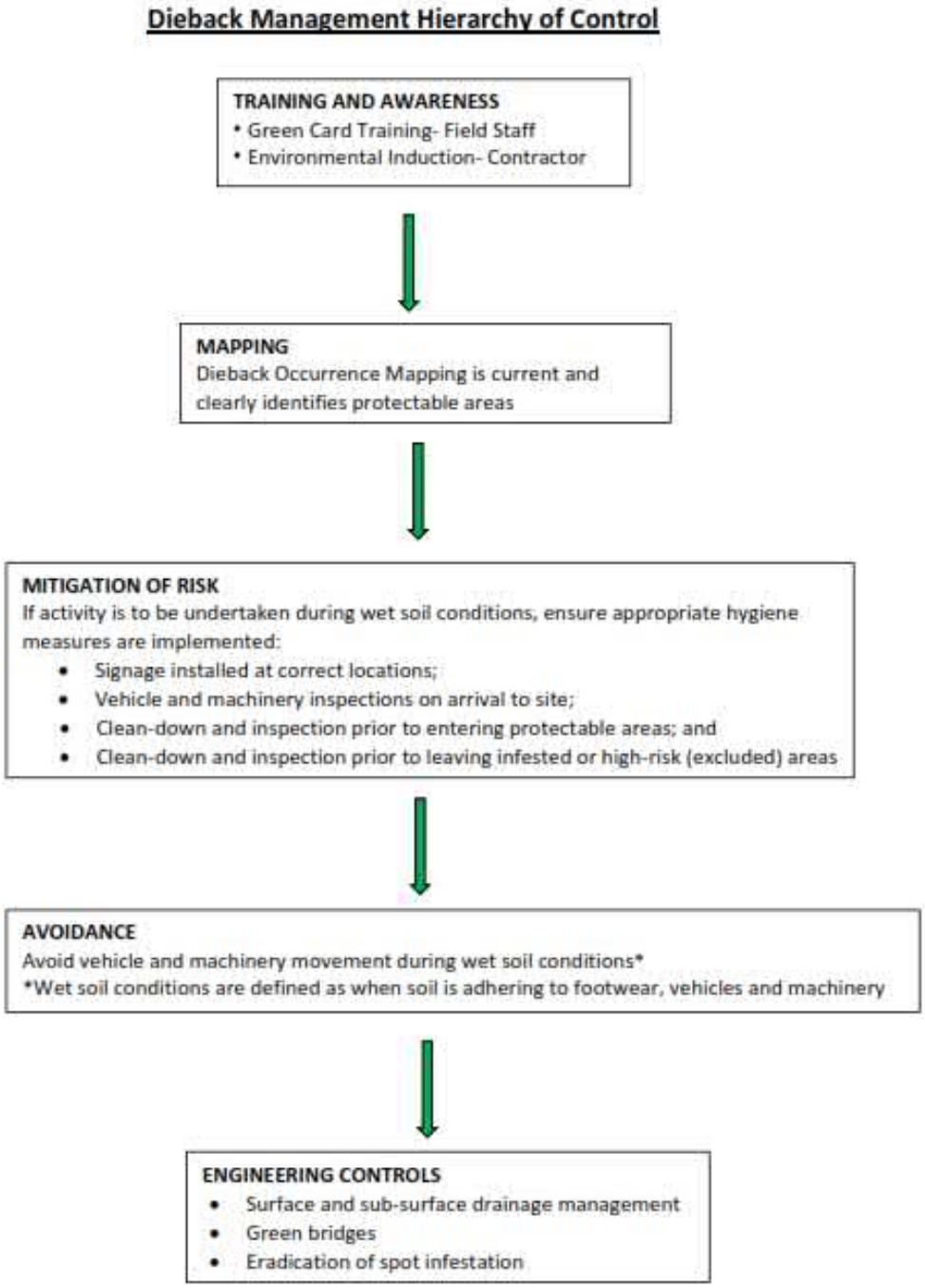

Table 4 below lists the *Phytophthora* management objectives, management actions during each phase (pre-construction, Construction and operation), key personnel with responsibility of the management actions and reporting.

Table 4: *Phytophthora* Management Actions

Objectives	Management Actions	Key personnel with responsibility for actions	Reporting System
Objective 1	Prevent new *Phytophthora* infestations		
Vehicle and Equipment Hygiene	Unacceptably dirty vehicles and equipment will be refused entry to the project area. Vehicle and machinery inspections should be undertaken by a suitably qualified person using the vehicle and machinery inspection sheet (**Appendix 2**)	Environmental Co-ordinator	Audit
	All vehicles and machinery will adhere to hygiene requirements for each Dieback occurrence category as outlined in **Table 5.**	All Personnel and Contractors	Audit
Importation of Materials	Only soils, road base or vegetation from known Dieback free areas are to be allowed on site. Importation of these materials is on the condition that the risk associated with these materials has been determined to be 'low'.	Construction Manager	Audit
Objective 2	Ensure education, awareness, and control measures for Dieback management are communicated to Jacobs personnel and contractors		
Support	Provide advice and support to ensure implementation of appropriate Dieback management strategies.	Environmental Co-ordinator	
Training	▪ Awareness of environmental issues, including Dieback management, is communicated to personnel through presentations in safety meetings and toolbox sessions. Posters and maps of infestation areas are to be displayed around the site. Dieback management is discussed at daily production meetings, as required. ▪ Have all environmental personnel undertake Green Card training.	Environmental Co-ordinator	Audit

Hygiene management requires that all vehicles and machinery be:

- 'clean on entry' when entering uninfested areas;
- 'clean on exit' when exiting infested areas; and
- 'clean on entry' and 'clean on exit' when entering and exiting both uninterpretable and 'temporarily uninterpretable area'.

Table 5 presents the hygiene requirements for each Dieback occurrence category present within the project area.

Table 5: Dieback Occurrence categories and required hygiene management

Dieback Occurrence Category	Clean on Entry	Clean on Exit	Comment
Uninfested	✓		Clean on Entry for areas determined to be 'protectable'
Uninterpretable	✓	✓	Clean on Entry and Exit for areas determined to be 'protectable'
Infested		✓	Follow hygiene procedures to ensure clean-down effluent is kept within infested area
Excluded		✓	Management will depend on results of risk assessment to determine the likelihood of the excluded area being infested and potential impacts to biodiversity

4.2 Design Considerations

As the geographic area of the proposed disturbance activity increases so does the likelihood of introducing or spreading Dieback. Mini-catchments (the catchment area of a first order stream) should be used to define areas of risk because this is the unit of area impacted when Dieback is introduced into an area.

The project design should carefully consider the potential impacts of surface water drainage in terms of spreading Dieback. Surface water traversing infested areas should not be directed into protectable areas within a mini catchment. Effluent entering an infested area should be retained in sumps within the infested area and not allowed to drain into protectable areas or areas that have not been assessed for the presence of Dieback.

Soil movement is a major consideration when managing Dieback in construction projects. The basic principle is to only move soil to areas of equal or greater risk, in terms of the likelihood of the pathogen being present and potential impacts to biodiversity. For example soil from and infested area should not be moved to an uninfested area.

As 2320.30ha (71.28%) of the assessment area was mapped as 'excluded' a hygiene management plan for the construction phase of the project should include a risk assessment of these areas. The assessment should examine the likelihood of the pathogen being present in excluded areas, and the potential consequences to biodiversity should soil be moved from one location to another. For example if soil from an excluded area immediately adjacent to an infested area is moved to an excluded area which drains into a mini catchment then this could have severe consequences for protectable areas downstream of the excluded area.

4.3 Access Management

The Dieback Management Hierarchy of Control states that vehicular and machinery access should be restricted to 'dry soil conditions' in the first instance. If unavoidable then measures should be implemented to mitigate the risk of spreading Dieback into protectable areas. These measures include vehicle and machine hygiene control measures and inspections.

4.4 Hygiene Control Measures

All vehicles and machinery arriving on site should be required to go directly to a quarantine inspection area and will not be permitted to leave the area until they have been inspected by environmental personnel or a trained delegate and certified as being clean of soil and vegetative material. A quarantine inspection point should be established at a Hygiene Inspection Area.

Hygiene requirements vary considerably depending on whether the work is to be conducted during wet or dry soil conditions. Wet conditions are defined as the situation where soil is adhering to vehicles and machinery. Conversely, in dry soil conditions, soil will not be adhering to vehicles and machinery. When operating during wet soil conditions, all vehicles and machinery are required to be Clean on Entry (CoE) when entering protectable areas (either uninfested or uninterpretable). This includes entering from cleared farmland (excluded areas) and from uninterpretable to uninfested areas.

Clean-down requirements are considerably less onerous during dry soil conditions as soil and vegetative material does not adhere to vehicles and machinery. When operating during dry soil conditions all vehicles and machinery are required to be CoE when entering protectable areas (either uninfested or uninterpretable

Figure 2-7 presents protectable areas (uninfested and uninterpretable). This information should be used to determine suitable locations for CoE points

4.4.1 Field Hygiene Kits

All operational vehicles should carry a field hygiene kit. The kit enables staff to undertake vehicle clean-down in the field when required by hygiene management protocols for each Dieback occurrence category (

Table 5 presents the hygiene requirements for each Dieback occurrence category present within the project area.

Table 5). The kit should include the following items and be checked on a regular basis to ensure that material quantities are adequate:

- 20 litres of water;
- 8 litres methylated spirits and sealed container to store;
- 8-10 litre spraying unit;
- Hand spray bottles;
- Hard bristle scrubbing brush;
- Long handled scrubbing brush; and
- Dustpan and brush (for interior cleaning).

While all field staff should undertake Green Card training, which demonstrates correct clean-down techniques, the basic principles are:

1. Vehicle movement should be avoided within protectable areas during ‘wet soil conditions’.
2. Vehicles and machinery should be maintained clean but should always be inspected when entering protectable areas.
3. All soil and vegetative materials adhering to the vehicle or machine entering a protectable area should be removed by either dry brushing, spraying, disinfecting, or a combination of these methods.
4. The interior of vehicles should be checked and cleaned if required so that the cab is free from soil and vegetative materials.

5 Conclusion and Recommendations

Although the likelihood of the pathogen residing in soil within cleared (excluded) upland areas with annual rainfall between 600mm-700mm is low, a precautionary approach to hygiene management is recommended. The risk of transporting infected soil increases during wet conditions when soil and vegetative material can easily adhere to vehicles and machinery. Clean-down requirements are considerably less onerous during dry soil conditions because soil and vegetative material does not adhere as readily to vehicles and machinery and is less likely to be transported.

If staff and contractors are adequately informed and the CoE strategy is followed then the risk of introducing or spreading the pathogen in protectable areas will be minimised.

Terratree makes the following recommendations to ensure the Dieback management strategy for the Bindoon Bypass project is correctly implemented:

- Provide Green Card training to personnel including environmental managers, supervisors and key staff members to ensure compliance with the Dieback management strategy;
- Prevent access to low lying areas;
- Provide clear instruction to staff and contractors about hygiene requirements when entering protectable areas; and
- Conduct inspections of machinery and vehicles to ensure that they are free of soil and vegetative materials.

6 References

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7 Glossary of Terms

Chlamydospores – a thick walled big resting spore of several kinds of fungi. It is a life stage that survives in unfavourable conditions, such as dry or hot seasons.

Disease - the combination of a pathogen, host and correct environmental conditions, which results in disease symptoms or death of a host.

symptoms or death of a host.

Environment - the sum of all external factors which act on an individual organism during its lifetime.

Excluded Area - areas that have been disturbed to an extent that they are not assessable and therefore excluded from dieback interpretation

Host - means the plant which is invaded by a pathogen and from which the pathogen derives its energy.

Infested Areas - areas that accredited person have determined have plant disease symptoms consistent with the presence of the pathogen *Phytophthora*

Inoculum - cells, tissue, or viruses that are used to inoculate a new culture

Pathogen - any organism or factor causing disease within a host

Pathogenic – causing or capable of causing disease

***Phytophthora* Dieback Management Map** - the map prepared as part of 'protectable' areas *Phytophthora* Dieback management planning process. It records details of planned management actions.

***Phytophthora* Dieback Management Plan -** the document (includes appended maps) that describes and controls how human access to uninfested 'protectable' areas is to be managed so that the role of humans as vectors in establishing new centres of infestation will be reduced to the lowest possible level.

***Phytophthora* Dieback -** a term referring to the disease symptoms caused by *Phytophthora* species in susceptible vegetation.

Precautionary Principle- has the meaning as stated in the Intergovernmental Agreement on the Environment (1992):"Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by:
(a) careful evaluation to avoid, where-ever practicable, serious or irreversible damage to the environment; and,
(b) an assessment of the risk-weighted consequences of various options."

Protectable Area - Defines areas of land managed by the department, over which hygiene management rules for the plant pathogen Phytophthora, including clean on entry, will apply. These areas are generally free of disease.

Risk Analysis - s a systematic use of available information to determine how often specified events may occur and the magnitude of their consequences.

Risk Control - part of risk management that involves the implementation of policies, standards, procedures and physical changes to eliminate or minimise adverse risks.

Risk Evaluation - the process used to determine risk management priorities.

Risk Management - the culture, processes and structures that are directed towards the effective management of potential opportunities and adverse effects

Susceptible – Likely to be influenced or able to be harmed by particular pathogen

Sporulation - a type of reproduction that occurs in fungi, algae, and protozoa and involves the formation of spores by the spontaneous division of a cell into four or more daughter cells, each of which contains a part of the original nucleus.

Stromata - The connective tissue framework of an organ, gland or other structure, as distinguished from the tissues performing the special function of the organ or part.

Susceptible - influenced or able to be harmed by *Phytophthora* Dieback

Uninfested – An area that does not contain infected plants or show visible signs of disease

Uninterpretable – a natural area where there are inadequate visible symptoms present to make a diagnosis

Unmappable – A naturally vegetated area that has had disturbance and from which is likely to recover in the short term

8 Figures

400000 410000 420000 430000

6560000 6550000 6540000 6530000 6520000

Bindoon Moora Rd

Wannamal

Wongan Hills Calingiri West Rd

Great Northern Hwy

Gingin

Bindoon

Brand Hwy

Great Northern Hwy

Brand Hwy

Legend

Project Location

Roads

Local Road

State Road

Geographic Locations

Town

Project Location

Project Location

Bindoon Bypass 2018 Dieback Assessment

N

Datum: GDA 1994
Projection: MGA Zone 50

Scale: 1: 150,000 at A3

Date: 22/05/2018	Prepared: G. Maslen	Project No: T18002
Expiry:	Checked: J. Grehan	
Figure 1	Revision:	
	Review:	

Terratree

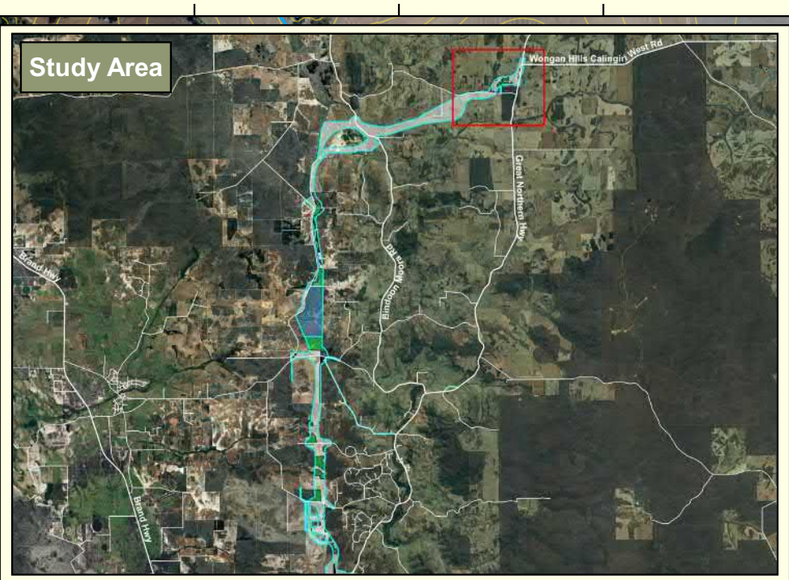


Table: Dieback occurrence categories and required hygiene management

Dieback Occurrence Category	Clean on Entry	Clean on Exit	Comment
Uninfested	✓		Clean on Entry for areas determined to be 'protectable'
Uninterpretable	✓	✓	Clean on Entry and Exit for areas determined to be 'protectable'
Infested		✓	Follow hygiene procedures to ensure clean-down effluent is kept within infested area
Excluded		✓	Management will depend on results of risk assessment to determine the likelihood of the excluded area being infested and potential to impact biodiversity

Wongan Hills Calingiri West Rd

Great Northern Hwy

NOTE: Terratree Pty Ltd does not guarantee that this figure is without any mistakes and disclaims all liability for any errors, loss or other consequence that may arise from any of the spatial information illustrated. Spatial information on this figure is based on observable disease symptoms made during the field survey component of this assessment and does not take into account recent or incipient disease symptoms.

Legend

Topography
- Hydrology
- 5m Contours

Road Network
- Local Road
- State Road

Dieback Assessment
- Assessment Area

Dieback Management Categories
- Excluded
- Uninterpretable
- Protectable Uninfested
- Unprotectable

Base Map: Google Satellite WMS

Project Location

Bindoon Bypass Dieback Protectable Areas

Bindoon Bypass Dieback Management Strategy

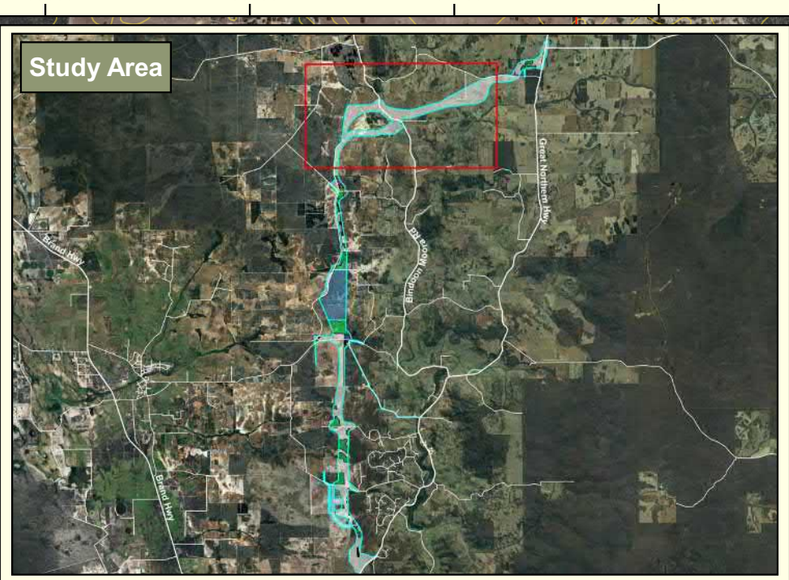
0 200 400 600 800 1000 m

N

Datum: GDA 1994
Projection: MGA Zone 50

Scale: 1: 15000 at A3

Date: 05/07/2018	Prepared: G. Maslen	Project #: T18009
Expiry: 05/07/2019	Checked:G. Maslen	
Figure 2	Review: J. Grehan	Terratree
	Revision: Rev A	



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405000 406000 407000 408000 409000 410000 411000 412000 413000 414000 415000 416000

6551000 6550000 6549000 6548000 6547000 6546000

Bindoon Moora Rd

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Legend

Topography
- Hydrology
- 5m Contours

Road Network
- Local Road
- State Road

Dieback Assessment
- Assessment Area

Dieback Management Categories
- Excluded

Base Map: Google Satellite WMS

Project Location

Bindoon Bypass Dieback Protectable Areas

Bindoon Bypass Dieback Management Strategy

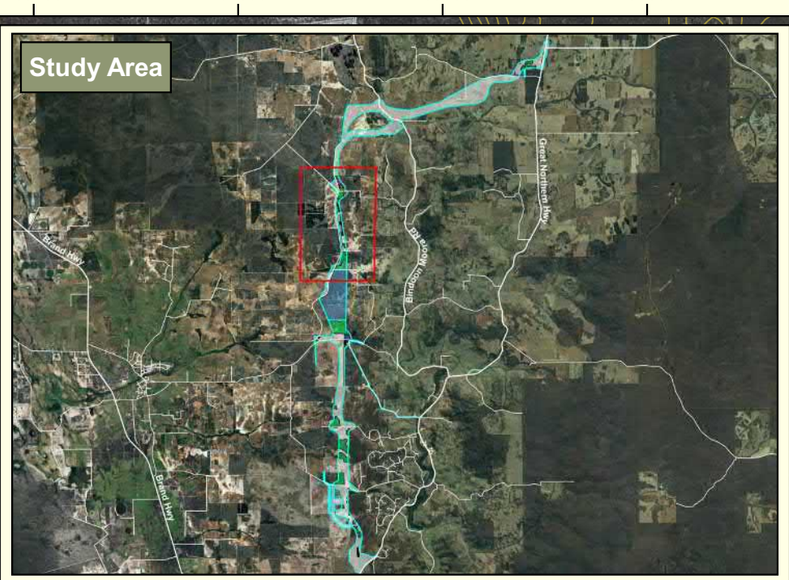
0 500 1000 1500 2000 m

N

Datum: GDA 1994
Projection: MGA Zone 50

Scale: 1: 30000 at A3

Date: 05/07/2018	Prepared: G. Maslen	Project #: T18009
Expiry: 05/07/2019	Checked:G. Maslen	
Figure 3	Review: J. Grehan	Terratree
	Revision: Rev A	



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6544000 6543000 6542000 6541000 6540000 6539000

Bindoon Moora Rd

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Topography
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- 5m Contours

Road Network
- Local Road
- State Road

Dieback Assessment
- Assessment Area

Dieback Management Categories
- Excluded
- Infested
- Not Assessed
- Uninterpretable
- Protectable Uninfested
- Unprotectable

Base Map: Google Satellite WMS

Project Location

Bindoon Bypass Dieback Protectable Areas

Bindoon Bypass Dieback Management Strategy

0 500 1000 1500 2000 m

N

Datum: GDA 1994
Projection: MGA Zone 50

Scale: 1: 30000 at A3

Date: 05/07/2018	Prepared: G. Maslen	Project #: T18009
Expiry: 05/07/2019	Checked:G. Maslen	
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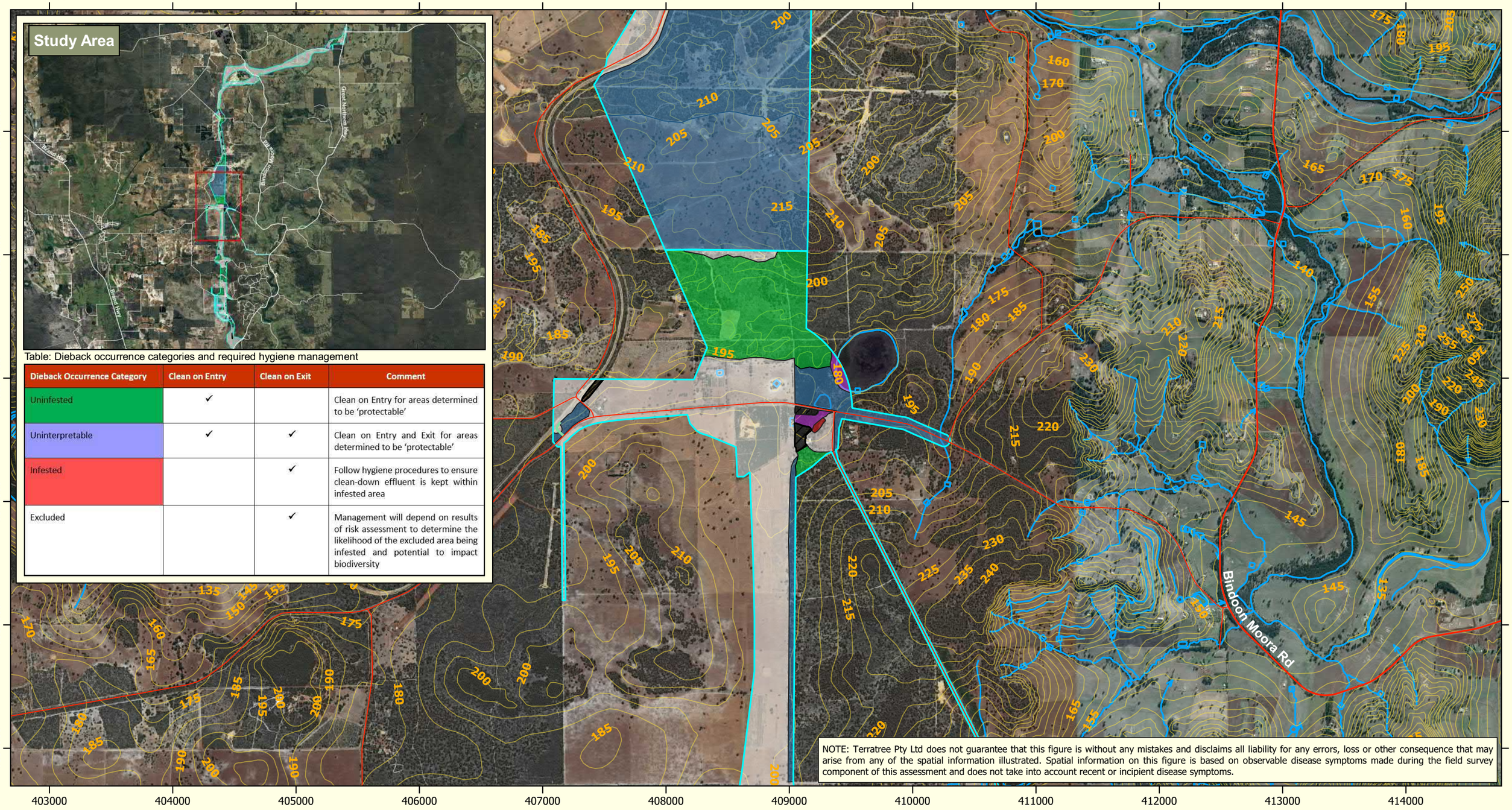
	Revision: Rev A	



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Base Map: Google Satellite WMS

Project Location

Bindoon Bypass Dieback Protectable Areas

Bindoon Bypass Dieback Management Strategy

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Datum: GDA 1994
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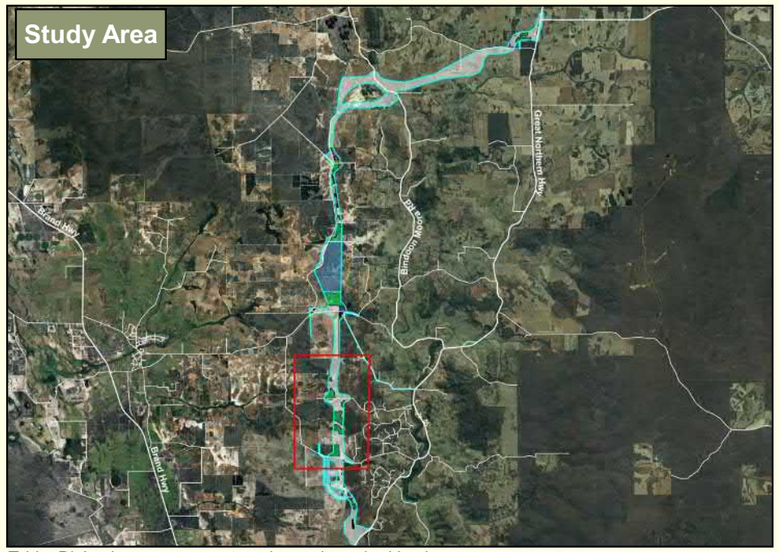
Date: 05/07/2018	Prepared: G. Maslen	Project #: T18009
Expiry: 05/07/2019	Checked:G. Maslen	
Figure 5	Review: J. Grehan	Terratree
	Revision: Rev A	



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Dieback Management Categories
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- Unprotectable

Base Map: Google Satellite WMS

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Datum: GDA 1994
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Scale: 1: 30000 at A3

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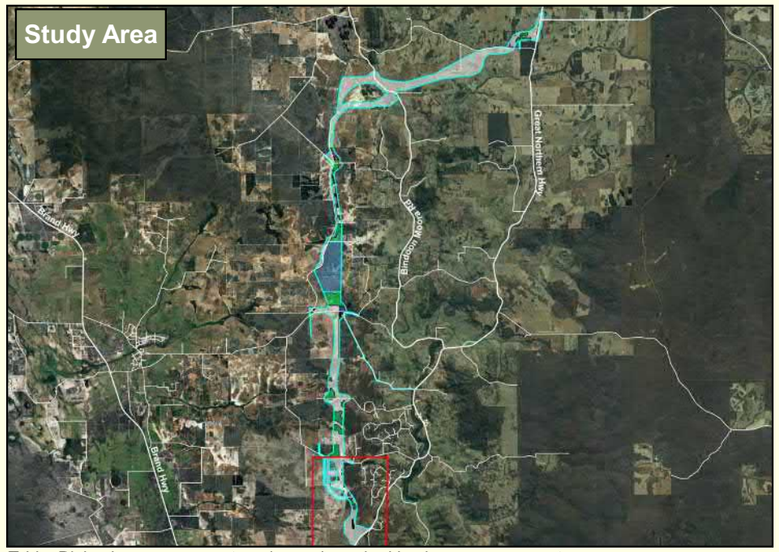

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Legend

Topography
- Hydrology
- 5m Contours

Road Network
- Local Road
- State Road

PPA Management Zones
- PPA Muchea Uninfested High Value Hotspot

Dieback Assessment
- Assessment Area

Dieback Management Categories
- Excluded
- Infested
- Uninterpretable
- Protectable Uninfested
- Unprotectable

Base Map: Google Satellite WMS

Project Location

Bindoon Bypass Dieback Protectable Areas

Bindoon Bypass Dieback Management Strategy

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Datum: GDA 1994
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Expiry: 05/07/2019	Checked:G. Maslen	
Figure 7	Review: J. Grehan	Terratree
	Revision: Rev A	

9 Appendices

Appendix 1: Risk Assessment Methodology

Risk Assessment Methodology

The risk assessment of the different activities was undertaken by asking the following two questions:

1) What is the likelihood of *Phytophthora* being spread as a result of a particular activity and where/when that activity occurs? and
2) What are the potential consequences in terms of impacts to biodiversity if infected material is vectored into protectable vegetation (uninfested and uninterpretable)?

Table 6: Dieback Likelihood Ratings

LIKELIHOOD RATING		
Descriptor	**Definition**	**Probability**
Rare	**The event may occur only in exceptional circumstances** For example: - The activity is not being undertaken within a protectable area - Dieback occurrence mapping is current - Hygiene controls measures (clean down locations) in place; - Activities occur only during 'dry soil conditions' (i.e. when soil is not adhering to boots, vehicles and machinery); and - Person(s) undertaking the activity have the required training and awareness about Dieback (e.g. Green Card holder (staff); or environmental induction (contractor)	<5%
Unlikely	**The event could occur at some time** For example: - Dieback occurrence mapping is current - Hygiene controls measures (vehicle and equipment inspections and clean down locations & signage) in place; - Activities occur only during 'dry soil conditions' (i.e. when soil is not adhering to boots, vehicles and machinery); and - Person(s) undertaking the activity have the required training and awareness about Dieback (e.g. Green Card holder (staff); or environmental induction (contractor)	5<24%
Possible	**The event should occur at some time** For example: - Dieback occurrence mapping is **not** current - **No** hygiene controls measures (vehicle and equipment inspections and clean down locations & signage) in place; - Activities occur only during 'dry soil conditions' (i.e. when soil is adhering to boots, vehicles and machinery) if occurring within protectable areas; - Person(s) undertaking the activity have the required training and awareness about Dieback (e.g. Green Card holder (staff); or environmental induction (contractor)	25-49%
Likely	**The event will probably occur in most circumstances** For example:	50-74%

LIKELIHOOD RATING		
Descriptor	**Definition**	**Probability**
	- Dieback occurrence mapping is **not** current - **No** Hygiene controls measures (vehicle and equipment inspections and clean down locations & signage) in place; - Activities occur within, upslope or immediately adjacent to protectable areas during 'wet soil conditions' (i.e. when soil is adhering to boots, vehicles and Person(s) undertaking the activity **don't** have the required training and awareness about Dieback (e.g. Green Card holder (staff); or environmental induction (contractor)machinery); - Soil movement is likely to occur	
Almost Certain	**The event is expected to occur in most circumstances** For example: - Dieback occurrence mapping is **not** current - Vehicles and machinery arrive on site dirty and are not inspected - **No** Hygiene controls measures (vehicle and equipment inspections and clean down locations) in place; - Activities undertaken across boundaries (infested and uninfested areas) during 'wet soil conditions' (i.e. when soil is adhering to boots, vehicles and machinery); and - Person(s) undertaking the activity **don't** have the required training and awareness about Dieback (e.g. Green Card holder (staff); or environmental induction (contractor)). - Soil movement will occur across boundaries	>75%

Table 7: Dieback Consequence Rating

CONSEQUENCE Rating	
Descriptor	**Environment**
Insignificant	Limited damage to area of low significance. **Example:** a spot infestation in area of little or no biodiversity value ('Degraded' or 'Completely Degraded' (WAPC 2000) native vegetation).
Minor	Minor effects on biological or physical environment. **Example:** Spot infestation into a small area (<4ha) with a low proportion of susceptible species (e.g. a wetland area dominated by *Melaleuca, Lepidosperma* and *Juncus* spp. with scattered *Banksia littoralis.*
Moderate	Moderate effects on the local environment. **Example:** Dieback spread into an area that has a high proportion of susceptible species (e.g. Banksia woodland) but has been determined to be unprotectable due to size (<4ha) or proximity to known infestation(s).
Major	Very serious, long-term localised impact on biodiversity and ecosystem function. **Example:** *Phytophthora cinnamomi* introduced into protectable area (>4ha <50ha) of urban bushland or area of high conservation values (e.g. an area that has Priority Flora species or Ecological Community and or significant fauna habitat values that are susceptible to Dieback).

CONSEQUENCE Rating	
Descriptor	**Environment**
Catastrophic	Critical widespread impact on biodiversity and ecosystem function. **Example:** *Phytophthora cinnamomi* spread into large conservation reserve (>50ha) or into an area with critical values (e.g. Threatened (Declared Rare) Flora species or Threatened Ecological Communities or significant fauna habitat values that are susceptible to Dieback.

Table 8: Series of risk assessment tables (identified by soil moisture) used to determine the overall dieback risk of an activity (adapted from '*Phytophthora* Dieback management manual', Forest and Ecosystem Management FEM 079, DBCA 2017)

DRY SOIL					
	CONSEQUENCE				
LIKELIHOOD	**Insignificant**	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	Low	Moderate	High	High	High
Likely	Low	Moderate	Moderate	High	High
Possible	Low	Low	Moderate	Moderate	High
Unlikely	Low	Low	Low	Moderate	High
Rare	Low	Low	Low	Moderate	High

MOIST SOIL					
	CONSEQUENCE				
LIKELIHOOD	**Insignificant**	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	Low	High	High	High	High
Likely	Low	Moderate	High	High	High
Possible	Low	Moderate	Moderate	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Rare	Low	Low	Low	Moderate	High

WET SOIL					
	CONSEQUENCE				
LIKELIHOOD	**Insignificant**	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	Low	High	High	High	High
Likely	Low	High	High	High	High
Possible	Low	Moderate	High	High	High
Unlikely	Low	Moderate	Moderate	High	High
Rare	Low	Low	Moderate	Moderate	High

Appendix 2:Example of Vehicle and Machinery Inspection Form (DBCA 2017)