4.3 Key Environmental Factor – Terrestrial Fauna

4.3.1 EPA Objective

To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.

4.3.2 Policy and Guidance

The following EPA policy and guidance have been considered during the preparation of this ERD and the supporting technical studies:

- Statement of environmental principles, factors and objectives (EPA 2016a)
- Terrestrial fauna surveys for environmental impact assessment in WA (EPA 2004b)
- Environmental factor guideline - terrestrial fauna (EPA 2016d)
- Technical guidance: sampling methods for terrestrial vertebrate fauna (EPA 2016e)
- Technical guidance: sampling of short range endemic invertebrate fauna (EPA 2016f)
- Technical guidance: terrestrial fauna surveys (EPA 2016g).

Other policy and guidance considered during the preparation of this ERD and the supporting technical studies includes:

- Survey guidelines for Australia's threatened bats: guidelines for detecting bats listed as threatened under the EPBC Act (Department of the Environment, Water, Heritage and the Arts—DEWHA, now DAWE—2010)
- Standards for reporting bat detector surveys (Australian Bat Society 2006)
- Survey guidelines for Australia's threatened mammals: guidelines for detecting mammals listed as threatened under the EPBC Act (Department of Sustainability, Environment, Water, Population and Communities—DSEWPaC, now DAWE—2011a)
- Survey guidelines for Australia's threatened reptiles: guidelines for detecting reptiles listed as threatened under the EPBC Act (DSEWPaC 2011b)
- EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's Cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (vulnerable) *Calyptorhynchus baudinii*, Forest Red-tailed Black Cockatoo (vulnerable) *Calyptorhynchus banksii naso* (DSEWPaC 2012a)
- Revised draft referral guideline for three threatened black cockatoo species: Carnaby's Cockatoo (Endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (Vulnerable) *Calyptorhynchus baudinii*, Forest Red-tailed Black Cockatoo (Vulnerable) *Calyptorhynchus banksii naso* (DoEE 2017)
- Chuditch (*Dasyurus geoffroii*) recovery plan (Department of Environment and Conservation—now DBCA—2012)
- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) recovery plan (Department of Parks and Wildlife—now DBCA—2013)
- Forest Black Cockatoo (Baudin's Cockatoo *Calyptorhynchus baudinii* and Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*) recovery plan (Chapman 2008)
- EPBC Act environmental offsets policy (DSEWPaC 2012b)
- WA environmental offsets policy (Government of WA 2011)
- WA environmental offsets guidelines (Government of WA 2014a)
- WA environmental offsets template (Government of WA 2014b).

4.3.3 Receiving Environment

4.3.3.1 Surveys Undertaken

In order to characterise the fauna assemblage of the Development Envelope and identify the presence/absence of any conservation significant fauna, a Level 1 fauna survey was undertaken by BCE on 6-7, 12 and 18 October 2016 and 13 December 2016. A desktop assessment was undertaken prior to the field surveys in order to produce a list of species considered representative of the vertebrate fauna assemblage of the region, and to identify conservation significant fauna which should be targeted during field surveys. Based on the information identified from the desktop study, the field surveys included targeted searches for Black Cockatoos, Chuditch, Quenda, Brush-tailed Phascogale, Brush Wallaby and Australian Water-rat (also known as the Rakali—BCE 2017). Motion-sensitive cameras were deployed at two wetland locations (Mooliabeenee Road and Teatree Road) between 7 October and 15 November 2016 (BCE 2017).

Additional targeted surveys were undertaken throughout 2017 and 2018, as follows (BCE 2018a, b):

- Black Cockatoo surveys:
  - 2017: 9 April; 7, 17 and 31 May; 31 July to 4 August; 4-8 September; 9-13 and 17 October; and 12 November
  - 2018: 20 and 21 February; 11 and 12 September; and 22 and 23 November.
- motion-sensitive camera surveys for mammals: 7 July – 4 August; and 4-8 September (targeting the Water-rat)
- owl call-playback and frog aural surveys: 31 May
- aquatic fauna surveys: 7 July, 3, 9 and 13 October
- short-range endemic invertebrates: 31 July – 4 August 2017; 4 – 8 September 2017 and 2 August 2018
- Anabat acoustic bat surveys: 4-8 September and 11-12 October
- Shield-backed trapdoor spider surveys: 2 August 2018.

The Black Cockatoo breeding tree survey undertaken on Lot 18 GNH, Bindoon, Lot 9001, Lot 104 Brennan Road, Bindoon and Lot 1 Teatree Road Bindoon on 20 and 21 February 2018 was undertaken to identify any trees with hollows used by or suitable for Black Cockatoos, which was then fed into a review and redesign of the alignment in this area.

The surveys encompass a larger area than the Development Envelope. The full BCE (2017, 2018) survey reports are provided in **Appendix E**. The surveys have been undertaken in accordance with the appropriate regulator guidance and published literature, with no deviations reported (BCE 2017, 2018). The regulator guidance considered consisted of:

- Terrestrial fauna surveys for environmental impact assessment in WA (as superseded by *Technical guidance: terrestrial fauna surveys*—EPA 2004b, 2016g)
- Technical guidance: sampling methods for terrestrial vertebrate fauna (EPA 2016e)
- Technical guidance: sampling of short range endemic invertebrate fauna (EPA 2016f)
- Survey guidelines for Australia's threatened bats: guidelines for detecting bats listed as threatened under the EPBC Act (DSEWPaC 2010)
- Survey guidelines for Australia's threatened mammals: guidelines for detecting mammals listed as threatened under the EPBC Act (DSWEPaC 2011a)
- Survey guidelines for Australia's threatened reptiles: guidelines for detecting reptiles listed as threatened under the EPBC Act (DSWEPaC 2011b)

- EPBC Act referral guidelines for three threatened Black Cockatoo species: Carnaby's Cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (vulnerable) *Calyptorhynchus baudinii*, Forest Red-tailed Black Cockatoo (vulnerable) *Calyptorhynchus banksii naso* (DSEWPaC 2012a).

In addition, the owl call-back and bat aural surveys were conducted in accordance with the following published literature:

- Owls in the southwest forests of Western Australia (Liddlelow, Wheeler & Kavanagh 2002)
- A survey of large forest owls in State Forests of south-western New South Wales, Australia (Parker et al. 2007)
- Owl survey of the Peel–Harvey Estuary in south-western Australia (Fulton 2017)
- Surveys of large forest owls in northern New South Wales: methodology, calling behaviour and owl responses (Debus 1995)
- Standards for reporting bat detector surveys (Australasian Bat Society 2006).

4.3.3.2 Fauna Habitats

Vegetation Substrate Associations

Fauna habitats are defined through a combination of vegetation types, soils or other substrate, and landforms to create vegetation and substrate associations (VSAs). The surveys undertaken by BCE (2017) identified nine major VSAs, including cleared paddocks with or without large remnant trees, wetland and waterways, heath and a range of woodlands (**Table 4-23** and **Figure 4-12**). A tenth VSA, plantation, was identified from aerial photography. Paddocks and paddocks with large remnant trees make up 66% of the survey area. The next most common habitat is Banksia woodlands, which makes up 15% of the survey area, followed by Marri-Jarrah woodland at 13% of the study area. It should be noted that the fauna habitats do not exactly align with vegetation associations and, as such, the boundaries identified and areas encompassed will vary between the two. For example, areas that have been classified as paddock for the purposes of vegetation association mapping may be mapped as VSA 1 through to VSA 7 (i.e. not paddocks or paddocks with large remnant trees).

As noted by BCE (2017), most of the VSAs are widespread regionally, with the exception of the wetlands and watercourses, which are restricted in extent by the nature of this VSA. BCE (2017) also noted that some of the drainage lines in the north of the survey area appear to be salt-affected due to large-scale clearing of the catchment. This view is supported by both Chittering Landcare Centre (R Hindmarsh 2018, pers. comm., 23 January) and the DBCA (R Huston 2018, pers. comm., 14 February), who have commented that salinity is a concern for the Bindoon area in general.

Table 4-23: Vegetation Substrate Associations (Fauna Habitats—BCE 2017, 2018)

VSA	Description	Area Mapped within Study Area (ha)	Habitat Condition[1]
VSA 1	**Banksia woodland**. Areas of predominantly *Banksia attenuata, B. menziesii, B. ilicifolia* and/or *B. prionotes* overstorey with diverse understorey, on sands. Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) absent.	480.6	Degraded to Excellent (Majority Very Good to Excellent)
VSA 2	**Banksia woodland with scattered Marri and/or Jarrah**. Areas of predominantly *B. attenuata, B. menziesii, B. ilicifolia* and/or *B. prionotes* and Jarrah and/or Marri. Substrate sand to gravelly-sand.	110.6	Degraded to Excellent (Majority Good to Very Good)

VSA	Description	Area Mapped within Study Area (ha)	Habitat Condition[1]
VSA 3	**Marri-Jarrah woodland**. Marri and/or Jarrah woodland with relatively complete and diverse understorey, on shallow sands over gravel.	389	Degraded to Excellent (Majority Good to Very Good. Large areas are Degraded)
VSA 4	**Marri-Jarrah woodland with little to no remnant understorey** (e.g. grazed), on sands or gravel. Tree canopy reasonably complete/in its native form but grassy and/or herbaceous stratum mostly introduced species.	107.9	Completely Degraded to Good. (Majority Degraded)
VSA 5	**Wandoo woodland (with or without understorey)**. Wandoo (*E. wandoo*) at variable densities with highly variable overstorey; i.e. monoculture of Wandoo; or with Jarrah, Marri, Flooded Gum (*E. rudis*) and/or York Gum (*E. loxophleba*). Understorey variable, ranging from cleared/grazed through weed-dominated to relatively intact native understorey. Usually on heavy soils or gravels.	132.2	Completely Degraded to Good. (Majority Degraded)
VSA 6	**Heath**. Dwarf Allocasuarina (*Allocasuarina humilis*), with Grasstrees (*Xanthorrhoea preissii*) and *Hibbertia hypericoides*, usually on stony rises. No overstorey.	1.8	Degraded
VSA 7	**Waterways or wetlands/damplands**. Swamps, damplands and watercourses and immediate fringing vegetation, including Flooded Gum and/or *Melaleuca* spp.	61.4	Completely Degraded to Degraded and some areas of Very Good to Excellent.
VSA 8	**Paddocks with large remnant trees**. Cleared understorey that has been cultivated for agricultural use but that retains sparsely-spread remnant large trees (usually Jarrah, Marri or Wandoo).	1,855.60	Completely Degraded to Degraded
VSA 9	**Paddocks**. Completely cleared lands cultivated for agricultural use	736.6	Completely Degraded
VSA 10	**Plantations**. Plantations of introduced flora species (e.g. pine).	36.3	Completely Degraded

[1] *Habitat Condition based on the recorded vegetation condition as per FVC (2018a).*

Habitats Supporting Conservation Significant Fauna

The habitats mapped by BCE (2017) are likely to support conservation significant fauna expected to occur within the Development Envelope and/or recorded during field surveys, as follows:

- Brush Wallaby:
  - Banksia woodlands (with or without scattered Marri and Jarrah)
  - Marri-Jarrah woodland (with or without remnant understorey)
  - Wandoo woodland (with or without understorey)

- Brush-tailed Phascogale:
  - Marri-Jarrah woodland (with or without remnant understorey)
  - Wandoo woodland (with or without understorey)
- Chuditch: Marri-Jarrah woodland (with or without remnant understorey).
- Water-rat: waterways or wetland/damplands.

These species are discussed further in **Chapter 4.3.3.5**.

Critical Habitat

Habitats critical to the survival of Carnaby's Black Cockatoo, the Forest Red-tailed Black Cockatoo and the Chuditch have been defined in their respective recovery plans (DPaW 2013; Chapman 2008; DEC 2012). For Carnaby's Black Cockatoo, critical habitat is identified as:

- "the eucalypt woodlands that provide nest hollows used for breeding, together with nearby vegetation that provides feeding, roosting and watering habitat that supports successful breeding;
- woodland sites known to have supported breeding in the past and which could be used in the future, provided adequate nearby food and/or water resources are available or are re-established;
- in the non-breeding season, the vegetation that provides food resources as well as the sites for nearby watering and night roosting that enable the cockatoos to effectively utilise the available food resources" (DPaW 2013, p. 1).

Critical habitat for the Forest Red-tailed Black Cockatoos 'comprises all Marri *Corymbia calophylla*, Karri *Eucalyptus diversicolor* and Jarrah *Eucalyptus marginata* forests, woodlands and remnants in the south-west of Western Australia receiving more than 600 mm of annual average rainfall' (Chapman 2008, p. 13). For the Chuditch, critical habitat comprises those areas of native vegetation currently occupied by the species, are used to move from one area to another, are within the recorded range and may thus be occupied by the species, or provide suitable habitat for the reintroduction of the species (DEC 2012).

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

Fauna Habitat Mapping (BCE 2018)

- 1 - Banksia woodland
- 3 - Marri-Jarrah woodland
- 4 - Marri-Jarrah woodland with little to no remnant understorey
- 8 - Paddocks with large remnant trees
- 9 - Paddocks

Legend

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

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Fauna Habitats (BCE 2017, 2018)

Figure: 4 - 12 Page 1 of 15

Drawing No	Issue
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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

Fauna Habitat Mapping (BCE 2018)

- 1 - Banksia woodland
- 2 - Banksia woodland with scattered Marri and/or Jarrah
- 3 - Marri-Jarrah woodland
- 4 - Marri-Jarrah woodland with little to no remnant understorey
- 7 - Waterways or wetlands/damplands
- 8 - Paddocks with large remnant trees
- 9 - Paddocks

BINDOON

Legend

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

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Fauna Habitats (BCE 2017, 2018)

Figure: 4 - 12 Page 2 of 15

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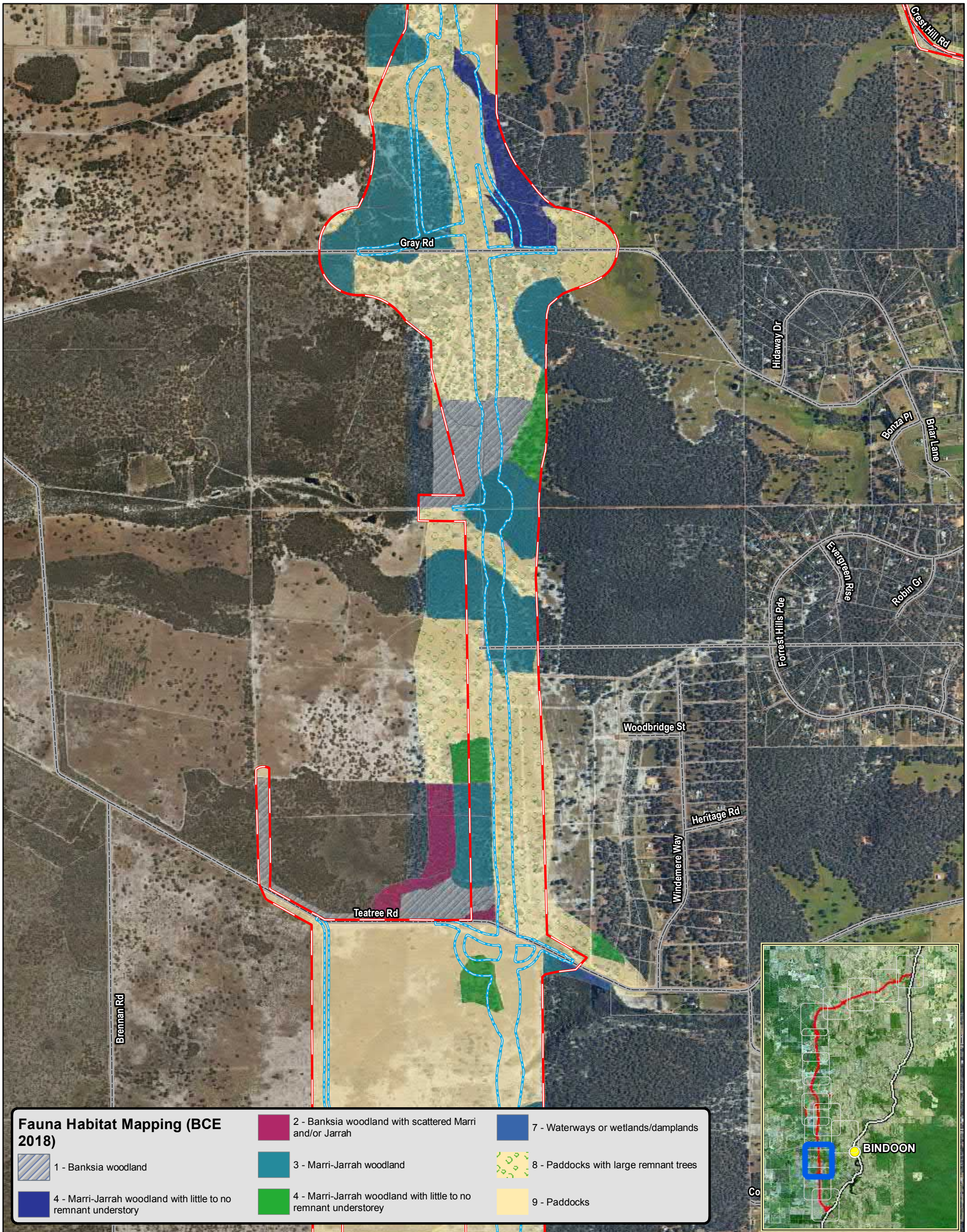

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Fauna Habitats (BCE 2017, 2018)

Figure: 4 - 12 Page 3 of 15

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Mooliabeenee Rd

Crest Hill Rd

Gray Rd

BINDOON

Fauna Habitat Mapping (BCE 2018)

- 1 - Banksia woodland
- 2 - Banksia woodland with scattered Marri and/or Jarrah
- 3 - Marri-Jarrah woodland
- 4 - Marri-Jarrah woodland with little to no remnant understory
- 4 - Marri-Jarrah woodland with little to no remnant understorey
- 5 - Wandoo woodland (with or without understorey)
- 8 - Paddocks with large remnant trees
- 9 - Paddocks
- 10 - Plantation

Legend

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- Minor Road

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Figure: 4 - 12 Page 4 of 15

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Cullalla Rd

Barn Rd

Ashworth Rd

Mooliabeenee Rd

Wells Glover Rd

Crest Hill Rd

BINDOON

Fauna Habitat Mapping (BCE 2018)

- 1 - Banksia woodland
- 2 - Banksia woodland with scattered Marri and/or Jarrah
- 3 - Marri-Jarrah woodland
- 4 - Marri-Jarrah woodland with little to no remnant understorey
- 5 - Wandoo woodland (with or without understorey)
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Figure: 4 - 12 Page 5 of 15

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

Fauna Habitat Mapping (BCE 2018)

- 1 - Banksia woodland
- 2 - Banksia woodland with scattered Marri and/or Jarrah
- 3 - Marri-Jarrah woodland
- 4 - Marri-Jarrah woodland with little to no remnant understory
- 4 - Marri-Jarrah woodland with little to no remnant understorey
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Figure: 4 - 12 Page 6 of 15

Drawing No	Issue
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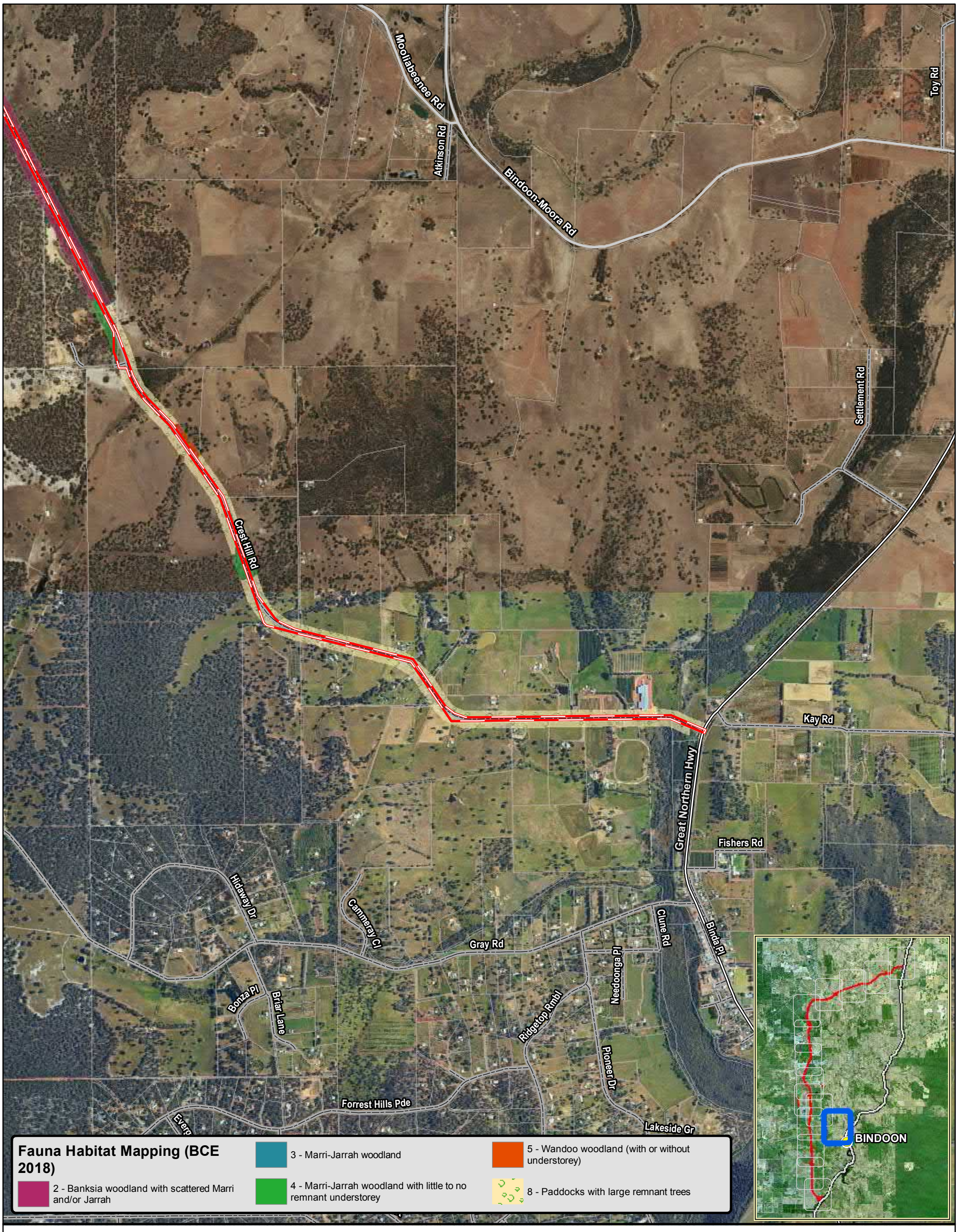

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- Development Envelope
- Cadastral Boundary
- Highway
- Major Road
- Minor Road

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Figure: 4 - 12 Page 7 of 15

Drawing No	Issue
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Kinkella Rd

Cullalla Rd

Bam Rd

Ashworth Rd

Mooliabeenee Rd

Wells Glover Rd

Crest Hill Rd

BINDOON

Fauna Habitat Mapping (BCE 2018)

- 1 - Banksia woodland
- 2 - Banksia woodland with scattered Marri and/or Jarrah
- 3 - Marri-Jarrah woodland
- 4 - Marri-Jarrah woodland with little to no remnant understorey
- 8 - Paddocks with large remnant trees
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Figure: 4 - 12 Page 8 of 15

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Culialla Rd

Barn Rd

Kinkella Rd

BINDOON

Fauna Habitat Mapping (BCE 2018)

- 1 - Banksia woodland
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Fauna Habitats (BCE 2017, 2018)

Figure: 4 - 12 Page 9 of 15

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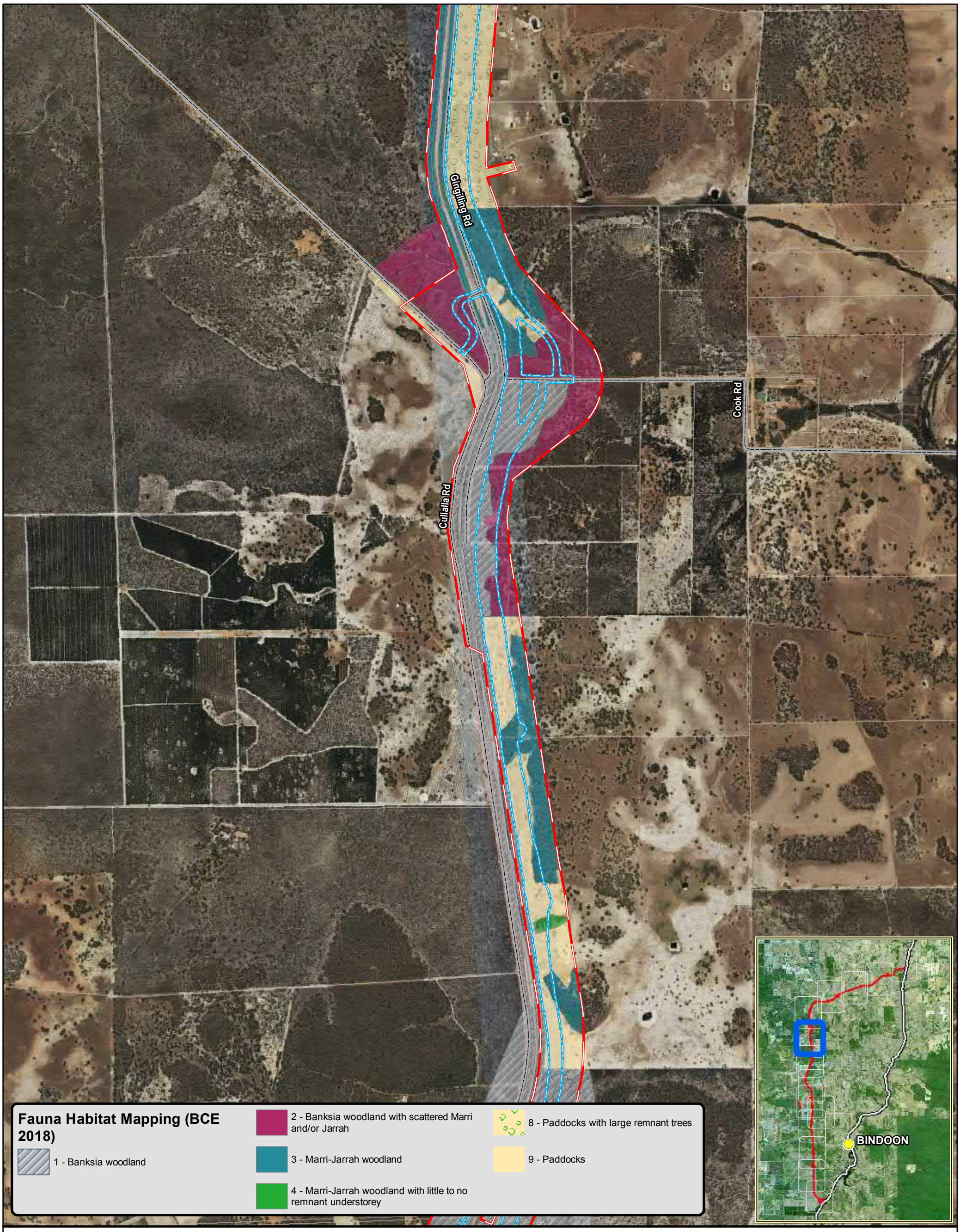

Legend

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

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Great Northern Highway
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Fauna Habitats (BCE 2017, 2018)

Figure: 4 - 12 Page 10 of 15

Drawing No	Issue
GNH-CN12-EA-PER-0001 F4-12	1

Task No	Drawing Status / Other
ERD	Draft

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Wannamal Rd South

Gingilling Rd

Cullalla Rd

Cool

BINDOON

Fauna Habitat Mapping (BCE 2018)

1 - Banksia woodland

2 - Banksia woodland with scattered Marri and/or Jarrah

3 - Marri-Jarrah woodland

8 - Paddocks with large remnant trees

9 - Paddocks

Legend

Development Envelope

Development Footprint

Cadastral Boundary

Minor Road

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Figure: 4 - 12

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Hay Flat Rd

Kangaroo Gully Rd

Bindoon-Moora Rd

BINDOON

Fauna Habitat Mapping (BCE 2018)

- 3 - Marri-Jarrah woodland
- 4 - Marri-Jarrah woodland with little to no remnant understorey
- 5 - Wandoo woodland (with or without understorey)
- 7 - Waterways or wetlands/damplands
- 8 - Paddocks with large remnant trees
- 9 - Paddocks
- 10 - Plantation

Legend

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- Major Road
- Minor Road

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Fauna Habitats
(BCE 2017, 2018)

Figure: 4 - 12 Page 12 of 15

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GNH-CN12-EA-PER-0001 F4-12	1

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Hay Flat Rd

Head Rd

Kangaroo Gully Rd

Bindoon-Moora Rd

BINDOON

Fauna Habitat Mapping (BCE 2018)

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Fauna Habitats (BCE 2017, 2018)

Figure: 4 - 12 Page 13 of 15

Drawing No	Issue
GNH-CN12-EA-PER-0001 F4-12	1

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30/05/2019	BG	LB	TJ

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Hay Flat Rd

Head Rd

BINDOON

Fauna Habitat Mapping (BCE 2018)

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Figure: 4 - 12

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Calingiri Rd

Great Northern Hwy

Hay Flat Rd

BINDOON

Fauna Habitat Mapping (BCE 2018)

- 3 - Marri-Jarrah woodland
- 5 - Wandoo woodland (with or without understorey)
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Figure: 4 - 12

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Black Cockatoo Breeding Habitat

The surveys undertaken by BCE (2017, 2018) have identified a total of 11,554 potential breeding trees across the study area. Of these, approximately 75% did not have hollows suitable for Black Cockatoos. A total of 1,352 tree hollows were recorded that are suitable for use by Black Cockatoos (BCE 2018), with a further 83 identified with evidence of chew marks around hollow entrances, indicating these are likely to be used for breeding. During the 2017 survey, one active nest was recorded within the Development Envelope (BCE 2018). Two additional active nests were recorded outside of the Development Envelope. Those trees with hollows suitable for breeding or showing evidence of use by, Black Cockatoos are shown in **Figure 4-13**.

During the surveys undertaken by BCE (2017, 2018), feral Honey Bees were confirmed to have colonised 30 hollows that would otherwise have been suitable for use by Black Cockatoos.

Black Cockatoo Foraging and Roosting Habitat

Foraging habitat for both Carnaby's Black Cockatoo and the Forest Red-tailed Black Cockatoo was recorded across the study area by BCE (2017, 2018). It should be noted that the Proposal is located outside of the core habitat for the Forest Red-tailed Black Cockatoo, as identified by mapping undertaken for the Perth-Peel strategic assessment (Department of the Premier and Cabinet 2015). The value of the foraging habitat ranged from Negligible to High for both species (**Table 4-24**, **Figure 4-14** and **Figure 4-15**). For the Forest Red-tailed Black Cockatoo, 68.5% of the survey area was determined to consist of habitat with Low or Negligible foraging value, while for Carnaby's Black Cockatoo 59% of the study area was recorded as Low or Negligible (BCE 2018). 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 encompasses Moderate value foraging habitat for both species (BCE 2018).

The criteria and method used to define habitat value are provided in Appendix 5 of BCE's report (**Appendix E**). The relationship between the categories defined by BCE (2018) and the draft Black Cockatoo referral guidelines (DoEE 2017) are provided in **Table 4-25**. In summary, the score attributed by BCE (2018) is added to a score out of three for the site context (e.g. availability of foraging habitat nearby) and a score out of one for density of foraging species.

There are an estimated 93 004 ha of remnant native vegetation within 15 km of the Development Envelope, which is likely to provide foraging habitat for Black Cockatoos.

Three roost sites for the Forest Red-tailed Black Cockatoo were identified by BCE (2018) (**Table 4-26**, **Figure 4-15**). None of these roosts are within the Development Envelope. No roost sites for Carnaby's Black Cockatoo were recorded (BCE 2018).

Table 4-24: Black Cockatoo Foraging Habitat Value of the Study Area

Habitat Value	Forest Red-tailed Black Cockatoo		Carnaby's Black Cockatoo	
	Area (ha)	%	Area (ha)	%
6: High	106.5	2.7	243.3	6.2
5: Moderate to High	202.1	5.2	383.7	9.8
4: Moderate	365.1	9.4	664.4	17.0
3: Low to Moderate	555.2	14.2	313.3	8.0
2: Low	1,362.0	34.9	1,452.0	37.1
1: Negligible	1,308.5	33.6	855.4	21.9
0: Nil	0.0	0.0	0.0	0.0

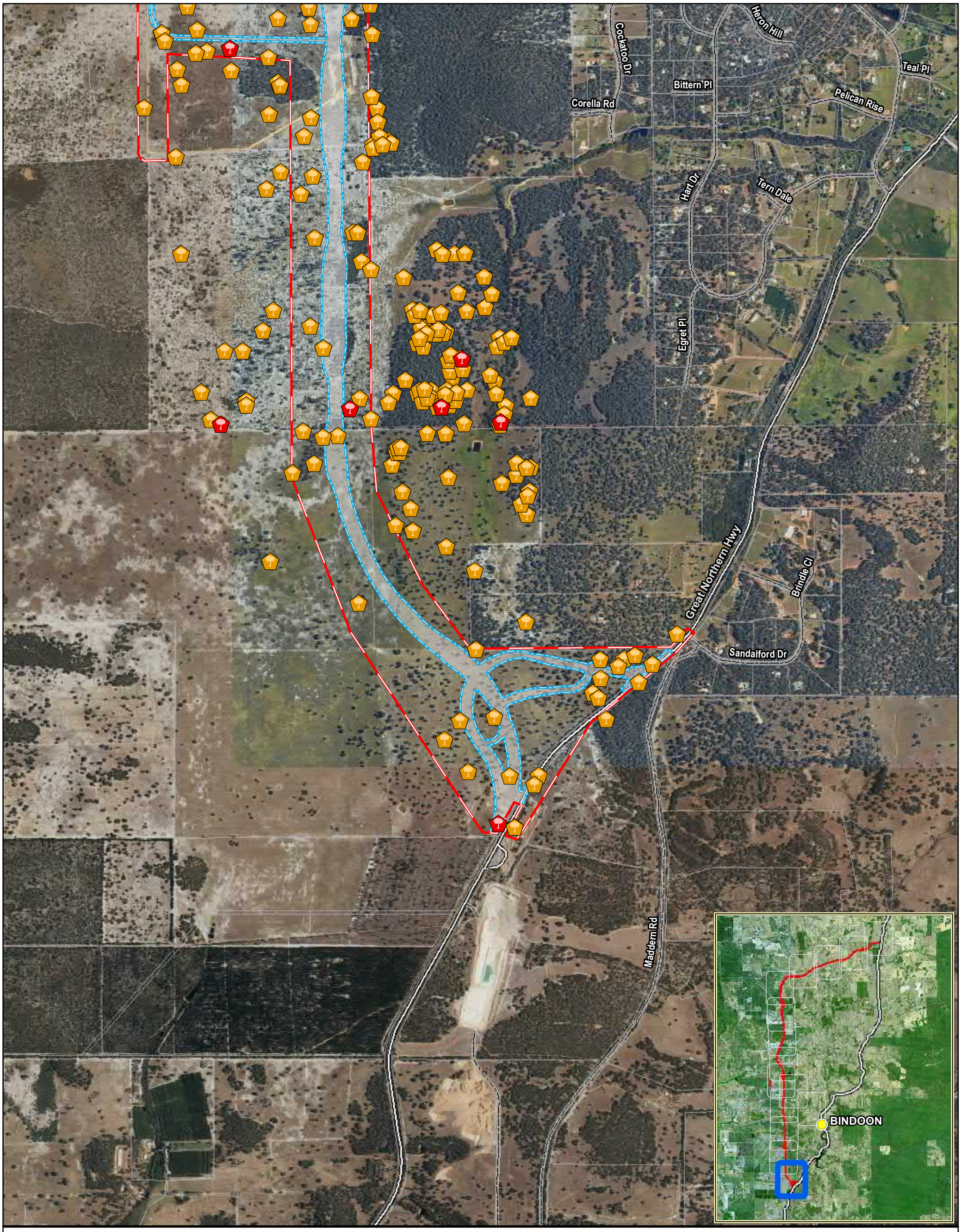
Table 4-25: Relationship between Foraging Habitat Value of BCE (2018) and DoEE (2017)

Habitat Value as per BCE (2018)	Context Score		Species Density Score		Habitat Value as per DoEE (2017)
	CBC	FRTBC	CBC	FRTBC	
6: High	2	2	1	1	9. Very High Quality
5: Moderate to High	2	2	1	1	8. Very High Quality
4: Moderate	2	2	1	1	7. High Quality
3: Low to Moderate	2	2	1	1	6. Quality
2: Low	0	0	0	0	N/A (veg. score <3)
1: Negligible	0	0	0	0	N/A (veg. score <3)
0: Nil	2	2	1	1	N/A (veg. score <3)

CBC = Carnaby's Black Cockatoo; FRTBC = Forest Red-tailed Black Cockatoo

Table 4-26: Black Cockatoo Roost Sites

Roost ID	Location	Distance from Development Envelope (m)
FRTBC Roost 01	In paddock trees and remnant woodland north-east of the cemetery on Gray Road	130
FRTBC Roost 02	In remnant woodland between Cockatoo Road and Warbler Court, Bindoon	980
FRTBC Roost 03	In paddock trees and remnant woodland south of the Mooliabeenee Road/Glover-Wells Road intersection	220



Legend

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

Black Cockatoo Trees (FVC)

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

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 4-13 Page 1 of 15

Drawing No	Issue
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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
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Black Cockatoo Trees (FVC)

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 4-13 Page 2 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	1

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Crest Hill Rd
Gray 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
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- Cadastral Boundary

Black Cockatoo Trees (FVC)

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 4-13 Page 3 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	1

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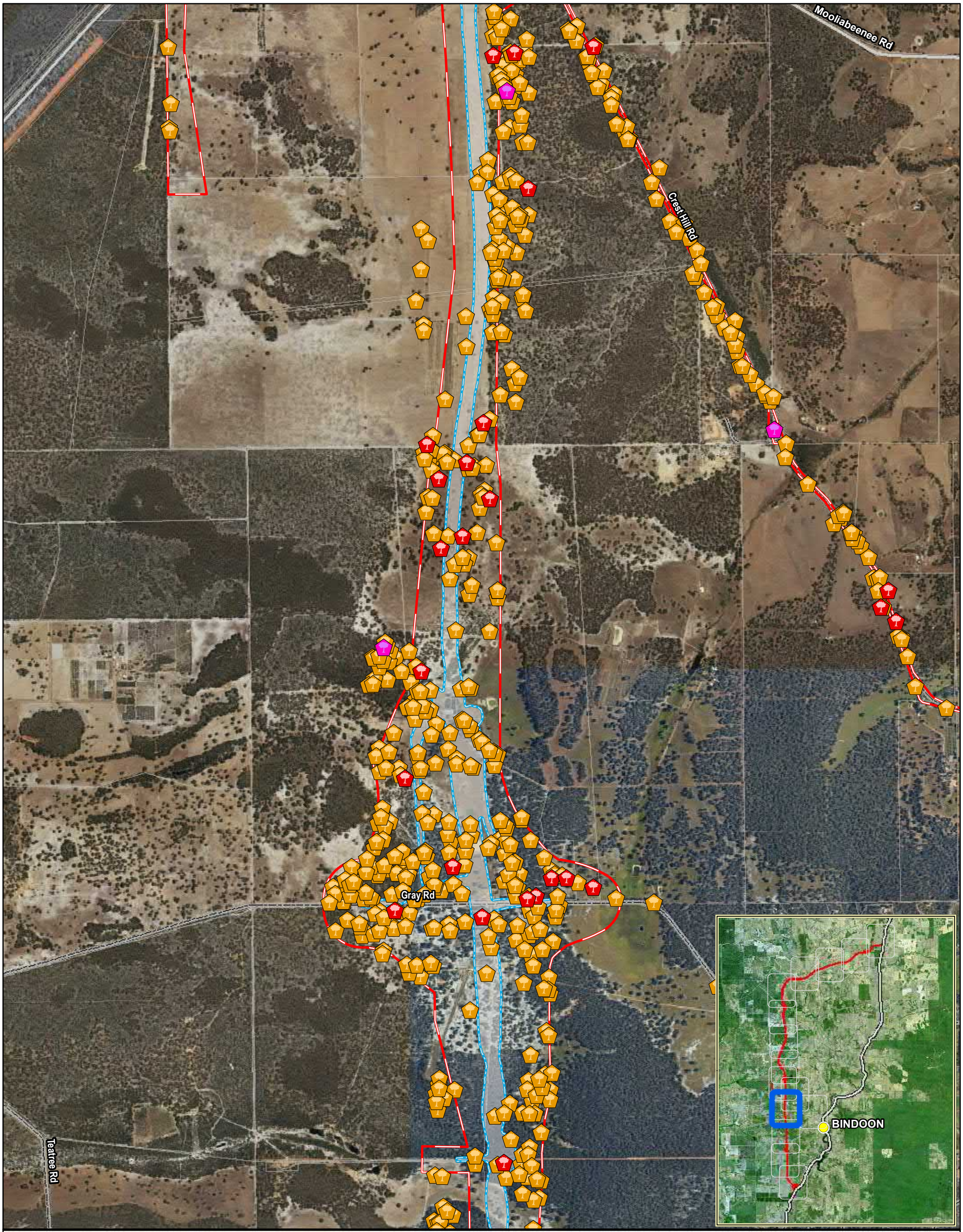

Legend

- Development Envelope
- Development Footprint
- Major Road
- Minor Road
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Black Cockatoo Trees (FVC)

- Hollow currently in Use
- Hollow with Evidence of Use (Previously Used Hollow)
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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 4-13 Page 4 of 15

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GNH-CN12-EA-PER-00001 - F4-13	1

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

Legend

- Development Envelope
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Black Cockatoo Trees (FVC)

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 4-13 Page 5 of 15

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

Legend

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Figure: 4-13 Page 6 of 15

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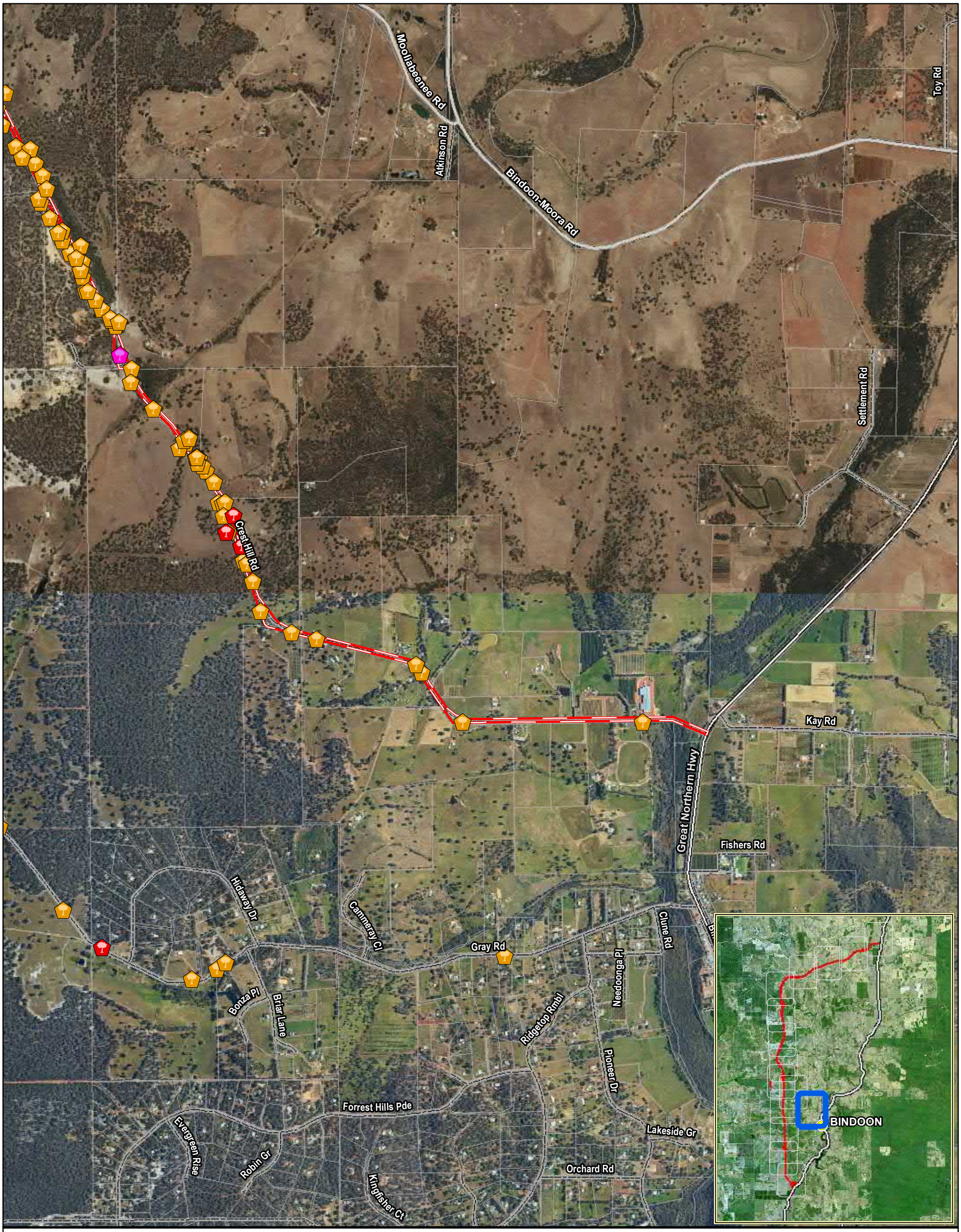

Legend

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Black Cockatoo Trees (FVC)

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 4-13 Page 7 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	1

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Kinkella Rd
Cullalla Rd
Bam Rd
Wells Glover Rd
Mooliabeenee Rd
Ashworth Rd
Crest Hill Rd
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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 4-13 Page 8 of 15

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

Cullalla Rd

Barn Rd

Kinkella Rd

BINDOON

Legend

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

Black Cockatoo Trees (FVC)

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

Joint Venture Partners:

Arup Pty Ltd
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www.arup.com

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 4-13 Page 9 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
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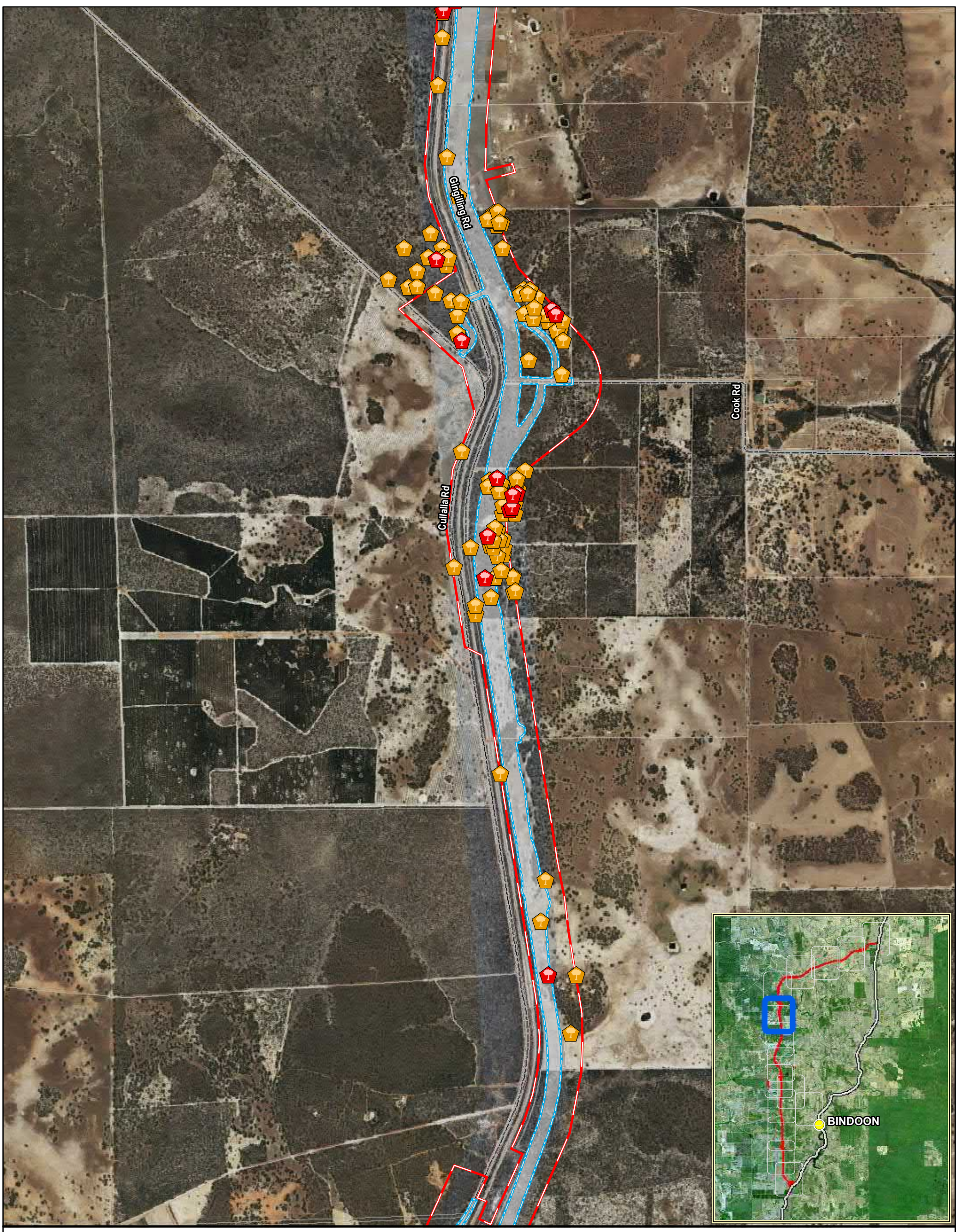

Legend

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Black Cockatoo Trees (FVC)

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 4-13 Page 10 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
9/08/2019	BG	LB	TJ

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Wannamal Rd South

Gingilling Rd

Cullalla Rd

BINDOON

Legend

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

Black Cockatoo Trees (FVC)

- Hollow with Evidence of Use (Previously Used Hollow)
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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 4-13 Page 11 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
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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

Black Cockatoo Trees (FVC)

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

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 4-13 Page 12 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
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Hay Flat Rd

Head Rd

Kangaroo Gully Rd

Bindoon-Moora Rd

BINDOON

Legend

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

Black Cockatoo Trees (FVC)

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 4-13 Page 13 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
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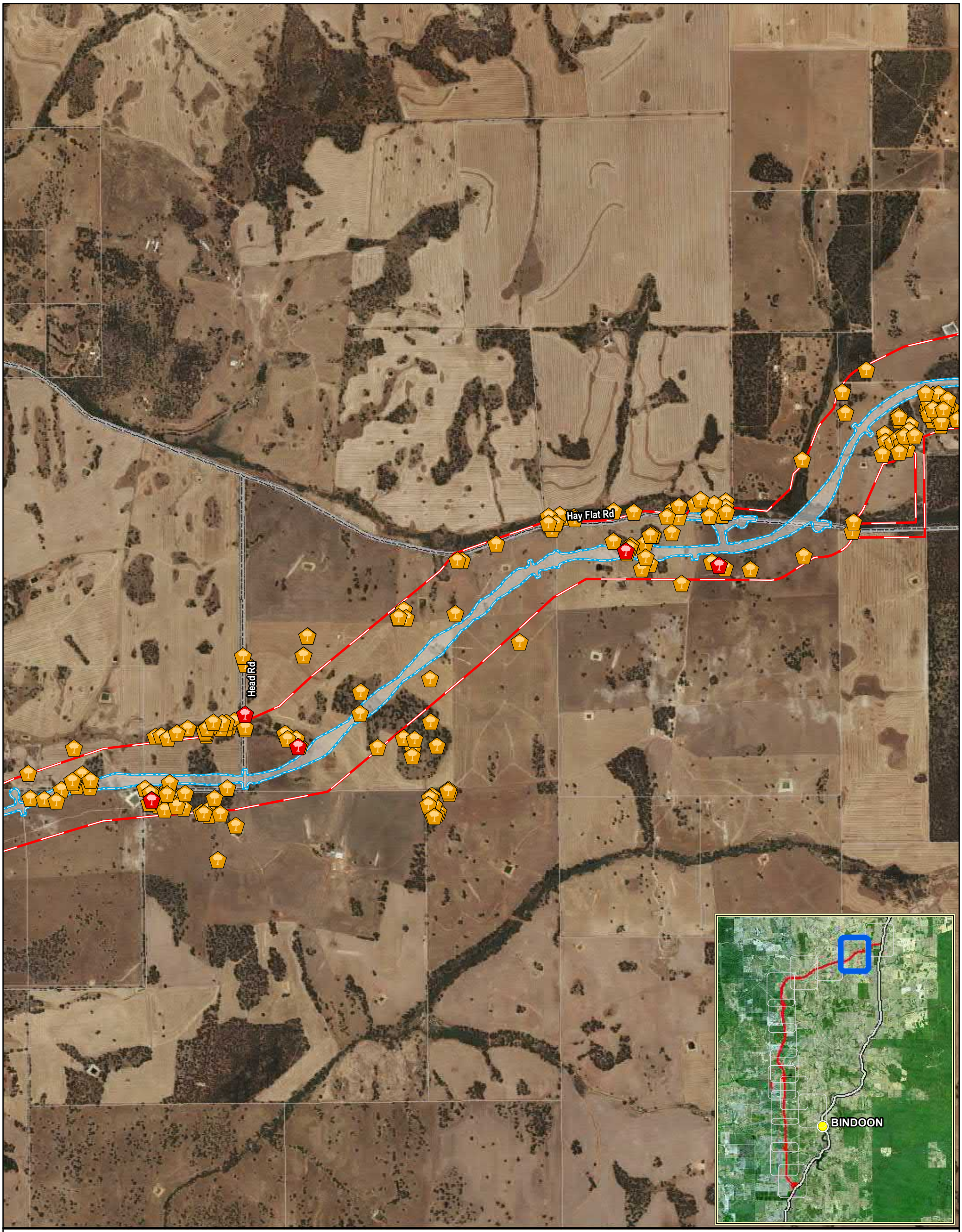

Legend

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- Development Footprint
- Minor Road
- Cadastral Boundary

Black Cockatoo Trees (FVC)

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 4-13 Page 14 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
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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

Black Cockatoo Trees (FVC)

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

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Black Cockatoo Habitat –Trees with Suitable or Used Hollows

Figure: 4-13 Page 15 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-13	1

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
9/08/2019	BG	LB	TJ

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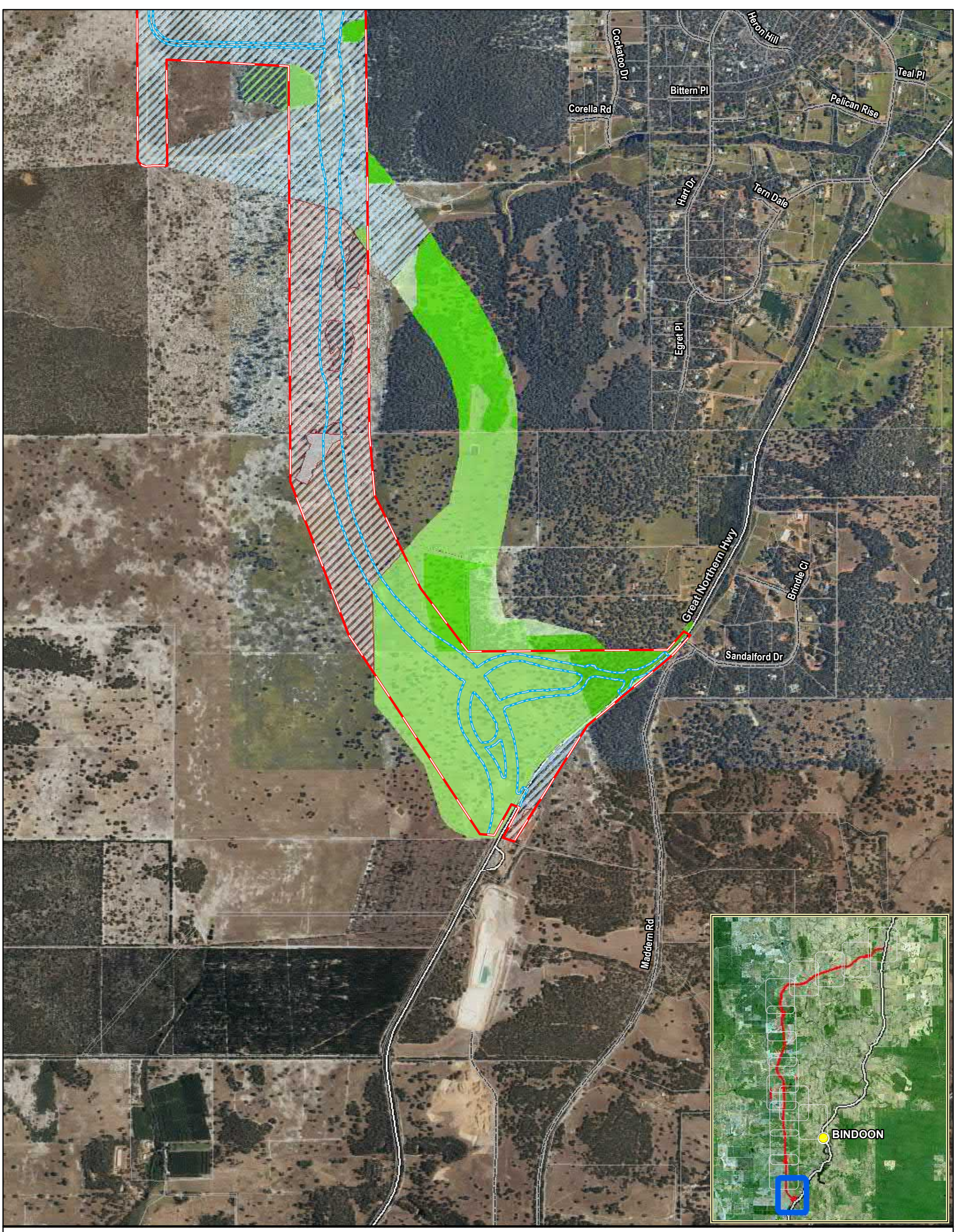

Legend

- 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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Carnaby's Black Cockatoo Habitat Foraging Value

Figure: 4-14 Page 1 of 15

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

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
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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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Environmental Review Document

Carnaby's Black Cockatoo Habitat Foraging Value

Figure: 4-14 Page 2 of 15

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

Task No	Drawing Status / Other
ERD	Draft

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

Crest Hill Rd
Gray 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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Environmental Review Document

Carnaby's Black Cockatoo Habitat Foraging Value

Figure: 4-14 Page 3 of 15

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

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
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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

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Carnaby's Black Cockatoo Habitat Foraging Value

Figure: 4-14 Page 4 of 15

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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Cullalla Rd

Barn Rd

Ashworth Rd

Mooliabeenee Rd

Wells Glover Rd

Crest Hill 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
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Carnaby's Black Cockatoo Habitat Foraging Value

Figure: 4-14 Page 5 of 15

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

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
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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)
- 5 - Moderate - High
- 6 - High

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Carnaby's Black Cockatoo
Habitat Foraging Value

Figure: 4-14 Page 6 of 15

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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Moolialbeenee 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
Ridgetop Rmbl
Pioneer Dr
Bonza Pl
Briar Lane
Forrest Hills Pde
Lakeside Gr
Evergreen Rise
Robin Gr
Orchard Rd
Kingfisher Ct
BINDOON

Legend

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

CBC Habitat (FVC)
Foraging Vales

- 0 - Nil
- 1 - Negligible
- 2 - Low
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Carnaby's Black Cockatoo
Habitat Foraging Value

Figure: 4-14 Page 7 of 15

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

Legend

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

CBC Habitat (FVC)

Foraging Vales

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

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Carnaby's Black Cockatoo Habitat Foraging Value

Figure: 4-14 Page 8 of 15

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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Cullalla Rd

Barn Rd

Kinkella Rd

BINDOON

Legend

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

CBC Habitat (FVC)

Foraging Vales

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

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Carnaby's Black Cockatoo Habitat Foraging Value

Figure: 4-14 Page 9 of 15

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

Gingilling Rd

Cullalla Rd

Cook 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
- 3 - Low-Moderate
- 4 - Moderate

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

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Project

Great Northern Highway
Bindoon Bypass
Environmental Review Document

Carnaby's Black Cockatoo Habitat Foraging Value

Figure: 4-14 Page 10 of 15

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

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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

0 240 480

Metres

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

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Figure: 4-14 Page 11 of 15

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

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
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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

CBC Habitat (FVC)

Foraging Vales

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

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Carnaby's Black Cockatoo
Habitat Foraging Value

Figure: 4-14 Page 12 of 15

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

Task No	Drawing Status / Other
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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

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

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Carnaby's Black Cockatoo
Habitat Foraging Value

Figure: 4-14 Page 13 of 15

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

Task No	Drawing Status / Other
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Hay Flat Rd

Head Rd

BINDOON

Legend

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

CBC Habitat (FVC)

Foraging Vales

- 0 - Nil
- 0 - Nil (Extrapolated)
- 1 - Negligible
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- 4 - Moderate
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Carnaby's Black Cockatoo Habitat Foraging Value

Figure: 4-14

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

Task No	Drawing Status / Other
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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)
- 2 - Low
- 2 - Low (Extrapolated)
- 3 - Low-Moderate
- 4 - Moderate
- 5 - Moderate - High

0 240 480

Metres

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Carnaby's Black Cockatoo Habitat Foraging Value

Figure: 4-14 Page 15 of 15

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

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
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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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Environmental Review Document

Forest Red-tailed Black Cockatoo Roost Sites and Habitat Foraging Value

Figure: 4-15 Page 1 of 15

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

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
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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
- 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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Environmental Review Document

Forest Red-tailed Black Cockatoo
Roost Sites and Habitat
Foraging Value

Figure: 4-15 Page 2 of 15

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

Task No	Drawing Status / Other
ERD	Draft

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

Crest Hill Rd
Gray 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
- 2 - Low
- 3 - Low-Moderate
- 4 - Moderate
- 5 - Moderate - High
- 6 - High

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Forest Red-tailed Black Cockatoo
Roost Sites and Habitat
Foraging Value

Figure: 4-15 Page 3 of 15

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

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
- 2 - Low
- 3 - Low-Moderate
- 4 - Moderate
- 5 - Moderate - High
- 6 - High

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Environmental Review Document

Forest Red-tailed Black Cockatoo
Roost Sites and Habitat
Foraging Value

Figure: 4-15 Page 4 of 15

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

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
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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
- 1 - Negligible
- 2 - Low
- 3 - Low-Moderate
- 4 - Moderate
- 5 - Moderate - High
- 6 - High

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Forest Red-tailed Black Cockatoo
Roost Sites and Habitat
Foraging Value

Figure: 4-15 Page 5 of 15

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

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
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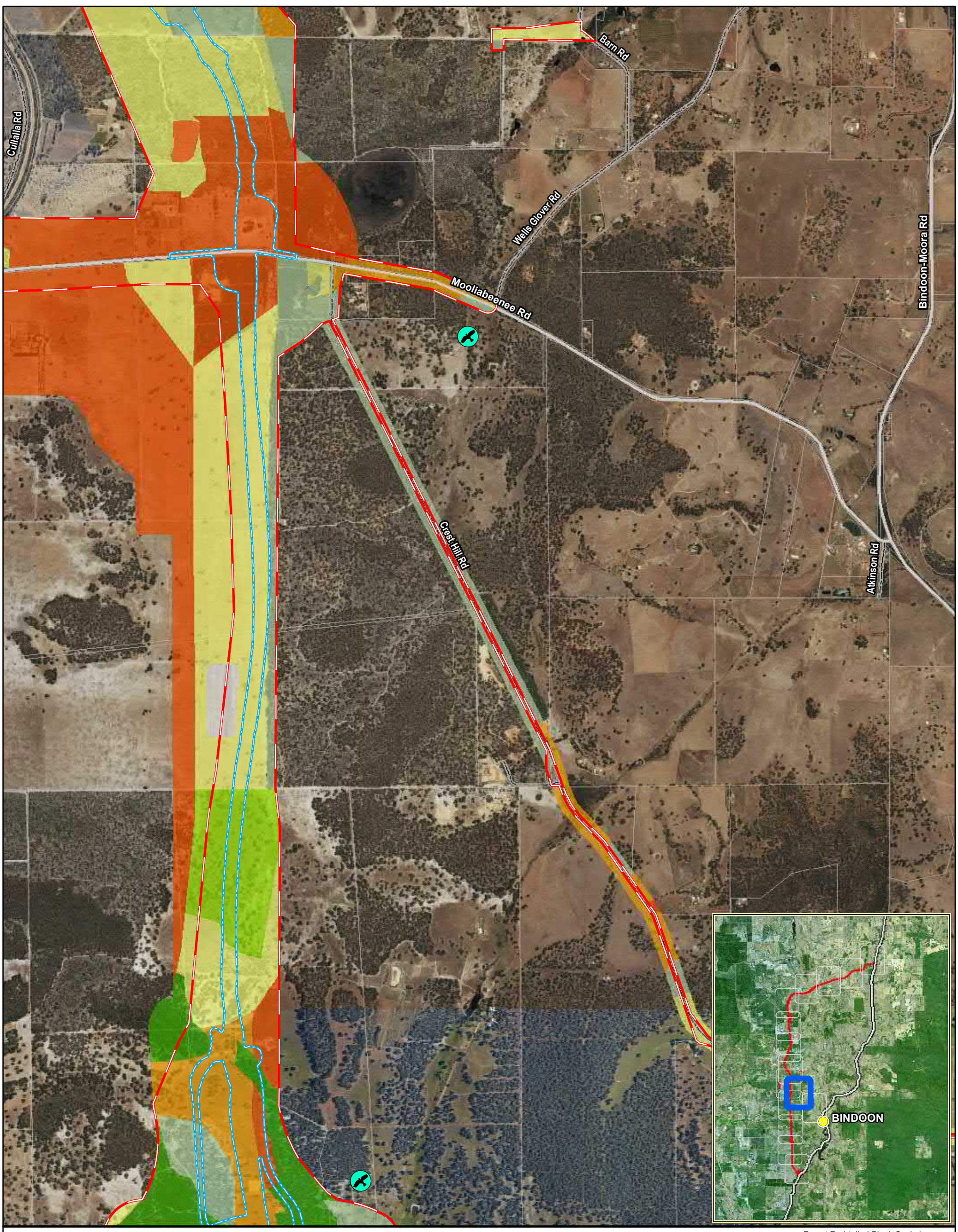

Legend

- Development Envelope
- Development Footprint
- Major Road
- 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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Forest Red-tailed Black Cockatoo Roost Sites and Habitat Foraging Value

Figure: 4-15

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

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
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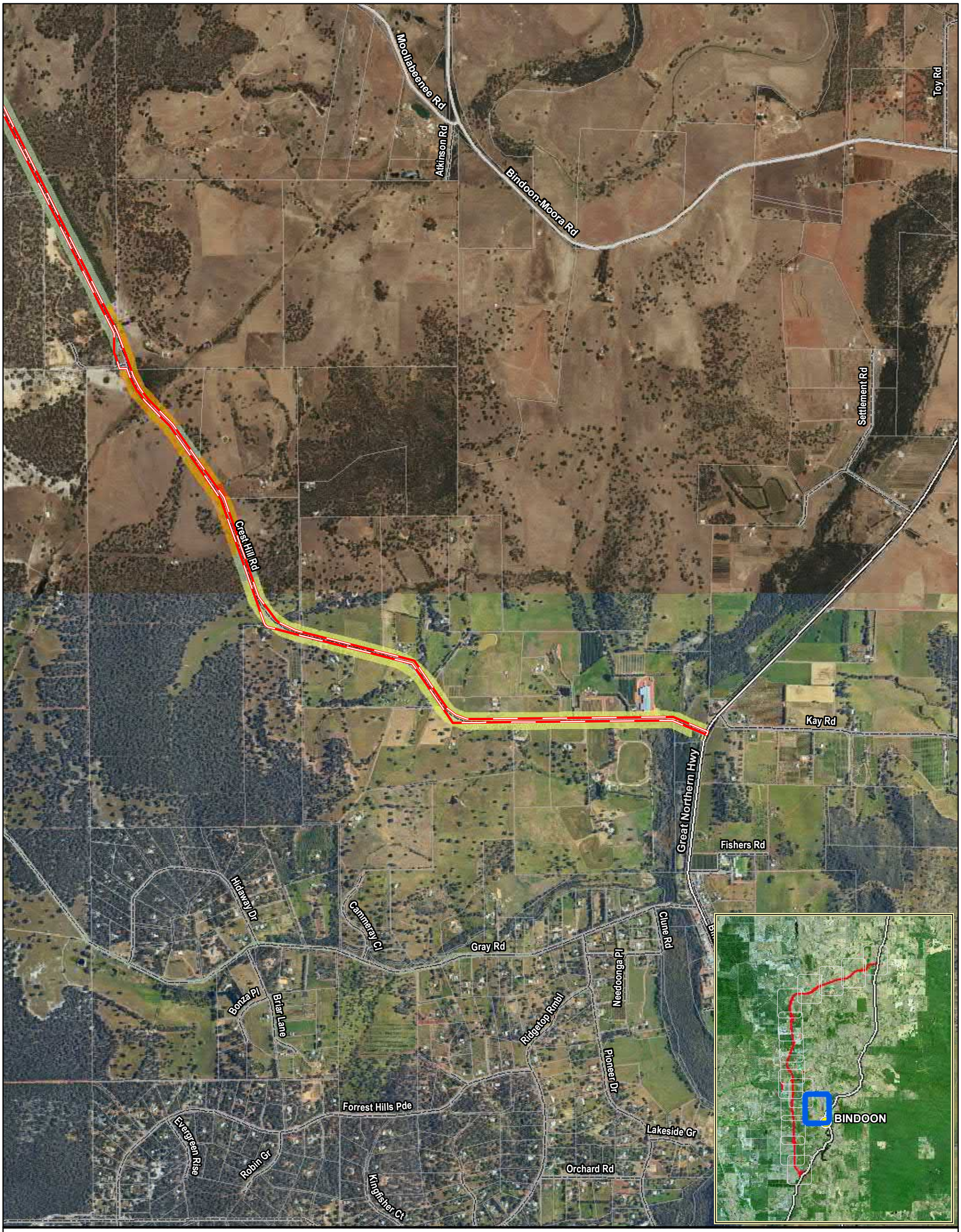

Legend

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

RTBC Habitat (FVC)

Foraging Vales

- 1 - Negligible
- 2 - Low
- 3 - Low-Moderate
- 4 - Moderate

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Forest Red-tailed Black Cockatoo Roost Sites and Habitat Foraging Value

Figure: 4-15 Page 7 of 15

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

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
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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
- Minor Road
- Cadastral Boundary
- RTBC Roost Sites

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

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Forest Red-tailed Black Cockatoo
Roost Sites and Habitat
Foraging Value

Figure: 4-15 Page 8 of 15

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

Task No	Drawing Status / Other
ERD	Draft

Date	By	Chkd	Appd
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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

- 1 - Negligible
- 2 - Low
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Forest Red-tailed Black Cockatoo
Roost Sites and Habitat
Foraging Value

Figure: 4-15 Page 9 of 15

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

Task No	Drawing Status / Other
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Date	By	Chkd	Appd
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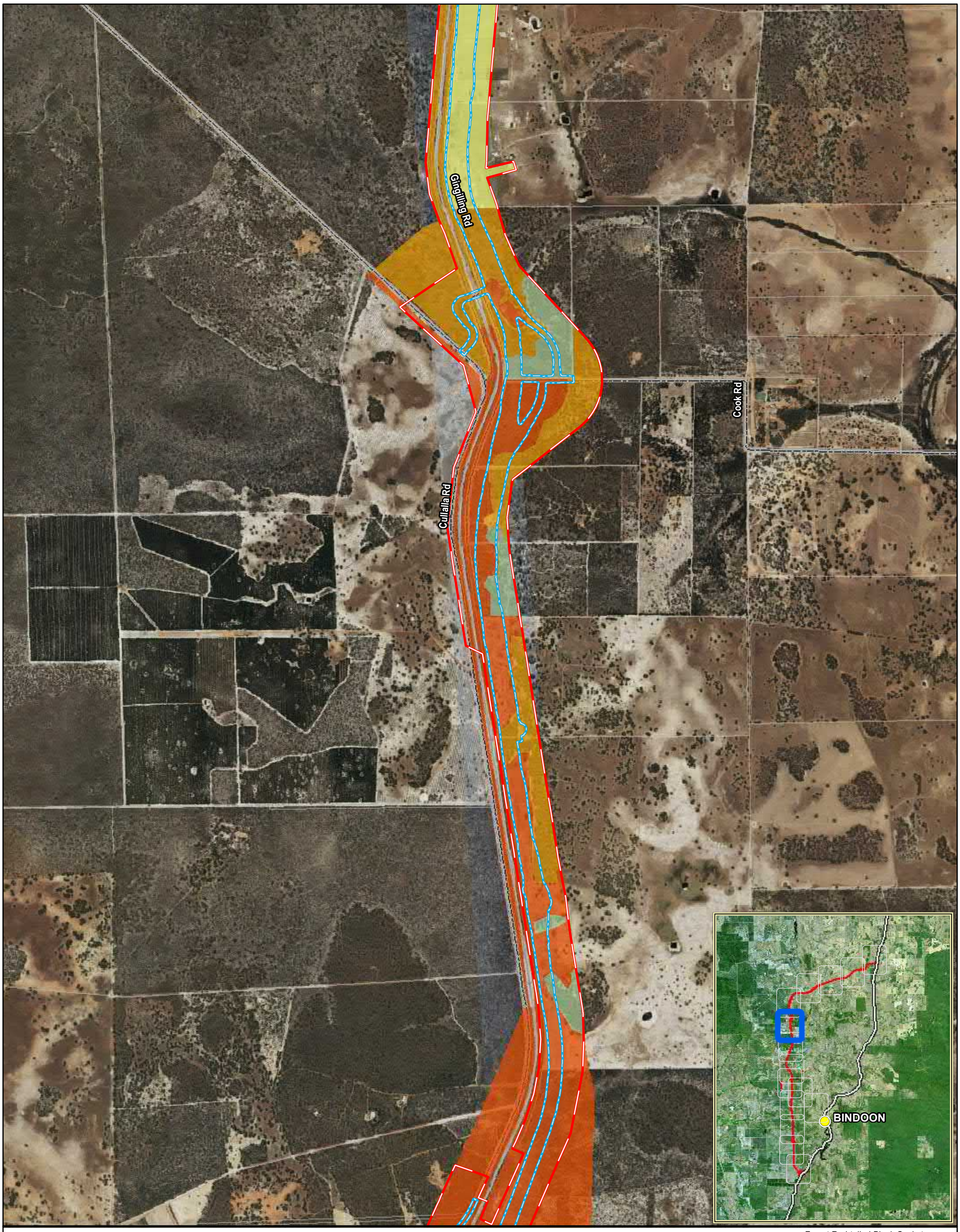

Legend

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

RTBC Habitat (FVC)

Foraging Vales

- 1 - Negligible
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- 3 - Low-Moderate
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Forest Red-tailed Black Cockatoo
Roost Sites and Habitat
Foraging Value

Figure: 4-15 Page 10 of 15

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

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Wannamal Rd South

Gingilling Rd

Cullalla Rd

BINDOON

Legend

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

RTBC Habitat (FVC)

Foraging Vales

- 1 - Negligible
- 2 - Low
- 3 - Low-Moderate
- 4 - Moderate

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0 240 480
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Bindoon Bypass
Environmental Review Document

Forest Red-tailed Black Cockatoo
Roost Sites and Habitat
Foraging Value

Figure: 4-15 Page 11 of 15

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

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

0 240 480

Metres

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

Coordinate System: GDA 1994 MGA Zone 50

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Forest Red-tailed Black Cockatoo
Roost Sites and Habitat
Foraging Value

Figure: 4-15 Page 12 of 15

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

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Forest Red-tailed Black Cockatoo
Roost Sites and Habitat
Foraging Value

Figure: 4-15 Page 13 of 15

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

Task No	Drawing Status / Other
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Hay Flat Rd

Head Rd

BINDOON

Legend

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

RTBC Habitat (FVC)

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Roost Sites and Habitat
Foraging Value

Figure: 4-15 Page 14 of 15

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Task No	Drawing Status / Other
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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

RTBC Habitat (FVC)
Foraging Vales

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

0 240 480
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Roost Sites and Habitat
Foraging Value

Figure: 4-15 Page 15 of 15

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Task No	Drawing Status / Other
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4.3.3.3 Existing Fragmentation, Habitat Connectivity and Fauna Movement Corridors

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), and are likely to be important corridors for fauna movement. The presence of the railway at Barn Road and Cook Road presents an existing barrier to fauna movement, particularly ground dwelling fauna.

The Shire of Chittering developed a local biodiversity strategy in 2010 with the objective of retaining, managing and protecting natural areas within the Shire (Shire of Chittering 2010). As part of this strategy, the Perth Biodiversity Project and Chittering Landcare Centre identified networks of regional and local ecological linkages within the Shire (**Figure 4-16**). These are considered to be equivalent to fauna movement corridors within both the region and the Development Envelope. In order to identify these linkages, the following principles were applied (Shire of Chittering 2010):

- continuous corridors of native vegetation, with a minimum width of 500 m where these are available
- thin corridors (<500 m wide) along roads mainly consisting of trees over a highly disturbed understorey may be of little value, except for already highly-mobile species, and have generally been avoided
- where continuous corridors of native vegetation are not available, linkages made up of local natural areas that form stepping stones between larger intact areas have been selected
- the target maximum distance between local natural areas is from 500 m to 1000 m
- as many natural areas as possible are selected within each
- the widest ranges of habitats within the linkages with similar habitats are no more than 500 m to 1000 m apart
- the number of links to any given natural area has been maximised
- linkages have been chosen to maximise the width, connectivity and structural complexity of vegetation to make them suitable for a broad range of fauna and flora.

Natural areas that are part of, or close to, the identified linkages are considered to be of higher value than natural areas that are more distant. Ecological linkages are identified to have the following advantages (Shire of Chittering 2010):

- increase species immigration rates, which maintain or increase species richness, increase population sizes and/or prevent inbreeding depression, and facilitate recolonization following local extinctions
- provide increased foraging areas
- provide cover from predators between patches
- provide a mix of habitats and successional stages
- provide alternative refuge from large disturbances
- provide greenbelts to limit the effects of urbanisation.

The Development Envelope crosses three regional and nine local linkages. As discussed above, these linkages align with areas of native vegetation that extend across the Development Envelope, and are considered to represent fauna movement corridors.

West Point Rd
Clewleys Rd
Wannamal Rd West
Hay Flat Rd
Calingiri Rd
Head Rd
Wannamal Rd South
Great Northern Hwy
Perry Rd
Bindoon-Moora Rd
Gingilling Rd
Pines Rd
Gallahawk Rd
Cook Rd
Ashman Rd
Cullalla Rd
Spillman Rd
Owen Rd
Yagan Rd
Whakea Rd
Wells Glover Rd
Barn Rd
Ashworth Rd
Crest Hill Rd
Koy Rd
Bindoon-Dewars Pool Rd
Mooliabeenee Rd
Teatree Rd
Stephens Rd
Kay Rd
Gray Rd
Lennards Rd
Creighton Rd
Nullilla Rd
Brennan Rd
Hart Dr
Densley Rd
Flat Rocks Rd
Lake Rd
Breera Rd
Brand Hwy
Ioppolo Rd
Maddern Rd
Blue Plains Rd
Chittering Rd
Julimar Rd
Timaru Rd
Reserve Rd
BINDOON

Legend

- Development Envelope
- Development Footprint
- Cadastral Boundary
- Highway
- Major Road
- Minor Road
- Shire of Chittering Regional Linkages
- Shire of Chittering Local Linkages
- Chuditch Habitat

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Regional and Local Ecological Linkages

Figure: 4-16

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-16	1

Task No	Drawing Status / Other
ERD	Draft

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

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4.3.3.4 Fauna Assemblage

Desktop studies found 306 vertebrate fauna species as potentially occurring in the Bindoon region, including freshwater fish, frogs, reptiles, birds and mammals (BCE 2017). Of the 306 species identified in the desktop study, 14 are considered to be locally extinct while 45 are not expected to occur due to a lack of habitat, or the Development Envelope occurring outside the accepted range of the species (BCE 2017). Field surveys confirmed the presence of 66 species, including one freshwater fish, five frogs, three reptiles, 52 birds and five mammals (BCE 2017).

The fauna assemblage expected in the survey area is described as being typical of the region and dominated by terrestrial species. The fauna assemblage is expected to vary across the survey areas and contains many species at the extremes of their distribution, with some parts of the survey area being richer in species than others.

4.3.3.5 Conservation Significant Fauna

Of the 306 vertebrate fauna identified by the desktop study, 20 are listed under the BC Act or EPBC Act, or both (**Table 2-5**). An additional seven species of vertebrate fauna are listed on the DBCA's Priority Fauna List. Three conservation significant invertebrate fauna species may also occur within the Development Envelope and are included in **Table 2-5**. Recorded locations of conservation significant fauna, both those recorded during the field surveys and from the DBCA fauna database, are shown on **Figure 4-17**.

Desktop analysis highlighted that the Forest Red-tailed Black-Cockatoo (listed as Vulnerable under both the EPBC Act and BC Act) and Carnaby's Black-Cockatoo (listed as Endangered under both the EPBC Act and BC Act) are conservation significant species at likely risk of impact from the Proposal. Field surveys identified four VSAs within the study area most likely to support hollow-bearing trees suitable for Black Cockatoo breeding: Marri-Jarrah woodland, Marri-Jarrah woodland with little to no remnant understorey, Wandoo woodland (with or without understorey) and paddocks with large remnant trees. During field surveys, Forest Red-tailed Black-Cockatoos and Carnaby's Black-Cockatoos were regularly recorded.

The field surveys undertaken by BCE (2018) 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 (2018).

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).

Page 6
Page 5
Page 4
Page 3
Page 2
Page 1
Calingiri Rd
Great Northern Hwy
Bindoon-Moora Rd
Bindoon-Dewars Pool Rd
Mooliabeenee Rd
Chittering Rd
BINDOON

Legend

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

Fauna locations (DBCA)

- Baudin's Black Cockatoo
- Carnaby's Balck Cockatoo
- Chuditch, Western Quoll
- Eastern Great Egret
- Brush Wallaby
- Carnaby's Black-Cockatoo
- Forest Red-tailed Black-Cockatoo
- Rakali (Water-rat)
- Unidentifed black-cockatoo

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Known and Recorded Locations of Conservation Significant Fauna Species
Figure: 4 - 17

Drawing No	Issue
GNH-CN12-EA-PER-0001 F4-17	1

Task No	Drawing Status / Other
ERD	Draft

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

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Great Northern Hwy

BINDOON

Legend

- Development Envelope
- Development Footprint
- Cadastral Boundary
- Highway
- Major Road
- Minor Road
- Brush Wallaby
- Carnaby's Black-Cockatoo
- Forest Red-tailed Black-Cockatoo
- Unidentifed black-cockatoo

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Known and Recorded Locations of Conservation Significant Fauna Species

Figure: 4 - 17 Page 1 of 7

Drawing No	Issue
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BINDOON

Legend

- Development Envelope
- Development Footprint
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- Minor Road
- Brush Wallaby
- Carnaby's Black-Cockatoo
- Forest Red-tailed Black-Cockatoo
- Unidentifed black-cockatoo

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Known and Recorded Locations of Conservation Significant Fauna Species

Figure: 4 - 17 Page 2 of 7

Drawing No	Issue
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Mooliabeenee Rd

BINDOON

Legend

- Development Envelope
- Development Footprint
- Cadastral Boundary
- Major Road
- Minor Road
- Brush Wallaby
- Carnaby's Black-Cockatoo
- Forest Red-tailed Black-Cockatoo
- Unidentifed black-cockatoo

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Known and Recorded Locations of Conservation Significant Fauna Species

Figure: 4 - 17 Page 3 of 7

Drawing No	Issue
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Bindoon-Moora Rd

BINDOON

Legend

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

Fauna locations (DBCA)

- Eastern Great Egret
- Carnaby's Black-Cockatoo
- Forest Red-tailed Black-Cockatoo

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Known and Recorded Locations of Conservation Significant Fauna Species

Figure: 4 - 17 Page 4 of 7

Drawing No	Issue
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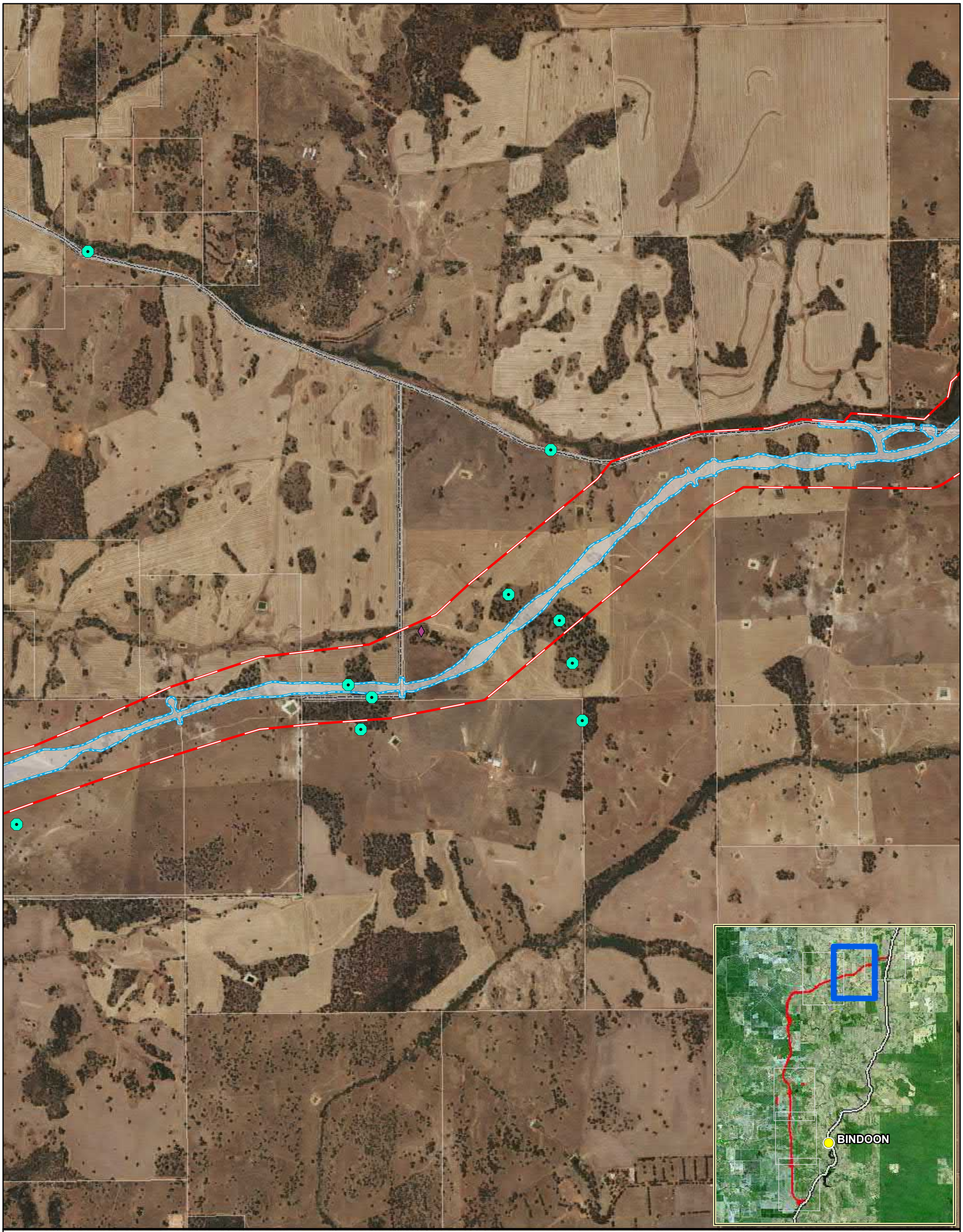

Legend

- Development Envelope
- Development Footprint
- Cadastral Boundary
- Minor Road
- Carnaby's Black-Cockatoo
- Unidentifed black-cockatoo

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Known and Recorded Locations of Conservation Significant Fauna Species

Figure: 4 - 17 Page 5 of 7

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Calingiri Rd

Great Northern Hwy

BINDOON

Legend

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

Fauna locations (DBCA)

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- Carnaby's Balck Cockatoo
- Chuditch, Western Quoll
- Carnaby's Black-Cockatoo
- Forest Red-tailed Black-Cockatoo
- Rakali (Water-rat)
- Unidentifed black-cockatoo

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Known and Recorded Locations of Conservation Significant Fauna Species

Figure: 4 - 17 Page 6 of 7

Drawing No	Issue
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4.3.4 Potential Impacts

The implementation, construction, operation and ongoing maintenance of the Proposal will have both direct and indirect impacts to terrestrial fauna. Potential impacts may arise as a result of the following aspects of the Proposal:

- vegetation clearing, topsoil stripping and earthmoving
- vehicle movements
- watercourse and wetland crossings
- road reserve fencing
- physical presence of cut and fill areas.

The following impacts are anticipated as a result of the Proposal:

- permanent loss of fauna habitat
- permanent loss of foraging and breeding habitat for Black Cockatoos
- fragmentation of habitat and loss of connectivity
- habitat degradation due to altered ground and surface water hydrology
- habitat degradation due to introduction or spread of weed or dieback
- fauna mortality from vehicle strikes.

A total of 137.1 ha of fauna habitats will be cleared as a result of implementation of the Proposal (**Table 4-27**). As noted previously, fauna habitats do not exactly align with native vegetation associations. Areas categorised as paddock for the purposes of vegetation association mapping may not be mapped as such for the purposes of habitat mapping. As a result, the area of fauna habitat to be cleared is larger than the area identified for clearing within native vegetation associations.

The amount of fauna habitat to be cleared does not include areas identified as paddocks (VSA 9) or paddocks with large remnant trees (VSA 8); these areas provide limited value as fauna habitat generally, though the remnant trees do provide habitat for Black Cockatoos. VSA8 and VSA9 account for 351.5 ha (70.5%) of the Development Footprint. Of the remaining fauna habitats, clearing will predominantly occur within the Banksia woodland (VSA 1—39 ha) and Marri-Jarrah woodland (VSA 3—38.4 ha). The Heath habitat (VSA 6) will not be cleared for the Proposal.

The habitats recorded by BCE (2017, 2018) are likely to support the Brush Wallaby, Chuditch, Brush-tailed Phascogale and Water-rat. **Table 4-28** outlines the clearing required in relation to these species and their habitat preferences.

Table 4-27: Clearing Required by Fauna Habitat

Fauna Habitat	Proposed Area Cleared (ha)
Banksia woodland	51.0
Banksia woodland with scattered Marri and/or Jarrah	10.1
Marri-Jarrah woodland	42.6
Marri-Jarrah woodland with little to no remnant understorey	11.8
Wandoo woodland (with or without understorey)	14.8
Heath	0.0
Waterways or wetlands/damplands	6.8
Subtotal (ha)	***137.1***
Paddocks	100.3
Paddocks with large remnant trees	251.2
Plantations	7.6
Total (ha)	**496.2**

Table 4-28: Clearing of Habitats Supporting Conservation Significant Species

Common Name	Preferred Habitats	Proposed Area Cleared (ha)
Brush Wallaby	Banksia woodland. Marri-Jarrah woodland. Wandoo woodland.	130.3
Chuditch	Marri-Jarrah woodland.	54.4
Brush-tailed Phascogale	Marri-Jarrah woodland. Wandoo woodland.	69.2
Water-rat	Waterways or wetland/damplands.	6.8

As discussed previously, the large remnant trees present within the paddock areas provide habitat for Black Cockatoos. As a result of this, habitat mapping for Black Cockatoos differs to the mapping of general fauna habitat. The whole of the Development Footprint has been mapped has having at least some value as foraging habitat for Black Cockatoos (**Table 4-29** and **Table 4-30**). A total of 204.8 ha of foraging habitat identified as having Moderate or higher value for Carnaby's Black Cockatoo will be cleared, while 168 ha or foraging habitat with a Moderate or higher value for the Forest Red-tailed Black Cockatoo will be cleared. This includes 79.3 ha of potential breeding habitat for Carnaby's Black Cockatoo and 69.2 ha of potential breeding habitat for the Forest Red-tailed Black Cockatoo. As the foraging preferences of the two species are similar, the foraging habitat mapped for each overlaps to a large extent. The main difference in foraging preference is in relation to the species that make up the Banksia woodlands: Carnaby's Black Cockatoo forages on the seeds and flowers of a range of Banksia species and other proteaceous plants (e.g. Hakea and Grevillea), whereas the Forest Red-tailed Black Cockatoo does not, being restricted to the seeds of Eucalypt species (and Cape Lilac in more urban areas). The Banksia woodlands habitat therefore has a higher foraging value for Carnaby's Black Cockatoo than for the Forest Red-tailed Black Cockatoo.

Table 4-29: Clearing of Carnaby's Black Cockatoo Foraging Habitat

Habitat Value	Proposed Area Cleared (ha)
6: High	18.8
5: Moderate to High	40.2
4: Moderate	83.6
3: Low to Moderate	62.2
Subtotal	***204.8***
2: Low	174.1
1: Negligible	117.3
Total	**496.2**

Table 4-30: Clearing of Forest Red-tailed Black Cockatoo Foraging Habitat

Habitat Value	Proposed Area Cleared (ha)
6: High	17.4
5: Moderate to High	24.7
4: Moderate	28.5
3: Low to Moderate	97.4
Subtotal	***168.0***
2: Low	176.6
1: Negligible	151.5
Total	**496.1**

A total of ten trees containing hollows showing evidence of previous use by Black Cockatoos, and 117 trees with suitable (but not currently or previously used) hollows, are located within the Development Footprint and will be cleared. This represents 12% and 9.2% respectively of the total number of hollows previously used by or suitable for Black Cockatoos in the study area, as recorded by BCE (2017, 2018) (**Table 4-31**).

Table 4-31: Impacts to Black Cockatoo Hollows

Hollow Type	Recorded by BCE (2018)[1]	Within Development Footprint	% Cleared
Evidence of previous use	83	10	12.0
Suitable (no evidence of use)	1 269	117	9.2
Total	**1 352**	**127**	**9.4**

[1] *within the study area and includes results of extrapolation in unmapped areas*

4.3.5 Assessment of Impacts

Impacts to fauna and fauna habitat have been avoided and minimised as far as practicable during the concept design phase, by preferentially locating the Development Footprint within previously cleared paddock. This approach has resulted in 351.5 ha (70.5%) of the Development Footprint being located within cleared or mostly cleared paddocks, which provide little to no value as fauna habitats—although the large remnant trees may provide habitat for Black Cockatoos.

4.3.5.1 Impacts to Fauna Habitat

Loss of Fauna Habitat

Land clearance is a key threatening process listed under the EPBC Act. Land clearance and the associated loss of fauna habitat has the potential to adversely affect fauna species, with large scale clearing, or clearing of significant habitat, having potential to change the conservation status of species. For example, previously not threatened fauna may become eligible for listing under the BC Act or EPBC Act, or currently threatened fauna may have their threat status raised.

The majority of the Development Footprint (351.5 ha—70.5%) consists of cleared paddocks or paddocks with large remnant trees. These areas offer limited or no habitat value for native fauna in general, though they may provide habitat for Black Cockatoos. The six fauna habitats that make up 26.4% (137.1 ha) of the Development Footprint are distributed across both the Development Envelope and the region more broadly. This distribution of these six fauna habitats across the Development Footprint effectively disperses the impact over a larger area, rather than concentrating impacts in one, much smaller area. While the Proposal will result in the loss of fauna habitat in the local area, the linear nature of the Bindoon Bypass means that surrounding habitats of the same or similar type will remain.

Remnant native vegetation mapping available from the DPIRD Geographic Information Services (2018) indicates approximately 93,004 ha of native vegetation exists within 15 km of the Development Envelope while 22,956.4 ha exists within 5 km. The six fauna habitats within the Development Footprint represents 0.1% and 0.6% of habitats within 15 km and 5 km of the Development Envelope respectively.

As the habitats within the Development Footprint represent less than 1% of the habitats within the local area (within 15 km and 5 km from the Development Envelope), and the habitats are common and widespread, the clearing of 137.1 ha of natural fauna habitat is not considered significant in a regional context. Impacts specific to Black Cockatoo habitat are addressed separately in this ERD.

Fragmentation of Fauna Habitat and Loss of Connectivity

Clearing of the Development Footprint is likely to increase habitat fragmentation within the broader area, and may increase the distance between patches of already fragmented habitat. Ground-dwelling fauna are considered most at risk from habitat fragmentation and loss of connectivity, as they are less able to travel between patches and more greatly impacted by barriers such as areas of cut or fill than, for example, avifauna (birds) or bats.

The Development Footprint crosses three regional and nine local ecological linkages, which represent fauna movement corridors in the region. Three local linkages are currently crossed by the Midland to Geraldton railway line, which represents an existing barrier to fauna movement, although the vegetation within the rail corridor does allow for fauna movement along the railway. The regional linkage that follows the Brockman River is patchy in respect to vegetation cover, so is likely to have limited value for terrestrial fauna other than birds.

The local linkages at Barn Road, south of Gray Road and Teatree Road connect larger areas of native vegetation with local waterways, and ultimately the Brockman River and Chittering-Needonga Lake System. The Proposal will not increase existing fragmentation of the linkages at Teatree Road as the Development Footprint in this location is in previously cleared paddocks. Clearing of vegetation which forms part of the local linkages at Gray Road and Barn Road will be required. With the implementation of appropriate mitigation measures (for example, fauna underpasses), this impact is not considered significant.

Wetlands are likely to be important water sources for fauna, particularly those wetlands that retain water all year round. Patches of vegetation that connect these wetlands with other areas of native vegetation are likely to be important corridors of fauna movement. Loss of connectivity could therefore change movement patterns of ground-dwelling fauna in particular. However, similar wetlands and watercourses exist to the west of the Development Envelope, and potential impacts to fauna species from the loss of connectivity with wetlands in the local area are therefore considered negligible.

The Development Footprint is unlikely to increase the distance between habitat patches to the extent that it creates a barrier to movement for bird species, particularly Black Cockatoos. The referral guidelines for three species of Black Cockatoo (DoEE 2012) suggest that a gap of 4 km or more is likely to impact movement of Black Cockatoos. Implementation of the Proposal will not result in gaps between remnant vegetation being increased above this.

Revegetation of the Development Envelope has the potential to provide ecological services for fauna, and enhance existing fauna movement corridors through appropriate selection of species, including a mix of tree, shrub and groundcover/herb species.

The Brush Wallaby, Chuditch and Brush-tailed Phascogale are all expected to occur within the Development Envelope and surrounds, particularly within the southern portion, although they are anticipated to be in low numbers. Management measures have been proposed to minimise the level of impact to as low as reasonably practical.

The Water-rat has been recorded (through secondary evidence) along Udumung Brook, near Hay Flat Road. Fragmentation of habitat and barriers to fauna management in this location could have moderate impacts on this species in the absence of appropriate mitigation actions and controls.

Degradation of Fauna Habitat

Degradation of fauna habitats may occur through edge effects in fragmented habitats, weed invasion, spread of *Phytophthora* Dieback, changes to ground and surface water hydrology, and through anthropogenic effects resulting from increased human access to the area (for example, fire and rubbish). Habitat degradation is a known threatening process for Carnaby's Black Cockatoo and the Forest Red-tailed Black Cockatoo.

No significant environmental weeds have been recorded from the Development Envelope or surrounds. Agricultural weeds are known to occur throughout the Development Envelope, and introduced species used for pasture or cropping can establish in areas of native vegetation, gradually encroaching from the edges where native vegetation abuts agricultural land. The implementation of the Proposal has the potential to introduce new weeds or spread existing weeds; however, as the majority of the Development Envelope is agricultural land, the Proposal is unlikely to increase the risk of weed encroachment into areas of native vegetation.

The majority of native vegetation area within the Development Envelope have been mapped as Dieback-free. Spread of Dieback as a result of implementation of the Proposal has the potential to cause significant degradation to fauna habitats, particularly those which provide foraging and breeding habitat for Black Cockatoos (i.e. Banksia woodlands and Marri-Jarrah woodlands). Should appropriate management controls not be put in place, the impacts resulting from the spread of Dieback within the Development Envelope are likely to be significant.

The Proposal may increase the risk of accidental and/or deliberately lit fires (particularly during the operational phase), due to greater access into areas of native vegetation. Fires already occur in the region, and local landowners and land managers manage this risk through hazard reduction burns during the cooler months.

Changes to Hydrological Regimes

The Proposal may disrupt the surface flow of water or lower local groundwater levels. This could affect groundwater-dependent vegetation, particularly around waterway or wetland habitats, in turn causing habitat degradation and reducing the ability of these habitats to support fauna such as the Water-rat. Wetland and waterway crossings have been designed to maintain surface water flow paths, quantities and velocities. Disruption to the hydrological regime due to the Proposal is unlikely to significantly impact the productivity and survival of groundwater-dependent plant species. Impacts to the hydrological regime will be temporary in nature during construction, and the extent of the hydrological change is unlikely to impact these deep rooted groundwater-dependent species. Negligible impacts to fauna habitat are therefore expected as a result of the Proposal. A detailed assessment of impacts to hydrological regimes is presented in **Chapter 4.4**.

4.3.5.2 Impacts to Black Cockatoo Species and Habitat

Impacts to hollows showing evidence of use by Black Cockatoos have been avoided and minimised where practicable, through alignment changes and engineering solutions such as steepening of batters. These changes have resulted in 15 trees with hollows used by Black Cockatoos being avoided. A total of ten trees with hollows previously used by Black Cockatoos are within the Development Footprint and are proposed to be cleared (**Figure 4-18**). This equates to 12% of the hollows used by Black Cockatoos recorded by BCE (2017, 2018). These trees have been examined to determine if they can be avoided and the results are presented in **Table 4-32**.

Although the clearing of trees with hollows used by Black Cockatoos has been minimised to as low as reasonably practicable, the clearing of up to ten trees is considered a significant impact. In addition, 117 trees with hollows suitable for Black Cockatoos, but with no evidence of them having been previously used, are within the Development Footprint and will be cleared. An additional 83 hollows previously used by Black Cockatoos have been recorded within the Development Envelope and surrounds (BCE 2018).

A number of trees with hollows that have been previously used by, or a suitable for, Black Cockatoos will remain within the Development Envelope. No long-term impacts to the use of these hollows by Black Cockatoos is predicted as a result of the presence of the Bindoon Bypass once constructed. Black Cockatoos have been recorded breeding in natural and artificial hollows within the road reserve along the existing GNH, south of Bindoon.

A total of 204.8 ha of foraging habitat, which includes 79.3 ha of potential breeding habitat for Carnaby's Black Cockatoo, will be cleared as a result of the Proposal. For the Forest Red-tailed Black Cockatoo, 168 ha of foraging habitat, which includes 69.2 ha of potential breeding habitat, will be cleared for the Proposal. This equates to 0.2% of the potential habitat (approximately 34,600 ha) within 15 km of the Development Envelope for both species. No roost sites or roosting habitat has been recorded from the Development Envelope for the Proposal.

Although there is substantial foraging habitat within 15 km of the Proposal, the Development Envelope is located within habitat that meets the definition of critical habitat for each species, as outlined in their respective recovery plans (Department of Parks and Wildlife 2013; Chapman 2008). The required clearing is therefore considered significant. Land clearance and loss of habitat is a key threatening process for Black Cockatoos. Main Roads will further mitigate these impacts through land acquisition offsets as detailed in **Chapter 7**.

Table 4-32: Review of Impacted Trees with Hollows Used by Black Cockatoos

Tree ID	Location	Reason for Impact
1232	Lot 18 (no. 5077), GNH, Chittering	Tree is located at the very start of the alignment, where the existing road ties into the southern interchange. Due to the geometry requirements and the need to tie in to the Muchea North upgrade, it is not possible to avoid this tree.
4317	Lot 20 Gray Road, Bindoon	Localised steep ground to the east of the alignment in this vicinity leads to a significant cutting, which results in unavoidable impact to the tree. The vertical profile to the north and south of this location, as well as the requirement to connect the adjacent Water Corp access road to the west, means that the highway cannot be raised through here to reduce the depth of the cut and avoid impact to the tree.
5806	Lot 21 Gray Road, Bindoon	The alignment veers slightly to the west to avoid a thick array of trees and an existing farm dam, and to minimise severance of the property. While this causes one tree to be impacted it allows a further six to be avoided to the north. It may be possible to retain this tree within the median.
4142 and 4135	Lot M2059 Cullalla Road, Mooliabeenee	Two trees are impacted at this location. The alignment runs parallel to the Midland to Geraldton railway to minimise severance of the adjacent properties. There is a high density of hollows in this area and moving the alignment to avoid these will result in others being impacts. It may be possible to retain the tree that falls within the median.
1746	Lot M2082 (no. 176) Gingilling Road, Mooliabeenee	The alignment follows the railway closely in this location so as to avoid impact to additional farm dwellings and minimise severance of the property. Movement of the alignment in this location will have unacceptable social impacts.
2949 and 1650	Lot 1 (no. 428) and Lot 2 (no. 434) Gingilling Road, Mooliabeenee	The alignment follows the railway closely to minimise severance of the property. Horizontal geometry requirements mean it is very difficult to avoid impacting the two trees. Were the alignment moved east these particular trees could be avoided, but four more would be impacted.
2999	Lot 2 (no. 434) Gingilling Road, Mooliabeenee	The alignment follows the railway closely to minimise severance of the property. Horizontal geometry requirements mean it is very difficult to avoid impacting this tree. Were the alignment moved west slightly this particular tree could be avoided, but four more would be impacted.
9081	Lot 3252 (no. 1080) Hay Flat Road, Wannamal	The alignment is constrained by three existing farm dams to the south and the tie-in location of Hay Flat Road to the north. The concept level design was not able to avoid this tree.

Tern Dale
Hart Dr
Egret Pl
Great Northern Hwy
Brindle Cl
Sandalford Dr
Tree ID: 1232
BINDOON

Legend

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

Black Cockatoo Trees (FVC)

- Hollow with Evidence of Use

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Trees with Hollows Used by Black Cockatoos within the Development Envelope

Figure: 4-18 Page 1 of 18

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-18	1

Task No	Drawing Status / Other
ERD	Draft

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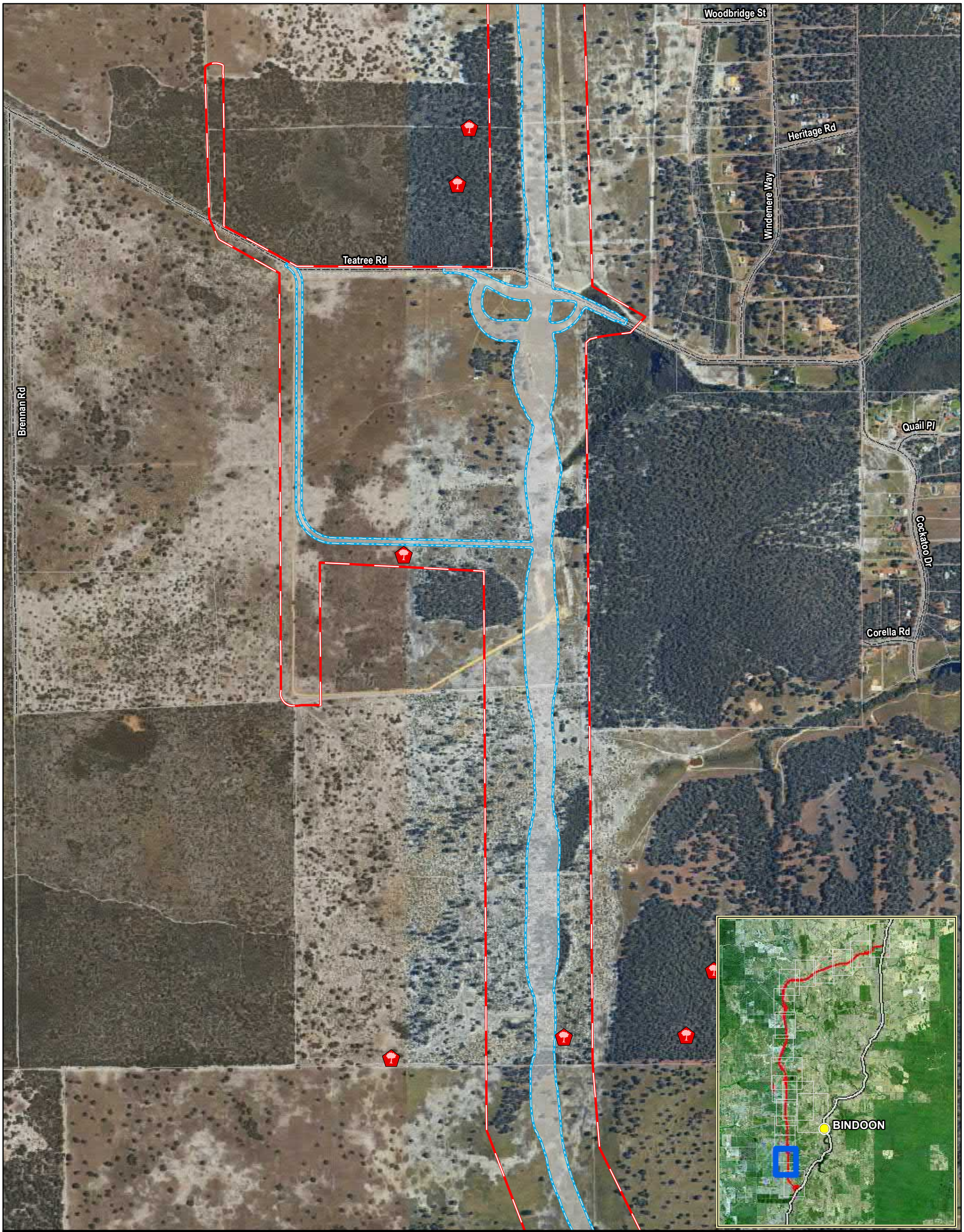

Legend

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

Black Cockatoo Trees (FVC)

- Hollow with Evidence of Use

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Trees with Hollows Used by Black Cockatoos within the Development Envelope

Figure: 4-18

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Legend

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

Black Cockatoo Trees (FVC)

- Hollow with Evidence of Use

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Trees with Hollows Used by Black Cockatoos within the Development Envelope

Figure: 4-18 Page 3 of 18

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-18	1

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Gray Rd

Tree ID: 5806

Tree ID: 4317

Hidaway Dr

BINDOON

Legend

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

Black Cockatoo Trees (FVC)

- Hollow currently in Use
- Hollow with Evidence of Use

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Trees with Hollows Used by Black Cockatoos within the Development Envelope

Figure: 4-18 Page 4 of 18

Drawing No	Issue
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Task No	Drawing Status / Other
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Crest Hill Rd

Mingah Rd

Gray Rd

Tree ID: 5806

BINDOON

Legend

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

Black Cockatoo Trees (FVC)

- Hollow currently in Use
- Hollow with Evidence of Use

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Trees with Hollows Used by Black Cockatoos within the Development Envelope

Figure: 4-18 Page 5 of 18

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Task No	Drawing Status / Other
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Cullalla Rd

Ashworth Rd

Mooliabeenee Rd

Wells Glover Rd

Crest Hill Rd

BINDOON

Legend

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

Black Cockatoo Trees (FVC)

- Hollow currently in Use
- Hollow with Evidence of Use

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Trees with Hollows Used by Black Cockatoos within the Development Envelope

Figure: 4-18 Page 6 of 18

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Mooliabeenee Rd
Bindoon-Moora Rd
Crest Hill Rd
Atkinson Rd
Mingah Rd
BINDOON

Legend

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

Black Cockatoo Trees (FVC)

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Trees with Hollows Used by Black Cockatoos within the Development Envelope

Figure: 4-18 Page 7 of 18

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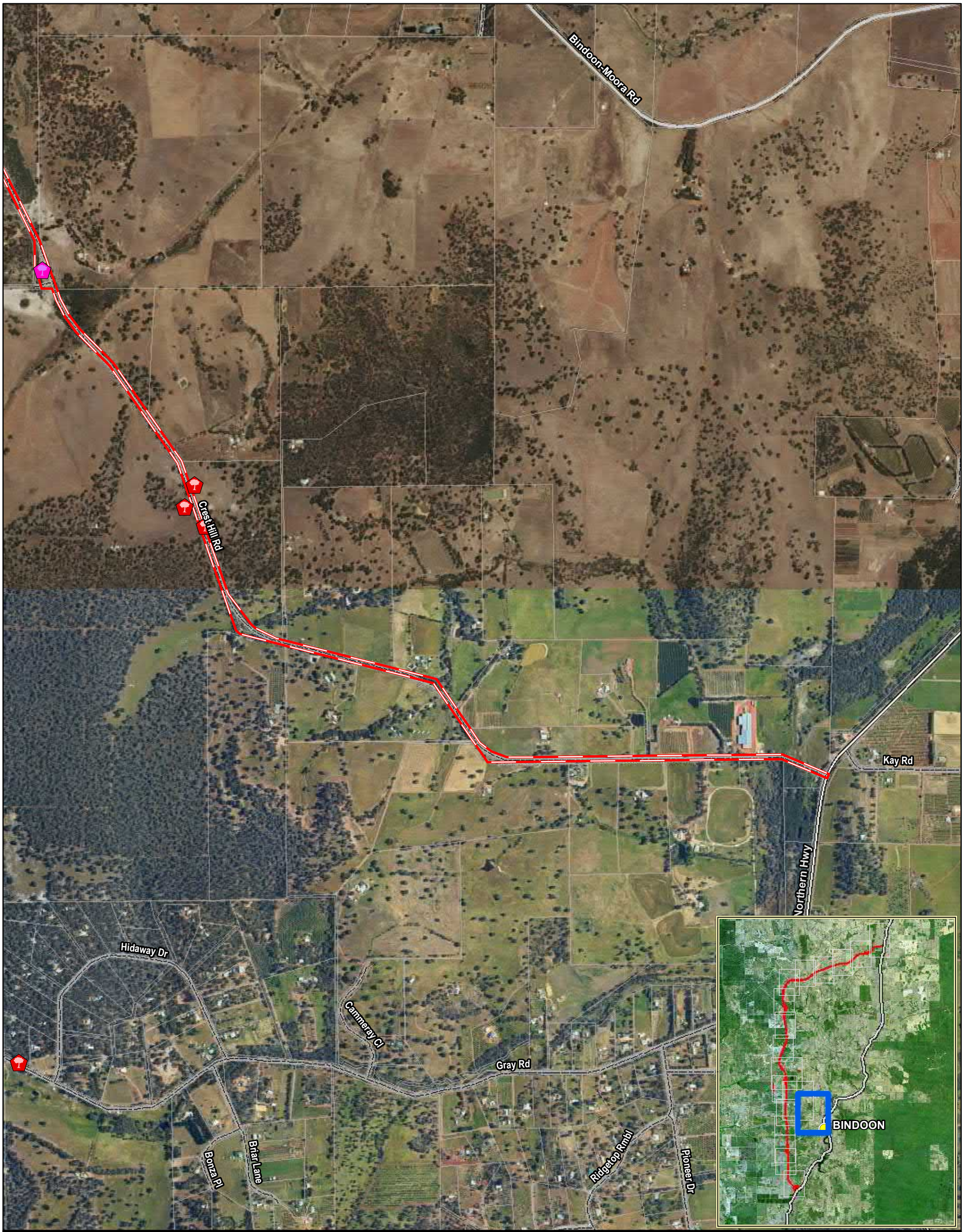

Legend

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

Black Cockatoo Trees (FVC)

- Hollow currently in Use
- Hollow with Evidence of Use

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Trees with Hollows Used by Black Cockatoos within the Development Envelope

Figure: 4-18 Page 8 of 18

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Tree ID: 4135

Cullalla Rd

Barn Rd

Ashworth Rd

Mooliabeenee Rd

Wells Glover Rd

Crest Hill Rd

BINDOON

Legend

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

Black Cockatoo Trees (FVC)

- Hollow currently in Use
- Hollow with Evidence of Use

Joint Venture Partners:

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Trees with Hollows Used by Black Cockatoos within the Development Envelope

Figure: 4-18

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-18	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-F4-18.mxd

Tree ID: 1746

Barn Rd

Tree ID: 4142

Tree ID: 4135

Cullalla Rd

BINDOON

Legend

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

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Trees with Hollows Used by Black Cockatoos within the Development Envelope

Figure: 4-18 Page 10 of 18

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GNH-CN12-EA-PER-00001 - F4-18	1

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ERD	Draft

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Cook Rd

Gingilling Rd

Tree ID: 2999

Tree ID: 2948

Tree ID: 1650

Cullalla Rd

Tree ID: 1746

Legend

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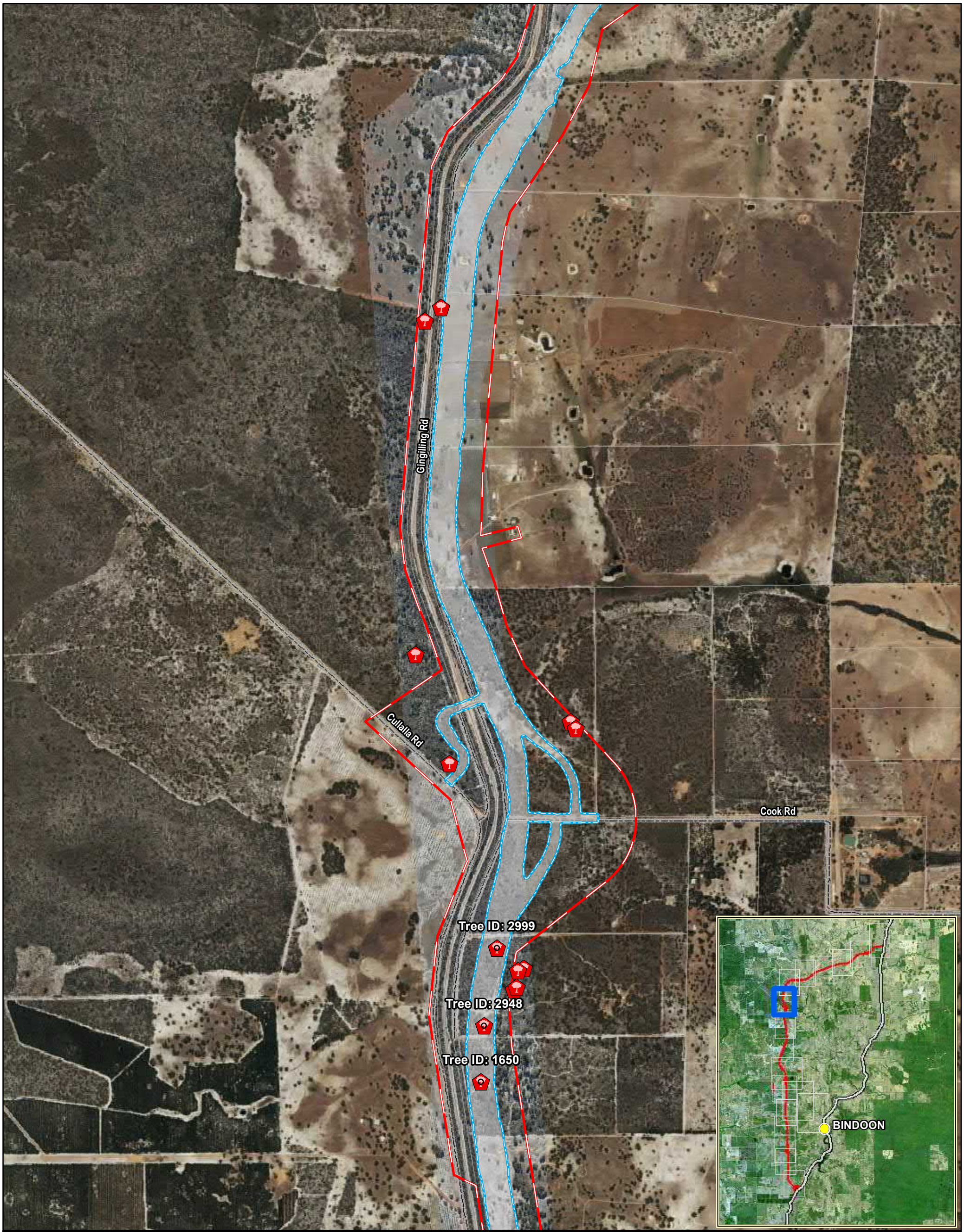

Legend

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Bindoon-Moora Rd

Gingilling Rd

Cullalla Rd

BINDOON

Legend

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

Black Cockatoo Trees (FVC)

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Hay Flat Rd

Bindoon-Moora Rd

Kangaroo Gully Rd

Pines Rd

BINDOON

Legend

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

Black Cockatoo Trees (FVC)

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Hay Flat Rd

Kangaroo Gully Rd

Bindoon-Moora Rd

BINDOON

Legend

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- Minor Road
- Cadastral Boundary

Black Cockatoo Trees (FVC)

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Trees with Hollows Used by Black Cockatoos within the Development Envelope

Figure: 4-18 Page 15 of 18

Drawing No	Issue
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Task No	Drawing Status / Other
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Hay Flat Rd

Head Rd

BINDOON

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Trees with Hollows Used by Black Cockatoos within the Development Envelope

Figure: 4-18

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Task No	Drawing Status / Other
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Date	By	Chkd	Appd
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Hay Flat Rd

Tree ID: 9081

Head Rd

BINDOON

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Trees with Hollows Used by Black Cockatoos within the Development Envelope

Figure: 4-18 Page 17 of 18

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Great Northern Hwy

Calingiri Rd

Hay Flat Rd

BINDOON

Legend

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- Highway
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Trees with Hollows Used by Black Cockatoos within the Development Envelope

Figure: 4-18

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GNH-CN12-EA-PER-00001 - F4-18	1

Task No	Drawing Status / Other
ERD	Draft

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

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4.3.5.3 Impacts to Other Fauna Species

Brush Wallaby

Brush Wallabies were opportunistically observed in bushland at Teatree Road and north of Mooliabeenee Road (east of the Development Footprint). Both of these locations are near to wetlands, which may provide a source of water and foraging areas, particularly during the summer months. Approximately 130.3 ha of habitat for the Brush Wallaby will be cleared for the Proposal. The species occupies a range of habitats which are widespread throughout the region. There are 22 956.4 ha of remnant native vegetation within 5 km of the Development Envelope, the majority of which is expected to provide habitat for this species. Clearing of 125.2 ha therefore represents 0.5% of the habitat available within 5 km of the Development Envelope. Provided appropriate management measures to address loss of habitat connectivity are implemented, impacts on this species as a result of the Proposal are not likely to be significant.

Water-rat

Secondary evidence of the Water-rat was recorded along the waterway near Hay Flat Road. Suitable habitat for the species consists or creeklines and riparian habitats. Based on the vegetation complex mapping for south-western WA, 287 ha of similar habitat is expected to occur within 5 km of the Development Envelope. Within the Development Footprint for the Proposal, 7.09 ha of waters and wetland/dampland habitat will be cleared. This is likely to provide habitat for the Water-rat and equates to 2.5% of the habitat present within 5 km of the Development Envelope. Provided appropriate management and mitigation measures are in place in relation to habitat connectivity, fauna movement and stabilisation of waterways following construction of culverts and crossings, impacts to this species are expected to be minimal and not significant.

Chuditch

While BCE (2017, 2018) did not record Chuditch within the Development Envelope, it is expected that they do occur, albeit in low numbers. Suitable habitat for the species within the Development Envelope is the Marri-Jarrah woodlands. A total of 54.4 ha of this habitat is within the Development Footprint and will be cleared. An estimated 7302 ha of the native vegetation within 5 km of the Development Envelope is expected to provide additional habitat for this species. The area to be cleared therefore represents 0.6% of the habitat available within 5 km of the Development Envelope. As such, and provided appropriate management and mitigation measures are in place in relation to habitat connectivity and fauna movement, impacts to the Chuditch are not expected to be significant.

Brush-tailed Phascogale

If the Brush-tailed Phascogale occurs within the Development Envelope and surrounds, it is expected to be present in low numbers across most of the habitats recorded. An estimated 69.2 ha of suitable habitat will be cleared by the Proposal. This represents 0.3% of the potential habitat (22 956.4 ha) present within 5 km of the Proposal. As such, and with the implementation of appropriate management and mitigation measures in relation to habitat connectivity and fauna movement, impacts to the Brush-tailed Phascogale are not expected to be significant.

4.3.5.4 Cumulative Impacts

While the impacts from a single Proposal may not be considered significant if considered in isolation, the cumulative impact from multiple proposals in a region may add up to a significant impact on a particular fauna species or habitat. In relation to the Bindoon Bypass, the effect of cumulative impacts is considered to be most relevant to Black Cockatoos: loss of habitat and breeding hollows are key threats for both Carnaby's Black Cockatoo and the Forest Red-tailed Black Cockatoo, particularly given their status under both the BC Act and EPBC Act. The cumulative impacts assessment therefore focuses on loss of habitat in relation to these two species.

In order to identify proposals contributing to cumulative impacts on Black Cockatoos, a search for EP Act approvals (Part IV and Part V) within 15 km of the Development Envelope was undertaken. A 15 km search

radius was selected as this correlates to the distance typically covered by Black Cockatoos while foraging. The search identified 24 projects that impact on Black Cockatoo habitat, as detailed in **Table 4-33**.

Predicted impacts for the two Main Roads proposals included in the cumulative impacts assessment (Perth-Darwin National Highway - Swan Valley Bypass and GNH Muchea North) have been taken directly from the assessment documentation prepared for these proposals. The predicted impacts for the remaining Part V EP Act approvals have been estimated based on the vegetation complexes detailed in the NVCP decision reports for each permit, accessed via the clearing permit system maintained by the DWER.

As shown in **Table 4-33**, 722.1 ha of foraging habitat for Carnaby's Black Cockatoo has been, or will be, cleared as a result of these proposals. The clearing of 204.8 ha required for the Bindoon Bypass Proposal represents 28.4% of this total; however, the cumulative impact of this clearing on foraging habitat present within 15 km of the Bindoon Bypass (based on DBCA remnant vegetation mapping) is less than 1%. In relation to the Forest Red-tailed Black Cockatoo, 471.3 ha is assessed to have been cleared as a result of these proposals. The clearing of 168 ha of habitat for this Proposal represents 35.6% of this total. The cumulative impact on foraging habitat within 15 km of the Bindoon Bypass (based on DBCA remnant vegetation mapping) is approximately 0.5%. The Proposal will therefore not significantly add to the cumulative loss of Black Cockatoo habitat in the region.

To assess impacts from these proposals on a bioregional scale, information on the extent of foraging habitat for Black Cockatoos in the Swan Coastal Plain and Jarrah Forest bioregions was sourced from mapping undertaken as part of the strategic assessment of the Perth to Peel Region (Department of the Premier and Cabinet 2015). According to this mapping, 2,960,141.1 ha of foraging habitat for Carnaby's Black Cockatoo and 2,616,621.0 ha of foraging habitat for the Forest Red-tailed Black Cockatoo remains within the Swan Coastal Plain and Jarrah Forest bioregions. The cumulative impact from proposals within 15 km of the Bindoon Bypass corresponds to 0.02% of foraging habitat for each species respectively. The Proposal will therefore not significantly add to the cumulative loss of foraging habitat for Black Cockatoos in a bioregional context.

Table 4-33: Cumulative Impacts to Black Cockatoos

Project	Carnaby's Black Cockatoo		Forest Red-tailed Black Cockatoo	
	Foraging (ha)	Potential Breeding (ha)	Foraging (ha)	Potential Breeding (ha)
Perth-Darwin National Highway - Swan Valley Bypass	201.8	120.1	120.1	120.1
GNH Muchea North	52.5	52.5	52.5	0.0
Clearing permits with 1 ha - 5 ha of clearing (13 permits)	25.9	14.8	13.9	11.9
Clearing permits with 5 ha – 10 ha of clearing (3 permits)	18.8	0.0	5.2	0.0
NVCP CPS 7574	12.1	12.1	11.4	0.0
NVCP CPS 615	13.3	13.3	0.0	0.0
NVCP CPS 2701	17.6	17.6	0.0	0.0
NVCP CPS 7948	22.6	0.0	0.0	0.0
NVCP CPS 2860	29.7	29.7	29.7	29.7
NVCP CPS 7959	38.0	38.0	38.0	38.0
NVCP CPS 4	40.0	0.0	40.0	0.0
NVCP CPS 172	45.0	0.0	45.0	0.0
Subtotal	**517.3**	**298.1**	**303.3**	**199.7**
Bindoon Bypass (the Proposal)	*204.8*	*79.3*	*168.0*	*69.2*
Total	**722.1**	**377.4**	**471.3**	**268.9**
Habitat remaining within 15 km of the Proposal (ha)	93,004.0	Cannot be determined	93,004.0	Cannot be determined
Cumulative proportion of habitat cleared (within 15 km of the Proposal)	0.8%	Cannot be determined	0.5%	Cannot be determined
Habitat remaining within Swan Coastal Plain (SCP) and Jarrah Forest (JF)[1]	2,960,141.1	Cannot be determined	2,616,621.0	Cannot be determined
Cumulative proportion of Black Cockatoo habitat cleared in SCP and JF	0.02%	Cannot be determined	0.02%	Cannot be determined

1 – Determined using data from the strategic assessment of the Perth to Peel Region mapping

4.3.6 Mitigation

The mitigation hierarchy (refer to **Chapter 4.2.6**) has been implemented throughout the concept design phase of the Proposal, and will continue to be implemented during detailed design and construction. Impacts to terrestrial fauna and their habitats have been avoided and minimised during the concept design phase, by preferentially locating the Development Footprint within previously cleared paddock. Additionally, the concept alignment has sought to avoid hollow-bearing trees, particularly those identified as previously used by Black Cockatoos. Where impacts to fauna habitat are unavoidable, the extent of clearing has been minimised as far as practicable by the employment of road safety barriers, steepening batters of cut and fill areas and adjusting road levels to minimise the depth/height of cut and fill areas.

To further minimise and mitigate potential impacts to terrestrial fauna, the following management measures, actions and controls are proposed:

- During the detailed design phase:
  - Clearing of native vegetation will be further reduced through the use of engineering solutions including but not limited to:
    - additional steepening of batters
    - installation of barriers in areas of high conservation value (e.g. where Black Cockatoo hollows are close to the road) to reduce clear zone requirements
    - reduction of median widths or design of medians to reduce the clearing required between carriageways.
  - Drainage will be designed to avoid:
    - ponding of water near the roadside to avoid attraction of fauna including Black Cockatoos
    - the movement of soils and/or water potentially carrying *Phytophthora* dieback into areas mapped as dieback-free.
  - Fauna underpasses will be included in the detailed design within the broad areas indicated on **Figure 4-19**. Underpasses may be co-located with culverts where appropriate, and will be designed to allow movement of fauna including Grey Kangaroos, Brush Wallabies, Chuditch and Water-rat (in watercourse areas). Underpass locations have been selected based on the following criteria:
    - align with ecological linkages identified by the Shire of Chittering's local biodiversity strategy (Shire of Chittering 2010). These linkages are considered to represent the fauna movement corridors within the local area.
    - (re)connect areas of good quality vegetation or high value areas, such as wetlands
    - align with areas where the road is at or higher than the natural land surface (i.e. fill areas). This allows for easier construction of fauna underpasses and avoids issues with flooding of underpasses that are below the natural land surface.
- During the Proposal implementation phase:
  - The areas to be cleared will be accurately marked in the field with pegs/flagging.
  - Trapping and relocation of fauna will occur in areas of fauna habitat prior to clearing occurring. Preferentially, fauna will be encouraged to disperse on their own accord.
  - Fauna trapping and relocation will be conducted in accordance with the DBCA's standard operating procedures—available at <https://www.dpaw.wa.gov.au/plants-and-animals/96-monitoring/standards/99-standard-operating-procedures>.
  - Fauna spotters will be engaged during clearing of fauna habitat to supervise the dispersal and/or relocation of remnant fauna.

- Excavations and trenches will be fenced to exclude fauna, or temporary fauna escape ramps will be installed and excavations inspected daily before 9 am for trapped fauna.
- Trees with hollows previously used by, or suitable for, Black Cockatoos within the Development Envelope but not within the Development Footprint will be clearly marked as no-go zones, and access to these areas restricted.
- If clearing of Black Cockatoo habitat is to occur during the breeding season, all potential nesting trees identified by BCE (2017, 2018) within the area to be cleared will be inspected by a suitably qualified person, to determine if any hollows are currently being used by Black Cockatoos.
- If any hollows within the Development Footprint are identified as being in use by Black Cockatoos, the hollow-bearing tree and a 10 m-diameter buffer around the tree 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.
- Revegetation will commence in autumn, following completion of construction works within designated revegetation areas and corridors to reinstate ecological linkages.
- Species mixes used in revegetation will aim to provide the following ecological services:
    - provide foraging and potential breeding habitat for Black Cockatoos
    - support fauna movement within the road reserve and between patches of existing native vegetation outside of the Development Envelope.
- Revegetation will include placement of hollow logs and brush, to provide fauna habitat and protection from feral predators while vegetation establishes.
- No plant species which provides habitat for Black Cockatoos will be planted within 10 m of the edge of the road seal.
- During construction, speed limits will be reduced (for example, to 40 km/h) to reduce the risk of fauna strikes.
- All fauna injured during the construction period will be taken to an authorised veterinarian or wildlife carer.
- Fauna warning signs will be installed in areas where native vegetation occurs next to the roadside.
- Educational and induction material about the significant flora and ecological communities will be provided to contractors working on the construction, to reduce the risk of accidental clearing.

Impacts to Black Cockatoo hollows will be offset through the acquisition of land containing at least an equivalent number of suitable or previously used hollows, or a combination of land acquisition and installation of artificial hollows. Details of the offsets proposed are provided in **Chapter 7**.

West Point Rd
Clewleys Rd
Wannamal Rd West
Calingiri Rd
Hay Flat Rd
Head Rd
Wannamal Rd South
Perry Rd
Great Northern Hwy
Gingilling Rd
Cullalla Rd
Pines Rd
Waldeck West Rd
Gallahawk Rd
Cook Rd
Ashman Rd
Spillman Rd
Owen Rd
Whakea Rd
Barn Rd
Wells Glover Rd
Bindoon-Moora Rd
Ashworth Rd
Toy Rd
Bindoon-Dewars Pool Rd
Crest Hill Rd
Mooliabeenee Rd
Wowra Dr
Teatree Rd
Stephens Rd
Kay Rd
Gray Rd
Lennards Rd
Spice Rd
Densley Rd
Flat Rocks Rd
Nullilla Rd
Brennan Rd
Hart Dr
Lake Rd
Breera Rd
Chittering Rd
Maddern Rd
Ioppolo Rd
Blue Plains Rd
BINDOON
MUCHEA
PERTH

Legend

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

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0 1,300 2,600
Metres

Scale at A3
1:112,823

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
Environmental Review Document
Project

Locations for Inclusion of Fauna Underpasses in Detailed Design

Figure: 4-19

Drawing No	Issue
GNH-CN12-EA-PER-00001 - F4-19	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-F4-19.mxd

4.3.7 Predicted Outcome

The Proposal will result in the clearing of up to 137.1 ha of fauna habitat. The impact to fauna habitat is not considered significant as:

- the mapped fauna habitats are common and generally widespread
- the clearing required represents 0.6% of the habitat available within 5 km of the Development Envelope
- detailed design will seek to reduce the amount of clearing required
- fauna underpasses will be constructed to maintain ecological connection across the Proposal, and minimise potential for fauna to cross the highway.

In addition, the Proposal will result in the clearing of 204.8 ha of foraging habitat identified as having Moderate or higher value for Carnaby's Black Cockatoo, and 168 ha of foraging habitat with a Moderate or higher value for the Forest Red-tailed Black Cockatoo. As the Development Footprint includes critical habitat for these species (as defined by the relevant recovery plans), the impact to Black Cockatoo foraging habitat is considered significant.

The clearing of up to ten hollows previously used by Black Cockatoo is considered significant, as the loss of hollows is a key threatening process for these species.

Main Roads will further mitigate impacts to Black Cockatoos through implementation of the offsets proposed in **Chapter 7**. This involves acquisition of land that will be placed into secure tenure and may include installation of artificial nesting hollows.

Impacts to the Brush Wallaby, Water-rat, Chuditch and Brush-tailed Phascogale are not significant, given the amount of suitable habitat for these species present within 5 km of the Development Envelope. Wetlands and water sources are located both the west and east of the Development Envelope, serving to reduce the risk posed by temporary loss of connectivity during construction.

No conservation significant aquatic species have been recorded from the Development Envelope or surrounds.

The impacts to terrestrial fauna can be managed to meet the EPA's objective. In general, these impacts are not considered to be significant, with the exception of impacts to tree hollows and foraging habitat for Black Cockatoos. However, with an ongoing commitment to further minimise the amount of clearing required during the detailed design phase, the implementation of appropriate management and mitigation controls and provision of offsets, the Proposal is likely to meet the EPA's objectives. An offset proposal for these impacts is provided in **Chapter 7**. Main Roads commits to the following outcomes in relation to terrestrial fauna in order to meet the EPA's objective:

- A maximum of 137.1 ha of natural fauna habitats (i.e. those not classified as paddock) will be cleared.
- A maximum of 204.8 ha of Carnaby's Black Cockatoo foraging habitat (of Moderate value or higher) will be cleared.
- A maximum of 168 ha of Forest Red-tailed Black Cockatoo foraging habitat (of Moderate value or higher) will be cleared.
- No more than 10 trees with hollows previously used by Black Cockatoos and 76 hollows suitable for Black Cockatoos as identified in BCE (2018) will be cleared.
- Ecological connectivity will be maintained across the Proposal.