4. Environmental Principles and Factors

4.1 Principles

The five core principles of environmental protection under the EP Act have been considered throughout the development of the Proposal and will continue to be considered through the detailed design and construction phases. Each of the environmental protection principles considered are summarised in **Table 4-1**.

Table 4-1: Principles of Environmental Protection

Principle	Consideration
1. The precautionary principle *Where there are threats of serious or irreversible damage, lack of full scientific certainty should not* *be used as a reason for postponing measures to prevent environmental degradation.* *In application of this precautionary principle, decisions should be guided by:* *a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and* *b) an assessment of the risk-weighted consequences of various options.*	A range of studies have been undertaken to inform the EIA presented in this ERD. These studies are: • flora and vegetation • terrestrial and aquatic fauna • wetlands • groundwater and surface water hydrology and quality • heritage (aboriginal and non- indigenous) • amenity (noise, light, visual impact). This information has reduced the uncertainty surrounding the impact assessment and prediction of impacts and their significance. During the design process the findings from the technical studies have been fed back into the design and modifications made where feasible to reduce or mitigate potential environmental impacts. This has resulted in a design which avoids serious or irreversible damage to the environment. This feedback process will continue through the detailed design phase, where further reductions in environmental impact may be realised. Where desktop analysis identified high value environmental assets, such as CC wetlands or known occurrences of TECs or PECs, which could be impacted by alternative alignment options, a multi-criteria analysis process was undertaken to objectively select the most appropriate route.
2. The principle of intergenerational equity *The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.*	The Proposal will ensure the health, diversity and productivity of the environment is maintained through the creation of an offset area(s) to mitigate the impacts. Implementation of the Infrastructure Sustainability Council of Australia (ISCA) framework will also drive sustainable practices and support the principle of intergenerational equity.
3. The principle of the conservation of biological diversity and ecological integrity	The Proposal design has given consideration to avoiding areas of high biological diversity or maintaining biological diversity by minimising the

Principle	Consideration
Conservation of biological diversity and ecological integrity should be a fundamental consideration.	impact on flora, vegetation, wetlands and fauna habitats as far as practicable. Impacts on flora, vegetation and terrestrial fauna have been assessed and mitigation and management measures proposed.
4. Principles relating to improved valuation, pricing and incentive mechanisms *(1) Environmental factors should be included in the valuation of assets and services.* *(2) The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and abatement.* *(3) The users of goods and services should pay prices based on the full life-cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste.* *Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and responses to environmental problems.*	Main Roads acknowledges that the cost of constructing and operating the Bindoon Bypass must include proposed management and mitigation measures, offset requirements, monitoring, maintenance activities and waste avoidance or disposal requirements. These costs will be included in the budget for the proposal, which will be updated as certainty around these environmental requirements increases. Environmental objectives and goals for the Bindoon Bypass were established at the beginning of the project. These were: • undertake practices to help retain and enhance the environmental values of roadsides • no overall loss of the quality and quantity of vegetation communities or habitats • offset significant losses through acquisition of suitable land or other measures in line with State and EPBC environmental offset policies. The Proposal will implement the ISCA framework which encourages design and construction teams to develop innovative solutions to environmental and other sustainability problems.
5. The principle of waste minimisation *All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.*	Through the ISCA framework the Proposal has developed concepts and practices for the minimisation of waste and diversion of waste from landfill. This includes the use of recycled materials in the road formation. During the design phases, the amount of cut verses fill across the alignment is calculated to determine if there is an excess or shortfall of fill material, with the objective being that the majority of material excavated from areas of cut is reused in areas where fill is required.

4.2 Key Environmental Factor – Flora and Vegetation

4.2.1 EPA Objective

To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

4.2.2 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)
- Guidance for terrestrial flora and vegetation surveys for environmental impact assessment in WA[1] (EPA 2004a)
- Technical guide for flora and vegetation surveys for environmental impact assessment[2] (EPA & DPaW 2015)
- Environmental factor guideline - flora and vegetation (EPA 2016b)
- Technical guidance: flora and vegetation surveys for environmental impact assessment (EPA 2016c).

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

- Banksia woodlands of the Swan Coastal Plain: draft guidance for Part 7 referrals (DoEE 2016a)
- Banksia woodlands of the Swan Coastal Plain: a nationally protected ecological community (DoEE 2016b)
- Survey guidelines for Australia's threatened orchids: guidelines for detecting orchids listed as 'Threatened' under the EPBC Act (Department of the Environment 2013)
- Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* (Department of the Environment 2014)
- Approved conservation advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain Ecological Community (Threatened Species Scientific Community 2016)
- Geomorphic wetlands of the Swan Coastal Plain dataset (DBCA 2016)
- WA environmental offsets policy (Government of WA 2011)
- WA environmental offsets guidelines (Government of WA 2014a)
- WA environmental offsets template (Government of WA 2014b).

4.2.3 Receiving Environment

4.2.3.1 Surveys Undertaken

During spring 2016, Focused Vision Consulting Pty Ltd (FVC) were engaged to conduct flora and vegetation assessments of three proposed corridor options for the Bindoon Bypass—collectively referred to as the study area (FVC 2018a). In 2017, the Western Bypass A was chosen to be the preferred corridor (**Chapter 2.4**) and is referred to in this report as the Development Envelope.

[1] This was superseded by EPA (2016b) after the 2016 Spring Survey, which was conducted in accordance with this guidance
[2] This was superseded by EPA (2016c) after the 2016 Spring Survey, which was conducted in accordance with this guidance

The 2016 spring surveys commenced with desktop reviews, to determine flora and vegetation likely to be found within the study area, and to inform field survey methodology. Desktop reviews were based on the following:

- DAWE's MNES search tool
- DBCA's NatureMap
- WA Herbarium database
- Threatened and Priority taxa listed under the BC Act and by DBCA
- TECs and PECs listed by DBCA
- Declared Pests under WA's Biosecurity and Agriculture Management Act 2007 (BAM Act).

The desktop surveys identified flora species that may be present in the study area, including Commonwealth-listed Threatened flora, State-listed Threatened flora and State-listed Priority flora. The identified flora species were then assessed to determine whether they are known to occur, likely to occur, may occur or unlikely to occur in the study area. This assessment was based on habitat preference, current distribution data and previous survey records. Desktop reviews also identified EPBC Act-listed TECs, TECs endorsed by the WA Minister for the Environment, and DBCA-listed PECs.

Detailed flora and vegetation field assessments (previously referred to as Level 2 flora and vegetation assessments) commenced once desktop assessments were completed. Field assessments took place in October 2016 within the same study area as the desktop assessments, with targeted assessments for *Thelymitra stellata* (Star Sun-orchid) in November 2016 to coincide with the flowering period for this species (FVC 2018a).

All survey and reporting was undertaken in accordance with the following:

- Guidance for terrestrial flora and vegetation surveys for environmental impact assessment in WA[3] (EPA 2004a)
- Technical guide for flora and vegetation surveys for environmental impact assessment[4] (EPA & DPaW 2015)
- Environmental factor guideline - flora and vegetation (EPA 2016b)
- Technical guidance: flora and vegetation surveys for environmental impact assessment (EPA 2016c)
- Survey guidelines for Australia's threatened orchids: guidelines for detecting orchids listed as 'Threatened' under the EPBC Act (Department of the Environment 2013).

These detailed flora and vegetation field assessments collected data from quadrats and opportunistic observations (FVC 2018a). Floristic data for each quadrat was analysed, classified and rationalised into vegetation communities, and described as national vegetation information system (NVIS) Level III and VI. Each local-scale vegetation community was then rationalised with regional vegetation associations as per Shepherd, Beeston and Hopkins (2002—FVC 2018a).

Targeted surveys focusing on *T. stellata* were conducted in November 2016 in locations with habitats that were deemed suitable for the species (FVC 2018a). Sampling methods were designed in accordance with Commonwealth guidelines (Department of the Environment 2013) and included chance finds, meandering searches, area searches and systematic targeted searches, aiming to target at least 50% of the intact vegetation remnants considered to provide suitable habitat for *T. stellata* within the study area (FVC 2018a).

FVC were re-engaged to undertake autumn, winter and further spring surveys of the study area in 2017, following endorsement of the Development Envelope, and in 2018. The results from these surveys provided

[3] This was superseded by EPA (2016b) after the 2016 Spring Survey, which was conducted in accordance with this guidance
[4] This was superseded by EPA (2016c) after the 2016 Spring Survey, which was conducted in accordance with this guidance

new information on autumn and winter conditions, updated information on spring conditions to supplement 2016 data and provided full survey coverage for new areas that were added to the Development Envelope as a result of changes to the proposed alignment following consultation with landowners and other stakeholders. The 2017 and 2018 surveys followed the same desktop assessment approach previously described for the 2016 surveys, with the same databases having been used. Detailed flora and vegetation field assessments followed, including targeted assessments focusing on *T. stellata and Drakaea elastica* (Glossy-leafed Hammer Orchid). These surveys were conducted in accordance with:

- Survey guidelines for Australia's threatened orchids: guidelines for detecting orchids listed as 'Threatened' under the EPBC Act (Department of the Environment 2013)
- Technical guidance: flora and vegetation surveys for environmental impact assessment (EPA 2016c)
- Approved conservation advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain Ecological Community (Threatened Species Scientific Community 2016).

A collective total of 139 quadrats (inclusive of two releves) were sampled over the 2016, 2017 and 2018 surveys, 40 of which are located in the wider region (i.e. outside the Development Envelope) and contribute to the definition of the regional context (FVC 2018a). Quadrats were established and sampled in areas of native vegetation classified as 'Good' or better condition. In accordance with the requirements of the EPA (2016c), observations and opportunistic data were also collected continuously throughout the survey. The targeted surveys for *T. stellata* were conducted in November 2017 and 2018, and for *D. elastica* in July 2017 and mid-July to mid-August 2018. These targeted surveys coincided with the respective species lifecycle phase in which they are most easily identifiable; for *T. stellata* this coincides with flowering, while for *D. elastica* the species is most readily identifiable by the leaf during winter, with follow-up confirmation of identification with the flower in spring (FVC 2018a).

Rainfall observations from the Bureau of Meteorology weather stations at Bindoon (Station ID 9112) and Wannamal (Station ID 9040) show that early winter rainfall in 2017 was below the long-term average, as recorded at Gingin Aero (Station ID 9178) (**Table 4-2, Figure 4-1** and **Figure 4-2**). Rainfall in May and June was well below average with both stations reporting rainfall totals more than 40% lower than the long-term average. Rainfall in July and August was well above average with September rainfall close to average. This late start to the season in 2017 may have had had an impact on flowering of target species, particularly *T. stellata*, and leaf emergence and flowering of *D. elastica*. Additional targeted surveys were undertaken in 2018. Rainfall in May and June was closer to the long-term average with June exceeding the average at Bindoon. July and August were both at or above the long-term average rainfall for the month. The 2108 season was therefore more favourable for flowering and leaf emergence of the target species and therefore addresses the possible limitations of the 2017 survey due to the late start of the winter (wet) season. Targeted searches for *T. stellata* were also undertaken in November 2016. Rainfall during the preceding Winter months was generally close to the long-term average.

Table 4-2: Winter Rainfall Observations from Bindoon and Wannamal and Gingin Aero Long-term Average

Station	Year	Rainfall (mm)				
		May	Jun	Jul	Aug	Sep
Bindoon	2016	87.4	102.6	129.4	141.4	62.6
	2017	45.2	44.4	194.3	151.2	88.4
	2018	62.6	121.6	157.6	201.2	24.0
Wannamal	2016	73.8	77.1	126.1	107.2	42.7
	2017	25.8	39.9	131.3	112.7	76.2
	2018	53.8	92.1	123.5	158.0	19.3
Gingin Aero	**Long-term Average**	**75.2**	**109.8**	**125.3**	**109.8**	**80.3**

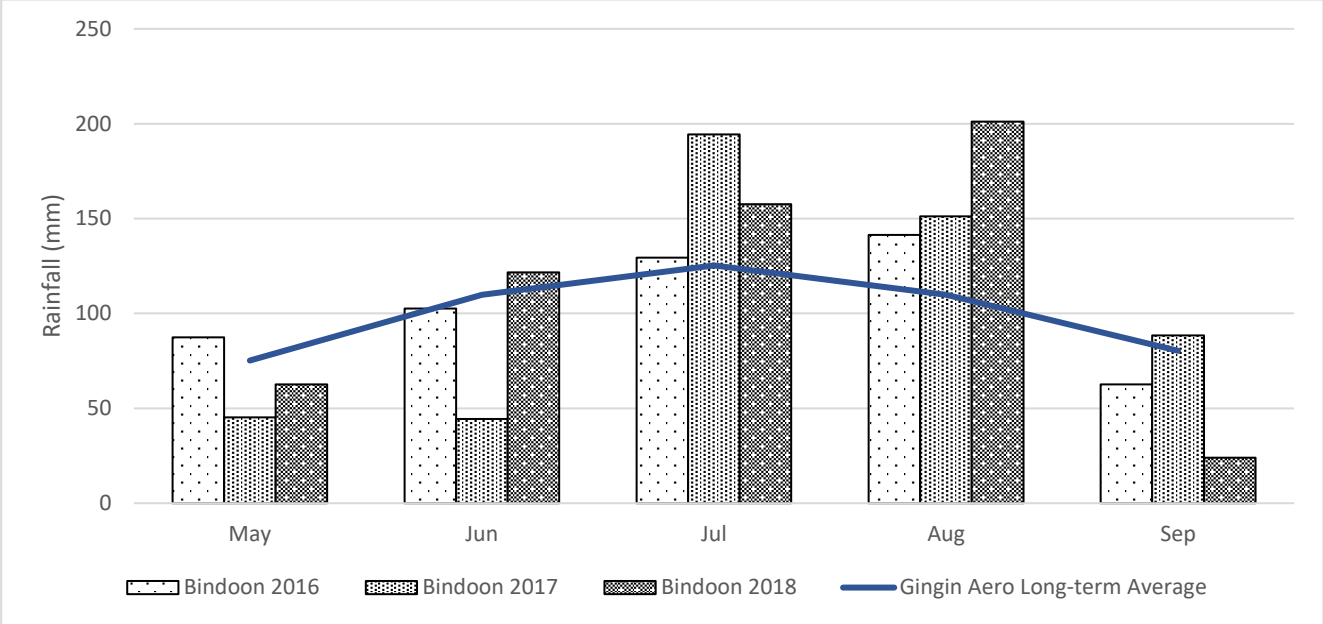


Figure 4-1: Comparison of 2016 and 2018 Winter Rainfall at Bindoon Against the Long-term Average

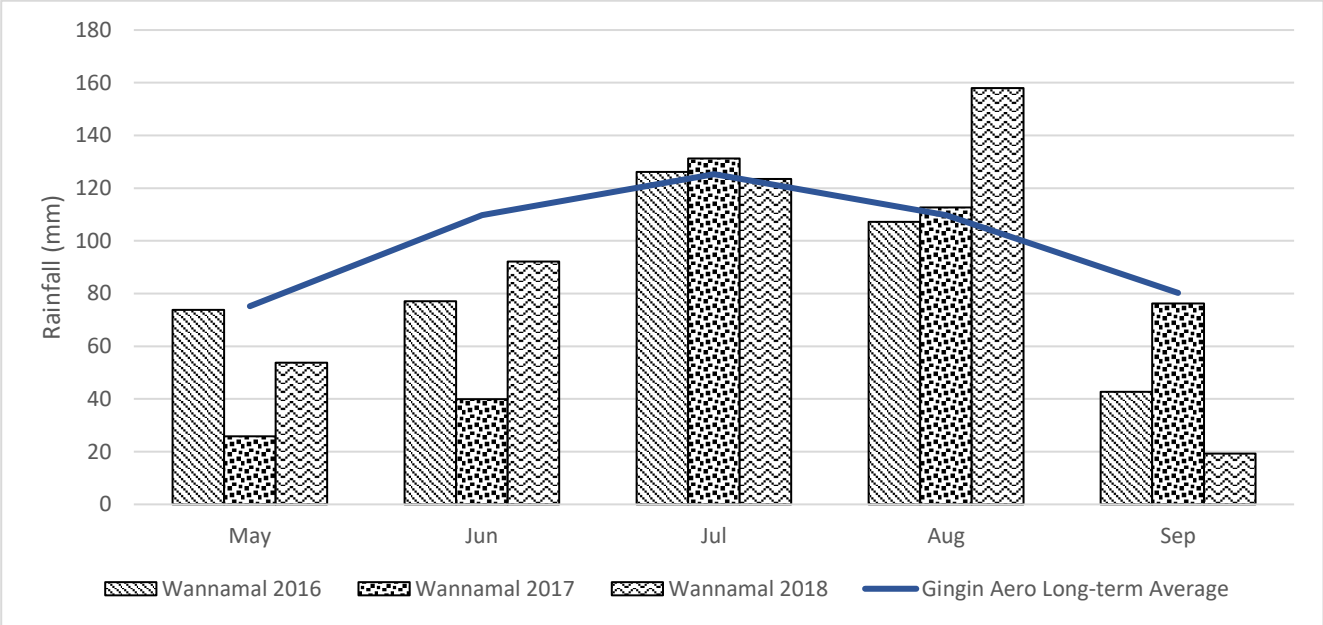


Figure 4-2: Comparison of 2016 to 2018 Winter Rainfall at Wannamal Against the Long-term Average

FVC also undertook a detailed assessment of the wetlands associated with the Brockman River at the proposed crossing location (FVC 2018b). This survey was conducted in accordance with the *Protocol for proposing modifications to the geomorphic wetlands of the Swan Coastal Plain* (DEC 2007), and included:

- detailed desktop assessment, which gathered a range of information about the wetlands adjacent to the Brockman River crossing, including vegetation
- field assessments, which confirmed information from the desktop study and made further observations of the existing environment, including vegetation.

Appendix D contains full copies of the FVC reports, which include detailed descriptions of the surveys that have been undertaken to support this ERD.

4.2.3.2 Flora

A total of 572 flora taxa from 218 genera and 63 families were recorded during the 2016, 2017 and 2018 surveys (FVC 2019). Of these, 30 taxa (7%) were identified as weed species. Over 30% of the taxa recorded were from three families: Fabaceae (12.2%), Proteaceae (10.3%) and Myrtaceae (9.9%) (FVC 2018a). The number of flora taxa recorded is considered relatively high in terms of species diversity, and reflects the diversity of landform types, soils and the location of the Proposal on the boundary of two IBRA regions (FVC 2018a).

Conservation Significant Flora

The desktop studies identified a total of 103 flora species of conservation significance that may occur in the study area. Of these, 55 are considered unlikely to occur in the Development Envelope, for the following reasons:

- proximity of previous records to the Development Envelope
- currency of data
- lack of suitable habitat within the study area.

Of the remaining 48 species, ten are listed under the BC Act—eight of these are also listed under the EPBC Act—and 38 are on the DBCA Priority Flora List (five P1, four P2, nineteen P3 and ten P4). The complete list of 48 conservation significant flora species that may occur in the Bindoon area is provided in Appendix A of FVC's report (2018a), which is provided in **Appendix D** of this ERD.

The 2016 and 2017 field surveys recorded 11 Priority flora within the study area (FVC 2018a) (**Table 4-3**). No flora species listed under the BC Act or EPBC Act were recorded within the study. **Figure 4-3** shows the locations of all conservation significant flora records for the Bindoon area, including those recorded by FVC (2018a) and from the DBCA and WA Herbarium databases.

Table 4-3 : Conservation Significant Flora Species Recorded by FVC (2018a)

Species	Status	Description	Number of Individuals	
			FVC (2018a, 2019)	Development Envelope
Gastrolobium ?crispatum	P1	Tall shrub, to 2.5 m high. Flowers are yellow and orange and red and flowering occurs September to October.	2	0
Synaphea panhesya (incl. *Synaphea ?panhesya*)	P1	Erect shrub, 0.3-0.6 m high. Flowers are yellow and flowering occurs August to September.	14	0
Drosera sewelliae (incl. *Drosera ?sewelliae*)	P2	Fibrous-rooted, rosetted perennial, herb, to 0.06 m high, to 0.025 m wide. Flowers are orange and flowering occurs in October.	303	34
Hibbertia glomerata subsp. *ginginensis*	P2	Erect shrub, to 0.5 m high. Flowers are yellow and flowering occurs July to September.	383	0
Leucopogon squarrosus subsp. *trigynus*	P2	Shrub to 1.5 m high and 1.2 m wide. Flowers are white. The flowering period is uncertain but there are records of flowering in July and September. Grows on white sands in association with Banksia woodlands	5	5

Species	Status	Description	Number of Individuals	
			FVC (2018a, 2019)	Development Envelope
Acacia drummondii subsp. *affinis* (incl. *Acacia drummondii* subsp. *?affinis*)	P3	Erect shrub, 0.3-1.0 m high. Flowers are yellow and flowering occurs July to August.	342	23
Adenanthos cygnorum subsp. *chamaephyton*	P3	Prostrate, mat-forming, non-lignotuberous shrub, to 0.3 m high. Flowers are white, cream, pink or green and flowering occurs in any month from July to January.	1,068	1
Halgania corymbosa	P3	Erect shrub up to 1 m high. Flowers are blue-purple and flowering occurs in August to November. Grows in gravelly soils and soils over granite.	2	2
Styphelia filifolia	P3	Erect shrub to 0.9 m high and 0.7 m wide. Flowers are white with flowering occurring between March and May. Grows on sandy soils of the coastal plain.	1	0
Verticordia rutilastra	P3	Shrub up to 0.9 m high. Flowers are yellow and flowering occurs between September and November. Grows on hills in sands and lateritic gravels.	2	2
Anigozanthos humilis subsp. *chrysanthus*	P4	Rhizomatous perennial herb, 0.2-0.4 (-0.8) m high. Flowers are yellow and flowering occurs July to October.	11	3
Hibbertia miniata	P4	Decumbent or erect shrub, 0.1-1.0 m high. Flowers are orange or orange-red and flowering occurs August to November.	1,494	851
Hypolaena robusta	P4	Dioecious rhizomatous perennial herb, about 0.5 m high. Flowers September to October.	4	1
Jacksonia ?sericea	P4	Low spreading shrub, to 0.6 m high. Flowers are orange with flowering usually occurring in December or January to February. Grows in calcareous and sandy soils.	1	0
Verticordia paludosa (incl. *Verticordia ?paludosa*)	P4	Erect shrub, 0.3-0.9 m high. Flowers are pink or white with flowering occurring January to May.	281	125

Identifications for *Gastrolobium ?crispatum, Synaphea ?panhesya, Drosera ?sewelliae, Acacia drummondii* subsp. *?affinis, Jacksonia ?sericea* and *Verticordia ?paludosa* could not be confirmed due to a lack of identifiable material. Where sufficient identifiable material was available, identifications for Priority flora species were verified by Dr Udani Sirisena of the WA Herbarium, with difficult identifications also reviewed by WA Herbarium plant group specialists (FVC 2018a).

The recorded location of the P1 species *Gastrolobium ?crispatum* is approximately 900 m from the Development Envelope, in private land opposite Burroloo Well Nature Reserve. All recorded locations of the P1 species *Synaphea panhesya* are outside of the Development Envelope, though three of these are adjacent to the Development Envelope. The recorded location for the P2 species *Hibbertia glomerata* subsp. *ginginensis* is approximately 420 m from the Development Envelope. The recorded location of the P3 species *Styphelia filifolia*, is just outside of the Development Envelope near the Cook Road rail crossing. The possible *Jacksonia ?sericea* (P4) record is approximately 155 m from the Development Envelope (**Figure 4-3**).

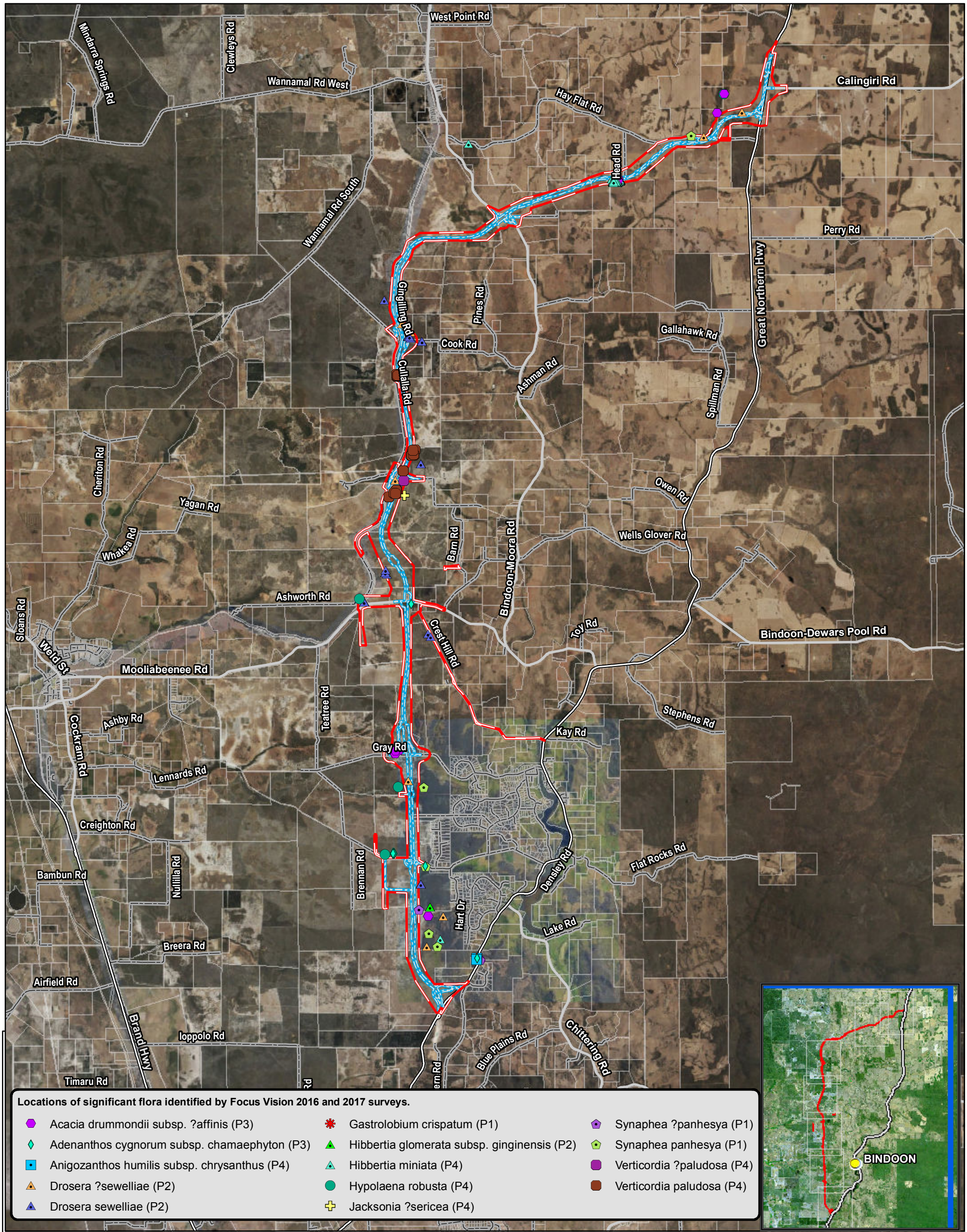
The targeted surveys undertaken for *Thelymitra stellata*, and *Drakaea elastica* focused on areas with suitable habitats for these species. For *D. elastica*, survey included a historic DBCA population record. No evidence of either species was found within the study area. Furthermore, the area where the historic *D. elastica* population was located was found to be significantly degraded. As there were no potential *D. elastica* leaves identified during the July 2017 (winter) survey, follow-up confirmation during spring was not required (FVC 2018a).

Targeted searches were conducted for all Threatened or Priority flora identified as “likely to occur” or “may occur” within the study area, including *Asterolasia nivea* (Bindoon Starbush), *Darwinia acerosa* (Fine-leaved Darwinia), *Darwinia foetida* (Muchea Bell), *Chamelaucium* sp. Gingin—NG Marchant 6 (Gingin Wax), *Grevillea corrugata* and *Spirogardnera rubescens* (Spiral Bush). None of these species were recorded, despite extensive searches of suitable habitat and locations of previous/known records. *Darwinia acerosa* is considered unlikely to occur in the Development Envelope as its preferred habitat includes granite rocks, outcrops and orange-brown gravelly soils, none of which are present in the Development Envelope.

Groundwater-Dependent Flora

A number of Banksia and Eucalypt species are considered to be (at least partially) groundwater-dependent. Facultative species do not depend entirely on groundwater and can draw water from elsewhere, such as surface water or water contained within soil pores above the water table. Obligate species have a higher dependency on groundwater and are therefore more at risk of impacts from changes to groundwater levels. For example, *Banksia ilicifolia* generally occurs in areas where the water table is no more than 5 m from the ground surface (Threatened Species Scientific Committee 2016). Species recorded within the Development Envelope include:

- Banksia attenuata – facultative
- B. ilicifolia – obligate
- B. littoralis – obligate
- *B. menziesii* – facultative
- Corymbia calophylla – facultative
- Eucalyptus rudis – obligate
- *E. todtiana* – facultative.



Locations of significant flora identified by Focus Vision 2016 and 2017 surveys.

- Acacia drummondii subsp. ?affinis (P3)
- Adenanthos cygnorum subsp. chamaephyton (P3)
- Anigozanthos humilis subsp. chrysanthus (P4)
- Drosera ?sewelliae (P2)
- Drosera sewelliae (P2)
- Gastrolobium crispatum (P1)
- Hibbertia glomerata subsp. ginginensis (P2)
- Hibbertia miniata (P4)
- Hypolaena robusta (P4)
- Jacksonia ?sericea (P4)
- Synaphea ?panhesya (P1)
- Synaphea panhesya (P1)
- Verticordia ?paludosa (P4)
- Verticordia paludosa (P4)

Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 1,500 3,000 Metres

Scale at A3 1:130,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia

Client

Project

Great Northern Highway
Bindoon Bypass
Environmental Review Document

Locations of Conservation Significant Flora

Figure: 4-3 Page 1 of 8

Drawing No	Issue
GNH-CN12-EA-PER-0001-F4-3	1

Task No	Drawing Status / Other
ERD	Draft

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

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-1.mxd

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

Locations of significant flora identified by Focus Vision 2016 and 2017 surveys.

- Acacia drummondii subsp. ?affinis (P3)
- Adenanthos cygnorum subsp. chamaephyton (P3)
- Anigozanthos humilis subsp. chrysanthus (P4)
- Drosera ?sewelliae (P2)
- Drosera sewelliae (P2)
- Gastrolobium crispatum (P1)
- Hibbertia glomerata subsp. ginginensis (P2)
- Hibbertia miniata (P4)
- Synaphea ?panhesya (P1)
- Synaphea panhesya (P1)

Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

Scale at A3 1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
Environmental Review Document
Project

Locations of Conservation Significant Flora

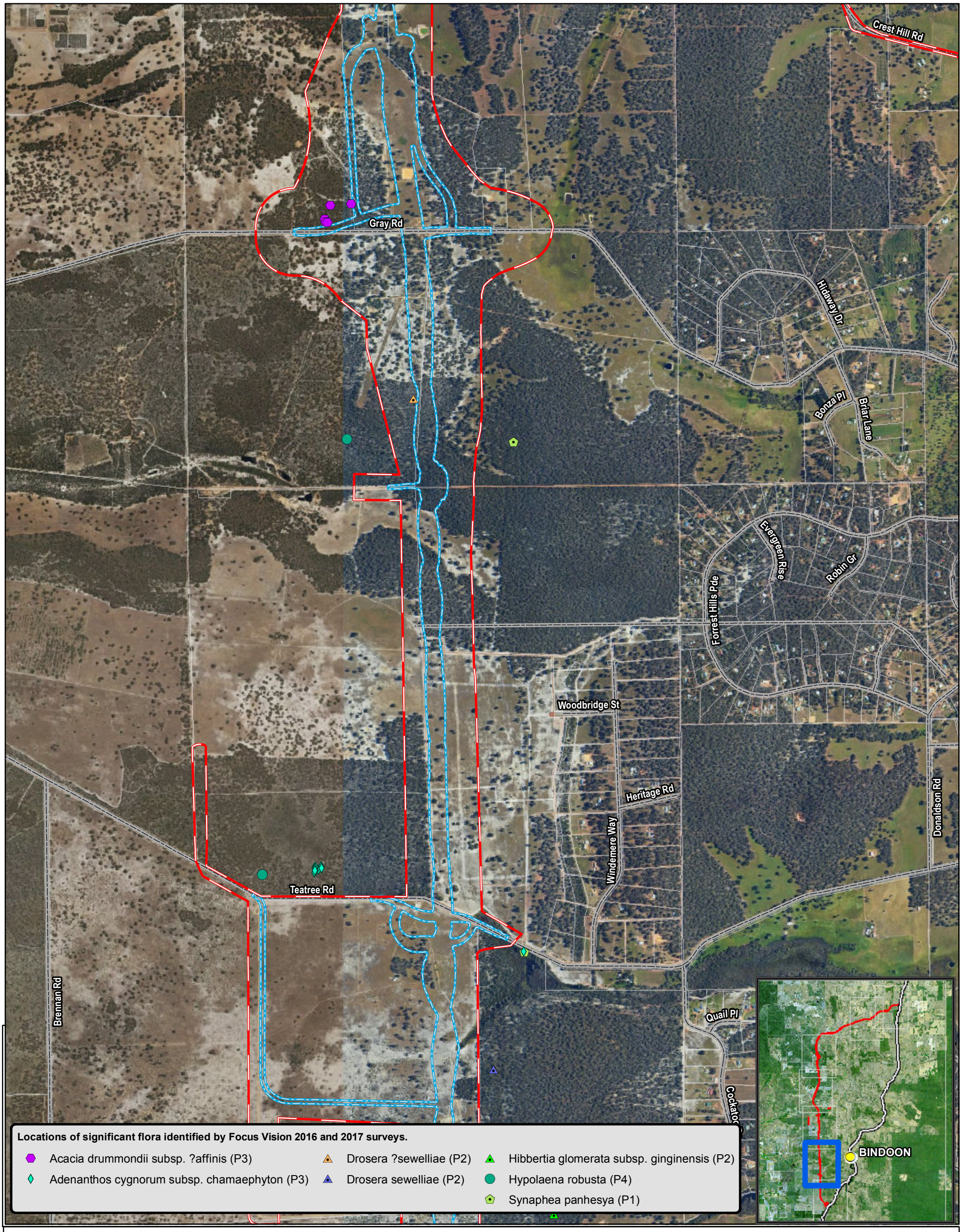
Figure: 4-3 Page 2 of 8

Drawing No	Issue
GNH-CN12-EA-PER-0001-F4-3	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-F4-1.mxd



Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

Scale at A3 1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
Environmental Review Document
Project

Locations of Conservation Significant Flora

Figure: 4-3 Page 3 of 8

Drawing No	Issue
GNH-CN12-EA-PER-0001-F4-3	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-F4-1.mxd

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

Locations of significant flora identified by Focus Vision 2016 and 2017 surveys.

Adenanthos cygnorum subsp. chamaephyton (P3) Drosera sewelliae (P2) Hypolaena robusta (P4)

Legend

Development Envelope
Development Footprint
Cadastral Boundary
Major Road
Minor Road

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

Scale at A3
1:20,000

Coordinate System: GDA 1994 MGA Zone 50

mainroads WESTERN AUSTRALIA
GHD
ARUP TRADING AS ASJV
JACOBS

Client: **Main Roads Western Australia**

Project:
Great Northern Highway
Bindoon Bypass
Environmental Review Document

Locations of Conservation Significant Flora

Figure: 4-3 Page 4 of 8

Drawing No	Issue
GNH-CN12-EA-PER-0001-F4-3	1

Task No	Drawing Status / Other
ERD	Draft

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

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-1.mxd

Kinkella Rd

Cullalla Rd

Barn Rd

BINDOON

Locations of significant flora identified by Focus Vision 2016 and 2017 surveys.

Drosera ?sewelliae (P2)
Drosera sewelliae (P2)
Jacksonia ?sericea (P4)
Verticordia ?paludosa (P4)
Verticordia paludosa (P4)

Legend

Development Envelope
Development Footprint
Cadastral Boundary
Minor Road

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

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

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
Environmental Review Document
Project

Locations of Conservation Significant Flora

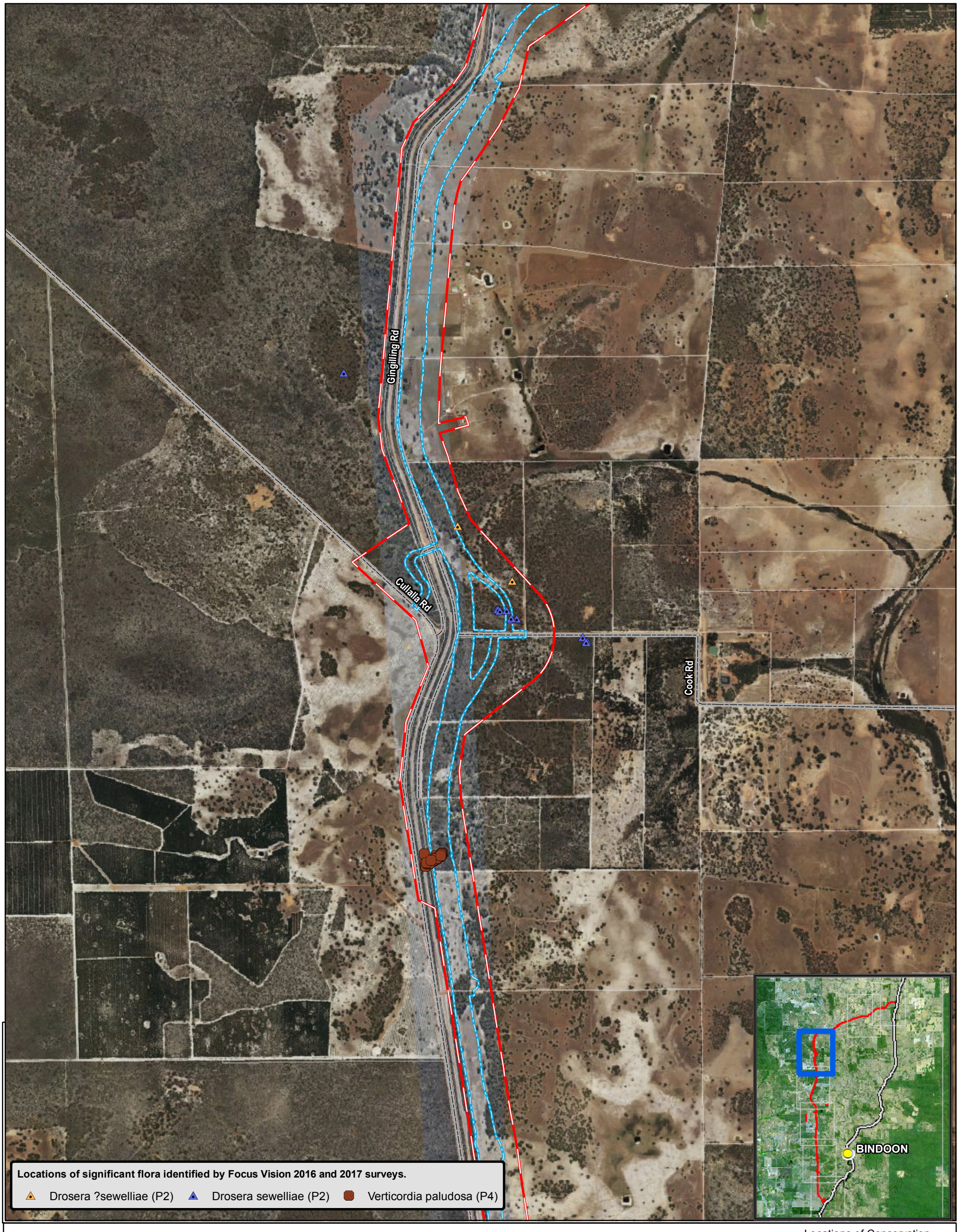
Figure: 4-3 Page 5 of 8

Drawing No	Issue
GNH-CN12-EA-PER-0001-F4-3	1

Task No	Drawing Status / Other
ERD	Draft

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

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-1.mxd



Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

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

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
Environmental Review Document
Project

Locations of Conservation Significant Flora

Figure: 4-3 Page 6 of 8

Drawing No	Issue
GNH-CN12-EA-PER-0001-F4-3	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-F4-1.mxd

Hay Flat Rd

Head Rd

Kangaroo Gully Rd

BINDOON

Locations of significant flora identified by Focus Vision 2016 and 2017 surveys.

- Acacia drummondii subsp. ?affinis (P3)
- Drosera sewelliae (P2)
- Hibbertia miniata (P4)
- Verticordia ?paludosa (P4)

Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

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

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
Environmental Review Document
Project

Locations of Conservation Significant Flora

Figure: 4-3 Page 7 of 8

Drawing No	Issue
GNH-CN12-EA-PER-0001-F4-3	1

Task No	Drawing Status / Other
ERD	Draft

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

MXD Location: \\Jacobs.com\PERP.rojects\PBIFI\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-1.mxd

Calingiri Rd

Great Northern Hwy

Hay Flat Rd

BINDOON

Locations of significant flora identified by Focus Vision 2016 and 2017 surveys.

Acacia drummondii subsp. ?affinis (P3)

Drosera ?sewelliae (P2)

Hypolaena robusta (P4)

Synaphea panhesya (P1)

Legend

Development Envelope

Development Footprint

Cadastral Boundary

Highway

Major Road

Minor Road

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

Scale at A3 1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass
Environmental Review Document
Project

Locations of Conservation Significant Flora

Figure: 4-3 Page 8 of 8

Drawing No	Issue
GNH-CN12-EA-PER-0001-F4-3	1

Task No	Drawing Status / Other
ERD	Draft

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

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-1.mxd

4.2.3.3 Vegetation

Vegetation Associations

Vegetation within the study area has broadly been characterised as Banksia low woodland, Jarrah-Marri woodland, Marri woodland, Bullich and Blackbutt (FVC 2018a). The flora and vegetation surveys identified and mapped 12 vegetation associations (FVC 20189). These are detailed in **Table 4-4**, along with their extent within the Development Envelope and the total mapped extent of each vegetation association (**Figure 4-4**).

Table 4-4: Vegetation Associations of the Development Envelope

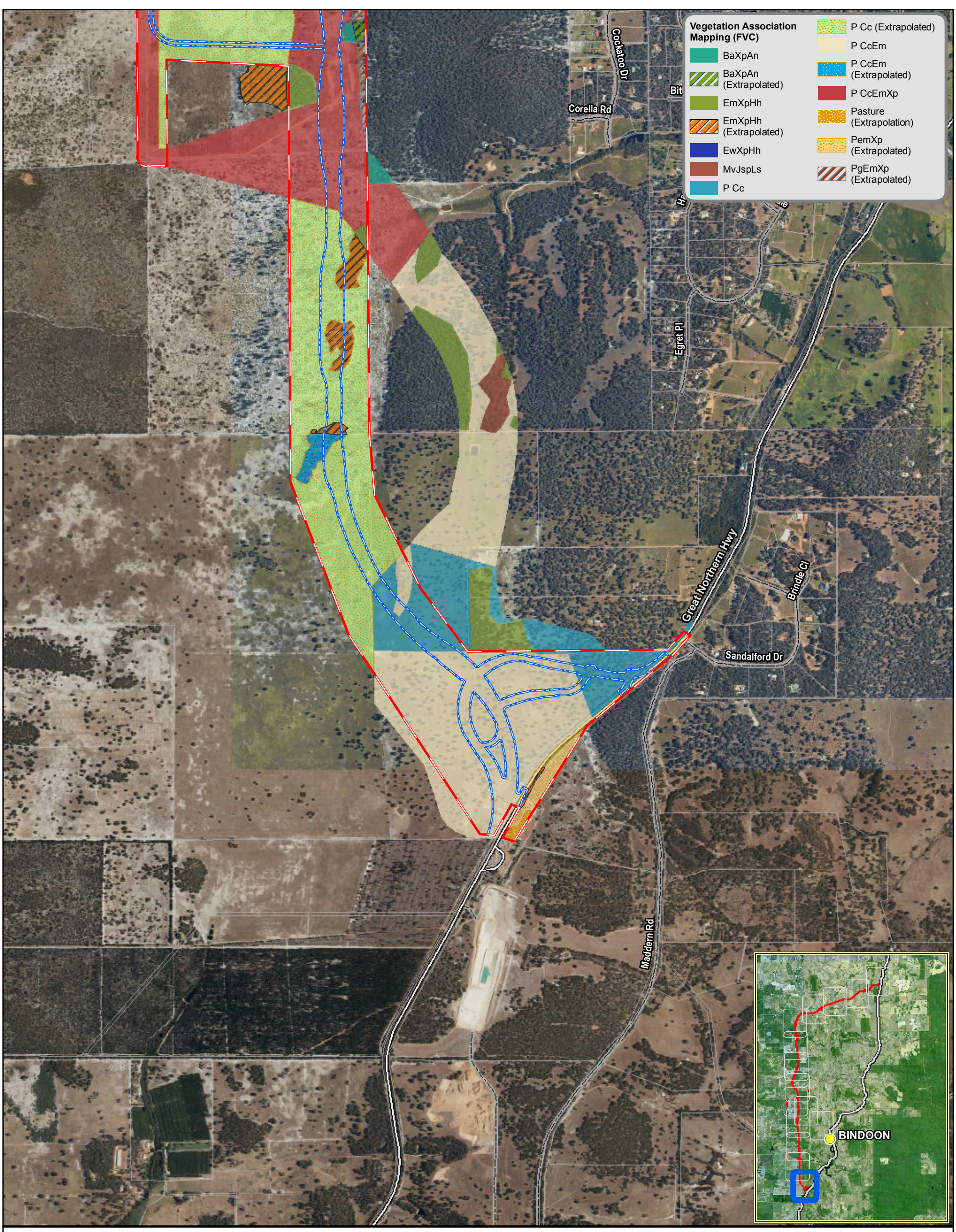
Vegetation Association[1]	Description	Extent within Development Envelope (ha)	Extent Mapped by FVC (ha)
BaXpAn	***Banksia* spp. sparse woodland** *Banksia attenuata*, *Banksia menziesii* and *Eucalyptus todtiana* low sparse woodland over *Xanthorrhoea preissii* mid isolated to sparse shrubs over *Bossiaea eriocarpa*, *Gompholobium tomentosum* and *Petrophile linearis* low isolated shrubs over *Alexgeorgea nitens* and *Lyginia imberbis* sparse sedgeland.	61.0	95.2
BaXpUa	***Banksia attenuata* sparse woodland** *Banksia attenuata* low sparse woodland (with occasional *Banksia menziesii*) over *Xanthorrhoea preissii* mid isolated shrubs over *Bossiaea eriocarpa*, *Hibbertia hypericoides* and *Petrophile linearis* low isolated shrubs over **Ursinia anthemoides*, *Conostylis aculeata* and **Hypochaeris glabra* isolated herbs.	41.7	49.1
BmKgHg	***Kunzea glabrescens* shrubland** *Banksia menziesii* low sparse to open woodland over *Kunzea glabrescens* and *Xanthorrhoea preissii* mid shrubland over **Hypochaeris glabra* and *Drosera erythrorhiza* isolated herbs.	8.6	16.8
EmBsHh	***Eucalyptus marginata* and *Banksia sessilis* sparse woodland** *Eucalyptus marginata* and *Corymbia calophylla* low sparse woodland over *Banksia sessilis* and *Xanthorrhoea preissii* tall to mid sparse shrubland over *Hibbertia hypericoides* and *Bossiaea eriocarpa* low isolated to sparse shrubland over **Hypochaeris glabra* and **Ursinia anthemoides* isolated herbs.	115.0	139.6
EmXpAn	***Eucalyptus marginata* sparse woodland** *Eucalyptus marginata* (and *Banksia attenuata*) low sparse woodland over *Xanthorrhoea preissii* mid sparse shrubland over *Bossiaea eriocarpa, Hibbertia hypericoides* and *Petrophile linearis* low isolated to sparse shrubland over *Alexgeorgea nitens* and *Lomandra* spp. isolated sedges.	13.4	122.8

Vegetation Association[1]	Description	Extent within Development Envelope (ha)	Extent Mapped by FVC (ha)
EmXpHh	***Eucalyptus marginata* sparse woodland** *Eucalyptus marginata* and *Corymbia calophylla* low sparse woodland over *Xanthorrhoea preissii* mid sparse shrubland over *Hibbertia hypericoides*, *Bossiaea eriocarpa* and *Banksia dallanneyi* low isolated shrubs over Conostylis setosa, *Xanthosia* sp. and *Philotheca spicata* isolated herbs.	131.3	222.3
ErXpBm	***Eucalyptus rudis* and *Melaleuca preissiana* sparse woodland** *Eucalyptus rudis*, *Melaleuca preissiana* and *Corymbia calophylla* low sparse woodland over *Xanthorrhoea preissii* and *Jacksonia furcellata* mid isolated shrubs over *Hypocalymma angustifolium* low shrubland over *Lepidosperma tenue* isolated sedges and **Briza* spp. sparse grassland.	48.1	62.2
EtBeAn	***Eucalyptus todtiana* sparse woodland** *Eucalyptus todtiana*, *Banksia attenuata* and *Banksia menziesii* low sparse woodland over *Bossiaea eriocarpa*, *Hibbertia hypericoides* and *Petrophile linearis* low isolated shrubs over *Alexgeorgea nitens*, *Lyginia imberbis* and *Mesomelaena pseudostygia* sparse sedgeland.	152.2	257.5
EtEpAn	***Eucalyptus todtiana* sparse woodland** *Eucalyptus todtiana* and *Banksia* spp. low sparse woodland over *Adenanthos cygnorum* tall sparse shrubland over *Eremaea pauciflora* and *Stirlingia latifolia* mid sparse to isolated shrubland over *Bossiaea eriocarpa* and *Conostephium pendulum* low isolated shrubs over *Austrostipa hemipogon* and *Briza maxima* grasses and *Alexgeorgea nitens* sedges.	39.2	59.1
EwBeNa	***Eucalyptus wandoo* and *Casuarina obesa* sparse woodland** *Eucalyptus wandoo* and *Casuarina obesa* mid to low sparse woodland over *Bossiaea eriocarpa* and *Gastrolobium calycinum* and *Hakea lissocarpha* low isolated shrubs over *Neurachne alopecuroidea* and *Lepidosperma tenue* isolated grasses and sedges.	4.5	4.6
EwXpHh	***Eucalyptus wandoo* sparse woodland** *Eucalyptus wandoo* mid sparse woodland over *Xanthorrhoea preissii* mid isolated shrubs over *Hibbertia hypericoides*, *Bossiaea eriocarpa* and *Banksia dallanneyi* low isolated shrubs over *Conostylis setosa*, **Hypochaeris glabra* and *Drosera* spp. isolated herbs.	44.5	45.3
MvJspLs	***Melaleuca viminea* shrubland** *Melaleuca viminea* tall shrubland over *Juncus* spp. and *Isolepis* spp. sparse sedgeland and *Cotula coronopifolia*, *Lotus* spp. and *Utricularia multifida* isolated herbs.	0.1	2.1

Vegetation Association[1]	Description	Extent within Development Envelope (ha)	Extent Mapped by FVC (ha)
Not mapped (not within disturbance footprint)		43.6	43.6
Pasture (with or without trees)		1,732.8	2,750.9
Planted/Plantation		36.1	50.5
Cleared (roads, railway, etc.)		79.5	22.2
Total		**2,552.50**	**3,843.80**

*Weeds are identified using **

The majority of the vegetation associations that were recorded during field surveys have relatively high average species richness values (at least 20-30 taxa per quadrat). BaXpAn (*Banksia* spp. sparse woodland), EwXpHh (*Eucalyptus wandoo* sparse woodland) and EmXpAn (*E. marginata* sparse woodland) were the most floristically diverse vegetation associations, with average species richness values of 42.2, 39.9 and 38.6 taxa respectively. Vegetation association MvJspLs (*Melaleuca viminea* shrubland), which is a wetland vegetation type, had the lowest average species richness with 8.0 species recorded. As the vegetation associations mapped by FVC (2018a, 2018b, 2019) all support at least one Priority flora species, all vegetation associations are considered locally significant.



Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

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

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia

Client

Project

Great Northern Highway
Bindoon Bypass South
Environmental Review Document

Mapped Vegetation Associations

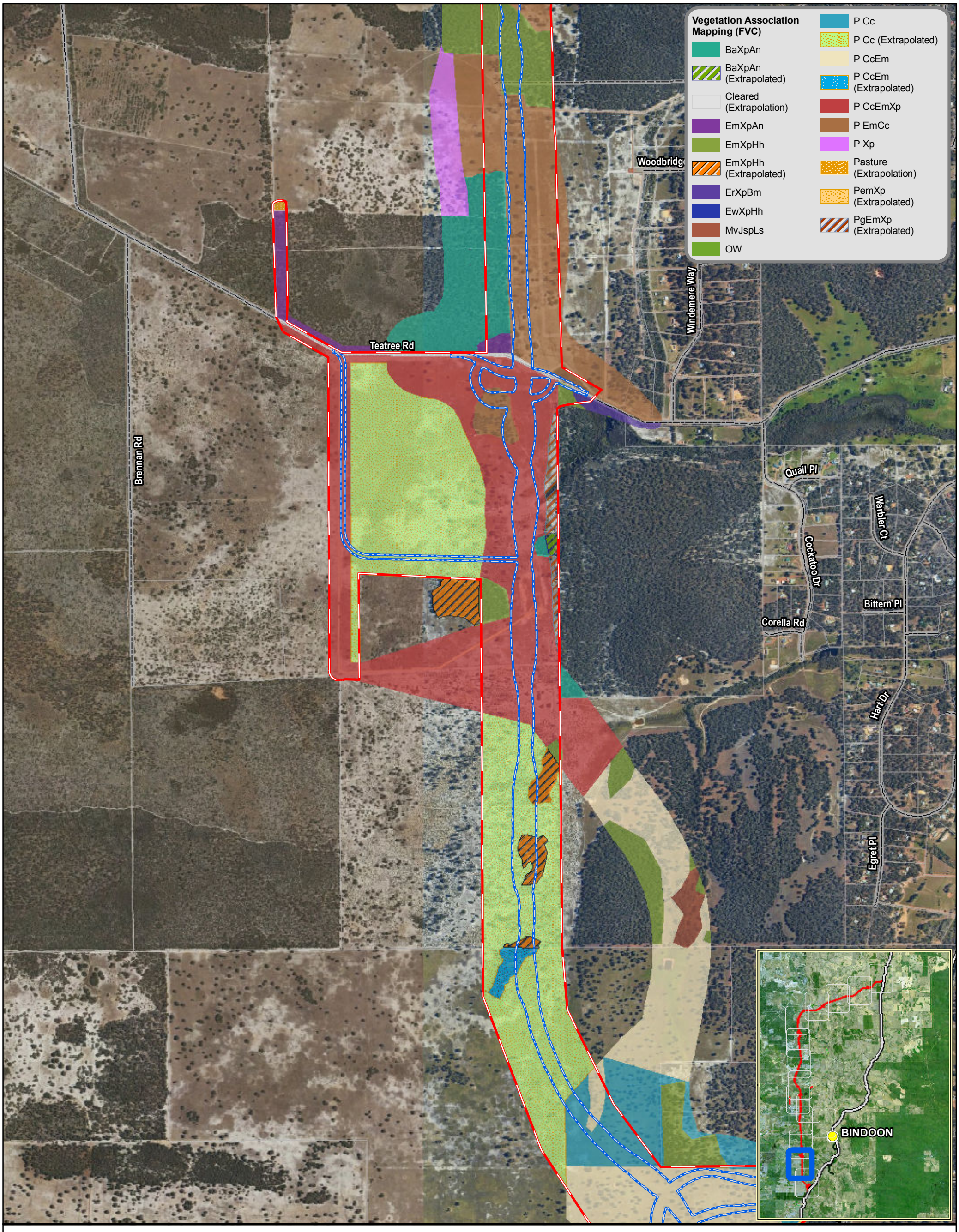
Figure: 4-4 Page: 1 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001-F4-4	1

Task	Drawing Status / Other
EDR	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-F4-2.mxd



Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

Scale at A3 1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass South
Environmental Review Document
Project

Mapped Vegetation Associations

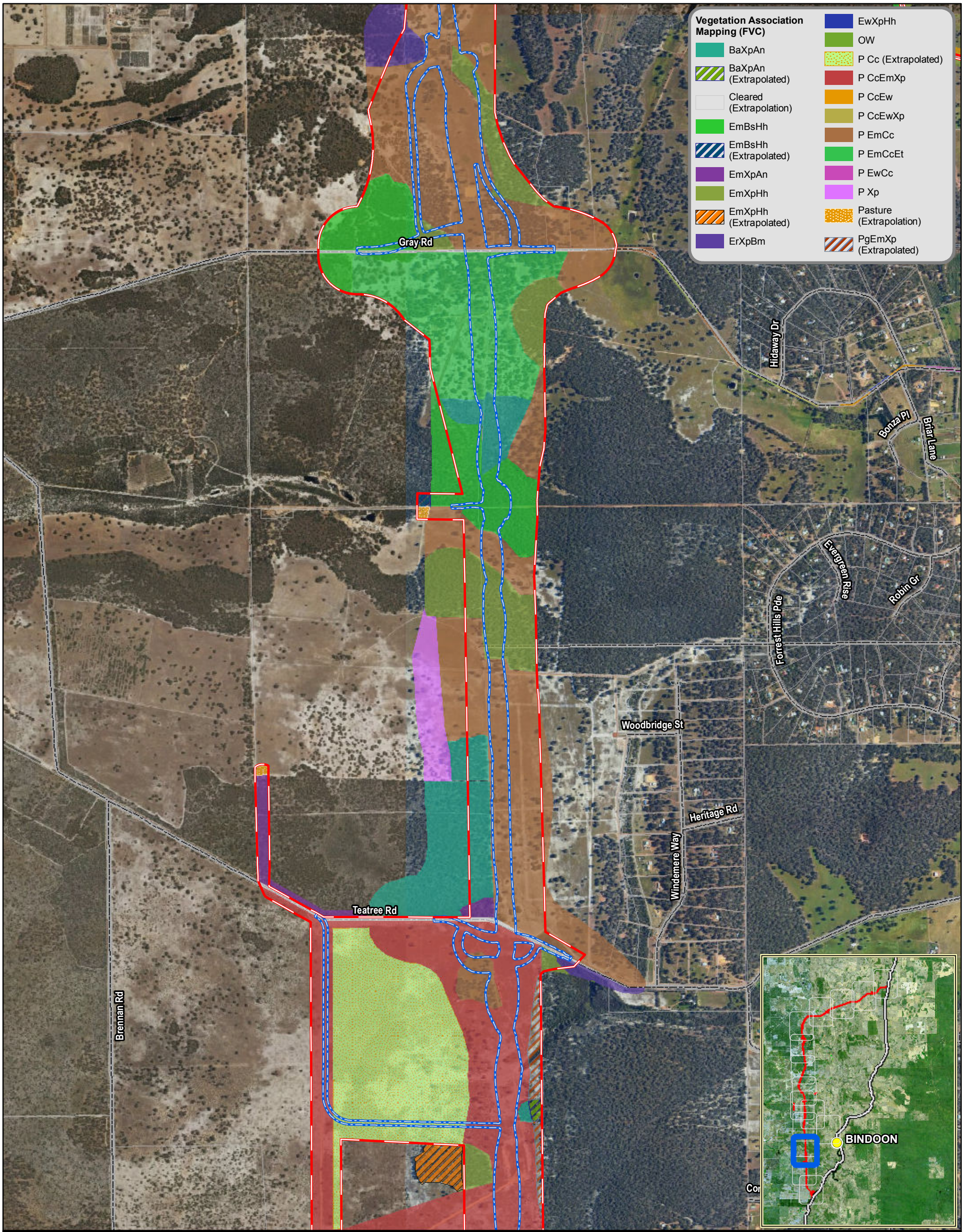
Figure: 4-4 Page: 2 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001-F4-4	1

Task	Drawing Status / Other
EDR	Draft

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

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-2.mxd



Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

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

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Project
Great Northern Highway
Bindoon Bypass South
Environmental Review Document

Mapped Vegetation Associations

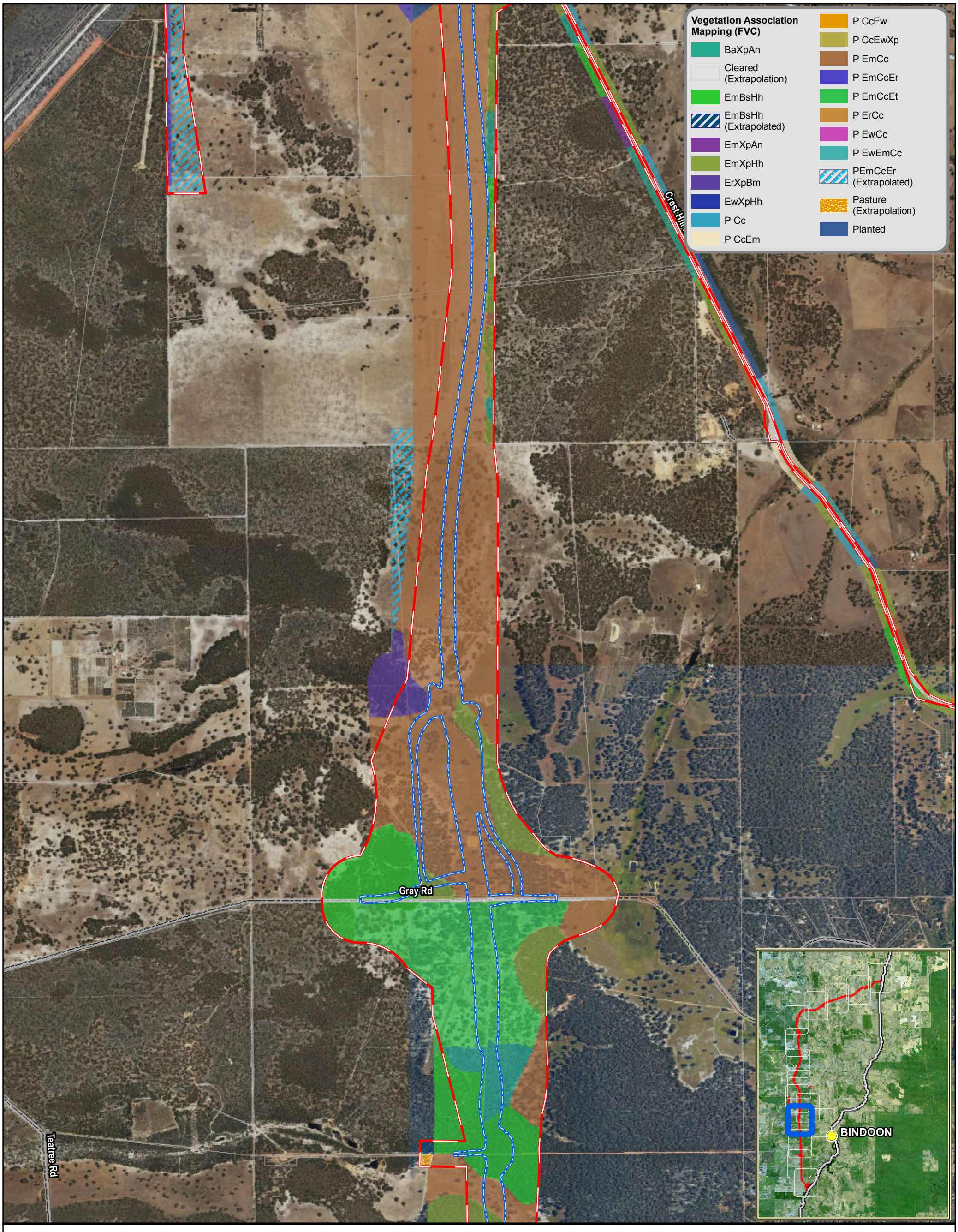
Figure: 4-4 Page: 3 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001-F4-4	1

Task	Drawing Status / Other
EDR	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-F4-2.mxd



Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

Scale at A3
1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia

Client

Project

Great Northern Highway
Bindoon Bypass South
Environmental Review Document

Mapped Vegetation Associations

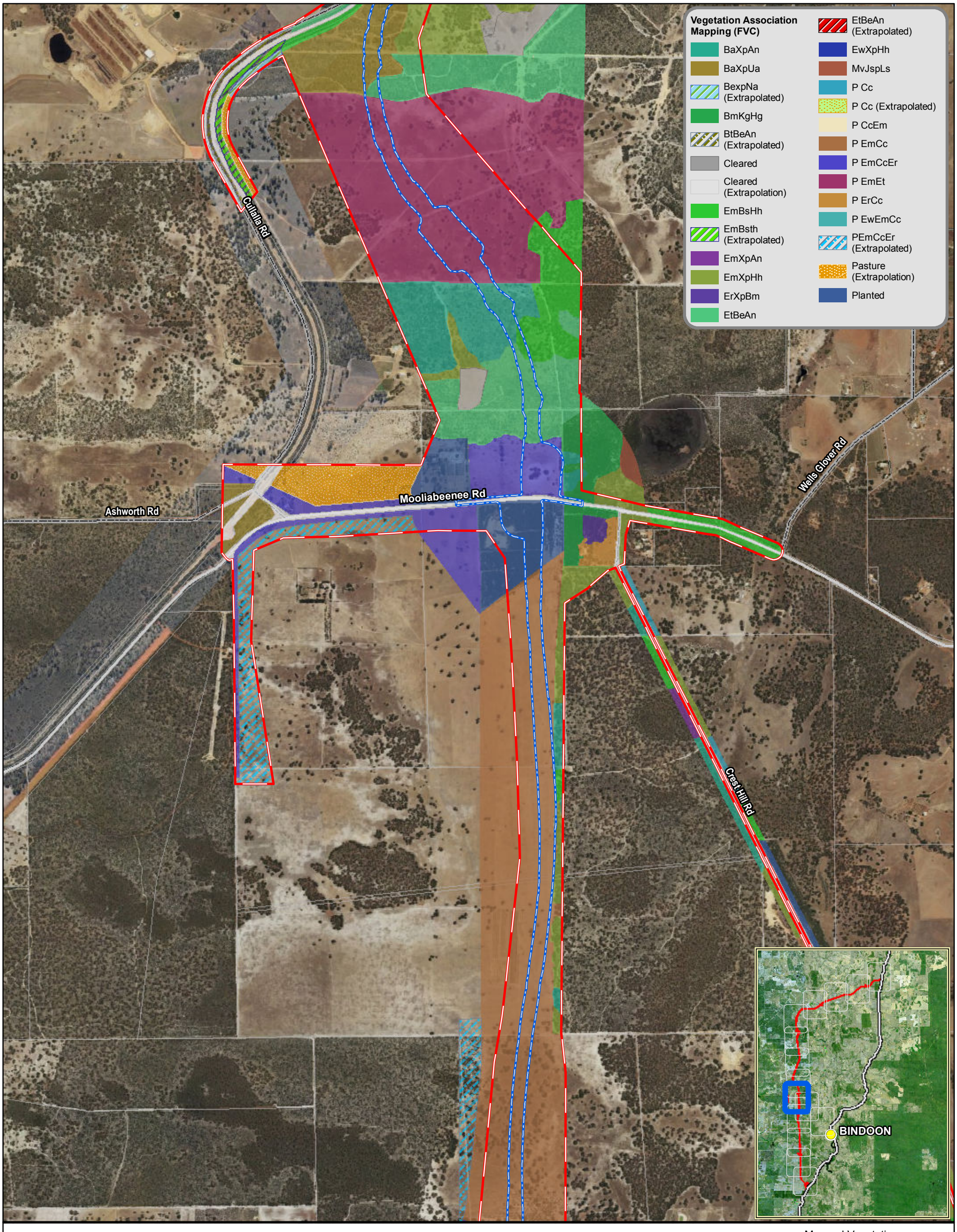
Figure: 4-4 Page: 4 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001-F4-4	1

Task	Drawing Status / Other
EDR	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-F4-2.mxd



Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480 Metres

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

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia

Client

Project

Great Northern Highway
Bindoon Bypass South
Environmental Review Document

Mapped Vegetation Associations

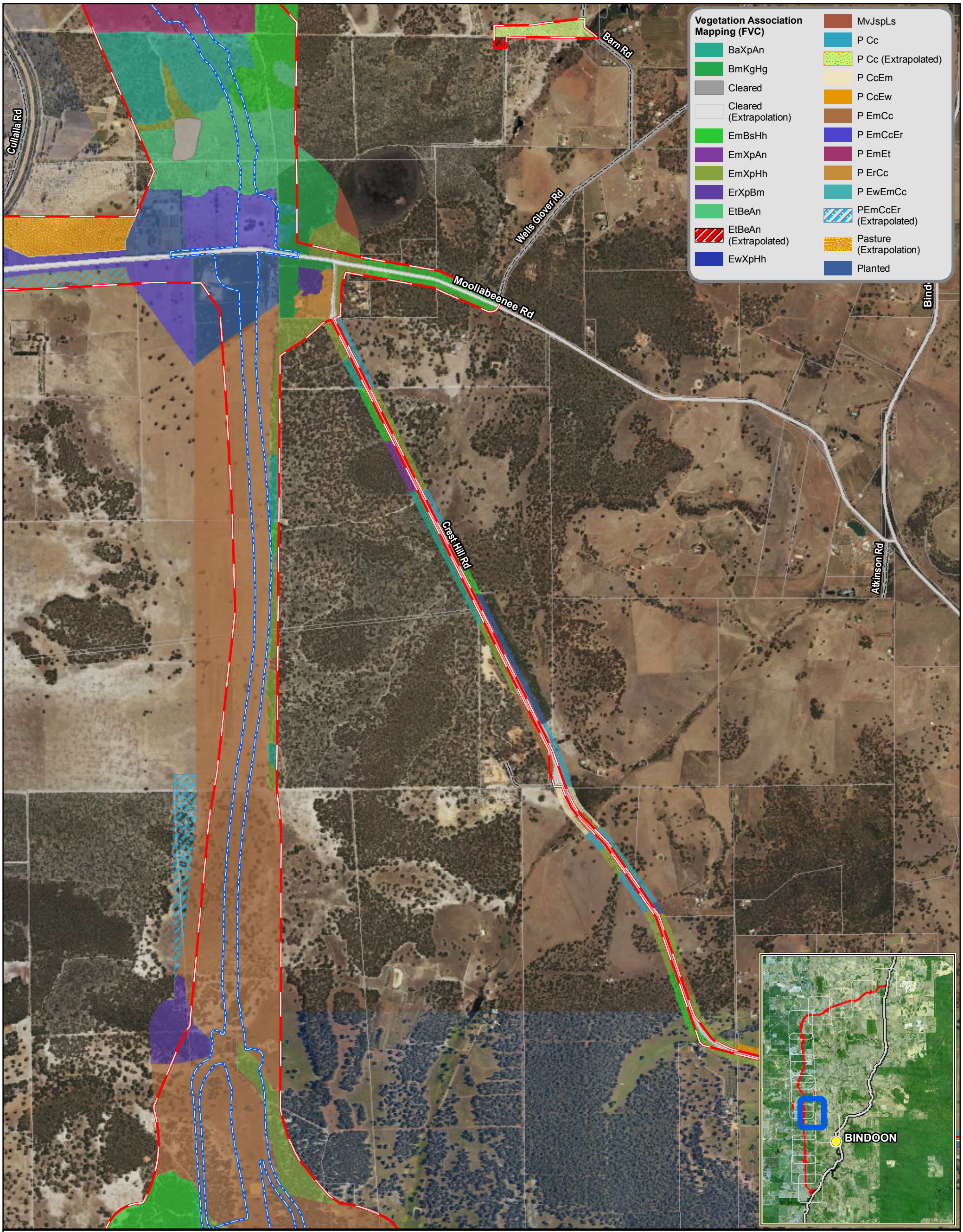
Figure: 4-4 Page: 5 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001-F4-4	1

Task	Drawing Status / Other
EDR	Draft

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

MXD Location: \\Jacobs.com\PERP\projects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-2.mxd



Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

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

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Project
Great Northern Highway
Bindoon Bypass South
Environmental Review Document

Mapped Vegetation Associations

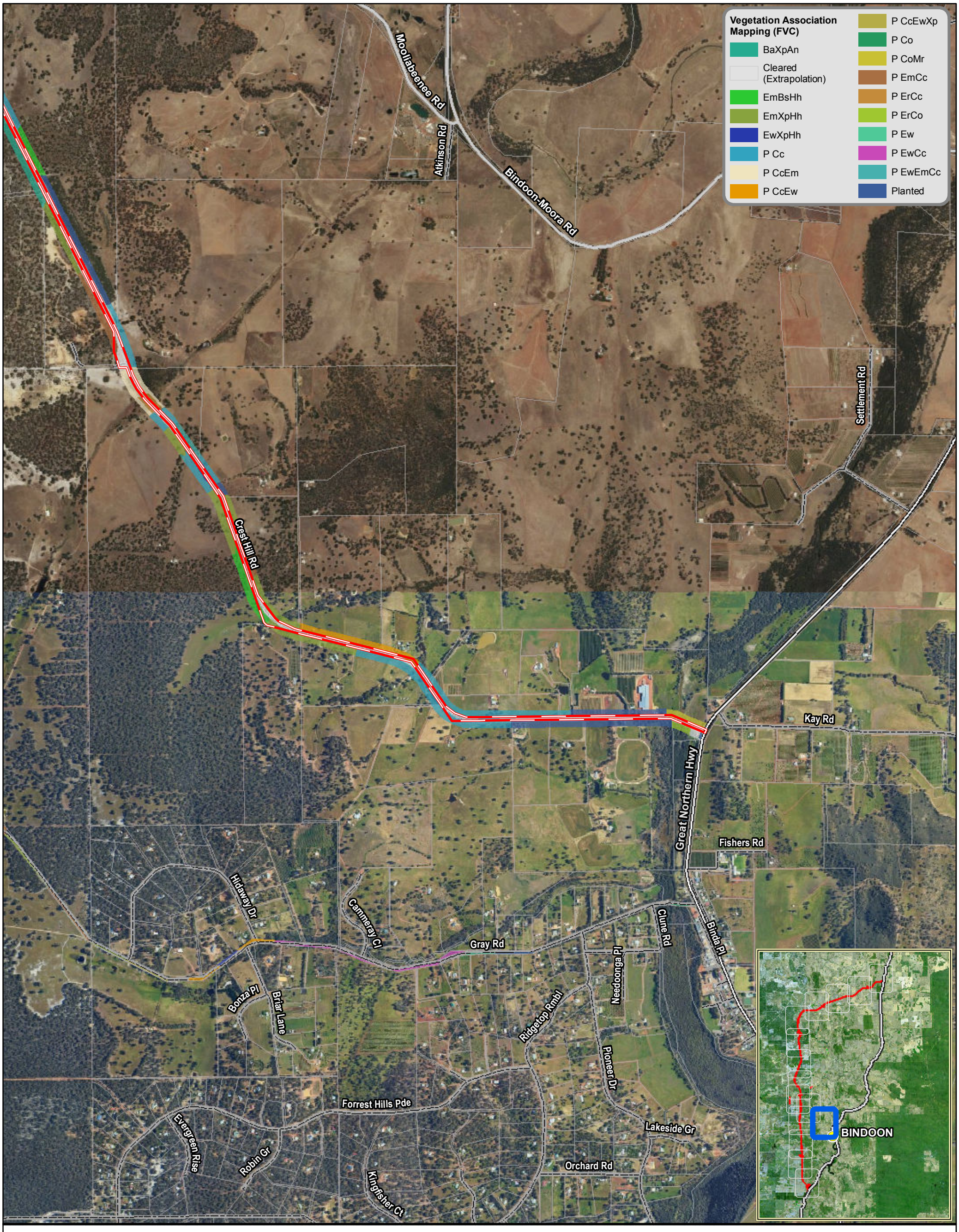
Figure: 4-4 Page: 6 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001-F4-4	1

Task	Drawing Status / Other
EDR	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-F4-2.mxd



Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

Scale at A3 1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass South
Environmental Review Document
Project

Mapped Vegetation Associations

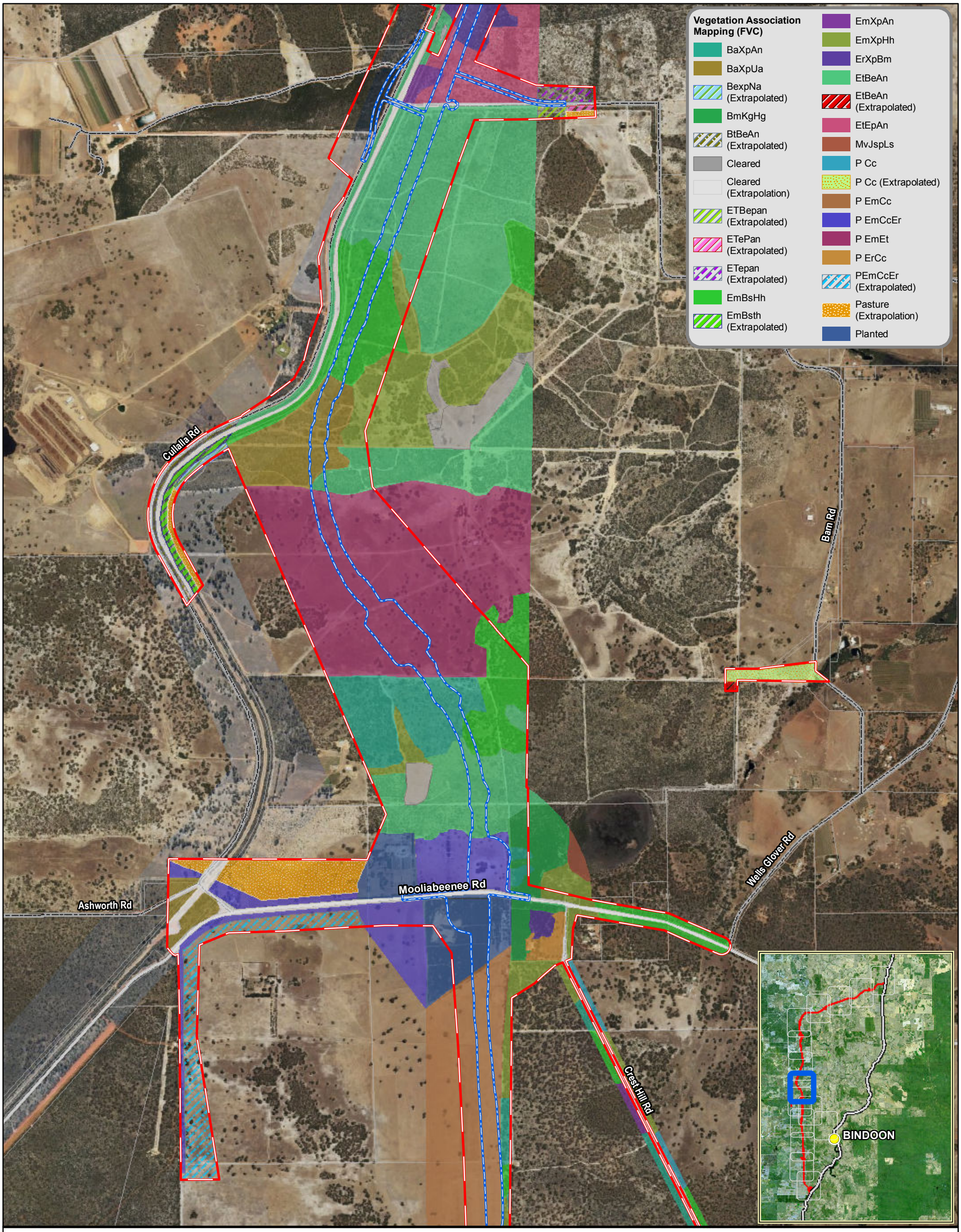
Figure: 4-4 Page: 7 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001-F4-4	1

Task	Drawing Status / Other
EDR	Draft

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

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-2.mxd



Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

Scale at A3 1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass South
Environmental Review Document
Project

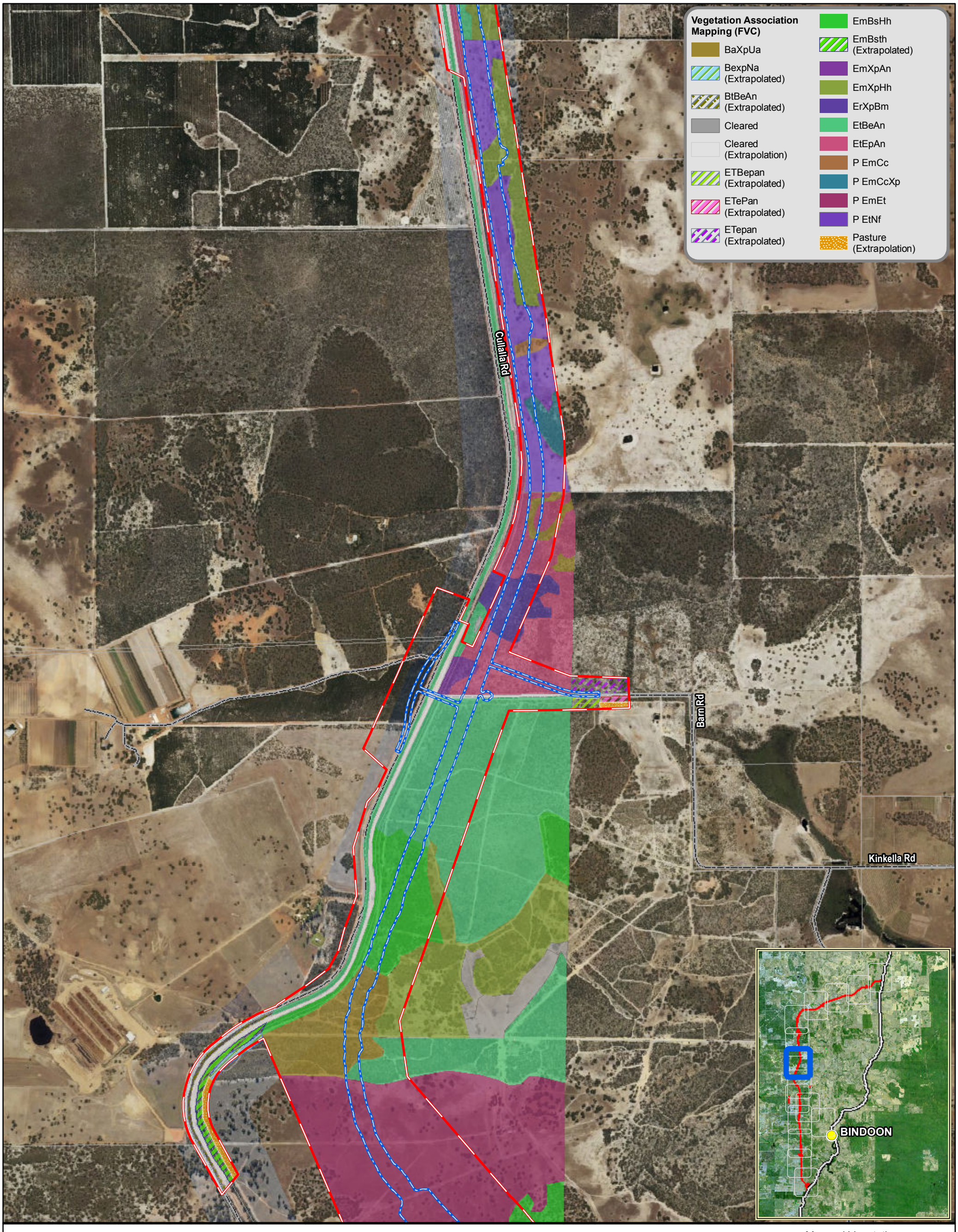
Mapped Vegetation Associations

Figure: 4-4 Page: 8 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001-F4-4	1

Task	Drawing Status / Other
EDR	Draft

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



Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

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

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Project
Great Northern Highway
Bindoon Bypass South
Environmental Review Document

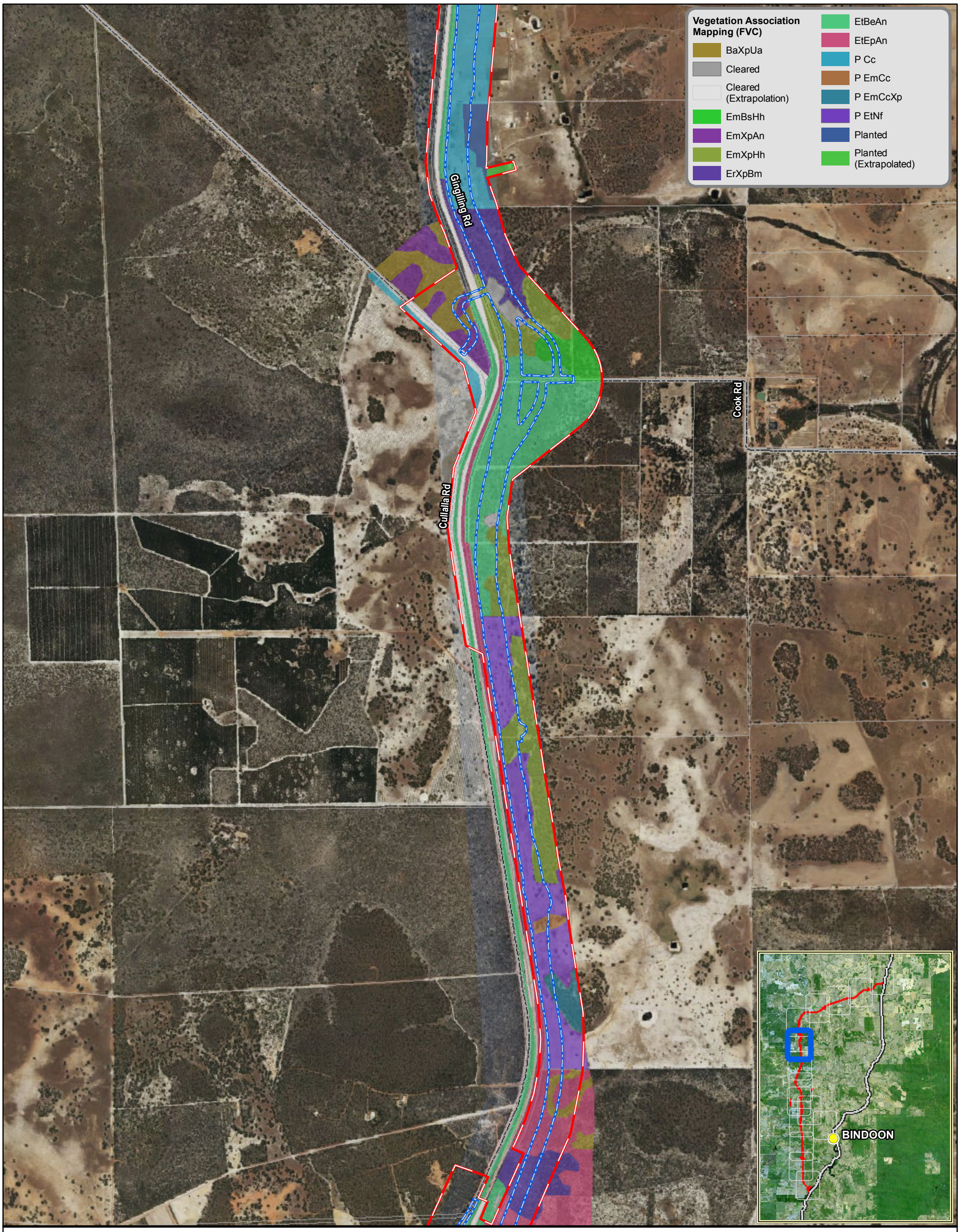
Mapped Vegetation Associations

Figure: 4-4 Page: 9 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001-F4-4	1

Task	Drawing Status / Other
EDR	Draft

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



Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

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

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia

Client

Project

Great Northern Highway
Bindoon Bypass South
Environmental Review Document

Mapped Vegetation Associations

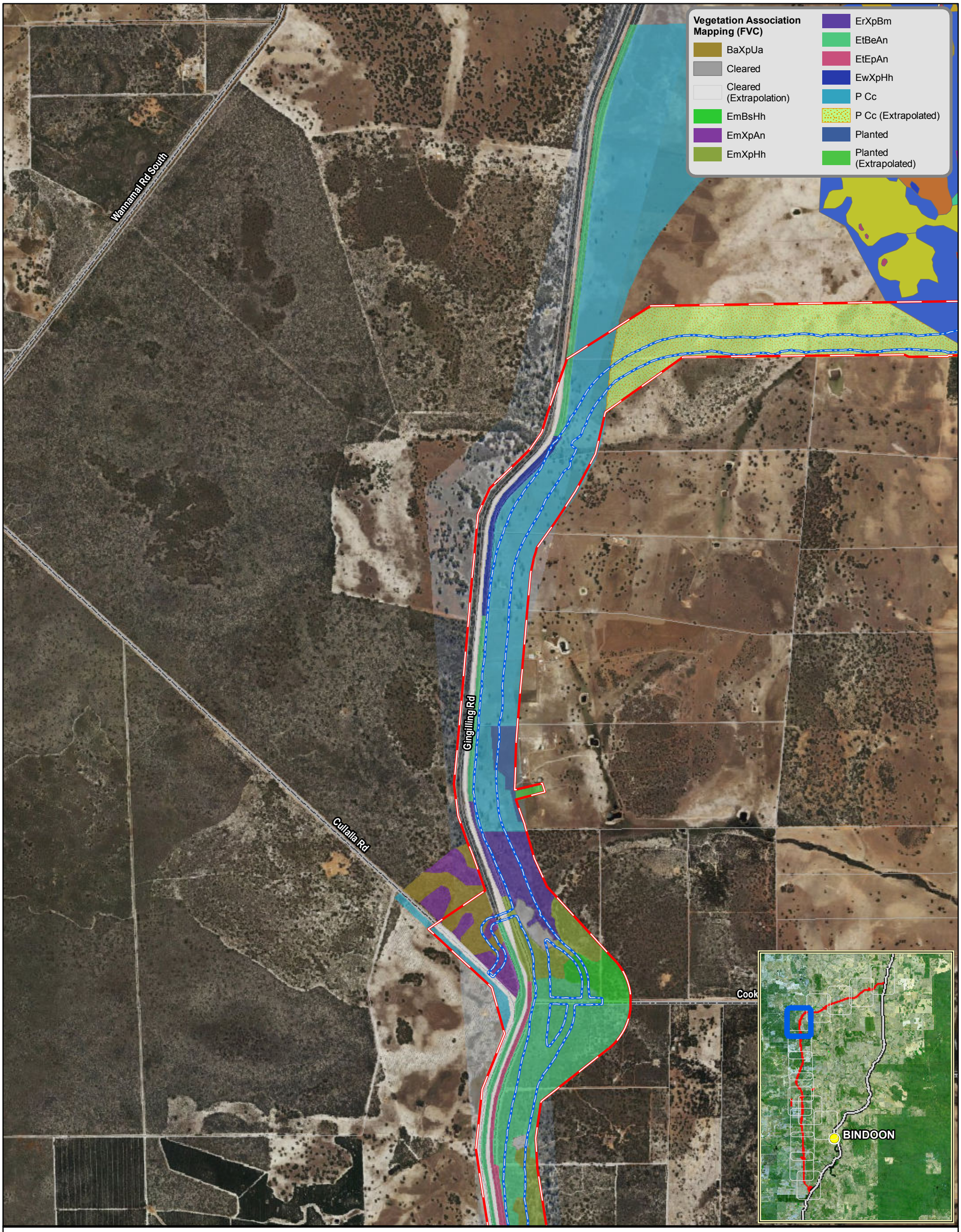
Figure: 4-4 Page: 10 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001-F4-4	1

Task	Drawing Status / Other
EDR	Draft

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

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-2.mxd



Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

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

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia

Client

Project

Great Northern Highway
Bindoon Bypass South
Environmental Review Document

Mapped Vegetation Associations

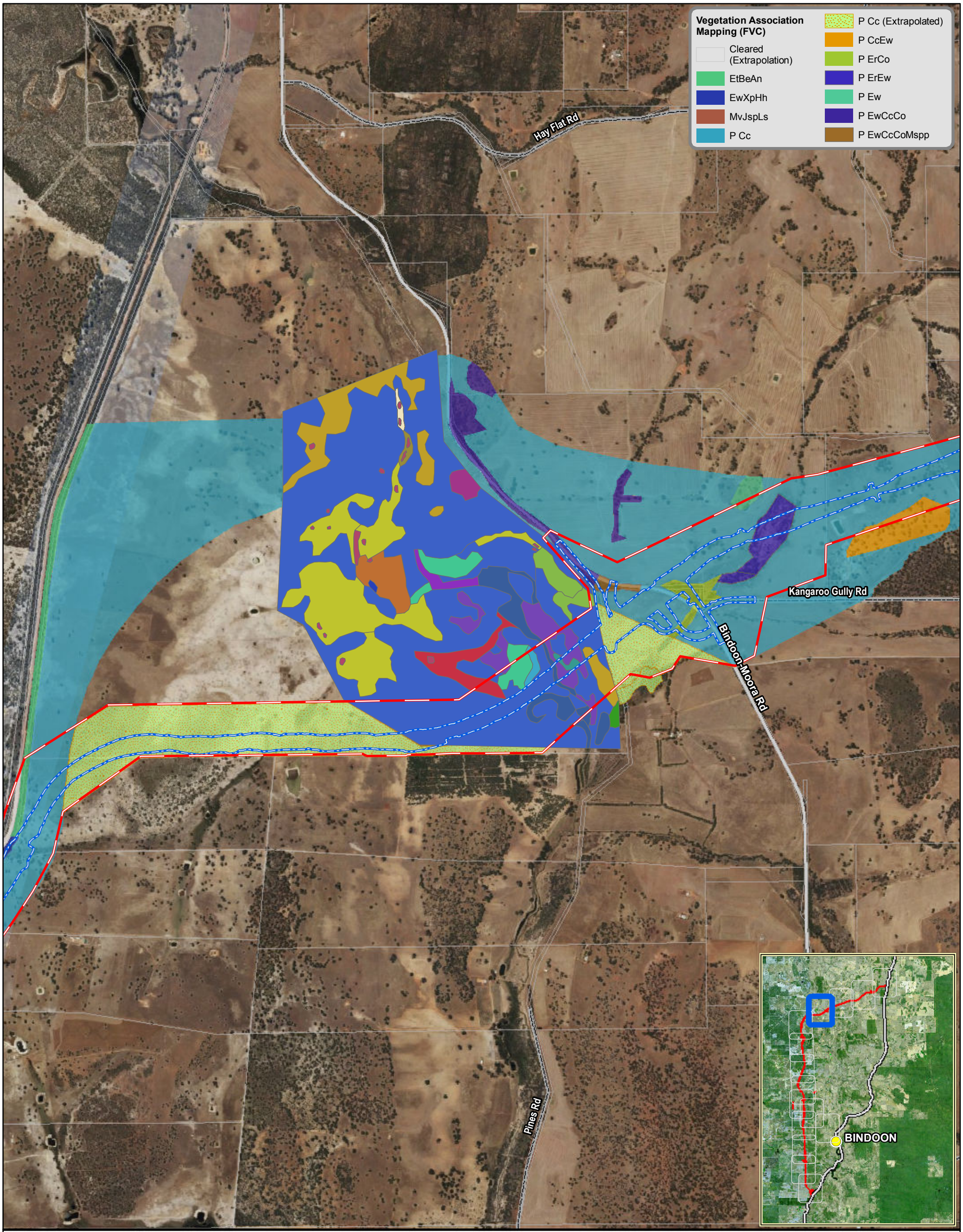
Figure: 4-4 Page: 11 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001-F4-4	1

Task	Drawing Status / Other
EDR	Draft

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

MXD Location: \\Jacobs.com\PERProjects\PBIFI\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\EIRD Figures\GNH-CN12-EA-PER-0001-F4-2.mxd



Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

Scale at A3 1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass South
Environmental Review Document
Project

Mapped Vegetation Associations

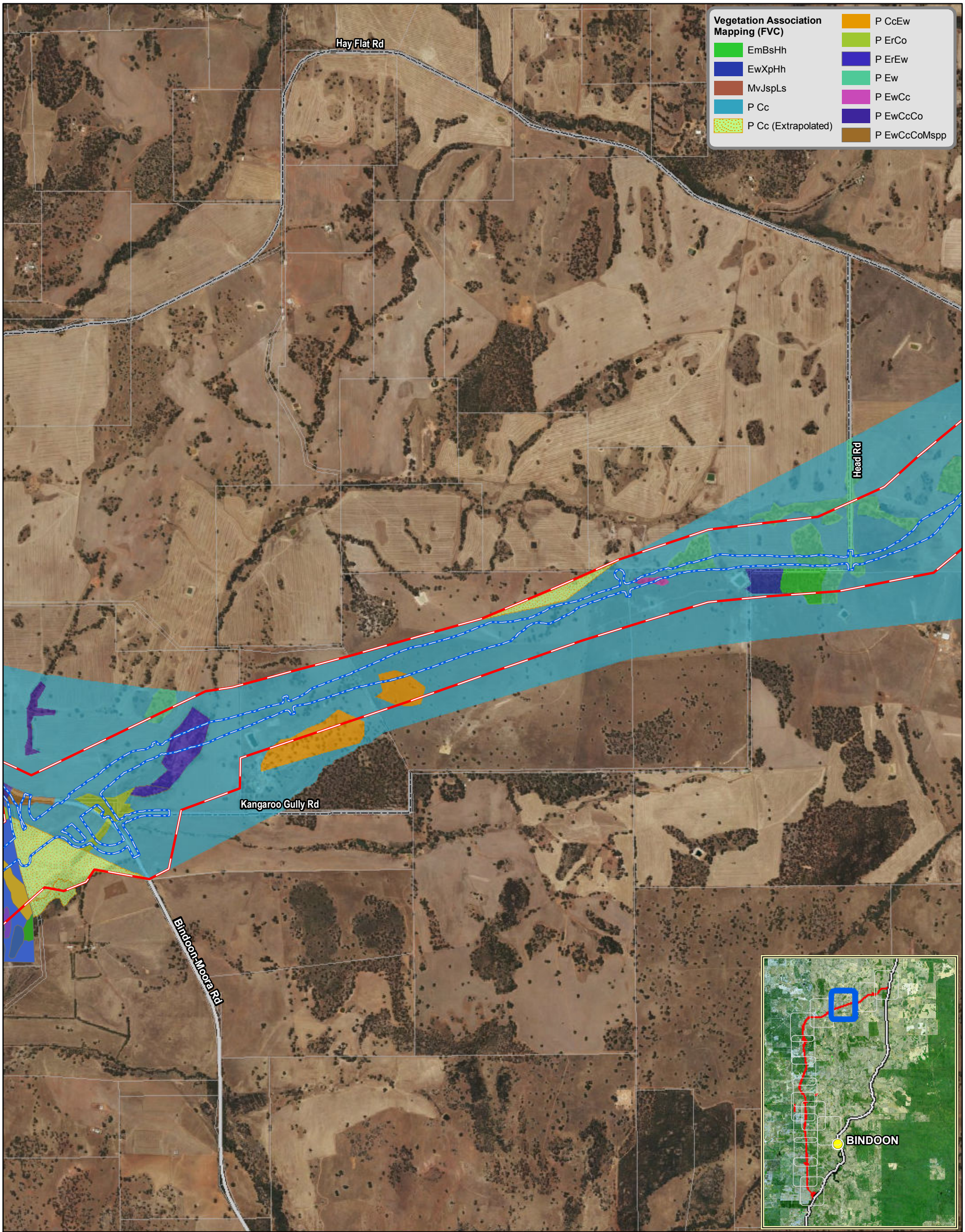
Figure: 4-4 Page: 12 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001-F4-4	1

Task	Drawing Status / Other
EDR	Draft

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

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-2.mxd



Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

Scale at A3
1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Project
Great Northern Highway
Bindoon Bypass South
Environmental Review Document

Mapped Vegetation Associations

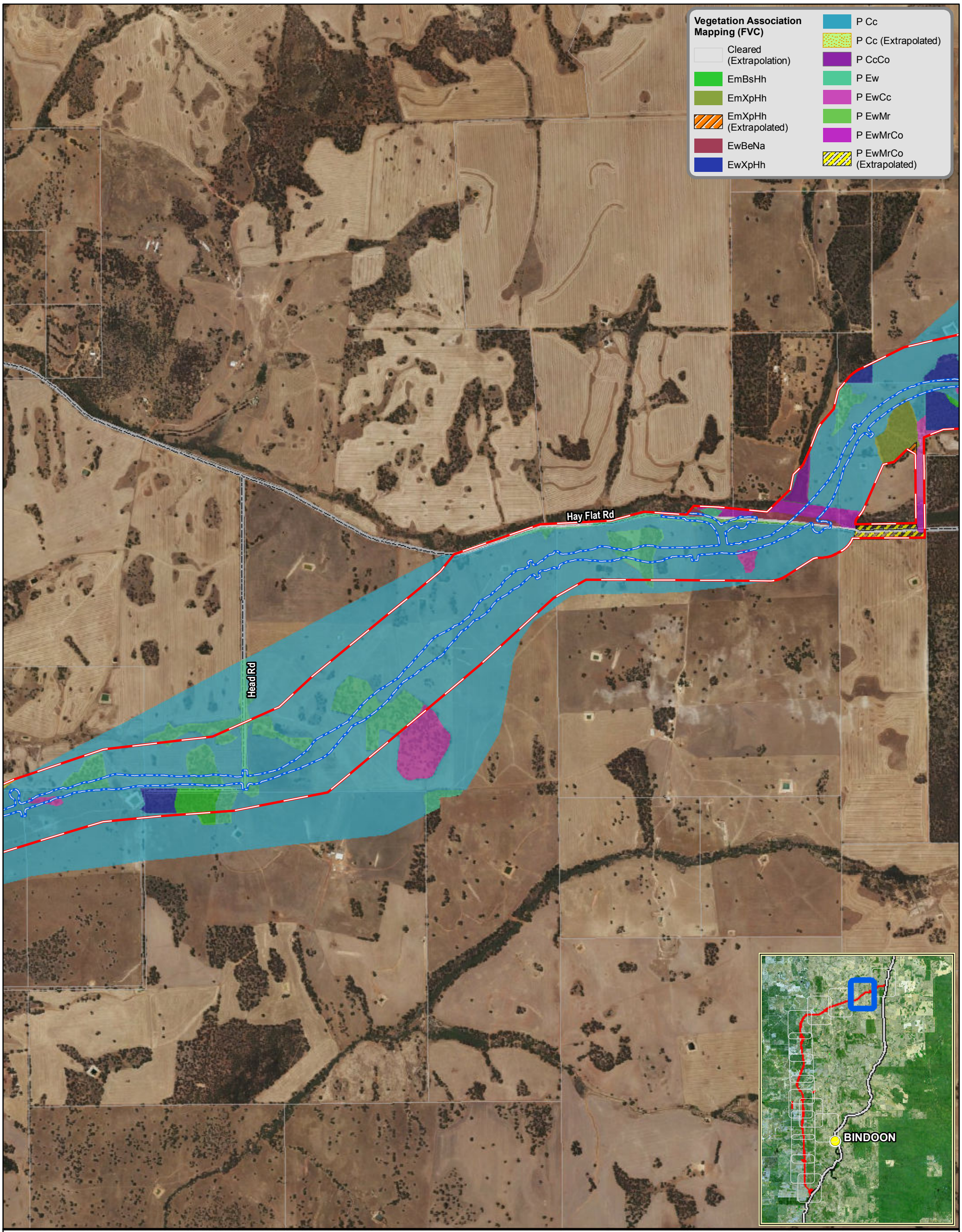
Figure: 4-4 Page: 13 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001-F4-4	1

Task	Drawing Status / Other
EDR	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-F4-2.mxd



Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

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

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Project
Great Northern Highway
Bindoon Bypass South
Environmental Review Document

Mapped Vegetation Associations

Figure: 4-4 Page: 14 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001-F4-4	1

Task	Drawing Status / Other
EDR	Draft

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

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-2.mxd

Vegetation Association Mapping (FVC)

- Cleared (Extrapolation)
- EmBsHh
- EmXpHh
- EmXpHh (Extrapolated)
- EwBeNa
- EwXpHh
- P Cc
- P Cc (Extrapolated)
- P CcCo
- P Ew
- P EwCc
- P EwMr
- P EwMrCo
- P EwMrCo (Extrapolated)
- PgEmXp (Extrapolated)

Calingiri Rd

Great Northern Hwy

Hay Flat Rd

BINDOON

Legend

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

Joint Venture Partners:

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

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 240 480
Metres

Scale at A3 1:20,000

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Bindoon Bypass South
Environmental Review Document
Project

Mapped Vegetation Associations

Figure: 4-4 Page: 15 of 15

Drawing No	Issue
GNH-CN12-EA-PER-00001-F4-4	1

Task	Drawing Status / Other
EDR	Draft

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

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN12\ERD Figures\GNH-CN12-EA-PER-0001-F4-2.mxd

Vegetation Condition

Field surveys also established the quality of the vegetation within the study area. Vegetation condition ranges from Completely Degraded to Excellent, with the majority of the study area being Completely Degraded to Degraded due to the large amount of cleared land and pasture (**Figure 4-5**). Whilst cleared land and pasture do support occasional trees or stands of trees, the absence of understorey reduces the quality of the vegetation and the value that the vegetation presents as habitat for native fauna. **Table 4-5** provides a summary of the condition of vegetation within the Development Envelope, including areas mapped as paddock, while **Table 4-6** details the condition by vegetation association and does not include areas mapped as paddock.

Table 4-5: Vegetation Quality of the Development Envelope

Vegetation Condition Rating	Area Mapped by FVC (ha)	Total in Development Envelope (ha)	Proportion of Development Envelope (%)
Completely Degraded	83.8	126.6	5.0%
Completely Degraded - Degraded	2,758.7	1,727.00	68.8%
Degraded	61.3	28.5	1.1%
Degraded - Good	70.0	34.4	1.4%
Good	85.1	64	2.5%
Good – Very Good	88.2	143.5	5.7%
Very Good	241.5	168.1	6.7%
Very Good – Excellent	228.4	134	5.3%
Excellent	106.9	84.4	3.4%
Total	**3,723.9**	**2,510.50**	**100.0%**

Table 4-6: Condition of Vegetation within the Development Envelope

Vegetation Association	Vegetation Condition (ha)							Total (ha)
	Degraded	Degraded - Good	Good	Good – Very Good	Very Good	Very Good - Excellent	Excellent	
BaXpAn	3.0	0.0	0.1	2.5	16.1	2.8	36.5	**61.0**
BaXpUa	0.0	14.1	0.0	18.7	3.4	5.6	0.0	**41.7**
BmKgHg	0.2	0.0	0.0	0.0	0.0	4.3	4.0	**8.6**
EmBsHh	0.3	7.6	6.4	17.0	45.6	21.4	18.2	**116.5**
EmXpAn	0.0	0.0	0.0	0.6	0.0	12.8	0.0	**13.4**
EmXpHh	7.0	7.4	25.2	21.1	54.5	11.7	0.0	**127.0**
ErXpBm	5.3	4.0	17.3	0.0	5.1	4.0	0.0	**35.8**
EtBeAn	0.0	0.5	0.0	60.2	13.4	52.5	25.7	**152.2**
EtEpAn	0.0	0.0	0.0	0.0	25.6	13.6	0.0	**39.2**
EwBeNa	0.6	0.0	0.0	3.5	0.4	0.0	0.0	**4.5**
EwXpHh	0.0	0.8	15.1	19.9	3.9	5.3	0.0	**45.0**
MvJspLs	0.1	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
Total	**16.6**	**34.4**	**64.0**	**143.5**	**168.1**	**134.0**	**84.4**	**644.9**