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REVIEW

Significance Determination of Best Practices in the Perth-Darwin National Highway (Swan Valley Section), Western Australia

Priya Khangotra

School of Science, Edith Cowan University, Western Australia, Australia.

Correspondence and requests for materials should be addressed to PK (email: khangotra97priya@gmail.com)

Abstract

Environmental Impact Assessment (EIA) is a process to determine, allocate, and inter-communicate the most significant impacts of a developed project related to the environment hereby, environmental significance as a concept is at the heart of discretionary decision-making in the process of EIA. This review paper aims to analyze how significance is addressed to the Perth-Darwin National Highway project as well as to mitigate the environmental impacts by applying best practice criteria of significance determination. Further, various surveys were conducted to investigate the potential impacts on species in flora and fauna environmental factors.

Keywords: Environment; Impact; Assessment; Australia; EIA; Vegetation

Introduction

Environmental Impact Assessment (EIA) was first proposed in the USA under the Environmental Policy Act (1969). EIA is a process applied to investigate the environmental impacts to watch out pros and cons, of a developed program or project to assure that these consequences are taken into consideration in the project plan (Mugabo et al., 2017). The environmental key factors such as flora and fauna, inland waters, and surroundings have been affected by various human activities including projects or programs started for global development. Therefore, the Environmental Protection Act (EPA) recommended that an EIA should be used for programs that have potential environmental effects. The word "significance" is described many times in EIA but no clear definition has been found yet, even in the Environmental Protection Act 1986 (EP Act) of Western Australia (WA) (EPA, 2020; Morrison-Saunders, 2018). It has been examined that different people define it in different ways. Therefore, it leads to conflict for significance in the EIA process (Lawrence, 2007; Wood, 2008; Jones & Morrison-Saunders, 2016). Significance determination is one of the most vital decisions throughout the EIA process (Ehrlich and Ross, 2015).

Perth-Darwin National Highway (PDNH) (Swan Valley Section)

The Perth-Darwin National Highway (PDNH) will elevate transport capacities between the Perth metropolitan area, Northwest WA, and the Northern Territory (MRWA, 2012a). It draws a significant connection between the State and National Road networks. In 2012, MRWA organized a strategic road network assessment to endorse the route alliance and network arrangement for the PDNH between Reid Highway and Maralla Road (MRWA, 2012b). This assessment evaluated various limitations for the region which include environmental, social, heritage and land use, and strategic planning considerations also. The EPA demonstrated environmental schemes for every significant environmental factor (such as Flora and Vegetation, Terrestrial Fauna, Hydrological Processes, and Inland Waters Environmental Quality, Amenity – Noise and Vibration, Rehabilitation and Decommissioning and Offsets), and referred in Environmental Assessment Guideline 8 – Environmental Factors and Objectives (EAG 8) (EPA, 2015a). The EPA Environmental Assessment Guideline 9 – Application of a Significance Framework in the Environmental Impact Assessment (EIA) Process (EAG 9) (EPA, 2015b) represented the usage of the guideline by the EPA in depicting the importance of a proposal in the whole EIA process, also this significance pattern applied to the determination of every significant environmental factor.

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Best practice component of significance determination

Even though various criteria delineated in EIA literature, no agreement has been reached on the most efficacious measurements to identify impact significance (Lawrence, 2007a). On the basis of a literature review, two best practice criteria for significance determination have been found which included extent (magnitude) of likely impact and sensitivity of the environment that is likely to be impacted. The extent represented magnitude, intensity and the duration of estimated effect on the receiving environment due to the proposed project (European Commission, 2017, p.49). When considering the significance of potential impact, the EPA may consider the extent of the likely impacts (EIA Proc Manual, 2020, s2.3.1; EP Act, s39A (7)). Significance determination depends on the sensitivity of receiving environment to a large extent (Government Gazette, 2012, 57; Wood, 2008; Lawrence, 2007a). "Sensitivity is understandable as the sensitivity of the environmental receptor to alteration, also its efficiency to accommodate the variations the proposal may bring about" (European Commission, 2017, p.49).

Flora and vegetation

According to Section 4, 4.1 and 4.2 of the Technical Guide (Flora and Vegetation for EIA), the proponent set the three kinds of flora and vegetation survey to analyze the extent of potential impact on flora and vegetation. The environmental aim of EPA for flora and vegetation factor is to retain representation, diversity, viability and ecological function at the species, population and community level (EPA, 2015a). The determination of effects for this factor has been assigned in the reference of the Swan Coastal Plain Region of the Interim Biogeographic Regionalization of Australia (IBRA). Additionally, the EPA examined these effects at a subregional level, also applied the governmental extremities of the Perth-Peel Region (PPR). However, this is relevant to PS 3 and GS 51 positions (EPA, 2002; EPA, 2004a). The project has both the direct and indirect effects on the factor (former, by the alienated of more than 206 ha of connatural flora and later, by introducing or disperse of weeds and dieback, and surface and groundwater outflow impacts throughout construction and operation. To attenuate the impacts on native vegetation, the proponent evaluated methods and used the mitigation hierarchy.

Potential impacts on vegetation complexes

However, the major part of the proposal region where clearance of entire connatural vegetation occurs, falls within the Swan Coastal Plain area of the Perth Metropolitan Region that is Bush Forever Study Area, where five vegetation complexes were discovered (Figure 1). The objective of the Bush Forever Strategy was to conserve vegetation complexes (at least 10% of each native 26) of the SCP part of the Perth Metropolitan Region (PMR) (Government of Western Australia, 2000b) (Table 1).

Table 1. Vegetation complexes impacted by the proposal within the Swan Coastal Plain portion of the Perth Metropolitan Region.

Vegetation Complex	Extent of intact native vegetation to be removed by the proposal (ha)	Pre-European extent remaining after the proposal (%) and (%) loss)	Extent in secure conservation tenure (%)
Bassendean Complex Central and South	62.1	21.2 (0.1 %)	1.4
Southern River Complex	44.8	14.2 (0.1%)	0.7
Yanga Complex	12.5	13.2 (0.2%)	4.3
Bassendean Complex North-Transition Vegetation Complex	19.2	64.7 (0.6%)	23.9
Bassendean Complex North	73.4	50.9 (0.3%)	3.0

At presently, 290 Bush Forever Sites forming around 51,200 ha of regional significance bushland. However, 14 Bush Forever Sites situated within or adjacent to the proposal (within 1 Km), 9 and 5 (within 1 Km) sites located within the proposal footprint. The Yanga Vegetation Complex affected by the proposal which is surrounded by the Bush Forever Study Area, is nearby 10 percent target with 13.2 percent rest. In results of the proposal, there would be removal of 12.5 ha or 0.2 percent of rest of the Swan Coastal Plain extent. The EPA demonstrated the cumulative loss of the same vegetation complex, and considered as a significant remaining affect. Moreover, according to the current policies and with the WA Environmental Offsets Guideline, the EPA examined that an offset is expected to balance the loss of 5.5 ha Yanga Complex outside the Swan Coastal Plain area of the Perth Metropolitan Region (Government of WA, 2014).

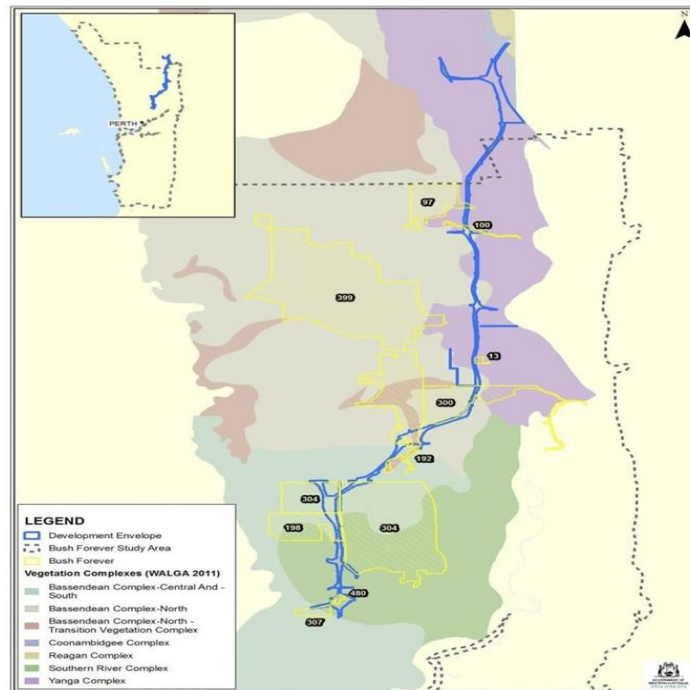


Fig. 1. Vegetation Complexes within Bush Forever areas.

Significant impact of the proposal on species (*Millotia tenuifolia* var. *laevis* and *Meeboldina decipiens* subsp. *decipiens* ms)

Five species of prior flora of the proposal have been found through the vegetation surveys. It has been analyzed that the proposal would have less impact on the three species (<0.2%), 18.8 percent of the studied extent of an initial 2 species *Millotia tenuifolia* var. *laevis* and 50 percent of 3 species *Meeboldina decipiens* subsp. *decipiens* ms (Table 2). To ratify the impact significance, the additional spring surveys deduced that the impact to the *Millotia tenuifolia* var. *laevis* is presently not reckoned significant at a local or regional scale whereas it has been examined that *Meeboldina decipiens* subsp. *Decipiens* ms was identified incorrectly in the initial surveys and not detected in the development envelope. In addition to this, The EPA considers that SPP 2.8 Bushland Policy for the Perth Metropolitan Region (WAPC, 2010) gives guidelines and criteria for decision making associated to regional significance Bushland recognized in Bush Forever.

Terrestrial Fauna

The EPA reckoned the terrestrial fauna effects at a sub-regional level and has applied the administrative boundaries of the Perth-Peel Region (PPR), with the guidance in PS 3 and GS 56 (EPA, 2002; EPA, 2004b). The exploration for terrestrial fauna organized in the year 2014 (Coffey, 2015b) and constructed on former surveys (360 Environmental, 2013 and GHD, 2013c). The survey in 2014, enclosed an area of around 1,028.4 ha, named as the 'fauna study area', and just about coequal to the development envelope. Therefore, the correlation of the fauna study area, development envelope and the proposal fingerprint has been presented in figure 2.

Table 2. Local and regional impacts on threatened and priority flora. Source: Coffey (2015a) (Appendix C).

Species	Conservation status	Total number of known populations	Number of populations known within the study area	Number of populations to be impacted within the proposal footprint	Proportion of population to be impacted (%)	Total minimum number of known individuals
<i>Sps.1*</i>	P ₂	12	4	2	16.7	16
<i>Sps.2*</i>	P ₃	12	2	2	16.7	22

**Sps.1*, *Millotia tenuifolia* var. *laevis* *Sps.2*, *Meeboldina decipiens* subsp. *Decipiens* ms

Analysis of potential impacts on the Fauna Study Area via surveys (Methodology)

The proposal has both direct and indirect effects on terrestrial fauna. The proponent organized surveys for the fauna study area that had direct or indirect significant effects by the proposal (EPA, 2014c) (Table 3). In the first level of survey, analysis of habitat involved and the investigation organized within the fauna study area. The objective of this survey was to examine consistency significant fauna by evaluating and mapping the habitats of present fauna and record the fauna species present within this study area. On contrary, in the second level of survey, trapping program organized in considerable fauna areas which includes Whiteman Park/ Cullacabardee Bushland and Maralla Road Bushland. These locations investigated in the ESD where the movement of fauna effected (EPA, 2014a). The objective of trapping program was to analyze species that mainly occurred in mentioned areas instead of a systematic trapping program in which the whole fauna study area involved. Therefore, the survey methodology applied was accepted by DPAW and EPA for the project.

Habitation of Black Cockatoo

To investigate fresh animal locations and types of fauna movement corridors, a fauna movement exploration was organized at Maralla Road Bushland and Whiteman Park/ Cullacabardee Bushland. By using ARC GIS Hot Spot investigation, the findings showed that there were ground dwelling native species recorded only. Evenmore, level 1 fauna and a Black Cockatoo habitat analysis were organized in these mentioned regions (Coffey, 2015c). In proposal footprint, four natural habitats of fauna were discovered which includes Banksia Woodland, Eucalypt/Corymbia Woodland, Dampland and Wetland habitats. On the basis of existing landforms, the fauna significance and vegetation mapping from the flora survey, these habitats were determined (Coffey, 2015a). Even then, the secondary fauna habitats consisted three categories named as Modified Vegetation, Paddock and Pine Plantation (Figure 2 and Table 3). The tiny variations examined between the fauna habitat mapping and the vegetation community categories (section 8.2) as mapping examined at a various scale (magnitude). The whole area of natural fauna habitats (159.3 ha) considered as an approximately equivalent to the proposal footprint (21.4%). Notwithstanding that the secondary habitats not supported the entire fauna assortment as they distributed moderate habitat to few species. Therefore, the whole area of secondary fauna habitats (514.9 ha) classified as an almost coequal to the proposal footprint (69%) whereas cleared areas or infrastructure (71.5 ha) considered as an approximately equal to the proposal footprint (9.6%). To avert and reduce the effects to natural habitat of fauna, the proponent formulated the proposal to adhere currently infrastructure and alienated or insignificant regions (MRWA, 2015).

Evaluation of Black Cockatoo habitat quality in specific habitats and their correlation with each other

According to the distribution maps in the EPBC Act Referral Guidelines for the Three Threatened Black Cockatoo Species (DSEWPAC, 2012c), two out of three Black Cockatoo species estimated to present in

the proposal footprint and these Black Cockatoos named as Carnaby's Cockatoo (*Calyptorhynchus latirostris*) and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*). The proposal footprint was evaluated to investigate the Black Cockatoo habitat quality in specific foraging, roosting and breeding habitat (Figure 3 and Table 4), also, the mentioned particular habitats correlated with each other.

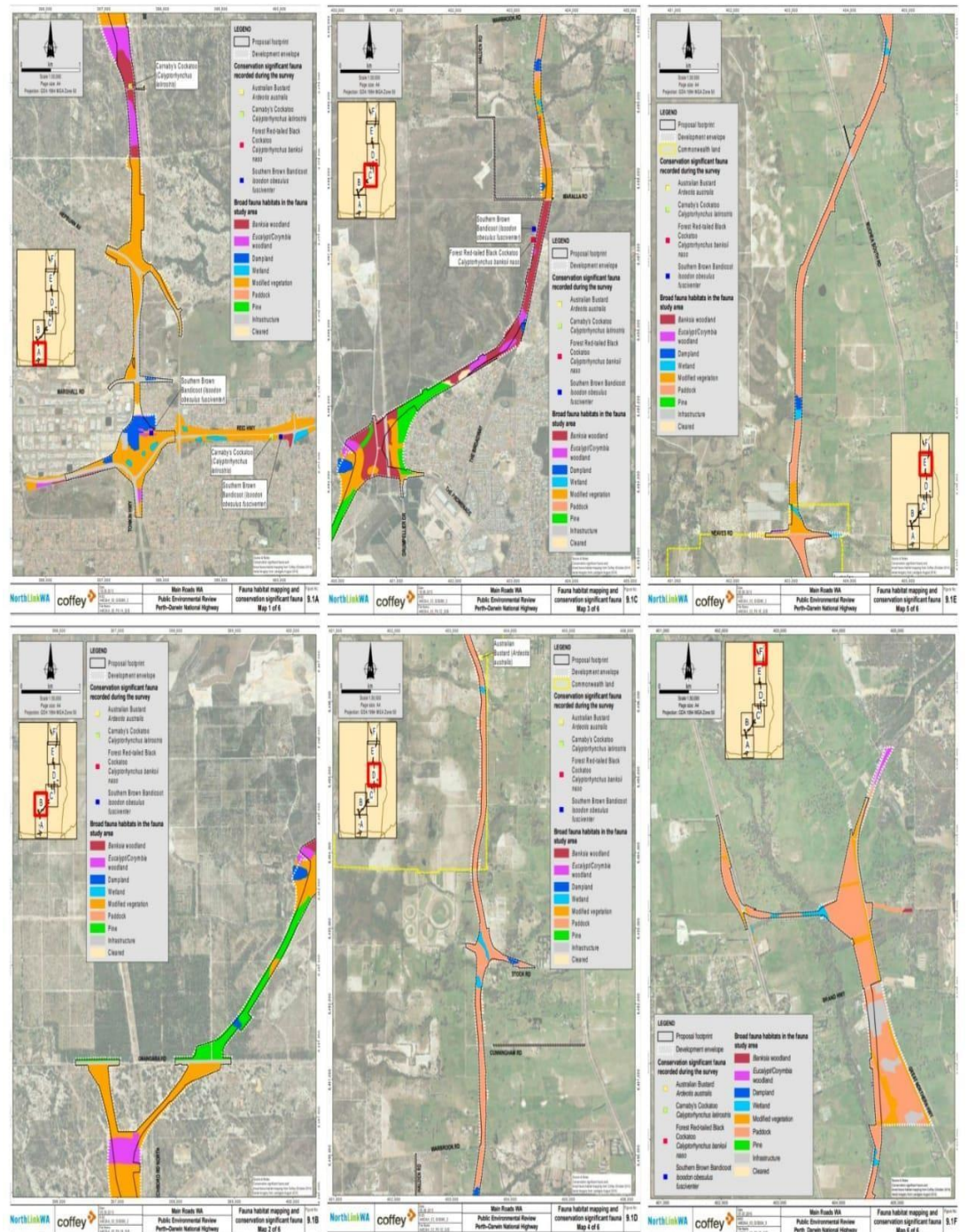


Fig. 2. Habitat mapping of fauna and significant fauna conservation.

However, the effects on both Black Cockatoo species by the proposal examined opposed to the Significant Impact Guidelines 1.1 (DOTE, 2013). Therefore, both these Black Cockatoos impacted by the proposal which contained a significant impact (DPAW, 2013a; Chapman, 2007). The species of Black Cockatoo usually feed on roadside vegetation but their capability to fly low, specifically after take-off,

mainly due to their large size. Hence, the feature of the same species considered as sensitive to vehicle accidents (Saunders et al., 2011). Moreover, the entire local and regional scale significant fauna listed in the proposal area evaluated usually either on the SCP or in other parts of their distributions but the proposal not induced the significance level of some species.

Table 3. Fauna habitats of the proposal footprint.

HABITAT TYPE	AREA (ha)	HABITAT VALUE
Natural fauna habitats		
Banksia woodland	81.7	Moderate
Eucalypt/Corymbia Woodland	43.1	High
Dampland	19.0	Moderate
Wetland	15.5	Moderate
Secondary fauna habitats		
Modified Vegetation	208.2	Low
Paddock	255.7	Low
Pine Plantation	51.0	Low
Nil habitats		
Infrastructure/cleared	71.5	Nil
Total	745.7	-

Table 4. Black Cockatoo habitats of the proposal footprint.

HABITAT	BLACK COCKATOO HABITAT			
	High value (contains potential breeding, roosting and foraging habitat)	Moderate value (contains quality foraging habitat)	Low value (contains limited foraging habitat)	Nil value (contains no habitat)
Eucalypt/Corymbia Woodland	43.1	-	-	-
Banksia Woodland	-	81.7	-	-
Dampland	-	-	19	-
Wetland	12.9	-	2.6	-
Modified Vegetation	64.1	-	144.1	-
Pine Plantation	-	-	-	51
Paddock	-	-	255.7	-
Cleared/Infrastructure	-	-	-	71.5
Total (hectares)	120.1	81.7	421.4	122.5

Amenity (Noise and Vibration)

The monitoring of other environmental key factor that is amenity (noise and vibration) occurred at nine regions from south Reid Highway to Muchea (Figure 4) (Table 5). To identify the variations between the LA_{10,18} hour and LA_{eq} (Day) or LA_{eq} (Night) noise descriptors, also to examine whether the day or night time traffic noise is effective in comparison to SPP 5.4 criteria, noise assessment was used. The results of the difference between the LA_{eq} (Day) and LA_{eq} (Night) showed in between 4 dB and 7 dB. Therefore, this proposal estimated that the traffic noise levels for daytime more than 5 dB that of the traffic noise levels for night time, hence, day-time noise levels differentiated against SPP 5.4 noise criteria. On contrary, the noise monitoring not applied to traffic noise under the State Planning Policy 5.4 (SPP 5.4) Road and Rail Transport Noise and Freight Consideration in Land Use Planning (WAPC, 2009). However, the policy used to introduce newly general road proposals and re-establishment of currently road in the surroundings of present or upcoming noise-sensitive land uses. According to EAG 13, the EPA anticipated that the proponents applied management of noise best practice to reduce effects on amenity, considered with SPP 5.4 and other appropriate recognized levels and conveyed their endowment to cumulative noise emissions.

In greenfield site, the SPP 5.4 “target” attained where suitable and sensible as well as there was no requirements of more mitigation measurements under SPP 5.4 but from the Tonkin/Reid Highway intersection to Maralla Road, noise-sensitive land uses efforts made to obtained the “limit”. However, the noise impact analysis reckoned the likely traffic noise emissions occurring from the proposal on sensitive receivers (Lloyd George Acoustics, 2015b).

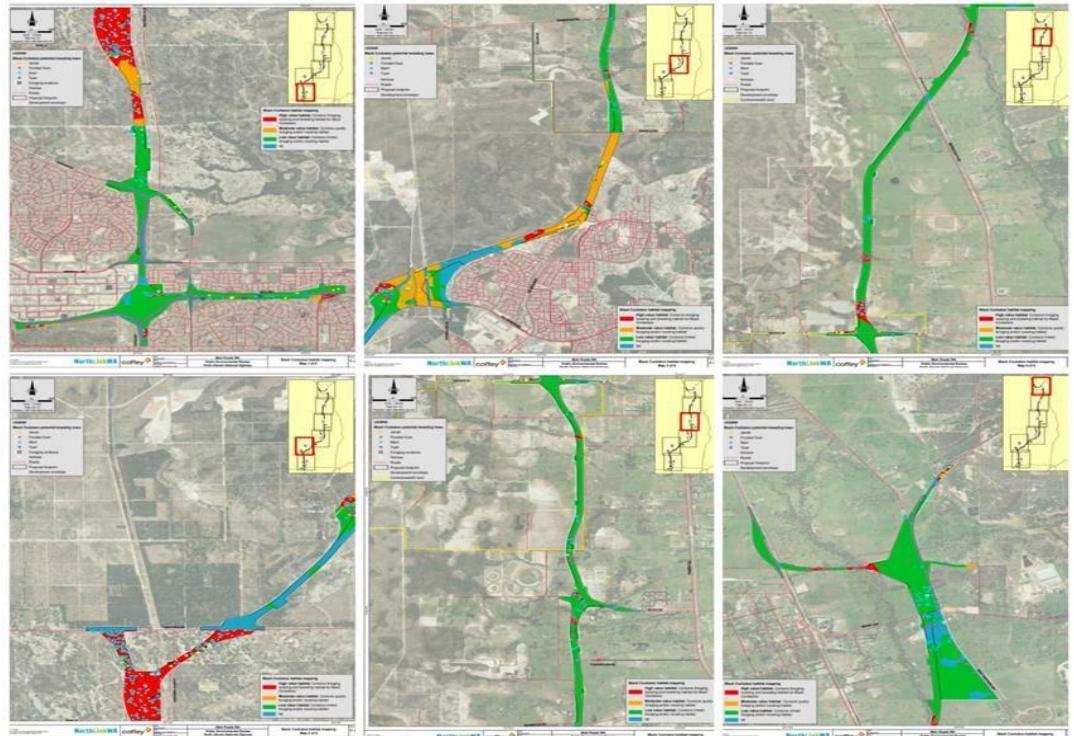


Figure 3. Mapping of Black Cockatoo Habitat.

SITE NUMBER	ADDRESS	AVERAGE WEEKLY NOISE LEVEL (dB)		
		LA10,18 hour	LAeq (Day)	LAeq (Night)
10	6 Acacia Court, Beechboro	57.1	54.9	50.9
11	11 Willow Ct, Beechboro	53.9	52.2	48
12	8 Jarrah Court, Beechboro	51.6	50.6	45.5
13	43 Mitra Loop, Beechboro	50.9	50.1	52.8
14	10 Cootha Court, Ballajura	47.8	47.4	43.2
15	21 Madura Close, Ballajura	50.3	49.4	47.0
16	12 Fewson Turn, Ellenbrook	45.6	49.1	44.1
17	32 Stock Road West, Bullsbrook	51.1	54.2	48.2
18	144 Strachan Road, Bullsbrook	45.6	47.7	43.2
19	591 Muchea South Road, Muchea	52.1	50.7	49.3

Table 5. Noise monitoring locations.

Mitigation Approach and Comparison between the brownfields and greenfields areas

MRWA enunciated to acquiring environmental results via suitable management procedures regarding to particular conditions on site. Hence, this strategy has been related with the Environmental Assessment Guideline for Recommending Environmental Conditions (EPA, 2013a). A comparison between the brownfields and greenfields areas demonstrated that the proposal fulfilled the EPA’s purpose with the development envelope (Table 6). For brownfields regions between Reid Highway and Hepburn Avenue, the proposal obtained the noise target of 60 dB LAeq described in State Planning

Policy 5.4. On contrary, for greenfields regions between Hepburn Avenue and Ellenbrook, the proposal obtained 55 dB LAeq noise limit at noise sensitive receptors where workable whereas obtaining the 60 dB LAeq at rest of noise sensitive receptors where 55 dB LAeq not attained. However, mitigation measurements failed to attain the 55 dB LAeq limit for eight countryside habitancy properties in the north of Ellenbrook, hence, façade treatment allotted to obtain interior noise limits but unsuccessful to decrease exterior noise.

In principle 5 of the WA Environmental Offsets Policy and debated in the WA Environmental Offsets Guideline, the EPA demonstrated that the considerable residual effects such as the extent of the impact, vegetation condition, conservation significance of the effected region and land tenure, should be measured properly.

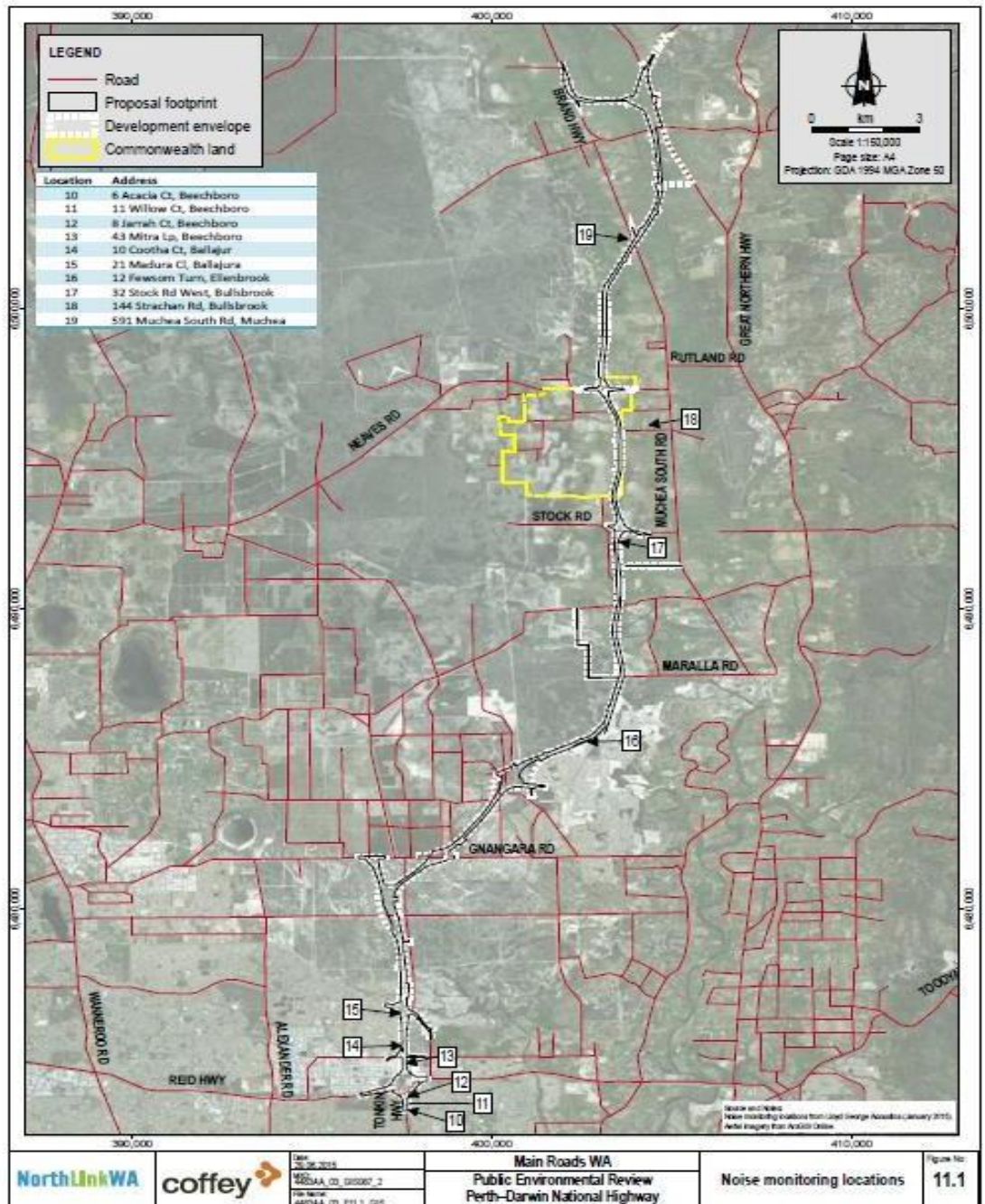


Fig. 4. Monitoring of noise locations.

Table 6. SPP 5.4 outdoor noise criteria.

Period	Target	Limit
Day (6am to 10pm)	55 dB LAeq (Day)	60 dB LAeq (Day)
Night (10pm to 6am)	50 dB LAeq (Night)	55 dB LAeq (Night)

Source: State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning (Government of Western Australia, 2009).

Conclusion

To conclude, the proposal evaluated many limitations for the region. The number of environmental key factors that affected by the project were examined. Studies retrieved for the present review revealed the potential impacts on flora and vegetation (Bush Forever Strategy); terrestrial fauna (Black Cockatoo's species); and amenity (Noise and vibration) by the project. For significance determination, various surveys conducted to evaluate the direct and indirect impacts on the species of flora and fauna. With the appropriate best practice criteria, the proposal is likely to meet the EPA's objectives.

TERM	DEFINITION
DOTE	Department of the Environment
DPAW	Department of Parks and Wildlife
EAG 13	Environmental Assessment Guideline 13
EIA	Environmental Impact Assessment
EP Act	<i>Environmental Protection Act 1986</i>
EPA	Environment Protection Authority
EPBC	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
ESD	Environmental Scoping Document
GSS	Gnangara Sustainability Strategy
IBRA	Interim Biogeographic Regionalization of Australia
MRWA	Main Roads Western Australia
PDNH	Perth–Darwin National Highway
PMR	Perth Metropolitan Region
PPR	Perth–Peel Region
SCP	Swan Coastal Plain
SPP	Statement of Planning Policy
TECs	Threatened Ecological Community
WA	Western Australia
WAPC	Western Australia Planning Commission

Table 7. Abbreviations

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Author Contributions

PK conceived the concept. PK wrote and approved the manuscript.

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Competing interest

The author declares no competing interests.

Ethics approval

Not applicable.



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