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Dear Lee

Re: Response to Central Coast Council in Relation to the Lake Munmorah Biodiversity Corridor

It is understood that following a meeting with Darkinjung Local Aboriginal Land Council (DLALC), Central Coast Council (CCC) and the Department of Planning, Industry and Environment (DPIE) in relation to the draft Lake Munmorah Structure Plan (Urbis 2020), that CCC have raised concerns in relation to impacts from the proposal to the regional biodiversity corridor at Lake Munmorah included in the draft Greater Lake Munmorah Structure Plan (2019) (dGLMSP).

The following comments from CCC were provided via email from Jenny Mewing on the 20th March 2020 in response to a meeting between Darkinjung LALC, CCC and DPIE in discussing the draft Lake Munmorah Structure Plan.

> *"The structure plan proposes a significant encroachment into the regional corridor. This is not supported and further consultation should be undertaken with BCD on this matter before the plans are finalised for public exhibition. Council's estimate of the extent of the corridor for the dGLMSP has been based on the attached advice from the former DECCW (now BCD) which recommends that regional wildlife corridors be 500 m wide not 200 m which is cited in the Lake Munmorah Structure Plan report prepared by Urbis for the Planning Proposal.*
>
> *It is important that the revised ecological assessments include justification (including support by relevant and appropriate literature reviews and analysis, considering (but not limited to) edge effects, present and potentially present species and movement patterns etc.) for the narrowing of the regional corridor."*

This letter outlines a detailed review of the relevant literature and guidelines available to inform the assessment of the corridor proposed to be retained by Darkinjung's Lake Munmorah Planning Proposal.

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1.0 Literature and Guidelines on Corridor Design and Function

There is a wide range of research on the design principles in relation to biodiversity corridors and factors in determining their functionality in the landscape. However, there is no formal guidance on minimum corridor characteristics for projects assessed under the Biodiversity Assessment Method (BAM). It is understood that the biodiversity assessment report is required to present the most appropriate corridor proposal in the context of the individual site and locality based on available literature and resources.

For the purposes of this review, Umwelt has selected the key resources that were considered to be most relevant for the assessment of the Lake Munmorah biodiversity corridor. These included:

Government Documents and Resources

- Wildlife Corridors North East NSW - fact sheet (DIPNR 2004)
- Fauna Corridors for Climate Change report to Hunter Central Rivers Catchment Management Authority (HCRCMA) (DECC 2007)
- Draft National Wildlife Corridors Plan (National Wildlife Corridors Plan Advisory Group 2012)
- BAM data power query – Species Export, accessed 12 May 2020.

Journal Articles and Literature

- Key habitats and corridors for forest fauna – A landscape framework for conservation links in North-East NSW (Scotts 2003)
- Ecological Principles for the Design of Wildlife Corridors (Lindenmayer and Nix 1993)
- Linkages in the Landscape – the Role of Corridors and Connectivity in Wildlife Conservation (Bennett 2003)
- Reducing the impacts of development on wildlife (Gleeson and Gleeson 2012)
- Investigations of corridor use by arboreal and scansorial mammals and an analysis of yellow-bellied glider (*Petaurus australis*) populations and connectivity on the lower central coast of NSW (Chrismar 2018)
- Wildlife Corridors and the Mitigation of Logging Impacts on Fauna in Wood-production Forests in South-eastern Australia - a Review (Lindenmayer 1994)

Local Studies and Plans

- Central Coast Council Draft Biodiversity Strategy (CCC 2019a)
- Draft Greater Lake Munmorah Structure Plan (CCC 2019b)
- North Wyong Shire Structure Plan (DPI 2012)
- Central Coast Regional Plan 2036 (DPE 2016)
- Fauna Habitat Modelling and wildlife linkages in Wyong Shire (Smith, Watson and Murray 2002), and
- Central Coast Council's Wildlife Corridor and Fauna Gap Crossing Network GIS Dataset – North Coast Aerial Mapping, June 2018 (Harre, C 2018).

2.0 Biodiversity Corridor Width and Functionality

A 'biodiversity corridor' generally describes a strip of vegetation that differs from the surrounding vegetation and connects otherwise separate areas of habitat (Gleeson and Gleeson 2012). Corridors may include large expanses of intact native landscapes, river systems and floodplains, networks of habitat patches or scattered paddock trees. Connectivity is a critical function of biodiversity corridors. These corridors may help to reduce or moderate some of the adverse effects of habitat fragmentation by facilitating dispersal of individuals between substantive patches of remaining habitat.

It is widely accepted that biodiversity corridors are not necessarily continuous intact vegetation, as currently fragmented or cleared areas can also contribute to overall landscape connectivity (Scotts 2003). These patches provide connectivity and can function as corridors for mobile species, particularly those willing to cross expanses of cleared land. One of the key principles for the design of corridors as stated in the Commonwealth Draft National Wildlife Corridors Plan (2012) notes that corridors should connect the landscape across a mosaic of land tenures and land uses without affecting property rights.

Due to their generally linear nature, vegetated corridors tend to be impacted by edge effects, such as the invasion by exotic plants and animals. Maximising width has been suggested as the most practical way to reduce edge effects, however narrow corridors may still have significant conservation values and wider corridors may not necessarily facilitate fauna movement any more than narrower ones (Chrismar 2018).

While it is acknowledged that the DIPNR (2004) 'Wildlife Corridors' fact sheet and digital resources (Scotts 2003) operate on a general guidance of 500 metres in width for regional corridors (as suggested by Council's comments on the draft plan), it is noted in many research publications that there is no 'one-size-fits all' rule when it comes to determining appropriate corridor widths. Lindenmayer and Nix (1993) conclude that corridor width was "not a significant variable in any of the models that were developed" and notes that determining the appropriate widths of corridors needs to consider the habitat types and species utilising these areas. Scotts (2003) also acknowledges that, while wide corridors are better than narrow corridors, spatial dimensions should reflect the demographic requirements of species that are rare and that have specialised habitat and foraging requirements.

To demonstrate the importance of assessing corridors in relation to the species likely to be utilising them, Scotts (2003) allocates key faunal species to each identified corridor. The Lake Munmorah site occurs within the Coastal Corridor strip identified within the Coastal Complex habitat type with the key faunal species/assemblages being the koala (*Phascolarctos cinereus*) and the wallum froglet (*Crinia tinnula*). For the purposes of this review, Umwelt has used the threatened species likely to occur in and around the Lake Munmorah development site as predicted by the BAM calculator (refer to **Table 1**).

3.0 Corridors in the Context of the Lake Munmorah Planning Proposal

3.1 Existing Environment

The development footprint is located within an indicative regional and local corridor identified in the North Wyong Shire Structure Plan (DPI 2012), draft Greater Lake Munmorah Structure Plan (CCC 2019a), and the Central Coast Regional Plan 2036 (NSW DPE 2016). This is primarily due to the nature of the landscape being situated on a relatively narrow portion of land between southern Lake Macquarie and the northern portion of Lake Munmorah and the graphical presentation of corridors on regional scale mapping (refer to **Figure 1**).

This key corridor relevant to the development site relates to the east-west linkages between the suburbs of Doyalson and Lake Munmorah. This narrowed strip of land between the two lakes is approximately 2km wide and contains a variety of existing land uses and zoning including residential, rural, public recreation, remnant intact vegetation associated with environmental zoning and the Pacific Highway (refer to **Figure 1**). Due to previously cleared areas in the locality, there is an existing narrow 'pinch point' along this corridor as described in the draft Greater Lake Munmorah Structure Plan (refer to **Figure 2**):

"Due to existing land use patterns, the proposed corridor is only 700m wide at the widest point. The remainder of the corridor is narrower, reducing to 300m-400m some areas, down to 30m at its narrowest point in the location of 103 Carters Road, Lake Munmorah."[1]

This statement acknowledges that while the area is identified as an important corridor in a range of plans and strategies, existing land uses around Lake Munmorah mean that not all areas within the corridor currently meet any minimum width requirements to facilitate its current functionality for local fauna species. While it is acknowledged that strategic planning needs to consider retaining connectivity in the landscape, it is also important to understand the context of existing corridor and habitat functionality in the locality to ensure an appropriate balance of conservation initiatives and strategic developments.

It is understood that the recent LGA corridor mapping was prepared by CCC and BCD in 2018 to understand corridor functions in the LGA in more detail. The Central Coast Council's Wildlife Corridor and Fauna Gap Crossing Network – North Coast Aerial Mapping (Harre 2018) for the site and immediate environs are show in **Figure 2**. This mapping appears to have identified remnant vegetation, including narrow corridors throughout existing developed areas in Doyalson, Lake Munmorah and to the north of the development site as wildlife corridors.

Based on this, it is unreasonable to impose restrictions on developments based on generalised corridor widths/features which are clearly not applicable for the locality in question. As suggested in a number of published literature resources on the design principles for corridor function, the sections below describe the threatened fauna species likely to occur at the Lake Munmorah site and their relevant dispersal ability and habitat requirements and an assessment of the Project's expected impacts to the connectivity in the locality.

[1] The reference to a 'pinch point' of 70m in the draft Greater Lake Munmorah Structure Plan is likely referring to an area of 'intact' canopy vegetation associated with the property at 103 Carters Road, whereas the mapping of the corridor appears to include areas previously cleared (i.e. paddock grassland), which demonstrates a narrow point of approximately 200 metres. For the purposes of this assessment and avoidance efforts by Darkinjung, we have adopted the larger, more conservative estimate of a 200 metre pinch point in the locality.

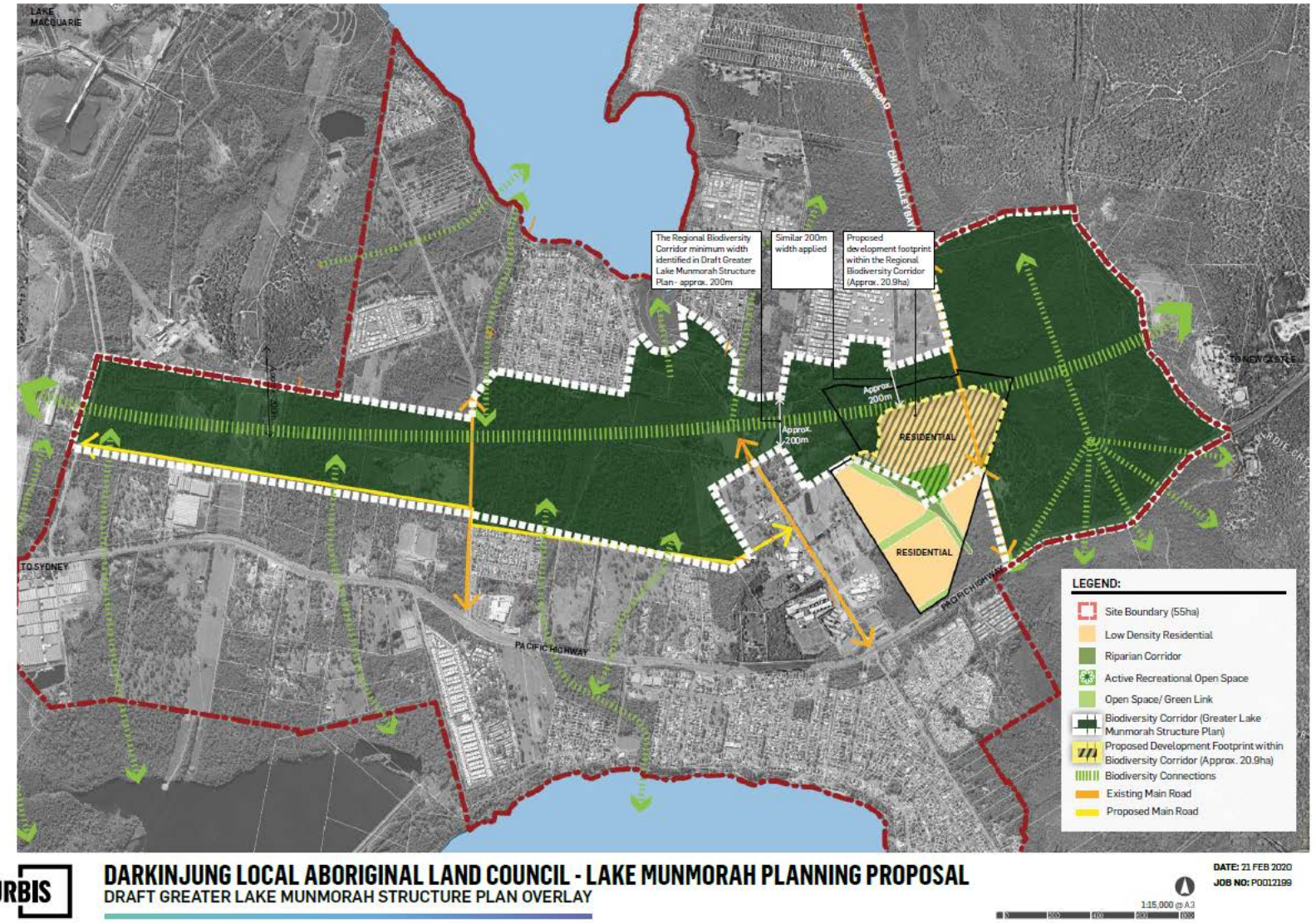
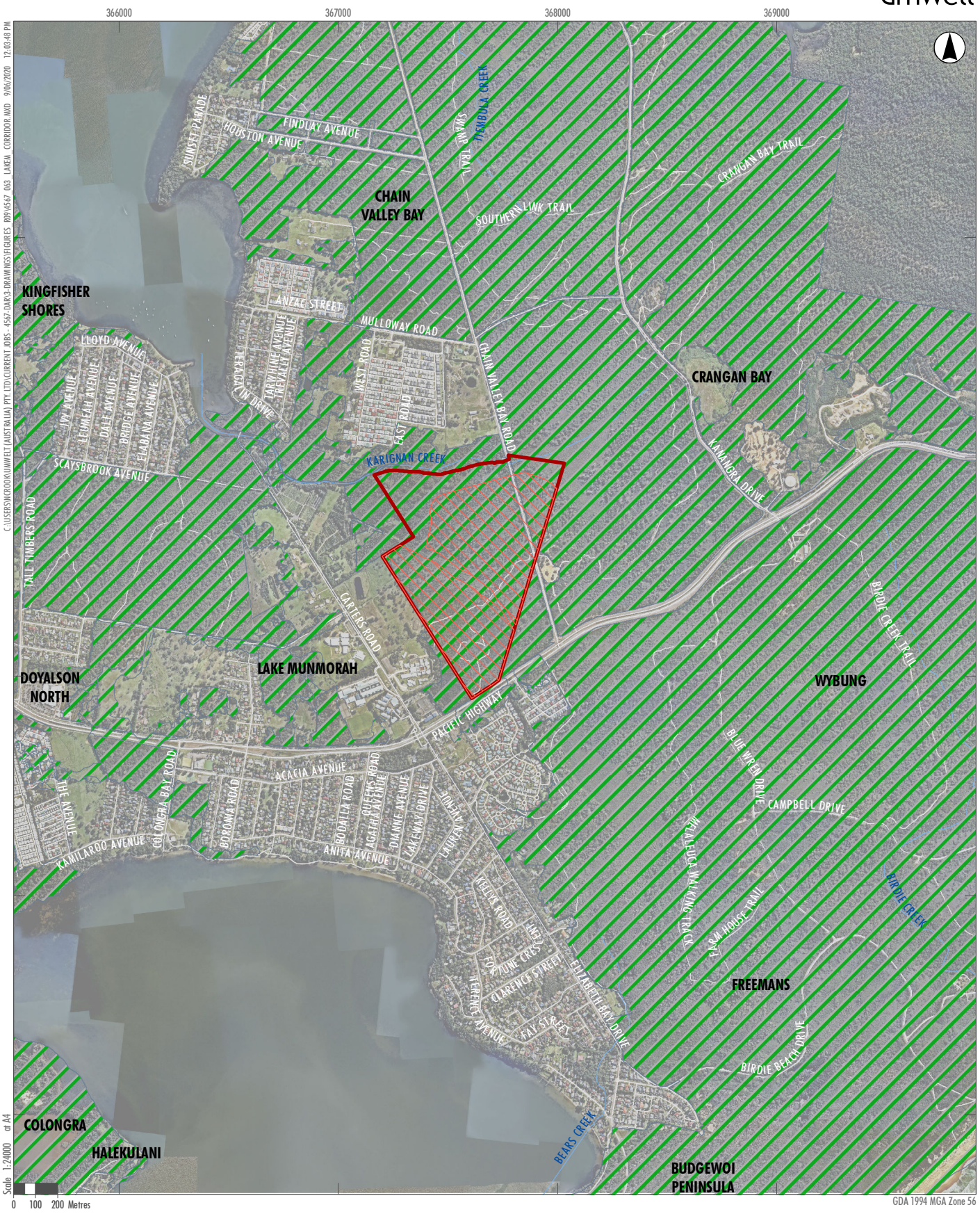


Figure 1 Draft Greater Lake Munmorah Structure Plan Overlay (from Urbis 2020)



Legend

- Proposed Rezoning Area
- Development Footprint
- Wildlife Corridor
- Watercourses
- Roads

FIGURE 2

Central Coast Council Wildlife Corridor

Image Source: Nearmap (April 2020) Data source: DSFI (2017); NSW LPI (2019)

3.2 Threatened Species Likely Occurring in the Locality

Table 1 outlines the threatened fauna species likely to occur at the Lake Munmorah site as predicted by the BAM calculator. It also presents the data supporting the BAM in relation to the species' dispersal ability and patch size class/native vegetation cover predictors within the 1500 metre buffer area. While these factors may not align absolutely with a species ability to move through corridors specifically, they give an indication of what sort of connective habitat is required to facilitate movement through the landscape.

As shown in **Table 1**, the fauna species predicted by the BAM calculator as likely occurring in the Lake Munmorah locality are generally highly mobile and based on the existing fragmentation in the locality, these species are likely to persist in areas that are moderately fragmented as is frequently seen in the coastal environment. None of the threatened species likely to occur in the locality require 'intact' native vegetation cover (i.e. greater than 70% cover) to occur. Furthermore, many of these species are highly dispersive, able to traverse areas greater than 10 km. Arguably the species requiring the strictest habitat requirements include the eastern chestnut mouse, some micro-bat species and the yellow-bellied glider, either due to lower dispersal abilities, higher patch size requirements and/or requiring larger percentage of retained habitat (at least between 31-70% retention). As discussed in **Section 3.4**, the Project is not proposing to reduce native vegetation cover or patch sizes in a manner that would reduce these habitat factors outside the acceptable range of these species.

Table 1 Fauna Species Predicted by the BAM Calculator for Lake Munmorah

Fauna Species	BAM Data		
	Colonisation (Dispersal) Ability	Patch Size Class Predictor	Native Vegetation Cover Predictor
Ecosystem Credit Species – reliably predicted by the landscape			
Barking Owl	> 10km	25 - 100 ha	fragmented (between 11 and 30% habitat retained)
Black Bittern	> 10km	< 5 ha	fragmented (between 11 and 30% habitat retained)
Black-chinned Honeyeater	> 10km	5 - 24 ha	fragmented (between 11 and 30% habitat retained)
Black-necked Stork	> 10km	< 5 ha	relictual (with 10% or less habitat retained)
Brown Treecreeper	Between 100m and 10km	< 5 ha	relictual (with 10% or less habitat retained)
Eastern Chestnut Mouse	<100m and/or specific dispersal corridor or vector requirements	25 - 100 ha	variegated (between 31 and 70% habitat retained)
Eastern Coastal Free-tailed Bat	> 10km	< 5 ha	relictual (with 10% or less habitat retained)
Eastern False Pipistrelle	> 10km	5 - 24 ha	variegated (between 31 and 70% habitat retained)
Eastern Osprey	> 10km	< 5 ha	relictual (with 10% or less habitat retained)
Gang-gang Cockatoo	> 10km	< 5 ha	fragmented (between 11 and 30% habitat retained)

Fauna Species	BAM Data		
	Colonisation (Dispersal) Ability	Patch Size Class Predictor	Native Vegetation Cover Predictor
Glossy Black-Cockatoo	> 10km	< 5 ha	relictual (with 10% or less habitat retained)
Golden-tipped Bat	Between 100m and 10km	< 5 ha	variegated (between 31 and 70% habitat retained)
Greater Broad-nosed Bat	> 10km	5 - 24 ha	variegated (between 31 and 70% habitat retained)
Grey-crowned Babbler	Between 100m and 10km	< 5 ha	relictual (with 10% or less habitat retained)
Grey-headed Flying-fox	> 10km	< 5 ha	relictual (with 10% or less habitat retained)
Koala	Between 100m and 10km	< 5 ha	relictual (with 10% or less habitat retained)
Large Bent-winged Bat	> 10km	< 5 ha	relictual (with 10% or less habitat retained)
Little Bent-winged Bat	> 10km	< 5 ha	relictual (with 10% or less habitat retained)
Little Eagle	> 10km	< 5 ha	fragmented (between 11 and 30% habitat retained)
Little Lorikeet	> 10km	< 5 ha	relictual (with 10% or less habitat retained)
Masked Owl	> 10km	< 5 ha	fragmented (between 11 and 30% habitat retained)
Painted Honeyeater	> 10km	< 5 ha	fragmented (between 11 and 30% habitat retained)
Powerful Owl	> 10km	< 5 ha	fragmented (between 11 and 30% habitat retained)
Regent Honeyeater	> 10km	< 5 ha	relictual (with 10% or less habitat retained)
Scarlet Robin	Between 100m and 10km	< 5 ha	relictual (with 10% or less habitat retained)
Speckled Warbler	Between 100m and 10km	< 5 ha	relictual (with 10% or less habitat retained)
Spotted-tailed Quoll	Between 100m and 10km	< 5 ha	relictual (with 10% or less habitat retained)
Square-tailed Kite	> 10km	< 5 ha	fragmented (between 11 and 30% habitat retained)
Swift Parrot	> 10km	< 5 ha	relictual (with 10% or less habitat retained)
Turquoise Parrot	> 10km	< 5 ha	fragmented (between 11 and 30% habitat retained)
Varied Sittella	Between 100m and 10km	< 5 ha	fragmented (between 11 and 30% habitat retained)

Fauna Species	BAM Data		
	Colonisation (Dispersal) Ability	Patch Size Class Predictor	Native Vegetation Cover Predictor
White-bellied Sea-Eagle	> 10km	< 5 ha	relictual (with 10% or less habitat retained)
Yellow-bellied Glider	<100m and/or specific dispersal corridor or vector requirements	25 - 100 ha	variegated (between 31 and 70% habitat retained)
Yellow-bellied Sheathtail-bat	> 10km	< 5 ha	fragmented (between 11 and 30% habitat retained)
Species credit species – recorded on the site			
Wallum froglet	Between 100m and 10km	< 5 ha	relictual (with 10% or less habitat retained)

3.3 Impacts on the Lake Munmorah Corridor

While the BAM cannot calculate impacts to corridor and movement habitat through the generation of biodiversity credits, the impacts of development on the connectivity of threatened species habitat that facilitates movement of species across their range is considered to be a 'prescribed impact' under the Biodiversity Conservation Regulation 2017.

The project will result in the clearance of native vegetation for a residential development primarily on Lot 642 DP 1027231 and partially on Lot 100 DP 1044282 which will result in the reduction of approximately 20.9 ha of native vegetation included in the indicative corridor identified in the draft Greater Lake Munmorah Structure Plan (refer to **Figure 1**) and the draft Central Coast Wildlife Corridor (refer to **Figure 2**). This impact would also reduce the width of the east-west corridor in this specific location from a maximum of 600 metres to 200 metres, however the overall corridor width in the wider locality will not change from the existing pinch point of 200 metres currently located to the west of the site (refer to **Table 2** and **Figure 1**). The widest portion of the corridor occurs on Darkinjung-owned land to the east of the site (approximately. 1400 metres wide), which is not proposed to be developed as part of the current project footprint. However some potential exists for future development of the southern portions of this land, subject to further biodiversity assessment and resolution of mining lease and mining impact issues.

Table 2 outlines the key connectivity features in the locality and the changes in the landscape likely to result from the Project.

Table 2 Changes in the Landscape as a Result of the Project

Key Connectivity Features	Existing Environment	Post-development
Native Vegetation Cover*	760 hectares (61%)	719 hectares (58%)
Patch Size Class*	> 100 hectares	> 100 hectares
East-west corridor width (minimum)^	200 metres	200 metres
East-west corridor width (maximum)^	1400 metres	1400 metres
Relevant landscape features	Karignan Creek (3rd order stream)	

*Within 1500m buffer area and as per BAM (2017).

^As per corridor identified in draft Greater Lake Munmorah Structure Plan.

The Project's potential impacts on corridor widths and functionality in the locality was raised early in the design of the project footprint following re-zoning advice from the Department of Planning in relation to the Project's original proposed layout. The advice received by Darkinjung was to ensure that the corridor was not reduced to less than 200 metres, which was consistent with the width of the corridor to the west of the site, as identified in the draft Greater Lake Munmorah Structure Plan (refer to **Section 3.1**). Darkinjung then amended the project layout again to ensure the project would not result in narrowing this east-west corridor to less than 200 metres (refer to **Figure 2**). The guidance of retaining a 200 metre east-west corridor is considered an appropriate balance between conservation outcomes and facilitating development in the locality given the existing mixed land use and the habitat requirements for the species considered likely to occur on site.

The project will not sever the patch size class which is currently over 700 hectares in the 1500m buffer area in accordance with the BAM. This patch is much larger in the wider locality connecting habitats outside the 1500 metre buffer area. The native vegetation cover in the 1500m buffer area is expected to be reduced from 61% to 58%, which still represents the required percent native vegetation cover range quoted for the local threatened species outlined in **Table 1**.

Indirect impacts may occur in the corridor in relation to edge effects including potentially an increased exposure to weed invasion, pest animal predation, light penetration, noise and wind impacts and rubbish dumping. Available literature cannot provide an estimate of the extent to which edge effects can impact adjacent retained habitats and vegetation. Darkinjung will incorporate a detailed mitigation strategy to minimise any edge effects on the adjoining habitats along the corridor. These may include the following in relation to the design, construction and operation of the project:

- Implementation of a green 'buffer zone' within bushfire asset protection zones at the back of proposed blocks, within the development footprint, adjacent to the corridor that restricts building envelopes directly adjoining the corridor and provides for retention of trees consistent with planning for bushfire protection requirements.
- Where fencing is required adjacent to the corridor, fauna-friendly fencing is to be used to allow for dispersal and safe fauna movement.
- Targeted weed and pest management strategy.
- Signage and community education program to ensure the community understands the importance of the retained corridor.
- Restricted pedestrian access within the retained corridor to reduce unwanted damage and rubbish dumping.

In the context of cumulative impacts, it is noted that there are a number of current planning proposals in the vicinity of the main west to east biodiversity corridor shown in **Figure 1** including:

- Current planning proposal (PP_2020_CCOAS_002_00) is seeking rezoning to RE2 private recreation to allow for manufactured home estate at Lot 5 DP1228880, 45 Mulloway Road Chain Valley Bay to the east of Valhalla Lifestyle Community Estate and north of this proposed development. The planning proposal includes environmental conservation zoning for vegetated buffer to Karignan Creek.
- PP_2017_CCOAS_003_00 which provides for rezoning of land at 15 Mulloway Road Chain Valley Bay to allow for residential development and environmental conservation, to the north of the project between Chain Valley Bay residential area and the Valhalla Lifestyle Community Estate. This development area is not included in the main riparian corridor however it is identified as a local link and occurs to the north of the corridor where it is already 200 m wide (refer to

Figure 1). However, it is noted that this area is identified in **Figure 2** as a wildlife corridor. Like this proposed development, the rezoning has retained a conservation land (E2 zoned) buffer to Karignan Creek.

- Proposed residential development off the Pacific Highway to the east of the Lake Munmorah Shopping Centre (PP_2020_CCOAS_004_00) that while to the south of the main riparian corridor would impact on a local conservation link.

All of the proposed developments are retaining a buffer to the west to east wildlife corridor along Karignan Creek.

3.4 Avoidance and Retained Functionality of the Corridor

The Biodiversity Conservation Division (BCD) of DPIE has acknowledged that there is no specific guidance on the appropriate corridor widths that should be maintained for any particular development in NSW. Council's draft Biodiversity Strategy (CCC 2019a) does not include references to proposed widths or corridor characteristics. It is up to the proponent to demonstrate that the functionality of corridors is maintained when assessing impacts under the BAM.

The BAM (OEH 2017) refers to the importance of development proposals demonstrating avoidance of important connectivity features by "locating the project such that connectivity enabling movement of species and genetic material between areas of adjacent or nearby habitat is maintained." (Section 8.1.1.3 (d)). It should be noted that no minimum threshold is cited in the BAM for the required maintenance and avoidance of corridors.

As outlined above, the proposed development has been designed to avoid as much as possible impacts on the functionality of the connectivity and biodiversity corridors in the locality and region while balancing the needs of the development. As a result of the placement of the development footprint, existing connectivity values between the east and west will be retained and the existing functionality of corridor will be preserved. Darkinjung is proposing a minimum corridor width that is equal or greater to an existing pinch point in the locality and will actively mitigate any likely indirect impacts associated with edge effects in this area.

The long-term future of the east-west corridor in this locality is envisaged in the draft Greater Lake Munmorah Structure Plan (CCC 2019b) and opportunities exist for Darkinjung land to the north east of the development footprint to be conserved in-perpetuity which would represent a large portion of the identified corridor.

4.0 Conclusion

The available and relevant literature stress the importance of strategic planning for biodiversity corridors by considering the local species' habitat requirements to adequately determine appropriate corridor design features, such as width. The threatened fauna species predicted or known to occur on the site and in the locality have a moderate to high dispersal ability and do not require large expanses of intact vegetation to persist. The existing fragmentation and mixed land use within and around the east-west corridor demonstrate that not all areas within the corridor currently meet any minimum width requirements to facilitate its current functionality for local fauna species.

One of the key principles in the draft Greater Lake Munmorah Structure Plan is to "ensure future development is undertaken in a manner sensitive to the natural environment, and improving long term environmental outcomes." Darkinjung has demonstrated avoidance at Lake Munmorah by reducing the development footprint along the identified east-west corridor to retain a width of 200 metres, which is consistent with an existing pinch point to the west of the site.

The retention of a 200 metre east-west corridor is considered an appropriate balance between conservation outcomes and facilitating development in the locality given the existing mixed land use and the assessment of habitat requirements for the species considered likely to occur on site.

We trust this information meets with your current requirements. Please do not hesitate to contact the undersigned on 1300 793 267 should you require clarification or further information.

Yours sincerely

Les Seddon
Principal Environmental Consultant

References

Bennett (2003) Linkages in the Landscape – the Role of Corridors and Connectivity in Wildlife Conservation

Central Coast Council (2019a) Central Coast Council Draft Biodiversity Strategy

Central Coast Council (2019b) Draft Greater Lake Munmorah Structure Plan

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Harre, C (2018) Central Coast Council's Wildlife Corridor and Fauna Gap Crossing Network – North Coast Aerial Mapping, June 2018

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Smith, Watson and Murray (2002) Fauna Habitat Modelling and wildlife linkages in Wyong Shire