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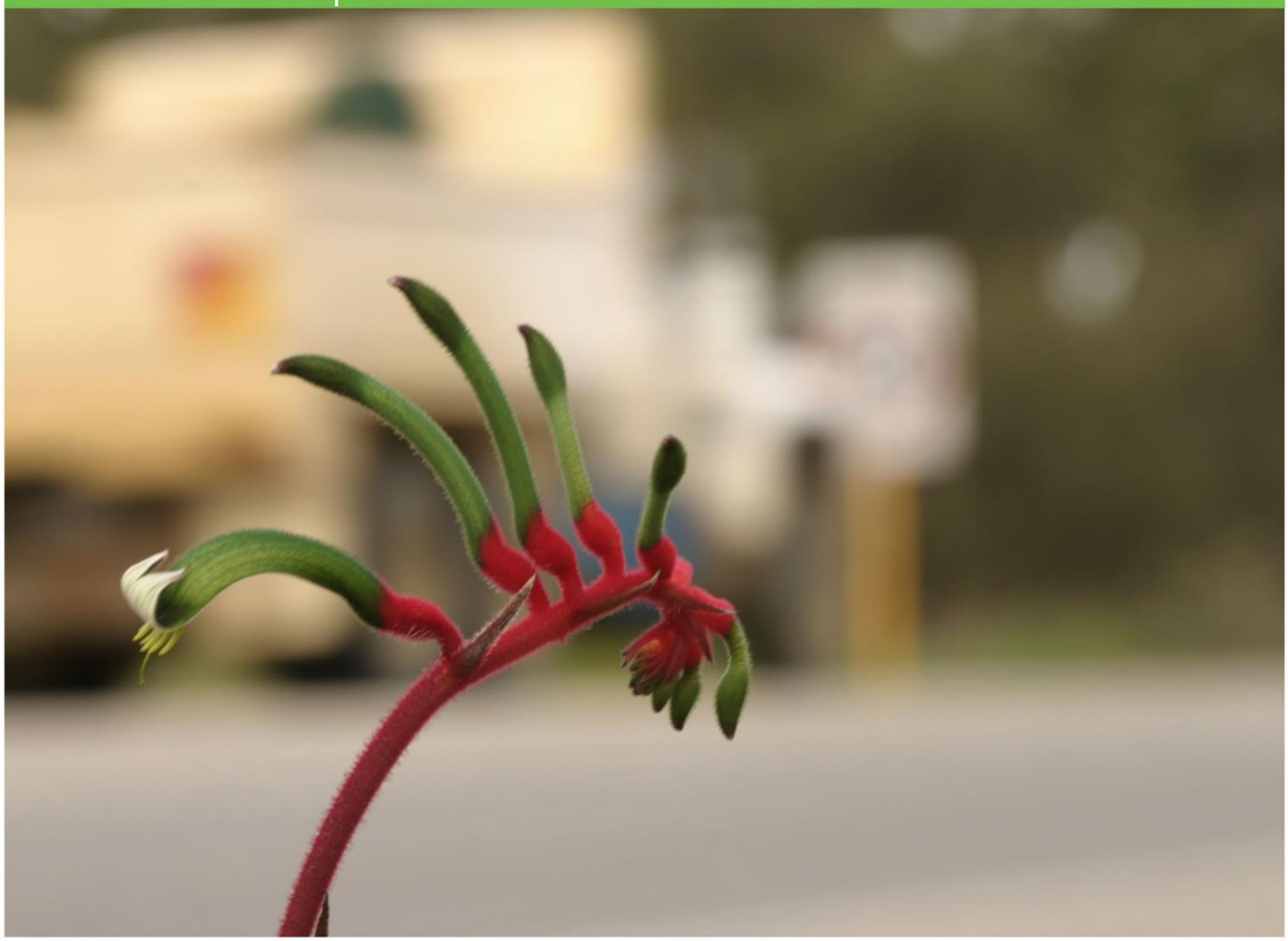
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Perth–Darwin National Highway (Swan Valley Section)

FEBRUARY 2016 | PART B: RESPONSE TO SUBMISSIONS



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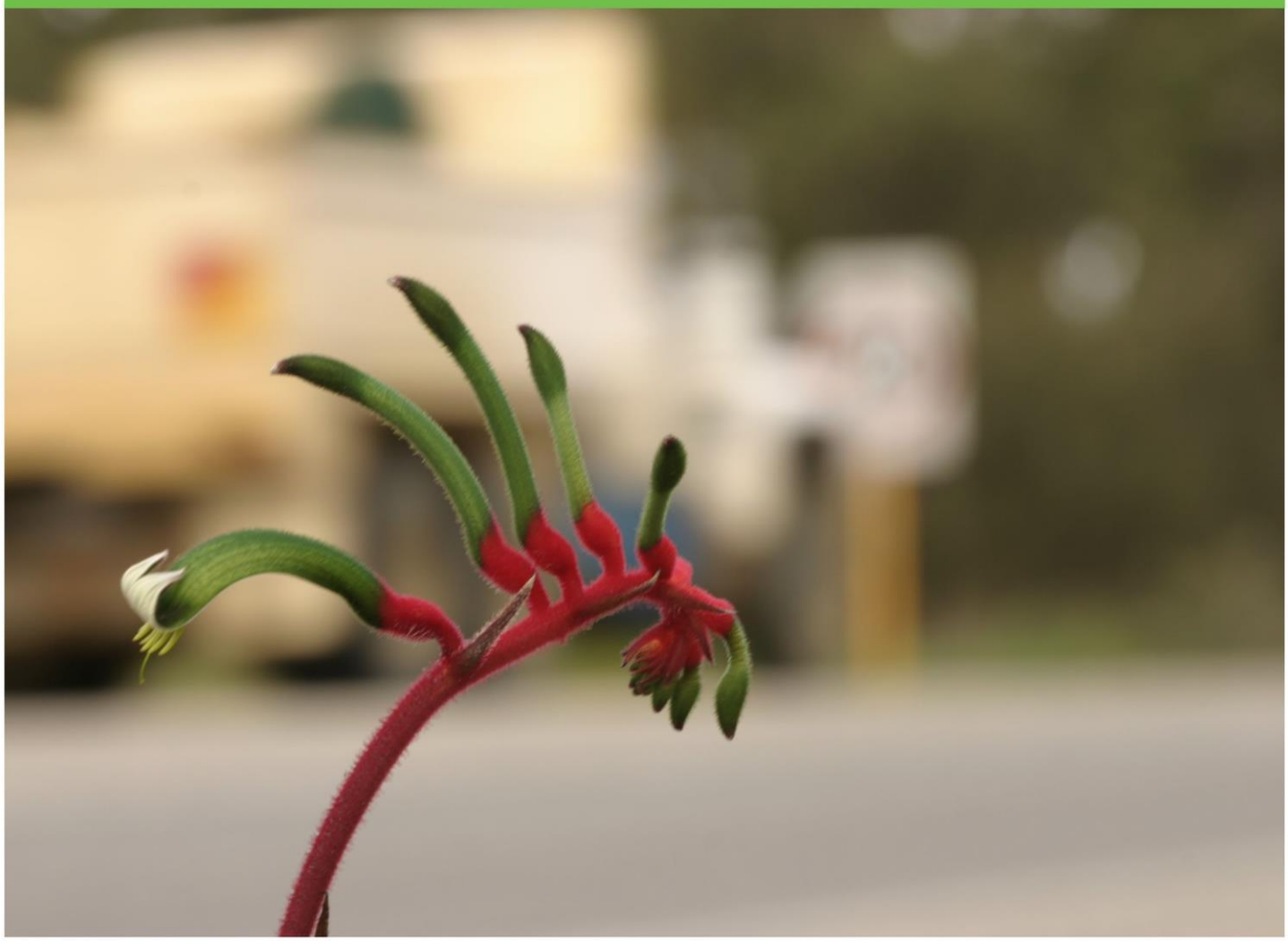
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NorthLinkWA
Perth-Darwin National Highway

Response to Submissions

Perth–Darwin National Highway (Swan Valley Section)

FEBRUARY 2016



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M Technical Advice on Fauna Issues

Document *Control*

Revision	Date	Description	Prepared	Reviewed	Approved
A	4/12/2015	Draft for Main Roads review (Coffey v1)	Coffey	B. Napier	B. Napier
B	6/12/2015	Final for Main Roads review (Coffey v2)	Coffey	B. Napier	B. Napier
0	7/12/2015	Final for submission to Office of Environmental Protection Authority (Coffey v3)	Coffey	B. Napier	B. Napier
1	23/02/2016	Revised for Main Roads review following OEPA and DOTE comment (Coffey v4)	Coffey	B. Napier	B. Napier
2	25/02/2016	Final for Main Roads review (Coffey v5)	Coffey	B. Napier	B. Napier
3	29/02/2016	Final for submission to OEPA (Coffey v6)	Coffey	B. Napier	B. Napier

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1 INTRODUCTION

1.1 Background

Main Roads Western Australia (MRWA) proposes to construct a new section of the Perth–Darwin National Highway (Swan Valley Section) between Malaga and Muchea, in the Swan Valley in Western Australia (the proposal).

A Public Environmental Review (PER) under the *Environmental Protection Act 1986* (EP Act) was prepared for the proposal (Coffey, 2015a). The PER also satisfies the requirement for a draft Public Environment Report under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for potential impacts on Matters of National Environmental Significance (MNES). The draft Public Environment Report and this Response to Submissions document together form the final Public Environment Report for the proposal under the EPBC Act.

The PER was exhibited for public review for four weeks from 7 September 2015 to 6 October 2015. Eighteen submissions were received on the PER. Table 1.1 lists the submissions received.

Table 1.1 List of submissions on the PER received by Office of the Environment Protection Authority

Submission number	Submitter	OEPA reference
1	Private individual	ANON-FD3J-U7K7-N
2	Bullsbrook Residents and Ratepayers Association	ANON-FD3J-U7K8-P
3	Private individual	ANON-FD3J-U7KB-Z
4	Maralla Land Syndicate Pty Ltd	ANON-FD3J-U7KD-2
5	Department of Lands	ANON-FD3J-U7KE-3
6	Wildflower Society of Western Australia Inc.	ANON-FD3J-U7KG-5
7	Department of Water	ANON-FD3J-U7KH-6
8	Private individual	ANON-FD3J-U7KM-B
9	Private individual	ANON-FD3J-U7KS-H
10	Private individual	ANON-FD3J-U7KT-J
11	Department of Aboriginal Affairs	DAA
12	Private individual	ANON-FD3J-U7KV-M
13	Private individual	ANON-FD3J-U7KW-N
14	Department of Planning	DOP
15	Department of Parks and Wildlife	DPAW
16	Private individual	ANON-FD3J-U7KZ-R
17	Department of Environment Regulation	DER
18	Office of the Environmental Protection Authority	OEPA

The Office of the Environmental Protection Authority (OEPA) provided copies of all submissions to MRWA. Issues raised in submissions made by non-government organisations, private individuals and the development group were summarised by the OEPA in its submission on the 23 October 2015 (Appendix A, OEPA Summary). The OEPA redacted personal details prior to making submissions available to MRWA.

The OEPA subsequently provided additional comments and advice on this Response to Submissions document on the 2 February 2016 (Appendix A, OEPA Summary).

1.2 Purpose of This Document

This document sets out MRWA's responses to issues raised in submissions. This document also provides MRWA with an opportunity to:

- Address any errors and/or omissions identified in the PER by submissions.
- Present additional information and/or technical reports collected since the PER and used in the preparation of MRWA's responses to submissions.
- Modify aspects of the proposal in response to submissions received.
- Amend environmental commitments and/or include additional environmental commitments in response to submissions received.

1.3 Response Method and Framework

All submissions were entered into a database and analysed to identify the underlying issues. Similar issues were grouped together to form a single consolidated issue. A single response has been developed for each consolidated issue. Consolidated issues and responses are categorised into one of the following categories, which follow the chapter structure of the PER:

- Proposal background and justification.
- Route selection development.
- Detailed description of proposal.
- Regulatory context.
- Stakeholder consultation.
- Environmental Impact Assessment (EIA) framework.
- Terrestrial flora and vegetation.
- Terrestrial fauna.
- Hydrological processes and inland waters environmental quality.
- Amenity (noise and vibration).
- Rehabilitation and decommissioning.
- Aboriginal and European heritage.
- Amenity (reserves).
- Matters Protected Under the EPBC Act.
- Offsets.
- Other (i.e. any issues raised that did not fit directly under a chapter of the PER).

Responses are provided for each consolidated issue, taking into consideration each of the contributing issues raised in the submissions. Where a consolidated issue comprises only one contributing issue, the consolidated issue and contributing issue are conflated and presented as one.

The OEPA requested MRWA respond to issues raised in its submission, issues raised in submissions by Western Australian Government agencies and its summary of non-government issues. This document addresses submissions in a structure consistent with OEPA's request. Responses are provided in the following order:

- OEPA submission.
- Department of Parks and Wildlife (DPAW) submission.
- Department of Water (DOW) submission.
- Department of Environment Regulation (DER) submission.
- Other Government agency submissions:
  - Department of Aboriginal Affairs (DAA).
  - Department of Lands (DOL).
  - Department of Planning (DOP).
- Public submissions.

If two or more submitters have raised the same issue, the consolidated issue may appear in two or more sections of this document.

Individual submitters may use Appendix B, Index to Submission Issues to locate where issues raised by their submissions have been responded to in this document.

The Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 (EPP Lakes Policy) was revoked on 20 November 2015, which was after the public review period ended. References to lakes formerly protected by the EPP Lakes Policy have been retained for consistency.

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2 PROPOSAL UPDATE

2.1 Changes to the Development Envelope

The PER was submitted for public review on 4 September 2015. Following submission of the PER a number of changes were made to the development envelope boundary described in the PER. The majority of additional areas were required to facilitate connections between the proposal and other roads (both the highway and the Principal Shared Path (PSP)). Other areas were required to enable removal of redundant road infrastructure and associated rehabilitation (i.e., sections of Old Beechboro Road North). In the majority of these cases, these additional amendments are minor in scale, situated within previously disturbed environments and/or the proposed works do not require clearing and so do not result in a significant change to the environmental values impacted. The additional areas required are described in Table 2.1.

2.2 Changes to the Proposal Footprint

As discussed in Table 2.1, only one of the changes to the development envelope (addition of 0.1 ha along Reid Highway, west of the proposed interchange) will require clearing. The proposal footprint has been amended to include this additional 0.1 ha of disturbance, but has not increased the total proposal footprint considered in the PER (746 ha), due to this number having been rounded up to the nearest hectare.

The other amendments to the development envelope have not been included in the proposal footprint as no clearing is required in these areas.

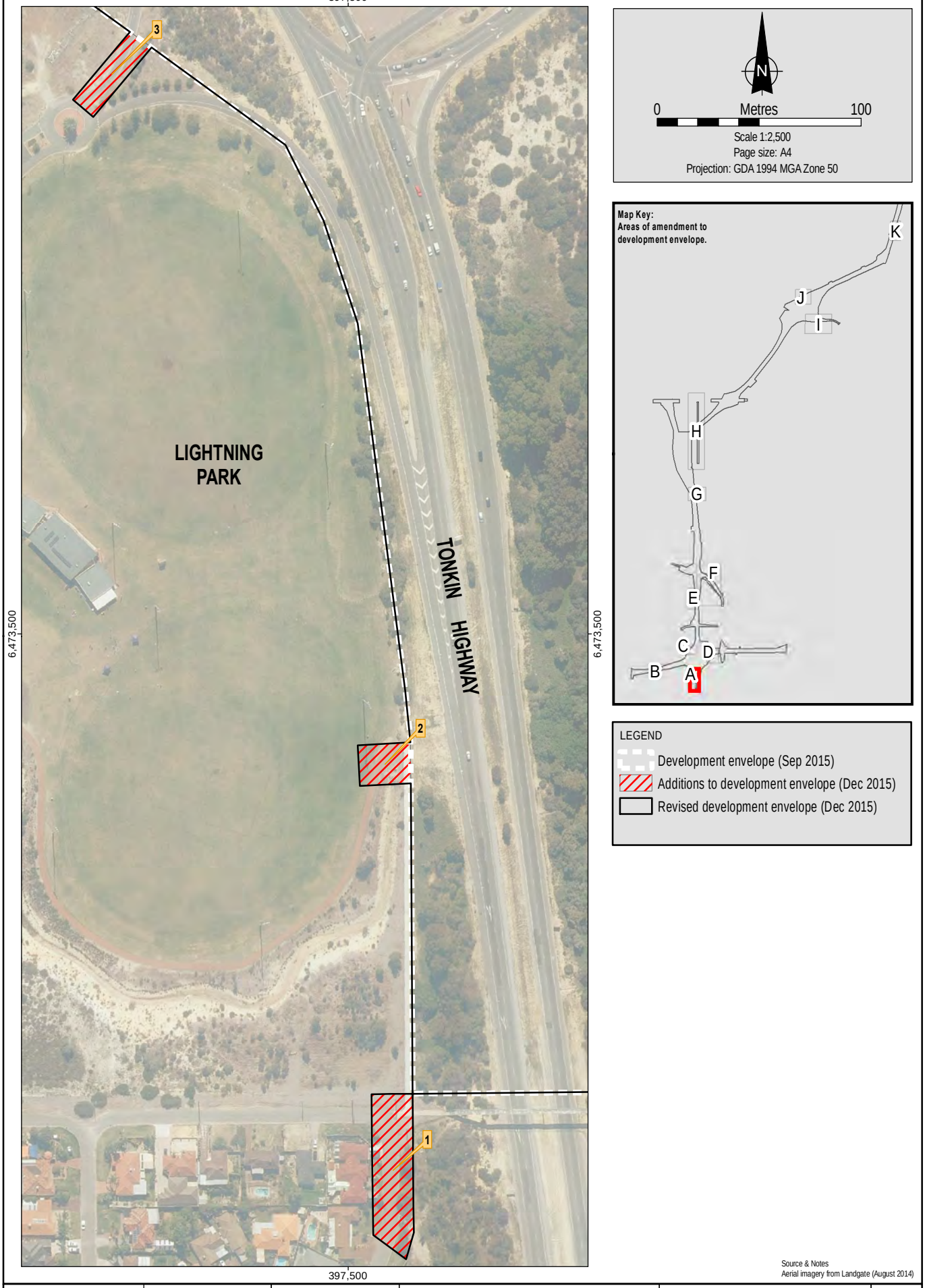
Table 2.1 Changes to proposal development envelope

Location	Change in development envelope	Relative impact as a result of change
Belstead Avenue (Addition 1, Figure 2.1A)	An additional area of 0.1 ha within existing road reserve is required to facilitate a connection between the PSP along the highway and the local road network, to provide improved connectivity for pedestrians and cyclists.	This additional area is within a previously disturbed environment. No clearing of native vegetation is proposed and so increasing the size of the development envelope at this location will not result in an increase in the impact the proposal may have on the environment.
Lightning Park (Addition 2, Figure 2.1A)	An area of 0.1 ha is required to facilitate a connection between the PSP along the highway and the existing shared path that borders the southern boundary of Lighting Park, to provide improved connectivity for pedestrians and cyclists.	This additional area is within a previously disturbed environment and (Lightning Park). No clearing of native vegetation is proposed and so increasing the size of the development envelope at this location will not result in an increase in the impact the proposal may have on the environment.
Lightning Park (Addition 3, Figure 2.1A)	An additional area of 0.1 ha is required to facilitate a connection between the PSP along the highway and the Lighting Park sporting facilities in the north of the Park, to provide improved connectivity for pedestrians and cyclists.	This additional area is within a previously disturbed environment (Lightning Park). No clearing of native vegetation is proposed and so increasing the size of the development envelope at this location will not result in an increase in the impact the proposal may have on the environment.
Reid Highway, west of the proposed interchange (Addition 4, Figure 2.1B)	An additional area of 0.1 ha within the existing road reserve is necessary to bridge the gap between this proposal and the area covered by existing approvals for the Malaga Drive Interchange Upgrade project. This land is required to facilitate the construction of the Reid Highway additional traffic lanes and the provision of a continuous PSP along Reid Highway. Other infrastructure to be constructed in this area includes lighting, fencing and road safety barriers.	This amendment will result in the additional removal of less than 0.1 ha of: • Vegetation association Et[1], Eucalyptus sparse mid woodland (see PER Figure 8.2A), which is mapped as in very good condition (see PER Figure 8.6A) • Moderate value Black Cockatoo foraging or roosting habitat (see PER Figure 9.2A). • Bush Forever Site 307. There will be no impact to priority or threatened ecological communities or conservation significant flora (see PER Figure 8.1A and 8.4A); potential Black Cockatoo breeding trees (see PER Figure 9.2A) or geomorphic wetlands (PER Figure 10.2A).

Location	Change in development envelope	Relative impact as a result of change
Victoria Road (Addition 5, Figure 2.1C)	An additional area of 0.3 ha within existing road reserve is required to facilitate a connection between the PSP along the highway and the local road network, to provide improved connectivity for pedestrians and cyclists.	This additional area is within a previously disturbed environment. No clearing of native vegetation is proposed and so increasing the size of the development envelope at this location will not result in an increase in the impact the proposal may have on the environment.
Northwest of Conifer Place (Addition 6, Figure 2.1D)	An additional area of 0.1 ha is required to facilitate a connection between the PSP along the highway and the local road network and the existing pedestrian facilities within the reserve, this land will facilitate improved connectivity for pedestrians and cyclists.	This additional area is within a previously disturbed environment. No clearing of native vegetation is proposed and so increasing the size of the development envelope at this location will not result in an increase in the impact the proposal may have on the environment.
Yerilla Glen (Addition 7, Figure 2.1E)	An additional area of 0.1 ha within the existing road reserve is required to facilitate a connection between the PSP along the highway and the local road network, to provide improved connectivity for pedestrians and cyclists.	This additional area is within a previously disturbed environment. No clearing of native vegetation is proposed and so increasing the size of the development envelope at this location will not result in an increase in the impact the proposal may have on the environment.
Hamelin Drive and Premier Place intersection (Addition 8, Figure 2.1E)	An additional area of 0.1 ha within the existing road reserve is required to facilitate a connection between the PSP along the highway and the local road network, to provide improved connectivity for pedestrians and cyclists.	This additional area is within a previously disturbed environment. No clearing of native vegetation is proposed and so increasing the size of the development envelope at this location will not result in an increase in the impact the proposal may have on the environment.
Beechboro Road North (Southeast of the Hepburn Avenue Interchange) (Addition 9, Figure 2.1F)	An additional area of 2.7 ha within the existing road reserve is required to facilitate the removal of redundant road infrastructure and associated rehabilitation.	No clearing of native vegetation is proposed. Rehabilitation of the old road alignment will provide positive environmental outcomes. This area will be rehabilitated in accordance with the revegetation strategy discussed in PER Chapter 12, Rehabilitation and Decommissioning and will be supported by a detailed revegetation plan.
Northeast quadrant of the Hepburn Avenue interchange (Addition 10, Figure 2.1F)	An additional area of 0.2 ha is required to facilitate improved connectivity between the regional road network and Beechboro Road North. This land will facilitate a more direct connection and reduce the risk of traffic congestion at the proposed interchange.	This additional area is within a previously disturbed environment. No clearing of native vegetation is proposed and so increasing the size of the development envelope at this location will not result in an increase in the impact the proposal may have on the environment.

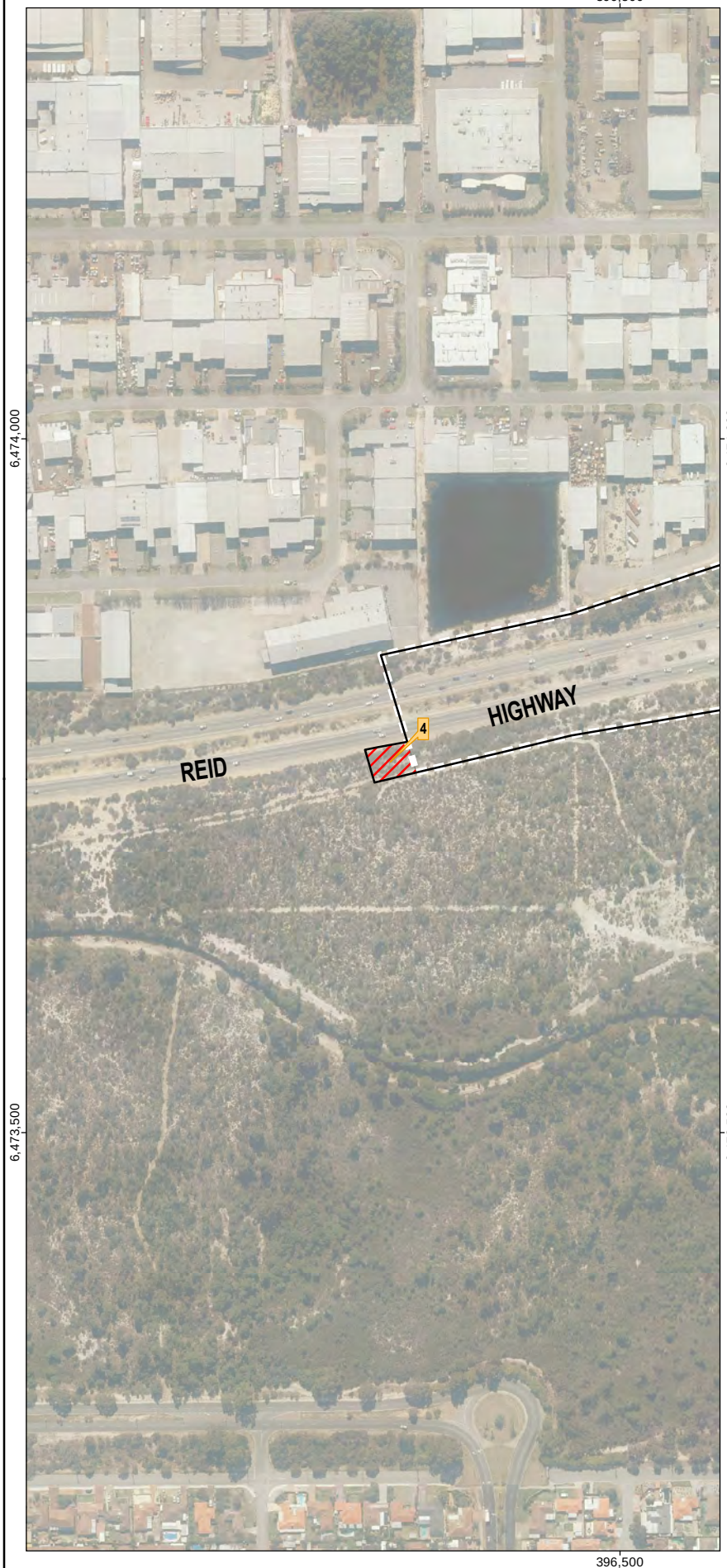
Location	Change in development envelope	Relative impact as a result of change
Baal Street and Beechboro Road North intersection (Addition 11, Figure 2.1G)	An additional area of 0.2 ha is required to ensure the development envelope includes the existing Baal Street. This land is directly over the existing road servicing the Cullacabardee community.	This additional area is within a previously disturbed environment. No clearing of native vegetation is proposed and so increasing the size of the development envelope at this location will not result in an increase in the impact the proposal may have on the environment.
Beechboro Road North (south of intersection with Gnangara Road) (Addition 12, Figure 2.1H)	An additional area of 4.1 ha within the existing road reserve is required to facilitate the removal of redundant road infrastructure and associated rehabilitation.	No clearing of native vegetation is proposed. Rehabilitation of the old road alignment will provide positive environmental outcomes. This area will be rehabilitated in accordance with the revegetation strategy discussed in PER Chapter 12, Rehabilitation and Decommissioning and will be supported by a detailed revegetation plan.
Beechboro Road North (between the proposal and Jules Steiner Memorial Drive) (Addition 13, Figure 2.1H)	An additional area of 2.6 ha within the existing road reserve is required to facilitate the removal of redundant road infrastructure and associated rehabilitation.	No clearing of native vegetation is proposed. Rehabilitation of the old road alignment will provide positive environmental outcomes. This area will be rehabilitated in accordance with the revegetation strategy discussed in PER Chapter 12, Rehabilitation and Decommissioning and will be supported by a detailed revegetation plan.
To the south of the interchange west of Ellenbrook (Addition 14, Figure 2.1I)	An additional area of 0.1 ha within the existing road reserve is required to accommodate the tie in with Drumpellier Drive.	This additional area is within a previously disturbed environment. No clearing of native vegetation is proposed and so increasing the size of the development envelope at this location will not result in an increase in the impact the proposal may have on the environment.
Interchange west of Ellenbrook (Addition 15, Figure 2.1I)	An area of 0.2 ha within the existing road reserve is required to facilitate the removal of redundant road infrastructure and associated rehabilitation.	No clearing of native vegetation is proposed. Rehabilitation of the old road alignment will provide positive environmental outcomes. This area will be rehabilitated in accordance with the revegetation strategy discussed in PER Chapter 12, Rehabilitation and Decommissioning and will be supported by a detailed revegetation plan.

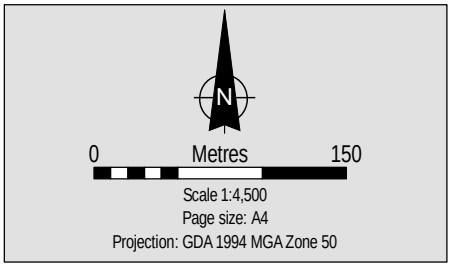
Location	Change in development envelope	Relative impact as a result of change
Gaskell Avenue, Rocla access (Addition 16, Figure 2.1J)	An additional area of 0.1 ha within the existing road reserve is required to accommodate the tie in to Gaskell Avenue.	This additional area is within a previously disturbed environment. No clearing of native vegetation is proposed and so increasing the size of the development envelope at this location will not result in an increase in the impact the proposal may have on the environment.
Mitre Bend, Ellenbrook (Addition 17, Figure 2.1K)	An area of 0.1 ha within the existing road reserve is required to facilitate a connection between the PSP along the highway and the local road network, to provide improved connectivity for pedestrians and cyclists.	This additional area is within a previously disturbed environment. No clearing of native vegetation is proposed and so increasing the size of the development envelope at this location will not result in an increase in the impact the proposal may have on the environment.
Warrego Outlook, Ellenbrook (Addition 18, Figure 2.1K)	An area of 0.1 ha within the existing road reserve is required to facilitate a connection between the PSP along the highway and the local road network, to provide improved connectivity for pedestrians and cyclists.	This additional area is within a previously disturbed environment. No clearing of native vegetation is proposed and so increasing the size of the development envelope at this location will not result in an increase in the impact the proposal may have on the environment.

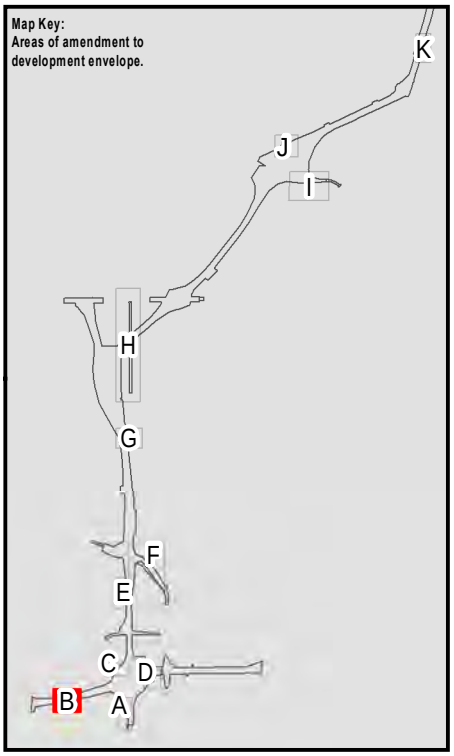


Source & Notes
Aerial imagery from Landgate (August 2014)

NorthLinkWA	coffey	Date: 05.12.2015 MXD: 4483AA_42_GIS002 File Name: 4483AA_42_F002.1A_GIS	Main Roads WA Response to Submissions Perth–Darwin National Highway	Changes to the development envelope	Figure No: 2.1A





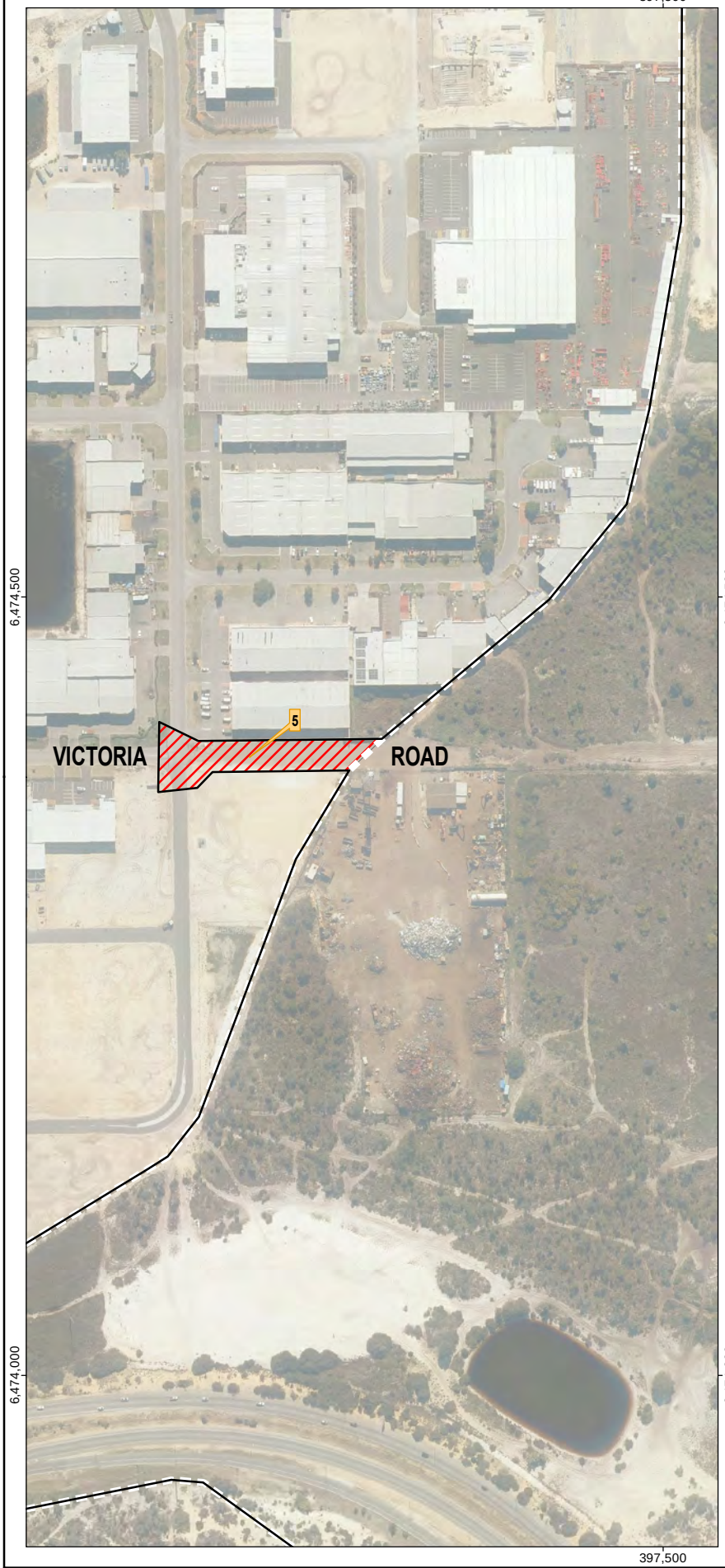


LEGEND

- Development envelope (Sep 2015)
- Additions to development envelope (Dec 2015)
- Revised development envelope (Dec 2015)

Source & Notes
Aerial imagery from Landgate (August 2014)

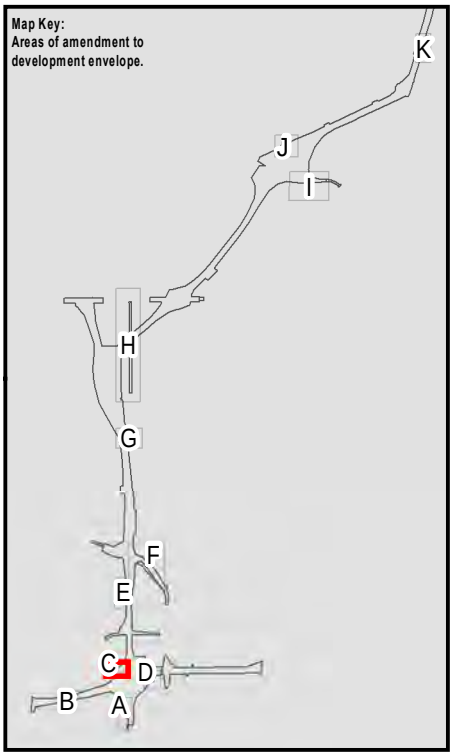
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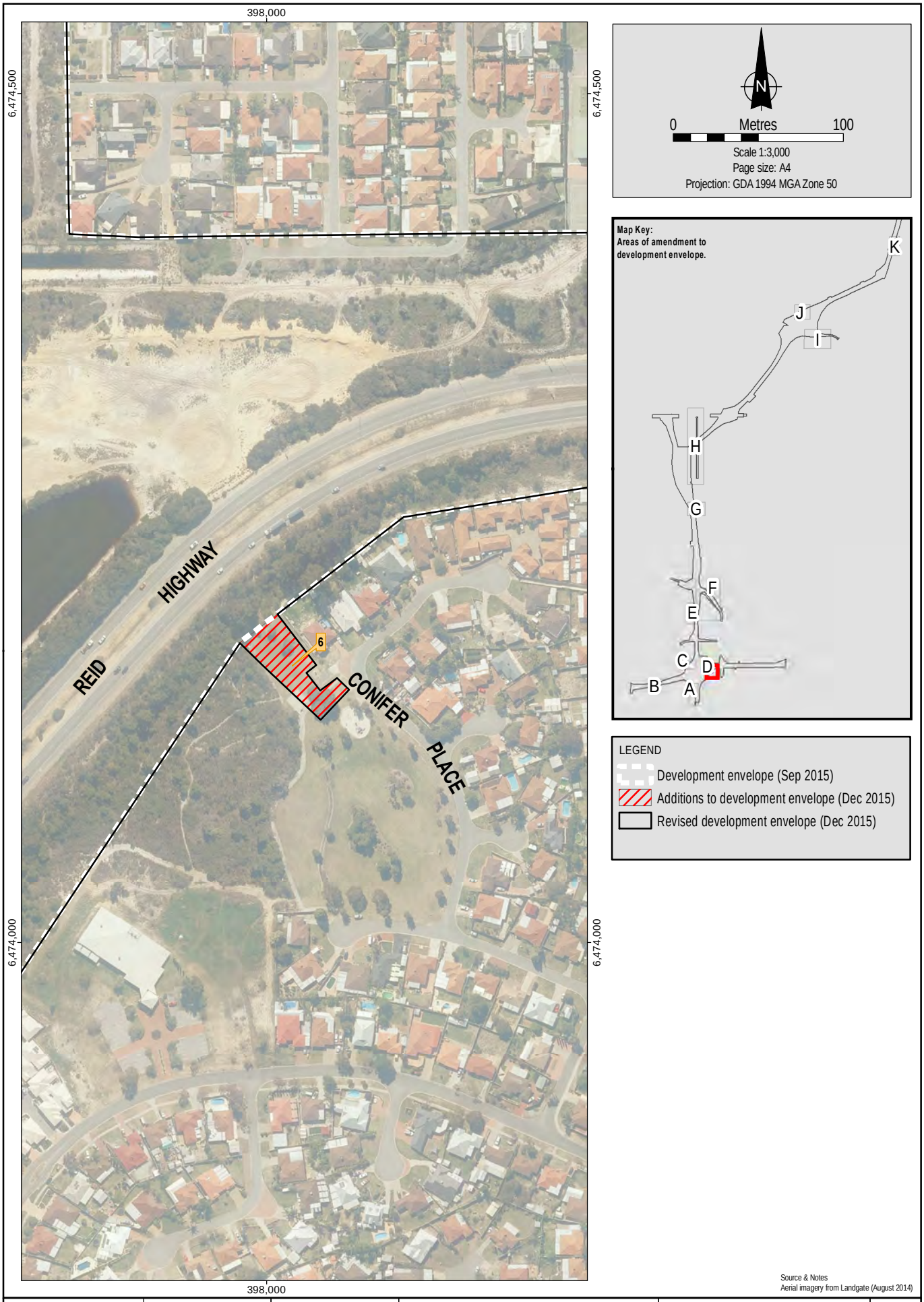


LEGEND

- Development envelope (Sep 2015)
- Additions to development envelope (Dec 2015)
- Revised development envelope (Dec 2015)

Source & Notes
Aerial imagery from Landgate (August 2014)

NorthLinkWA	coffey	Date: 05.12.2015 MXD: 4483AA_42_GIS002 File Name: 4483AA_42_F002.1C_GIS	Main Roads WA Response to Submissions Perth–Darwin National Highway	Changes to the development envelope	Figure No: 2.1C



NorthLinkWA	coffey	Date: 05.12.2015 MXD: 4483AA_42_GIS002 File Name: 4483AA_42_F002.1D_GIS	Main Roads WA Response to Submissions Perth–Darwin National Highway	Changes to the development envelope	Figure No: 2.1D



NorthLinkWA

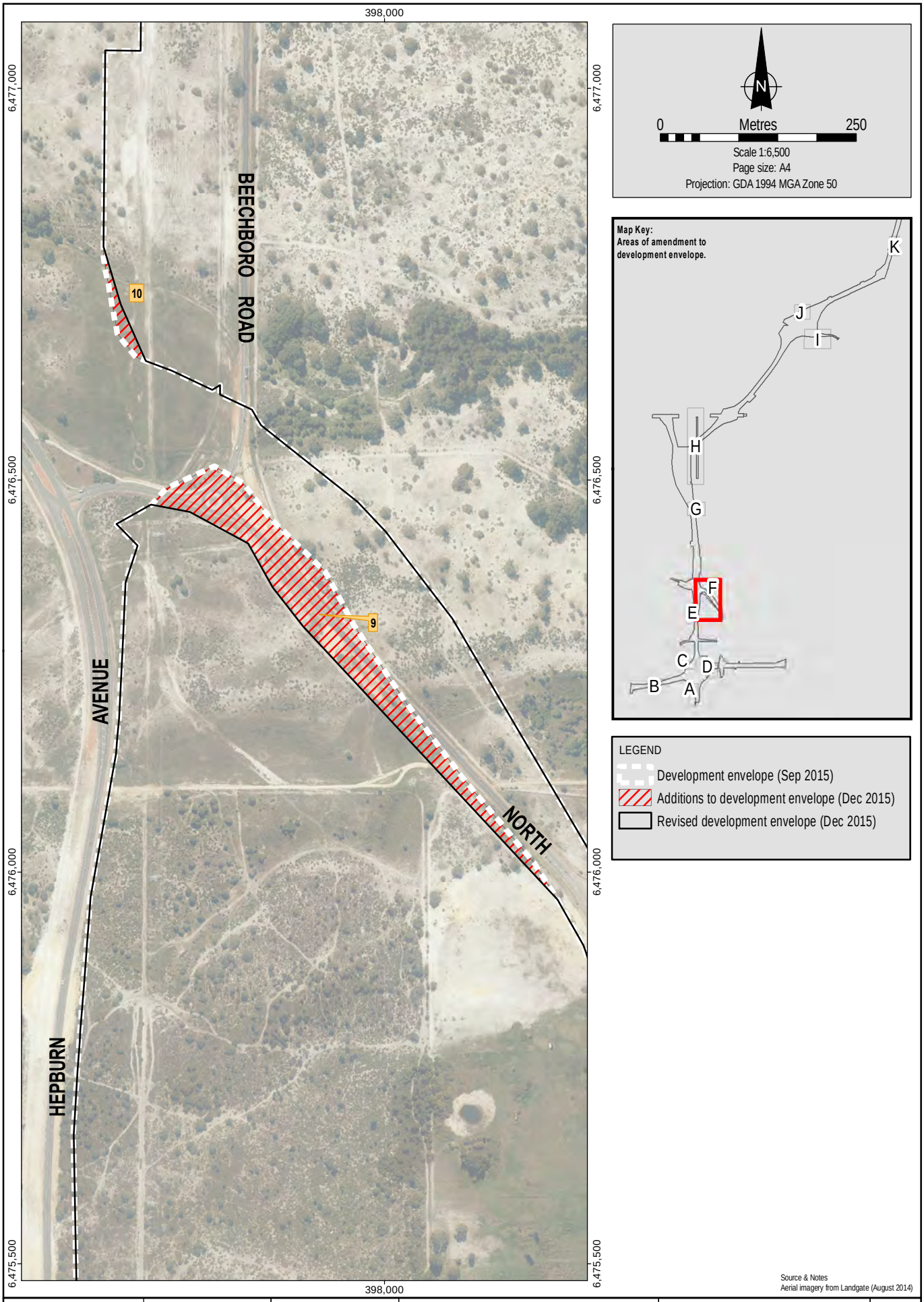
coffey

Date: 05.12.2015
MXD: 4483AA_42_GIS002
File Name: 4483AA_42_F002.1E_GIS

Main Roads WA
Response to Submissions
Perth–Darwin National Highway

Changes to the development envelope

Figure No: 2.1E



Source & Notes
Aerial imagery from Landgate (August 2014)

NorthLinkWA	coffey	Date: 05.12.2015 MXD: 4483AA_42_GIS002 File Name: 4483AA_42_F002.1F_GIS	Main Roads WA Response to Submissions Perth–Darwin National Highway	Changes to the development envelope	Figure No: 2.1F



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Projection: GDA 1994 MGA Zone 50

Map Key:
Areas of amendment to development envelope.

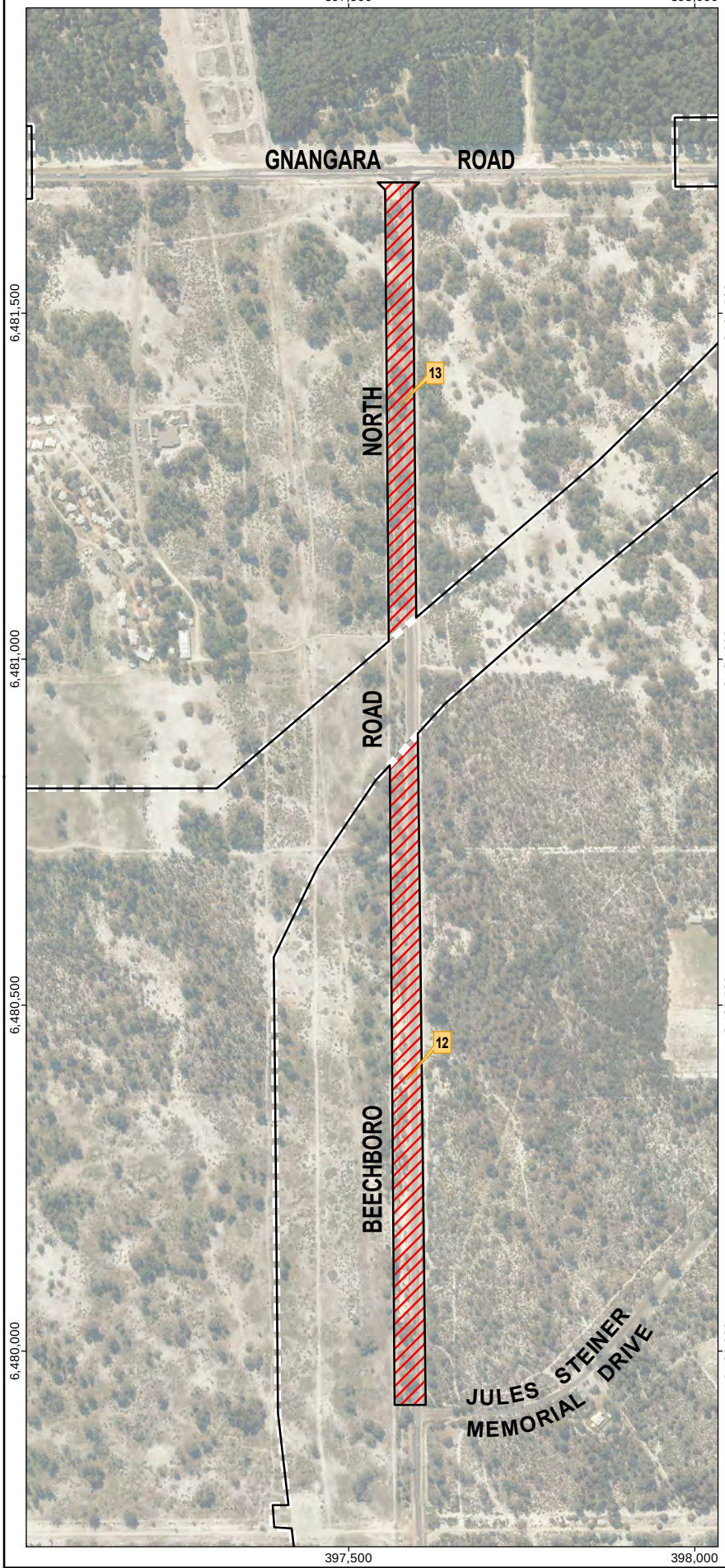


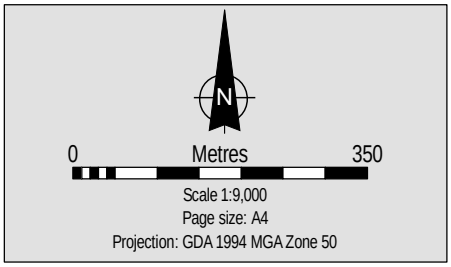
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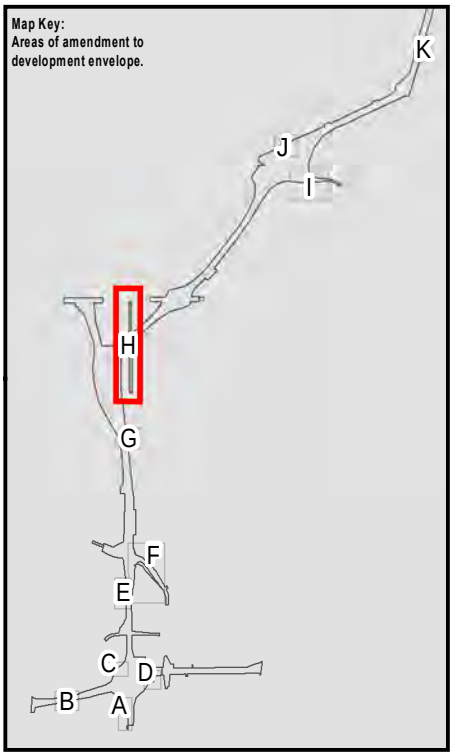
- Development envelope (Sep 2015)
- Additions to development envelope (Dec 2015)
- Revised development envelope (Dec 2015)

Source & Notes
Aerial imagery from Landgate (August 2014)

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LEGEND

- Revised development envelope (Dec 2015)
- Development envelope (Sep 2015)
- Additions to development envelope (Dec 2015)

Source & Notes
Aerial imagery from Landgate (August 2014)

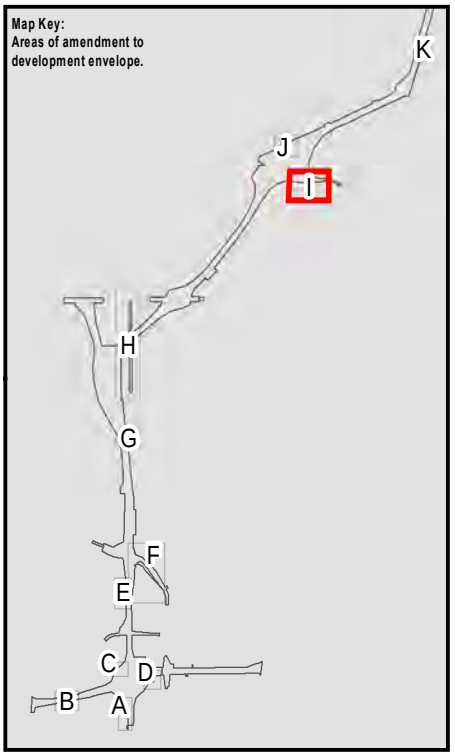
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LEGEND

- Development envelope (Sep 2015)
- Additions to development envelope (Dec 2015)
- Revised development envelope (Dec 2015)

Source & Notes
Aerial imagery from Landgate (August 2014)

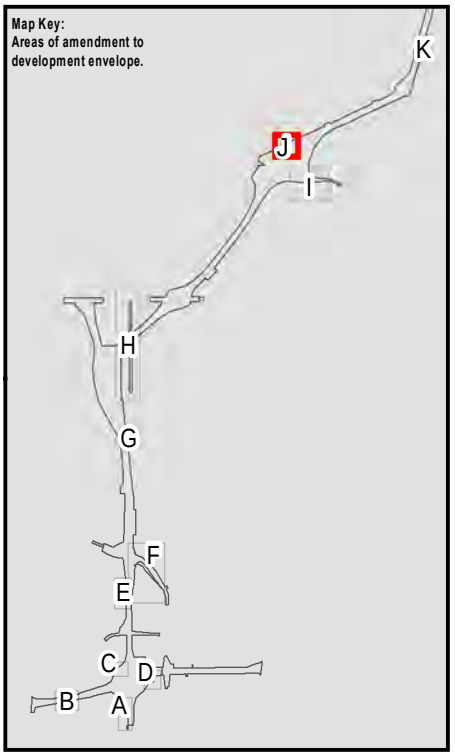
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N

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Scale 1:4,000
Page size: A4
Projection: GDA 1994 MGA Zone 50



LEGEND

- Development envelope (Sep 2015)
- Additions to development envelope (Dec 2015)
- Revised development envelope (Dec 2015)

Source & Notes
Aerial imagery from Landgate (August 2014)

NorthLinkWA	coffey	Date: 05.12.2015 MXD: 4483AA_42_GIS002 File Name: 4483AA_42_F002.1J_GIS	Main Roads WA Response to Submissions Perth–Darwin National Highway	Changes to the development envelope	Figure No: 2.1J

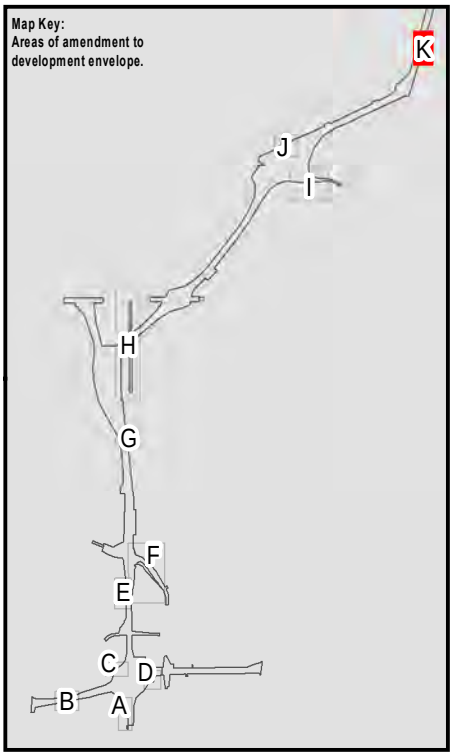


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Map Key:
Areas of amendment to development envelope.



LEGEND

- Development envelope (Sep 2015)
- Additions to development envelope (Dec 2015)
- Revised development envelope (Dec 2015)

Source & Notes
Aerial imagery from Landgate (August 2014)

NorthLinkWA	coffey	Date: 05.12.2015 MXD: 4483AA_42_GIS002 File Name: 4483AA_42_F002.1K_GIS	Main Roads WA Response to Submissions Perth–Darwin National Highway	Changes to the development envelope	Figure No: 2.1K

2.3 Updated Key Proposal Characteristics

In light of the changes discussed in Section 2.1 and 2.2, the key characteristics of the proposal presented in PER Chapter 1, Introduction, Table 1.2 have been revised and are included in Table 2.2.

Table 2.2 Key proposal characteristics

Element	Description
Proponent name	Main Roads Western Australia
Proposal title	Perth–Darwin National Highway (Swan Valley Section)
Short description	This proposal is to construct a new 38 km long section of the Perth–Darwin National Highway between Malaga and Muchea, Western Australia. It will consist of a dual carriageway highway and will connect the intersection of Tonkin Highway and Reid Highway in the south with Great Northern Highway (GNH) and Brand Highway in the north.
Development envelope	985 ha
Proposal footprint	Disturbance for construction purposes to be no more than 746 ha.
Noise walls	• Noise walls will be constructed only as required in the development envelope south of Maralla Road, either adjacent to property boundaries or adjacent to the road carriageways. • The height of noise walls will be capped at 5 m and confirmed in the detailed infrastructure plan.
Area of native vegetation cleared	No more than 206 ha.
Area of conservation category wetland cleared or indirectly impacted	No more than 16.0 ha.

Note: MRWA is seeking approval to construct and operate the proposal within the development envelope. The impact assessment is based on the proposal footprint, which is the area required to be disturbed based on the proposal's current design. The proposal footprint is wholly contained within the development envelope.

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3 SPRING ECOLOGICAL SURVEYS

This chapter summarises the results of additional work that has been completed since the publication of the PER in September 2015.

3.1 Additional Targeted Surveys for *Caladenia huegelii* Critical Habitat

A targeted field survey to confirm the extent of critical habitat for *Caladenia huegelii* was undertaken on 18 September 2015 by suitably qualified and experienced botanists (Woodman Environmental, 2015a) (Appendix C, Assessment & Refinement of Potential Critical Habitat for *Caladenia huegelii* (T-DRF) within the Development Envelope).

The field survey targeted potential areas of critical habitat within the study area west of Ellenbrook. The survey was conducted during the peak flowering period for *Caladenia huegelii*. The area of potential critical habitat originally mapped in the study area west of Ellenbrook (PER Appendix C, Level 2 Spring Flora and Vegetation Assessment) was revised and reduced by 42.8 ha from 184.6 ha to 141.4 ha. The extent of critical habitat in the study area, including critical habitat in Whiteman Park (not re-surveyed), is now 185.1 ha. As a result of the revised mapping, the proposal's direct impact to *Caladenia huegelii* critical habitat has been reduced by 9.2 ha from 39.2 ha to 30.0 ha (Figure 3.1).

The survey did not record any new locations of *Caladenia huegelii*.

3.2 Additional Targeted Surveys for *Meeboldina decipiens* subsp. *decipiens* and *Millotia tenuifolia* var. *laevis*

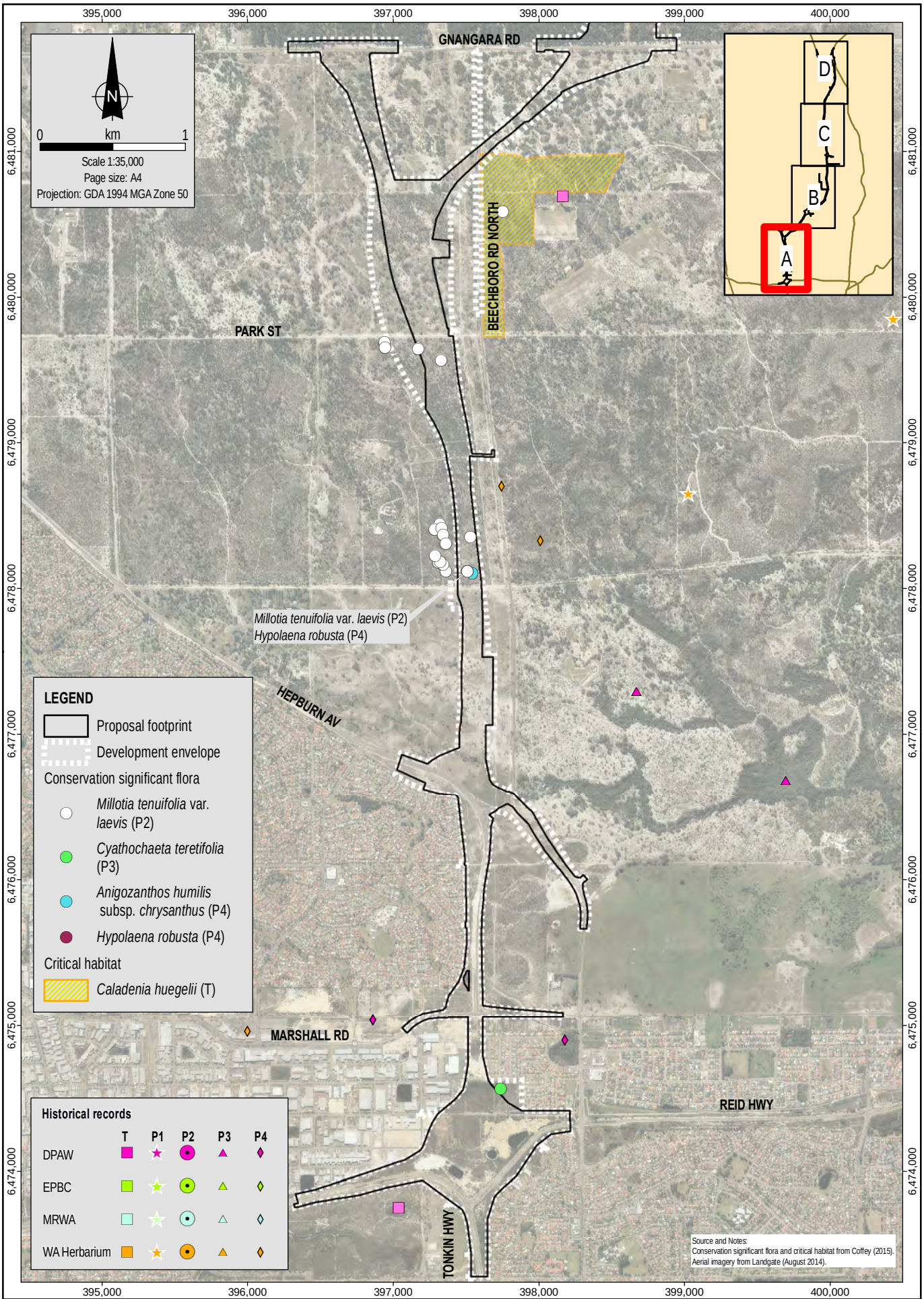
A targeted spring survey for *Meeboldina decipiens* subsp. *decipiens* (P3) and *Millotia tenuifolia* var. *laevis* (P2) was undertaken over five days between 6 and 15 October 2015 (Woodman Environmental, 2015b) (Appendix D, Spring Surveys for *Meeboldina decipiens* subsp. *decipiens* (P3) and *Millotia tenuifolia* var. *laevis* (P2).

The survey for *Millotia tenuifolia* var. *laevis* recorded a total of 5,222 individuals within eight populations outside the development envelope. This included two populations (1,652 individuals) adjacent to the proposal footprint west of Beechboro Road North in Cullacabardee. Of the 5,222 individuals recorded, 3,345 are in conservation estate (State Forest, Regional Park or MRWA's proposed offset property at Ioppolo Road).

The proposal will impact two populations of *Millotia tenuifolia* var. *laevis* comprising three individuals (PER Appendix C, Level 2 Spring Flora and Vegetation Assessment, Figure 3.1). The impact is not significant at a local or regional scale due to the number of individuals identified outside the proposal footprint in Woodman's 2015 survey.

Woodman collected plant material for individuals identified as *Meeboldina decipiens* subsp. *decipiens* (P3) in surveys for the PER. The material was re-identified by Western Australian Herbarium (WAH) staff to be *Lepyrodia muirii* (not a threatened species). *Meeboldina decipiens* subsp. *decipiens* (P3) is not in the proposal footprint and will not be impacted.

Local and regional numbers of and updated impacts to *Millotia tenuifolia* var. *laevis* and *Meeboldina decipiens* subsp. *decipiens* are tabulated in Section 3.5, New Records of *Darwinia foetida* as a revised version of PER Table 8.15.



NorthLinkWA

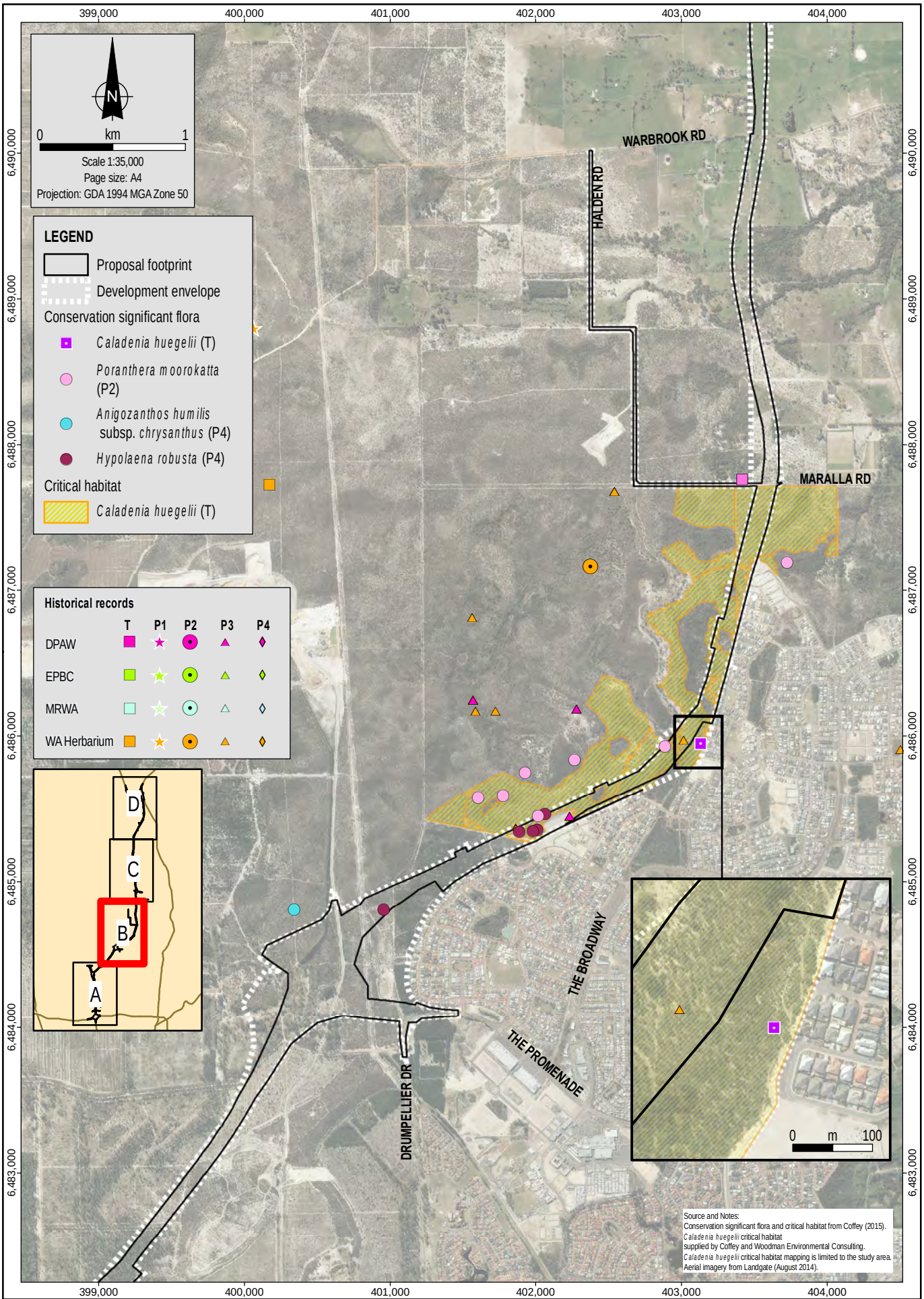
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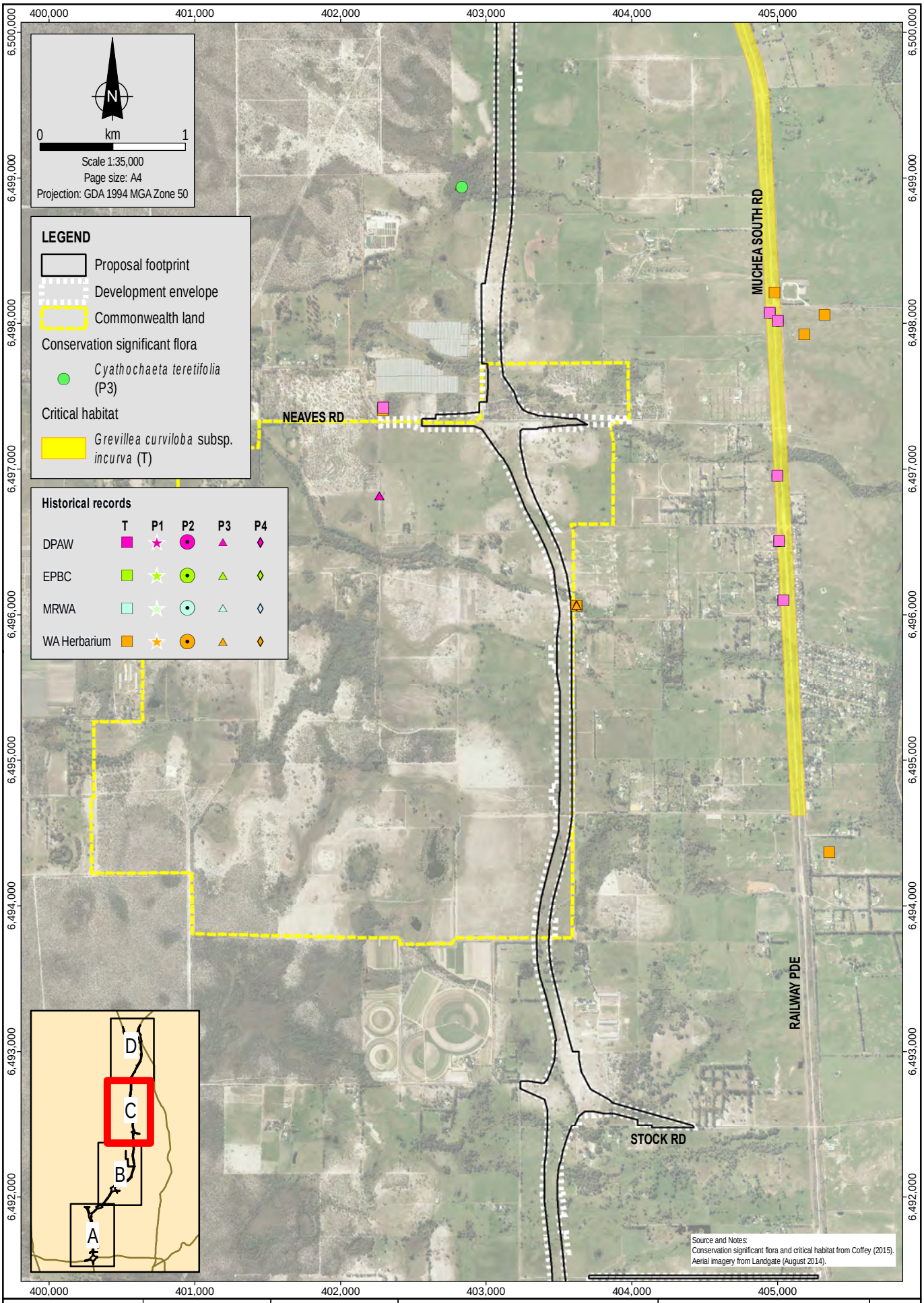
Main Roads WA
Response to Submissions
Perth–Darwin National Highway

Conservation significant flora
Map 1 of 4

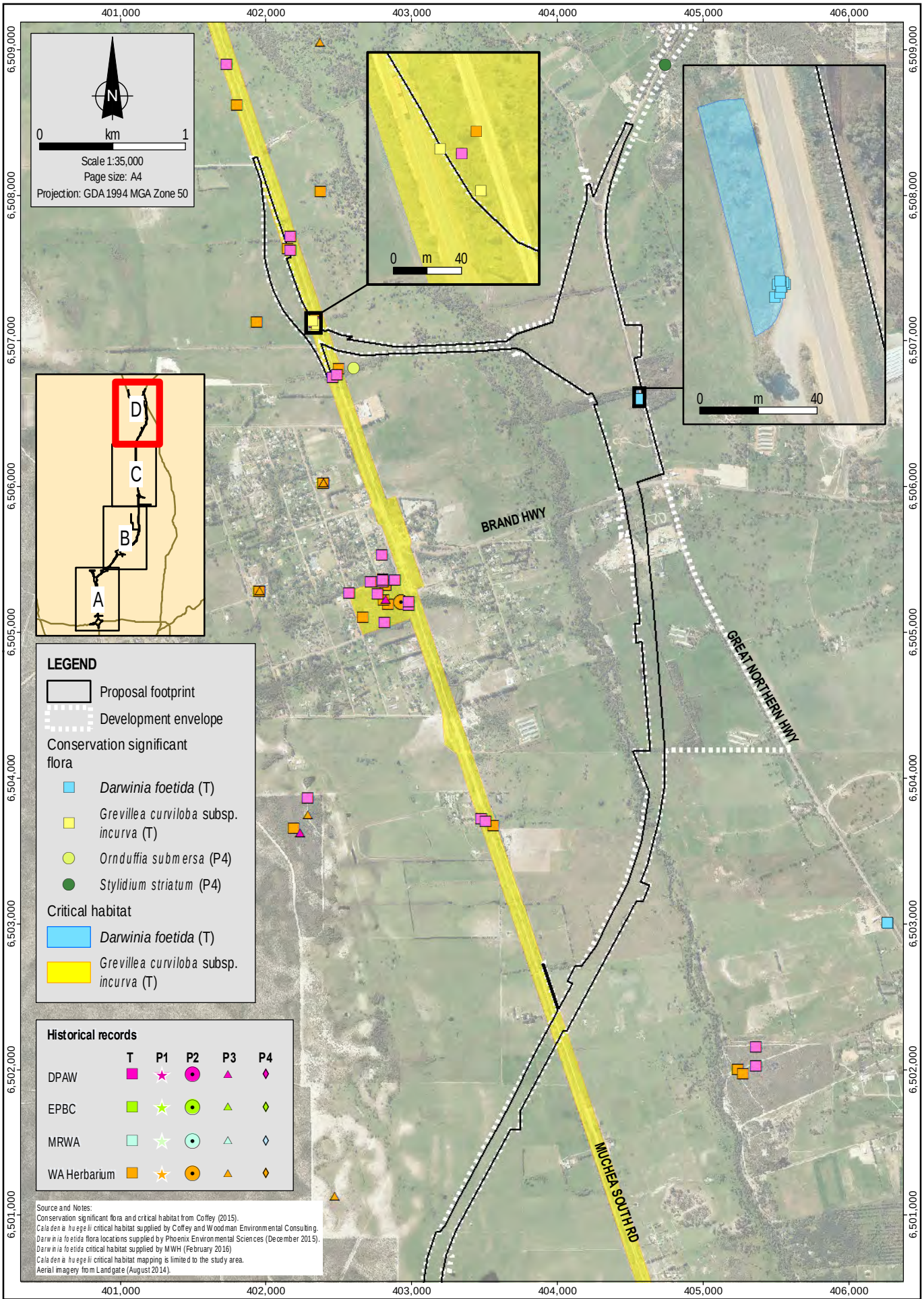
Figure No:
3.1A



NorthLinkWA	coffey	Date: 05.12.2015 MXD: 4483AA_42_GIS001 File Name: 4483AA_42_F003.1B_GIS	Main Roads WA Response to Submissions Perth–Darwin National Highway	Conservation significant flora Map 2 of 4	Figure No: 3.1B



NorthLinkWA	coffey	Date: 05.12.2015 MXD: 4483AA_42_GIS001 File Name: 4483AA_42_F003.1C_GIS	Main Roads WA Response to Submissions Perth–Darwin National Highway	Conservation significant flora Map 3 of 4	Figure No: 3.1C



NorthLinkWA

coffey

Date: 25.02.2016
MXD: 4483AA_42_GIS001
File Name: 4483AA_42_F003.1D_GIS_1

Main Roads WA
Response to Submissions
Perth–Darwin National Highway

Conservation significant flora
Map 4 of 4

Figure No:
3.1D

3.3 Additional Surveys to Investigate the Presence of SCP02 in the Proposal Footprint

An additional field survey was conducted on 17 September 2015 near Hepburn Avenue in Ballajura to further investigate the potential occurrence of the Threatened Ecological Community (TEC) SCP02 (Woodman Environmental, 2015c) (Appendix E, Spring Surveys and Analysis to Investigate SCP02 Presence).

Two new quadrats were placed in the vegetation community to the west of Hepburn Avenue, north of its intersection with Marshall Road (Figure 3.2). One new quadrat was placed in the vegetation community to the east of Hepburn Avenue.

The quadrat data was analysed using PATN and interpreted to determine the floristic community type (FCT) most closely resembling the vegetation communities. The quadrats were placed in the same supergroup as SCP02 due to similar dominant taxa, but occur within different subgroups. There was no direct match with FCTs for the three quadrats in this survey. The vegetation was grouped with SCP04 and S02, and most closely resembles SCP04. SCP04 is a common vegetation community of the Swan Coastal Plain (SCP) and is not listed as a TEC or Priority Ecological Community (PEC).

SCP02 is no longer considered to exist in the proposal footprint (Figure 3.2). The proposal will no longer impact SCP02.

3.4 Assessment of the Presence of SCP20a at the Ioppolo Road Offset Site

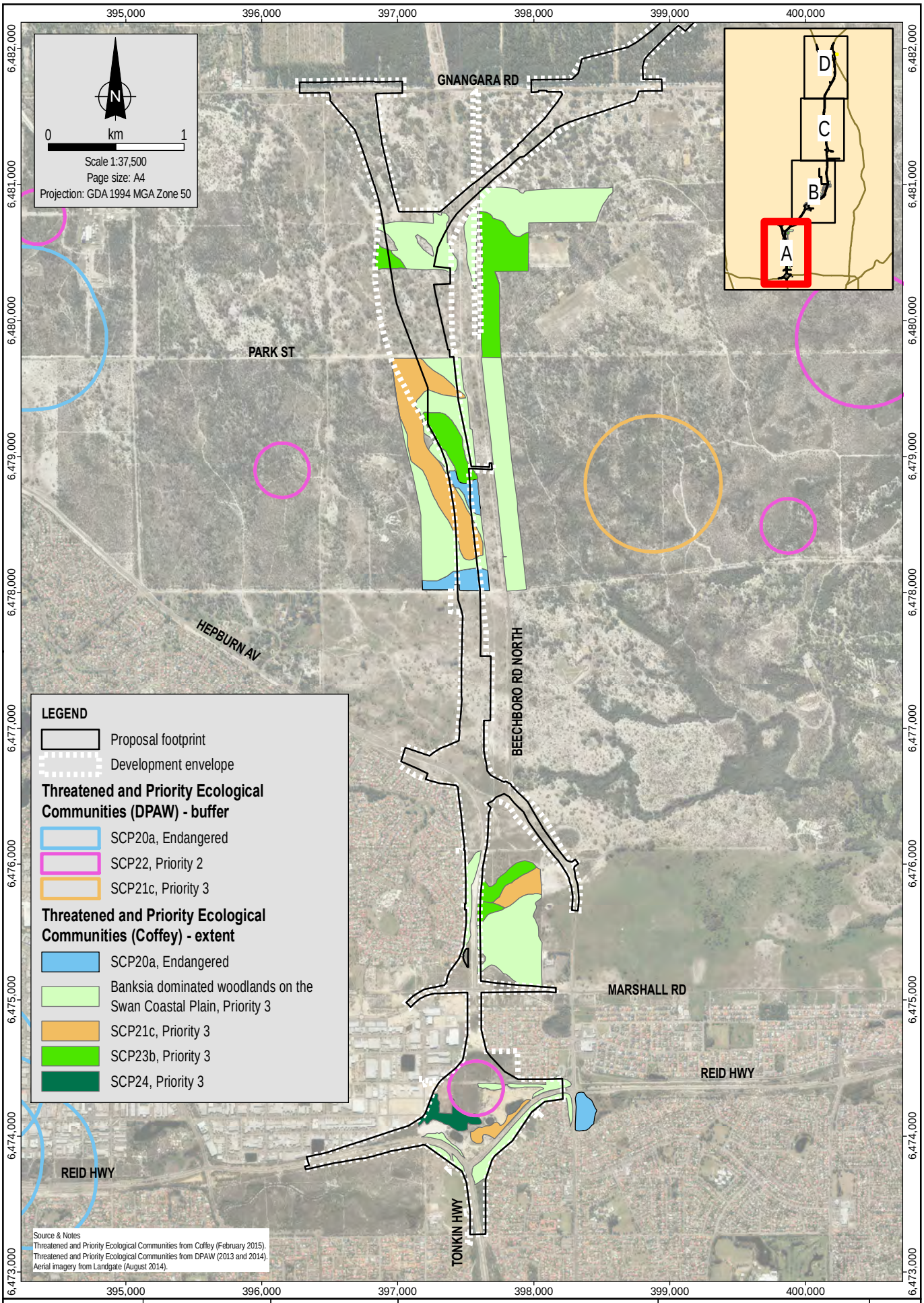
A supplementary field survey and investigation of the presence and extent of SCP20a within the proposed offset site at Ioppolo Road, Chittering was undertaken on 15 and 16 September 2015 (Woodman Environmental, 2015d) (Appendix F, Assessment of the Presence of the TEC SCP20a).

The quadrats surveyed in the offset proposal had a close association with SCP28. Two quadrats IR-01 and IR-05 had species in common with SCP20a, but analysis shows they are most closely related to SCP28. Other quadrats had the most species in common with SCP23c and SCP28 in the updated SCP dataset (Keighery et al., 2012).

The vegetation within the proposed offset site occurs in the same supergroup as SCP20a, but is more closely related to the subgroup SCP28, which is a common vegetation community.

This analysis (Woodman Environmental, 2015d) used the System Six dataset updated by Keighery et al. (2012) with all available records used in the analysis (i.e., 1,815 quadrats). To confirm the veracity of the results, the quadrats surveyed by Woodman were independently analysed by Griffin and Trudgen (2015) using the Gibson et al. (1994) and the System Six update, a total of 1,098 quadrats including 100 quadrats from the Dandaragan Plateau. Gibson et al. (1994) formed the basis for the original assessment presented in PER Appendix C, Level 2 Spring Flora and Vegetation Assessment (Appendix G, Analysis of floristic data from Ioppolo Road and Hepburn Avenue to assign sites to floristic community types). The Dandaragan Plateau quadrats provide useful context, as the Ioppolo Road offset site is located on the plateau. The Griffin and Trudgen analysis concluded that vegetation at the proposed offset site more closely resembled SCP23 (including subgroups SCP23a and SCP23b) and SCP28, noting that an analogue of SCP20a might exist at the site. The analogue appears to reflect a Dandaragan Plateau variation of SCP20a.

While DPAW has previously recorded the presence of SCP20a at Ioppolo Road, these studies found that SCP20a is unlikely to be represented in vegetation at Ioppolo Road and that vegetation communities at that site more closely resemble SCP23 (including subgroups) and SCP28.



NorthLinkWA

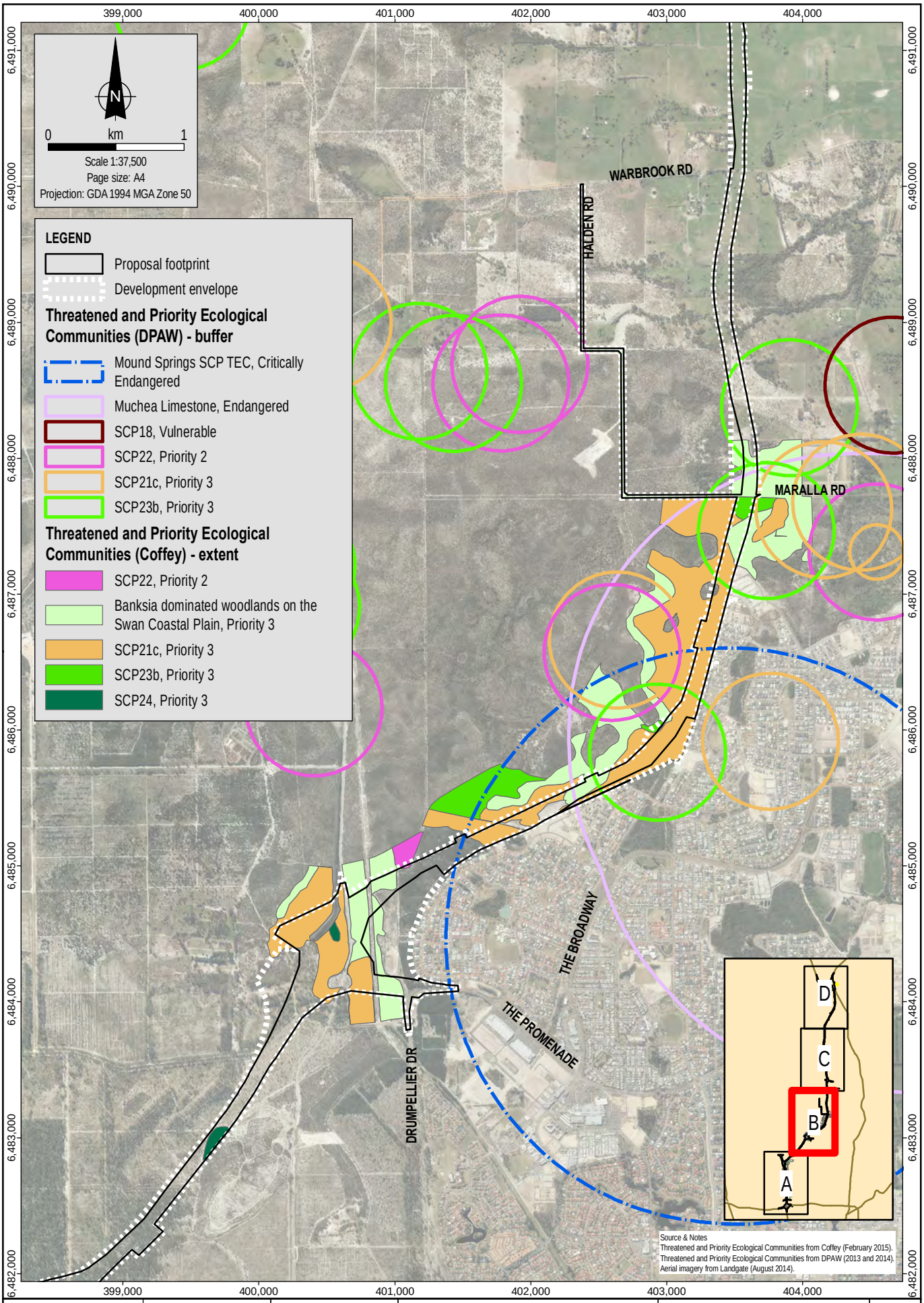
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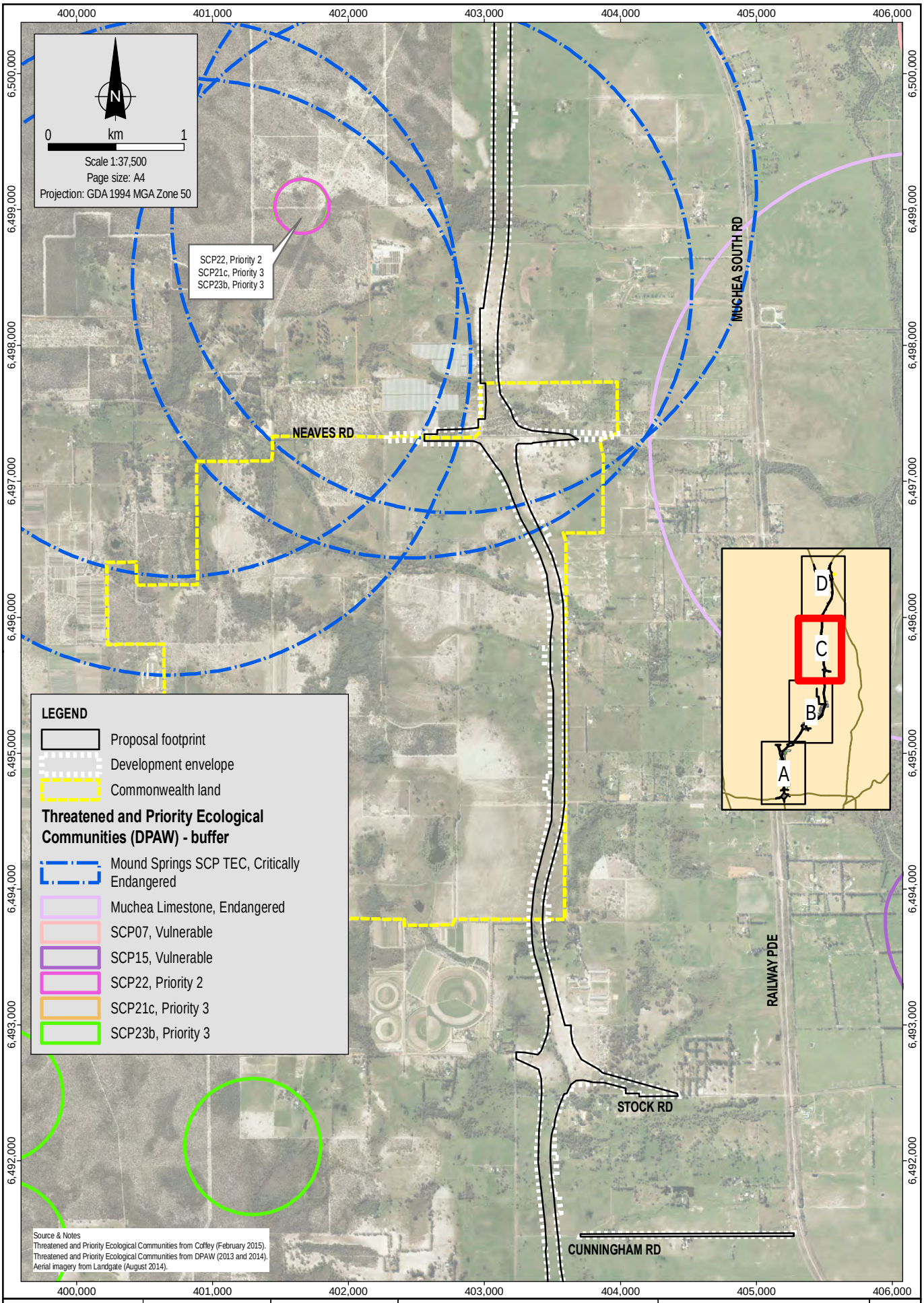
Main Roads WA
Response to Submissions
Perth–Darwin National Highway

Threatened and Priority Ecological Communities
Map 1 of 4

Figure No:
3.2A



NorthLinkWA	coffey	Date: 05.12.2015 MXD: 4483AA_42_GIS003 File Name: 4483AA_42_F003.2B_GIS	Main Roads WA Response to Submissions Perth–Darwin National Highway	Threatened and Priority Ecological Communities Map 2 of 4	Figure No: 3.2B



NorthLinkWA

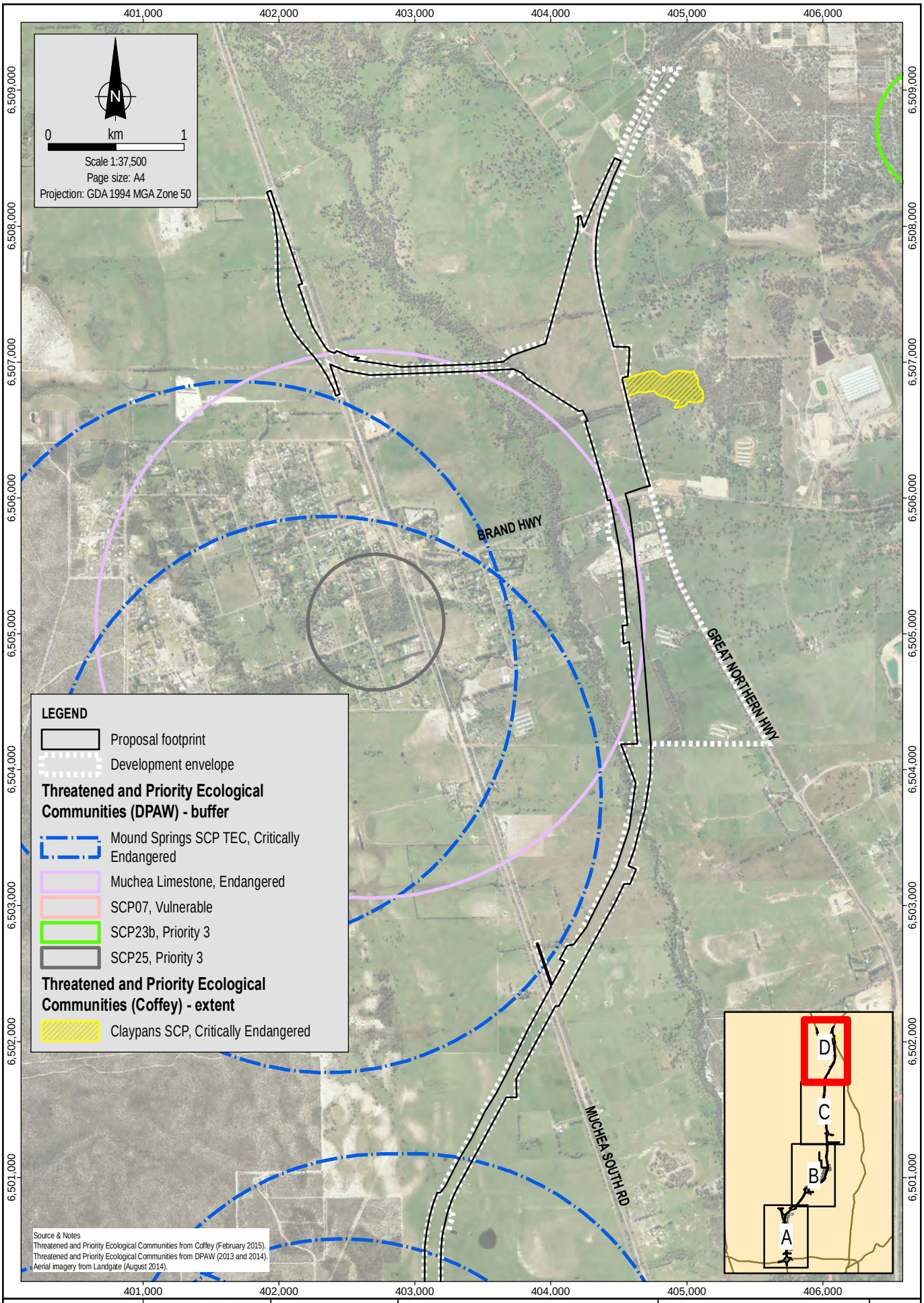
coffey

Date: 05.12.2015
MXD: 4483AA_42_GIS003
File Name: 4483AA_42_F003.2C_GIS

Main Roads WA
Response to Submissions
Perth–Darwin National Highway

Threatened and Priority Ecological Communities
Map 3 of 4

Figure No:
3.2C



NorthLinkWA	coffey	Date: 05.12.2015 MXD: 4483AA_42_GIS003 File Name: 4483AA_42_F003.2D_GIS	Main Roads WA Response to Submissions Perth–Darwin National Highway	Threatened and Priority Ecological Communities Map 4 of 4	Figure No: 3.2D

3.5 New Records of *Darwinia foetida*

The following sections provide existing environment, impact assessment, mitigations and residual impact assessment for *Darwinia foetida* in revision of (or in addition to) the information contained in PER Chapter 8, Flora and Vegetation.

3.5.1 Existing Environment

Darwinia foetida is listed as Endangered (EN) under the *Wildlife Conservation Act 1950* (WC Act) and Critically Endangered (CR) under the EPBC Act. *Darwinia foetida* was identified in a desktop assessment as occurring within the flora study area (see PER Chapter 8, Flora and Vegetation, Section 8.2, Existing Environment). Subsequent field surveys undertaken for the proposal did not locate *Darwinia foetida* within the proposal footprint. The assessment of *Darwinia foetida*'s presence in the proposal footprint was given in PER Table 8.1 as 'Likely'.

Phoenix Environmental Sciences carried out a flora and fauna assessment along parts of the Great Northern Highway (GNH) road reserve in Muchea and Chittering (Phoenix Environmental, 2015). The assessment was undertaken as part of a separate MRWA project to upgrade GNH between Muchea and Wubin. The assessment included the results of several field surveys during 2014 and 2015, some of which overlapped parts of the GNH road reserve within the development envelope of the proposal.

Two new populations of the Threatened (T) flora Muchea Bell (*Darwinia foetida*) were recorded during the Phoenix Environmental surveys. One new population of seven individuals was located on the western side of Great Northern Highway road reserve, adjacent to the northern end of the roadside rest area north of the Brand Highway intersection in Muchea (see Figure 3.1D). This population is nominally within the proposal footprint. A second new population of ten individuals was recorded from the GNH road reserve, about 4 km southeast of Muchea and outside the development envelope.

MWH was commissioned to undertake a further targeted search of the *Darwinia foetida* population nominally within the proposal footprint (MWH, 2016) (Appendix H, *Darwinia foetida* further information). MWH located the individuals recorded by Phoenix Environmental and revised the plant count to 16 mature individuals and 1 seedling. The population is located approximately 2 m from the edge of the sealed area of the roadside rest area. The extent of the population was identical to that mapped by Phoenix Environmental.

No critical habitat has been formally defined or described for *Darwinia foetida* (DOTE, 2016). MWH defined approximately 0.12 ha of roadside vegetation surrounding this population as critical habitat based on its area of occupancy, the hydrology of the area, coexisting species and the local habitat of this population. The critical habitat is bounded on the south by the roadside rest area, on the west by a fence, on the east by GNH and on the north by a drain under GNH (see Figure 3.1). The critical habitat is not considered to extend outside this area due to changes in vegetation and soils (MWH, 2016).

Table 3.1 provides an updated entry for *Darwinia foetida* in PER Table 8.1.

Table 3.1 Updated *Darwinia foetida* entry for PER Table 8.1 Threatened and priority listed flora occurring in proximity to the proposal footprint

Taxon	Conservation code			Generalised description of known locations	Flowering period	Closest record (km)	Likelihood of occurrence in the proposal footprint[2]
	EPBC Act	WC Act[1]	DPAW				
Darwinia foetida	CR	EN	–	Grey-white sand on swampy, seasonally wet sites.	Oct to Nov	0	Present

Note: this table shows the updated entry for *Darwinia foetida* only. The remainder of PER Table 8.1 is unchanged and is not repeated here.
Numbered notes:
1. *Wildlife Conservation Act 1950*.
2. 'Present' = occurring within the proposal footprint based on surveys.

PER Table 8.6 lists locally significant vegetation associations supporting threatened and priority taxa. The new population of *Darwinia foetida* in Muchea was recorded in a road reserve mapped as Cleared (Highway) (see PER Chapter 8, Flora and Vegetation, Figure 8.2F). There are no vegetation associations from the flora and vegetation assessment in the PER that can be attributed as locally significant to *Darwinia foetida*. There are consequently no updates or additions to PER Table 8.6 for *Darwinia foetida*.

Changes to PER Chapter 16, Matters Protected Under the EPBC Act, Table 16.2 'Significant impact criteria for flora' resulting from the new *Darwinia foetida* records are addressed in Chapter 5, Matters Protected Under the EPBC Act.

3.5.2 Assessment of Potential Impacts

This section updates PER Chapter 8, Flora and Vegetation, Section 8.1.5, Assessment of Potential Impacts with respect to *Darwinia foetida* only.

The new population adjacent to the roadside rest area in Muchea is nominally within the proposal footprint. Activities proposed for this area are works relating to the upgrading or removal of existing infrastructure only. The proposal will result in the removal of the roadside rest area and the upgrading of GNH. Upgrade works include resealing and/or reshouldering the road in connection with a realignment of GNH that will commence about 200 m north of the *Darwinia foetida* locations. While the proposal will not result in direct impacts to *Darwinia foetida* at this location, its immediate proximity to the rest area and Great Northern Highway potentially expose it and its critical habitat to indirect impacts. These indirect impacts potentially include habitat degradation from dust, altered hydrology, weeds and dieback. Due to the proximity of GNH, this location is already exposed to many of these threats as well as illegal rubbish dumping and an altered fire regime resulting from introduced grasses and weeds (MWH, 2016).

The other new population of *Darwinia foetida* recorded by Phoenix Environmental 4 km to the south is outside the development envelope and will not be impacted by the proposal.

Local and regional impacts to *Darwinia foetida* are shown in Table 3.2, which is an updated version of PER Table 8.15. Table 3.2 also contains the updates to *Meeboldina decipiens* subsp. *decipiens* and *Millotia tenuifolia* var. *laevis* described in Section 3.2.

The proposal will not impact the four populations of *Darwinia foetida* already considered in the PER.

Table 3.2 Updated PER Table 8.15 Local and regional impacts on threatened and priority flora

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 populations to be impacted (%)	Total minimum number of known Individuals	Number of individuals within study area	Number of known individuals to be impacted within the proposal footprint	Proportion of known individuals to be impacted (%)
Caladenia huegelii	T	19	1	–	–	355	1	–	–
Grevillea curviloba subsp. *incurva*	T	24	3	–	–	682	137	–	–
Darwinia foetida	T	6	2	–	–	1,911	41	–	–
Millotia tenuifolia var. *laevis*	P2	8	2	2	25.0	5,222	1,652	3	0.06
Poranthera moorokatta	P2	4	2	1	25.0	2,508	7	1	0.04
Meeboldina decipiens subsp. *decipiens* ms[1]	P3	11	–	–	–	7,137	–	–	–
Cyathochaeta teretifolia	P3	30	2	–	–	1,375	30	–	–
Anigozanthos humilis subsp. *chrysanthus*	P4	18	2	1	5.6	1,334	4	2	0.15
Hypolaena robusta	P4	30	3	3	10.0	17,742	25	17	0.1
Ornduffia submersa	P4	43	1	–	–	10,297	1	–	–
Stylidium striatum	P4	24	1	–	–	2,965	1	–	–

Sources: Coffey (2015b), MWH (2016), Phoenix Environmental (2015) and Woodman Environmental (2015b).

Notes:

1. Total number of known populations and minimum number of individuals includes populations of *Meeboldina decipiens* not resolved to infra-species level.

3.5.3 Management Measures

This section updates PER Chapter 8, Flora and Vegetation, Section 8.5, Management Measures with respect to *Darwinia foetida* only.

A 10 m buffer will be established, demarcated and maintained in existing vegetation around *Darwinia foetida* (See MPM02 in Table 13.1). The buffer will protect potential critical habitat and maintain hydrological regimes as far as practicable. Given existing infrastructure at the site, the buffer will be constrained to the road reserve not already used for Great Northern Highway and the roadside rest area. The buffer is also constrained by private property to the west. However, the buffer includes the roadside drainage structure that provides sumpland habitat for the species.

Existing mitigation measures proposed for flora and vegetation will apply to the new population of *Darwinia foetida* at Muchea. The following existing management as documented in Table 13.1, is particularly relevant to *Darwinia foetida*:

- Delineation of the clearing boundary prior to clearing (see FVM02 in Table 13.1).
- Preparation and implementation of an EMP to limit risk of fire, the introduction and/or spread of weeds (i.e. WONS and declared pests) and/or dieback, littering and unauthorised access (see FVM03 in Table 13.1).
- Preparation and implementation of a Flora and Vegetation Management and Monitoring Plan to manage impacts on environmentally significant flora and vegetation (see FVM04 in Table 13.1).
- Preparation and implementation of a weed and dieback hygiene management plan (see FVM07 in Table 13.1).
- Educational and induction material will include information on significant flora and ecological communities to reduce the risk of accidental clearing. (see FVM08 in Table 13.1).

3.5.4 Residual Environmental Outcome

This section updates PER Chapter 8, Flora and Vegetation, Section 8.6, Residual Environmental Outcome with respect to *Darwinia foetida* only.

The proposal will not directly impact any individuals or populations of *Darwinia foetida*. The proposal will result in the removal of the roadside rest area and upgrades to GNH, both of which may have indirect impacts on *Darwinia foetida* such as increased dust and altered hydrology. Given the proposed management and the species' current persistence next to GNH in a highly modified and weedy environment, the proposal is not expected to have a significant impact.

4 AMENITY (NOISE AND VIBRATION)

The DER raised concerns about calibration of the noise model in its submission on the PER. DER expressed concern that traffic noise impact from the proposed highway may have been underestimated due to the method adopted for calibrating the noise model.

This chapter summarises the revised transportation noise assessment (Appendix I, Revised Transportation Noise Assessment) undertaken in response to DER's concerns. This assessment supersedes the noise level predictions in PER Appendix O, Transportation Noise Assessment, as presented in PER Chapter 11, Amenity (Noise and Vibration).

4.1 Method Update

This section describes the review and update of the calibration factor and traffic volumes used in the revised assessment.

4.1.1 Calibration Factor

A calibration factor is used to adjust noise model outputs for differences between measured and modelled noise levels at monitoring locations. Differences may arise from spatial variations in parameters such as ground adsorption and noise propagation.

The modelled noise levels presented in the PER are 5 to 11 dB higher than the measured levels at sites A to L (PER Appendix O, Transportation Noise Assessment, Table 4.2). Typically, differences between measured and modelled noise levels range from 1 to 3 dB. The large variation between measured and modelled noise levels could be a result of the difference between the traffic conditions (and noise) modelled and those measured. For example, congestion on Tonkin Highway and local road traffic are not reflective of free-flowing traffic on a highway.

Additional monitoring was undertaken at a more analogous site on GNH at Muchea (Appendix I, Revised Transportation Noise Assessment, Figure 3-3 (Location T)) to enable review of the calibration factor. GNH is more reflective of the traffic conditions (and noise) expected for the proposal. The results of the monitoring and comparison with the modelled noise levels at this location are presented in Table 4.1.

Table 4.1 Comparison of measured and modelled noise levels at Location T

Rec ID	Address	Noise level (dB)		
		Measured $L_{Aeq(Day)}$	Modelled $L_{Aeq(Day)}$	Difference
T	3362 Great Northern Highway, Muchea	61.5	62.1	-0.6

The measured noise levels adjacent to the GNH show good correlation with the noise model. A calibration factor of -0.6 dB was adopted for the noise model.

4.1.2 Traffic Volumes

MRWA and the DOP periodically develop regional traffic models for the Perth Metropolitan area to account for predicted changes in land use and population. The 2050 regional traffic model was developed as part of this proposal and used in the transportation noise assessment (PER Appendix O, Transportation Noise Assessment). The previous regional traffic model was for predicted traffic in 2031.

State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning (SPP 5.4) (Government of WA, 2009) requires a 15 to 20 year transport planning horizon (from the opening date) for new roads. Neither 2031 (not far enough into the future) or 2050 (too far into the future) are suitable forecasts for modelling traffic noise for this proposal.

Traffic volumes for 2040 were used in the revised assessment. They were calculated from Perth–Darwin National Highway (PDNH) traffic models for 2031 and 2050 assuming linear growth, which is consistent with the land use and population growth trends used in those regional traffic models for Perth Metropolitan area.

4.2 Assessment of Potential Impacts

This section presents the revised noise impacts for operation based on a calibration factor of -0.6 dB and modelling with 2040 traffic volumes. The noise criteria for this assessment are unchanged from the PER (PER Appendix O, Transportation Noise Assessment).

4.2.1 Noranda, Ballajura and Ellenbrook

The noise level (55 dB $L_{Aeq(Day)}$ target and 60 dB $L_{Aeq(Day)}$ limit) contour plots (including location of noise walls) for Noranda, Ballajura and Ellenbrook are provided in Appendix I, Revised Transportation Noise Assessment, figures 5-1 to 5-4. In consultation with DER, a maximum height of 5 m has been adopted for noise walls, with the height of noise walls designed, where practicable, to achieve the following noise levels:

- SPP 5.4 noise target (55 dB $L_{Aeq(Day)}$) at residential properties in the vicinity of Ellenbrook.
- SPP 5.4 noise limit (60 dB $L_{Aeq(Day)}$) at noise sensitive premises at the Tonkin Highway/Reid Highway Interchange and along the highway section between Reid Highway and Hepburn Avenue.

4.2.2 Properties North of Ellenbrook

The predicted noise levels at rural residential properties north of Ellenbrook (with consideration of noise attenuation provided by 2.4-m-high visual screen walls constructed where residences are within 100 m of the road) are provided in Appendix I, Revised Transportation Noise Assessment, Table 5-1. The locations are identified in Figures 5-5 and 5-6. Sixteen rural residential properties north of Ellenbrook will experience noise levels exceeding the SPP 5.4 noise limit of 60 dB $L_{Aeq\ (Day)}$. Environmental Assessment Guidelines (EAG) EAG13 states that (EPA, 2014):

> *If, for a road or rail proposal, it has been identified that SPP 5.4 noise criteria cannot be met, the proponent is expected to follow the procedures provided for in SPP 5.4 to implement 'reasonable and practicable measures' to reduce noise impacts. This includes consulting with the community to identify the best overall solutions for noise management.*

To ensure the Environment Protection Authority's (EPA) objective will be met at these locations, indoor noise levels at these properties will be reduced to as low as reasonably practicable through the application of noise mitigation, set out in the Implementation Guidelines for SPP 5.4 (WAPC, 2014), as discussed and agreed with the affected property owners.

4.3 Management Measures

This section presents changes to the management measures proposed to manage noise impacts during operation, as a result of the revised transportation noise assessment (Table 4.2).

Table 4.2 Noise management measures

PER management measure	Revised/Deleted/New	Final management measure/Reason for deleting measure
Should the construction of noise walls not result in achieving the noise target of 55 dB L_{Aeq} at noise sensitive receptors between Hepburn Avenue and Ellenbrook, efforts will be made to achieve the noise limit of 60 dB L_{Aeq}.	Deleted	Not applicable. Reason for deletion: The revised transportation noise assessment has shown that the noise limit of 60 dB $L_{Aeq(Day)}$ can be met at noise sensitive receivers south of Maralla Road. While modelling shows that the noise target of 55 dB $L_{Aeq\ (Day)}$ will be achieved at most residences in Ellenbrook, it is not practicable to achieve this noise level at some locations due to the 5 m cap on noise wall height.
Façade protection packages will be implemented at identified properties north of Ellenbrook where noise levels are likely to exceed the day limit criteria of 60 dB L_{Aeq}. The level of treatment provided will be determined on a case-by-case basis in consultation with affected property owners and is likely to consist of 6 mm thick glazing to windows (see Figure 11.4).	Revised	Where the SPP 5.4 noise limit (60 dB $L_{Aeq\ (Day)}$) is unable to be achieved at rural residential properties north of Ellenbrook, indoor noise levels at these properties will be reduced to as low as reasonably practicable through the application of noise mitigation, set out in the Implementation Guidelines for SPP 5.4 (WAPC, 2014), as discussed and agreed with the affected property owners (See NVM06 Table 13.1).
Not applicable.	New	Noise monitoring will be undertaken to confirm the as built and operating highway achieves the SPP 5.4 noise limit (60 dB $L_{Aeq\ (Day)}$) at residences south of Maralla Road. Based on the results of the monitoring, MRWA may implement additional noise mitigation (See NVM07 Table 13.1).

The revised management proposed in this document supersedes the statement in PER Table 11.3 on page 11-12 that “Façade treatment will be provided to achieve indoor noise targets”. This statement is incorrect and inconsistent with other statements made in PER Chapter 11 regarding the intended outcome of façade treatment packages. Indoor noise targets within SPP 5.4 do not apply to major road infrastructure proposals such as this proposal.

The full list of management measures relating to noise is provided in Section 13, Summary of Management Measures.

4.4 Residual Impact

This section presents the revised residual impact assessment for traffic noise during operation. No updates to the assessment of construction impacts presented in PER Chapter 11, Amenity (Noise and Vibration), Table 11.3 are required, as a result of the revised impact assessment. Table 4.3 presents a summary of the residual operational noise impacts.

Table 4.3 Summary of residual operational noise impacts following implementation of management measures

Aspect	Predicted impact	Management	Residual impact
Road traffic using PDNH	Changes in noise levels for local communities	• Locate road infrastructure as far as practicable to the west within the road reserve in the vicinity of Ellenbrook (See NVM02 Table 13.1). • Use the quietest practical road surface (See NVM03 Table 13.1). • Construct noise walls to a maximum height of 5 m adjacent to noise sensitive premises between Reid Highway and Ellenbrook and of a material with a surface density exceeding 15 kg/m^2 to achieve the noise limit of 60 dB $L_{Aeq\ (Day)}$ (See NVM04 Table 13.1). • Construct screening walls of a maximum height of 2.4 m at noise sensitive premises north of Ellenbrook where they are within 100 m of the road (See NVM05 Table 13.1). • Where the SPP 5.4 noise limit (60 dB $L_{Aeq\ (Day)}$) is unable to be achieved at rural residential properties north of Ellenbrook, indoor noise levels at these properties will be reduced to as low as reasonably practicable through the application of noise mitigation, set out in the Implementation Guidelines for SPP 5.4 (WAPC, 2014), as discussed and agreed with the affected property owners (See NVM06 Table 13.1). • Noise monitoring will be undertaken to confirm the as built and operating highway achieves the SPP 5.4 noise limit (60 dB $L_{Aeq\ (Day)}$) at residences south of Maralla Road. Based on the results of the monitoring, MRWA may implement additional noise mitigation (See NVM07 Table 13.1).	The SPP 5.4 noise limit (60 dB $L_{Aeq\ (Day)}$) will be met at noise sensitive premises south of Maralla Road. The SPP 5.4 noise target (55 dB $L_{Aeq\ (Day)}$) will be met at most noise sensitive premises in the vicinity of Ellenbrook. It is not practicable to achieve the noise target at all residences due to the 5 m cap on noise wall height. Where noise levels exceed the noise limit (60 dB $L_{Aeq\ (Day)}$) at residences north of Maralla Road, noise mitigation set out in the implementation guidelines for SPP 5.4 will be applied, in consultation and by agreement with the property owner, to reduce indoor noise levels to acceptable levels. Outdoor noise levels will not be reduced by application of building mitigation.

5 MATTERS PROTECTED UNDER THE EPBC ACT

5.1 Changes to Matters Protected under the EPBC Act

MRWA committed to undertake additional spring surveys following publication of the PER in September 2015 to clarify the extent of critical habitat of the Threatened Grand Spider Orchid (*Caladenia huegelii*). A flora survey for a separate MRWA project recorded the Threatened Muchea Bell (*Darwinia foetida*) within the proposal footprint. This chapter updates the assessment of potential impacts on *Caladenia huegelii* to incorporate the findings of the survey and adds an assessment of potential impacts on *Darwinia foetida*.

5.2 Listed Threatened Flora Species and Communities

5.2.1 *Caladenia huegelii*

One individual of *Caladenia huegelii* was recorded from a location adjacent to Ellenbrook (Coffey, 2015b). The individual is located in remnant vegetation 20 m west of the housing estate and east of the proposal footprint. A noise wall will be constructed adjacent to the southbound carriageway of the proposed highway. The vegetation surrounding the individual has been identified as critical habitat for the species (DEC, 2009).

Critical habitat for the *Caladenia huegelii* was mapped in the flora study area which encompasses the proposal footprint (see PER Chapter 8, Flora and Vegetation, Figure 8.1B). A targeted field survey for potential critical habitat for *Caladenia huegelii* was undertaken on 18 September 2015 (see Section 3.1 and Appendix C). The area of potential critical habitat mapped in the study area west of Ellenbrook (near the recorded individual) by Coffey (2015c), was reduced by 42.8 ha to 141.4 ha. The extent of critical habitat in the study area, including critical habitat in Whiteman Park (not re-surveyed) is 185.1 ha. As a result of the revised mapping, the proposal's direct impact to *Caladenia huegelii* critical habitat has been reduced by 9.2 ha from 39.2 ha to 30.0 ha (see Figure 3.1).

Opportunistic survey for plants did not record any new locations of *Caladenia huegelii*.

5.2.1.1 Potential Impacts and Management Measures

The proposal will not result in any direct impact to known individuals of *Caladenia huegelii*. Indirect impacts potentially include habitat degradation from fragmentation, weeds, illegal rubbish dumping, dieback and potentially reduced visitation by pollinators (i.e., Thynnid wasps).

Direct impacts during construction will be managed by establishing and maintaining a 50 m vegetated buffer around the plant, where possible given the proximity of the plant to Ellenbrook boundary fences. Indirect impacts will be managed through development and implementation of a construction EMP, which will include measures to control the introduction and spread of weeds and dieback, and control access to reduce the potential for illegal rubbish dumping. A FVMMP will be developed and implemented to manage impacts on significant vegetation, including threatened flora, priority flora, TECs and PECs. This will include establishing baseline condition, undertaking monitoring and implementing remedial actions should changes to vegetation health and condition be detected.

The proposal will indirectly impact 1.9 ha of *Caladenia huegelii* critical habitat through the isolation of a potentially unviable fragment of critical habitat between Ellenbrook and the proposal (discussed later in response to consolidated issue 154 in Chapter 7, Response to Office of the Environmental Protection Authority Issues, Section 7.3.2). Other indirect impacts on *Caladenia huegelii* caused by the highway creating a barrier to the movement of wasps from critical habitat on the western side of the highway to the

patch of bushland east of the highway will be reduced by incorporating species used by Thynnid wasps as food sources in revegetation of the road reserve.

The significance of potential direct and indirect impacts on *Caladenia huegelii* has been assessed against the Department of the Environment's (DOTE) significant impact criteria (DOTE, 2013) and is detailed in Table 5.1.

Table 5.1 Significant impact criteria to *Caladenia huegelii*

Species	Significant impact criteria	Proposal relevance	Significant impact?
Caladenia huegelii	Lead to a long-term decrease in the size of a population.	The proposal will not directly impact any known individual.	No
	Reduce the area of occupancy of the species.	The proposal is unlikely to reduce the area of occupancy for *Caladenia huegelii*, as four separate surveys over four seasons have not recorded other individuals.	No
	Fragment an existing population into two or more populations.	The proposal will not fragment a population (one individual) into two.	No
	Adversely affect habitat critical to the survival of a species.	The proposal will remove 30 ha of native vegetation that is potential critical habitat and potentially indirectly impact a further 1.9 ha through habitat fragmentation. The individual will be protected within the vegetation to be retained east of the proposed highway.	Potential
	Disrupt the breeding cycle of a population.	A vegetated buffer will be maintained and managed around the known population to retain habitat for native pollinators.	No
	Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	The proposal is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that *Caladenia huegelii* is likely to decline. Potential critical habitat for *Caladenia huegelii* exists outside the proposal footprint within the study area (185.1 ha) and potentially beyond the study area. The loss of 31.9 ha of potential critical habitat will not cause species decline.	No
	Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.	The proposal has the potential to introduce invasive weeds which could degrade critical habitat supporting the known population. The construction EMP will manage the introduction and/or spread of invasive weeds. The FVMMP will monitor and manage impacts on threatened flora including *Caladenia huegelii.*	No
	Introduce disease that may cause the species to decline.	The construction EMP for the proposal will include measures to manage the risk of introduction or spread of diseases, specifically *Phytophthora* dieback.	No
	Interfere with the recovery of the species.	The proposal will not interfere with the recovery of *Caladenia huegelii*.	No

5.2.1.2 Residual Impacts

A summary of the management measures and residual impacts on *Caladenia huegelii* is provided in Table 5.2. Based on the significant impact criteria (Table 5.1), the clearing of 30 ha of potential critical habitat and potential loss of a further 1.9 ha of critical habitat through fragmentation may have a significant impact on the *Caladenia huegelii*.

The management measures are consistent with MRWA policies and procedures and are aligned with current industry practice. The effectiveness of the management measures in mitigating the residual impact on the *Caladenia huegelii* will be dependent on the successful implementation of the construction EMP and the FVMMP.

The management measures will reduce indirect impacts of the proposal on *Caladenia huegelii*.

Table 5.2 Summary of residual impacts to *Caladenia huegelii* following implementation of mitigation measures

Species and EPBC Act conservation status	Existing environment	Management measures	Residual impacts
Grand Spider Orchid (*Caladenia huegelii*) Endangered	One individual was recorded 60 m from the proposal footprint. Previous records of this species are known to occur within 100 m of the proposal footprint (Coffey, 2015b). The extent of critical habitat in the flora study area has been revised to 185.1 ha.	• Establish, clearly demarcate and maintain a 50 m vegetated buffer around known locations of *Caladenia huegelii* (see MPM013 in Table 13.1). • Preparation and implementation of an EMP to limit risk of fire, the introduction and/or spread of weeds (i.e. WONS and declared pests) and/or dieback, littering and unauthorised access (see FVM03 in Table 13.1). • Preparation and implementation of a Flora and Vegetation Management and Monitoring Plan to manage impacts on environmentally significant flora and vegetation (see FVM04 in Table 13.1). • Preparation and implementation of a weed and dieback hygiene management plan (see FVM07 in Table 13.1). • Species used by Thynnid wasps as food sources will be incorporated in revegetation of the road reserve adjacent to *Caladenia huegelii* critical habitat in the vicinity of Ellenbrook (see FVM13 in Table 13.1).	Up to 31.9 ha of potential critical habitat will be impacted within the proposal footprint.

5.2.2 *Darwinia foetida*

Darwinia foetida is listed as Critically Endangered under the EPBC Act. *Darwinia foetida* was identified in a desktop assessment as occurring within the flora study area (see PER Chapter 8, Flora and Vegetation, Section 8.2, Existing Environment). Subsequent field surveys undertaken for the proposal did not locate *Darwinia foetida* within the proposal footprint. The assessment of *Darwinia foetida*'s presence in the proposal footprint was given in PER Table 8.1 as 'Likely'.

Phoenix Environmental Sciences carried out a flora and fauna assessment along parts of the GNH road reserve in Muchea and Chittering (Phoenix Environmental, 2015). The assessment was undertaken as part of a separate MRWA project to upgrade GNH between Muchea and Wubin. The assessment included the results of several field surveys during 2014 and 2015, some of which overlapped parts of the GNH road reserve within the development envelope of the proposal.

Two new populations of the Threatened flora Muchea Bell (*Darwinia foetida*) were recorded during the Phoenix Environmental surveys. One new population of seven individuals was located on the western side of GNH road reserve, adjacent to the northern end of the roadside rest area north of the Brand Highway intersection in Muchea (see Figure 3.1D). This population is nominally within the proposal footprint. A second new population of ten individuals was recorded from the GNH road reserve, about 4 km southeast of Muchea and outside the development envelope.

MWH was commissioned to undertake a further targeted search of the *Darwinia foetida* population nominally within the proposal footprint (MWH, 2016) (Appendix H, *Darwinia foetida* further information). MWH located the individuals recorded by Phoenix Environmental and revised the plant count to 16 mature individuals and 1 seedling. The population is located approximately 2 m from the edge of the sealed area of the roadside rest area. The extent of the population was identical to that mapped by Phoenix Environmental.

No critical habitat has been formally defined or described for *Darwinia foetida* (DOTE, 2016). MWH defined approximately 0.12 ha of roadside vegetation surrounding this population as critical habitat based on its area of occupancy, the hydrology of the area, coexisting species and the local habitat of this population. The critical habitat is bounded on the south by the roadside rest area, on the west by a fence, on the east by GNH and on the north by a drain under GNH (see Figure 3.1). The critical habitat is not considered to extend outside this area due to changes in vegetation and soils (MWH, 2016).

5.2.2.1 Potential Impacts and Management Measures

Direct impacts during construction will be avoided by establishing and maintaining a 10 m buffer in existing vegetation around *Darwinia foetida*, within the constraints of the site. Indirect impacts will be managed through development and implementation of a construction EMP, which will include measures to control the introduction and spread of weeds and dieback. A FVMMP will be developed and implemented to manage impacts on significant vegetation, including threatened flora, priority flora, TECs and PECs. This will include establishing baseline condition, undertaking monitoring and implementing remedial actions should changes to vegetation health and condition be detected.

While the proposal will not result in direct impacts to *Darwinia foetida*, the proximity of *Darwinia foetida* to the rest area and Great Northern Highway potentially expose it and its critical habitat to indirect impacts. These indirect impacts potentially include habitat degradation from dust, altered hydrology, weeds and dieback. Due to the proximity of Great Northern Highway, this location is already exposed to many of these threats as well as illegal rubbish dumping and an altered fire regime resulting from introduced grasses and weeds (MWH, 2016).

The significance of potential direct and indirect impacts on *Darwinia foetida* has been assessed by MWH (MWH, 2016) against DOTE's significant impact criteria (DOTE, 2013) and is detailed in Table 5.3.

Table 5.3 Significant impact criteria to *Darwinia foetida*

Species	Significant impact criteria	Proposal relevance	Significant impact?
Darwinia foetida	Lead to a long-term decrease in the size of a population.	The proposal will not directly impact any known individual. The individuals currently persist in a highly altered environment despite weed and hydrological threats.	No
	Reduce the area of occupancy of the species.	Although the area of occupancy of the species is small (about 0.06 ha), the proposal will not further reduce the area of occupancy of the species.	No
	Fragment an existing population into two or more populations.	The proposal will not fragment a population into two.	No
	Adversely affect habitat critical to the survival of a species.	The proposal will not directly impact the 0.12 ha of critical habitat mapped in this location.	No
	Disrupt the breeding cycle of a population.	While the breeding cycle of *Darwinia foetida* is not known, the majority of *Darwinia* species are pollinated by insects and possibly birds. The proposal will not have any impacts that are expected to disrupt the breeding cycle of the species.	No
	Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	The proposal may indirectly modify or decrease the availability of habitat within the drain due to localised altered hydrology. However, given the persistence of the species in low quality habitat with dense weed cover including **Eragrostis curvula* and **Watsonia meriana*, indirect impacts are unlikely to cause the species to decline.	No
	Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.	The species persists in an area heavily infested with weed species including **Watsonia meriana*, **Eragrostis curvula*, **Avena barbata* and **Briza maxima*. The implementation of weed and dieback hygiene management plan will minimise the introduction of new weed species. The implementation of a Flora and Vegetation Management and Monitoring Plan will include monitoring of the buffer around *Darwinia foetida*. The proposal is not expected to significantly impact *Darwinia foetida* in relation to invasive species.	No
	Introduce disease that may cause the species to decline.	The construction EMP for the proposal will include measures to manage the risk of introduction or spread of diseases, specifically *Phytophthora* dieback.	No
	Interfere with the recovery of the species.	The proposal will not interfere with the recovery of *Darwinia foetida*.	No

Adapted from MWH (2016).

5.2.2.2 Residual Impacts

A summary of the management measures and residual impacts on *Darwinia foetida* is provided in Table 5.4. Based on the significant impact criteria (Table 5.2), the proposal will not directly impact any individuals or populations of *Darwinia foetida*. The proposal will result in the removal of the roadside rest area and upgrades to GNH, both of which may have indirect impacts on *Darwinia foetida* such as habitat degradation from dust, altered hydrology, weeds and dieback.

The management measures are consistent with MRWA policies and procedures and are aligned with current industry practice. The effectiveness of the management measures in mitigating the residual impact on the *Darwinia foetida* will be dependent on the successful implementation of the construction EMP and the FVMMP.

The management measures will reduce indirect impacts of the proposal on *Darwinia foetida*. Given the proposed management and the species' current persistence next to GNH in a highly modified and weedy environment, the proposal is not expected to have a significant impact.

Table 5.4 Summary of residual impacts to *Darwinia foetida* following implementation of mitigation measures

Species and EPBC Act conservation status	Existing environment	Management measures	Residual impacts
Muchea Bell (*Darwinia foetida*) Critically Endangered	Sixteen mature plants and one seedling have been recorded within the nominal proposal footprint. Previous records of this species are known to occur within 200 m of the proposal footprint (Coffey, 2015b). The extent of critical habitat at this location is 0.12 ha.	• Establish, clearly demarcate and maintain a 10 m buffer in existing vegetation around known locations of *Darwinia foetida* (see MPM02 in Table 13.1). • Delineation of the clearing boundary prior to clearing (see FVM02 in Table 13.1). • Preparation and implementation of an EMP to limit risk of fire, the introduction and/or spread of weeds (i.e. WONS and declared pests) and/or dieback, littering and unauthorised access (see FVM03 in Table 13.1). • Preparation and implementation of a Flora and Vegetation Management and Monitoring Plan to manage impacts on environmentally significant flora and vegetation (see FVM04 in Table 13.1). • Preparation and implementation of a weed and dieback hygiene management plan (see FVM07 in Table 13.1). • Educational and induction material will include information on significant flora and ecological communities to reduce the risk of accidental clearing. (see FVM08 in Table 13.1).	No direct impacts. No significant indirect impacts.

6 ENVIRONMENTAL OFFSETS

This chapter documents the proposal's offset strategy to address residual impacts on environmental values relevant to both the State, as assessed by the EPA, and for MNES, as determined by DOTE.

6.1 Definition of Offsets

Under the Commonwealth Environmental Offsets Policy (Government of Australia, 2012) the term 'environmental offsets' refers to measures that compensate for the residual adverse impacts of an action on the environment. Offsets provide environmental benefits to counterbalance the impacts that remain after avoidance and mitigation.

Under the WA Environmental Offsets Policy (Government of Western Australia, 2011) an environmental offset is an off-site action or actions that addresses significant residual environmental impacts of a development or activity.

Both State and Commonwealth policies specify that environmental offsets are not intended to make proposals with unacceptable impacts acceptable and are not a substitute for undertaking all reasonable avoidance and environmental mitigation measures.

Under both the State and Commonwealth offset policies, environmental offsets can be classified as direct or indirect. Definitions for direct and indirect offsets under these policies are discussed in Table 6.1.

Table 6.1 Definition of direct and indirect offsets

Offset category	Definition	
	State	Commonwealth
Direct	Actions designed to provide for on-ground improvement, rehabilitation and conservation of habitat outside the proposal footprint. Direct offsets vary, depending on the specific circumstances of environmental impacts, and include acquisition, restoration, revegetation and rehabilitation of natural areas.	Actions that provide a measurable conservation gain for an impacted protected matter. A conservation gain may be achieved by improving or creating new habitat, reducing threats, or averting the loss of a protected matter or its habitat that is under threat.
Indirect	Actions aimed at improving scientific or community understanding and awareness of environmental values that are affected by a development or activity. These actions are designed to result in positive conservation outcomes and may include research to improve the management and protection of existing conservation estate or contributions to State Government initiatives, policies or strategic funds.	Actions that do not directly offset the impacts on the protected matter, but are anticipated to lead to benefits for the impacted protected matter, for example funding for research or educational programs. Requirements for other compensatory measures.

Sources: Government of Western Australia (2011) and Government of Australia (2012).

6.2 Application of Offsets

Environmental offsets aim to counterbalance the significant residual environmental impacts or risks of a particular activity or project. Both the State and Commonwealth Governments provide advice on the application of offsets and principles for their use. The Western Australian Government endeavours to work cooperatively with the Commonwealth Government to avoid duplication of offsets, however, this is not always possible where a proposal or action is not jointly assessed under a bilateral agreement or a strategic assessment.

The State and Commonwealth Governments have formally agreed to conduct a strategic assessment in accordance with section 146 of the EPBC Act, focussing on the Perth and Peel regions of the SCP. While this proposal lies within the boundary of this strategic assessment, none of the proposed offsets are to be secured through the Strategic Assessment of the Perth and Peel Regions (SAPPR) process.

6.3 Offset Policies

6.3.1 State Offset Policy

The State's Environmental Offset Guidelines (Government of Western Australia, 2014) assist the EPA in the determination and application of environmental offsets on a project by project basis and ensure that decisions made on environmental offsets are consistent and accountable.

In general, significant residual impacts include those that affect rare and endangered plants and animals, areas within the formal conservation reserve system, important environmental systems and species that are protected under international agreement (e.g. Ramsar wetlands) (Government of Western Australia, 2014). A residual impact significance model has been developed to assist proponents in consistently determining the significance of residual impacts and when an offset is likely to, or may, require an offset (Government of Western Australia, 2014).

Following the determination of the level of significance for residual impacts, the type of offset should be determined in line with the EPA principles for the development of an offset package (Government of Western Australia, 2011). These are:

1. Environmental offsets will only be considered after avoidance and mitigation options have been pursued.
2. Environmental offsets are not appropriate for all projects.
3. Environmental offsets will be cost-effective, as well as relevant and proportionate to the significance of the environmental value being impacted.
4. Environmental offsets will be based on sound environmental information and knowledge.
5. Environmental offsets will be applied within a framework of adaptive management.
6. Environmental offsets will be focussed on longer term strategic outcomes.

6.3.2 Commonwealth Offset Policy

The Commonwealth's Offset Assessment Guide (DSEWPAC, 2012a) provides a framework to determine the suitability (i.e. appropriateness and adequacy) of proposed offsets for protected matters, including an impact and offset calculator. The Commonwealth outlines that (Government of Australia, 2012):

- Suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the protected matter.
- Suitable offsets must be built around direct offsets, but may include other compensatory measures.

- Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter.
- Suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter.
- Suitable offsets must effectively account for and manage the risks of the offset not succeeding.
- Suitable offsets must be additional to what is already required, determined by law or planning regulations or agreed to under other schemes and programs.
- Suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reliable.
- Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.

6.4 Rationale

The offset strategy for this proposal has been developed in consideration of field assessments and supporting studies and consultation with the EPA, DOTE, DPAW and the Department of the Premier and Cabinet. The objectives for this offset strategy are:

- A net environmental benefit.
- Offsets are 'like for like' or better, where possible.
- Significant residual impacts are offset.
- Regulatory requirements are met.
- Offsets are consistent with government policy.
- The strategy is enforceable and measurable, and adaptable, if required.

6.5 Summary of Significant Residual Impacts

A summary of significant residual impacts that are likely to require offsetting and the relevant offset proposal, under which they are addressed, is provided in Table 6.2.

Table 6.2 Summary of significant residual impacts requiring offset

Significant environmental value	Residual impact	Extent of significant residual impact[1]	Extent of significant residual impact outside SAPPR boundary	Relevant offset proposal[2]
Habitat for conservation significant fauna[3]	Removal of Carnaby's Black Cockatoo habitat.	207.2 ha foraging habitat[3,4,5,6], including: • 120.5 ha breeding habitat. • 763 potential breeding trees. • 56.5 ha roosting habitat.	5.15 ha of foraging, roosting and breeding habitat and 107 potential breeding trees.	1 and 2
	Removal of Forest Red-tailed Black Cockatoo habitat.	120.5 ha foraging habitat[3,4,5], including: • 120.5 ha breeding habitat. • 763 potential breeding trees. • 56.5 ha roosting habitat.	5.15 ha of foraging, roosting and breeding habitat and 107 potential breeding trees.	1 and 2
Wetlands and waterways	Partial or complete loss of seven CCWs	16.0 ha[4,6]	None.	2
Threatened Flora	Removal of critical habitat for *Caladenia huegelii*.	31.9 ha[4,6]	None.	3
TECs[3]	Removal of SCP20a (*Banksia attenuata* woodlands over species rich dense shrublands).	4.0 ha[3,4]	None.	4
Under-represented vegetation[3]	Removal of 124.9 ha of intact native vegetation within three vegetation complexes below the 30% retention target within the Perth to Peel Region.	• 62.1 ha[3,4] Bassendean Complex – Central and South. • 44.8 ha[3,4] Southern River Complex. • 18.0 ha[3,4] Yanga Complex.	5.5 ha Yanga Complex.	2 and 4
Conservation areas[5]	Excision of 10.1 ha of Class A Nature Reserve.	• 0.7 ha of Carnaby's Black Cockatoo foraging habitat.	None.	1
	Excision of 106 ha of State Forest.	• Under-represented vegetation: 2.1 ha Bassendean Complex – Central and South. • 34.8 ha of Carnaby's Black Cockatoo habitat, including 31.7 ha breeding habitat. • 31.7 ha of Forest Red-tailed Black Cockatoo foraging and breeding habitat.	None.	1 and 2

Significant environmental value	Residual impact	Extent of significant residual impact[1]	Extent of significant residual impact outside SAPPR boundary	Relevant offset proposal[2]
	Partial and complete removal of nine Bush Forever sites	• Under-represented vegetation: – 58.9 ha[7] Bassendean Complex – Central and South. – 18.6 ha Southern River Complex. – 3.4 ha Yanga Complex. • 124.5 ha[6, 7] of Carnaby's Black Cockatoo habitat, including 93.4 ha breeding habitat. • 93.4 ha of Forest Red-tailed Black Cockatoo foraging and breeding habitat. • 3.8 ha of TEC SCP20a.	None.	1, 2 and 4

Notes:
1. Total extent of residual impact, both inside and outside the SAPPR boundary. None of the proposed offsets will be secured through the SAPPR process.
2. For details relating to each of the offset proposals, see Section 6.6.
3. Inclusive of impacts discussed under conservation areas.
4. Impact includes the area to be cleared (i.e. proposal footprint) and any additional areas excised from conservation estate.
5. These figures represent the area to be impacted on both state and Commonwealth lands.
6. Impact includes severed portions that are not anticipated to persist, as discussed in the fragmentation analysis in Table 7.3.
7. Where an impact is within more than one type of conservation area, it has been attributed to the conservation area with the highest value (e.g., where an occurrence of or impact to a PEC is within both State Forest and Bush Forever site it has been attributed to State Forest).

6.6 Offset Proposals

6.6.1 Offset Proposal 1 – Ioppolo Road, Chittering

6.6.1.1 Commitment

MRWA will fund the acquisition of 673.5 ha of land at Lot M2091 (Plan 6457) Ioppolo Road, Chittering to be vested with the Conservation Commission for conservation purposes in perpetuity, and subsequent management by DPAW to offset the loss of Black Cockatoo habitat.

6.6.1.2 Description of Offset

The proposed 673.5 ha offset area occurs within a larger 983 ha block of land located on Lot M2091 (Plan 6457) Ioppolo Road, Chittering (herein referred to as Ioppolo Road). Ioppolo Road is surrounded by private land, with the exception of existing Class A and C Nature Reserves managed by DPAW to the west (Figure 6.1). It is currently zoned 'Agriculture Resource' under the Shire of Chittering Town Planning Scheme No. 6. MRWA has funded the purchase of Ioppolo Road by DPAW for the purpose of offsetting impacts of the wider NorthLink WA Project (including this proposal and the Tonkin Grade Separations project).

A field survey was undertaken to determine the existing environmental values within Ioppolo Road (Coffey, 2015c) (PER Appendix V, Preliminary Black Cockatoo Offset Considerations). The environmental assessment included a Level 1 flora and vegetation survey and a Level 1 fauna survey and Black Cockatoo habitat assessment (Coffey, 2015d). The results of this assessment are provided in Attachment D (Flora,

vegetation and fauna assessment – Lot M2091 Ioppolo Road, Chittering) to PER Appendix V, Preliminary Black Cockatoo Offset Considerations.

A follow-up survey to investigate the presence and extent of SCP20a within Ioppolo Road was completed in Spring 2015, and did not confirm the presence of SCP20a, as discussed in Chapter 3, Spring Ecological Surveys. Further consideration of the potential for *Caladenia huegelii* to occur within the offset site also determined that the site was unlikely to support this species and so no additional surveys for this species (or its habitat) were completed at Ioppolo Road.

Carnaby's Black Cockatoo foraging habitat within the offset area is associated with Eucalypt Woodland and Banksia Woodland and contains 17 species of foraging resources, including the following dominant species: *Eucalyptus marginata*, *E. todtiana*, *Corymbia calophylla*, *Allocasuarina humilis*, *Banksia menziesii* and *B. attenuata*. The Forest Red-tailed Black Cockatoo habitat within the offset area is associated with Eucalypt Woodland that contains *Eucalyptus marginata* and *Corymbia calophylla,* both of which are the main constituents of this species' diet (Figure 6.1).

Eucalypt Woodland habitat (specifically the stands of tall *Eucalyptus marginata*, *E. todtiana* and *Corymbia calophylla) w*ithin the offset area also represents Black Cockatoo breeding and roosting habitat. An estimated 6,300 potential breeding trees are present within the Eucalypt Woodland habitat, based on an average tree density of 20 trees per hectare. This habitat is considered to have current breeding potential given that tree age is sufficient to produce large hollows, the offset area is within the current modelled breeding and non-breeding range of Carnaby's Black Cockatoo (DSEWPAC, 2012) and is within 16 km of a number of significant roost sites at Gingin town site (Finn et al., 2014).

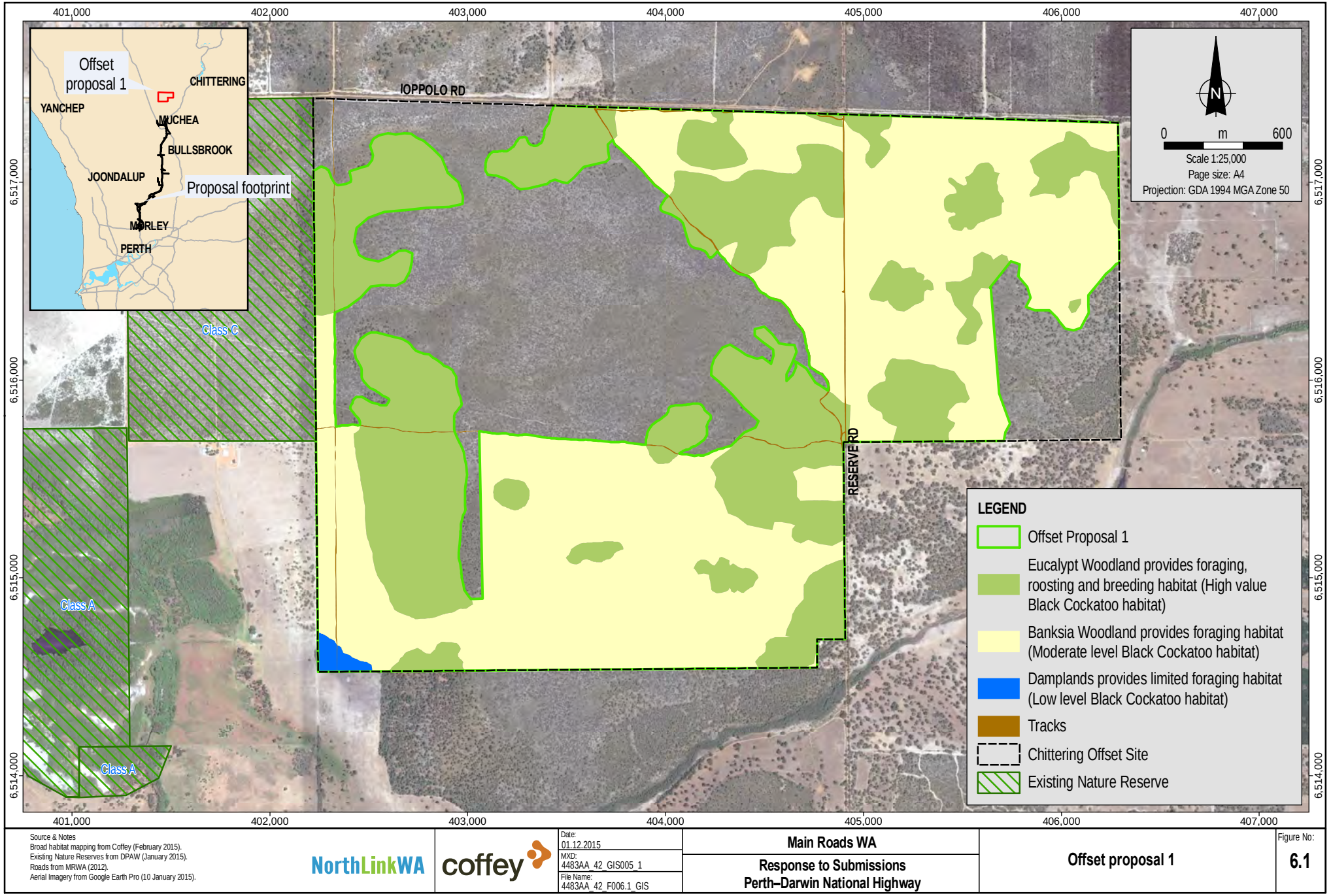
While this offset area is outside the modelled distribution for the Forest Red-tailed Black Cockatoo (DSEWPAC, 2012), DPAW has recently confirmed that there have been regular sightings of Forest Red-tailed Black Cockatoos in the surrounding area including as far north as Bindoon (Errington, pers. comm.). DPAW is currently arranging for these records to be incorporated into their database, which will extend the known range of this species to include this offset area.

6.6.1.3 Purpose of Offset

The primary purpose of Offset Proposal 1 is to offset the majority of the proposal's significant residual impact on Black Cockatoo habitat, including the loss of Black Cockatoo habitat from within conservation areas and within both State and Commonwealth land (see Table 6.2).

This offset proposal provides the following values for Black Cockatoos:

- Formal protection of 673.5 ha of foraging habitat for Carnaby's Black Cockatoo, including 279 ha of potential breeding habitat and approximately 5,580 trees. This is equivalent to 97.51% of this species offset requirement based on the Commonwealth offset assessment guide (see Appendix J, EPBC Act Offset Assessment Guide - Carnaby's Black Cockatoo).
- Formal protection of 279 ha of foraging and potential breeding habitat for Forest Red-tailed Black Cockatoo including approximately 5,580 trees. This is equivalent to 82.23% of this species offset requirement based on the Commonwealth offset assessment guide (see Appendix K, EPBC Act Offset Assessment Guide – Forest Red-tailed Black Cockatoo).



Source & Notes
Broad habitat mapping from Coffey (February 2015).
Existing Nature Reserves from DPAW (January 2015).
Roads from MRWA (2012).
Aerial Imagery from Google Earth Pro (10 January 2015).

NorthLinkWA

coffey

Date: 01.12.2015
MXD: 4483AA_42_GIS005_1
File Name: 4483AA_42_F006.1_GIS

Main Roads WA

Response to Submissions
Perth–Darwin National Highway

Offset proposal 1

Figure No: **6.1**

Offset Proposal 1 also provides the following additional values and net conservation benefits:

- Vesting with the Conservation Commission for long-term management as a conservation reserve.
- Vegetation in better condition (Excellent) than the majority of the vegetation to be cleared (although within different vegetation complexes) including increasing the pre-European extent remaining within formal protection of each of the following vegetation complexes, Coonambidgee (0.2%), Karamal (south) (0.8%), Mogumber (south) (3%), Moondah (0.6 ha) and Reagan (2.9%) vegetation complexes.
- One inferred TEC (SCP20b), one known TEC (SCP20c), and two inferred PECs (Banksia yellow-orange sands and SCP23b).
- One Threatened (*Chamelaucium* sp. Gingin (N.G. Marchant 6)) and one Priority flora species (*Hypolaena robusta* (P4)) were recorded, another four Priority listed plant taxa (Caustis sp. gigas (A.S. George 9318) (P2), *Schoenus griffinianus* (P3), *Verticordia rutilastra* (P3) and *Verticordia serrata* var. *linearis* (P3)) are known to occur. *Hypolaena robusta* (P4) is known from the proposal footprint.
- Known to support the Western Brush Wallaby (*Macropus irma*) (P4).
- Provides an ecological linkage to adjacent Class A and Class C conservation reserves and forms part of the catchment protecting Chandala wetlands, a significant conservation area.
- Management of Ioppolo Road as part of the conservation estate will include management of threatening processes such as dieback.

MRWA will continue to liaise with DPAW to reach agreement on the scope, duration and funding for ongoing management of this offset in line with DPAW's Corporate Guideline No. 14 Environmental Offsets – Proponent Land Management Contributions (DPAW, 2015). Details of the activities and funding arrangements for ongoing management will be documented in a Land Acquisition and Management Plan and may include such activities as rubbish removal, prevention of third party access, weed and dieback management. It is anticipated that MRWA will fund the ongoing management of this offset area for a period of up to 10 years, which is above the reasonable term of 5 to 7 years for implementing the works as recommended within the DPAW's Corporate Guideline No. 14 Environmental Offsets – Proponent Land Management Contributions (DPAW, 2015).

6.6.2 Offset Proposal 2 – Restoration Offset Plan

6.6.2.1 Commitment

MRWA will prepare a restoration offset plan that will include the acquisition and covenanting of several properties to be managed for conservation, including restoration and management funding for a period of 7 years (or until restoration completion criteria are met), to offset the loss of CCWs, Forest Red-tailed Black Cockatoo habitat and under-represented vegetation.

6.6.2.2 Purpose of Offset

The primary purpose of Offset Proposal 2 is to offset the loss of:

- 16 ha of CCWs in Completely Degraded to Excellent condition.
- 5.2 ha of Carnaby's Black Cockatoo habitat (remainder of proposal impact not addressed by Offset Proposal 1) in Completely Degraded to Pristine condition.
- 21 ha of Forest Red-tailed Black Cockatoo habitat (remainder of proposal impact not addressed by Offset Proposal 1) in Completely Degraded to Pristine condition.

- 124.9 ha of under-represented vegetation in Degraded to Excellent condition, including the loss of under-represented vegetation from within conservation areas (see Table 6.2).

This offset proposal will aim to:

- Protect and/or restore values to a commensurate or greater value/standard than those impacted.
- Locate offset sites as close to the proposal as possible, unless it can be demonstrated that an offset site achieves commensurate or greater value (e.g. wetland offsets which may not be in close proximity to the proposal but are located within the same consanguineous suite as impacted wetlands).

MRWA has identified three potential properties (31.5 ha) located close to the proposal footprint containing wetlands, Black Cockatoo habitat and under-represented vegetation (Yanga Complex) values. Based on a preliminary assessment of these sites, in consideration of the proposed restoration and using the EPBC Act offset assessment guide, the following ratios/areas will be required under this restoration offset plan to offset the loss of Black Cockatoo habitat:

- Carnaby's Black Cockatoo habitat: Ratio of 2.1:1 resulting in an offset requirement of 10.9 ha.
- Forest Red-tailed Black Cockatoo habitat: Ratio of 1.9:1 resulting in an offset requirement of 39.9 ha.

MRWA commits to a 3:1 offset ratio for CCWs, as has recently been recommended by the EPA for other assessments. Applied to this proposal an offset requirement of 48 ha of CCWs will be required under this restoration offset plan.

A 1:1 offset ratio, resulting in an offset requirement of 124.9 ha, is proposed for under-represented vegetation complexes in the Perth-Peel Region impacted by the proposal, on the basis that:

- Only minor area of the proposal's impact (2.1 ha or 1.4%) on vegetation complexes occurs within State Forest.
- While 80.9 ha (57.4%) of the proposal's impact on vegetation complexes occurs within Bush Forever sites, these vegetation complexes will still retain over 10% representation within the total area of Bush Forever sites.
- The remaining 41.9 ha impact on under-represented vegetation occurs outside conservation estate and Bush Forever.

Additional property/properties will need to be identified and included in the restoration offset plan to address the full offset requirement identified above. Specific details of the properties involved in the restoration offset plan will be made available following their acquisition.

This offset proposal will include the provision of funding for:

- Acquisition and vesting or covenanting of the properties with a suitable vesting authority.
- Restoration and ongoing management for a minimum of 7 years (or until restoration completion criteria are met).

The restoration offset plan will document the restoration and management (including monitoring) required over this period and will be provided to the OEPA and DPAW for comment ahead of implementation.

MRWA is considering opportunities to involve community groups in the delivery and management of this offset proposal. MRWA will ensure that the selected vesting authority/authorities are suitably qualified and experienced to implement the restoration offset plan.

6.6.3 Offset Proposal 3 – Critical Habitat for *Caladenia huegelii*

6.6.3.1 Commitment

MRWA is proposing to provide funding for a period of up to 10 years for the ongoing management of potential critical *Caladenia huegelii* habitat within existing reserves 46919 and 46875, Bush Forever Site 300 and Whiteman Park.

6.6.3.2 Purpose of Offset

The purpose of Offset Proposal 3 is to offset the loss of 31.9 ha of potential critical habitat for *Caladenia huegelii*.

The WA Environmental offsets policy states that:

> *Offsets will take account of, and contribute towards, broader State Government conservation objectives through existing programs, policies, initiatives and strategic funds. This includes the establishment and ongoing management of national parks, reserves and other conservation estate.*

The policy recognises that there are some environmental values that are not readily replaceable.

Due to the difficulty of replacing 'like-for-like' *Caladenia huegelii* habitat, MRWA proposes funding the development and implementation of an offset management plan for potential *Caladenia huegelli* critical habitat within reserves 46919 and 46875, Bush Forever Site 300 and Whiteman Park.

MRWA has currently proposed funding for a period of up to 10 years, which is above the reasonable term of 5 to 7 years for implementing management works as recommended within the DPAW's Corporate Guideline No. 14 Environmental Offsets – Proponent Land Management Contributions (DPAW, 2015). The scope, duration and funding of this plan will be determined in consultation with DPAW (and other landowners/managers) and in accordance with the Grand Spider Orchid (*Caladenia huegelii*) recovery plan (DEC, 2009).

The management plan will also ensure that, any proposed funding of DPAW management actions within reserves 46919 and 46875 are additional to the work already undertaken by the DPAW and not part of their normal responsibilities (in accordance with the WA Environmental Offsets Policy (Government of Western Australia, 2011).

The management plan may include the following:

- Weed and dieback mapping and control.
- Management of controlled access (e.g., installation of cable fencing).
- Additional surveys to identify and/or confirm critical habitat and the locations and distribution of populations/individuals.
- Monitoring of populations and habitat quality.

6.6.4 Offset Proposal 4 – SCP20a

6.6.4.1 Commitment

MRWA is proposing to fund the acquisition or covenanting of a property or properties to be managed for conservation, including management funding for a period of 7 years to offset the loss of SCP20a.

6.6.4.2 Purpose of Offset

The purpose of Offset Proposal 4 is to offset the loss of 4 ha of excellent quality SCP20a through protection of 23 ha of similar or better quality habitat. The acquisition of 23 ha of SCP20a of the same or better quality

than the area impacted will provide a ratio of 6:1, determined using the EPBC Act offset assessment guide (Appendix K). Where an offset site is identified that provides a restoration opportunity (lower quality start value) this ratio/area would be reduced. This offset proposal will include the provision of funding for:

- Acquisition and vesting or covenanting of the properties with a suitable vesting authority.
- Restoration and ongoing management for a minimum of 7 years (or until restoration completion criteria are met).

MRWA is considering opportunities to involve community groups in the delivery and management of this offset proposal. MRWA will ensure that the selected vesting authority/authorities are suitably qualified and experienced to implement the restoration offset plan.

6.6.5 Offset Summary

To effectively offset the significant residual impacts of the proposal MRWA will provide:

- Offset Proposal 1: Acquisition of 673.5 ha of land at Lot M2091 (Plan 6457) Ioppolo Road, Chittering to be vested with the Conservation Commission for conservation purposes in perpetuity, and subsequent management by DPAW to offset the loss of Black Cockatoo habitat.
- Offset Proposal 2: Preparation of a restoration offset plan that will include the acquisition and covenanting of several properties to be managed for conservation, including restoration and management funding for a period of 7 years (or until restoration completion criteria are met), to offset the loss of CCWs, Black Cockatoo habitat and under-represented vegetation.
- Offset Proposal 3: Funding for a period of up to 10 years for the ongoing management of potential critical *Caladenia huegelii* habitat within existing reserves 46919 and 46875, Bush Forever site 300 and Whiteman Park.
- Offset Proposal 4: Acquisition or covenanting of a property or properties to be managed for conservation, including management funding for a period of 7 years to offset the loss of SCP20a.

A summary of all four offset proposals using the WA offsets template is provided in Table 6.3.

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Table 6.3 Quantification of offset proposals

Existing environment and impact	Mitigation			Significant residual impact	Offset calculation methodology				
	Avoid and minimise	Rehabilitation type	Likely rehab. success		Type	Risk	Likely offset success	Time lag	Offset quantification
Carnaby's Black Cockatoo habitat Removal of foraging, breeding and roosting habitat.	The proposal predominantly (approximately 78.6%) follows existing infrastructure, cleared areas or secondary habitats, which reduces impacts to existing fauna habitats. Through design efficiencies the proposal footprint has been reduced from 1,028.4 ha to about 746 ha in size and reduced impacts to fauna habitats by a total of 49.6 ha across the alignment (PER, Terrestrial Fauna, Table 9.5). To avoid an area containing a high concentration of Black Cockatoo breeding trees, the width of the proposal footprint was reduced between Baal Street and Gnangara Road (see Figure 4.3), reducing the number of breeding trees cleared from 410 to 342.	Onsite rehabilitation opportunities will be limited to temporary construction areas. Furthermore the use of Banksia and other Black Cockatoo foraging resources will be limited as part of revegetation activities within 10 m of the road, as this increases the risk of bird strike. As MRWA will work to minimise its footprint, temporary areas of disturbance greater than 10 m from the road are anticipated to be limited.	N/A	**Extent:** Significant residual impact remains as 207.2 ha foraging habitat, inclusive of 120.0 ha breeding habitat (and 763 potential breeding trees) and 56.0 ha roosting habitat as potential area of suitable rehabilitation unknown at this stage. **Quality:** In accordance with the How to Use the Commonwealth Offset Assessment Guide (DSEWPAC, 2012a) the assessment of a threatened species' habitat must consider the site's condition, the site's context and the species' stocking rate. A Quality Score of 6 has been applied to this species habitat within the proposal footprint (see PER Appendix V, Preliminary Black Cockatoo Offset Considerations). **Conservation significance:** Endangered species. **Land tenure:** The following habitat features are located in conservation areas: • Nature Reserve: 0.7 ha of foraging habitat. • State Forest: 34.8 ha of foraging habitat inclusive of 31.7 ha of breeding habitat. • Bush Forever Site: 124.5 ha of foraging habitat inclusive of 93.4 ha of breeding habitat. **Timescale:** Permanent.	Offset Proposal 1 (Acquisition, protection and management, no restoration.)	Low – land to be acquired and transferred to conservation estate.	This is not applicable for land acquisition – see risk comments.	No time lag. The proposed offset site has already been acquired and has been ceded to the Conservation Commission for ongoing management by DPAW for the purpose of conservation.	In accordance with the EPBC Act Offset Assessment Guide (see Appendix J, EPBC Act Offset Assessment Guide – Carnaby's Black Cockatoo): 673.5 ha of foraging habitat, inclusive of 279 ha of Eucalyptus Woodland (which contains approximately 5,580 breeding/roosting trees) will offset this impact by 97.51%.
					Offset Proposal 2 (Acquisition, protection, restoration and management)	Low – land is expected to be vested with a suitable vesting authority with the intention that the land will be managed for conservation in perpetuity.	**Can the values be defined and measured:** Yes **Operator experience/ evidence:** MRWA will ensure that the selected vesting authority is suitably qualified and experienced to implement this offset proposal. **What is the type of vegetation being revegetated:** The restoration offset plan will endeavour to restore wetland and Carnaby's Black Cockatoo habitat, using local provenance species suited to the surrounding landscape characteristics.	Time until ecological benefit – 7 to 10 years for species to become productive.	In consideration of this proposal and the EPBC Act Offset Assessment Guide a ratio of 2.1:1, equivalent to an area of 10.9 ha of foraging and breeding habitat will be required.

Existing environment and impact	Mitigation			Significant residual impact	Offset calculation methodology				
	Avoid and minimise	Rehabilitation type	Likely rehab. success		Type	Risk	Likely offset success	Time lag	Offset quantification
Forest Red-tailed Black Cockatoo habitat Removal of 120.5 ha of foraging and breeding habitat (and 763 potential breeding trees), inclusive of 56.5 ha roosting habitat.	The proposal predominantly (approximately 78.6%) follows existing infrastructure, cleared areas or secondary habitats, which reduces impacts to existing fauna habitats. Through design efficiencies the proposal footprint has been reduced from 1,028.4 ha to about 746 ha in size and reduced impacts to fauna habitats by a total of 49.6 ha across the alignment (PER, Terrestrial Fauna, Table 9.5). To avoid an area containing a high concentration of Black Cockatoo breeding trees, the width of the proposal footprint was reduced between Baal Street and Gnangara Road (see Figure 4.3), reducing the number of breeding trees cleared from 410 to 342.	Onsite rehabilitation opportunities will be limited to temporary construction areas. Furthermore the use of Black Cockatoo foraging resources will be limited as part of revegetation activities within 10 m of the road, as this increases the risk of bird strike. As MRWA will work to minimise its footprint, temporary areas of disturbance greater than 10 m from the road are anticipated to be limited.	N/A	**Extent:** Significant residual impact remains as 120.1 ha foraging habitat, inclusive of 120.1 ha breeding habitat (and 763 potential breeding trees) and 58.6 ha roosting habitat as potential area of suitable rehabilitation unknown at this stage. **Quality:** In accordance with the How to Use the Commonwealth Offset Assessment Guide (DSEWPAC, 2012a), the assessment of a threatened species' habitat must consider the site's condition, the site's context and the species' stocking rate. A Quality Score of 6 has been applied to this species habitat within the proposal footprint (see Appendix V). **Conservation significance:** Vulnerable species. **Land tenure:** The following habitat features are located in conservation areas: • Nature Reserve: 0.7 ha of foraging habitat. • State Forest: 31.7 ha of foraging and breeding habitat. • Bush Forever Site: 93.4 ha of foraging and breeding habitat. **Timescale:** Permanent.	Offset Proposal 1 (Acquisition, protection and management, no restoration.)	Low – land to be acquired and transferred to conservation estate.	This is not applicable for land acquisition – see risk comments.	No time lag. The proposed offset site has already been acquired and has been ceded to the Conservation Commission for ongoing management by DPAW for the purpose of conservation.	In accordance with the EPBC Act Offset Assessment Guide (see Appendix K, EPBC Act Offset Assessment Guide – Forest Red-tailed Black Cockatoo): 279 ha of foraging and breeding habitat (which contains approximately 5,580 breeding/roosting trees) will offset this impact by 82.23%.
					Offset Proposal 2 (Acquisition, protection, restoration and management.)	Low – land is expected to be vested with a suitable vesting authority with the intention that the land will be managed for conservation in perpetuity.	**Can the values be defined and measured:** Yes **Operator experience/ evidence:** MRWA will ensure that the selected vesting authority is suitably qualified and experienced to implement this offset proposal. **What is the type of vegetation being revegetated:** The restoration offset plan will endeavour to restore wetland and Forest Red-tailed Black Cockatoo habitat, using local provenance species suited to the surrounding landscape characteristics.	Time until ecological benefit – 7 to 10 years for species to become productive.	In consideration of this proposal and the EPBC Act Offset Assessment Guide a ratio of 1.9:1, equivalent to an area of 39.9 ha of foraging and breeding habitat will be required.

Existing environment and impact	Mitigation			Significant residual impact	Offset calculation methodology				
	Avoid and minimise	Rehabilitation type	Likely rehab. success		Type	Risk	Likely offset success	Time lag	Offset quantification
CCWs Partial or complete loss of CCWs.	The proposal has been designed to avoid and minimise impacts to wetlands and other hydrological values as much as possible (including CCW 8800, CCW 8798, CCW 8926, Mound Springs SCP TEC at Gaston Road, Claypans of the SCP TEC) as depicted in PER, Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Figure 10.2.	No rehabilitation possible: Onsite rehabilitation opportunities will be limited to temporary construction areas. MRWA will work to minimise its footprint, and will locate any temporary construction areas (i.e. laydown areas) outside CCWs and their buffers.	N/A	**Extent:** Partial or complete loss of seven CCWs totalling 16 ha. **Quality:** Varying condition, Completely Degraded to Excellent. **Conservation significance:** Conservation Category wetland. **Land tenure:** N/A. **Timescale:** Permanent.	Offset proposal 2 (Acquisition, protection, restoration and management.)	Low – land is expected to be vested with a suitable vesting authority with the intention that the land will be managed for conservation in perpetuity.	**Can the values be defined and measured:** Yes **Operator experience/ evidence:** MRWA will ensure that the selected vesting authority is suitably qualified and experienced to implement this offset proposal. **What is the type of vegetation being revegetated:** The restoration offset plan will endeavour to restore wetland and Black Cockatoo habitat, using local provenance species suited to the surrounding landscape characteristics.	Time until ecological benefit – 7 to 10 years.	MRWA commits to a 3:1 offset ratio for CCWs, as has recently been recommended by the EPA for other assessments. Applied to this proposal an offset requirement of 48 ha of CCWs will be required under this restoration offset plan.
Under-represented vegetation Removal of 124.9 ha of under-represented vegetation in the Perth-Peel Region.	The alignment and width of the development envelope was reviewed to identify a proposal footprint that minimises clearing in areas with very good to pristine condition vegetation. Nearly 80% of the proposal footprint occurs within vegetation mapped as degraded or worse condition. Design measures including use of wire rope barriers along the full extent of the highway and installation of road safety barriers between the northbound and southbound lane have assisted in reducing road width.	No rehabilitation possible: Onsite rehabilitation opportunities will be limited to temporary construction areas. MRWA will work to minimise its footprint, and will locate any temporary construction areas (i.e. laydown areas) within existing disturbed areas or areas planned for future development under this proposal.	N/A	**Extent:** Removal of 124.9 ha of under-represented vegetation in the Perth-Peel Region, including: • 62.1 ha Bassendean Complex – Central and South. • 44.8 ha Southern River Complex. • 18.0 ha Yanga Complex. **Quality:** Varying condition, Degraded to Excellent. **Conservation significance:** Vegetation complexes below the 30% retention target within the Perth to Peel Region **Land tenure:** The following area of under-represented vegetation impacted is located in conservation areas: • State Forest: 2.1 ha. • Bush Forever Site: 80.9 ha. **Timescale:** Permanent.	Offset proposal 2 (Acquisition, protection, restoration and management.)	Low – land is expected to be vested with a suitable vesting authority with the intention that the land will be managed for conservation in perpetuity.	Moderate to high – based on restoration success.	Time until ecological benefit – 7 to 10 years.	In consideration of this proposal and that impacted vegetation complexes will still retain over 10% representation within Bush Forever sites a ratio of 1:1 is proposed, which is equivalent to 124.9 ha.

Existing environment and impact	Mitigation			Significant residual impact	Offset calculation methodology				
	Avoid and minimise	Rehabilitation type	Likely rehab. success		Type	Risk	Likely offset success	Time lag	Offset quantification
Threatened Flora Removal of critical habitat for *Caladenia huegelii*	The proposal was designed to avoid the single known individual of *Caladenia huegelii* within the development envelope. Design measures including use of wire rope barriers along the full extent of the highway and installation of road safety barriers between the northbound and southbound lane have assisted in reducing road width and impacts to habitat.	No rehabilitation possible: Onsite rehabilitation opportunities will be limited to temporary construction areas. MRWA will work to minimise its footprint, and will locate any temporary construction areas (i.e. laydown areas) within existing disturbed areas or areas planned for future development under this proposal.	N/A	**Extent:** 31.9 ha **Quality:** Varying condition, Completely Degraded to Pristine. **Conservation significance:** Threatened. **Land tenure:** The following areas of critical habitat impacted is located in conservation areas: • Nature Reserve: 0.4 ha. • Bush Forever Site: 13.7 ha. **Timescale:** Permanent	Offset Proposal 3 (On-ground management and research)	Low – land proposed to be managed and researched is already in conservation estate and/or Bush Forever.	**Can the values be defined and measured:** Yes **Operator experience/ evidence:** MRWA will ensure that the selected vesting authority is suitably qualified and experienced to implement this offset proposal. **What is the type of vegetation being revegetated:** N/A	Time until ecological benefit – 5 years.	Due to the difficulty of replacing like-for-like *Caladenia huegelii* habitat, MRWA proposes funding the management and research of potential critical habitat in existing conservation areas (reserves 46919 and 46875, Bush Forever site 300 and Whiteman Park) in accordance with the Grand Spider Orchid (*Caladenia huegelii*) recovery plan (DEC, 2009) for a period of up to 10 years
TECs Removal of inferred SCP20a	A location of inferred SCP20a along Reid Highway, east of the Reid Highway/Tonkin Highway interchange, has been avoided. Through design efficiencies the proposal footprint has been refined to reduce the impact to inferred SCP20a from 4.3 ha to 4.0 ha.	No rehabilitation possible: Onsite rehabilitation opportunities will be limited to temporary construction areas. MRWA will work to minimise its footprint, and will locate any temporary construction areas (i.e. laydown areas) outside of any known locations of this TEC and its buffer.	N/A	**Extent:** 4.0 ha of inferred SCP20a (*Banksia attenuata* woodlands over species rich dense shrublands). **Quality:** Mostly in Excellent condition. **Conservation significance:** State listed TEC. **Land tenure:** 3.8 ha of the impact to SCP20a occurs within Bush Forever. **Timescale:** Permanent.	Offset Proposal 4 (Acquisition, protection, and management, including restoration where possible)	Low – land is expected to be vested with a suitable vesting authority with the intention that the land will be managed for conservation in perpetuity.	The likely success of the offset will be assessed when a property or properties are identified.	Time until ecological benefit – 7 to 10 years.	In consideration of this proposal and the EPBC Act Offset Assessment Guide a ratio of 6:1 (equivalent to an area of 23 ha of TEC20a) would be required where the offset area had, or would be managed to retain values commensurate with the area impacted. Where an offset site is located that provides a restoration opportunity this ratio would be reduced.

7 RESPONSE TO OFFICE OF THE ENVIRONMENTAL PROTECTION AUTHORITY ISSUES

7.1 Route Selection Development

Consolidated issue 156 (contributing issue 257): Bush Forever site 480 at Victoria Road will be significantly impacted. How has the proponent tried to avoid and mitigate this significant impact through consideration of other interchange designs?

Bush Forever site 480 is impacted by the Reid/Tonkin interchange. A freeway to freeway, free-flowing interchange is required at this site to maintain traffic flow and separation. This complex interchange requires considerable land to achieve relevant road design criteria including sight distances, curve radii and merging distances. Assessments of interchanges with smaller footprints have been carried out but these proved to be unsafe and inefficient. The intersection is constrained by adjacent residential, commercial and industrial development, recreation facilities and Lightning Swamp. The configuration of the interchange results in an unavoidable impact on Bush Forever site 480 and associated CCW 15033.

The impact on Bush Forever site 480 is consistent with State Planning Policy 2.8 Bushland Policy for the Perth Metropolitan Region Scheme (SPP 2.8). The Reid Highway/Tonkin Highway interchange has been in the MRS as a primary regional road since before 1994. SPP 2.8 states that for public infrastructure proposals that impact Bush Forever sites, proposals should seek to protect regionally significant bushland as a priority, except where the proposal is consistent with the overall purpose and intent of an existing road reserve (regional or local). This proposal is consistent with the overall purpose and intent of the existing MRS Primary Regional Road reservation. MRWA has sought to reduce the impact through design, but is unable to compromise on road safety and design standards. During detailed design further efforts will be made to reduce the impact on this Bush Forever site.

7.2 Regulatory Context

Consolidated issue 190 (contributing issue 296): Please show how EPA policies relevant to the proposal have been considered.

Table 7.1 sets out EPA policies/guidelines relevant to the proposal, the relevance of each policy/guideline to the proposal and how the proposal has met the requirements of each policy/guideline.

Table 7.1 Adherence of proposal to EPA policies

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
Flora and vegetation		
Guidance Statement No. 51 – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in WA (June 2004)	Guidance Statement No. 51 sets out the minimum standards for flora and vegetation surveys for assessment of impacts on environmental factors. It implements two position statements: No. 3 Terrestrial Biological Surveys as an Element of Biodiversity Protection, and No. 2 Environmental Protection of Native Vegetation in Western Australia. The guidance statement encourages best practice in flora and vegetation survey and reporting. It advocates engagement and involvement with universities and the wider scientific community to develop skills, experience and a better understanding of Western Australian biodiversity. It seeks to ensure consistency with the principles, targets and objectives of other state and federal legislation and guidelines. Guidance and information on expected standards and protocols for terrestrial flora and vegetation surveys is provided to achieve the following environmental objectives: • Clarity on the scale of flora and vegetation survey required to understand and assess potential impacts. • Suitable quality and consistent methodology of surveys, analysis, interpretation and reporting. • Significant flora and vegetation is identified and protected.	Field surveys for the PER were conducted in accordance with Guidance Statement No. 51. Suitably qualified botanists were used to undertake the surveys and subject experts including the Western Australia Herbarium and taxonomic specialists consulted to confirm identification of floral species and Threatened Ecological Communities. The surveys were carried out at the optimum time for species identification (spring) and used the results of previous surveys to provide a comprehensive understanding of flora and vegetation in and adjacent to the proposal footprint; i.e., at the local scale. Peer review and follow-up surveys were used to resolve uncertainties in identification, extent and condition of flora and vegetation. The analysis, interpretation and reporting of potential impacts on flora and vegetation is consistent with current best practice being informed by recent decisions on similar or related projects and departmental advice. The quality of baseline information has enabled a comprehensive management and monitoring program to be developed to monitor edge effects and protect Threatened flora and Threatened Ecological Communities. PER Chapter 8, Flora and Vegetation presents the findings of the flora and vegetation surveys undertaken for the PER. The results of the surveys, analysis and interpretation are

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
	• Surveys are capable of underpinning long-term observation and measurement for compliance and audit purposes. • Knowledge base developed over time to assist decision-making, particularly at the local scale.	presented in PER Appendix C, Level 2 Spring Flora and Vegetation Assessment and Response to Submissions Chapter 3, Spring Ecological Surveys and Appendices C, D, E, F and G.
Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment (December 2015)	The technical guide applies to flora and vegetation surveys carried out to inform environmental impact assessment under Part IV of the Environmental Protection Act 1986. It aims to ensure adequate data of an appropriate standard for environmental impact assessment in the local and regional context. It provides advice on: • Survey preparation and licencing requirements; • Desktop study requirements; • Survey design and sampling techniques; • Data analysis and reporting. The guide acknowledges the diversity of Western Australia flora and vegetation, noting that deviation from the methods described in the document might be required in some instances.	This document has been updated since the surveys for the PER were conducted. It was released on 17 December 2015. Field surveys for the PER were conducted in accordance with the previous version of the technical guide. Qualified botanists were used to undertake the surveys and subject matter experts including the Western Australia Herbarium and taxonomic specialists were consulted to confirm identification of floral species and Threatened Ecological Communities. PER Chapter 8 Flora and Vegetation presents the findings of the flora and vegetation surveys undertaken for the PER. The results of the surveys, analysis and interpretation are presented in PER Appendix C, Level 2 Spring Flora and Vegetation Assessment and Response to Submissions Chapter 3 Spring Ecological Surveys and Appendices C, D, E, F and G.
Position Statement No. 2 – Environmental Protection of Native Vegetation in WA (December 2000)	Position Statement No. 2 outlines EPA's expectations that land clearing in agricultural areas will be reduced to relatively small areas and that mechanisms for protecting Western Australia's biodiversity will be considered. It seeks to stop and reverse the decline in remnant native vegetation, particularly from broad scale clearance.	The road alignment and design has been refined throughout planning of the proposal to avoid and minimise clearing of remnant native vegetation. Over 50% of the road alignment is located in cleared farmland or predominantly cleared farmland with sparse *Corymbia* and *Eucalyptus* species (PER Chapter 8, Flora and Vegetation, Tables 8.3 and 8.7). Existing infrastructure corridors or land adjacent to existing corridors

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
	It adopts the principles and objectives of the National Strategy for the Conservation of Australia's Biological Diversity for removal of remnant native vegetation in agricultural and other land. The position statement seeks to preserve biodiversity in-situ and to protect remnant native vegetation through comprehensive, representative and adequate systems of ecologically viable protected areas. The Western Australian Government has sought to implement this objective through the Bush Forever program along with other initiatives.	has been utilised where possible, reducing the extent of remnant native vegetation impacted. Bush Forever site 13 has been avoided and impacts on other Bush Forever sites minimised. Impacts to Class A Nature Reserves have been minimised to the greatest extent possible, noting that road design constraints, particularly horizontal geometry (minimum radius curves, sight distances, carriageway separation) preclude avoidance. PER Chapter 2, Proposal Background and Justification and PER Chapter 3, Route Selection and Development describe how impacts on remnant native vegetation were considered in route selection and design of the road alignment. PER Chapter 8, Flora and Vegetation presents the findings of the flora and vegetation surveys undertaken for the PER, including measures to minimise impacts to remnant native vegetation.
Position Statement No. 3 – Terrestrial Biological Surveys as an Element of Biodiversity Protection (March 2002)	Position Statement No. 3 outlines EPA's expectations that impacts on biodiversity will be avoided and where not avoidable, the impacts will not result in unacceptable loss. To achieve this, EPA expects the significance of biodiversity to be integral to flora and vegetation surveys for environmental impact assessment. This position statement encourages best practice in terrestrial biological surveys and requires that surveys meet its standards, guidelines and protocols. It defines the principles the EPA uses to assess proposals that may impact on biodiversity values. It advocates adoption of the precautionary principle where protection of biodiversity values cannot be assured.	Terrestrial flora and vegetation surveys for the PER were conducted in accordance with Position Statement No. 3, specifically Guidance Statement 51, the technical guides for flora and vegetation surveys and associated standards and protocols. Required licences for taking flora for scientific purposes were obtained. PER Chapter 8, Flora and Vegetation presents the findings of the flora and vegetation surveys undertaken for the PER, including measures to minimise impacts to remnant native vegetation. The results of the surveys, analysis and interpretation are presented in PER Appendix C, Level 2 Spring Flora and Vegetation Assessment and Response to Submissions Chapter 3, Spring Ecological Surveys and Appendices C, D, E, F and G.

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
Environmental Protection Bulletin No. 20 – Protection of naturally vegetated areas through planning and development (December 2013)	Environmental Protection Bulletin No. 20 sets out EPA's expectations for the design of urban, new residential and rural residential developments to protect naturally vegetated areas. It complements other guidance statements, clearing principles and Bush Forever. The bulletin aims to maintain biodiversity through adequate representation of flora, vegetation and fauna (habitat) at the species, population and assemblage/community level. Its focus is on regionally significant natural areas. The bulletin nominates the following as defining regionally significant natural areas: • Adequate representation of the range of ecological communities. • Areas with a high diversity of landforms, flora and/or fauna species or communities. • Areas containing rare or threatened species or communities. • Maintaining ecological processes or natural systems. • Areas of scientific or evolutionary importance. • Areas of wetland, streamline and estuarine fringing vegetation and coastal vegetation. The bulletin seeks to protect the above significant natural areas through design. The design guidelines for planning and development are: 1. Locate development on cleared land. 2. Consider the impact of fire protection requirements	The proposal addresses the design guidelines in Environmental Protection Bulletin No. 20 as follows: • Over 50% of the road alignment is located in cleared farmland or predominantly cleared farmland with sparse *Corymbia* and *Eucalyptus* species (PER Chapter 8, Flora and Vegetation, Tables 8.3 and 8.7). • The proposed highway has avoided naturally vegetated areas to the greatest extent possible noting that road design constraints, particularly horizontal geometry (minimum radius curves, sight distances, carriageway separation) preclude avoidance in all instances. The road has been located adjacent to Ellenbrook reducing the fire protection requirements adjacent to this residential subdivision. • PER Chapter 2 Proposal Background and Justification and PER Chapter 3 Route Selection and Development describe how route selection and road (alignment) design minimised impacts on large consolidated naturally vegetated areas including Whiteman Park/Cullacabardee Bushland and Maralla Road Bushland. • Regional ecological linkages have been identified and described in PER Section 9.2.8 and shown in Figures 9.4A and 9.4B. Connectivity will be maintained through the installation of fauna underpasses to facilitate fauna movement in the Whiteman Park/Cullacabardee Bushland and Maralla Road Bushland. • Temporary workspaces, excess land and road reserves will be rehabilitation and revegetated with local provenance species in areas of remnant native vegetation, principally

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
	on biodiversity. 3. Protect large consolidated naturally vegetated areas 4. Ecological linkages should be planned in the regional context and connect large naturally occurred vegetated areas. 5. Ensure clear and ongoing management responsibilities in retained naturally vegetated areas. 6. Infrastructure should not be located within consolidated retained naturally vegetated areas.	the section of highway between Hepburn Avenue and Maralla Road. The construction EMP will include measures for weed and plant pathogen (*Phytopthora cinnamomi*) disease control. Edge effects will be monitored (refer Flora and Vegetation Management and Monitoring Plan). • Avoidance of retained naturally vegetated areas is not possible because of road design constraints, particularly horizontal geometry including minimum radius curves, sight distances and carriageway separation. Fragmentation of large tracts has been minimised. Response to Submissions Section 7.2.2 and Table 2 present an analysis of fragmentation of naturally vegetated areas. The analysis concludes that most fragments will persist with only the smaller, narrower fragments being less viable.
Terrestrial fauna		
Guidance Statement No. 56 – Terrestrial Fauna Surveys for Environmental Impact Assessment in WA (June 2004)	Guidance Statement No. 56 provides direction and information on general standards and protocols for terrestrial fauna surveys including the minimum requirements. It implements Position Statement No 3. Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002). The guidance statement encourages sufficient rigour in survey work to enable discrete surveys to contribute to a more systematic inventory of Western Australia's terrestrial and aquatic fauna. Guidance and information on expected standards and	Terrestrial fauna surveys for the PER were conducted in accordance with Guidance Statement No. 56. Suitably experienced zoologists were used to undertake the surveys and advice sought from subject matter experts to address uncertainty in understanding the behavioural characteristics and habitat requirements of threatened fauna. The analysis, interpretation and reporting of potential impacts on fauna is consistent with best practice being informed by recent decisions on similar or related projects and DPAW advice. PER Chapter 9. Terrestrial Fauna presents the findings of the fauna surveys undertaken for the PER. The results of the

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
	protocols for terrestrial fauna and faunal assemblage is provided to achieve the following environmental outcomes: • The scale of fauna and faunal assemblage survey is appropriate for different areas. • Suitable quality and consistent methodology of surveys, analysis, interpretation and reporting. • Significant fauna and faunal assemblages is identified and protected through application of best practice. • Surveys are capable of underpinning long-term observation and measurement for compliance and audit purposes. • Knowledge base developed over time to assist decision-making at the local and regional scales.	survey are presented in PER Appendix G, Level 2 Targeted Fauna Assessment.
Position Statement No. 3 – Terrestrial Biological Surveys as an Element of Biodiversity Protection (March 2002)	Position Statement No. 3 outlines EPA's expectations that impacts on biodiversity will be avoided and where not avoidable, the impacts will not result in unacceptable loss. To achieve this, EPA expects the significance of biodiversity to be integral to flora and vegetation surveys for environmental impact assessment. This position statement encourages best practice in terrestrial biological surveys and requires that surveys meet its standards, guidelines and protocols. It defines the principles the EPA uses to assess proposals that may impact on biodiversity values. It advocates adoption of the precautionary principle where protection of	Terrestrial fauna surveys for the PER were conducted in accordance with Position Statement No. 3, specifically Guidance Statement No. 56 – Terrestrial Fauna Surveys for Environmental Impact Assessment in WA. Required licences for trapping animals for scientific purposes were obtained. PER Chapter 9, Terrestrial Fauna presents the findings of the fauna surveys undertaken for the PER. The results of the survey are presented in PER Appendix G, Level 2 Targeted Fauna Assessment.

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
	biodiversity values cannot be assured.	
Technical Guide on Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (September 2010)	The technical guide sets outs guidance to ensure adequate data of a high standard is obtained for environmental impact assessment (EIA). It sets out EPA's expectations for Level 1 and Level 2 terrestrial vertebrate surveys and the associated protocols and standards. It provides advice on fauna sampling techniques and methods for different regions of the state and includes the requirements for analysis, interpretation and reporting for EIA	Terrestrial fauna surveys for the PER were conducted in accordance with this Technical Guide. Suitably qualified and experienced zoologists were used to undertake the surveys. The minimum requirement was exceeded with eight consecutive trapping nights (minimum requirement is seven consecutive nights). A DPAW Regulation 17 Licence (SF010008) and a DPAW Regulation 4 Authority Licence (CE004607) were obtained. The analysis, interpretation and reporting of potential impacts on fauna is consistent with best practice being informed by recent decisions on similar or related projects and DPAW advice. PER Chapter 9, Terrestrial Fauna presents the findings of the fauna surveys undertaken for the PER. The results of the survey are presented in PER Appendix G, Level 2 Targeted Fauna Assessment.
Environmental Protection Bulletin No. 20 – Protection of naturally vegetated areas through planning and development (December 2013)	Environmental Protection Bulletin No. 20 sets out EPA's expectations for the design of urban, new residential and rural residential developments to protect naturally vegetated areas. It complements other guidance statements, clearing principles and Bush Forever. The bulletin aims to maintain biodiversity through adequate representation of flora, vegetation and fauna (habitat) at the species, population and assemblage/community level. Its focus is on regionally significant natural areas. The bulletin nominates the following as defining regionally significant natural areas:	The proposal addresses the design guidelines in Environmental Protection Bulletin No. 20 as follows: 1. Over 50% of the road alignment is located in cleared farmland or predominantly cleared farmland with sparse *Corymbia* and *Eucalyptus* species (PER Chapter 8, Flora and Vegetation, Tables 8.3 and 8.7). 2. The proposed highway has avoided naturally vegetated areas to the greatest extent possible noting that road design constraints, particularly horizontal geometry (minimum radius curves, sight distances, carriageway separation) preclude avoidance in all instances. The road

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
	• Adequate representation of the range of ecological communities. • Areas with a high diversity of landforms, flora and/or fauna species or communities. • Areas containing rare or threatened species or communities. • Maintaining ecological processes or natural systems. • Areas of scientific or evolutionary importance. • Areas of wetland, streamline and estuarine fringing vegetation and coastal vegetation. The bulletin seeks to protect the above significant natural areas through design. The design guidelines for planning and development are: 1. Locate development on cleared land. 2. Consider the impact of fire protection requirements on biodiversity. 3. Protect large consolidated naturally vegetated areas 4. Ecological linkages should be planned in the regional context and connect large naturally occurred vegetated areas. 5. Ensure clear and ongoing management responsibilities in retained naturally vegetated areas. 6. Infrastructure should not be located within consolidated retained naturally vegetated areas.	has been located adjacent to Ellenbrook reducing the fire protection requirements adjacent to this residential subdivision. 3. PER Chapter 2 Proposal Background and Justification and PER Chapter 3 Route Selection and Development describe how route selection and road (alignment) design minimised impacts on large consolidated naturally vegetated areas including Whiteman Park/Cullacabardee Bushland and Maralla Road Bushland. 4. Regional ecological linkages have been identified and described in PER Section 9.2.8 and shown in Figures 9.4A and 9.4B. Connectivity will be maintained through the installation of fauna underpasses to facilitate fauna movement in the Whiteman Park/Cullacabardee Bushland and Maralla Road Bushland. 5. Temporary workspaces, excess land and road reserves will be rehabilitation and revegetated with local provenance species in areas of remnant native vegetation, principally the section of highway between Hepburn Avenue and Maralla Road. The construction EMP will include measures for weed and plant pathogen (*Phytopthora cinnamomi*) disease control. Edge effects will be monitored (refer Flora and Vegetation Management and Monitoring Plan). 6. Avoidance of retained naturally vegetated areas is not possible because of road design constraints, particularly horizontal geometry including minimum radius curves, sight distances and carriageway separation. Fragmentation of large tracts has been minimised. Response to Submissions Section 7.2.2 and Table 2

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
		present an analysis of fragmentation of naturally vegetated areas. The analysis concludes that most fragments will persist with only the smaller, narrower fragments being less viable.
Hydrological Process and Inland Waters Environmental Quality		
Position Statement No. 4 – Environmental Protection of Wetlands (November 2004)	Position Statement No. 4 sets out EPA's expectations for the protection of wetlands during development of project proposals. It requires consideration of prudent and feasible alternatives to direct and indirect impacts on remaining wetlands. The statement lists the environmental values and functions that are important and establishes principles for environmental protection. It seeks to: • Protect wetland values and functions. • Protect and restore the biological diversity of wetland habitats. • Protect the quality of wetland ecosystems through various principles including ecologically sustainable development. • Achieve the aspirational goal of no net loss of wetland values and functions.	The road alignment and design has been refined throughout planning of the proposal to avoid direct and indirect impacts on wetlands (PER Chapter 2, Proposal Background and Justification and PER Chapter 3, Route Selection and Development describe how the road design took into account the environmental values). The road alignment avoids a number of CCW and REW and minimises impacts on other wetlands as far as practicable (PER Chapter 10 Hydrological Processes and Inland Waters Environmental Quality, Section 10.4.6). Wetland ecosystems and function are highly dependent on the maintenance of hydrology. The road has been designed to maintain existing hydrology and water quality. Retention and infiltration basins will assist in maintaining water quality in wetlands and surface water features supporting wetlands PER Chapter 10 Hydrological processes and inland waters environmental quality and PER Appendix H, Drainage Strategy describe the existing hydrology and how it will be maintained. Rehabilitation and restoration of wetland riparian vegetation will be undertaken where wetlands are partially disturbed. Revegetation. Offset proposals for unavoidable losses include formal protection and enhancement of CCW and REW which might be exposed to future development proposals. PER Chapter 10 Hydrological Processes and Inland Waters

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
		Environmental Quality presents the findings of the wetland assessment undertaken for the PER. The assessment and results are presented in PER Appendix I, Wetland Assessment, which considers wetland stratigraphy, hydrology and vegetation.
Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011	The purpose of the Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011 is to protect habitat suitable for long term survival of wild populations of the Western Swamp Tortoise. The policy applies to the area defined in Schedule 1 and shown in the map attached as Schedule 2. The policy seeks to protect the Western Swamp Tortoise and its habitat by ensuring discharges do not exceed water quality limits, water quality and quantity is maintained, interconnections between terrestrial and aquatic ecosystems and processes are understood and land is appropriately managed to protect the tortoise and its habitat. Where uncertainty exists, it recommends the precautionary principle is applied.	The proposal has avoided any direct or indirect impact on the Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011 policy area. The proposal is located 500 m west of the Western Swamp Tortoise policy area which encompasses the catchment of Twin Swamps Nature Reserve (2.6 km east of the proposed highway), critical habitat for the tortoise. Ellen Brook Nature Reserve which also contains critical habitat is located in the southern part of the policy area 4.8 km east-southeast of the proposed road alignment. Ellenbrook and The Vines residential subdivisions are located between Ellen Brook Nature Reserve and the proposed highway. PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.4 presents the assessment of impacts on Ellen Brook and Twin Swamps Nature Reserve. It notes that potential impacts on surface water flow and quality in the swamps are unlikely given the separation distance and arrangement of drainage line which bypass Twin Swamps Nature Reserve. Groundwater contaminated by road pavement runoff or spills is unlikely to impact these wetlands due to distance and groundwater flow rate which is predicted to be over 60 years for Twin Swamps Nature Reserve. Two position papers were prepared for the PER (PER Appendix J, Twins Swamps Hydrology and PER Appendix N, Ellen Brook Nature Reserve). The papers present the findings of the assessment of potential impacts on these wetlands.

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
		The assessment of potential impacts on Western Swamp Tortoise is presented in PER Chapter 9, Terrestrial Fauna. Impacts on its habitat are described in PER Chapter 10 Hydrological Processes and Inland Waters Environmental Quality.
Guidance Statement No. 7 – Protection of the Western Swamp Tortoise Habitat, Upper Swan/Bullsbrook (June 2006)	Guidance Statement No. 7 has been prepared to protect the habitat of the critically endangered Western Swamp Tortoise through managing activities and land use in catchments containing habitat. Specifically, the statement applies to habitat in the policy area which is defined in Schedule 1 and shown in Schedule 2 of the Environmental Protection (Western Swamp Tortoise Habitat) Policy 2002. The key habitats protected by the policy area are Twin Swamps Nature Reserve and Ellen Brook Nature Reserve. The guidance statement focuses on development in the policy area outside these reserves. Key threats to the Western Swamp Tortoise and its habitat are: • Impacts from intensive land use; e.g., residential and rural residential estates. • Changed land use that results in adverse impacts on the catchments of the wetlands protected by the reserves. • Increased pressure from human activity including manmade structures and land use practices. • Reduced rainfall as a consequence of climate change.	The proposal is located 500 m west of the Western Swamp Tortoise policy area which encompasses the catchment of Twin Swamps Nature Reserve (2.6 km east of the proposed highway), critical habitat for the tortoise. Ellen Brook Nature Reserve which also contains critical habitat is located in the southern part of the policy area 4.8 km east-southeast of the proposed road alignment. Ellenbrook and The Vines residential subdivisions are located between Ellen Brook Nature Reserve and the proposed highway. The proposed highway is outside the policy area to which the guidance statement applies. Construction and operation of the highway will not result in adverse impacts on the catchments of the wetlands protected by Twin Swamps Nature Reserve and Ellen Brook Nature Reserve.

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
Amenity (Noise and Vibration)		
Environmental Assessment Guideline (EAG) 13 - Consideration of environmental impacts from noise. (September 2014)	EAG 13 sets out how EPA considers the impacts from noise emissions in environmental impact assessment. It encourages the use of best practice in noise management by requiring adherence to State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning to achieve compliance and protect human health and amenity. EAG 13 provides guidance on applicable regulatory standards, how noise impacts are considered by EPA in the environmental impact assessment process and understanding if noise emissions could have a significant impact.	Noise monitoring was conducted in accordance with Australian Standard 2702:1984 Acoustics – Methods for the Measurement of Road Traffic Noise. Noise modelling was done using SoundPlan and the CORTN algorithm, adjusted to account for Australian road traffic conditions. The noise model was calibrated using noise measurements from the Great Northern Highway at Muchea, which is indicative of rural highway traffic. The significance of noise emissions was determined by comparison of predicted noise levels to the targets and limits from State Planning Policy 5.4. Noise mitigation was applied in accordance with the procedures in SPP 5.4 to ensure the targets and/or limits were met at sensitive receivers. Where noise limits could not be achieved, reasonable and practicable mitigation measures will be implemented in accordance with State Planning Policy 5.4. These will be discussed and agreed with affected property owners. PER Chapter 11, Amenity (Noise and Vibration) presents the findings of the Traffic Noise Assessment undertaken for the PER. The results, analysis and interpretation are presented in PER Appendix O, Traffic Noise Assessment and Response to Submissions Chapter 4, Amenity (Noise and Vibration) and Appendix I, Revised Transportation Noise Assessment.
Heritage		
Guidance Statement No. 41 – Assessment of Aboriginal Heritage (April 2004)	Guidance Statement No. 41 provides advice regarding the minimum requirements for assessment of Aboriginal heritage, where it is a relevant environmental factor in proposals. The statement acknowledges the relationships between	Aboriginal heritage was not identified as a key environmental factor in the Environmental Scoping Document but was recognised as an environmental factor that required consideration. Consequently, a desktop study, field survey and consultation were carried out in accordance with the

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
	the aesthetic, social, cultural, physical and biological environments and notes that these environments apply to specific places to which Indigenous people relate. Guidance Statement No. 41 requires that EPA has sufficient information to determine whether Aboriginal heritage is a key environmental factor and if so, sufficient information to consider the nature of the impact and report to the relevant minister.	*Aboriginal Heritage Act 1972* and Guidance Statement No. 41. PER Chapter 13, Aboriginal Heritage presents the findings of the Aboriginal heritage surveys undertaken for the PER. The results and interpretation are presented in PER Appendix P, Aboriginal Heritage Desktop Assessment, Appendix Q, Ethnographic Aboriginal Heritage Survey and Appendix R, Aboriginal Archaeological Assessment. MRWA will be seeking consent to disturb Aboriginal heritage sites under the *Aboriginal Heritage Act 1972*
Offsets		
WA Environmental Offsets Policy	WA Environmental Offset Policy sets out the Western Australian Government's expectation for environmental offsets. It seeks to protect and conserve environmental and biodiversity values through compensation for unavoidable residual impacts on biodiversity values. The policy states that offsets are a last resort when avoidance and minimisation options have been exhausted. It seeks to ensure transparency in the provision of offsets to provide certainty that they will be adequate and achieve the desired goals. It recommends cooperation between the Western Australian and Australian Governments to ensure, where possible and permitted by each jurisdictions legislation and regulations, that offsets are not duplicated. The policy outlines the principles for use of environmental offsets which may be either direct or indirect. It notes that offsets must be proportionate to	The proposal addresses the principles for use of environmental offsets as follows: 1. MRWA has applied the mitigation hierarchy to this proposal as far as practicably possible. However after all avoidance and minimisation options have been exhausted, a residual environmental impact remains. PER Chapter 2 Proposal Background and Justification and PER Chapter 3 Route Selection and Development describe how route selection and road (alignment) design minimised impacts on significant remnant native vegetation including Whiteman Park/Cullacabardee Bushland and Maralla Road Bushland. 2. The proposal will have a significant impact on

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
	the significance of the impact. The principles are: 1. Environmental offsets will only be considered after avoidance and mitigation options have been pursued. 2. Environmental offsets are not appropriate for all projects. 3. Environmental offsets will be cost-effective, as well as relevant and proportionate to the significance of the environmental value being impacted. 4. Environmental offsets will be based on sound environmental information and knowledge. 5. Environmental offsets will be applied within a framework of adaptive management. 6. Environmental offsets will be focussed on longer term strategic outcomes.	Threatened Ecological Communities and Threatened species through loss of individuals and habitat. The significant impacts require offsets. 3. MRWA has proposed a suite of offsets to compensate for unavoidable losses of environmental values including threatened species and ecological communities listed under state and federal legislation. The offset packages comprise multiple values highlighting a focus on ecosystem function. Recent decisions and MRWA's experience on other road projects has informed the offset proposals including multipliers that reflect the conservation and biodiversity significance of lost species and ecological communities. 4. Desktop study and preliminary and detailed survey has informed the identification of suitable offsets. DPaW has been consulted on the suitability of the sites. The offsets increase the environmental values under protection. 5. MRWA intends to vest the land in DPaW or an appropriate land manager and fund the management of the offsets for a period to be agreed with DPaW and/or the land manager. Preliminary discussions have been held with DPaW regarding management of the offset

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
		properties. 6. Offsets that are contiguous with Nature Reserves, Bush Forever sites and other Crown land managed for conservation purposes have been favoured over isolated parcels. Excess land from acquisition of the road reserve has also been considered and proposed as an offset where it enhances or augments existing corridors and regional ecological linkages. 7. PER Chapter 17, Offsets outlines the impacts of the proposal on key environmental factors and the rationale for proposed offsets. Response to Submissions Chapter 6, Environmental Offsets provides updated offset proposals. The updated proposals reflect the revised assessment of impacts on threatened flora and critical habitat resulting from the spring ecological surveys (Response to Submissions Chapter 3, Spring Ecological Surveys and Appendices C, D, E, F and G).
WA Environmental Offsets Guidelines (August 2014)	WA Environmental Offsets Guidelines clarify the determination and application of environmental offsets in Western Australia. The guidelines seek to ensure a consistent approach to the provision of offsets regardless of the legislative instrument. They provide further detail on the Western Australian Government's expectations for demonstrating application of the mitigation hierarchy and seek to	The mitigation hierarchy was implemented in planning, designing and developing management measures for the proposed highway. Avoidance of significant environmental values was a key objective of route selection and alignment design. Road design has minimised impacts on sensitive environmental values through realignment and narrowing of the road carriageways to avoid threatened species and their habitat.

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
	ensure consistency through application of the residual impact significance model. The model identifies four levels of significance: • Unacceptable impacts (offsets not appropriate). • Significant impacts requiring an offset. • Potentially significant impacts which may require an offset. • Impacts which are not significant and do not require an offset. The guidelines provide advice on appropriate offsets including quantification, implementation and audit/review to determine success.	The impact assessment presented in PER Chapters 8 to 16 has identified significant residual impacts that require offset. No unacceptable impacts were identified. The residual impact significance model was used in developing the offset proposals presented in PER Chapter 17, Offsets and the revised proposals presented in Response to Submissions Chapter 6, Environmental Offsets. Where appropriate the requirements of the Australian Government under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) have been considered.
Environmental Protection Bulletin No. 1 – Environmental Offsets (August 2014).	Environmental Protection Bulletin No. 1 clarifies how the EPA considers offsets through the environmental impact assessment process. It provides a summary of the key requirements of the WA Environmental Offset Policy and WA Environmental Offset Guidelines including the mitigation hierarchy need to use the Residual Impact Significance Model, and information required by the OEPA to decide on the appropriateness of offsets to compensate for the significant residual impacts. It explains what feedback will be provided by OEPA and information on related matters including existing approvals and offsets for non-biodiversity matters.	The mitigation hierarchy was implemented in planning, designing and developing management measures for the proposed highway. Avoidance of significant environmental values was a key objective of route selection and alignment design. Road design has minimised impacts on sensitive environmental values through realignment and narrowing of the road carriageways to avoid threatened species and their habitat. The impact assessment presented in PER Chapters 8 to 16 has identified significant residual impacts that require offset. No unacceptable impacts were identified. The residual impact significance model was used in developing the offset proposals presented in PER Chapter 17, Offsets and the revised proposals presented in Response to Submissions Chapter 6, Environmental Offsets. Where appropriate the requirements of the Australian Government

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
		under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) have been considered.
Rehabilitation and decommissioning		
Guidance Statement No. 6 – Rehabilitation of Terrestrial Ecosystems (June 2006)	Guidance Statement No. 6 sets out minimum standards necessary for rehabilitation of terrestrial ecosystems including wetlands. The aim of the statement is to ensure the return of biodiversity values in rehabilitated areas. It seeks to achieve this goal by improving the quality, uniformity and efficiency of standards and processes for rehabilitation of native vegetation. It also seeks more effective monitoring and auditing of outcomes. Guidance is provided to achieve the following outcomes: • Greater awareness on the limitations of rehabilitation in WA and the environmental impacts of permanent changes to ecosystems. • Compare internationally recognised standards with those used in WA for assessing outcomes. • General standards and common framework for setting rehabilitation objectives for EIA. • Uniform standards for analysis, interpretation and reporting of outcomes for auditing purposes and increased data access. • Acknowledge the importance of scientific knowledge as a basis for effective rehabilitation. • List sources of further information and summarise	Temporary work areas and excess land will be rehabilitated. Roadside revegetation using endemic species will augment rehabilitation which will be done using local provenance species. Where practicable it will restore and enhance ecological linkages, specifically north of Maralla Road. Rehabilitation has been designed to reflect the landscapes through which the proposed highway runs: urban zone, transition zone and rural zone. MRWA experience in rehabilitating roads in similar landscapes and ecosystems will be utilised. Rehabilitation will be implemented and managed through the construction environmental management plan which will include measures for the control of weeds and pathogens, completion criteria and performance measurement. The revegetation strategy is described in PER Chapter 12, Rehabilitation and Decommissioning.

Policy or guideline	Purpose of policy/guideline	Consideration given to policy/guideline
	stakeholder roles and responsibilities. The guidance statement encourages the use of completion criteria, which should be: • Specific enough to reflect unique set of environmental, social and economic circumstances. • Flexible enough to adapt to changing circumstances without compromising objectives. • Include environmental indicators suitable for demonstrating that rehabilitation trends are heading in the right direction. • Undergo periodic review resulting in modification if required due to changed circumstances or improved knowledge. • Based on targeted research which results in more informed decisions.	

7.3 Flora and Vegetation

7.3.1 Threatened Flora

Consolidated issue 152: Risk from proposal to *Grevillea curviloba* subsp. *incurva* is understated. The PDNH needs to be moved further from individuals. Every effort needs to be taken to protect, and if possible re-introduce, this species in its critical habitat area.

Contributing issues:

71: Risk from proposal to *Grevillea curviloba* subsp. *incurva* is understated. The PDNH needs to be moved further from individuals. Every effort needs to be taken to protect, and if possible re-introduce, this species in its critical habitat area.

263: Please provide justification as to why a 10 m buffer is sufficient for avoiding indirect impacts to *Grevillea curviloba* subsp. *incurva* given that a 50 m buffer is proposed for *Caladenia huegelii*.

The population of *Grevillea curviloba* subsp. *incurva* is located in a 20-m-wide strip of degraded, weedy vegetation located between Brand Highway and the Midland–Geraldton railway line. The populations in this location are already confined with the distance of individuals from current active transport corridors a maximum of 10 m away.

Direct impacts to this population have been avoided through the construction of a bridge over the railway, Brand Highway and the railway/road reserve, which spans the location of this population. No section of the proposed highway will be positioned closer to individuals than the current Brand Highway.

The draft EMP (PER Appendix F, Environmental Management Plan) contains measures to protect Threatened and Priority flora from accidental disturbance and prevent the introduction and spread of weeds and dieback. The implementation of weed control measures may lead to an improvement in the condition of the *Grevillea curviloba* subsp. *incurva* critical habitat in the road reserve.

Consolidated issue 171 (contributing issue 260): Please provide additional detail on the management, monitoring and mitigation measures to be implemented to demonstrate that indirect impacts of the proposal will not impact *Caladenia huegelii.*

A 50 m buffer around the *Caladenia huegelii* individual will be established and maintained for the duration of construction to ensure that direct impacts to the *Caladenia huegelii* individual are avoided.

A construction Environmental Management Plan (EMP) to be prepared before construction commences will include management measures for indirect impacts including weed and dieback management, drainage management and management of uncontrolled access, fire and dust (PER Chapter 8, Flora and Vegetation, Section 8.5 and summarised in PER Chapter 8, Flora and Vegetation, Section 8.6, Table 8.16). The implementation of these management measures will ensure that indirect impacts to the known location of *Caladenia huegelii* can be minimised.

MRWA will develop and implement a FVMMP to manage impacts on significant vegetation, including threatened flora, priority flora, TECs and PECs. This will include: establishing baseline condition, undertaking monitoring and implementing contingencies should changes to vegetation health and condition be detected. The FVMMP will include monitoring of the buffer protecting the known occurrence of *Caladenia huegelii*. The plan will be prepared in consultation with DPAW.

Consolidated issue 172 (contributing issue 259): Please provide additional detail on the significance of the impact to *Caladenia huegelii* critical habitat.

A total of 228.3 ha of *Caladenia huegelii* critical habitat was mapped in the study area (see PER Appendix C, Level 2 Spring Flora and Vegetation Assessment, Section 5.7.1.1). This area of critical habitat comprises two areas: one adjacent to Ellenbrook (184.6 ha) and one in Whiteman Park (43.7 ha). A very small part of the Whiteman Park habitat is impacted by the proposal (less than 0.1 ha).

The extent of the Ellenbrook habitat was revised to 141.4 ha in the 2015 spring survey (Appendix C, Assessment & Refinement of Potential Critical Habitat for *Caladenia huegelii* (T-DRF) within the Development Envelope). Following further surveys, the proposal's direct impact of 39.2 ha (see PER Chapter 8, Flora and Vegetation, Section 8.4.5) has subsequently been revised to 30 ha. This impact constitutes 16.2% of *Caladenia huegelii* critical habitat known in the study area (185.1 ha). Although not mapped, it is likely that *Caladenia huegelii* critical habitat extends beyond the study area, particularly to the northwest of the mapped critical habitat in the nature reserve west of Ellenbrook.

7.3.2 Impact Assessment

Consolidated issue 154: Please provide further analysis on indirect impacts to wetlands, TECs, threatened flora/fauna and reserves remaining after construction. If long term persistence is unlikely, the significance should be considered as the whole occurrence of the value.

Contributing issues:

268: Please provide further analysis on indirect impacts, particularly relating to TECs and threatened flora that will remain after construction. If long-term persistence is unlikely, the significance should be considered as the whole occurrence of the value.

269: Please provide further analysis on indirect impacts, particularly with regards to threatened fauna that will remain after construction. If long-term persistence is unlikely, the significance should be considered as the whole occurrence of the value.

270: Please provide further analysis on indirect impacts, particularly with regards to wetlands that will remain after construction. If long-term persistence is unlikely, the significance should be considered as the whole occurrence of the value.

271: Please provide further analysis on indirect impacts, particularly with regards to conservation reserves that will remain after construction. If long-term persistence is unlikely, the significance should be considered as the whole occurrence of the value.

The PER considers both direct and indirect impacts to each of the key environmental factors in PER Chapters 8 to 15 and MNES in PER Chapter 16. Conservation significant values such as Threatened Ecological Communities (TECs), threatened flora, threatened fauna, conservation areas and wetlands have the potential to be indirectly impacted through edge effects and fragmentation.

Edge effects are identifiable as any difference in environment between the edge and the interior of a particular patch of vegetation. For example, edge effects can occur along the boundary of two different vegetation communities as well as edges with cleared areas (see PER Chapter 8, Flora and Vegetation, Section 8.4.9). The average width of edge effects on other major MRWA road projects has been demonstrated to be less than 10 m and in some cases almost zero where road fill batters are present (South Metro Connect, 2011).

An analysis of potential indirect impacts of edge effects on conservation significant values was undertaken. The analysis identified all conservation significant values within 10 m of the proposal footprint. Table 7.2 summarises potential indirect impacts of edge effects on conservation significant values. Potential indirect impacts occurring within conservation areas (including Class A Nature Reserve 46919, Class A Nature Reserve 46920, Gnangara–Moore River State Forest No. 65 and Bush Forever sites) are also provided in Table 7.2.

Table 7.2 Potential indirect impacts of edge effects on conservation significant values

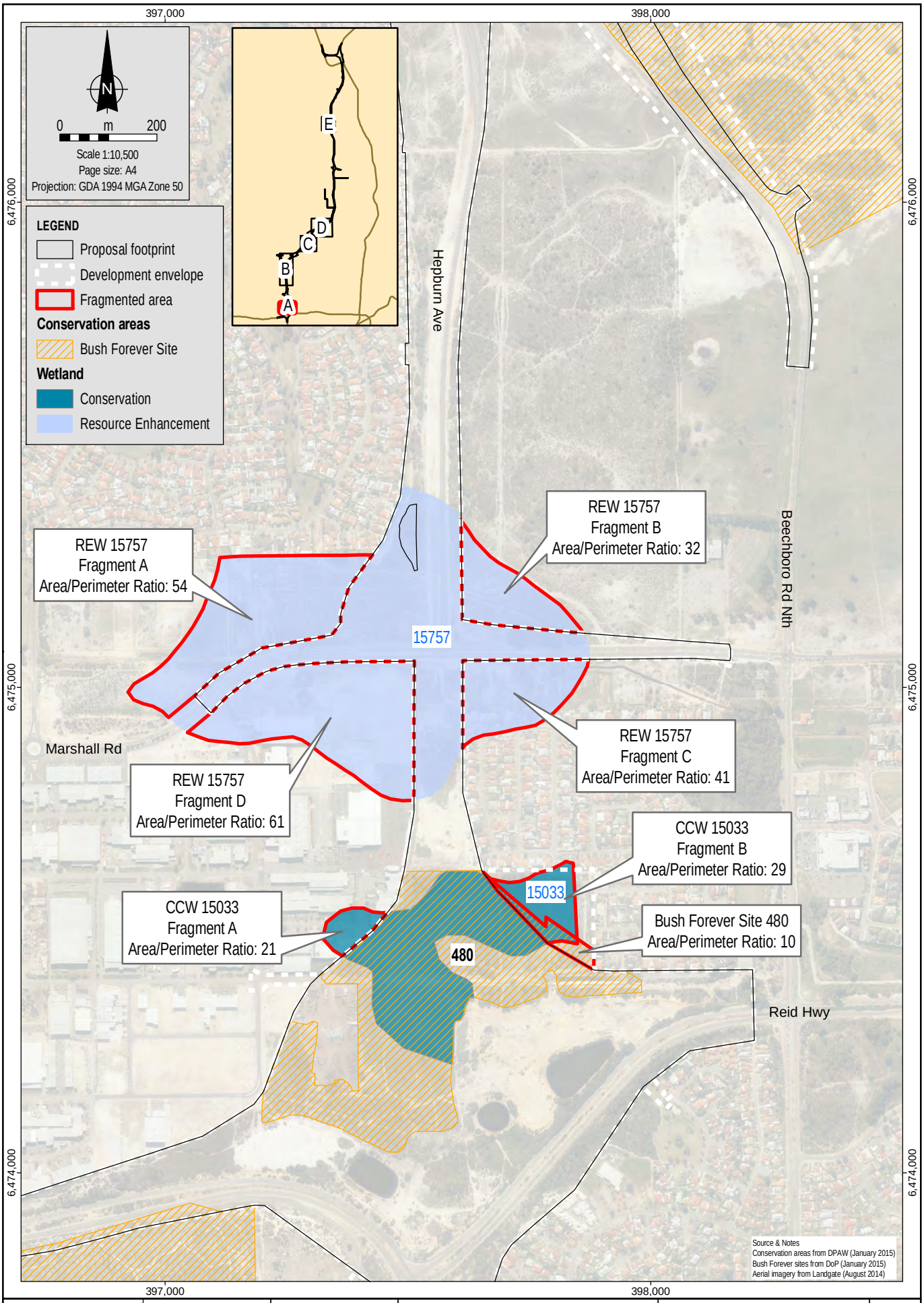
Conservation significant value		Total potential indirect impact	Potential indirect impact within conservation areas
Vegetation complexes	Bassendean Complex – Central and South	6.2 ha	6.1 ha
	Bassendean Complex – North	8.8 ha	5.2 ha
	Bassendean Complex – North Transition Vegetation Complex	1.4 ha	1.4 ha
	Southern River Complex	2.6 ha	0.9 ha
	Yanga Complex	4.2 ha	0.7 ha
TEC	SCP20a (Endangered)	0.5 ha	0.5 ha
PEC	SCP21c (Priority 3)	7.1 ha	5.2 ha
	SCP22 (Priority 2)	0.1 ha	0.1 ha
	SCP23b (Priority 3)	1.2 ha	0.7 ha
	SCP24 (Priority 3)	0.3 ha	0.3 ha
	Banksia dominated woodlands on the Swan Coastal Plain (Priority 3)	6.2 ha	4.4 ha
Wetlands	Conservation category wetland (CCW)	1.6 ha	1.2 ha
	Resource enhancement wetland (REW)	3.4 ha	–
Critical habitat	*Caladenia huegelii*	4.9 ha	3.3 ha
	Grevillea curviloba subsp. *incurva*	1.6 ha	–
Threatened flora	*Grevillea curviloba* subsp. *incurva*	4 records	–
Priority flora	*Poranthera moorokatta* (P2)	1 record	1 record
	Hypolaena robusta (P4)	1 record	1 record

Note: not all values in this table are mutually exclusive. For example, an area may be mapped as both a particular vegetation complex and a PEC.

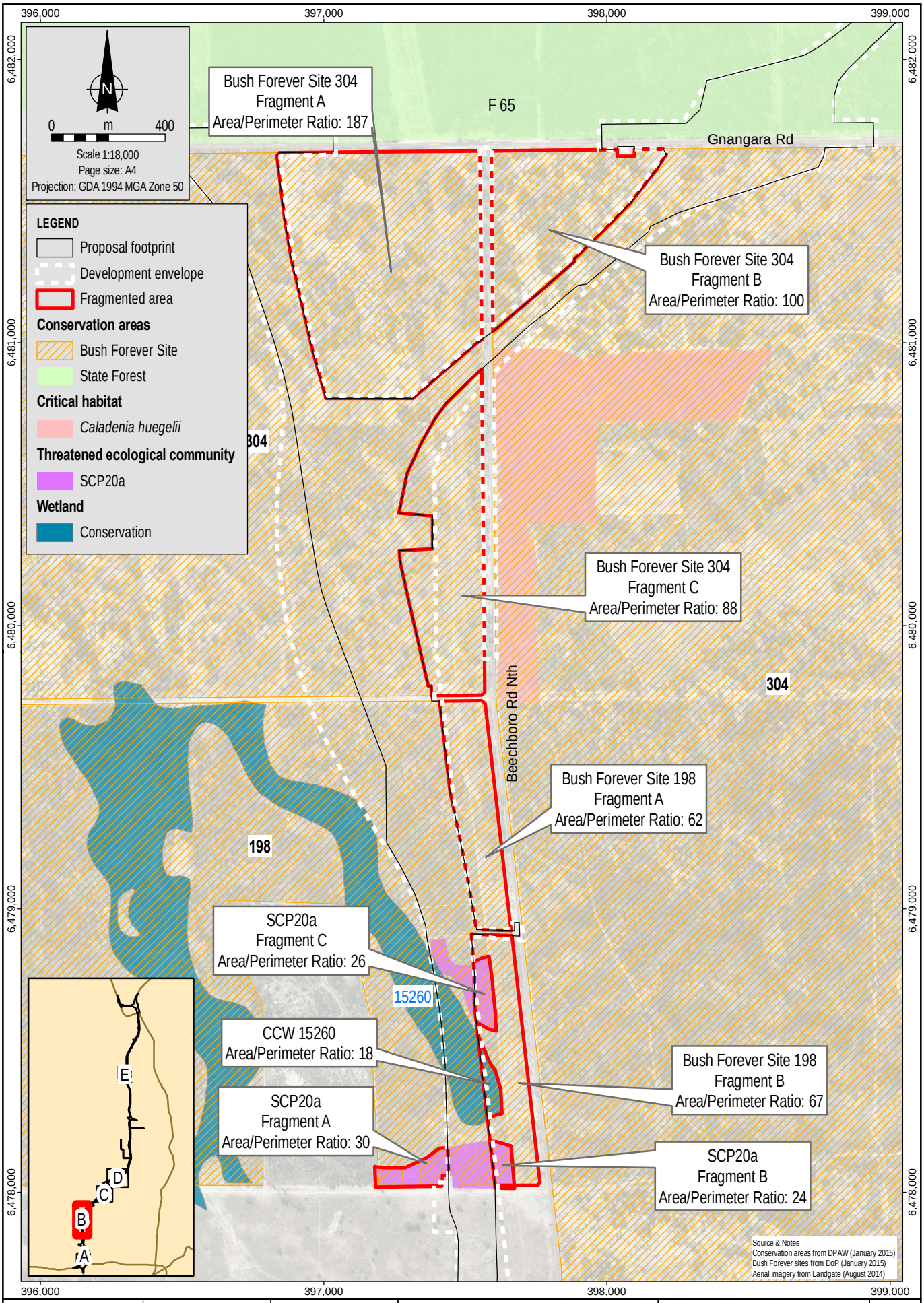
Fragmentation occurs when one part of a conservation significant value is severed or isolated from another. In general, smaller fragments are less likely to retain the same values as larger fragments. A long and narrow fragment is also likely to retain fewer values and be more exposed to edge effects than a circular fragment of the same size. The area-to-perimeter is one measure of potential viability of a fragment. Its area, proximity to adjacent vegetation and exposure to threatening processes all contribute to its viability. For example, Bush Forever site 298 with an area-to-perimeter ratio of 48 persists as a viable patch (see PER Chapter 15, Amenity (Reserves), Figures 15.3B and 15.3C).

The persistence of fragments of native vegetation depends on management such as restricting access, weed control and, where practicable, reconnection with other areas of native vegetation through rehabilitation. Ecologically-connected remnants are likely to remain viable for fauna provided they are managed appropriately (see Appendix M, Technical Advice on Fauna Issues and consolidated issue 154 in Chapter 7, Response to Office of the Environmental Protection Authority Issues, Section 7.3.2). Management measures set out in PER Chapter 8, Flora and Vegetation, Table 8.16 and PER Chapter 12, Rehabilitation and Decommissioning, Table 12.1 will assist in maintaining the viability of fragments. Management of impacts to wetland and dampland habitat fragments is set out in PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Table 10.9. Connectivity through rehabilitation or use of underpasses is important to connect isolated fragments (PER Chapter 9, Terrestrial Fauna, Table 9.7). Advice on the impacts of habitat fragmentation on fauna is provided in Appendix M, Technical Advice on Fauna Issues and consolidated issue 154 in Chapter 7, Response to Office of the Environmental Protection Authority Issues, Section 7.3.2.

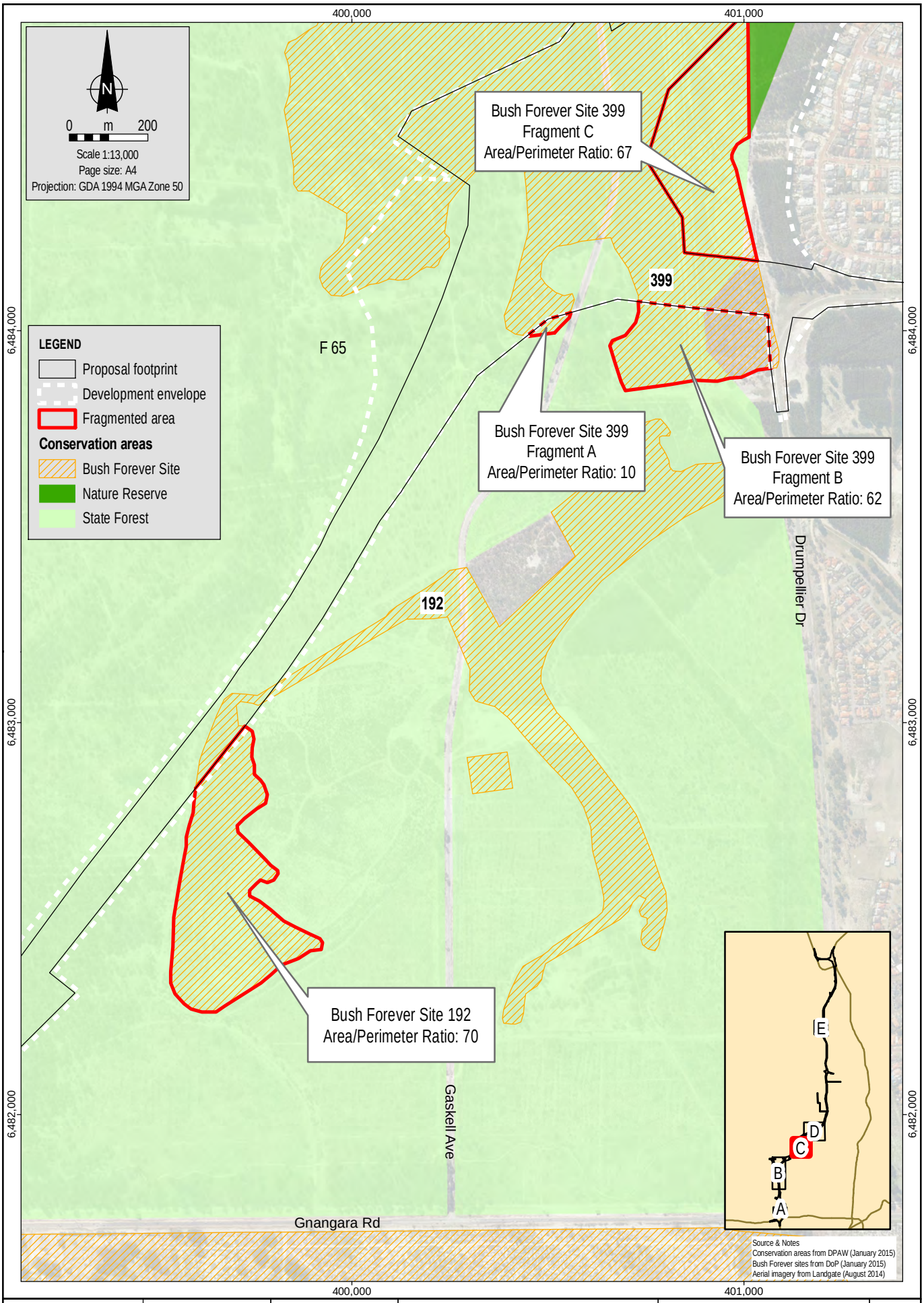
A fragmentation analysis was undertaken to identify conservation significant values that may be fragmented by the proposal. Figure 7.1 shows occurrences of conservation significant values that will be fragmented by the proposal. Table 7.3 summarises each of the fragments shown on Figure 7.1 and discusses their likely persistence following construction of the proposal. The discussion on persistence considers the area-to-perimeter of each fragment (shown on Figure 7.1), which favours fragments with shorter perimeters (e.g. circles), and the likelihood that the values of each fragment will be retained.



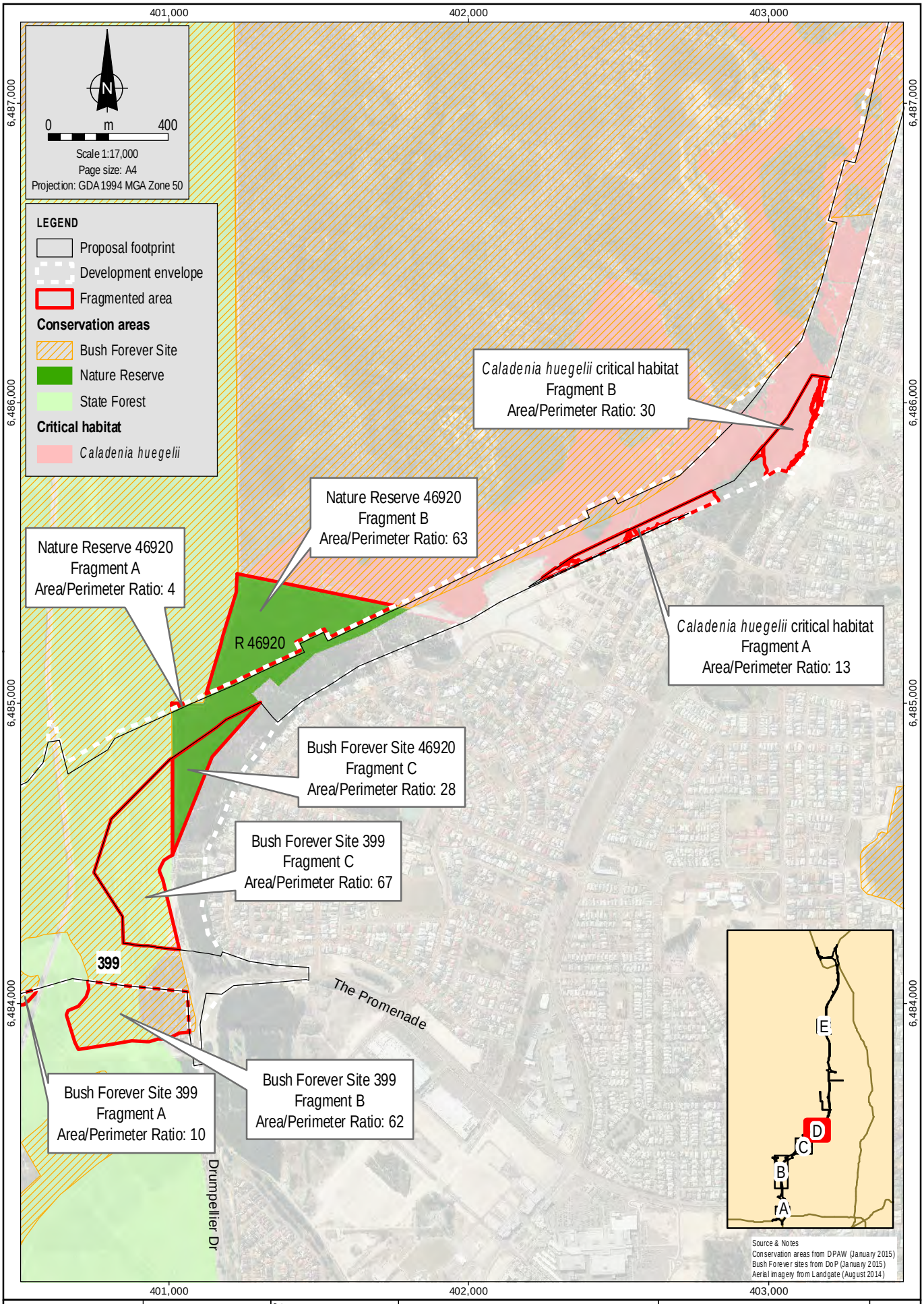
NorthLinkWA	coffey	Date: 05.12.2015 MXD: 4483AA_42_GIS007 File Name: 4483AA_42_F007.1A_GIS	Main Roads WA Response to Submissions Perth–Darwin National Highway	Fragmentation analysis Map 1 of 5	Figure No: 7.1A



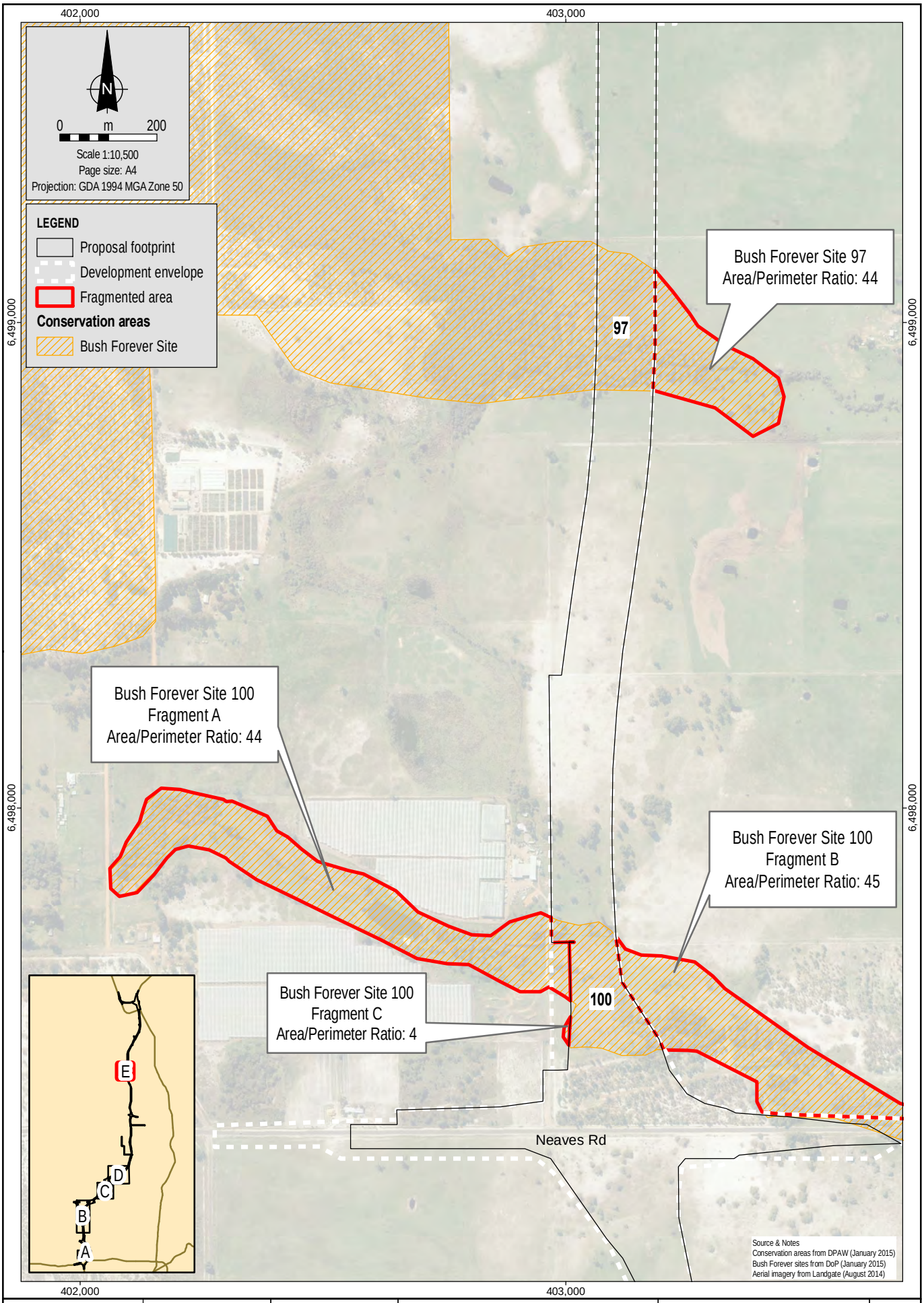
NorthLinkWA	coffey	Date: 01.03.2016 MXD: 4483AA_42_GIS007 File Name: 4483AA_42_F007.1B_GIS_3	Main Roads WA Response to Submissions Perth Darwin National Highway	Fragmentation analysis Map 2 of 5	Figure No: 7.1B



NorthLinkWA	coffey	Date: 05.12.2015 MXD: 4483AA_42_GIS007 File Name: 4483AA_42_F007.1C_GIS	Main Roads WA Response to Submissions Perth–Darwin National Highway	Fragmentation analysis Map 3 of 5	Figure No: 7.1C



NorthLinkWA	coffey	Date: 09.02.2016 MXD: 4483AA_42_GIS007 File Name: 4483AA_42_F007.1D_GIS_2	Main Roads WA Response to Submissions Perth–Darwin National Highway	Fragmentation analysis Map 4 of 5	Figure No: 7.1D



NorthLinkWA	coffey	Date: 05.12.2015 MXD: 4483AA_42_GIS007 File Name: 4483AA_42_F007.1E_GIS	Main Roads WA Response to Submissions Perth–Darwin National Highway	Fragmentation analysis Map 5 of 5	Figure No: 7.1E

Table 7.3 Potential indirect impacts of fragmentation on conservation significant values

Value	Discussion	Figure reference
Bush Forever		
Bush Forever site 480	Although this fragment is 0.7 ha and has a small area-to-perimeter ratio of 10, it is likely that its values will be retained given the larger remnant portion of CCW 15033 within and immediately adjacent to the fragment. CCW 15033 is mapped in association with vegetation in Very Good and Excellent to Very Good condition.	Figure 7.1A
Bush Forever site 198	Fragments A and B of Bush Forever site 198 are contiguous with Bush Forever site 304 to the east and north, forming part of the greater Bush Forever reserve coincident with Whiteman Park. Given their larger area-to-perimeter ratios and connectivity with adjacent Bush Forever, these fragments are both likely to retain their values.	Figure 7.1B
Bush Forever site 304	Fragments A, B and C of Bush Forever site 304 are contiguous with larger sections of the site and Bush Forever site 198 to the south, forming part of the greater Bush Forever reserve coincident with Whiteman Park. Given their large area-to-perimeter ratios and connectivity with adjacent Bush Forever, these fragments are all likely to retain their values.	Figure 7.1B
Bush Forever site 192	Bush Forever site 192 contains two larger areas connected by a narrow strip 40 m wide and 500 m long. The proposal will clear a small portion of the connecting part of Bush Forever site 192. The resulting fragment is bordered by a quarry to the east and will be bordered by the proposal on the west and north. Despite the loss of connectivity to the remainder of the site, it is likely to retain its values as a Bush Forever site given its relatively large size (13.9 ha) and high area-to-perimeter ratio (70).	Figure 7.1C
Bush Forever site 399	The proposal's Ellenbrook interchange will result in three areas of Bush Forever site 399 being isolated on the eastern side of the proposal from the remainder of Bush Forever site 399 to the west and north of the proposal. Fragment A is unlikely retain its value given its small size (0.3 ha) and low area-to-perimeter ratio (10). This fragment contains vegetation mapped in SCP21c (P3) and is within vegetation complex Bassendean Complex–North. It does not any records of Threatened or Priority flora. Fragment A likely comprises foraging habitat for Carnaby's Black Cockatoo by extension of the Black Cockatoo habitat mapping shown in PER Chapter 9, Terrestrial Fauna, Figure 9.2C. The proposal's offsets include the loss of Carnaby's Black Cockatoo foraging habitat from this fragment (see Chapter 6, Environmental Offsets). Fragment B is likely to retain its values given its size (6.9 ha), relatively high area-to-perimeter ratio (62) and connectivity with bushland immediately to the south leading into Bush Forever site 192. Fragment C is located within the development envelope between the interchange and Ellenbrook residential areas. It is likely to retain its values given its size (10.7 ha), high area-to-perimeter ratio (67) and connectivity to other remnant native vegetation also in the development envelope but outside the proposal footprint.	Figure 7.1C, Figure 7.1D

Value	Discussion	Figure reference
Bush Forever site 100	Bush Forever site 100 occurs in connection with a drainage line and wetlands adjacent to Neaves Road. Fragment A is not expected to lose any of its values as Bush Forever due to its 10.9 ha size and location upstream of the proposal. While downstream of the proposal, the use of culverts (see PER Appendix H, Drainage Strategy) will ensure the maintenance of surface water flows to Fragment B. Fauna underpasses installed adjacent to the watercourse will enable wildlife movement between the fragments. Fragment B is expected to retain its values as Bush Forever. Fragment C is too small (0.05 ha) to be likely to retain its values, even with adjacent revegetation works completed as part of the proposal. The vegetation in this fragment is from the vegetation complex Bassendean Complex–North. It contains low value Black Cockatoo foraging and/or roosting habitat. There are no records of TECs, PECs, Priority flora or Threatened flora in this fragment.	Figure 7.1E
Bush Forever site 97	Bush Forever site 97 will be severed by the proposal, with the majority of the site remaining intact on the western side of the proposal footprint. A 4.3 ha fragment will be isolated on the eastern side of the proposal. This fragment occurs downstream of Mound Springs SCP TEC. The use of culverts (see PER Appendix H, Drainage Strategy) will ensure the maintenance of surface water flows across the proposal. Fauna underpasses will enable wildlife movement between the fragments. Road reserve revegetation will link this fragment with the Bush Forever site 100 fragment enabling fauna movement. These management measures will minimise impacts to its values as Bush Forever.	Figure 7.1E
Critical habitat for Threatened flora		
Caladenia huegelii	While the majority of *Caladenia huegelii* critical habitat adjacent to Ellenbrook is west of the proposal, two fragments will be left isolated between the proposal and the rear of residential areas in Ellenbrook. Fragment A is less likely to retain its values as it is smaller in size (1.9 ha) and has a much smaller area-to-perimeter ratio of 13. The proposal's offsets include the loss of *Caladenia huegelii* critical habitat from this fragment (see Chapter 6, Environmental Offsets). Fragment B, which contains one *Caladenia huegelii* individual, is likely to retain its values given its moderate area-to-perimeter ratio and 4.9 ha size. There are many instances where populations of *Caladenia huegelii* have existed for many years within 50 m or less of roads including the busy Roe Highway (Stage 7). Indirect impacts to *Caladenia huegelii* critical habitat including impacts associated with uncontrolled access, fires, spread of introduced weeds and *Phytophthora* dieback will be managed through the management measures proposed in PER Chapter 8, Flora and Vegetation, Section 8.5.	Figure 7.1D
Nature Reserves		
Class A Nature Reserve 46920	The proposal will result in the loss of about half of Class A Nature Reserve 46920. While fragment A is small and has a small area-to-perimeter ratio of 4, the values currently in reservation in fragments A, B and C (predominantly pine plantation) are likely to be retained given its connectivity with similar vegetation and habitats in the adjoining Gnangara–Moore River State Forest No. 65.	Figure 7.1D

Value	Discussion	Figure reference
Threatened Ecological Communities		
SCP20a	SCP20a has been mapped in two occurrences along Beechboro Road North. The proposal will sever the southern occurrence, resulting in a 2.2 ha fragment to the west of the proposal (fragment A) and a 1.1 ha fragment to the east (fragment B). A second occurrence of SCP20a to the north will be isolated, also on the eastern side of the proposal footprint (fragment C). Fragments B and C both occur in a narrow corridor between the proposal footprint, a high voltage powerline easement and Beechboro Road North. Despite their low area-to-perimeter ratios, these fragments are likely to retain their values given their co-location with the larger patch of Bush Forever site 198, which is contiguous with Bush Forever site 304 immediately to the north and east. Fragment A has a higher area-to-perimeter ratio and is likely to retain its values.	Figure 7.1B
Wetlands		
CCW 15033	A Wetland Management and Monitoring Plan will be developed and implemented including groundwater monitoring to ensure impacts to wetlands are appropriately managed and there are no unforeseen impacts (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.5). The Wetland Management and Monitoring Plan will consider the conservation status and proximity of wetlands to the proposal. The plan will include monitoring of CCW 15033 in fragment B and will ensure the retention of values of this fragment. Fragment A has already been impacted by historical clearing and development in Milly Court, Malaga and no longer exists.	Figure 7.1A
REW 15757	REW 15757 has already been impacted and modified by historical clearing, residential and industrial developments including the presence of Marshall Road and Hepburn Avenue. As a result, fragments A and B already exist and will not be created as a result of the proposal. Fragment A will be reduced in size by about 35% but is expected to retain its values with an area-to-perimeter ratio of 54. Fragment D is already highly altered by clearing and land development and no longer exists. Fragment C already exists albeit to a larger extent including the proposal footprint south of Marshall Road. Construction of the proposal will result in fragment C reducing in size but it will retain an area-to-perimeter ratio of 41 and is likely to retain its values.	Figure 7.1A
CCW 15260	CCW 15260 is mapped over a large area in Cullacabardee. The proposal will isolate a fragment of CCW 15260 in a narrow corridor between the proposal footprint, a high voltage powerline easement and Beechboro Road North. This wetland is unlikely to retain its values as a CCW given its low area-to-perimeter ratio, its shape and the degraded condition of the vegetation in this corridor (see PER Chapter 8, Flora and Vegetation, Figure 8.6). This impact is discussed in PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.4.6.1.	Figure 7.1B

Consolidated issue 173 (contributing issue 262): The Swan Coastal Plain Interim Biogeographic Regionalisation for Australia (SWA IBRA) bioregion is incorrectly stated as being a constrained area, when it is portions of the Swan Coastal Plain that are considered constrained.

The constrained area within the Metropolitan Region Scheme (MRS) is defined as urban, urban deferred, industrial areas and roads. The proposal alignment does not traverse any of these zones, with the exception of the existing Tonkin Highway/Reid Highway intersection.

Three of the five vegetation complexes occurring within the proposal footprint are below the retention target of 30%; Bassendean Complex – Central and South (21.3%), Southern River (16.8%) and Yanga Complex (13.5%) (EPA, 2015a).

Consolidated issue 174 (contributing issue 261): Please revise PER Table 8.2 with the recently updated remaining extents of vegetation complexes on the Swan Coastal Plain.

PER Chapter 8, Flora and Vegetation, Table 8.2, Native vegetation extent remaining on the Swan Coastal Plain has been revised to reflect the updated figures for the remaining extent of vegetation complexes on the Swan Coastal Plain (EPA, 2015a), including a revised assessment of the proposal's impacts (see Table 7.4).

Less than 30% of the pre-European extent of Bassendean Complex – Central and South, Southern River Complex and Yanga Complex is currently remaining in the Perth-Peel Region, and will be further reduced by the proposal (0.1 to 0.3%). The Bassendean Complex North – Transition Vegetation Complex and Bassendean Complex North have more than 30% of their pre-European extent remaining. The proposal will not reduce these two vegetation complexes below the 30% retention target.

Consolidated issue 177 (contributing issue 258): Please provide additional information to demonstrate that impacts to SCP23b are not likely to be significant despite the proposal removing 20% of its known extent.

One recorded occurrence of SCP23b – Northern *Banksia attenuata* – *Banksia menziesii* woodlands within the proposal footprint was identified in geospatial database searches. This record was not able to be confirmed during the 2014 survey (Coffey, 2015b). The 2014 survey did however record eight occurrences of SCP23b in the study area totalling 57.5 ha, including five within the proposal footprint (11.6 ha).

Keighery et al. (2012) identified 79 occurrences of SCP23b in the region, 23 of which occur within 15 km of the development envelope. The majority of these occurrences are in Bush Forever sites and/or within state forest.

The proposal will remove 11.6 ha of SCP23b which is approximately 20% of the mapped extent within the study area. Based on Keighery et al.'s assessment of SCP23b distribution, the total extent of SCP23b in the region will be considerably larger than that mapped within the study area and so the proposal is unlikely to have a significant impact on this priority ecological community.

Table 7.4 Native vegetation extent remaining within the Perth and Peel regions for the Swan Coastal Plain

Vegetation complex	IBRA region			Perth-Peel Region (PPR)						
	IBRA Pre-European extent (ha)[1]	2015 extent (ha)[2]	Extent remaining 2015 (%)[3]	PPR Pre-European extent (ha)[4]	PPR 2015 extent (ha)[5]	PPR % remaining 2015[6]	PPR Secure for conservation (ha)[7]	PPR Secure for conservation (%)[8]	Extent of intact native vegetation to be removed by the proposal (ha) [9,10]	Pre-European extent remaining after proposal (ha)
Bassendean Dunes										
Bassendean Complex – Central and South	87,416	22,846	26.1	63,451	13,486	21.3	733	1.2	62.1	13423.9 (21.2%)
Bassendean Complex North Transition Vegetation Complex	17,644	16,069	91.1	4,594	3,498	76.2	2,200	47.9	19.2	3,478.8 (75.7%)
Bassendean Complex North	74,131	53,218	71.8	35,389	23,859	67.4	9,092	25.7	73.4	23,785.6 (67.2%)
Combinations of Bassendean Dunes / Pinjarra Plain										
Southern River Complex	57,163	10,533	18.4	41,192	6,936	16.8	629	1.5	44.8	6,891.2 (16.7%)
Pinjarra Plain										
Yanga Complex	26,176	4,312	16.5	5,776	777	13.4	247	4.3	18.0	759 (13.2%)

Source: EPA (2015a).

Notes to Table 7.4:

1. Pre-clearing extent of vegetation complex (EPA, 2015a).
2. Current extent of the vegetation complex in 2015 (EPA, 2015a).
3. The remaining area of complex in 2015 as a percentage of its pre-clearing extent (EPA, 2015a).
4. Pre-clearing extent of the vegetation complex within PPR.
5. Current extent of the vegetation complex within PPR in 2015.
6. Percentage of remaining area of complex within PPR in 2015.
7. Remaining area of complex within PPR with some form of conservation purpose in 2015.
8. Percentage of remaining area of complex within PPR with some form of conservation purpose in 2015.
9. Intact native vegetation is defined as areas of vegetation where; both the vegetation condition is 'Degraded' or better and the vegetation is not mapped as cleared, highly altered or non-native vegetation associations (excluding rehabilitation).
10. The area removed includes the area to be cleared (i.e. proposal footprint) and any additional areas excised from conservation estate.

Consolidated issue 178 (contributing issue 256): Please provide detail on how the 205 ha extent of native vegetation was calculated and whether it accords with the definitions of native vegetation in the EP Act and regulations.

The total area of intact native vegetation within the proposal footprint in PER Chapter 8, Flora and Vegetation, Table 8.10 is 205 ha. Intact native vegetation is defined in the PER as areas of vegetation where both:

- The vegetation condition is in the category 'Degraded' or better (i.e. excludes vegetation mapped as 'Degraded to Completely Degraded', 'Completely Degraded', 'Cleared', 'Infrastructure' and 'Road').
- The vegetation is not mapped as one of the following cleared, highly altered or non-native vegetation associations: Cc1, CcMpMr, ErCo, MpAl, Xp^2, $CcEr^3$, Pr, Pp, R, Rehab, Former Settlement or any variant of Cl.

Chapter 8, Flora and Vegetation, Section 8.4.1 'Permanent Loss of Native Vegetation' is more accurately titled 'Permanent Loss of Vegetation' because the section considers both native and non-native vegetation. In this section, Table 8.9 includes not only native vegetation but also non-native vegetation that may be in a degraded or better condition (e.g., plantations of *Pinus pinaster* mapped as the Pp vegetation association). The sum of values from Table 8.9 column 'Extent to be cleared within the proposal footprint' and rows 'Pristine' to 'Degraded' exceeds 205 ha because these values include non-native vegetation. The 205 ha total of intact native vegetation to be cleared does not include non-native vegetation.

Native vegetation is defined in the EP Act as "indigenous aquatic or terrestrial vegetation, and includes dead vegetation unless that dead vegetation is of a class declared by regulation to be excluded from this definition but does not include vegetation in a plantation". It "does not include vegetation that was intentionally sown, planted or propagated unless [it was done] under this Act or another written law" or for similar purposes in accordance with Regulation 4 of the Environment Protection (Clearing of Native Vegetation) Regulations 2004 (Clearing Regulations). The criteria used in the PER for intact native vegetation were formulated to include areas of vegetation that would be considered native vegetation under the EP Act and Clearing Regulations (see PER Chapter 8, Flora and Vegetation, Section 8.4.1.1). Further consultation with the OEPA has identified that vegetation mapped as the Rehab vegetation association should be included in the calculation of intact native vegetation if the vegetation was intentionally sown, planted or propagated as described in the EP Act and Clearing Regulations.

Following revisions to the development envelope and proposal footprint described in Section 2.1, the extent of intact native vegetation within the proposal footprint is 206 ha. This value incorporates two areas of vegetation mapped as the Rehab vegetation association that meet the legislated definition of native vegetation.

Consolidated issue 179 (contributing issue 255): It is not clear whether the 205 ha of native vegetation to be cleared includes or is separate from values of GDEs, Bush Forever, TECs, PECs, *Caladenia huegelii* critical habitat and *Grevillea curviloba* subsp. *incurva* critical habitat.

The extent of intact native vegetation in the proposal footprint (revised to 206 ha) is inclusive of groundwater dependent ecosystems (GDEs), Bush Forever, TECs, PECs, Caladenia *huegelii* critical habitat and *Grevillea curviloba* subsp. *incurva* critical habitat.

Consolidated issue 180 (contributing issue 264): Assessment of local vegetation units is not at the appropriate scale for considering impacts in the region. Significance of impacts to 4 local vegetation units may be overstated. Please provide additional information in this regard.

PER Chapter 8, Flora and Vegetation, Table 8.10 presents the proposal's local impact on vegetation associations within the study area. Impacts to four of the vegetation associations (AsMIEvCl, Ba, BaBmMp and CcMp) appear high given this assessment is focused on the mapped extent within study area and does not consider their regional extent. To address this issue, vegetation associations have been linked with the relevant FCT for which regional scale information is available (Table 7.5).

Table 7.5 Relationship of vegetation associate to floristic community type

Vegetation association	Related quadrat	FCT	Other occurrences of FCT within the region
AsMIEv(Cl)	SVB002	SCP13	8
	SVB005	SCP12	8
Ba	SVB004	SCP21c	35
BaBmMp	360Q29	SCP21c	
CcMp	360Q15	SCP21c	

Vegetation association AsMIEvCl is associated with quadrats SVB002 and SVB005 (PER Appendix C, Level 2 Spring Flora and Vegetation Assessment, Table 18). Quadrat SVB002 is associated with SCP13 (PER Appendix C, Level 2 Spring Flora and Vegetation Assessment, Table 19) which is not a listed FCT. There are eight known occurrences of SCP13 in the region (Keighery et al., 2012) ranging from as far south as Ruabon, near Busselton, to near Yeal in the north (approximately 25 km northwest of the development envelope).

Quadrat SVB005 is associated with SCP12 (PER Appendix C, Level 2 Spring Flora and Vegetation Assessment, Table 19) which is not a listed FCT. There are eight known occurrences of SCP12 in the region. SCP12 ranges from Capel in the south to approximately 15 km southwest of Muchea in the north (Keighery et al., 2012). The nearest occurrence of SCP12 to the development envelope is approximately 9 km southeast of the Reid/Tonkin highways interchange.

Vegetation association Ba is associated with quadrat SVB004, vegetation association BaBmMp with quadrat 360Q29 and vegetation association CcMp with quadrat 360Q15 (PER Appendix C, Level 2 Spring Flora and Vegetation Assessment, Table 18). All three quadrats are associated with SCP21c, which is listed as PEC (P3). Twenty seven records were returned from DPAW 2005 Swan Coastal Plain dataset (Keighery et al., 2012) and a further eight records were returned in a custom search of DPAW's databases for existing records of SCP21c within 10 km of the proposal. SCP21c ranges from approximately 10 km north of Muchea, along Ioppolo Road to approximately 12 km south of Bunbury (Keighery et al., 2012). The closest occurrences of SCP21c are approximately 1 km east of the development envelope near Maralla Road.

When considered in this regional context, impacts on these vegetation associations are not considered to be significant, as the vegetation association is well represented outside the development envelope.

Consolidated issue 182 (contributing issue 272): Please resolve inconsistencies in extent of direct impact to Bush Forever sites.

The proposal footprint intersects 188.7 ha of Bush Forever sites. However, the proposal will impact only 129.9 ha of intact native vegetation within Bush Forever sites. Impacts to Bush Forever sites are shown in Table 7.6.

Table 7.6 Impacts to Bush Forever sites

Bush Forever site	Extent of intact native vegetation impacted by proposal (ha)	Total area impacted by proposal (ha)
No. 97 – Kirby Road bushland, Bullsbrook	3.3	3.3
No. 100 – Neaves Road creek, Bullsbrook	0.2	3.5
No. 192 – Wetherell Road bushland, Lexia/Ellenbrook	1.3	1.3
No. 198 – Beechboro Road bushland, Cullacabardee/Ballajura	30.7	31.3
No. 300 – Maralla Road bushland, Ellenbrook/Upper Swan	16.9	16.9
No. 304 – Whiteman Park, Whiteman/West Swan	29.9	75.1
No. 307 – Lightning Swamp and adjacent bushland, Noranda	1.0	1.1
No. 399 – Melaleuca Park and adjacent bushland, Bullsbrook/Lexia	30.8	37.9
No. 480 – Victoria Road bushland, Malaga/Beechboro	15.9	18.2
Total	**129.9**	**188.7**

Note: values may not sum to totals due to rounding error.

Table 6.2 sets out the offset requirements for the significant values impacted by the proposal.

7.3.3 Priority Flora

Consolidated issue 176 (contributing issue 254): Please discuss outcome of additional regional surveys for *Millotia tenuifolia* var. *laevis* and *Meeboldina decipiens* subsp. *decipiens*, including final residual impacts, revised management, monitoring, mitigations and any amendments to offset proposals.

The results of the regional survey are presented in Appendix D, Spring Surveys for *Meeboldina decipiens* subsp. *decipiens* (P3) and *Millotia tenuifolia* var. *laevis* (P2). A summary of the key findings is presented in Chapter 3, Spring Ecological Surveys, Section 3.2 and summarised below.

Millotia tenuifolia* var. *laevis

The survey for Millotia tenuifolia var. laevis recorded a total of 5,222 individuals within eight populations outside the development envelope. This included two populations (1,652 individuals) adjacent to the proposal footprint west of Beechboro Road North in Cullacabardee. Of the 5,222 individuals recorded, 3,345 are in conservation estate (State Forest, Regional Park or MRWA's proposed offset property at Ioppolo Road).

Due to the high number of individuals located nearby (1,652 across two populations) and regionally (3,570 across 6 populations), clearing of *Millotia tenuifolia* var. *laevis* within the proposal footprint (2 populations, 3 individuals) will have a negligible impact on the local and regional population.

Meeboldina decipiens* subsp. *decipiens ms

Material collected from the populations within the development envelope as part of the regional survey, were re-inspected by WAH staff who identified them as *Lepyrodia muirii*. The proposal footprint will not impact *Meeboldina decipiens* subsp. *decipiens* (P3).

As *Millotia tenuifolia* var. *laevis* was found to be abundant in the area and *Meeboldina decipiens* subsp. *decipiens* was determined to not occur in the proposal footprint, impacts on these species are not significant and do not require offset. The revised management relating to flora and vegetation is provided in Chapter 13, Summary of Management Measures.

7.3.4 Study and Survey Adequacy

Consolidated issue 170: Please discuss outcome of additional surveys for TEC SCP02 in development envelope, including final residual impacts, revised management, monitoring, mitigations and any amendments to offset proposals.

Contributing issues:

227: If Offset Proposal 3 proves difficult to implement, alternative offset options for the loss of 0.4 ha of SCP02 should be developed and implemented, in consultation with DPAW.

253: Please discuss outcome of additional surveys for TEC SCP02 in development envelope, including final residual impacts, revised management, monitoring, mitigations and any amendments to offset proposals

273: Please resolve inconsistencies in extent of direct impact to TEC SCP02.

275: It is not clear how the >2:1 ratio for TEC SCP02 was determined. The proponent should use the Commonwealth offsets calculator to determine an appropriate offset if SCP02 is confirmed present in the development envelope.

276: Please provide details of the TEC SCP02 spring survey. The proponent will need to provide a suitable offset for SCP02 and justify the rationale used if SCP02 is confirmed.

A targeted spring survey was undertaken on 17 September 2015 to confirm the presence of TEC SCP02 identified in surveys for the PER.

Surveyed quadrats showed the vegetation community most closely resembled SCP04, which is common on the SCP. The additional quadrats occurred in the same supergroup as SCP02 due to similar dominant taxa, but occur within different subgroups. SCP02 does not occur within the proposal footprint.

There is no residual impact to SCP02 and no offset required. The revised management measures are set out in Chapter 13, Summary of Management Measures.

Further information can be found in Chapter 3, Spring Ecological Surveys. The supporting report is attached as Appendix E, Spring Surveys and Analysis to Investigate SCP02 Presence.

7.4 Terrestrial Fauna

Consolidated issue 97: Study, survey and trapping procedures were inadequate. Richness of extant fauna is not captured in surveys.

Contributing issues:

25: Fauna assessment is inadequate because it does not consider arboreal and bird species, underestimating species diversity. Some species of reptiles, micro bats, invertebrates, birds not properly considered. Local extinctions could result.

27: Study, survey and trapping procedures were likely inadequate. Why were trapping nights not conducted across all four seasons?

194: The timing and duration of the surveys do not adequately represent the richness of fauna that longitudinal studies would have provided.

215: Surveys for flora and fauna, but especially birds, reptiles and invertebrates, was not comprehensive enough. Species have been overlooked because of the limited scope of surveys. How can the real impacts be known?

266: It is unclear if all fauna records from all surveys in the study area have been considered, or if only the results in the Level 2 Targeted Fauna Assessment by Coffey have been considered.

The fauna assemblage of the SCP is well documented with numerous systematic surveys completed in recent history (Government of Western Australia, 2000). The survey method (PER Chapter 9, Terrestrial Fauna, Section 9.2.1) addressed the requirements of the Environmental Scoping Document (ESD) and was approved by the EPA and DPAW.

A total of 97 species were recorded during these surveys, all of which were identified as potentially occurring in the desktop assessment. The number of fauna species recorded during the survey is comparable with other surveys completed in the vicinity and typical of the habitats present within the study area. For example, of the 232 birds identified during the desktop assessment, 62 of these were positively recorded during the surveys (PER Appendix G, Level 2 Targeted Fauna Assessment, Table 5.4).

The term "fauna assemblage" is used throughout the PER to describe the large number of species previously recorded. Fauna assemblage includes birds, arboreal mammals, bats, reptiles and invertebrates.

As the proposal's impacts to the fauna assemblage are expected to be localised, the PER focuses on impacts on conservation significant fauna, particularly those species confirmed to be present during the survey along with any other conservation significant species identified during the desktop assessment which were considered likely to occur within the proposal footprint (see PER Chapter 9, Terrestrial Fauna, Section 9.2.5).

Consolidated issue 168 (contributing issue 267): The incorrect regional scale has been used to assess impacts to fauna. Provide further analysis that addresses the impacts to fauna using the Swan Coastal Plain region as the regional scale.

EPA Guidance Statement 56 recommends a 15 km radius to the proposal to determine the size of remnants and habitat condition in a regional context (EPA, 2004a). However, a 15 km buffer for linear infrastructure would encompass vegetation associations and habitat different to those within the proposal footprint given the diversity of vegetation complexes in the Swan Coastal Plain bioregion. The use of 1 km and 10 km study areas is appropriate to determine local and regional context for linear infrastructure respectively (Appendix M, Technical Advice on Fauna Issues, Issue 168)).

A 10 km buffer to the proposal footprint defined the regional study area for the fauna assessment. A 1 km buffer to the proposal footprint defined the local study area. These areas provided appropriate context for assessing impacts on mapped vegetation associations, TECs, PECs and threatened and priority flora.

Information on the wider distribution of species (PER Chapter 9, Terrestrial Fauna, Section 9.4.1) was provided, where available. For the Western Carpet Python, Southern Brown Bandicoot and Western Brush Wallaby, this discussion provided additional context and was not used in the regional assessment.

Further discussion on the aforementioned species' distribution on the Swan Coastal Plain and the local and regional assessment is provided in Appendix M, Technical Advice on Fauna Issues, Issue 168.

Consolidated issue 169 (contributing issue 265): Provide detail to demonstrate that the EPA's objective for terrestrial fauna can be met for locally or regionally significant species including wetland fauna/ habitats. Is the assessment based on the results from all the surveys in the study area?

Locally and regionally significant species are exposed to the same impacts as listed species including habitat loss, habitat fragmentation, habitat degradation, increased predation and disturbance from noise and light (Appendix M, Technical Advice on Fauna Issues, Issue 169 (locally and regionally significant fauna)). Management of these impacts applies to the entire fauna assemblage not just significant species thereby meeting the EPA's objective.

Changed hydrology is the primary impact on wetland function and health (Appendix M, Technical Advice on Fauna Issues, Issue 169 (wetland fauna and wetland fauna habitats)). An assessment of potential impacts on wetlands is presented in PER Chapter 10, Hydrological Processes and Inland Water Environmental Quality, Section 10. Management measures to maintain hydrological processes are set out in PER Chapter 10, Hydrological Processes and Inland Water Environmental Quality, Table 10.9. The findings of this assessment were that the risk to damplands and wetlands affected by the proposal will be low, as only small portions of wetlands will be affected. The greatest residual impact was the removal of a wetland (Conservation Category Wetland (CCW) 15033) and Bush Forever site 480 at the intersection of Tonkin Highway and Reid Highway.

A desktop assessment of State and Commonwealth databases, regional and local contextual data for the northern SCP and existing biological surveys was undertaken prior to the majority of the field surveys for the fauna study area (see PER Chapter 9, Terrestrial Fauna, Section 9.2.1). The results of this desktop assessment were used to develop a list of fauna expected in the study area. PER Appendix G, Level 2 Targeted Fauna Assessment, Appendix H, Previously recorded fauna list presents the full list of species recorded during the Coffey survey and other surveys undertaken in or adjacent to the fauna study area. All publically available information and previous surveys were considered in the assessment including GHD (2013a) and Appendix M, Technical Advice on Fauna Issues.

7.5 Hydrological Processes and Inland Waters Environmental Quality

Consolidated issue 153 (contributing issue 274): Please resolve inconsistencies in extent of direct impact to CCWs.

Seven CCWs will be directly impacted by the proposal footprint (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Table 10.3). The impacted areas are detailed in PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Table 10.6. The total direct impact on the seven CCWs is 14.8 ha.

The proposal will fragment a 1.2 ha area of CCW 15260, this severed portion is unlikely to retain values commensurate with a CCW (see Table 7.2). The offsets proposed in PER Chapter 6, Environmental Offsets

address both the 14.8 ha of direct impacts to seven CCWs and the 1.2 ha fragmentation impact to CCW 15260.

7.6 Environmental Offsets

Consolidated issue 14: The proposal (including offsets) will still result in a net loss of biodiversity. Acquisition does not replace bushland, and MRWA should implement a revegetation offset.

Contributing issues:

10: Can offsets package include purchase of cleared/degraded land for rehabilitation to address net loss of important habitat associated with bushland and wetlands?

82: The net loss of black cockatoo habitat requires habitat replacement in the long term through acquisition and revegetation of degraded habitat to avoid continued cumulative losses. This also applies to all other fauna habitats.

85: While the implementation of Offset 1 is supported, the proposal will still result in a net loss of biodiversity at the species, population and community level.

87: The acquisition of properties does not sufficiently offset the impacts of the proposal. MRWA must be required to undertake a revegetation offset to actually replace lost bushland, even if attempts to do so do not completely succeed.

291: The acquisition of Ioppolo Road protects existing foraging habitat for black cockatoos but does not increase availability of habitat. Losses of habitat in the development envelope are therefore not mitigated.

292: The proponent should take into consideration rehabilitation and revegetation when proposing offsets, particularly regarding the EPA's recent strategic advice for the Perth and Peel regions.

MRWA's offset strategy (see Chapter 6) has been developed in accordance with the Commonwealth Environmental Offsets Policy (Government of Australia, 2012), WA Environmental Offsets Policy (Government of Western Australia, 2011) and WA Environmental Offsets Guideline (Government of Western Australia, 2014).

Land acquisition is recognised as an appropriate form of offset under these policies and guidelines:

- WA Environmental Offsets Policy: "Direct offsets vary... and include acquisition… of natural areas outside the project area."
- WA Environmental Offsets Guideline: "Land acquisition offsets… involve the protection of environmental values through improved security of tenure or restricting the use of the land."
- Commonwealth Environmental Offsets Policy: "The securing of existing unprotected habitat as an offset only provides a conservation gain if that habitat was under some level of threat of being destroyed or degraded, and as a result of offsetting will instead be protected in an enduring way and actively managed to maintain or improve the viability of the protected matter."

As detailed in Chapter 6, Environmental Offsets, MRWA has purchased a parcel of land in the Chittering area (Ioppolo Road) for the purpose of offsetting impacts to Black Cockatoos from the proposal. This offset (Offset proposal 1) protects existing high quality habitat for Black Cockatoo species that was otherwise under threat of clearing and degradation from third party access and exploration and agricultural activities. It is an important ecological linkage to existing reserves to the west. The details of activities and funding arrangements for ongoing management will be included in the Land Acquisition and Management Plan in consultation with DPAW.

MRWA acquired the Ioppolo Road site prior to the release of the OEPA's strategic advice 'Perth and Peel @ 3.5 million Environmental impacts, risks and remedies' (EPA, 2015a). While EPA acknowledged that acquisition of bushland provides immediate value and certainty, it is recommended that in future greater emphasis is placed on rehabilitation and revegetation of degraded areas to achieve a net improvement in habitat and other environmental values.

Offset proposal 1 does not completely satisfy the offset requirement for Black Cockatoos.. The proposal will also require offsets for a variety of other values, including SCP20a, a number of under-represented vegetation and CCWs, as discussed in Chapter 6. MRWA is considering the opportunity to include rehabilitation and revegetation in addressing these other offset requirements.

MRWA are currently developing a restoration offset plan for up to 31.5 ha across several properties adjacent to the alignment. The restoration plan will be aimed at wetlands, under-represented vegetation and Black Cockatoo habitat, as discussed in Chapter 6, Environmental Offsets.

Consolidated issue 15: Should Ioppolo Road not comprise critical habitat for *Caladenia huegelii*, an alternative offset package should focus on the management and protection of existing populations or critical habitat, rather than on translocation options.

Contributing issues:

217: Should Ioppolo Road not comprise critical habitat for *Caladenia huegelii*, an alternative offset package focus on the management and protection of existing populations or critical habitat, rather than on translocation options.

288: Please provide details of the spring survey at Ioppolo Road to determine presence of *Caladenia huegelii* critical habitat. If Ioppolo Road is not suitable, an alternative offset will need to be provided.

The Ioppolo Road offset site does not contain suitable habitat for *Caladenia huegelii*. An alternative offset package has been proposed (see Chapter 6, Offsets). Offset Proposal 3 offsets the loss of 31.9 ha of potential critical habitat for *Caladenia huegelii*.

MRWA is proposing to provide funding for a period of 10 years for the ongoing management of existing reserves 46919, 46875 and Bush Forever site 300 and Whiteman Park, which contain potential critical habitat for *Caladenia huegelii* (see Appendix C, Assessment and Refinement of Potential Critical Habitat for *Caladenia huegelii* (T-DRF) within the Development Envelope, Figure 1).

MRWA is proposing to provide funding for the development and implementation of a management plan in consultation with DPAW in accordance with the Grand Spider Orchid (*Caladenia huegelii*) recovery plan (DEC, 2009).

Consolidated issue 157: Please provide further details relating to the offset for TEC SCP20a.

Contributing issues:

252: Please discuss outcome of additional surveys for TEC SCP20a at Ioppolo Road, including final residual impacts, revised management, monitoring, mitigations and any amendments to offset proposals.

277: Please provide details of the spring survey for TEC SCP20a. If the Ioppolo Road offset site is not suitable then an alternative offset will need to be provided for SCP20a.

278: Please provide details of the rationale behind using a 2:1 offset ratio for TEC SCP20a. The Commonwealth Offsets calculator should be used to determine an appropriate offset for SCP20a.

A spring survey was undertaken on 15 and 16 September 2015 to confirm the presence of TEC SCP20a within the proposed offset site at Ioppolo Road.

The quadrats surveyed in the offset proposal had a close association with SCP28. Two quadrats IR-01 and IR-05 had species in common with SCP20a, but analysis shows they are most closely related to SCP28. Other quadrats had the most species in common with SCP23c and SCP28 in the updated SCP dataset (Keighery et al., 2012). Further information can be found in Chapter 3, Spring Ecological Surveys. The supporting report is attached as Appendix F, Assessment of the Presence of the TEC SCP20a at Ioppolo Road, Chittering. Ioppolo Road is not a suitable offset site for SCP20a.

Up to 4 ha of SCP20a will be impacted by the proposal. The EPBC Act offset assessment guide was used to calculate the likely quantum of offset taking into consideration the existing vegetation condition and threatening processes. The guide identified a need to offset 23 ha, a ratio of 6:1 (see Chapter 6, Offsets). MRWA will fund the acquisition or covenanting of a property or properties to be managed for conservation including restoration where possible to offset the loss of SCP20a.

Consolidated issue 158: Please provide further details relating to the offset for conservation areas.

Contributing issues:

281: It is unclear how the 1:1 ratio of offsets proposed for conservation estate has been determined. It is also likely to be inadequate.

282: The offset for conservation areas should be representative of the values being impacted and the associated attributes that may be lost. There is no consideration of how Offset Proposal 1 addresses this.

283: Class A Nature Reserves are the highest level of conservation reservation and a much higher offset ratio is likely to be required, if approval is granted.

284: Please provide details on the comparison of vegetation quality and composition between Bush Forever sites proposed to be impacted and proposed offsets to Bush Forever.

285: Overlaps between Bush Forever, Class A Nature Reserves and State Forest should be individually quantified. For offsetting purposes, State Forest < Bush Forever < Class A Nature Reserve. Indicate suitability of Offset Proposal 1.

286: A 1:1 offset ratio for State Forest may be appropriate if vegetation quality and values are the same. Please indicate the rationale behind the ratios chosen and the suitability of Offset Proposal 1.

287: A revision of the proposed offsets may be necessary to address residual impacts to conservation areas and should be provided if this is the case.

297: Please provide detailed maps defining boundaries of Class A Nature Reserves 46919 and 46920, the areas impacted by the proposal and the distinction between pine plantations and native vegetation in these reserves.

Conservation areas impacted by the proposal include Class A Nature Reserves, State Forest and Bush Forever sites. Class A Nature Reserves 46919 and 46920 (flora and fauna conservation) and Gnangara-Moore River State Forest No. 65 (timber production) are Crown land with statutory protection. Bush Forever sites 97, 100, 192, 198, 300, 304, 307, 399 and 480 are protected by policy.

The proposal will directly impact values in these conservation areas including vegetation complexes, threatened and priority ecological communities, and threatened species and habitat.

Five vegetation complexes of the SCP are affected by the proposal: Bassendean Complex – Central and North, Bassendean Complex – North Transition, Bassendean Complex – North, Southern River Complex and Yanga Complex. Table 7.4 details the pre-European extent of the complexes compared to the post-construction extent.

Three of these complexes are currently below the retention target of 30%: Bassendean Complex – Central and South, Southern River Complex and Yanga Complex (see Table 7.4) and are also below the 10% Bush Forever protection target (Table 7.7). The proposal's impacts to these vegetation complexes are addressed in Chapter 6, Environmental Offsets.

Table 7.7 Extent of vegetation complexes in Bush Forever sites

Vegetation complex	Pre-European extent (ha)	Extent in Bush Forever	Extent impacted by proposal[1] (ha)	Percentage remaining after proposal
Bassendean Complex – Central and South	87,416	7,980 ha (9.13%)	60.2	9.06%
Southern River Complex	57,163	5,075 ha (8.88%)	18.6	8.85%
Yanga Complex	26,176	706 ha (2.29%)	3.4	2.68%

Source: DOP (2015) and EPA (2015a).
Note:
1. Impacts on intact native vegetation in Bush Forever sites are calculated from the proposal footprint. Intact native vegetation is defined as areas of vegetation where both the vegetation condition is 'Degraded' or better and the vegetation is not mapped as cleared, highly altered or non-native vegetation associations (excluding rehabilitation).

Table 7.8 provides a breakdown of the extent of intact vegetation impacted in nature reserves, State Forest and Bush Forever sites for each vegetation complex below the 30% retention target. The totals are mutually exclusive. Where parts of Bush Forever sites overlap State Forest, the impact has been attributed to State Forest.

Table 7.8 Extent of impact on intact vegetation in vegetation complexes below the 30% retention target with each type of conservation area

Vegetation complex	Extent in Nature Reserve 46919[1] (ha)	Extent in Nature Reserve 49620[1] (ha)	Extent in Gnangara-Moore River State Forest No. 65 [1] (ha)	Extent in Bush Forever sites[2] (ha)	Total extent in conservation areas (ha)
Bassendean Complex – Central and South	–	–	2.1	58.9	61.0
Southern River Complex	–	–	–	18.6	18.6
Yanga Complex	–	–	–	3.4	3.4
Total	**0.0**	**0.0**	**2.1**	**80.9**	**86.4**

Notes:
1. Impacts in nature reserves and state forest are calculated from excision areas.
2. Impacts in Bush Forever sites are calculated from the proposal footprint.

PER Table 15.1 and 15.2 (PER Chapter 15, Amenity (Reserves) have been updated to show the extent of values affected in conservation areas. Table 7.9 (updated PER Table 15.1) shows the extent of impacts on conservation estate (nature reserves and state forest) within the development envelope. Impacts to vegetation associations in Class A Nature Reserves 46919 and 46920 are shown on Figure 7.2 and 7.3 respectively. Table 7.10 (updated PER Table 15.2) shows the extent of impacts on Bush Forever sites within the proposal footprint.

Table 7.9 Updated PER Table 15.1 Impacts to conservation estate

Conservation estate	Area of conservation estate[1]	Area of intact native vegetation	Area of Black Cockatoo habitat	Priority listed flora or area of PEC
Class A Nature Reserve 46919	0.4 ha	0.4 ha	• 0.4 ha of foraging habitat for Carnaby's Black Cockatoo.	• 0.4 ha of SCP21c (P3)
Class A Nature Reserve 46920	9.7 ha	0.5 ha	• 0.3 ha of foraging habitat for Carnaby's Black Cockatoo.	• 1 individual of *Hypolaena robusta* (P4) • 0.8 ha of SCP21c (P3) • 0.2 ha of SCP22 (P3)
Gnangara–Moore River State Forest No. 65	122.1 ha	43.6 ha	• 34.8 ha of foraging habitat for Carnaby's Black Cockatoo, including 3.0 ha of breeding habitat for Carnaby's Black Cockatoo and 3.0 ha of breeding and foraging habitat for Forest Red-tailed Black Cockatoo.	• 13.6 ha of Banksia dominated woodlands on the SCP (P3) • 21.3 ha of SCP21c (P3) • 0.1 ha of SCP22 (P3) • 2.9 ha of SCP24 (P3)

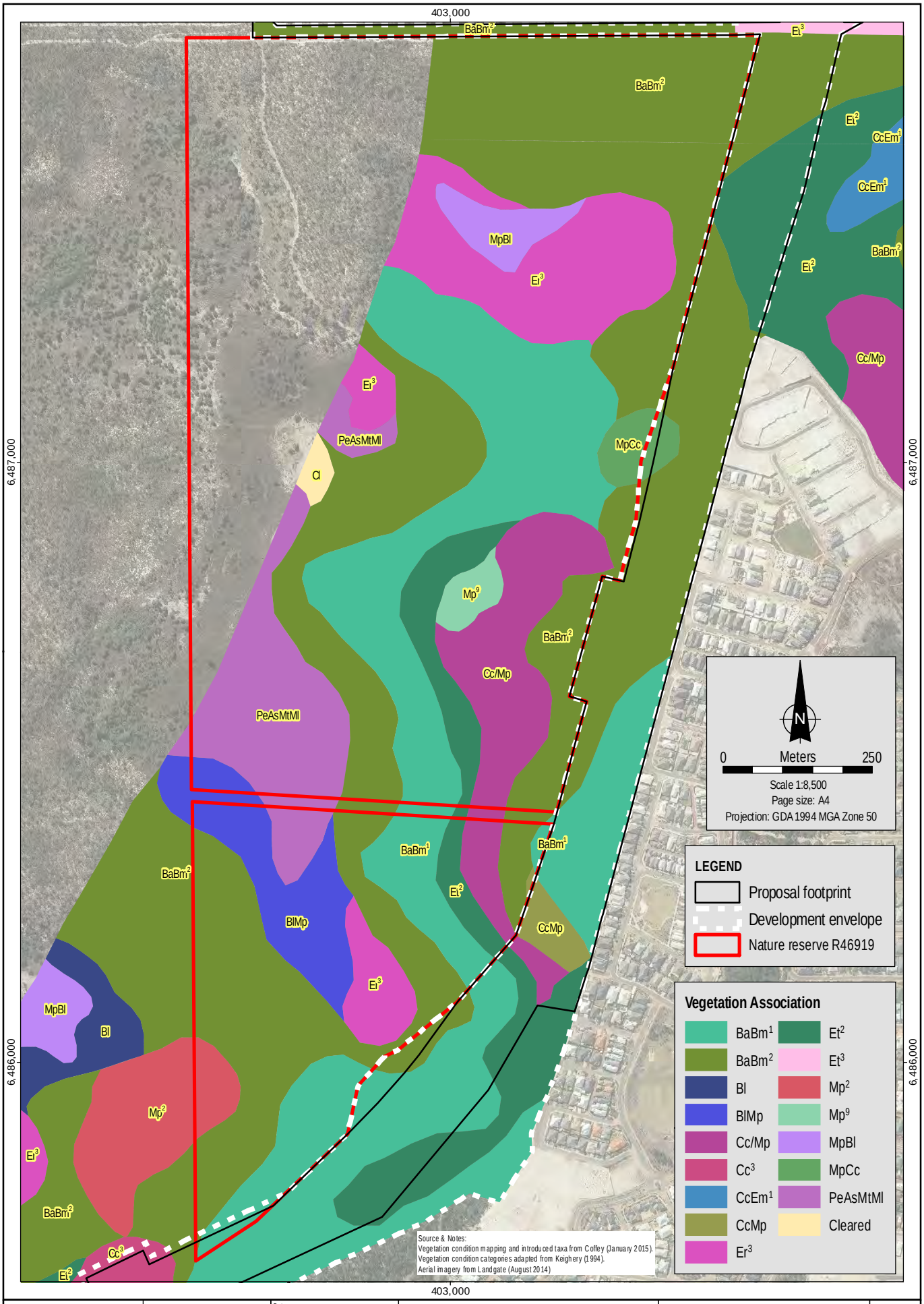
1. Based on the nature reserve and state forest excision areas.

Table 7.10 Updated PER Table 15.2 Impacts to Bush Forever sites

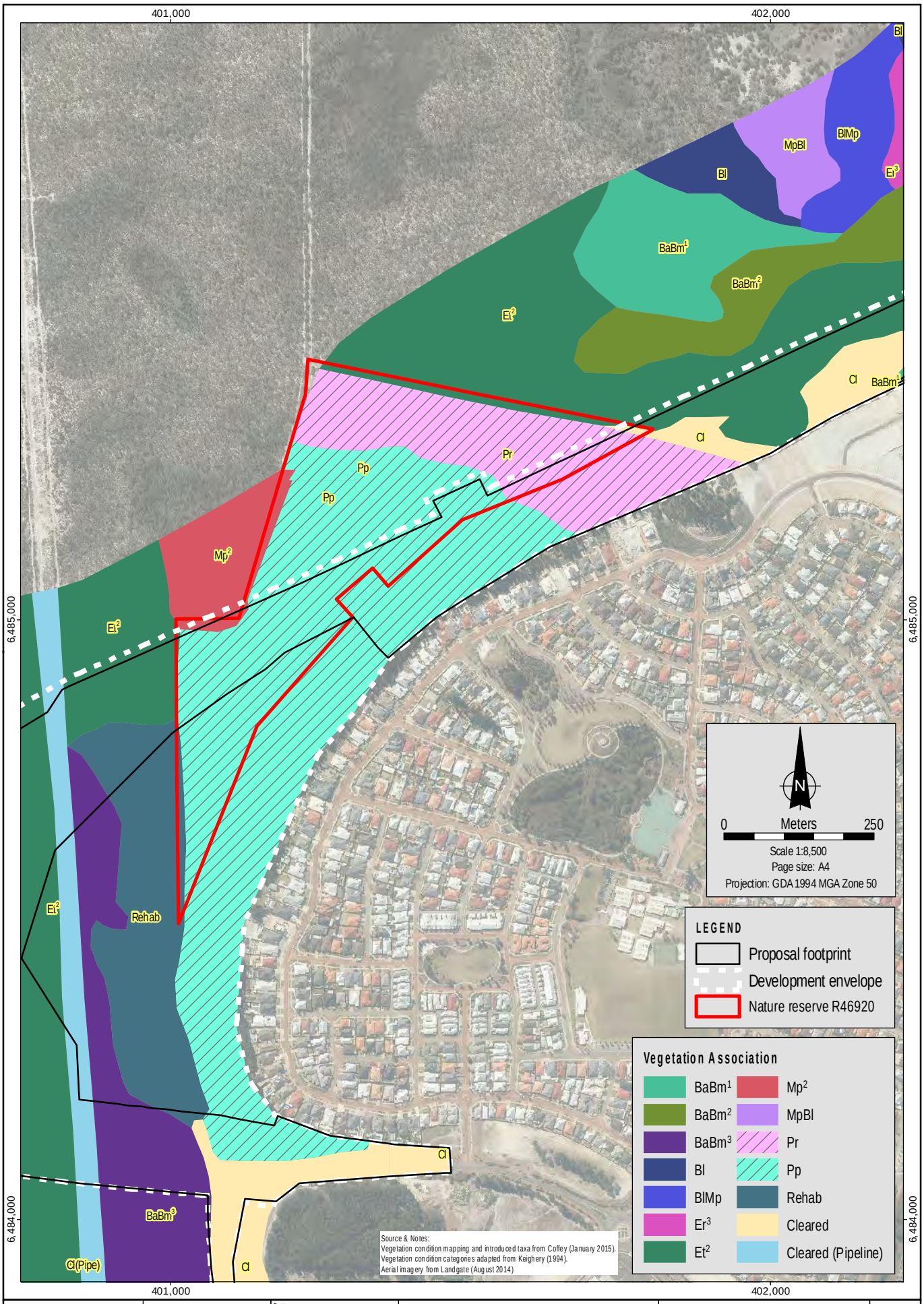
Bush Forever Site	Area of intact native vegetation	Area of Black Cockatoo habitat	Number of Priority listed flora	Area of Priority Ecological Community
97	3.3 ha	• 1.5 ha of foraging and breeding habitat for Carnaby's Black Cockatoo and Forest Red-tailed Black Cockatoo.	–	–
100	0.2 ha	• 1.9 ha of foraging and breeding habitat for Carnaby's Black Cockatoo and Forest Red-tailed Black Cockatoo.	–	–
192	1.3 ha	–	–	• 1.3 ha of SCP24 (P3)

Bush Forever Site	Area of intact native vegetation	Area of Black Cockatoo habitat	Number of Priority listed flora	Area of Priority Ecological Community
198	30.7 ha	• 30.8 ha of foraging habitat for Carnaby's Black Cockatoo, including 15.8 ha of breeding habitat for Carnaby's Black Cockatoo and 15.8 ha of breeding and foraging habitat for Forest Red-tailed Black Cockatoo.	• 3 individuals of *Millotia tenuifolia* var. *laevis* (P2) • 1 individual of *Hypolaena robusta* (P4) • 1 individual of *Anigozanthos humilis* subsp. *chrysanthus* (P4)	• 3.8 ha of SCP20a (En) • 10.6 ha of Banksia dominated woodlands on the SCP (P3) • 9.0 ha of SCP21c (P3) • 7.5 ha of SCP23b (P3)
300	16.9 ha	• 16.8 of foraging habitat for Carnaby's Black Cockatoo, including 1.3 ha of breeding habitat for Carnaby's Black Cockatoo and 1.3 ha of breeding and foraging habitat for Forest Red-tailed Black Cockatoo.	–	• 4.3 ha of Banksia dominated woodlands on the SCP (P3) • 10.4 ha of SCP21c (P3) • 1.9 ha of SCP23b (P3)
304	29.9 ha	• 71.1 ha of foraging and breeding habitat for Carnaby's Black Cockatoo and Forest Red-tailed Black Cockatoo.	–	• 12.0 ha of Banksia dominated woodlands on the SCP (P3) • 1.0 ha of SCP23b (P3)
307	1.0 ha	• 1.0 ha of foraging habitat for Carnaby's Black Cockatoo.	–	–
399	30.8 ha	• 30.5 ha of foraging habitat for Carnaby's Black Cockatoo, including 2.5 ha of breeding habitat for Carnaby's Black Cockatoo and 2.5 ha of breeding and foraging habitat for Forest Red-tailed Black Cockatoo.	–	• 10.6 ha of Banksia dominated woodlands on the SCP (P3) • 19.5 ha of SCP21c (P3) • 0.7 ha of SCP24 (P3)
480	15.9 ha	• 1.6 ha of foraging and breeding habitat for Carnaby's Black Cockatoo and Forest Red-tailed Black Cockatoo.	–	• 0.9 ha of Banksia dominated woodlands on the SCP (P3) • 4.5 ha of SCP24 (P3)

Note: impacts to Bush Forever sites are calculated from the proposal footprint.



NorthLinkWA	coffey	Date: 11.02.2016 MXD: 4483AA_42_GIS009_1 File Name: 4483AA_42_F07.2_GIS	Main Roads WA Response to Submissions Perth-Darwin National Highway	Impacts to Class A Nature Reserve 46919	Figure No: 7.2



NorthLinkWA	coffey	Date: 11.02.2016 MXD: 4483AA_42_GIS010 File Name: 4483AA_42_F07.3_GIS	Main Roads WA Response to Submissions Perth-Darwin National Highway	Impacts to Class A Nature Reserve 46920	Figure No: 7.3

Chapter 6, Environmental Offsets sets out the proposals for offsetting the significant impacts to environmental values within conservation areas (conservation estate and Bush Forever sites) as described above. Impacts on Priority flora species are not significant due to less than 0.2% of known individuals being impacted, as presented in PER Chapter 8, Flora and Vegetation, Table 8.15. The significance of impacts to Priority Ecological Communities (PEC) is difficult to determine as the extent of all known occurrences is undefined. However, on the basis of total known occurrences, the proposal is unlikely to have a significant impact on PECs.

Consolidated issue 160 (contributing issue 293): Please provide details of the rationale behind the ratio of 2:1 for offsetting CCWs.

Chapter 6, Environmental Offsets provides the proposal's revised offset strategy. The rationale for the offset ratio applied to CCWs is provided in Section 6.6.2.2.

Consolidated issue 162: Please provide further details relating to the 1:1 ratio chosen for the *Caladenia huegelii* critical habitat offset

Contributing issues:

251: Please discuss outcome of additional surveys for *Caladenia huegelii* critical habitat at Ioppolo Road, including final residual impacts, revised management, monitoring, mitigations and any amendments to offset proposals.

289: Please provide details of the rationale behind using a 1:1 offset ratio for *Caladenia huegelii* critical habitat. The Commonwealth Offsets calculator should be used to determine an appropriate offset for *Caladenia huegelii* critical habitat.

The Ioppolo Road offset site does not contain suitable habitat for *Caladenia huegelii*. An alternative offset package has been proposed (see Chapter 6, Offsets). Offset Proposal 3 offsets the loss of 31.9 ha of potential critical habitat for *Caladenia huegelii*.

MRWA will provide funding for a period of 10 years for the ongoing management of existing reserves 46919, 46875, Bush Forever site 300 and Whiteman Park, which contain potential critical habitat for *Caladenia huegelii* (see Appendix C, Assessment and Refinement of Potential Critical Habitat for *Caladenia huegelii* (T-DRF) within the Development Envelope, Figure 1).

MRWA will provide funding for the development and implementation of a management plan in consultation with DPAW in accordance with the Grand Spider Orchid (*Caladenia huegelii*) recovery plan (DEC, 2009).

Consolidated issue 163 (contributing issue 280): The EPA will confirm the suitability of Ioppolo Road as an offset for both species of black cockatoos, not the OEPA.

Noted. MRWA is aware that it is the EPA that will make the final decision regarding the suitability of any offsets.

Consolidated issue 164 (contributing issue 279): Please provide evidence that Ioppolo Road is suitable for black cockatoos given that the technical report stated the "entire area was adequately surveyed" while not finding any evidence of cockatoos.

The EPBC Act referral guidelines for three threatened black cockatoo species (DSEWPAC, 2012) states 'the lack of detection should not be taken to mean that black cockatoos do not use the site … due to the mobile nature of these birds'.

Two fauna surveys have been completed at Ioppolo Road, including:

- Level 1 fauna survey, including a Black Cockatoo habitat assessment between 8 and 11 July 2014 (Coffey, 2015d).
- Targeted Black Cockatoo survey 11 June 2015 (Coffey, 2015e).

While no evidence of Black Cockatoos was recorded from the site during these surveys, Carnaby's Black Cockatoos were recorded in a neighbouring property and the presence of suitable habitat within the site was confirmed (see Chapter 6):

- 981 ha of Carnaby's Black Cockatoo foraging habitat (including 673.5 ha within Offset Proposal 1).
- 315 ha of Forest Red-tailed Black Cockatoo habitat (including 279 ha within Offset Proposal 1).
- 315 ha of breeding and roosting habitat, including over 6,300 potential breeding trees for both Black Cockatoo species (including 279 ha and 5,580 trees within Offset Proposal 1).

This habitat is within the current modelled breeding and non-breeding range of Carnaby's Black Cockatoo (DSEWPAC, 2012) and within 16 km of a number of significant roost sites at Gingin town site (Finn et al., 2014).

While this habitat is outside the modelled distribution for the Forest Red-tailed Black Cockatoo (DSEWPAC, 2012), DPAW has recently confirmed that there have been regular sightings of Red-tailed Black Cockatoos in the surrounding area including as far north as Bindoon (Errington, pers. comm.). DPAW is currently arranging for these records to be incorporated into their database, which will extend the known range of this species.

DER and DOTE have acknowledged the new information from DPAW and the suitability of this site as an offset for both species of Black Cockatoos for MRWA's Tonkin Grade Separations Project, which adjoins this proposal to the south.

Consolidated issue 166 (contributing issue 290): Please provide detailed information on the proposed on-going management activities for the Ioppolo Road proposed offset site, including funding arrangements.

MRWA will continue to liaise with DPAW to determine the management required for any offsets that involve land acquisition. An agreement will be reached with DPAW on ongoing management in line with DPAW's Corporate Guideline No. 4 Environmental Offsets (December 2014). The details of these activities and funding arrangements for ongoing management will be included in the Land Acquisition and Management Plan and may include such activities as rubbish removal, prevention of third party access, weed and dieback management.

8 RESPONSE TO DEPARTMENT OF PARKS AND WILDLIFE ISSUES

8.1 Flora and Vegetation

Consolidated issue 120 (contributing issue 232): DPAW request that shape files of confirmed PEC and TEC areas be provided to communities.data@dpaw.wa.gov.au (Parks and Wildlife Species and Communities Branch).

This comment is noted. Shapefiles of confirmed areas of TECs and PECs will be provided to DPAW.

Consolidated issue 127 (contributing issue 197): DPAW supports MRWA's commitments for additional targeted surveys (described in PER Chapter 8, Section 8.5) and recommends the results be presented in the context of protected flora species distributions within and outside secure conservation reserves.

MRWA has fulfilled its commitment to complete additional targeted surveys for Threatened and Priority flora, specifically *Millotia tenuifolia* var. *laevis* (P2) and *Meeboldina decipiens* subsp. *decipiens* ms (P3). The results of the targeted surveys are discussed in Chapter 3, Spring Surveys and the reports are attached as Appendices C, D, E and F.

Consolidated issue 147 (contributing issue 219): Recommends that the EMP incorporates monitoring and performance criteria for Threatened and Priority flora, particularly in relation to *M. tenuifolia* var. *laevis* individuals occurring within 50 m of the proposal footprint.

MRWA notes DPAW support for the operational framework set out in the draft EMP (PER Appendix F, Environmental Management Plan) to protect Threatened and Priority flora from accidental disturbance, and the introduction and spread of weeds and dieback.

MRWA will develop and implement a FVMMP to manage impacts on significant vegetation, including threatened flora, priority flora, TECs and PECs. This will include: establishing baseline condition, undertaking monitoring and implementing contingencies should changes to vegetation health and condition be detected (see PER Chapter 8, Flora and Vegetation, Table 8.16 and PER Appendix F, Environmental Management Plan, Table 4.1).

The plan will be prepared in consultation with DPAW. MRWA will review the proposed monitoring program having regard to DPAW's recommendation for monitoring of priority flora within 50 m of the proposal footprint and establishment of associated performance criteria.

Consolidated issue 148: How will the EPA's objectives be met for Priority taxa *Meeboldina decipiens* subsp. *decipiens* and *Millotia tenuifolia* var. *laevis*? More work should be done on surveying and/or translocating these taxa.

Contributing issues:

72: Likely impacts to *Millotia tenuifolia* var. *laevis* and *Meeboldina decipiens* subsp. *decipiens* are potentially significant. As well as extra surveys proposed, *Meeboldina decipiens* subsp. *decipiens* needs to be translocated e.g. to wetlands. More work needs doing.

78: Clarification is sought on how the successful implementation of the EMP regarding Priority taxa *Meeboldina decipiens* subsp. *decipiens* and *Millotia tenuifolia* var. *laevis* will result in the proposal being likely to meet the EPA's objectives.

206: Targeted survey for *Meeboldina decipiens* subsp. *decipiens* (Priority 3) should include potential habitat within Lightning Swamp Bushland and targeted surveys for *Millotia tenuifolia* var. *laevis* should include potential habitat in Whiteman Park.

A follow-up spring survey for *Meeboldina decipiens* subsp. *decipiens* (P3) and *Millotia tenuifolia* var. *laevis* (P2) was conducted by Woodman Environmental from 6 to 9 October 2015 (see Section 3.2).

The collections of *Meeboldina decipiens* subsp. *decipiens* from the survey were re-identified by WA Herbarium staff as *Lepyrodia muirii*, which is not a conservation significant species. The proposal no longer impacts *Meeboldina decipiens* subsp. *decipiens* (P3).

The survey identified a relatively large number of *Millotia tenuifolia* var. *laevis* individuals outside the proposal footprint. A total of 5,222 *Millotia tenuifolia* var. *laevis* individuals were recorded from eight populations in the area covered by the survey, including 1,652 individuals adjacent to (but not within) the development envelope in Cullacabardee. The proposal will impact two populations of *Millotia tenuifolia* var. *laevis* comprising three individuals (see PER Appendix C, Level 2 Spring Flora and Vegetation Assessment). The impact is not significant at a local or regional scale due to the number of individuals identified outside the proposal footprint in Woodman's 2015 survey (see Appendix D, Spring Surveys for *Meeboldina decipiens* subsp. *decipiens* (P3) and *Millotia tenuifolia* var. *laevis* (P2)).

The draft EMP (PER Appendix F, Environmental Management Plan) contains measures to protect Threatened and Priority flora outside the proposal footprint (including *Millotia tenuifolia* var. *laevis* in Cullacabardee Bushland) from accidental disturbance and prevent the introduction and spread of weeds and dieback.

Consolidated issue 170: Please discuss outcome of additional surveys for TEC SCP02 in development envelope, including final residual impacts, revised management, monitoring, mitigations and any amendments to offset proposals.

Contributing issues:

227: If Offset Proposal 3 proves difficult to implement, alternative offset options for the loss of 0.4 ha of SCP02 should be developed and implemented, in consultation with DPAW.

253: Please discuss outcome of additional surveys for TEC SCP02 in development envelope, including final residual impacts, revised management, monitoring, mitigations and any amendments to offset proposals

273: Please resolve inconsistencies in extent of direct impact to TEC SCP02.

275: It is not clear how the >2:1 ratio for TEC SCP02 was determined. The proponent should use the Commonwealth offsets calculator to determine an appropriate offset if SCP02 is confirmed present in the development envelope.

276: Please provide details of the TEC SCP02 spring survey. The proponent will need to provide a suitable offset for SCP02 and justify the rationale used if SCP02 is confirmed.

A targeted spring survey was undertaken on 17 September 2015 to confirm the presence of TEC SCP02 identified in surveys for the PER.

Surveyed quadrats showed the vegetation community most closely resembled SCP04, which is common on the SCP. The additional quadrats occurred in the same supergroup as SCP02 due to similar dominant taxa, but occur within different subgroups. SCP02 does not occur within the proposal footprint.

There is no residual impact to SCP02 and no offset required. The revised management measures are set out in Chapter 13, Summary of Management Measures.

Further information can be found in Chapter 3, Spring Ecological Surveys. The supporting report is attached as Appendix E, Spring Surveys and Analysis to Investigate SCP02 Presence.

Consolidated issue 185 (contributing issue 295): MRWA should quantify the environmental values of conservation estates and identify the % remaining in each estate.

Presentation of potential impacts as a percentage of remaining vegetation, habitat or individuals within the affected reserves and the entire conservation estate is not possible, as the overall extent of these values in the conservation estate in the Swan Coastal Plain is not known or not publicly available. Vegetation, habitat and individuals have been mapped in the study area. This information and publicly available information on the distribution of ecological communities and species in the bioregion has been used to undertake the assessment. The occurrence or potential for ecological communities and species to exist beyond the study area (which encompasses the development envelope and proposal footprint) informed the assessment of significance of impact that is presented in PER Chapter 8, Flora and Vegetation and PER Chapter 15, Amenity (Reserves). PER Chapter 15, Amenity (Reserves) Tables 15.1 and 15.2, which detail impacts to the conservation estate, have been updated and are presented in the response to consolidated issue 158.

Table 8.1 shows the impact of the proposal on the conservation estate using vegetation complexes. The table compares the extent of vegetation complexes in conservation estate in secure tenure in the Perth-Peel Region pre- and post-construction using the 2015 assessment of remnant vegetation. Table 8.1 shows that in all but one instance, the proposal will impact less than 0.1% of vegetation complexes in the conservation estate. The impact on Bassendean Complex–North Transition results in a 0.4% reduction in that complex within the conservation estate.

Table 8.1 Extent of vegetation complexes in conservation estate in the Perth-Peel Region pre- and post-construction

Vegetation complex	PPR 2015 extent (ha)	PPR Secure for Conservation (ha)	PPR Secure for Conservation	Extent of impact on conservation areas (ha)	PPR Secure for Conservation (post-construction)
Bassendean Complex - Central and South	13,486	733	5.4%	2.1	5.4%
Bassendean Complex - North Transition	3,948	2,200	55.7%	17.7	55.3%
Bassendean Complex - North	23,859	9,092	38.1%	24.7	38.0%
Southern River Complex	6,936	629	9.1%	–	9.1%
Yanga Complex	777	247	31.8%	–	31.8%

Consolidated issue 186 (contributing issue 223): Impacts to GDEs (including Mound Springs SCP TEC) and management of those impacts.

MRWA is committed to preparing and implementing a Wetland and Drainage Management and Monitoring Plan (WDMMP), which includes a groundwater monitoring procedure to detect changes in groundwater levels, to ensure impacts to wetlands (and GDEs and vegetation mapped in association with these wetlands) are being appropriately managed.

Dewatering and abstraction will be temporary and associated with each stage of development. Existing bores will be used where available and where unavailable, new bores may need to be constructed. Groundwater bores will be operated in accordance with existing or new licences (see PER Chapter 10, Hydrological Processes and Inland Water Environmental Quality, Section 10.4.4.2).

Proposed dewatering locations are remote from Mound Springs SCP TECs and any new water abstraction bores will be located to avoid drawdown affecting wetlands and Mound Springs SCP TECs. As the location of existing and new groundwater bores will be identified in each stage of the development, a water balance will be problematic. Groundwater monitoring pre-, during and post-construction will detect changes outside seasonal variation. As wetlands potentially affected by the proposal are dependent on expressions of groundwater, the proposed monitoring program will provide an early indicator of change.

As discussed in PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.4.8, it is not anticipated that Mound Springs SCP TECs will be impacted by any potential contamination off the highway.

8.2 Terrestrial Fauna

Consolidated issue 117 (contributing issue 235): DPAW should be provided an opportunity to contribute to, and comment on, the planned development of an EMP relating to fauna management.

MRWA is committed to ongoing consultation with DPAW in the development of the construction EMP.

8.3 Hydrological Processes and Inland Waters Environmental Quality

Consolidated issue 76 (contributing issue 237): The estimated loss of wetland values and the extent of wetlands to be monitored should include wetlands that may retain values commensurate with CCWs despite not being mapped as CCWs.

Multiple use wetlands (MUWs) were evaluated against DPAW's Preliminary Evaluation Criteria for determining the potential of a candidate wetland to contain values commensurate with a CCW (DPAW, 2013a). The evaluations were undertaken using information available from investigations conducted for the PER and other publicly available data. The evaluations of MUWs 8464, 15030 and 15200 were inconclusive as to whether these wetlands could contain values commensurate with CCWs. MUW 15732 was unable to be properly assessed due to its large extent, extensive cleared areas and agricultural land uses. The floodplain wetland generally does not contain values commensurate with a CCW. On the basis of the inconclusive evaluations, elevation of these wetlands to a higher classification is not warranted.

A WDMMP will be developed and implemented including groundwater monitoring to ensure impacts to wetlands are appropriately managed and there are no unforeseen impacts (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.5). The WDMMP will consider the conservation status and proximity of wetlands to the proposal. The plan is likely to include monitoring of CCWs 15028 and 15033, which are adjacent to MUWs 8464, 15030 and 15200 and together form an extensive wetland. The Wetland Management and Monitoring Plan will be provided to the OEPA, DOW and DPAW for review/comment.

Consolidated issue 77: Impacts from and management of dewatering and groundwater abstraction.

Contributing issues:

49: How close to wetlands 8800 and 8801 will dewatering take place? What limits will there be on dewatering? How will dewatering impacts to wetlands be managed?

94: Dewatering during construction doesn't mention the impact to local residents that rely on groundwater for domestic/stock water.

145: Wetlands are already dry and construction dewatering, as well as subsurface compaction, must be minimised.

155: How will dewatering and water abstraction be monitored and addressed? In particular: abstraction rates, bore operating regimes, hydrogeology of bores, impacts to environmental values from drawdown, and existing groundwater licences.

204: During construction will there be dewatering near Maralla Road? If so, how will dewatering be managed especially with regard to wetland CCW 8800 and *Caladenia huegelii*?

230: How has construction water allocation been licensed properly? How has existing local over allocation of water been accounted for?

231: Will there be monitoring of the environments likely to be affected by water abstraction during construction?

242: That the potential for indirect impacts on wetlands be minimised by restricting to summer months, the construction of footings for bridges and utility services at locations where dewatering would be likely to lower the water table in CCWs.

243: The potential for indirect impacts on wetlands should be minimised by managing drawdown associated with extraction bores in the vicinity of CCWs to maintain groundwater at depths that will not result in significant impacts on wetlands.

Where practical, construction of bridge footings will be scheduled during summer to avoid or minimise dewatering requirements. If dewatering is required, dewatering methods (e.g. well-point spears) that minimise the radius of influence in confirmed areas of ASS and on sensitive receptors (e.g. wetlands) will be utilised (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.5). A dewatering licence will be obtained from the DOW under the *Rights in Water and Irrigation Act 1914* (RIWI Act) for any dewatering activities undertaken.

If works are undertaken during the wet season construction dewatering will potentially be required at eight locations to enable bridge footing construction. Of these eight locations, only two locations (Reid/Tonkin interchange and Stock Road interchange) have wetlands within the modelled drawdown radius of influence of up to 500 m (see PER Appendix L, Position Paper – Groundwater Level Impact from Construction Dewatering and Groundwater Abstraction, Table 1). Dewatering, if required, is expected to last up to six weeks.

MUW 8785 and MUW 8784 (former EPP Lake 450) are located adjacent to the Stock Road interchange. These wetlands have been degraded by clearing and grazing. Wetlands CCW 15028 and a large part of CCW 15033 will be removed to construct the Reid/Tonkin interchange (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.4.6.3). No bridge structures or dewatering is proposed at Maralla Road in the vicinity of wetlands CCW 8800 and Resource Enhancement Wetland (REW) 8801 or *Caladenia huegelii* habitat.

The requirement for dewatering was determined based on a review of groundwater levels in existing bores (including DOW Gnangara Mound bores) reported over a period of 40 to 50 years, which was undertaken as part of the design groundwater level study for the proposal (Golder, 2015a, b, c). Groundwater data collected over this period indicates the seasonal variation (wet season to dry season) in groundwater ranges between 1.0 m and 2.0 m. Hydrographs of the bores showed two periods of step change in groundwater levels, one associated with development of the Gnangara Mound as a public drinking water source and the other associated with the installation of subsoil drains to enable land development.

Construction of the proposal will require a supply of water for construction purposes at various locations along the alignment. Abstraction will be temporary and associated with each stage of development. While construction water requirements will not be known until detailed final design work has been carried out, construction water is likely to be sourced from existing bores in accordance with existing licences where possible. Should existing bores or licences be unavailable, new bores may need to be constructed and licenced in accordance with DOW requirements (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.4.4.2). The DOW considers existing groundwater user licence allocations during the licence application process.

The location and number of construction water abstraction bores proposed to be used (new and existing) will be assessed against a detailed hydrogeological model. Hydrogeological modelling will account for the proposed parameters of the bore as well as the hydrogeology of the proposed bore site. Preferentially, each construction water bore required will be sited such that no wetlands are located within the modelled drawdown radius of influence for the bore, thereby avoiding indirect hydrological impacts to wetlands as a result of drawdown. Where it is not possible to site a bore such that no wetlands occur within its drawdown radius of influence, the operating parameters of bores will be limited such that modelled changes to groundwater levels at wetlands remain within usual seasonal variations for those wetlands (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.4.6.3). Any impact to wetlands from drawdown is expected to be short-term and localised.

Step changes in groundwater levels as a result of construction (including dewatering and water abstraction) will be detected by a groundwater monitoring program as part of a WDMMP to protect public drinking water supply and to protect wetlands. The information presented in Golder (2015a, b, c) will be used to set

trigger levels for the target aquifers and wetlands. The WDMMP will be prepared in consultation with DPAW and the OEPA.

A dewatering management plan (including ASS management) will also be developed and implemented in support of any application for dewatering and a groundwater licence operating strategy will be developed and implemented as necessary to support the supply of construction water. These plans will include monitoring of abstraction rates. Opportunities for alternative construction water sources will also be investigated during project delivery.

8.4 Amenity (Reserves) and European Heritage

Consolidated issue 34 (contributing issue 244): MRWA should continue to work with the Swan Coastal District office of DPAW regarding the translocation of heritage cork trees and the reestablishment of fencing and access ways associated with DPAW managed lands.

MRWA will continue to work with DPAW on the preparation of detailed site plans and specifications to minimise impacts on Dick Perry Reserve. The plans and specifications will document:

- MRWA's commitment to retain and translocate heritage cork trees.
- Maintenance of access through connections to the PSP which forms part of the proposal.
- Fencing, the designs for which will reflect the requirements of bordering properties.

8.5 Environmental Offsets

Consolidated issue 15: Should Ioppolo Road not comprise critical habitat for *Caladenia huegelii*, an alternative offset package should focus on the management and protection of existing populations or critical habitat, rather than on translocation options.

Contributing issues:

217: Should Ioppolo Road not comprise critical habitat for *Caladenia huegelii*, an alternative offset package focus on the management and protection of existing populations or critical habitat, rather than on translocation options.

288: Please provide details of the spring survey at Ioppolo Road to determine presence of *Caladenia huegelii* critical habitat. If Ioppolo Road is not suitable, an alternative offset will need to be provided.

(Repeated from Section 7.6)

The Ioppolo Road offset site does not contain suitable habitat for *Caladenia huegelii*. An alternative offset package has been proposed (see Chapter 6, Offsets). Offset Proposal 3 offsets the loss of 31.9 ha of potential critical habitat for *Caladenia huegelii*.

MRWA is proposing to provide funding for a period of 10 years for the ongoing management of existing reserves 46919, 46875, Bush Forever site 300 and Whiteman Park, which contain potential critical habitat for *Caladenia huegelii* (see Appendix C, Assessment and Refinement of Potential Critical Habitat for *Caladenia huegelii* (T-DRF) within the Development Envelope, Figure 1).

MRWA is proposing to provide funding for the development and implementation of a management plan in consultation with DPAW in accordance with the Grand Spider Orchid (*Caladenia huegelii*) recovery plan (DEC, 2009).

Consolidated issue 17 (contributing issue 240): Offset Proposal 2 'Conservation of Land Comprising CCWs' should be refined to align as far as practicable with the types of impacted wetlands within each consanguineous suite.

Chapter 6, Environmental Offsets presents the proposal's revised offset strategy. Where possible offset sites will be selected that:

1. Protect and/or restore values to a commensurate or greater value than those impacted.
2. Are located as close to the proposal as possible, unless it can be demonstrated that an offset site achieves item one above (e.g. wetland offsets within the same consanguineous suite).

9 RESPONSE TO DEPARTMENT OF WATER ISSUES

Consolidated issue 69: Location of bio-retention basins with respect to production bores.

Contributing issues:

93: The Drainage Management Plan should commit to future consultation with DoW on bio-retention basin locations and other water quality mitigation measures.

246: A minimum of 100 m distance should separate production bores and bio-retention basins.

The proposal intercepts 12 wellhead protection zones (WHPZs) and comes within 15 to 30 m of the associated drinking water production bores (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.4.5). The proximity of the proposal to these wells makes it impractical to locate all water quality mitigation measures (e.g. bio-retention swales) 100 m from all production bores or outside the WHPZs. The Drainage Strategy's primary objective within the P1 zone is the protection of the Gnangara Groundwater Mound. Within WHPZs, water quality will be addressed by the provision of bio-retention swales, sized to treat the common rainfall event, with excess runoff directed away from the bores. All proposed infiltration basins (including bio-retention basins) will be at least 100 m from production bores.

The current Drainage Strategy (PER Appendix H) has been developed in consultation with the DOW and in accordance with the DOW's principles of water resource management, as detailed in the Stormwater Management Manual for Western Australia (DOW, 2004a) and the Decision Process for Stormwater Management in Western Australia (DOW, 2009). MRWA is committed to ongoing liaison with the DOW through the proposal's development and construction to ensure protection of the production bores. A detailed infrastructure plan will be prepared for each stage of the development prior to construction to ensure that the proposal is designed and constructed in accordance with the Drainage Strategy. This will include details of key elements including the location and dimensions of culverts, bio-retention swales and infiltration basins.

Consolidated issue 79: Consideration of Gnangara UWPCA and how potential impacts and management are addressed in EMP.

Contributing issues:

90: The EMP does not clearly state the importance of the Gnangara UWPCA. It should be revised to do so and also to refer to the appropriate policies and Water Quality Protection Notes (WQPNs).

91: The EMP omits details on the quality of water used for dust suppression. The water should be of the highest quality.

92: The EMP should commit to working closely with Water Corporation in the P1 and P3 areas. Regular joint inspections between Water Corp and MRWA should be included. Accidental spills should be reported to Water Corp.

MRWA will ensure that bores and associated infrastructure installed for the proposal are available for inspection by Water Corporation representatives at all stages of the construction. MRWA will undertake joint inspections with Water Corporation on a quarterly basis during construction. The construction EMP will be revised to include a commitment to work closely with Water Corporation during construction. MRWA will report accidental spills of fuel and chemicals greater than 5L within the P1 and P3 area to the Water Corporation.

The construction EMP will emphasise the importance of the Gnangara Underground Water Pollution Control Area (UWPCA) and refer to the appropriate policies and Water Quality Protection Notes. The temporary storage of fuel and other chemicals in the P1 area is allowed under SPP 2.2 for the purposes of construction with appropriate conditions. MRWA proposes that all fuel and chemicals be stored in a double skin tank and placed in bunds capable of storing 125% of the capacity of the largest tank. Spill response kits will be available during refuelling which will be conducted outside WHPZs. Individual fuel storage tanks will not exceed 5,000 L capacity within the P1 area.

MRWA intends to use groundwater or scheme water for compaction and dust suppression. Existing bores will be used where possible and subject to licence conditions. Where unavailable, new bores will be installed and operated in accordance with the licence conditions.

Consolidated issue 80 (contributing issue 89): Impacts to the P1 UWPCA have not been properly considered. Construction impacts need to be considered further in consultation with the DOW, and approval may be required.

Several state planning policies and DOW guidelines (e.g., Water Quality Protection Note No. 25 (DOW, 2004b)) identify activities that are potentially incompatible with UWPCAs. Aspects of the proposal that are potentially incompatible with UWPCAs include construction laydown areas, stockpiles, hazardous materials storage and refuelling.

Locations of construction infrastructure and activities have not yet been determined. MRWA met with the DOW in November 2015 to discuss the types of activities that may be conducted in the Gnangara UWPCA Priority 1 areas. The meeting identified management measures that will be requirements of an approval including specification of doubled-lined bunded fuel storage tanks in the Priority 1 area, with maximum individual tank capacity of 5,000 L.

A construction EMP will be prepared and include relevant policies, guidelines and management measures to be employed to manage impacts to the P1 UWPCA. DOW approval will be required for any activities proposed within the UWPCA that are considered incompatible activities under the relevant policies.

10 RESPONSE TO DEPARTMENT OF ENVIRONMENT REGULATION ISSUES

Consolidated issue 11 (contributing issue 239): Contaminated sites do not appear to have been addressed in the PER. However, the contaminated sites register suggests one or more possibly contaminated sites may be in close proximity to, or within, the proposed alignment.

The form, content and public review period of the PER document was determined by the EPA as set out in the proposal's ESD dated March 2014 (PER Appendix B, Environmental Scoping Document). Land contamination was not identified as a preliminary key environmental factor in the ESD and so was not assessed in the PER.

MRWA will comply with its obligations under the *Contaminated Sites Act 2003* (CS Act) regarding the identification and management of contamination within the proposal footprint. A number of studies have already been undertaken and further consultation with the DER (Contaminated Sites Branch) will be conducted.

Consolidated issue 53 (contributing issue 241): The noise modelling calibration value is not appropriate and likely results in an underestimation of the traffic noise impact.

The technical issues raised with regard to noise model calibration have been resolved in the revised transportation noise report (Appendix I, Revised Transportation Noise Assessment). A calibration factor of -0.6 dB was adopted for the revised assessment based on monitoring undertaken on the GNH and consultation with DER. The description of the calculation of the calibration factor and the results of the revised assessment are presented in Chapter 4, Amenity (Noise and Vibration), sections 4.1.1 and 4.2, respectively.

Consolidated issue 62: Management of acid sulfate soils (ASS).

Contributing issues:

154: How will ASS be managed?

238: Recommendations in the PER regarding further investigations to inform specific management of ASS are generally consistent with DER guidelines as applicable to large-scale linear projects.

DER noted "recommendations in the PER regarding further investigations to inform specific management of acid sulfate soils are generally consistent with DER guidelines as applicable to large scale linear projects."

Following final design and the definition of likely soil disturbance, a detailed ASS investigation will be undertaken to inform the development of an ASS Management Plan. PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Table 10.9 outlines proposed management strategies including the use of spread footings in final design where sands are deemed suitable to support structures at raised interchanges, to minimise the extent of any anticipated disturbance to ASS.

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11 RESPONSE TO OTHER GOVERNMENT AGENCY ISSUES

11.1 Department of Aboriginal Affairs

Consolidated issue 43: Aboriginal heritage sites with significance should be avoided and protected in a manner acceptable to the local Nyungah people.

Contributing issues:

160: Aboriginal heritage sites with significance should be avoided and protected in a manner acceptable to the local Nyungah people.

179: Any potential impacts to Aboriginal heritage from the proposal can be addressed through the proposed Aboriginal Heritage management Plan and the provisions of the *Aboriginal Heritage Act 1972* (e.g. Section 18 consent).

Where possible, Aboriginal heritage sites will be avoided and protected. However where disturbance of Aboriginal heritage sites is required consent to disturb an Aboriginal site under Section 18 of the *Aboriginal Heritage Act 1972* (AH Act) will be obtained.

Members of the Nyungah (Noongar) community were involved in field surveys for Aboriginal cultural heritage (see PER Appendix Q, Ethnographical Aboriginal Heritage Survey and PER Appendix R, Aboriginal Archaeological Assessment).

The management process developed to monitor and minimise impacts to Aboriginal archaeological records is supported by the Noongar people (see PER Appendix R, Aboriginal Archaeological Assessment).

PER Chapter 13, Aboriginal Heritage, Section 13.4 sets out the measures to be incorporated in an Aboriginal Heritage Management Plan. The measures incorporate the recommendations set out in PER Appendix R, Aboriginal Archaeological Assessment.

11.2 Department of Lands

Consolidated issue 21 (contributing issue 59): Proponent must seek approval to develop within Dampier to Bunbury Natural Gas Pipeline (DBNGP) corridor. Registration of new interests in corridor is not allowed.

MRWA is currently negotiating with DBP Transmission in relation to the approvals required to construct the proposal within the Dampier–Bunbury Natural Gas Pipeline (DBNGP) corridor.

Consolidated issue 63 (contributing issue 60): Proponent must ensure major water flows do not impact the DBNGP corridor.

Through the implementation of the proposal's Drainage Strategy (PER Appendix H) Main Roads will ensure that major water flows do not impact the DBNGP corridor. Main Roads will continue to liaise with the DOL and other stakeholders during design and construction to ensure that impacts on the DBNGP corridor are avoided or mitigated.

Without management and control measures, the proposal has the potential to alter surface water flow from earthworks (e.g., cut and fill) and crossing/impounding of waterways and wetlands. The assessment of impacts associated with altered surface water flow is outlined in PER Chapter 10, Hydrological Processes and inland Waters Environmental Quality, specifically Section 10.4.2. One of the main controls in the

management of hydrological impacts associated with the proposal is the implementation of the proposal's drainage strategy during design and construction. The objective of the drainage strategy is to maintain drainage across the site to as close as practicable to the pre-development condition. This strategy has influenced the design of the proposal and informed a number of the hydrological mitigation and management strategies, including the provision of sufficient drainage structures to maintain surface water flows in watercourses, drainage lines and to wetlands (see PER Chapter 10, Hydrological Processes and inland Waters Environmental Quality, Section 10.4.2 and Section 10.5).

11.3 Department of Planning

Consolidated issue 4 (consolidated issue 192): During the MRS and subsequent planning phases, the DOP will work with MRWA and Department of Transport to address the public transport network, zoning changes and noise mitigation measures.

The DOP's support for the proposed alignment is noted. MRWA will work with DOP and Department of Transport (DOT) during the MRS and subsequent planning phases.

Consolidated issue 39: The proposal is supported.

Contributing issues:

3: General support for the proposal.

57: Submission supports PDNH and believes it will reduce traffic congestion on GNH.

190: The proposal is supported.

The comment is noted.

12 RESPONSE TO ISSUES RAISED BY THE PUBLIC

12.1 Proposal Background and Justification

Consolidated issue 37 (contributing issue 181): What evidence shows that PDNH will significantly decrease traffic through the Swan Valley?

Extensive traffic modelling has been undertaken for the proposal. NorthLink WA has utilised MRWA's strategic traffic model, the Regional Operations Model (ROM). The ROM is a 24-hour multi-modal model of the Perth Metropolitan road network, which uses information on existing and forecast population and employment statistics obtained from DOP and Local Government authorities. It has been calibrated against existing traffic volumes. The proposed highway has been incorporated into the model and a number of different scenarios modelled including different forecast years and different options for the future road network.

ROM has been used to understand the traffic implications on surrounding routes such as Lord Street, West Swan Road and GNH. The model shows a significant shift in demand from GNH to the proposed highway, particularly for freight and regional traffic. It also shows a decrease in demand along Lord Street and West Swan Road compared to a scenario where the proposal is not constructed.

The proposal will be constructed as a high capacity, free-flowing (no traffic signals), high speed route. Travel times will be faster than competing routes such as GNH, which are generally lower speed and have traffic signals. ROM has shown that a trip along Tonkin Highway and this proposal from Kewdale to Muchea will be 10 to 15 minutes faster than the current route along Roe Highway and GNH. Signage (including electronic message signs) will show the reduced travel times along PDNH reinforcing the benefits of using this route.

Consolidated issue 38 (contributing issue 186): Do the benefits of this proposal outweigh the costs?

The financial costs and benefits of road projects are evaluated through cost benefit analysis process. The cost benefit analysis is documented in the business case for the proposal which confirms that the benefits greatly outweigh the costs.

Consolidated issue 39: The proposal is supported.

Contributing issues:

3: General support for the proposal

57: Submission supports PDNH and believes it will reduce traffic congestion on GNH.

190: The proposal is supported.

(Repeated from Section 11.3)

The comment is noted.

Consolidated issue 40 (contributing issue 182): The upgrading of GNH has been overlooked although it presents fewer environmental constraints.

A comprehensive upgrade of GNH was considered at a number of stages during the development of the proposal. The upgrade of GNH was deemed an unsuitable option due to the following:

- The intensity of land development along the section of GNH through the Swan Valley means there are several access locations which are not conducive to the operation of a safe and efficient freight route.
- There are numerous constraints including interfaces with existing rail tracks and corridors.
- There is considerable community concern with the current high level of freight traffic on the route including speed limits at a school in the southern section of the GNH.

Freight efficiency along this route could not be achieved due to the inability to upgrade GNH to a controlled access highway with appropriate grade separations.

12.2 Route Selection Development

Consolidated issue 41: Mapping and surveying of vegetation associations and good quality vegetation should have occurred at an earlier stage so it could be avoided during route selection.

Contributing issues:

183: Number of vegetation associations to be lost is too great. Mapping should have occurred at an earlier stage so they could be avoided during route selection.

185: Earlier surveys would have resulted in avoiding areas of native vegetation good and above to the west of Ellenbrook.

The availability of the detailed vegetation association mapping acquired and presented in PER Chapter 8, Flora and Vegetation, Figure 8.6 has influenced refinement of the alignment within the development envelope but would not have influenced the location of the development envelope or highway corridor. Corridor options to the west would have fragmented Bush Forever sites 300 and 399, both large contiguous tracts of remnant vegetation in very good to pristine condition. The proposed alignment of the highway avoids the majority of pristine, pristine to excellent and excellent to very good vegetation in the development envelope. Located adjacent to Ellenbrook residential area, the proposed alignment minimises impacts on the conservation estate and known location of *Caladenia huegelii*.

PER Chapter 3, Route Selection and Development, Section 3.3 presents details of the environmental constraints assessment that was undertaken on potential alignments. This assessment considered factors such as Bush Forever sites and conservation and ecologically sensitive areas. The survey effort and assessments completed were proportional to the stages of the proposal's development.

PER Chapter 4, Detailed Description of Proposal, Section 4.2.3 discusses changes to the design as a result of studies undertaken as part of the PER and PER Chapter 8, Flora and vegetation, specifically Section 8.5, discusses how changes to the proposal have reduced the proposal's overall impact to flora and vegetation values. Nearly 80% of the proposal footprint occurs within vegetation mapped as degraded or worse condition.

12.3 Detailed Description of Proposal

12.3.1 Footprint Minimisation

Consolidated issue 27: Clearing footprint should be minimised further through placement of proposal components such that fragmentation of vegetation and habitats is minimised.

Contributing issues:

61: Clearing of vegetation needs to be minimised especially in areas such as the interchange at The Promenade and behind Ellenbrook. Width of fragmented vegetation is excessive. Noise walls and wire rope barriers should be used to reduce highway width.

64: Which side of the PDNH will the PSP be? It should be located so as to minimise fragmentation.

75: Clearing footprint can be further reduced through use of wire rope barriers, increasing batter slopes, following natural contours, not clearing all vegetation, reducing table drain sizes, reducing fire track requirement, routing PSP through cleared area.

The Promenade interchange and section of highway adjacent to Ellenbrook have been designed to reduce fragmentation of conservation estate (Bush Forever site 300), avoid *Caladenia huegelii* habitat and minimise impacts to Black Cockatoo foraging and roosting habitat. Protection of the threatened species and habitat results in fragmentation of the Bush Forever site. The fragment also arises from community feedback requesting the highway be aligned adjacent to the western boundary of the development envelope to reduce noise impacts on residences (see PER Chapter 4, Detailed Description of Proposal, Table 4.1).

The PSP (pedestrian/cycle path) will be on the west side of the proposed highway south of Baal Street, Cullacabardee and east of the proposed highway north of Baal Street. The path will be located adjacent to the southbound carriageway adjacent to Ellenbrook to avoid *Caladenia huegelii* and minimise impacts to Black Cockatoo foraging and roosting habitat.

Wire rope barriers are proposed for the full extent of the proposal. They facilitate embankment slopes at 1 (V):3(H) but do not reduce the footprint significantly due to the relatively flat terrain. The width of the highway will be minimised by the installation of road safety barriers between the northbound and southbound carriageways. Vegetation will be cleared from the back slopes of drains to facilitate construction and maintenance. Table drain size is dependent on the catchment and expected runoff. The drains are designed to avoid flooding of the highway carriageways. Fire tracks will be designed to minimise clearing of significant vegetation.

Consolidated issue 42 (contributing issue 184): There is an opportunity in Beechboro Road to move the alignment into some degraded vegetation instead of through excellent/very good vegetation.

The degraded vegetation adjacent to Beechboro Road (PER Chapter 8, Flora and Vegetation, Figure 8.6A) is an easement for a 330 kV transmission line. Western Power has identified land adjacent to the easement as a state significant corridor for future expansion of the electricity network. Locating the highway on or adjacent to Beechboro Road would constrain this corridor.

12.3.2 Interchanges

Consolidated issue 28 (contributing issue 99): The Whiteman to Yanchep Highway bifurcation should be relocated immediately north of Gnangara Rd to avoid unnecessary excision of 8 ha from Whiteman Park and reduce number of interchanges from 2 to 1.

The Whiteman to Yanchep Highway bifurcation was designed to ensure the most direct routes and to avoid a large freeway to freeway interchange that would have increased the overall proposal footprint. The configuration of the interchange enables vehicles to maintain speed through the intersection, improving traffic flow and the efficiency of the highway. Moving the interchange north of Gnangara Road would reduce impacts on Whiteman Park but would make connection to Gnangara Road more complex and increase the proposal footprint and impact on State Forest. The existing 330 kV transmission line easement adjacent to Beechboro Road precludes using this road for the proposed highway.

Consolidated issue 29: There should/shouldn't be an interchange at Maralla Road.

Contributing issues:

58: Maralla Road interchange should be added to reduce distance between interchanges at The Promenade and Neaves Road. It would also enable future development north of Ellenbrook.

50: Maralla Road interchange is opposed. If interchange is required between Promenade and Stock Road, it should be located at Warbrook Road.

213: The proposed interchanges are supported, however any suggestion by developers to include an interchange at Maralla Road should be refused on grounds of Maralla Road's environmental and heritage values.

No interchange is proposed at Maralla Road. Interchange locations for the proposal have been selected based upon current land use planning, including the current Perth to Peel @ 3.5 million strategy (WAPC, 2015). Current land use planning does not require an interchange at Maralla Road. The assessment process required for any future proposals including new interchanges will be subject to determination by the relevant statutory authority at the time of referral.

12.3.3 Local Roads

Consolidated issue 30 (contributing issue 53): Will Maralla Road west of PDNH alignment retain its name?

No change to the naming of Maralla Road is proposed as a result of the proposal. Emergency services will be notified of the changed access arrangements.

Consolidated issue 31: When will Halden Road extension begin construction? Will it be sealed bitumen?

Contributing issues:

52: Will Halden Road extension to Maralla Road be sealed bitumen?

54: When will Halden Road extension begin construction?

Halden Road will be constructed ahead of part of Maralla Road being closed for construction of the proposal. Construction of the proposal is planned to start in 2016–17 and will proceed in a staged approach. The exact timing of construction of the Halden Road extension is to be determined. It is proposed that Halden Road be a sealed road.

Consolidated issue 32 (contributing issue 63): Why are Maralla Road and Halden Road being upgraded and to what extent? Good quality vegetation will be damaged.

Maralla Road and Halden Road are being upgraded to maintain access to properties along Maralla Road whose access to the east will be cut off by construction of the proposed highway. Maralla Road will be upgraded to a two lane 7-m-wide road and sealed. Emergency access gates will be installed in the highway reserve fence at the Maralla Road cul-de-sacs to enable emergency vehicle access and a secondary evacuation route for residents.

12.3.4 Other Issues

Consolidated issue 25: Accuracy of information used in decision-making processes and surveying for clearing.

Contributing issues:

148: How is the correct surveying of construction/clearing footprint assured, given inaccuracies in spatial data for EPP lakes?

233: Previous decisions and discussions have been made on the basis of incorrect information.

The location and extent of Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 lakes (EPP lakes) were wetlands with surface water at 1 December 1991. Geomorphic wetland mapping started in 1992 was based on digitised 1:25,000 scale maps held in the Wetlands of the Swan Coastal Plain Volume 2B Wetland mapping, Classification and Evaluation: Wetland Atlas (Hill et al., 1996). Discrepancies in the boundaries of wetlands maintained in Western Australia Government spatial data libraries reflects the different map bases used to map the extents of EPP lakes and geomorphic wetlands. Satellite imagery shows the proposal footprint avoids wetland vegetation associated with CCW 8800 and REW 8801, as reported in PER Chapter 10, Hydrological Processes and Inland Water Environmental Quality, Table 10.3. Note that the EPP Lakes Policy was revoked on 20 November 2015, as a result EPP lakes are no longer recognised.

MRWA is committed to delineating the proposal footprint ahead of clearing to ensure disturbance is restricted to the proposal footprint.

MRWA will be responsible for auditing the proposal during construction to ensure compliance with conditions. The OEPA and DOTE may conduct audits on implementation of approval conditions, including compliance with nominated buffers and clearance boundaries. Where required by the OEPA or the DOTE, MRWA will commission an independent auditor.

Consolidated issue 26 (contributing issue 65): An intermodal road/rail transfer hub near Muchea is required to reduce road freight. This planning failure needs to be rectified as part of this proposal.

An objective of the proposal is to improve the capacity, efficiency and productivity of the road network including freight movements. The proposal is not contingent on the provision of freight logistics facilities. The concept design includes provision for a road train assembly area and traveller's rest area in the vicinity of the GNH and Brand Highway at Muchea (PER Chapter 4, Detailed Description of Proposal, Section 4.8).

The Western Australia Planning Commission (WAPC) has prepared Amendment 1219/41 to the MRS. The amendment proposes rezoning land south of RAAF Pearce for the proposed South Bullsbrook Industrial Precinct which includes land set aside for an intermodal freight terminal. The freight terminal, if built, would be accessed from the Stock Road interchange.

12.4 Regulatory Context

Consolidated issue 22 (contributing issue 18): What impact could Department of Defence (DOD) lack of endorsement for the final alignment have on the proposal?

MRWA will continue to work with the Department of Defence (DOD) with the regard to the negotiation and transfer of this land under the Commonwealth Property's Disposal Policy. It is anticipated that the Defence Land required for the proposal will be available prior to the proposal's scheduled commencement date.

The development envelope is zoned as a Primary regional road in the MRS (Metropolitan Region Scheme, Map Sheet 8).

Consolidated issue 23 (contributing issue 66): Principle 4 (improved valuation, pricing and incentive mechanisms) under Section 4A of EP Act has not been properly addressed. Sections on Infrastructure Sustainability Council of Australia (ISCA) are light on detail and are inadequate.

The proposal design, scoping of environmental investigations and development of management measures has taken into account the value of social and environmental resources and impacts. Part of the alignment definition study included an assessment of potential physical constraints on the alignment including topography, development, major infrastructure, DOD facilities, watercourses, wetlands, rare flora, indigenous and non-indigenous heritage sites. Impacts on the following were avoided where possible or minimised:

- Wetlands, Bush Forever sites, rare flora and trees.
- Indigenous and non-indigenous heritage sites.
- Property severance, access and water supply.

The development and design of the proposal captures environmental and socio-economic aspects through the up-front alignment definition study, stakeholder and community consultation and expert technical advice.

In addition, MRWA has ensured that the proposal follows the principles relating to improved valuation, pricing and incentive mechanisms through use of the Infrastructure Sustainability Council of Australia (ISCA) rating tool. The ISCA rating tool provides a framework for focusing on sustainability and driving performance, and a method for capturing good practices in project delivery and measuring improvements in performance over time.

The proposal was registered with ISCA to receive a Design and an As-Built Rating, with planning towards this rating commencing during project development. While the ISCA rating tool is designed for application through the design and construction stages, MRWA and ISCA have used the proposal to explore its use at these earlier stages as a means of maximising project sustainability, the first time this has been done by MWRA.

Consolidated issue 24 (contributing issue 67): Principle 5 (waste minimisation) under Section 4A of EP Act has not been addressed. Waste minimisation does not appear to have been thought about at all.

Environmental Principle 5, Waste minimisation is discussed in PER Chapter 5, Regulatory Context, Waste. In a road construction project context, waste includes clearing residue, excess spoil requiring disposal, acid sulphate soils requiring treatment and/or disposal, wastewater discharge (e.g., trench and foundation seepage), waste road surfacing material, waste concrete, packaging, waste oil filters and rags etc. from vehicle, plant and equipment servicing, and general and domestic waste from site offices and amenities..

MRWA will ensure that all construction activities are carried out in accordance with the principles of cleaner production and waste minimisation in accordance with its Environmental Policy (MRWA, 2004).

A construction EMP (CEMP) will incorporate waste management measures and conditions of approval relevant to construction. The measures will need to demonstrate management in accordance with the waste hierarchy, giving preference to avoidance and recovery.

Examples of waste management strategies that will be employed for the proposal include:

- Balance cut and fill material to minimise spoil disposal. Fill material will be required for construction of the highway.
- Minimise dewatering and wastewater discharge requirements.
- Use of Recycled Asphalt Planings (RAP).
- Implementing the use of energy efficient measures where practicable (e.g., low-level lighting).
- The CEMP will include an Emergency Response Plan which will be prepared and implemented to reduce impacts associated with any release of contaminants, fire and other emergency situations.

As fly-tipping is known to occur in the Gnangara Park area and other areas of bushland near the proposal the detailed design will take into consideration opportunities to reduce access to bushland areas. Uncontrolled access and illegal dumping of rubbish within the proposal area will also be monitored during construction.

12.5 Stakeholder Consultation

Consolidated issue 3 (contributing issue 88): Stakeholder issues have only been addressed generally in the PER and should be addressed more directly.

Stakeholder issues are addressed in more detail in Table 12.1.

Table 12.1 Stakeholder issues

Area of interest	Key issues raised	Response
Proposal planning		
Proposal support and timing	• Support for the proposal. • Doubt that the proposal will proceed. • Timing of the proposal. • Concern at the time to completion (by 2019).	The proposal has been identified as a priority project by the Western Australia Government. Construction of the proposal is scheduled to commence in 2016. Procurement activities have commenced, award of contracts will be subject to environmental approval. The proposal is funded by the Western Australia Government (20%) and Australian Government (80%). The community has been made aware of the commitment to commence construction in 2016 and complete the proposal by 2019.
Proposal alignment, footprint and design issues	• The extent of the resultant proposal footprint. • Use of the former PDNH reservation along Lord St and Drumpellier Drive and potential to return it to public use at Whiteman Park. • Suggested realignment of the PDNH corridor further west to avoid the direct interface with residents of Ellenbrook.	The proposal footprint is nominally 746 ha as outlined in PER Chapter 4, Detailed description of proposal, Section 4.2. PER Chapter 3, Route Selection Development, Section 3.3 presents details of the environmental constraints assessment that was undertaken on potential alignments. The current alignment was selected over the Lord Street/Drumpellier Drive alignment, as it facilitated a more direct link between the proposal and Tonkin Highway and provided more significant transport benefits, while reducing impacts on existing and future residential areas. A number of changes to the design of the proposal were made as a result of studies undertaken as part of the PER and issues raised by stakeholders during the consultation process (see PER Chapter 3, Route selection and development). Positioning of the Ellenbrook interchange and highway along the western side of the road reserve was developed in consultation with the community through the Community Reference Group process and feedback from consultation activities. The proposed interchange location was determined by balancing impacts on the community with the impacts on the environment, including avoiding the newly recorded location of *Caladenia huegelii.*

Area of interest	Key issues raised	Response
Flora		
Flora (vegetation clearing)	• Impacts on remnant native vegetation. • Loss of vegetation and trees within the road reserve. • Identification and protection of TEC and other ecological communities along the corridor.	PER Chapter 8, Flora and vegetation, specifically Section 8.5, discusses how changes to the proposal have reduced the proposal's overall impact to flora and vegetation values. The alignment and width of the development envelope was reviewed to identify a proposal footprint that minimises clearing in areas with very good to pristine condition vegetation. Nearly 80% of the proposal footprint occurs within vegetation mapped as degraded or worse condition, and reduces the clearing of TECs and PECs. This includes the avoidance of the Mound Springs SCP and Claypans of the SCP TECs (see PER Chapter 4, Detailed description of the proposal). The proposal will impact: • 206 ha of intact native vegetation. • 4.0 ha of the state-listed TEC SCP20a. • 145.5 ha of PECs (64 ha of SCP21c, 0.1 ha of SCP22, 11.6 ha of SCP23b, 7.8 ha of SCP24 and 62.0 ha of Banksia dominated woodlands on the SCP). The following management measures have been proposed to mitigate the impact of native vegetation clearing: • Disturbance will be restricted to the proposal footprint. • Delineation of the proposal footprint ahead of clearing. • Staged clearing and revegetation (where applicable) in accordance with the detailed infrastructure plan. • Preparation and implementation of a construction EMP and a Flora and Vegetation Monitoring and Management Plan. • Revegetation and rehabilitation of roadside vegetation (PER Chapter 12, Rehabilitation and Decommissioning, Section 12.5).

Area of interest	Key issues raised	Response
Flora (weeds)	• Measures to identify and assess areas impacted by dieback. • Topsoil management and use of degraded topsoil or topsoil containing dieback as base level fill and covered.	Management of the introduction and spread of weeds and dieback will be addressed through the preparation and implementation of a weed and dieback hygiene management plan (see PER Chapter 8, Flora and Vegetation, Section 8.5). The weed and dieback management plan will set out the control and hygiene measures to avoid and manage the introduction and/or spread of weeds and dieback including: • A risk assessment of potential sources and activities. • The identification of 'protectable' areas adjacent to the proposal footprint. • Soils within the proposal footprint will not be moved between dieback occurrence categories. • Requirements for hygiene washdown locations that consider risk in the surrounding landscape. • A program to monitor and report on compliance and corrective actions where non-compliance has occurred. • Quarterly auditing of washdown sites to identify weed incursions. • Regular walk-overs at strategic locations along the proposal footprint (i.e. in association with native vegetation) to identify and ameliorate weed incursions. • An auditable hygiene inspection form will be prepared to detail inspection results at the hygiene locations. The Weed and Dieback Management Plan will include management of WONS and declared pests known to be present within the proposal footprint (as listed in PER Chapter 8, Flora and Vegetation, Section 8.2.13) along with weeds ranked as high priority for eradication and control within the DPAW (2013b) weed prioritisation process (WPP).

Area of interest	Key issues raised	Response
Flora (rehabilitation)	• Revegetation strategies. • Expand offsets to include rehabilitation of degraded land.	PER Chapter 12, Rehabilitation and Decommissioning details the revegetation strategies for the proposal. The strategies will be supported by a Detailed Revegetation Plan (PER Chapter 12, Rehabilitation and Decommissioning, Section 12.5). Revegetation will focus on using local native provenance species in each of the revegetation zones (urban, transition and rural) that are suited to the surrounding land use and landscape characteristics, including the floristic formation of adjacent vegetation and so will contribute to maintaining biodiversity. Rehabilitation and habitat restoration opportunities are being considered as part of this proposal's offset strategy (Chapter 6, Environmental Offsets).
Fauna		
Fauna (movement)	• Impacts on fauna movement corridors for terrestrial fauna and birds.	PER Chapter 9, Terrestrial Fauna, specifically Section 9.4.8 discusses the loss of ecological connectivity on terrestrial fauna with particular regard to three ecological linkage networks, Maralla Road Bushland, Whiteman Park/Cullacabardee Bushland and Micro Gardens Park (PER Chapter 9, Terrestrial Fauna, Figure 9.4). Fragmentation of ecological linkages has been avoided where possible, although road design constraints limit the extent to which all vegetation can be avoided. Installation of fauna underpasses (PER Chapter 9, Terrestrial Fauna, Section 9.5.8) and revegetation and rehabilitation of roadside vegetation (PER Chapter 12, Rehabilitation and Decommissioning, Section 12.5) will assist in the maintenance of ecological connectivity.
Fauna (reptiles)	• Impacts on reptiles in the proposal area.	A desktop assessment of State and Commonwealth databases, regional and local contextual data and existing biological surveys identified approximately 360 species of fauna previously recorded in the vicinity of the alignment. This included 64 reptile species, 19 of which were recorded during the Level 1 and Level 2 field surveys, including two conservation significant reptiles, the Jewelled Sandplain Ctenotus (*Ctenotus gemmula*) and Black-striped Snake (*Neelaps calonotos*), both listed as Priority 3 species. The assessment of potential impacts on fauna, including specific consideration of these two species is outlined in PER Chapter 9, Terrestrial Fauna, Table 9.4.

Area of interest	Key issues raised	Response
Fauna (Black Cockatoos)	• Impacts on Black Cockatoos.	PER Chapter 9, Terrestrial Fauna, Section 9.5, discusses how changes to the proposal have reduced the overall impact to fauna values, including Black Cockatoos. For example: • To avoid an area containing a high concentration of Black Cockatoo breeding trees, the width of the proposal footprint was reduced between Baal Street and Gnangara Road (see PER Chapter 9, Terrestrial Fauna, Figure 4.3). The revised proposal footprint reduced the number of breeding trees cleared from 410 to 342 (conserving 68 breeding trees). • The proposal alignment predominantly follows existing infrastructure, cleared areas or secondary habitats, which reduces impacts to existing fauna habitats. A total of 586 ha or 78.6% of the proposal footprint occurs in disturbed areas that offer little or no habitat for fauna. • The proposal alignment was moved to the western boundary of the development envelope in the vicinity of Gulf Cove, Ellenbrook to minimise impacts to high value habitat, avoid a known location of *Caladenia huegelii* and to minimise noise impacts on residents. Impacts on Black Cockatoos are assessed in PER Chapter 9, Terrestrial Fauna, Section 9.4.1.1 and include the loss of habitat and possible temporary displacement of birds during construction. Management measures have been proposed to reduce the impact on fauna and habitat as far as practicable (see PER Chapter 9, Terrestrial Fauna, Section 9.5). This includes restricting disturbance to the proposal footprint and delineation of the proposal footprint ahead of clearing. Additional management measures include the installation of rope wire barriers to reduce the proposal's overall footprint and impact on remnant vegetation.
Fauna (bird strike)	• Bird strikes as a result of vehicle collisions during flyover or as a result of road foraging.	The use of Banksia and other Black Cockatoo foraging resources will be limited as part of revegetation activities within 10 m of the highway, in order to manage the risk of bird strike. Proposed 1.8-m-high fauna fences to be installed on both sides of the highway in areas north of Hepburn Avenue to a minimum of 100 m north of Maralla Road will assist in deterring birds from foraging and roosting in roadside vegetation. Higher fences are not practical. Other measures for reducing fauna mortalities are presented in PER Chapter 9, Terrestrial Fauna, Section 9.5.4.

Area of interest	Key issues raised	Response
Hydrology		
Flooding and stormwater management	• Proposals for managing an extreme flood event. • Seek local infiltration solutions generally and manage flows locally without piping it to other areas or main drains. • Protect potable water quality by understanding and diverting stormwater away from production bores – spillage, hydrocarbons, weed management spraying etc. with provision for emergency response to allow for effective clean up. • Maintain sheet flow characteristics in the northern section to avoid local flooding and inundation outcomes resulting from the proposal.	PER Appendix H, Drainage Strategy, Section 10.4 sets out the strategy for managing flooding and stormwater runoff. Drainage will be designed to integrate with natural drainage lines to maintain existing hydrology/surface flow to watercourses and wetlands. In the northern section on the palusplain, runoff will be allowed to sheet flow across the road reserve to adjacent land where it will disperse via the existing drainage network of ephemeral watercourses and drainage lines. Bio-retention swales will be used within 100 m of wetlands to allow infiltration of normal rainfall events (see PER Appendix H, Drainage Strategy, Section 10.4). South of the palusplain, runoff will be directed as close to source as possible for treatment in bio-retention swales and basins before discharge to existing watercourses and drainage lines. Piped drainage systems will only be required at kerbed sections of the proposed highway in the urban drainage zone. Water quality within the WHPZ will be managed through the provision of bio-retention swales and basins, sized to treat average rainfall events, with excess runoff directed away from the bores. All proposed bio-retention/infiltration basins will be located as far as possible from WHPZs. All but one of the bio-retention basins are located at least 100 m from production bores. Provision has also been made for the preparation of a proposal specific An Emergency Spill Response Plan will be prepared and implemented to manage spills in the Gnangara UWPCA. Closed Circuit Television (CCTV) will be installed in the Priority 1 UWPCA to detect any incidents.
Management of drainage structures	• Recognise the long-term maintenance impacts and costs. • Adopting the appropriate technologies and treatment options.	The drainage strategy (PER Appendix H, Drainage Strategy) incorporates features that mimic existing hydrological conditions. Culverts and bridges will maintain flow in watercourses and drainage lines. Bio-retention swales and basins will use infiltration to settle, treat and filter contaminants in a similar manner to the predominantly sandy substrate of the proposal footprint. Graded verges in the palusplain will allow sheet flow across the road reserve, mimicking natural sheet flow. These features will be low maintenance.

Area of interest	Key issues raised	Response
Water supply to Cyrenian House	• Impacts for water self-sufficiency of Cyrenian House.	The proposal is not anticipated to impact the water self-sufficiency of Cyrenian House. Dewatering and water abstraction will be managed to avoid impacts on water supplies. A WDMMP will include groundwater monitoring to ensure impacts to the Gnangara Mound (public water supplies) are appropriately managed and there are no unforeseen impacts (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.5). Groundwater abstraction will be undertaken in accordance with approved licences under the RIWI Act (see PER Chapter 10, Hydrological Processes and Inland Water Environmental Quality, Section 10.5).
Impacts on the P1 water mound	• Impact on the Priority One water mound. • Ensure compliance with relevant water quality guidelines and standards and be informed by the Gnangara Water and Land Management Strategy.	The drainage strategy (PER Appendix H, Drainage Strategy) has been developed in consultation with the DOW and in accordance with the DOW's principles of water resource management, as detailed in the Stormwater Management Manual for Western Australia (DOW, 2004) and the Decision Process for Stormwater Management in Western Australia (DOW, 2009). MRWA is committed to ongoing liaison with the DOW to ensure protection of the Gnangara Mound production bores. All reasonable measures have been implemented to protect the Priority 1 water mound during construction and operation of the Highway. These include: • Water quality within the WHPZ will be managed through the provision of bio-retention swales, sized to treat the common rainfall event, with excess runoff directed away from the bores. All proposed infiltration basins (including bio-retention basins) have been located as far from the WHPZs as possible and all but one are located at least 100 m from production bores. • Preparation of a proposal specific Emergency Spill Response Plan. • Provision of CCTV throughout the Priority 1 UWPCA to detect any incidents. • MRWA is committed to ongoing liaison with the DOW through the proposal's development and construction to ensure protection of the production bores. A detailed infrastructure plan will be prepared for each stage of the development prior to construction to ensure that the proposal is designed and constructed in accordance with the drainage strategy. • Commitment for joint inspections with Water Corporation. • The EMP will be revised to emphasise the importance of the Gnangara UWPCA and to refer to

Area of interest	Key issues raised	Response
		the appropriate policies and Water Quality Protection Notes. • All fuel and chemicals be stored in a double skin tank and placed in a bunded enclosure capable of storing 125% of the full capacity of the largest tank. The capacity of any single tank will not exceed 5000 L in the Priority 1 area of the Gnangara UWPCA. • Refuelling activities will be carried out at least 50 m from WHPZ. Spill kits will be maintained on refuelling tankers. • Approval will be sought from DOW for any activities that are to be located in the Gnangara UWPCA and are considered incompatible activities under the relevant policies. See PER Chapter 10, Hydrological Processes and Inland Water Environmental Quality, Section 10.4.5 and 10.5 and responses to Consolidated issue 69, 79 and 80.
Impacts to Muchea residents	• Impacts to Muchea residents and others reliant upon groundwater as a potable water supply source. • Protect existing bores from spills and other impacts.	The proposal is not anticipated to impact water supply to Muchea residents. Dewatering and water abstraction will be managed to avoid impacts on domestic water supplies. A WDMMP will include groundwater monitoring to ensure impacts to aquifers are appropriately managed and there are no unforeseen impacts (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.5). Groundwater abstraction will be undertaken in accordance with approved licences under the RIWI Act (see PER Chapter 10, Hydrological Processes and Inland Water Environmental Quality, Section 10.5). Management measures for spills and runoff during construction and when the highway is operational are set out in PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.5 and Table 10.9. They include measures relating to the generation, storage, handling and release of pollutants, surface water management and a spill response procedure, which will be incorporated in the Emergency Response Plan developed in consultation with emergency services.

Area of interest	Key issues raised	Response
Impacts to fauna and flora	• Impacts for flora and fauna from changing surface water, runoff and drainage regimes.	The proposal has the potential to disrupt the surface flow of water which could affect groundwater-dependent vegetation particularly around Wetland and Dampland habitats, in turn causing habitat degradation and reducing the ability of these habitats to support fauna such as the Great Egret, Cattle Egret and Southern Brown Bandicoot. PER Appendix H, Drainage Strategy, Section 10.4 sets out the strategy for managing flooding and stormwater runoff. Drainage will be designed to direct runoff to close as source as possible for infiltration and discharge to natural drainage lines to maintain existing hydrology/surface flow to watercourses and wetlands. In the northern section on the palusplain, runoff will be allowed to sheet flow across the road reserve to adjacent land where it will disperse via the existing drainage network of ephemeral watercourses and drainage lines. Bio-retention swales will be used within 100 m of wetlands to allow infiltration of normal rainfall events (see PER Appendix H, Drainage Strategy, Section 10.4). A WDMMP will be developed and implemented including groundwater monitoring to ensure impacts to wetlands (and Ellen Brook) are appropriately managed and there are no unforeseen impacts (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.5). The Wetland Management and Monitoring Plan will consider the conservation status and proximity of wetlands to the proposal.
Wetlands		
Wetland rehabilitation	• Impacts on historic and planned wetland rehabilitation work undertaken by volunteers. • The potential role for community groups to play a part in identifying, restoring or even potentially managing rehabilitated wetlands.	The proposal has been aligned to avoid and where not possible, minimise impacts to wetlands, particularly CCWs and REWs north of Maralla Road where the proposal is less constrained with regard to existing development (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Figure 10.2). Chittering Landcare/Ellen Brockman Catchment Council and Perth Region RNM were involved in the Environmental Reference Group and Drainage Reference Group. The proposal may impact some existing areas of rehabilitation along watercourses near Muchea. MRWA will continue to consult with the Chittering Landcare/Ellen Brockman Catchment Council to identify opportunities to offset any loss of rehabilitation. MRWA is considering opportunities to involve community groups in the delivery/management of the proposal's rehabilitation and offsets.

Area of interest	Key issues raised	Response
Wetland connectivity	• Need for wetland connectivity to maintain the integrity of the existing wetland network.	Hydrological connectivity and the maintenance of surface water flows between areas of wetland intersected/fragmented by the proposal will be maintained through the installation of culverts in accordance with the Drainage Strategy (PER Appendix H).
Protection of wetlands	• Long-term protection and management of wetlands is a critical catchment management task for the future. • Wetland protection should be a priority wherever possible.	PER Appendix H, Drainage Strategy, Section 10 sets out the strategy for managing stormwater runoff from the highway to wetlands, including maintenance of water quality and hydrological connectivity through the installation of culverts and infiltration systems, e.g., bio-retention swales and basins. A Wetland Management and Monitoring Plan will be developed and implemented including groundwater monitoring to ensure impacts to wetlands are appropriately managed and there are no unforeseen impacts (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.5).
Aboriginal and European Heritage		
Aboriginal and European heritage	• Identification and protection and/or recognition of sites of Aboriginal or European heritage value.	Where possible, Aboriginal heritage sites will be avoided and protected. Where Aboriginal heritage sites are unavoidable and disturbance is required, a consent to disturb under Section 18 of the AH Act will be obtained. Members of the Noongar community were involved in field surveys for Aboriginal cultural heritage (see PER Appendix Q, Ethnographical Aboriginal Heritage Survey and PER Appendix R, Aboriginal Archaeological Assessment). The process developed to monitor and manage impacts to Aboriginal archaeological records is supported by the Noongar people (see PER Appendix R, Aboriginal Archaeological Assessment). PER Chapter 13, Aboriginal Heritage, Section 13.4 sets out the measures to be incorporated in an Aboriginal Heritage Management Plan. The measures incorporate the recommendations set out in PER Appendix R, Aboriginal Archaeological Assessment.

Area of interest	Key issues raised	Response
Noise		
Impacts on the community	• Noise impact for the communities of Beechboro, Noranda, Bennett Springs, Ballajura, Ellenbrook and rural properties. • Residential noise impacts.	Predicted noise impacts on residential and rural properties are detailed in the revised transportation noise assessment (Appendix I, Revised Transportation Noise Assessment) and summarised in Chapter 4, Amenity (Noise and Vibration), Table 4.3. The SPP 5.4 noise limit (60 dB $L_{Aeq\ (Day)}$) will be achieved at all noise sensitive properties south of Maralla Road including residences in Ellenbrook, Noranda and Ballajura. It is not practicable to achieve the noise target (55 dB $L_{Aeq\ (Day)}$) at some residences in Ellenbrook due to the limitation on noise wall height of 5 m. Noise levels at sixteen rural properties north of Ellenbrook will exceed the SPP 5.4 noise limit (60 dB $L_{Aeq\ (Day)}$). Indoor noise levels at these properties will be reduced by application of noise mitigation set out in the Implementation Guidelines for SPP 5.4 (WAPC, 2014), as discussed and agreed with the affected property owner.
Noise mitigation	• Concern about the already high noise levels and the lack of existing noise mitigation measures. • Noise mitigation measures.	PER Chapter 11, Amenity (Noise and Vibration), Table 11.3 lists proposed noise management measures. Updates to these management measures are detailed in Chapter 4, Amenity (Noise), Table 4.2. Proposed noise mitigation includes noise walls up to 5 m high adjacent to residential areas and screening walls to 2.4 m at appropriate locations in rural areas. Where noise levels at rural properties north of Maralla Road exceed the SPP 5.4 noise limit (60 dB $L_{Aeq\ (Day)}$) indoor noise levels at these properties will be reduced by application of noise mitigation set out in the Implementation Guidelines for SPP 5.4 (WAPC, 2014), as discussed and agreed with the affected property owner.

Area of interest	Key issues raised	Response
Amenity		
Amenity (Gnangara Park Management Plan)	• Impact on the recreational area under the Gnangara Park Management Plan.	Potential impacts on Gnangara Park and Dick Perry Reserve are discussed in PER Chapter 15, Amenity. The proposal footprint and overlap with the Gnangara Park recreational master plan are outlined in Figure 15.1. Management measures to address the continued use and viability of the reserve have been addressed through the design of the proposal and include: • Re-establishment of a barrier fence along the western side of the proposal to ensure access to the reserve is controlled. Gates for access for fire suppression will be established at regular intervals, in locations to be agreed with DPAW. • Linking of walking trails with the PSP at the interchanges on Gnangara Road and at Ellenbrook to ensure continuity of the trails. • Avoidance of, and translocation where necessary, of heritage cork trees. MRWA will continue to work with DPAW in the preparation of an agreement, including detailed site plans and specifications, for construction of the length of the proposed highway through Dick Perry Reserve. The agreement may include removal and provision of an alternative water source for Black Cockatoos.
Amenity (Cyrenian House)	• Concern that the sensitivities and importance of Cyrenian House facility (Rick Hamersley Centre) may not be recognised. • Retention of kangaroos, birds and wildlife and other fauna as a valued and positive benefit of the current location of Cyrenian House with fauna movement through the site.	Consultation with Cyrenian House representatives has included three individual meetings and their attendance at the Central Community Reference Group meetings. MRWA has agreed to address the concerns of Cyrenian House representatives which included emergency access. MWRA is also committed to providing additional planting in the vicinity of Cyrenian House for screening and amenity. MRWA has committed to install fauna underpasses along the alignment within Cullacabardee Bushland and Whiteman Park to ensure maintenance of fauna movement and ecological connectivity. PER Chapter 9, Terrestrial Fauna, Section 9.5.8 describes underpass design and includes a summary of design considerations.

Area of interest	Key issues raised	Response
Amenity (Whiteman Park)	• Concern at the severance and other impacts for Whiteman Park.	A working group was formed with representatives of City of Swan, Whiteman Park management and stakeholders from the existing sporting clubs to discuss potential impacts on Whiteman Park. This group met on two occasions to discuss and agree the proposed strategy to minimise any access impacts. The agreed proposal includes upgrade and construction of roads within Whiteman Park and the provision of improved security and access control. Potential impacts on Whiteman Park and associated mitigation are discussed in PER Chapter 15, Amenity, Section 15.3.2.
Amenity (rural)	• Concern at the introduction of a highway/freeway standard road in a rural area in the northern section.	The impact of severance of the local road network has been addressed by the proposed construction and/or upgrade of roads to ensure that access to all properties is maintained. As a result, routes and travel times to some properties may be longer. The new highway will improve travel times in the region. Access arrangements were discussed with the City of Swan and affected property owners. Invitations were sent to the occupiers and owners of all affected properties to attend facilitated public information sessions in Muchea and Bullsbrook. These were well attended by affected residents. Consultation with Department of Fire and Emergency Services (DFES) has resulted in the provision of regular emergency vehicle crossings/access points along the proposed highway. Noise levels at sixteen rural properties north of Ellenbrook will exceed the SPP 5.4 noise limit (60 dB $L_{Aeq\ (Day)}$). It is not practicable to construct noise walls in rural areas. Where practicable, 2.4-m-high screening walls have been incorporated into the design. Indoor noise levels at these properties will be reduced by application of noise mitigation set out in the Implementation Guidelines for SPP 5.4 (WAPC, 2014), as discussed and agreed with the affected property owner.
Amenity (visual)	• Visual and proximity impacts.	Visual screening will be achieved through the construction of screen walls and revegetation of the road reserve. Where practicable, screen walls will be constructed adjacent to rural residences north of Maralla Road. Planting may also be provided to affected private properties, subject to discussion and consent with individual property owners. Noise walls installed adjacent to residential areas south of Maralla Road will screen the highway from adjacent residences. Road reserve revegetation will reflect the existing environment as detailed in PER Chapter 12, Rehabilitation and Decommissioning. Revegetation strategies for the urban, transition and rural zones will focus on using local native provenance species that are suited to the surrounding land use and landscape characteristics, including the floristic formation of adjacent vegetation.

Area of interest	Key issues raised	Response
Social		
Social (housing)	• The distance of the new highway from existing homes.	The road reserve for the proposed highway has been gazetted and shown in the Perth MRS for many years, and pre-dates some residential development. Refinement of the alignment of the proposed highway within the gazetted road reserve to increase separation to residential developments has been considered in conceptual design. A number of changes to the design of the proposal were made as a result of studies undertaken as part of the PER and issues raised by stakeholders during the consultation process (refer to PER Chapter 3, Route selection and development). Where possible the proposal alignment has been moved away from adjacent residents (see PER Chapter 4, Detailed description of proposal, Table 4.1). Positioning of the Ellenbrook interchange and highway along the western side of the road reserve (ensuring no traffic lanes within 60 m of any residence) was developed in consultation with the community through the Community Reference Group process and feedback from consultation activities. The proposed interchange location was determined by balancing impacts on the community with the impacts on the environment, including avoiding the newly recorded location of *Caladenia huegelii.*
Social (crime)	• Crime and anti-social behaviour in residual land between noise walls and property boundaries – use of residual space.	Crime prevention has been considered in designing the highway and addressed by minimising the area of land behind noise walls within the road reserve. The exception is at Ellenbrook, where through the community consultation process (northern Community Reference Group); the community's desire to retain the vegetation close to properties and have any noise mitigation structures closer to the highway was adopted.
Social (business)	• Concern at the loss of passing trade and commercial opportunities for Muchea businesses and in particular the IGA store. • Impacts for business access to GNH at the northern reconnection point near Muchea.	The GNH/Brand Highway interchange located east of Muchea provides access to Muchea via the Brand Highway. The interchange will maintain access to the Muchea IGA and other Muchea business. Access to the GNH at this location is being considered through the provision of a parallel service road that will provide safe access to the regional road network while also allowing large vehicle access to these businesses to ensure minimal impacts.

Consolidated issue 5 (contributing issue 234): Any future interchanges must be done with more consultation with local landholders and residents as consultation has been substandard in the past.

Stakeholder engagement was undertaken with numerous groups (see PER Chapter 6, Stakeholder Consultation) throughout the preparation of the PER including with Members of Parliament, landowners, residents, business owners and operators, environmental interest groups, community members, the freight industry, highway users and cyclists. A number of changes to the design and proposal alignment options for the PDNH were undertaken in response to issues raised by stakeholders. These are listed in PER Chapter 4, Detailed Description of Proposal, Section 4.2.3 and include the construction of interchanges at selected existing roads to enable access to suburbs and key transport routes along the alignment.

Any future interchanges will be subject to necessary assessment as determined by relevant statutory at the time which will dictate the level of consultation required.

12.6 EIA Framework

Consolidated issue 1: PER review period was too short.

Contributing issues:

19: Public review period was too short and didn't allow proper time to read and respond to PER.

100: PER review period was too short.

188: Four weeks is not long enough for the public review period. Quality of feedback is compromised as a result.

214: Future public review period length should be commensurate with the size and detail of the PER so it can be responded to in full.

The length of the public review period of the PER document was determined by the EPA as set out in their decision (6 January 2014) to assess the Perth Darwin National Highway (Swan Valley Section) with a four-week public comment period.

Consolidated issue 2 (contributing issue 11): Future projects should consider cumulative impacts.

The PER presents the assessment of direct and indirect impacts of the proposal at a local, regional and State level.

Western Australian Ministers for Planning and Environment and the Commonwealth Minister for the Environment agreed to undertake a Strategic Assessment of the Perth and Peel regions (Strategic Assessment) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for impacts on matters of national environmental significance (MNES). The assessment will provide a framework for the assessment of direct, indirect and cumulative impacts of future projects on MNES. The assessment is in progress. More information on the Strategic Assessment can be found at https://www.dpc.wa.gov.au/Consultation/StrategicAssessment/Pages/Default.aspx.

The PER presents the assessment of impacts (habitat loss and fragmentation) on Black Cockatoos at local, regional and bioregional scales (see PER Chapter 9, Terrestrial Fauna, Table 9.4). The local scale is defined as a 1 km buffer to the proposal footprint. The regional scale is defined as all Bush Forever sites within a 10 km buffer to the proposal footprint. The bioregional scale is the Swan Coastal Plain bioregion. The loss of foraging habitat for Carnaby's Black Cockatoo is expected to be 0.2% at the regional scale and 0.04% at the

bioregional scale. The loss of foraging habitat for the Forest Red-tailed Black Cockatoo is expected to be 0.1% at the regional scale and 0.03% at the bioregional scale.

Avoidance and mitigation measures associated with Black Cockatoo habitat are discussed in response to consolidated issue 88 (see Section 12.8.1).

12.7 Flora and Vegetation

12.7.1 Threatened Flora

Consolidated issue 130: Confidentiality of threatened flora locations.

Contributing issues:

108: Why has the location of declared rare flora been published in the PER despite DPAW requesting it to be kept in confidence?

112: Should Threatened and Priority listed flora locations be kept confidential?

189: *Caladenia huegelii* should have been discussed in more detail without revealing its location. The importance at [address redacted] Maralla Road as stated may be misleading.

MRWA is aware of the DPAW's policy regarding the confidentiality of Threatened and Priority flora. Where feasible the general location is only shown but if it is necessary for the assessment of impacts to the species and disclosure provides benefits for the assessment, then the locations are provided.

MRWA was requested to clearly show the locations of *Caladenia huegelii* and *Grevillea curviloba* subsp. *incurva* identified in surveys for the proposal relative to the development envelope and proposal footprint. DOTE requested more general information regarding *C. huegelii*, *G. curviloba* subsp. *incurva* and *Darwinia foetida* that required the known locations of these species to be shown. The locations of these species are shown on PER Chapter 8, Flora and Vegetation, Figure 8.1 along with historical records. Historical records shown on this figure identify the record source and the conservation status but do not identify the species.

Consolidated issue 131 (contributing issue 103): Further surveys for *Caladenia huegelii.*

In addition to the three flora surveys described in the PER (PER Chapter 8, Flora and Vegetation, Section 8.2), a further targeted survey for *Caladenia huegelii* was undertaken on 18 September 2015, following release of the PER (see Appendix C, Assessment & Refinement of Potential Critical Habitat for *Caladenia huegelii* (T-DR) within the Development Envelope). The survey by Woodman Environmental was conducted in the area west of Ellenbrook previously identified as critical habitat for *C. huegelii*. The area of critical habitat in the proposal footprint was reduced from 39.2 ha to 30.0 ha. The flowering period for *C. huegelii* in 2015 commenced approximately two weeks earlier than its normal mid-September start time. The 18 September survey date is therefore considered appropriate.

The survey did not record any *C. huegelii* plants in the area. The survey commented on the relatively good condition of the vegetation in the critical habitat area and indicated that given the level of existing public access to the area, the long-term persistence of the orchid in this area will require appropriate management to protect the habitat's viability.

Consolidated issue 132: Impacts to known *Caladenia huegelii* from construction.

Contributing issues:

22: *Caladenia huegelii* on a private property is not identified in PER. Will monitoring during construction and operation focus include *Caladenia huegelii*, and who will be responsible for identifying it correctly?

109: Why has declared rare flora at Maralla Road been disregarded in planning the PDNH?

191: A *Caladenia huegelii* orchid [address redacted, but assumed to be on private property] exists within 50 m of the study boundary and will be subject to the impacts of highway construction and ongoing operation.

As detailed in the Level 2 Flora and Vegetation Assessment (PER Appendix C), a search of the DPAW database provided all known records of conservation significant flora that occur on the WAH database Florabase or otherwise recorded by DPAW.

The location of the private property on which *Caladenia huegelii* is located is not specified in the submission. It is therefore difficult to comment on the location of the site relative to the flora study area. If the occurrence is outside the study area it will not be directly impacted by the proposal. There are many instances where populations of *Caladenia huegelii* have existed for many years within 50 m or less of roads including the busy Roe Highway (Stage 7). The potential for impacts to *Caladenia huegelii* resulting from highway construction and operation will be mitigated by establishing a 50 m buffer between the known locations of *Caladenia huegelii* and the proposal footprint (see PER Chapter 8, Flora and Vegetation, Section 8.4.5).

Consolidated issue 133: Impacts to known *Caladenia huegelii* from construction.

Contributing issues:

104: How can the proponent guarantee that *Caladenia huegelii* will be fully protected?

106: The statement that 'there are no direct impacts to [*Caladenia huegelii*]' is wrong. How is the impact on unknown populations of *C. huegelii* considered?

The individual plant of *Caladenia huegelii* is located on land that is unprotected from public access and is very close to existing houses. Construction of the proposal will include fencing either side of the road reserve which will reduce public access, provide a management boundary for weeds and thereby better protect the plant. Current unrestricted public access into areas of critical habitat for *C. huegelii* west of the proposal will be further limited following the installation of fencing.

While it is acknowledged that *C. huegelii* plants do not necessarily flower every year there have now been four flora surveys undertaken in the spring-flowering period of *C. huegelii* in 2012, 2014 and 2015 (see PER Chapter 8, Flora and Vegetation, Section 8.2 and Appendix C, Assessment & Refinement of Potential Critical Habitat for *Caladenia huegelii* (T-DR) within the Development Envelope). The likelihood that unknown populations of *C. huegelii* occur in the survey area and will be impacted by the proposal is considered to be very low.

Consolidated issue 134 (contributing issue 216): Accuracy and completeness of survey information for *Caladenia huegelii*.

There have been three flora surveys undertaken in the optimal spring flowering period of *Caladenia huegelii* including 24 to 27 September 2012 (GHD, 2013b), 15 September to 26 November (360 Environmental, 2014), and 15 to 19 September and 22 to 26 September 2014 (Coffey, 2015b) (see PER

Chapter 8, Flora and Vegetation, Section 8.2 and Appendix C, Assessment & Refinement of Potential Critical Habitat for *Caladenia huegelii* (T-DR) within the Development Envelope). Only one individual has been identified from these surveys. In 2015, Woodman Environmental undertook a survey for *C. huegelii* critical habitat. The survey was undertaken by experienced botanists (see Appendix C, Assessment & Refinement of Potential Critical Habitat for *Caladenia huegelii* (T-DR) within the Development Envelope). The likelihood that unknown populations of *C. huegelii* occur in the survey area is considered to be low. However, the provision of an offset for the residual impact of the proposal on areas deemed suitable for *Caladenia huegelii* (i.e., critical habitat) recognises the cryptic nature of the species and the inherent uncertainty around numbers of individuals.

Consolidated issue 135: Commentary on fungi and *Zaspilothynnus* wasp supporting *Caladenia huegelii* are omitted.

Contributing issues:

105: *Caladenia huegelii* habitat loss is completely unacceptable, especially given vehicular impacts to the wasp *Zaspilothynnus* sp. that pollinates this species.

193: The impacts to the *Zaspilothyunnus* wasp responsible for pollinating *Caladenia huegelii* are unclear.

218: Why have no surveys been done for fungi and invertebrates that support *Caladenia huegelii* given their essential role in its survival?

Food plants used by the male Thynnid wasp responsible for pollinating *Caladenia huegelii* include *Dasypogon bromeliifolius*, *Hakea prostrata*, *Hibbertia hypericoides*, *Kunzea ericifolia* and *Pericalymma ellipticum* (A. Batty, cited in Roe Highway Stage 7 *Caladenia huegelii* Conservation and Management Plan 2004) (Batty cited in Roe 7 Alliance, 2004). These are all common species occurring in the *Caladenia huegelii* critical habitat defined in the PER and revised in Woodman Environmental (2015a) (see Appendix C, Assessment & Refinement of Potential Critical Habitat for *Caladenia huegelii* (T-DRF) within the Development Envelope), a large extent of which is to the west of the proposal and will not be impacted by the highway construction.

It is acknowledged that construction of the highway may introduce a barrier to the movement of wasps from the western side of the highway to the pocket of bushland east of the proposal containing the individual of *Caladenia huegelii*. In the Ellenbrook area, incorporating species used by Thynnid wasps as food sources in revegetation of the road reserve adjacent to *Caladenia huegelii* critical habitat will reduce the barrier effect of the highway.

Surveys to determine the extent of the mychorrizal fungi required in the lifecycle of *Caladenia huegelii* were considered but were not undertaken, as they are not typically required for vascular plant surveys and as they require seed from *Caladenia huegelii* to determine the presence of the specific mychorrizia. A fungi survey would have required more *Caladenia huegelii* seed than is currently available from the known individual plant.

Consolidated issue 136 (contributing issue 77): Clarification is sought on how the mitigation measures for Threatened flora will result in the proposal being likely to meet the EPA's objectives.

The EPA's objective for flora and vegetation is "to maintain representation, diversity, viability, and ecological function at the species, population and community level" (EPA, 2015b). As discussed in PER Chapter 8, Flora and Vegetation, Section 8.4.5, direct impacts to the three Threatened flora species *Caladenia huegelii, Grevillea curviloba* subsp. *incurva* and *Darwinia foetida* have been avoided. Impacts to critical habitat have been minimised for *Caladenia huegelii* and *Grevillea curviloba* subsp. *incurva*, .The EPA's objectives with respect to Threatened flora will therefore be met.

Consolidated issue 138 (contributing issue 70): *Caladenia huegelii* is even more threatened than it was previously, and hasn't been found in some regional locations listed. Every effort needs to be taken to protect/re-introduce *Caladenia huegelii* in its critical habitat area.

Three surveys in separate spring flowering seasons have identified only one individual of *Caladenia huegelii*, or Grand Spider Orchid, in the development envelope (see PER Chapter 8, Flora and Vegetation, Section 8.2). The PER assessed the impacts of the proposal on this known location and concluded that there are no direct impacts to the Grand Spider Orchid as it is outside the proposal footprint. Indirect impacts will be managed through the retention of a vegetated buffer around this location.

The Grand spider orchid (*Caladenia huegelii*) recovery plan (DEC, 2009) defines critical habitat as additional occurrences of similar habitat that may contain important populations of the species or be suitable sites for future translocations or other recovery actions intended to create important populations. Mapping conducted for the PER identified 39.2 ha of critical habitat for the Grand Spider Orchid within the proposal footprint. Subsequent detailed mapping refined this area to 30.0 ha (see Appendix C, Assessment & Refinement of Potential Critical Habitat for *Caladenia Huegelli* (T-DRF) within the Development Envelope).

Indirect impacts to critical habitat including impacts associated with uncontrolled access, fires, spread of introduced weeds and Phytophthora dieback will be managed through the management measures proposed in the PER (see PER Chapter 8, Flora and Vegetation, Section 8.5).

Unavoidable loss of Grand Spider Orchid critical habitat will be offset (see Chapter 6, Environmental Offsets).

12.7.2 Impact Assessment

Consolidated issue 122: Clearing of remnant intact native vegetation on the Swan Coastal Plain, particularly good to pristine native vegetation and vegetation in association with a Bush Forever site is unacceptable.

Contributing issues:

115: It is difficult to justify clearing yet another 205 ha of native vegetation. When will the continued clearing of native vegetation on the Swan Coastal Plain stop?

117: Clearing of good to pristine native vegetation is completely unacceptable. Clearing of Bush Forever is unacceptable. Does 'forever' mean only if it suits development proposals?

The proposal will impact 206 ha of intact native vegetation, including 149.1 ha in good to pristine condition, 129.9 ha of which is associated with a Bush Forever Site. Three of the five vegetation complexes impacted by the proposal within the Perth-Peel Region of the SCP are below the retention target of 30%: Bassendean Complex – Central and South (21.3%), Southern River (16.8%) and Yanga Complex (13.5%) (EPA, 2015a).

The proposed alignment avoids the majority of pristine, pristine to excellent and excellent to very good vegetation in the development envelope and was realigned to avoid Bush Forever Site 13 (PER Chapter 8, Flora and Vegetation, Figure 8.6 and 15.3). The Promenade interchange and the section of highway adjacent to Ellenbrook have been designed to reduce fragmentation of conservation areas (e.g., Bush Forever Site 300), avoid known location of *Caladenia huegelii* and minimise impacts to Black Cockatoo foraging and roosting habitat, whilst reducing noise impacts on residences.

PER Chapter 8, Flora and vegetation, specifically Section 8.5, discusses how changes to the proposal have reduced the proposal's overall impact to flora and vegetation values. Nearly 80% of the proposal footprint occurs within vegetation mapped as degraded or worse condition. PER Chapter 3, Route Selection and Development, Section 3.3 presents details of the environmental constraints assessment that was

undertaken on potential alignments. This assessment considered conservation and ecologically sensitive areas including Bush Forever sites.

While native vegetation clearing is required for the construction of the proposal, clearing has been minimised to as low as practicable. The alignment and width of the development envelope has been reviewed to identify a proposal footprint that minimises clearing in very good to pristine vegetation and reduces the clearing of TECs and PECs. The following management is proposed to minimise clearing and mitigate the impact of fragmentation:

- Disturbance will be restricted to the proposal footprint.
- Delineation of the proposal footprint ahead of clearing.
- Staged clearing and revegetation (where applicable) in accordance with the detailed infrastructure plan.
- Preparation and implementation of a construction EMP, including management and monitoring of intact native vegetation.
- Revegetation and rehabilitation of roadside vegetation (PER Chapter 12, Rehabilitation and Decommissioning, Section 12.5).
- Installation of fauna underpasses (PER Chapter 9, Terrestrial Fauna, Section 9.5.8 and Figure 9.5).

The response to consolidated issue 27 (see Section 12.3.1) provides further details on how the proposal has minimised impacts to native vegetation (e.g. reduction in the width of the highway through the installation of a concrete barrier between the northbound and southbound carriageways and wire rope barriers).

Consolidated issue 124 (contributing issue 69): Discussion on SCP21c is confusing and internally inconsistent.

The inconsistencies in the discussion of SCP21c arise from varying estimates of the number of sites (quadrats), occurrences and mapped extent. The areal extent of SCP21c has not been determined at the regional scale, as the extent of vegetation associations with SCP21c (occurrences) have not been mapped for all sites. The following discussion outlines the current understanding of the distribution and areal extent of SCP21c and forms the basis for the revised impact assessment.

SCP21c is known from at least 43 sites between Gelorup (near Bunbury) and Breera (near Muchea). Existing records of SCP21c include:

- 27 sites from the DPAW 2005 Swan Coastal Plain dataset (Keighery et al., 2012).
- 17 sites from a custom search of DPAW's databases for existing records of SCP21c within 10 km of the proposal. Nine of these records correspond to records from Keighery et al. (2012) and eight are unique.
- 53 records provided by DPAW's Species and Communities Branch, of which 41 are sites and 12 are occurrences (i.e., mapped areas). It is not known if the 41 sites are unique from the other DPAW records listed above. The 12 occurrences are 231 ha in extent.

The Level 2 Spring Flora and Vegetation Assessment (PER Appendix C) sampled new quadrats and previous quadrats from earlier studies of the study area. The floristic analysis grouped 23 of these quadrats with SCP21c (see PER Appendix C, Level 2 Spring Flora and Vegetation Assessment, Appendix F, Floristic analysis of vegetation site data from the Swan Valley Bypass proposal area). The flora and vegetation assessment combined the floristic analysis with the vegetation association mapping (see PER Appendix C, Level 2 Spring Flora and Vegetation Assessment, Chapter 5 Results, Table 18 and Figure 10) to generate mapping for

SCP21c and other FCTs. The 23 quadrats identified as SCP21c were mapped as 10 occurrences of SCP21c, as shown in PER Figure 8.3. These occurrences total 177.9 ha in extent.

Combining existing records of SCP21c with those from PER Appendix C, Level 2 Spring Flora and Vegetation Assessment, SCP21c is known from at least 65 and possibly over 100 sites and has a mapped extent of 408.9 ha.

Assessment of the proposal's impacts on SCP21c at a regional scale is complicated by the available data. The number of SCP21c sites within the proposal footprint is a coarse measure of the proposal's impact on SCP21c, as the impact is proportional to the survey intensity. Impacts to SCP21c are better assessed by area impacted; however, many records held by DPAW are of SCP21c sites only without spatial extent included.

Fourteen sites of SCP21c will be impacted by the proposal, representing 14% to 21% of existing sites of SCP21c in the region. The significance of this impact is low in a regional context given the distribution of existing sites and the limitations with using this measure as discussed above. At a local scale, the proposal will result in the removal of 64.0 ha of SCP21c, which is 36% of its 177.9 ha extent in the study area.

Consolidated issue 137 (contributing issue 107): What endangered and priority species other than *Caladenia huegelii* have their impact understated or denied?

The impact on *Caladenia huegelii* has been assessed with further information provided in this document (see response to consolidated issue 132 (Section 12.7.1)). PER Chapter 8, Flora and Vegetation, Table 8.1 lists the threatened and priority flora occurring in or proximate to the development envelope. The likelihood of occurrence is based on an assessment of suitable habitat or records.

Potential impacts to listed threatened and priority flora are assessed in PER Chapter 8, Flora and Vegetation, Section 8.4.5, specifically Tables 8.15 and 8.16. Table 8.16 lists the management measures to reduce impacts to these species.

12.7.3 Management

Consolidated issue 123 (contributing issue 225): Given that fire management is essential for conservation, what fire management measures will be put in place during and after construction?

Fire management measures to be implemented during construction will be set out in a fire management plan prepared in accordance with Main Roads Operational Guideline 94 (see PER Appendix F, Environmental Management Plan, Table 4.1 (Increase in wildfires) and Table 4.2 (Altered fire regimes)).

The plan is "likely to include hot works permits; obeying total fire bans; ensuring the serviceability of all equipment and plant (including spark arrestors on exhausts); induction of personnel; prevention of unauthorised access to the construction area and ensuring the work site is kept clean". Burning off will not be permitted under any circumstances in any part of the site or other land used for the purpose of construction.

Fire fighting equipment and trained personnel will be available during construction to suppress any fires that may arise from construction activities.

Gates will be installed in the road reserve boundary fence at closed roads and other places to enable emergency vehicle access and an evacuation route for residents during operation.

Consolidated issue 139 (contributing issue 180): Areas proposed to be cleared should be independently audited and local landowners should be allowed to check it before construction begins.

MRWA will complete land excision prior to commencing work, therefore no clearing will be occurring on local landowner's property. MRWA as the land manager will be responsible for auditing the proposal during construction to ensure compliance with conditions.

The OEPA and DOTE may conduct audits on implementation of approval conditions, including compliance with nominated buffers and clearance boundaries. Where required by the OEPA or DOTE, MRWA will commission an independent auditor to undertake these audits.

Consolidated issue 140: How will weeds and dieback be managed?

Contributing issues:

23: What procedures will be in place to reduce dieback risk? Will effective spraying and treatment regimes be implemented prior to construction to control dieback?

24: What controls will be in place to limit weeds? Will weed control be ongoing?

116: Will MRWA conduct a phosphorus acid spraying program in the proposal footprint to protect healthy vegetation from the likely spread of dieback?

153: How will the weeds Victorian Tea Tree (*Leptospermum laevigatum*), Arum Lily (*Zantedeschia aethiopica*) and Bridal Creeper (*Asparagus asparagoides*) be managed?

162: How will uncontrolled access, rubbish dumping, weeds, dieback and the degradation of vegetation through off-road activities be managed?

222: How will dieback be managed during construction so it does not worsen? Will phosphite treatments be used and, if so, how? Will relevant landowners be consulted?

Management of the introduction and spread of weeds and dieback will be addressed through the preparation and implementation of a weed and dieback hygiene management plan (see PER Chapter 8, Flora and Vegetation, Section 8.5). PER Chapter 8, Flora and Vegetation, Sections 8.4.6 and 8.4.7 assess the potential risk to native vegetation located adjacent to the proposal footprint associated with the introduction and spread of weeds and dieback.

The weed and dieback management plan will set out the control and hygiene measures to manage weeds and dieback and to avoid the introduction and/or spread of weeds and dieback including:

- A risk assessment of potential sources and activities.
- The identification of 'protectable' areas adjacent to the proposal footprint.
- Soils within the proposal footprint will not be moved between dieback occurrence categories.
- Requirements for hygiene washdown locations that consider risk in the surrounding landscape.
- A program to monitor and report on compliance and corrective actions where non-compliance has occurred.
- Quarterly auditing of washdown sites to identify weed incursions.
- Regular walk-overs at strategic locations along the proposal footprint (i.e. in association with native vegetation) to identify and ameliorate weed incursions.
- An auditable hygiene inspection form will be prepared to detail inspection results at the hygiene locations.

The weed and dieback management plan will take particular consideration into the management of WONS and declared pests known to be present within the proposal footprint (as listed in PER Chapter 8, Flora and Vegetation, Section 8.2.13) along with weeds ranked as high priority for eradication and control within the DPAW (2013b) WPP.

The management plan will also consider the effects of weed management on neighbouring tenure, to ensure any adverse impacts on neighbouring properties are minimised, including any need for notification and consultation. MRWA will not be responsible for conducting weed control on land managed by others.

There is no intention to implement a phosphite treatment program for managing dieback. Soil management measures within the weed and dieback management plan will minimise the risk of transporting or using dieback infested or uninterpretable soils into uninfested/protectable areas. Phosphite treatment may be considered if dieback is introduced to uninfested/protectable areas due to proposal activities and where the phosphite treatment will be effective in controlling the new infestation.

Consolidated issue 142 (contributing issue 118): The removal of 280 ha of TECs and PECs should be avoided. What measures will be put in place to protect TECs and PECs impacted by the proposal?

The proposed highway alignment is the product of numerous investigations over a long period of time. It seeks to balance impacts on remnant vegetation, wetlands, public drinking water supplies (Priority 1 and 3 areas of Gnangara UWPCA), amenity and existing and future land use (see PER Chapter 3, Route Selection and Development and Chapter 4 Detailed Description of Proposal).

The proposal has avoided all direct impact on Commonwealth-listed TECs and will only impact 4.0 ha of the state-listed TEC SCP20a and 145.5 ha of PECs (64 ha of SCP21c, 0.1 ha of SCP22, 11.6 ha of SCP23b, 7.8 ha of SCP24 and 62.0 ha of Banksia dominated woodlands on the SCP) as documented in PER Chapter 8, Flora and Vegetation, Table 8.13. The proposal will no longer impact the stated-listed TEC SCP02 following the additional surveys described in Chapter 3.

MRWA will offset unavoidable impacts to TECs. PER Chapter 17, Offsets, presents MRWA's proposal for environmental offsets. This report updates MRWA's offset strategy (Chapter 6, Environmental Offset) which incorporates the results of the spring surveys (Chapter 3) and addresses requests for further information set out in submissions on the PER.

Consolidated issue 143 (contributing issue 163): Which recommendations made by botanical environmental consultants will be implemented?

The majority of recommendations provided in the flora and vegetation report (PER Appendix C, Level 2 Spring Flora and Vegetation Assessment, Section 8 Recommendations) have been adopted for the proposal and are listed in PER Chapter 8, Flora and Vegetation, Section 8.5, including a discussion of flora and vegetation avoidance through design and the following management strategies:

- The avoidance or minimisation of vegetation clearing consistent with the three State TECs located within and adjacent to the proposal footprint.
- Additional targeted surveys for *Millotia tenuifolia* var. *laevis* to clearly define populations (currently underway).
- Demarcation of Threatened and Priority flora adjacent to the proposal footprint.
- Preparation and implementation of a construction EMP, including a monitoring program, to monitor impacts on environmentally significant vegetation adjacent to the proposal.
- Preparation and implementation of a weed and dieback management plan.

The proposal has successfully avoided direct impacts to both federally listed TECs and so no further studies are deemed necessary, as recommended in PER Appendix C, Level 2 Spring Flora and Vegetation Assessment.

Consolidated issue 144: There are no measures described regarding how to prevent, reduce or restore fragmentation.

Contributing issues:

79: There are no measures described regarding how to prevent, reduce or restore fragmentation.

249: Proposal should include measures to create/restore ecological linkages in Figure 8.5.

Fragmentation of remnant vegetation/ecological linkages has been avoided or minimised where possible. For example the proposal alignment was relocated around Bush Forever site 13 in order to avoid fragmenting the site (PER Chapter 8, Flora and Vegetation, Section 8.5). Linear road design constraints limit the extent to which fragmentation of patches of remnant vegetation can be avoided.

The development envelope is located adjacent to Ellenbrook residential area to minimise fragmentation impacts on conservation estate. It also avoids the known location of Caladenia huegelii and minimises noise impacts on residents, which results in a small area of fragmentation.

The following management has been proposed to mitigate the impact of fragmentation on ecological linkage networks:

- Disturbance will be restricted to the proposal footprint.
- Delineation of the proposal footprint ahead of clearing.
- Staged clearing and revegetation (where applicable) in accordance with infrastructure plan.
- Preparation and implementation of a construction EMP, including management and monitoring of intact native vegetation.
- Revegetation and rehabilitation of roadside vegetation (PER Chapter 12, Rehabilitation and Decommissioning, Section 12.5).
- Installation of fauna underpasses to maintain connectivity between patches (PER Chapter 9, Terrestrial Fauna, Section 9.5.8 and Figure 9.5).

PER Chapter 8, Flora and Vegetation, specifically Section 8.4.8 discusses the risks of fragmentation of native vegetation with particular regard to the six regional ecological linkage networks that traverse the proposal footprint (PER Chapter 8, Flora and Vegetation, Figure 8.5). PER Chapter 9, Terrestrial Fauna, specifically Section 9.4.8 discusses the loss of ecological connectivity on terrestrial fauna with particular regard to three ecological linkage networks, Maralla Road Bushland, Whiteman Park/Cullacabardee Bushland and Micro Gardens Park (PER Chapter 9, Terrestrial Fauna, Figure 9.4).

The selection of offset sites will consider the protection and enhancement of ecological linkages (see Chapter 6, Environmental Offsets).

12.7.4 Priority Flora

Consolidated issue 145 (contributing issue 73): Statement in Section 8.4.5 regarding clearing/removal of *Cyathochaeta teretifolia* (P3) is confusing.

PER Chapter 8, Flora and Vegetation, Table 8.1 provides results from a desktop search of relevant government databases to determine threatened and priority flora occurring within or in proximity to the proposal footprint. The desktop search identified a historical record of *Cyathochaeta teretifolia* within the proposal footprint, recorded during a survey conducted in 2013 by 360 Environmental (as cited in PER Appendix C, Level 2 Spring Flora and Vegetation Assessment).

This previously recorded population was not identified during the September 2014 survey (PER Appendix C, Level 2 Targeted Flora and Vegetation Assessment) The previously known location of *Cyathochaeta teretifolia* is in a cleared area. It is assumed that the clearing has resulted in the loss of this population.

The 2014 survey did however identify two new locations of *Cyathochaeta teretifolia* within the study area (see PER Chapter 8, Flora and Vegetation, Figure 8.1) however neither of these locations are within the proposal footprint and so no direct impact on this species is anticipated. This information is presented in PER Chapter 8, Flora and Vegetation, Table 8.15 and Section 8.4.5.

Four priority species will be impacted by the proposal: *Millotia tenuifolia* var. *laevis* (P2), *Poranthera moorokatta* (P2), *Anigozanthos humilis* subsp. *chrysanthus* (P4) and *Hypolaena robusta* (P4), as a subsequent study in 2015 has determined *Meeboldina decipiens* subsp. *decipiens ms* (P3) is no longer considered to be present within the proposal footprint (see Chapter 3, Spring Ecological Surveys, Section 3.2).

Consolidated issue 146 (contributing issue 113): Protection and management of Priority flora species.

Four priority-listed flora – *Millotia tenuifolia* var. *laevis, Poranthera moorokatta*, *Anigozanthos humilis* subsp. *Chrysanthus* and *Hypolaena robusta* – are located within the proposal footprint. Those within the footprint will be cleared during construction.

Individuals located adjacent of the proposal footprint will be protected through demarcation (based on a 50 m buffer) ahead of clearing as well as preparation and implementation of an EMP (see PER Chapter 8, Flora and Vegetation, Table 8.16).

Consolidated issue 148: How will the EPA's objectives be met for Priority taxa *Meeboldina decipiens* subsp. *decipiens* and *Millotia tenuifolia* var. *laevis*? More work should be done on surveying and/or translocating these taxa.

Contributing issues:

72: Likely impacts to *Millotia tenuifolia* var. *laevis* and *Meeboldina decipiens* subsp. *decipiens* are potentially significant. As well as extra surveys proposed, *Meeboldina decipiens* subsp. *decipiens* needs to be translocated e.g. to wetlands. More work needs doing.

78: Clarification is sought on how the successful implementation of the EMP regarding Priority taxa *Meeboldina decipiens* subsp. *decipiens* and *Millotia tenuifolia* var. *laevis* will result in the proposal being likely to meet the EPA's objectives.

206: Targeted survey for *Meeboldina decipiens* subsp. *decipiens* (Priority 3) should include potential habitat within Lightning Swamp Bushland and targeted surveys for *Millotia tenuifolia* var. *laevis* should include potential habitat in Whiteman Park.

(Repeated from Section 8.1)

A follow-up spring survey for *Meeboldina decipiens* subsp. *decipiens* (P3) and *Millotia tenuifolia* var. *laevis* (P2) was conducted by Woodman Environmental from 6 to 9 October 2015 (see Section 3.2).

The collections of *Meeboldina decipiens* subsp. *decipiens* from the survey were re-identified by WA Herbarium staff as *Lepyrodia muirii*, which is not a conservation significant species. The proposal no longer impacts *Meeboldina decipiens* subsp. *decipiens* (P3).

The survey identified a relatively large number of *Millotia tenuifolia* var. *laevis* individuals outside the proposal footprint. A total of 5,222 *Millotia tenuifolia* var. *laevis* individuals were recorded from eight populations in the area covered by the survey, including 1,652 individuals adjacent to (but not within) the development envelope in Cullacabardee. The proposal will impact two populations of *Millotia tenuifolia*

var. *laevis* comprising three individuals (see PER Appendix C, Level 2 Spring Flora and Vegetation Assessment). The impact is not significant at a local or regional scale due to the number of individuals identified outside the proposal footprint in Woodman's 2015 survey (see Appendix D, Spring Surveys for *Meeboldina decipiens* subsp. *decipiens* (P3) and *Millotia tenuifolia* var. *laevis* (P2)).

The draft EMP (PER Appendix F, Environmental Management Plan) contains measures to protect Threatened and Priority flora outside the proposal footprint (including *Millotia tenuifolia* var. *laevis* in Cullacabardee Bushland) from accidental disturbance and prevent the introduction and spread of weeds and dieback.

Consolidated issue 149 (contributing issue 114): The starflower species *Calytrix fraseri* Ellenbrook Form is a special form of the species and should be protected.

The *Calytrix fraseri* Ellenbrook Form is described in PER Appendix C, Level 2 Flora and Vegetation Assessment as being an unusual or unique species. This is due to its variation comprising up to 25 subspecies or variants. This taxon is not formally recognised as a Threatened or Priority species, and has been recorded from a number of survey quadrants within and outside of the proposal footprint. The *Calytrix fraseri* Ellenbrook Form was recorded in two vegetation associations (see PER Chapter 8, Flora and Vegetation, Table 8.3):

- Banksia sparse low woodland or BaBm[2], which comprises 4.9% or 147.6 ha of the study area.
- Corymbia sparse mid woodland or CcEm[2], which comprises 3.1% or 92.5 ha of the study area.

PER Chapter 8, Flora and Vegetation, Table 8.10 outlines the clearing impact of the proposal on the vegetation associations present in the study area. It is estimated that 82.2% of BaBm[2] and 70.7% of CcEm[2] will remain within the study area following clearing for the proposal. It is likely that some individuals of *Calytrix fraseri* Ellenbrook Form found within these vegetation associations will be impacted. MRWA will ensure the impact of vegetation clearance is reduced to as low as reasonably practicable and is restricted to the proposal footprint. As a large extent of both vegetation associations containing *Calytrix fraseri* Ellenbrook Form will remain, the impact on this species is not locally significant.

Consolidated issue 152: Risk from proposal to *Grevillea curviloba* subsp. *incurva* is understated. The PDNH needs to be moved further from individuals. Every effort needs to be taken to protect, and if possible re-introduce, this species in its critical habitat area.

Contributing issues:

71: Risk from proposal to *Grevillea curviloba* subsp. *incurva* is understated. The PDNH needs to be moved further from individuals. Every effort needs to be taken to protect, and if possible re-introduce, this species in its critical habitat area.

263: Please provide justification as to why a 10 m buffer is sufficient for avoiding indirect impacts to *Grevillea curviloba* subsp. *incurva* given that a 50 m buffer is proposed for *Caladenia huegelii*.

(Repeated from Section 7.3.1)

The population of *Grevillea curviloba* subsp. *incurva* is located in a 20-m-wide strip of degraded, weedy vegetation located between Brand Highway and the Midland–Geraldton railway line. The populations in this location are already confined with the distance of individuals from current active transport corridors a maximum of 10 m away.

Direct impacts to this population have been avoided through the construction of a bridge over the railway, Brand Highway and the railway/road reserve, which spans the location of this population. No section of the proposed highway will be positioned closer to individuals than the current Brand Highway.

The draft EMP (PER Appendix F, Environmental Management Plan) contains measures to protect Threatened and Priority flora from accidental disturbance and prevent the introduction and spread of weeds and dieback. The implementation of weed control measures may lead to an improvement in the condition of the *Grevillea curviloba* subsp. *incurva* critical habitat in the road reserve.

12.7.5 Study and Survey Adequacy

Consolidated issue 125: Will future/recommended surveys be conducted at Maralla Road and Halden Road?

Contributing issues:

4: Additional flora and vegetation surveys for Maralla Road. Were additional surveys undertaken? How will results be incorporated into project management documentation?

111: Will the spring surveys recommended for TECs, PECs, Threatened and Priority flora focusing on annual species at Maralla Road and Halden Road be conducted? When and by whom?

Prior to construction, a qualified ecologist will undertake a Level 2 targeted flora and vegetation survey of Maralla and Halden roads. The survey will confirm the presence/absence of TECs, PECs and Threatened or Priority flora in the area to be cleared in the road reserves. The results of the surveys will inform the detailed infrastructure plan prepared for this stage of the development (see PER Appendix F, Environmental Management Plan, Table 4.1).

Consolidated issue 126 (contributing issue 5): Timing of flora surveys for spring means flora surveys are limited.

The surveys were carried out in accordance with the ESD and EPA Guidance Statements 10 and 51. Guidance Statement No. 51 Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004b) states that surveys should be conducted following the season which normally contributes the most rainfall in the bioregion. This timing "ensures that the majority of the plant species in an area are flowering, fruiting and have foliage that allows identification. This is particularly important where ephemeral or cryptic species of interest may occur (e.g. geophytes, orchids)" (EPA, 2004b). For the proposal, located in the South-West Province, the main rain occurs in winter. The timing of the surveys in spring is consistent with this advice.

Consolidated issue 128: Clarifications regarding flora and vegetation surveys and results.

Contributing issues:

68: *Eryngium pinnatifidum* subsp. *palustre* (G.J. Keighery 13459) PN (P3) and *Verticordia serrata* var. *linearis* are not listed despite occurring in/near the area.

101: Our property was not surveyed for flora/vegetation. How can we be sure more significant species weren't missed?

102: 357 species of vascular flora taxa is probably an underestimation. Will MRWA fund additional surveys to characterise diversity of non-vascular plants and fungi, especially in the Maralla Road nature reserve?

110: *Millotia tenuifolia* var. *laevis* (P2), *Meeboldina decipiens* subsp. *decipiens* ms (P3), *Ornduffia submersa* (P4) and *Stylidium striatum* (P4) aren't mentioned in Table 8.1. Have they not been previously found? Or are they name changes?

Flora and vegetation surveys for the proposal were carried out in accordance with the proposal's ESD and EPA Guidance Statements 10 and 51 (EPA, 2004b).

The 2014 survey completed by Coffey (2015b) (see PER Appendix C, Level 2 Flora and Vegetation Assessment) covered an area of approximately 3,074 ha (the 'flora study area'), which is approximately four times larger than the proposal footprint (746 ha), to provide a broader floristic context. The flora study area followed the alignment of the proposal footprint and extended approximately 500 m from the edge of the proposal footprint in several locations south of Maralla Road. North of Maralla Road, the flora study area extended to the boundaries of the properties that the proposal footprint traverses (where access was granted).

PER Chapter 8, Flora and Vegetation, Section 8.2.1 states that the 2014 survey (Coffey, 2015b) identified a total of 456 vascular flora species from 73 families and 234 genera, while the total number of vascular taxa recorded from the three main surveys along the proposal footprint was 485 native taxa. This represents a high diversity of flora on the SCP and is higher than comparable surveys carried out in proximity to the proposal.

PER Chapter 8, Flora and Vegetation, Table 8.1 provides a list of potential Threatened and Priority flora occurring within or in proximity to the proposal footprint, based on a desktop search of relevant government databases. PER Chapter 8, Flora and Vegetation, Section 8.2.3 lists additional conservation significant species that were not identified in the desktop search but recorded during the 2014 survey including *Millotia tenuifolia* var. *laevis* (P2), *Meeboldina decipiens* subsp. *decipiens* ms (P3), *Ornduffia submersa* (P4) and *Stylidium striatum* (P4).

The desktop search identified 25 Threatened and 45 Priority-listed (two Priority 1, nine Priority 2, 21 Priority 3 and 13 Priority 4) taxa as occurring within and in proximity to the proposal footprint, including *Eryngium pinnatifidum* subsp. Palustre (G.J. Keighery 13459) PN. The known locations of *Eryngium pinnatifidum* subsp. Palustre (G.J. Keighery 13459) PN were visited during the 2014 survey but no plants were found, possibly due to it not flowering at the time of survey or becoming locally extinct. Notwithstanding, this species is considered to be present (PER Chapter 8, Flora and Vegetation, Table 8.1). *Verticordia serrata* var. *linearis* which is considered likely to be present was not recorded in surveys for the proposal which did not include private property.

No flora and vegetation surveys to characterise the diversity of non-vascular plants and fungi are proposed.

Consolidated issue 129 (contributing issue 236): Any future interchanges must be subject to thorough environmental review with surveys for flora/fauna to be more in depth than was done for PDNH.

The assessment process and the requirement for any further investigations to support future proposals including new interchanges will be subject to determination by the relevant statutory authority at the time of referral.

Flora and vegetation survey for the proposal was carried out in accordance with the ESD and EPA Guidance Statement Nos. 10 (EPA, 2006) and 51 (EPA, 2004b). The findings of this survey are presented in PER Appendix C, Level 2 Spring Flora and Vegetation Assessment. The Terrestrial fauna survey for the proposal was carried out in accordance with the ESD and the survey method was approved by the EPA and the DPAW. The findings of this survey are presented in PER Appendix G, Level 2 Targeted Fauna Assessment. The assessment of potential impacts on flora and fauna is presented in PER Chapter 8, Flora and Vegetation and Chapter 9, Terrestrial Fauna, respectively.

12.7.6 Weeds and Dieback

Consolidated issue 141 (contributing issue 74): MRWA weed control should be less procedural and more focused on outcomes, e.g. preventing weed incursion into adjacent vegetation and/or removing weeds from adjacent vegetation.

PER Chapter 8, Flora and Vegetation, Section 8.4.6 assesses the risk of introduction and spread of weeds to native vegetation located adjacent to the proposal footprint. Management of this risk during construction will be addressed through the preparation and implementation of a Weed and Dieback Hygiene Management Plan (see PER Chapter 8, Flora and Vegetation, Section 8.5). The management plan will include key objectives/outcomes and performance criteria and will be the responsibility of the contractor. During operations, MRWA will be responsible for weed control in the road reserve of the proposal.

12.8 Terrestrial Fauna

12.8.1 Black Cockatoos

Consolidated issue 85 (contributing issue 136): Black cockatoo watering sites within Dick Perry Reserve near PDNH needs to be replaced with new sites away from PDNH to lessen chance of mortalities.

MRWA will continue to work with DPAW in the preparation of an agreement, including detailed site plans and specifications, for construction of the length of the proposed highway through Dick Perry Reserve. The agreement may include removal and provision of an alternative water source for Black Cockatoos.

Consolidated issue 86: Black cockatoo surveys may have underestimated numbers due to timing and not asking local landholders.

Contributing issues:

134: Have field surveys been done during breeding season to determine black cockatoo roosting sites? Were landowners asked for local information?

226: Black Cockatoos have been sighted in increasing numbers very close to the proposal footprint. Given the PER surveys don't reflect this, the surveys appear not to have provided an accurate assessment of the species' presence. The impact may be greater.

The survey method described in PER Chapter 9, Terrestrial Fauna, Section 9.2.1 addressed the requirements of the ESD prepared by the EPA and the Referral Guidelines for Black Cockatoos (DSEWPAC, 2012) and was approved by the EPA and the DPAW.

The fauna study area was assessed and mapped to record the level of Black Cockatoo foraging, roosting and breeding habitat. The survey was conducted in September which coincides with the breeding season for Carnaby's Black Cockatoo (Johnstone and Storr, 1998). None of the species of Black Cockatoo are known to breed within the fauna study area. Their preferred breeding sites occur further to the southwest of Western Australia or in the Wheatbelt.

Consolidated issue 87 (contributing issue 133): Other options for reducing occurrences of black cockatoos at highway height.

PER Chapter 9, Terrestrial Fauna, Section 9.5.4 describes the management measures to reduce Black Cockatoo mortalities on the highway including limiting the use of Banksia and other Black Cockatoo foraging resources in revegetation planting within 10 m of the highway.

Proposed 1.8-metre-high fauna fences to be installed on both sides of the highway in areas north of Hepburn Avenue to a minimum of 100 m north of Maralla Road will also be a limited deterrent to the canopy foraging and roosting birds. Higher fences are not practical.

Consolidated issue 88: Minimisation of clearing of black cockatoo habitat.

Contributing issues:

32: Black cockatoo habitat preservation is of utmost importance. The removal of 13 breeding trees should absolutely be avoided.

62: Clearing of black cockatoo habit needs to be minimised especially in areas such as the interchange at The Promenade and behind Ellenbrook. Width of fragmented habitat is excessive. Noise walls and wire rope barriers should be used to reduce highway width.

81: The loss of 737 trees with a DBH over 500 mm and associated habitats is of considerable concern, highly significant and is not acceptable.

187: Approximately 10 large trees slightly northwest of the end of Gulf Cove in Ellenbrook should be retained. The alignment can be moved around these trees.

The proposal will not result in the removal of any known breeding trees. Impacts to Black Cockatoo habitat are addressed in PER Chapter 9, Terrestrial Fauna, Section 9.4.1.1.

PER Chapter 4, Detailed Description of Proposal, Section 4.2.3 discusses changes to the design as a result of studies undertaken as part of the PER and PER Chapter 9, Terrestrial Fauna, Section 9.5, discusses how changes to the proposal have reduced the proposal's overall impact to fauna values, including Black Cockatoos, for example:

- To avoid ecologically sensitive areas, the proposal alignment and design has been altered throughout the planning of the proposal.
- To avoid an area containing a high concentration of Black Cockatoo breeding trees, the width of the proposal footprint was reduced between Baal Street and Gnangara Road (see PER Chapter 9, Terrestrial Fauna, Figure 4.3). The updated proposal footprint design reduced the number of breeding trees cleared from 410 to 342 (a saving of 68 breeding trees).
- The proposal alignment predominantly follows existing infrastructure, cleared areas or secondary habitats, which reduces impacts to existing fauna habitats. A total of 586.4 ha or 78.6% of the proposal footprint occurs on these disturbed areas that offer little or no habitat for fauna. The proposal alignment was also moved to the western boundary of the development envelope in the vicinity of Gulf Cove, Ellenbrook to minimise impacts to high value habitat, avoid a known location of *Caladenia huegelii* and to minimise noise impacts on residents.

Where removal of habitat cannot be avoided, management measures have been proposed to reduce the impact on fauna and habitat as far as practicable (see PER Chapter 9, Terrestrial Fauna, Section 9.5). This includes restricting disturbance to the proposal footprint and delineation of the proposal footprint ahead of clearing.

Additional management measures, including the installation of rope wire barriers to reduce the proposal's overall footprint, are discussed in response to Issue 27. PER Appendix F, Environmental Management Plan includes measures to reduce impact to Black Cockatoo habitat through the development and implementation of detailed infrastructure plans for each stage of work to ensure Black Cockatoo habitat to be retained is clearly identified and demarcated before work commences.

Following revisions to the proposal described in Chapter 2, Proposal Update and reworking of spatial data, a maximum of 207.2 ha of Carnaby's Black Cockatoo foraging habitat, 120.5 ha of Forest Red-tailed Black Cockatoo foraging habitat, and 120.5 ha of breeding habitat (inclusive of 763 potential breeding trees) and 56.5 ha of roosting habitat for both species will be removed.

Offsets will address residual impacts where impacts cannot be avoided or minimised. Cleared Black Cockatoo habitat will be offset as discussed in Chapter 6, Environmental Offsets.

Consolidated issue 89 (contributing issue 33): What measures will be put in place to assess the extent of impact to Black Cockatoos?

Impacts on Black Cockatoos have been assessed in PER Chapter 9, Terrestrial Fauna, Section 9.4.1.1 and include the loss of habitat and possible temporary displacement of birds during construction.

PER Appendix F, Environmental Management Plan includes measures to reduce impact to Black Cockatoo habitat through the development and implementation of detailed infrastructure plans for each stage of work to ensure Black Cockatoo habitat to be retained is clearly identified and demarcated before work commences.

MRWA will be responsible for auditing the proposal during construction to ensure compliance with conditions. The OEPA and DOTE may conduct audits on implementation of approval conditions, including compliance with nominated buffers and clearance boundaries. Where required by the OEPA or the DOTE, MRWA will commission an independent auditor.

12.8.2 Fauna Underpasses

Consolidated issue 91: Effectiveness of fauna underpasses.

Contributing issues:

35: What is the likelihood that 100% of target species will use fauna underpasses?

202: Are fauna underpasses successful? Would all species in the area use them?

209: Is there any evidence that wildlife will use an underpass subject to noise and vibration from a highway being used by heavy traffic like the PDNH?

PER Chapter 9, Terrestrial Fauna, Section 9.5.8 describes underpass design and includes a summary of design considerations. Underpasses for this proposal were designed in line with MRWA Design of Fauna Underpass guideline (MRWA, 2010) and in consultation with a fauna underpass expert from UWA (Chambers, pers. comm.). The underpasses are designed for use by all ground dwelling fauna likely to occur in the study area.

Factors that influence the success of a fauna underpass that were considered in the design include presence of "furniture" such as logs and branches, vegetation at the openings, length, dry passage and natural flooring i.e., dirt or sediments. Limiting human access to underpasses is key to ensuring their use by fauna (Bamford, 2011).

Fauna underpasses have been successfully implemented on similar projects in the Perth region such as the Roe Highway, Kwinana Freeway and Mandjoogoordap Drive (UWA, 2013). A fauna underpass monitoring program will be developed as part of the proposal to assess their effectiveness (see PER Chapter 9, Terrestrial Fauna, Section 9.5.8).

Consolidated issue 92: Suitability of design of underpasses relative to target species.

Contributing issues:

34: Fauna underpass size may be limiting to larger animals. Can they be used by large kangaroos? Are there previous examples of successful implementation?

35: What is the likelihood that 100% of target species will use fauna underpasses?

36: Will all fauna underpasses include natural lighting throughout to ensure use by diurnal species?

126: What evidence demonstrates that 1.2 m x 3 m x 70 m fauna underpasses work for Western Grey Kangaroos, which can be 2 m tall?

203: Will there be natural lighting in fauna underpasses for daytime migrating species? If underpasses are in darkness they may not be used by all species.

PER Chapter 9, Terrestrial Fauna, Section 9.5.8 describes underpass design and includes a summary of design considerations. The underpasses were designed in line with MRWA requirements and in consultation with a fauna underpass expert. The design considers use by all ground-dwelling fauna likely to occur in the study area and natural lighting including sky lights will be used where practicable.

The results of a monitoring of existing underpasses has shown that adult Western Grey Kangaroos are able to use structures with a height of 1.2 m (Chambers, pers. comm.) and slowly move through the underpass on their haunches.

Fauna underpasses have been successfully implemented by MRWA on similar projects in the Perth region such as the Roe Highway, Kwinana Freeway and Mandjoogoordap Drive (UWA, 2013). A fauna underpass monitoring program will be developed as part of the proposal to proposal to assess their effectiveness (see PER Chapter 9, Terrestrial Fauna, Section 9.5.8).

The program will focus on underpasses on the Maralla Road Bushland and Whiteman Park/Cullacabardee ecological linkages.

Consolidated issue 93: Unauthorised uses of fauna underpasses such as rubbish dumping and illegal motorbike riding.

Contributing issues:

37: Will fauna underpasses be monitored for illegal use such as trail bikes and rubbish dumping?

38: Will fauna underpasses restrict access for motorbikes while allowing access for fauna?

196: Bollards or other devices should be installed in fauna underpasses to limit unauthorised access, e.g. from motorbikes.

199: Rubbish dumping is a problem around Maralla Road. Fauna underpasses will attract more dumping. Who will be responsible for cleaning up rubbish?

201: Underpasses will create additional problems for residents due to motorbikes using them and rubbish being dumped in them.

229: How will unauthorised human access into fauna underpasses be prevented to avoid discouraging use by fauna?

Limiting human access to underpasses is key to ensuring their use by fauna (Bamford, 2011) and has been considered in the design. PER Chapter 9, Terrestrial Fauna, Section 9.5.8 provides details of underpass design including features that encourage use by fauna.

The maximum height of underpasses for the proposal is 1.2 m, which will limit unauthorised access (e.g., trail bike riders). Fauna underpasses have been successfully implemented on similar projects in the Perth region such as Roe Highway, Kwinana Freeway and Mandjoogoordap Drive (UWA, 2013). A fauna underpass monitoring program will be developed to assess their effectiveness (see PER Chapter 9, Terrestrial Fauna, Table 15.3).

Uncontrolled access and illegal dumping of rubbish within the proposal footprint will be monitored during construction. Temporary fencing during construction and permanent fencing post construction (see PER Chapter 9, Terrestrial Fauna, Figure 9.5) will restrict access to the underpasses from the highway.

Illegal dumping of rubbish on public land including road reserves is regulated under the *Litter Act 1979*.

MRWA is also considering the installation of bollards at fauna underpass entries to further deter access.

Consolidated issue 94 (contributing issue 16): Can fauna underpasses also be placed in cleared areas?

Fauna underpasses are most effective in areas where there is vegetation in proximity to the opening (Bamford, 2011; QDMR, 2000). Fauna will be less likely to use an underpass in a cleared or open area as they will be at a higher risk of predation.

PER Chapter 9, Terrestrial Fauna, Section 9.5.8 describes underpass design and includes a summary of design considerations. Underpasses for this proposal were designed in line with MRWA requirements and in consultation with a fauna underpass expert. The final underpass designs will include revegetation close to the underpass openings using local species. A fauna underpass monitoring program will be developed as part of the proposal to assess the effectiveness (see PER Chapter 9, Terrestrial Fauna, Section 9.5.8).

Consolidated issue 184 (contributing issue 294): What monitoring and maintenance during operations will exist for revegetation? What will the measures of success be?

PER Chapter 9, Terrestrial Fauna, Section 9.5.8 describes underpass design and monitoring to be undertaken post construction. The monitoring program will assess the size of fauna populations prior to construction and continue for a minimum of one year post construction to determine the effectiveness of the underpasses. If fauna underpasses are deemed to be ineffective, remedial actions including extended rehabilitation of surrounding vegetation and installation of additional underpass furniture will be considered.

Following the completion of this monitoring program, Main Roads will conduct periodic inspections of the road and associated infrastructure. Where any damage is found, either through these inspections or other reports, the damage will be repaired as soon as practicable.

12.8.3 Impact Assessment

Consolidated issue 105: [address redacted] Maralla Road should be included in the ecological linkage corridor.

Contributing issues:

140: [address redacted] Maralla Rd should be included in the ecological linkage corridor.

198: Our land is an important contributor to the ecological linkages described in the PER. It should have been considered even though it is outside the study area.

Maralla Road Bushland is one of six ecological linkages identified in the Regional Ecological Linkage Network (see PER Chapter 8, Flora and Vegetation, Section 8.2.9 and Figure 8.5A). PER Chapter 9, Terrestrial Fauna, Section 9.2.8 and Figure 9.4A describe the importance of this link for wildlife movement. While the assessment focused on nature reserves and Bush Forever sites, it is acknowledged that remnant

vegetation along the north side of Maralla Road will contribute to ecological connectivity and support wildlife movement.

Consolidated issue 106 (contributing issue 20): Why is habitat at Lot 9 Maralla Road classified as 'modified' when it hasn't been used for agricultural or residential purposes?

Aerial photography shows that the vegetation at Lot 9 Maralla Road was cleared sometime between 1965 and 1974. This would have caused a significant modification to the original vegetation community. During ecological surveys, it was noted that the vegetation type differed significantly from adjacent native vegetation.

PER Appendix G, Level 2 Targeted Fauna Assessment, Section 5.1.5 provides a description of the 'modified vegetation' classification. Modified vegetation is classified as secondary fauna habitat i.e., it provides limited habitat for some species. Secondary fauna habitat acts as ecological linkage between areas of more suitable habitat. Modified vegetation occurs where there is disruption of original vegetation structure of the habitat due to removal of either the lower-, mid- or over-storey. Modified vegetation may occur in areas such as along roads where there has been some revegetation or may have been impacted by clearing, weeds or tracks or other evidence of human disturbance.

Consolidated issue 107 (contributing issue 28): What is the impact to species already noted as in decline?

Development of the proposal will result in loss of habitat for some fauna (mammals and birds). Fauna habitat is largely protected by minimising impacts to vegetation, avoiding Bush Forever sites and nature reserves and ecological connectivity is preserved through use of underpasses for fauna and revegetation. Some fauna will be permanently displaced by the proposal footprint and seek refuge or relocate to adjacent native vegetation. Some fauna such as birds will be temporarily displaced but will recolonise areas adjacent to the highway following construction.

The significance of impacts on fauna is assessed in PER Chapter 9, Terrestrial Fauna, Section 9.4. Impacts from the proposal are restricted to the local scale and are not expected to be significant; as such the proposal is not anticipated to alter the conservation status of any locally and regionally significant fauna.

Consolidated issue 108 (contributing issue 130): In Appendix G, column 9 in the previously recorded fauna list doesn't seem to match the location and results of trap sites list.

The results of the Level 2 Targeted Fauna Assessment are presented in Appendix E and Appendix H of PER Appendix G, Level 2 Targeted Fauna Assessment. Appendix E presents the fauna records from the six trap sites including opportunistic sightings. It does not include records from elsewhere during the fauna survey (e.g., those recorded during the Level 1 survey, fauna movement survey or targeted Black Cockatoo survey). Appendix H column 9 presents the full list of species recorded during the fauna survey (at trap sites and in other surveys). All species listed in Appendix E are recorded as 'present' in Appendix H. The only exception is the Spotted Pardalote, which was inadvertently omitted from the list in Appendix H.

Consolidated issue 118: How is it possible to justify the removal of 159 ha of natural fauna habitat?

Contributing issues:

21: Fauna habitats should be preserved as much as possible.

120: How is it possible to justify the removal of 159 ha of natural fauna habitat?

An environmental constraints assessment was undertaken on potential alignments (see PER Chapter 3, Route Selection Development, Section 3.3) and considered factors such as Bush Forever sites and conservation/ecologically sensitive areas. PER Chapter 4, Detailed Description of Proposal, Section 4.2.3

discusses changes to the design made as a result of studies undertaken as part of the PER and issues raised by stakeholders during consultation.

PER Chapter 9, Terrestrial Fauna, Section 9.5 discusses how changes to the proposal have reduced the proposal's overall impact to fauna values in particular, for example:

- To avoid ecologically sensitive areas, the proposal alignment and design has been altered throughout the planning of the proposal.
- To avoid impacts to habitat for the Critically Endangered Western Swamp Tortoise at Twin Swamps Nature Reserve, the interchange at Warbrook Road was relocated to Stock Road.
- To avoid an area containing a high concentration of Black Cockatoo breeding trees, the width of the proposal footprint was reduced between Baal Street and Gnangara Road (see PER Chapter 9, Terrestrial Fauna, Figure 4.3). The updated proposal footprint design reduced the number of breeding trees cleared from 410 to 342 (a reduction of 68 breeding trees).
- The proposal alignment predominantly follows existing infrastructure, cleared areas or secondary habitats, which reduces impacts to existing fauna habitats. A total of 586.4 ha or 78.6% of the proposal footprint occurs on these disturbed areas that offer little or no habitat for fauna.

Where removal of habitat cannot be avoided, management measures have been proposed to reduce the impact on fauna and habitat as far as practicable (see PER Chapter 9, Terrestrial Fauna, Section 9.5), including restricting disturbance to the proposal footprint, delineation of the proposal footprint ahead of clearing, the installation of fauna underpasses to assist in preserving ecological connectivity and revegetation using local native species. Offsets will address residual impacts where impacts cannot be avoided or minimised. Refer to Chapter 6, Environmental Offsets.

Following revisions to the proposal described in Chapter 2, Proposal Update and reworking of spatial data, the area of fauna habitat impacted by the proposal has been revised from 159.3 ha to 160.1 ha.

12.8.4 Impacts from Light, Noise and Vibration

Consolidated issue 95: Impacts and management of noise and vibration on fauna.

Contributing issues:

40: How will the impact of light and noise emissions on fauna be managed? Has the potential impact to wildlife in the area been assessed?

80: Potential impacts of noise and vibration on fauna has been dismissed. Many fauna are sensitive and the impact could be greater than thought.

172: Façade treatment will not reduce exterior noise and will impact fauna. Can thick vegetative buffers be considered?

210: It is not clear what impact ground vibration will have on wildlife in the area.

The impacts of light and noise on fauna are discussed in PER Chapter 9, Terrestrial Fauna, Section 9.4.6.

Studies of the impacts of light, noise and vibration on fauna are not extensive. Noise, vibration and light may result in disturbance or displacement of fauna and disrupt their natural behaviour. For example, noise (and vibration) can disturb roosting bats and birds and affect bats, birds and frogs which use noise to communicate and/or hunt. Artificial lighting can affect the behaviour of nocturnal fauna and will attract insects that are a food source for some fauna.

Construction will cause temporary displacement of fauna until some species assimilate to the changed acoustic environment and return to habitat adjacent to the highway. More sensitive and reclusive fauna

may be permanently displaced from the area adjacent to the highway, as they seek refuge in larger tracts of remnant vegetation.

Vibration impacts will be higher during construction due to piling activities and vibratory rollers. Vibration impacts during operation will be insignificant.

Measures to manage the impacts of light on fauna have been discussed in PER Chapter 9, Terrestrial Fauna, Section 9.5.6 and noise and vibration measures are presented in PER Chapter 11, Amenity (Noise and Vibration), Section 11.7 and Table 11.3. During construction, all works will be carried out in accordance with AS 2436:2010 Guide to Noise and Vibration control on Construction, Demolition and Maintenance Sites.

12.8.5 Management During Construction Only

Consolidated issue 109 (contributing issue 121): Clearing should be able to avoid mortalities in local vertebrates. Clearing should be done slowly and carefully to prevent mortalities.

MRWA is committed to minimising the number of fauna mortalities associated with vegetation clearing (see PER Chapter 9, Terrestrial Fauna, Section 9.5). A construction EMP will be developed and implemented to manage impacts during clearing and reduce the potential for fauna mortalities. The plan will include measures such as clearing outside of spring wherever possible, implementing a fauna trapping and relocation program prior to clearing activities, using fauna spotters during clearing activities and carrying out clearing progressively and in a way that directs escaping fauna away from clearing activities to adjacent vegetation.

Consolidated issue 110 (contributing issue 127): What staging measures will be put in place during construction to prevent the halting of fauna movements at all times?

Construction activities including vegetation clearing, road reserve fencing, road work and noise will displace fauna from the proposal footprint. The linear nature of construction activities precludes providing temporary access for fauna. Notwithstanding this, some fauna will cross the proposal footprint during construction. As revegetation establishes following construction, fauna are expected to explore and commence using underpasses.

The proposal is likely to be constructed in stages which will reduce the length of the proposal footprint and duration of time fauna is excluded from a particular area (see PER Chapter 4, Detailed Description of Proposal, Section 4.1). The typical construction timeframe for a stage is 2 to 3 years.

Consolidated issue 111 (contributing issue 137): *Merops ornatus* (Rainbow Bee-eater) is likely to occur but the nests will be at risk from construction. Will construction cease if nesting birds are noticed along or near Maralla Road?

A construction EMP will be developed and implemented to manage impacts to fauna (including the Rainbow Bee-eater) during construction (see PER Chapter 9, Terrestrial Fauna, Section 9.5).

The construction EMP will include a requirement to clear outside spring wherever possible to minimise impacts on to the breeding cycle of resident fauna (including nesting birds). It will also include a requirement for a fauna spotter to be on site during clearing activities (see PER Appendix F, Environmental Management Plan, Table 4.2). Any evidence of nesting Rainbow Bee-eaters will be recorded, demarcated and temporarily avoided until the birds have left the nest.

12.8.6 Management During Construction and Operation

Consolidated issue 112 (contributing issue 122): Will MRWA erect warning signs along the roadside about wildlife crossing, and provide wildlife rescue contact details?

MRWA will erect warning signs about wildlife crossing where there is a road safety issue. Fauna fencing and underpasses will reduce the potential for fauna to enter the road reserve and hence fauna warning signs are unlikely to be required.

MRWA has published the following information on its website to facilitate the recovery and care of fauna injured on its road network: "Call the Wildcare Helpline on 9474 9055 for sick, injured or orphaned native wildlife."

Consolidated issue 113: Roadside fencing.

Contributing issues:

128: Will the roadside fencing be kangaroo proof?

164: Will roadside fences be built into the ground and at a height of 1.8 m as recommended?

228: Roadside fencing height of 1.2 m is inadequate to prevent kangaroos and other animals getting past. Fencing should be 1.8 m minimum in all areas along bushland and wetlands. Fencing repair and monitoring must be ongoing.

PER Chapter 9, Terrestrial Fauna, Section 9.5.4 and Figure 9.5 provide details and shows the location of fauna fencing designed to restrict medium to large ground-dwelling fauna (including kangaroos) from accessing the highway. The fauna fence design is consistent with MRWA Drawing No. 200331-110; i.e., 1,800 mm high and 500 mm below ground level. The fence is designed to guide fauna to safe crossing points at the fauna underpass locations.

Where any damage is found, either through MRWA inspections or other reports, the damage will be assessed and repaired as soon as practicable.

Consolidated issue 114 (contributing issue 83): Are the proposed fauna escape ramps better than one-way fauna gates as found on some other projects?

Fauna escape ramps or gates (one-way devices that allow trapped animals safe egress from the road) will be installed every 200 m in sections of the alignment with fauna fencing to allow trapped animals egress from the road reserve (see Chapter 13). The ramps or gates are designed to prevent fauna access in the wrong direction i.e., to prevent fauna from entering the road reserve.

The effectiveness of ramps and one-way gates as escape strategies from road reserves depends on the design. One-way gates need to be large enough to accommodate the largest animal to use them and some fauna are known to be able to bypass the one-way design of the gates. Escape ramps resemble natural topography and can be vegetated with native plants to encourage use by fauna. In a study on the effectiveness of escape ramps and one-way gates in the United States of America, earthen ramps were found to be 8 to 11 times more effective than steel gates for large-hooved mammals (Bissonette and Hammer, 2000).

Consolidated issue 115 (contributing issue 147): The indirect impacts to fauna habitats discussed in Section 9.3 are unacceptable. Alterations to hydrology resulting in habitat destruction should be mitigated to prevent damage to wetlands.

Impacts to hydrology are predicted to be localised and temporary in nature during construction due to management measures aimed at maintaining hydrological connectivity across the proposed highway.

Culverts and bridges will be constructed on existing drainage lines to maintain flow during operation in watercourses and to wetlands fed by the watercourses.

Potential impacts to habitat from changes to hydrological conditions is described in PER Chapter 9, Terrestrial Fauna, Section 9.4.7, and in more detail (specifically with regard to wetlands) in PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality. Proposed management measures are detailed in PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.5. A Wetland Management and Monitoring Plan will be developed and implemented including groundwater monitoring to ensure impacts to wetlands (and Ellen Brook) are being appropriately managed and there are no unforeseen impacts (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.5). Edge effects could extend up to 10 m into remnant vegetation from the cleared area. The extent of edge effects will be ameliorated by revegetation and weed control in the road reserve. The Weed and Dieback Management Plan will control the introduction and spread of weeds and dieback during construction (see also response to consolidated issue 153). Ongoing maintenance of the road reserve will include inspection for, and control of weeds, during operation.

Uncontrolled access within the proposal area will be monitored during construction to reduce the risk of fire and illegal dumping of rubbish. Temporary fencing during construction and permanent fencing post construction (see PER Chapter 9, Terrestrial Fauna, Figure 9.5) will restrict access from the highway. Fauna underpasses have also been designed to limit human use (see PER Chapter 9, Terrestrial Fauna, Section 9.5.8).

Consolidated issue 116 (contributing issue 132): Will MRWA be proactive in removing animal carcasses from the PDNH to prevent impacts to carrion predators such as the Wedge-tailed Eagle?

Animal carcasses will be removed where they pose a road safety issue.

12.8.7 Monitoring

Consolidated issue 101 (contributing issue 125): What maintenance during operations will exist for underpasses, escape ramps, fences, logs, furniture and revegetation?

A fauna underpass monitoring program will be developed as part of the proposal to assess their effectiveness (see PER Chapter 9, Terrestrial Fauna, Section 9.5.8). The program will focus on underpasses on the Maralla Road Bushland and Whiteman Park/Cullacabardee ecological linkages.

During operation, MRWA will conduct periodic inspections of the highway and associated infrastructure in accordance with their maintenance program. Where any damage is found, either through these inspections or other reports, the damage will be assessed and repaired as soon as practicable.

12.8.8 Study and Survey Adequacy

Consolidated issue 96: Surveys for invertebrates were not extensive enough.

Contributing issues:

26: Desktop fauna survey records only 4 invertebrate species. Invertebrates should have been considered properly.

139: Invertebrates have not been surveyed extensively enough in the proposal footprint. Will MRWA help fund an extensive invertebrate survey?

195: Extent of invertebrate studies was non-existent or extremely limited. Invertebrates have a role in other processes, e.g. pollination. The view that insects are unimportant is unacceptable and outdated.

The fauna survey method (PER Chapter 9, Terrestrial Fauna, Section 9.2.1) addresses the requirements of the ESD prepared by the Environmental Protection Authority (EPA). The OEPA and the DPAW were consulted on the survey method.

PER Chapter 9, Terrestrial Fauna, Section 9.2.4 states:

> *Conservation significant invertebrates and fish species identified in the desktop assessment were assessed on their likelihood of occurrence in the fauna study area based on the habitats present, current distribution and relevance of previous records. The* [former] *DEC conducted a terrestrial invertebrate biodiversity assessment for the GSS* [Gnangara Sustainability Strategy]*, which identified three conservation significant invertebrates as currently occurring on the northern SCP (Wilson and Valentine, 2009). Of these, only the Priority 4 listed Graceful Sun Moth (*Synemon gratiosa*) occurs in close proximity (within 10 km) of the proposal footprint.*

Potential short-range endemic (SRE) habitat (predominantly associated with invertebrates) was identified at the Mound Springs SCP TEC. The proposal avoided this site and there will be no impact on this community and habitat. No specific SRE survey was required to comply with the ESD.

The role of the thynnid wasps in pollinating *Caladenia huegelii* is understood and addressed in the discussion of potential impacts on this species (see response to consolidated issue 135 in Chapter 12, Response to Issues Raised by the Public, Section 12.7.1).

Consolidated issue 97: Study, survey and trapping procedures were inadequate. Richness of extant fauna is not captured in surveys.

Contributing issues:

25: Fauna assessment is inadequate because it does not consider arboreal and bird species, underestimating species diversity. Some species of reptiles, micro bats, invertebrates, birds not properly considered. Local extinctions could result.

27: Study, survey and trapping procedures were likely inadequate. Why were trapping nights not conducted across all four seasons?

194: The timing and duration of the surveys do not adequately represent the richness of fauna that longitudinal studies would have provided.

215: Surveys for flora and fauna, but especially birds, reptiles and invertebrates, was not comprehensive enough. Species have been overlooked because of the limited scope of surveys. How can the real impacts be known?

266: It is unclear if all fauna records from all surveys in the study area have been considered, or if only the results in the Level 2 Targeted Fauna Assessment by Coffey have been considered.

(Repeated from Section 7.4)

The fauna assemblage of the SCP is well documented with numerous systematic surveys completed in recent history (Government of Western Australia, 2000). The survey method (PER Chapter 9, Terrestrial Fauna, Section 9.2.1) addressed the requirements of the ESD and was approved by the EPA and DPAW.

A total of 97 species were recorded during these surveys, all of which were identified as potentially occurring in the desktop assessment. The number of fauna species recorded during the survey is comparable with other surveys completed in the vicinity and typical of the habitats present within the study area. For example, of the 232 birds identified during the desktop assessment, 62 of these were positively recorded during the surveys (PER Appendix G, Level 2 Targeted Fauna Assessment, Table 5.4).

The term ‘fauna assemblage’ is used throughout the PER to describe the large number of species previously recorded. Fauna assemblage includes birds, arboreal mammals, bats, reptiles and invertebrates.

As the proposal’s impacts to the fauna assemblage are expected to be localised, the PER focuses on impacts on conservation significant fauna, particularly those species confirmed to be present during the survey along with any other conservation significant species identified during the desktop assessment which were considered likely to occur within the proposal footprint (see PER Chapter 9, Terrestrial Fauna, Section 9.2.5).

12.8.9 Study and Survey Scope

Consolidated issue 98 (contributing issue 131): There are no comprehensive lists of birds in the survey site. Some species are not mentioned. Will MRWA fund bird surveys in the proposal area?

The fauna survey method (PER Chapter 9, Terrestrial Fauna, Section 9.2.1) addresses the requirements of the ESD prepared by the Environmental Protection Authority (EPA). The OEPA and the DPAW were consulted on the survey method.

The desktop assessment of State and Commonwealth databases, regional and local contextual data and existing biological surveys identified approximately 360 species of fauna (including 232 birds) previously recorded in the vicinity of the proposal footprint. The Red-winged Fairy-wren (*Malurus elegans*) was previously recorded in the study area by Birdlife Australia but has not been recorded in any recent surveys including those conducted for the PER. The list of birds previously recorded in the study area is provided in PER Appendix G, Level 2 Targeted Fauna Assessment, Appendix H. The Level 1 opportunistic survey and Level 2 targeted survey conducted as part of the PER recorded 62 birds including three conservation significant birds, Carnaby's Black Cockatoo, Forest Red-tailed Black Cockatoo and the Australian Bustard.

No additional bird surveys are proposed.

Consolidated issue 99 (contributing issue 138): Jewelled Sandplain Ctenotus (*Ctenotus gemmula*), Black striped snake (*Neelaps calonotos*) and Western Brush Wallaby (*Macropus irma*) do occur within the proposal footprint, despite being stated as 'likely' to occur.

The nominated species were identified as ‘likely’ to occur in the study area based on the availability of suitable habitat and records close to the study area (see PER Appendix G, Level 2 Targeted Fauna Assessment, Section 5.5). Despite not being recorded in surveys conducted for the PER, they were assumed to be present and potential impacts on these species were assessed (see PER Chapter 9, Terrestrial Fauna, Section 9.4, specifically Sections 9.4.1.9 (Jewelled Sandplain Ctenotus), 9.4.1.10 (Black striped snake) and 9.4.1.12 (Western Brush Wallaby).

Consolidated issue 100 (contributing issue 39): Why were properties outside the study area not surveyed?

PER Appendix B, Environmental Scoping Document states that the PER should identify the values and significance of fauna, fauna habitat and habitat connectivity within the development envelope and immediate adjacent area. Properties not directly impacted by the proposal were not included in the terrestrial fauna survey. The search of historical records done as part of the Level 2 fauna survey informed the areas targeted for trapping. These areas included corridors that were important for the maintenance of ecological connectivity. OEPA and DPAW were consulted on the survey method.

12.8.10 Translocations

Consolidated issue 102: Fauna translocations during the construction phase.

Contributing issues:

15: Will funds be available to support wildlife carers with animals injured as a result of the construction of the proposal?

29: Provide details on fauna translocations prior to construction, viz. who will do it, where will animals be relocated to, what is the minimum distance, what about other animals, what about injured fauna?

123: What measures will be adopted during construction to monitor and remove species that can be relocated? What support will MRWA provide for ongoing monitoring of relocated fauna to determine relocation success?

124: What support will MRWA give to wildlife carers who have to care for injured and orphaned animals that result from extensive habitat destruction and relocation of adult females?

Fauna spotters (qualified zoologists) will be present during vegetation clearing. Ground-dwelling fauna will be trapped, other fauna will be captured. Trapped and captured fauna will be relocated to adjacent comparable habitat outside the proposal footprint (see PER Chapter 9, Terrestrial Fauna, Section 9.5.4), in accordance with a *Wildlife Conservation Act 1950* (WC Act) Regulation 15 Licence to take fauna for education or public purposes (fauna relocation and/or education). Injured fauna will be taken to an authorised veterinarian or wildlife carer.

Consolidated issue 103 (contributing issue 31): Will the relocation of fauna account for breeding patterns, e.g. the monogamous nature of the lizard *Tiliqua rugosa*?

The Bobtail Skink (*Tiliqua rugosa*) was recorded in multiple surveys in the vicinity of the proposal (see PER Appendix G, Level 2 Targeted Fauna Assessment, Appendix H) and is assumed widely distributed in adjacent areas such as Whiteman Park. Translocation of particular species (e.g., *Tiliqua rugosa*) will target suitable adjacent habitat avoiding segregation of individuals trapped or captured in the vicinity.

Consolidated issue 104 (contributing issue 30): Who is responsible for detecting and reducing disease in fauna? Will trapping personnel identify diseased animals and prevent its spread?

Injured (ill or diseased) fauna trapped or captured by fauna spotters during construction will be taken to an authorised veterinarian or wildlife carer who will be able to identify infectious diseases and recommend appropriate treatment.

12.9 Hydrological Processes and Inland Waters Environmental Quality

12.9.1 Acid Sulfate Soils

Consolidated issue 62: Management of acid sulfate soils (ASS).

Contributing issues:

154: How will ASS be managed?

238: Recommendations in the PER regarding further investigations to inform specific management of ASS are generally consistent with DER guidelines as applicable to large-scale linear projects.

(Repeated from Chapter 10)

DER noted "recommendations in the PER regarding further investigations to inform specific management of acid sulfate soils are generally consistent with DER guidelines as applicable to large scale linear projects."

Following final design and the definition of likely soil disturbance, a detailed ASS investigation will be undertaken to inform the development of an ASS Management Plan. PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Table 10.9 outlines proposed management strategies including the use of spread footings in final design where sands are deemed suitable to support structures at raised interchanges, to minimise the extent of any anticipated disturbance to ASS.

12.9.2 Dewatering and Water Abstraction

Consolidated issue 66 (contributing issue 144): The Water Corporation bores impacted by PDNH should be decommissioned.

MRWA will continue to liaise with the Water Corporation and DOW in relation to impacts to production bores and well head protection zones. The establishing and decommissioning of groundwater production bores is the responsibility of the Water Corporation. The licensing of groundwater bores and allocation of groundwater is the responsibility of the DOW.

Consolidated issue 77: Impacts from and management of dewatering and groundwater abstraction.

Contributing issues:

49: How close to wetlands 8800 and 8801 will dewatering take place? What limits will there be on dewatering? How will dewatering impacts to wetlands be managed?

94: Dewatering during construction doesn't mention the impact to local residents that rely on groundwater for domestic/stock water.

145: Wetlands are already dry and construction dewatering, as well as subsurface compaction, must be minimised.

155: How will dewatering and water abstraction be monitored and addressed? In particular: abstraction rates, bore operating regimes, hydrogeology of bores, impacts to environmental values from drawdown, and existing groundwater licences.

204: During construction will there be dewatering near Maralla Road? If so, how will dewatering be managed especially with regard to wetland CCW 8800 and *Caladenia huegelii*?

230: How has construction water allocation been licensed properly? How has existing local overallocation of water been accounted for?

231: Will there be monitoring of the environments likely to be affected by water abstraction during construction?

242: That the potential for indirect impacts on wetlands be minimised by restricting to summer months, the construction of footings for bridges and utility services at locations where dewatering would be likely to lower the water table in CCWs.

243: The potential for indirect impacts on wetlands should be minimised by managing drawdown associated with extraction bores in the vicinity of CCWs to maintain groundwater at depths that will not result in significant impacts on wetlands.

(Repeated from Section 8.3)

Where practical, construction of bridge footings will be scheduled during summer to avoid or minimise dewatering requirements. If dewatering is required, dewatering methods (e.g. well-point spears) that

minimise the radius of influence in confirmed areas of ASS and on sensitive receptors (e.g. wetlands) will be utilised (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.5). A dewatering licence will be obtained from the DOW under the RIWI Act for any dewatering activities undertaken.

If works are undertaken during the wet season construction dewatering will potentially be required at eight locations to enable bridge footing construction. Of these eight locations, only two locations (Reid/Tonkin interchange and Stock Road interchange) have wetlands within the modelled drawdown radius of influence of up to 500 m (see PER Appendix L, Position Paper – Groundwater Level Impact from Construction Dewatering and Groundwater Abstraction, Table 1). Dewatering, if required, is expected to last up to six weeks.

MUW 8785 and MUW 8784 (former EPP Lake 450) are located adjacent to the Stock Road interchange. These wetlands have been degraded by clearing and grazing. Wetlands CCW 15028 and a large part of CCW 15033 will be removed to construct the Reid/Tonkin interchange (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.4.6.3). No bridge structures or dewatering is proposed at Maralla Road in the vicinity of wetlands CCW 8800 and Resource Enhancement Wetland (REW) 8801 or *Caladenia huegelii* habitat.

The requirement for dewatering was determined based on a review of groundwater levels in existing bores (including DOW Gnangara Mound bores) reported over a period of 40 to 50 years, which was undertaken as part of the design groundwater level study for the proposal (Golder, 2015a, b, c). Groundwater data collected over this period indicates the seasonal variation (wet season to dry season) in groundwater ranges between 1.0 m and 2.0 m. Hydrographs of the bores showed two periods of step change in groundwater levels, one associated with development of the Gnangara Mound as a public drinking water source and the other associated with the installation of subsoil drains to enable land development.

Construction of the proposal will require a supply of water for construction purposes at various locations along the alignment. Abstraction will be temporary and associated with each stage of development. While construction water requirements will not be known until detailed final design work has been carried out, construction water is likely to be sourced from existing bores in accordance with existing licences where possible. Should existing bores or licences be unavailable, new bores may need to be constructed and licenced in accordance with DOW requirements (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.4.4.2). The DOW considers existing groundwater user licence allocations during the licence application process.

The location and number of construction water abstraction bores proposed to be used (new and existing) will be assessed against a detailed hydrogeological model. Hydrogeological modelling will account for the proposed parameters of the bore as well as the hydrogeology of the proposed bore site. Preferentially, each construction water bore required will be sited such that no wetlands are located within the modelled drawdown radius of influence for the bore, thereby avoiding indirect hydrological impacts to wetlands as a result of drawdown. Where it is not possible to site a bore such that no wetlands occur within its drawdown radius of influence, the operating parameters of bores will be limited such that modelled changes to groundwater levels at wetlands remain within usual seasonal variations for those wetlands (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.4.6.3). Any impact to wetlands from drawdown is expected to be short-term and localised.

Step changes in groundwater levels as a result of construction (including dewatering and water abstraction) will be detected by a groundwater monitoring program as part of a WDMMP to protect public drinking water supply and to protect wetlands. The information presented in Golder (2015a, b, c) will be used to set trigger levels for the target aquifers and wetlands. The WDMMP will be prepared in consultation with DPAW and the OEPA.

A dewatering management plan (including ASS management) will also be developed and implemented in support of any application for dewatering and a groundwater licence operating strategy will be developed and implemented as necessary to support the supply of construction water. These plans will include monitoring of abstraction rates. Opportunities for alternative construction water sources will also be investigated during project delivery.

12.9.3 Drainage Strategy

Consolidated issue 67: Will Saw Pit Gully definitely be used for outlet flow during flood overtopping events?

Contributing issues:

170: Will Saw Pit Gully definitely be used for outlet flow during flood overtopping events?

248: How will pollution be prevented and water quality in Saw Pit Gully be maintained?

Drainage will be designed to integrate with natural drainage lines to maintain existing hydrology/surface flow to watercourses and wetlands. Drainage features will be designed to prevent flooding of the highway carriageways and by necessity include overflow or spillway structures to discharge flood flows to adjacent watercourses or drainage lines including Saw Pit Gully. Proposed bio-retention drains adjacent to Saw Pit Gully will manage typical flows protecting wetlands associated with the watercourses (see PER Appendix H, Drainage Strategy, Appendix A, Major Event Flow Paths, drawing NLWA-00-DR-SK-0009 – Saw Pit Gully is the second waterway north of Maralla Road). The drainage strategy including details of bio-retention drains is set out in PER Appendix H, Drainage Strategy.

Consolidated issue 68: Use of infiltration systems in palusplain zone and just north of Maralla Road.

Contributing issues:

165: Figure 3 of Appendix H demonstrates an arbitrary division of the project site into different zones. The southern border of the palusplain section should not start until the actual palusplain starts.

171: The generalisation about infiltration systems not being appropriate for the palusplain zone does not apply just north of Maralla Road. Should infiltration systems be considered for this area instead?

The palusplain zone extends north from between Maralla Road and Warbrook Road to Muchea. The area just north of Maralla Road is transitional between the P1 and palusplain zones. PER Appendix H, Drainage Strategy, sections 10.3 and 10.4 set out the strategy for managing drainage in these zones respectively.

Infiltration mechanisms have been selected to ensure the key drainage objectives can be met including flood mitigation, protection of the Gnangara Groundwater Mound, wetlands and Ellen Brook.

Grassed swales leading to bio-retention swales are the preferred drainage strategy at this location. Hydrological connectivity is provided by culverts on watercourses and drainage lines. PER Appendix H, Drainage Strategy, Appendix A, Drawing NLWA-00-DR-SK-0009 shows the location of grassed swales, bio-retention swales and basins, and culverts at this location.

12.9.4 Impact Assessment

Consolidated issue 71 (contributing issue 96): How will unsurveyed Mound Springs on property be impacted by PDNH? Who will fix any impacts?

All known Mound Springs within the flora study area were surveyed and the alignment of the proposal designed to avoid impacts to these springs. No mound springs have been identified in the vicinity of Cooper Road and Stock Road (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Figure 10.2D). Mound Springs west of the proposal are located upstream of the alignment and so

are unlikely to be impacted, as discussed in PER Chapter 10, Hydrological Processes and Inland Water Environmental Quality, Section 10.4.8.

A WDMMP will be developed as part of the EMP. The plan will include monitoring of the closest known occurrence of Mound Springs SCP TEC at Gaston Road, which is located upstream of the proposal. Monitoring will ensure impacts to the Mound Spring SCP TEC are identified and appropriately managed.

The location of mound springs that may represent the TEC Community Tumulus Mound Springs of SCP outside the flora study area (which encompasses the development envelope) can be discussed with the DPAW for further investigation and management, and consideration for listing at the state and federal levels as an additional occurrence.

Consolidated issue 72 (contributing issue 166): Credibility of referencing R. Froend et al. in estimating effects of climate change and Ellenbrook drawdown on local wetland vegetation.

The comment is noted. PER Appendix I Wetland Assessment sourced ecological water requirements (EWR) from the DOW's Perth Shallow Groundwater Systems Investigation: Lexia Wetlands (DOW, 2011), which considers a range of information sources including but not limited to Froend et al. (2004a, b).

Consolidated issue 73 (contributing issue 149): What evidence shows that 50 m is a large enough buffer between laydown areas and wetlands?

Laydown areas will be located as far as possible from sensitive environmental values including at least 50 m from WHPZs, CCWs, Mound Springs SCP TECs and Claypans of the SCP TEC. Where hazardous materials (predominantly diesel fuel) are stored at laydown areas they will be stored in protected tanks or cabinets and bunds. Spill response kits will be available at all fuel and chemical storage sites.

Guideline for the Determination of Wetland Buffer Requirements (WAPC, 2005) provides guidance on buffers to protect wetlands from direct and indirect impacts. The recommended buffers are the distances considered necessary to achieve the maintenance of wetland function and conservation of attributes including habitat value and aesthetics. The guideline recommends a 100 m buffer to CCW and a 50 m buffer to REW to protect these wetlands from weed invasion and edge effects and to protect wetland birds, while Guidance Statement 33, Environmental Guidance for Planning and Development (EPA, 2008) recommends a minimum 50 m buffer.

The alignment of the proposed highway has been designed to avoid wetlands to the greatest extent possible, noting that the drainage system is typically west to east across the proposed north–south road. Van Etten (2014) studied edge effects from a road through Banksia woodland and Melaleuca dominated damplands. The road southeast of Perth provides a useful facsimile for the effects that might be experienced along the proposed highway.

Van Etten (2014) concluded that the maximum edge effects on damplands after 10 years could be in the order of 20 to 40 m (predominantly due to dieback and physical damage) with no management. Van Etten noted that with management, edge effects on damplands (mainly from weed invasion) could be in the order of 3 m after 10 years.

The proposed 50 m buffer to wetlands (CCW and REW) is appropriate for laydown areas. Two of the proposed management measures include protecting wetlands from accidental spills through procedures for the transport, storage, handling and disposal of hazardous materials, surface water management and an emergency spill response procedure to be developed in consultation with emergency services. The proposed management measures will reduce the extent and severity of potential edge effects associated with laydown areas on wetlands and achieves the desired outcomes – maintenance of function and protection of habit.

The drainage strategy (PER Appendix H, Drainage Strategy) includes bio-retention swales and basins to assist in the removal of contaminants through settling, filtering and biological action before discharge to the environment. Bio-retention swales and basins will be installed near wetlands.

A WDMMP will also be developed and implemented, including a groundwater monitoring procedure, to ensure impacts to wetlands are being appropriately managed (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.5).

Consolidated issue 74 (contributing issue 142): How is the partial loss of wetland EPP Lake No. 450 justified?

Former EPP Lake 450 is mapped in association with MUW 8785 and is located adjacent to the Stock Road interchange. The location of the Stock Road interchange is constrained by various wetlands and local road network. The proposal has been aligned to avoid impacts to wetlands as much as possible in this area as depicted in PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Figure 10.2D.

While impacts to former EPP Lake 450 were unavoidable, the impact was minimised through design. A minor portion (0.04 ha) of this EPP Lake will be affected by construction of the interchange. This former EPP lake was mapped in association with MUW 8785, the condition of which is generally degraded as a result of the large-scale clearing, cattle grazing and declared weeds (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.4.6.2).

Natural flow through the wetland and under the proposal will be maintained by a culvert constructed along the natural drainage line (see PER Appendix I, Wetland Assessment, Section 8.3.2 and PER Appendix H, Drainage Strategy, Drawing NLWA-00-DR-SK-0010, Major Flow Paths Sheet 10).

MRWA notes that the EPP Lakes Policy was revoked on 20 November 2015 and as a result EPP Lakes are no longer recognised. However, MRWA is committed to preparing and implementing a WDMMP, which includes a groundwater monitoring procedure to detect changes in groundwater levels, to ensure impacts to wetlands are being appropriately managed.

Consolidated issue 75: Impacts to and management of CCW 8800.

Contributing issues:

146: What specific management of key threatening processes to wetland CCW 8800 will be put in place?

150: Will wetland CCW 8800 be considered as a special case to ensure it is fully protected or ignored because it is 'not in the proposal area'?

205: The impacts to wetland CCW 8800 are opposed. There should be a buffer of 50 to 100 m from the PDNH road reserve. There does not appear to be a buffer.

CCW 8800 is located within 28 m of the proposal footprint; it will not be directly impacted by the proposal (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Table 10.6 and Figure 10.2). This section of the proposal was aligned to avoid and minimise impacts to CCWs as much as possible (including CCW 8800, CCW 8798 and CCW 8926), but could not be located further away from CCW 8800 due to existing development constraints to the south (Ellenbrook).

The proposal will be managed in accordance with the Drainage Strategy to ensure hydrology and hydrogeology (quantity and quality) of all CCWs and REWs adjacent to the highway are maintained (PER Appendix H, Drainage Strategy). The Drainage Strategy includes a bio-retention basin between the proposal and CCW 8800. Stormwater from the highway will be directed to the bio-retention basin to assist in the removal of contaminants through settling, filtering and biological action before discharge to the

environment (PER Appendix H, Drainage Strategy, Drawing NLWA-00-DR-SK-0009, Major Flow Paths Sheet 8).

Further information relating to the management of dewatering impacts on CCW 8800 is provided in Consolidated issue 78 and for information about the management of weeds and dieback refer to Consolidated issue 140.

MRWA is committed to preparing and implementing a WDMMP, which includes a groundwater monitoring procedure to detect changes in groundwater levels, to ensure impacts to wetlands (and GDEs/vegetation mapped in association with these wetlands) are being appropriately managed.

Consolidated issue 84 (contributing issue 143): The loss of CCWs is unacceptable. Impacts could be lessened through use of bridges or diverting the PDNH alignment around the wetlands.

There are two possible engineering solutions, avoidance/diversion and bridging. The proposal has been aligned to avoid and minimise impacts to a number of REWs and CCWs, particularly north of Maralla Road where the proposal is less constrained with regard to existing development (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Figure 10.2).

Significant hydrological values which have been avoided in the development of this proposal include Mound Springs SCP TEC at Gaston Road, Claypans of the SCP TEC, one CCW (unique feature identifier (UFI) 8914) and three REWs (UFIs 8916, 8915 and 8541). The interchange at Warbrook Road was also relocated to Stock Road to avoid potential impacts on Twin Swamps Nature Reserve. In addition, 2.8 ha of CCW and 4.5 ha of REW within the development envelope have been avoided by the proposal footprint (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.5).

As detailed in the PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.4.6.1, Table 10.6, 7 CCWs, 4 REWs and 14 MUWs occur within the proposal footprint and will be directly impacted by the proposal. Installation of bridges to minimise impacts, particularly in areas of key ecological linkages was found to not be a feasible option taking into consideration cost and implications for noise and visual amenity. With regard to the specific wetlands raised in the submission, the following is noted:

- CCW 8773 and 8909 – Avoidance of these wetlands was not possible due to interchange configuration.
- CCW 13096 and 15033 – Impact to these wetlands is unavoidable as they are within the Reid/Tonkin/proposal interchange footprint, which is constrained by existing development.
- CCW 8792 – The proposal has been situated adjacent to Ellenbrook estate to minimise fragmentation impacts on conservation estate. It is not possible to realign the proposal to avoid this wetland.
- CCW 8404 – The proposal could not be realigned within MUW 8442 and MUW 8444 as they are within a significant power transmission corridor. Realigning the proposal within this corridor is not possible due to the risk to power transmission infrastructure and the potential for induced current on road traffic from the transmission line. Whilst it is desirable to place infrastructure such as roads, power and water into the same corridor, these infrastructure types are not always compatible land uses and require separation distances in order to operate safely and efficiently.
- CCW 8800 and 8801 – The proposal will have no direct impact on these wetlands.

12.9.5 Management of Surface Water

Consolidated issue 64: How will spills and runoff be managed to protect wetlands and groundwater during construction and operation phases?

Contributing issues:

45: What measures will be implemented to minimise pollutant runoff to wetlands 8800 and 8801?

94: Dewatering during construction doesn't mention the impact to local residents that rely on groundwater for domestic/stock water.

95: How will accidental chemical spills be managed prior to construction of settlement basins and silt curtains?

167: What engineering solutions will be used to maintain maximum groundwater levels and flow during construction and operation, and prevent pollution of groundwater by inevitable fuel and chemical spills?

169: What will be done to prevent ongoing runoff and spill incidents polluting the local potable groundwater supply?

212: How will spills from trucks on PDNH be managed to prevent contamination and pollution of groundwater and wetlands?

247: How will pollution from spills be prevented?

Management measures for spills and runoff during construction and when the highway is operational are set out in PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.5 and Table 10.9. They include measures relating to the generation, storage, handling and release of pollutants, surface water management and an emergency spill response procedure (developed in consultation with emergency services). The measures will be included in an EMP which will incorporate a WDMMP and an Emergency Response Plan (PER Appendix F, Environmental Management Plan, Tables 4.2 (management) and 5.1 (performance monitoring).

CCW 8800 and 8801 located west of the development envelope and north of Maralla Road will be protected by bio-retention basins to assist in the removal of contaminants from highway runoff through settling, filtering and biological action before discharge to the environment. Overflow from the basins will drain to the wetlands, as indicated in PER Appendix H, Drainage Strategy, Appendix A, Major Event Flow Paths, drawing NLWA-00-DR-SK-0009.

Laydown areas and stockpiles (including storage of hazardous materials and refuelling activities) will be located outside wellhead protection zones and at least 50 m from all CCW and REW wetlands, Mound Springs SCP, TEC and Claypans of the SCP TEC.

Consolidated issue 70 (contributing issue 97): Who will review and monitor the Wetland and Drainage Management and Monitoring Plan referred to in PER?

The Wetland and Drainage Management and Monitoring Plan will be provided to the OEPA, DOW and DPAW for review/comment. MRWA will be responsible for the implementation of the plan which will include audit reports that will be provided to relevant agencies.

OEPA may conduct audits of approval conditions, including adherence to any proposal commitments, including the preparation and implementation of this plan.

12.9.6 Management of Wetlands

Consolidated issue 81: Wetlands are already impacted and PDNH will further disrupt hydrological regimes. Will MRWA help fund more frequent and thorough wetland monitoring?

Contributing issues:

141: Wetlands are already impacted by other factors and PDNH will further disrupt hydrological regimes. Will MRWA help fund more frequent and thorough wetland monitoring?

151: When will piezometer monitoring as recommended in the wetlands study commence?

231: Will there be monitoring of the environments likely to be affected by water abstraction during construction?

Impacts to hydrology are predicted to be localised and temporary in nature due to management measures aimed at maintaining hydrological connectivity across the proposed highway. Culverts and bridges will be constructed on existing drainage lines to maintain flow in watercourses and to wetlands fed by the watercourses (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Table 10.9).

MRWA is committed to the development and implementation of a WDMMP which will include a groundwater monitoring procedure to ensure impacts to wetlands are detected and appropriately managed. Groundwater monitoring is anticipated to commence late 2015.

MRWA is unable to fund additional wetland monitoring outside of that required for this proposal.

Consolidated issue 82: Sensitive bushland and wetland areas in the palusplain zone each require a special strategy to ensure their conservation.

Contributing issues:

168: How will the area just north of Maralla Road be treated in terms of drainage in order to filter runoff and protect wetlands?

220: Sensitive bushland and wetland areas in the palusplain zone each require a special strategy to ensure their conservation

The Palusplain zone extends from Maralla Road to Muchea. As outlined in PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Table 10.1, this zone contains small ephemeral streams, wetlands and Ellen Brook, as well as isolated pockets of vegetation in good or better condition (see PER Chapter 8, Flora and Vegetation, Section 8.2.10).

PER Appendix H, Drainage Strategy, Section 10.4 sets out the strategy for managing wetlands within the Palusplain zone. The primary objective is the maintenance of existing hydrology/surface flow to wetlands and Ellen Brook. In accordance with this strategy, runoff from small rainfall events will be directed to earthen areas as close to the source as possible for infiltration through the most appropriate infiltration drainage system (i.e., vegetated/grassed swales/verge, bio-retention swales, soak well type pits and retention/detention basins). Selection of an appropriate drainage system is dependent on whether the section of the alignment is kerbed or not and its location and proximity to sensitive values. Where wetlands are adjacent to the road, stormwater will be directed to a bio-retention basin to assist in the removal of contaminants through settling, filtering and biological action before discharge to the environment.

To ensure that the proposal is designed and constructed in accordance with the drainage strategy a detailed infrastructure plan will be prepared for each stage of the development prior to construction. This

will include details of key drainage features including culverts, bio-retention swales and infiltration basins, and where possible, identification of any CCWs and REWs that can be retained through final design.

A WDMMP will be developed and implemented including a groundwater monitoring procedure to ensure impacts to wetlands (and Ellen Brook) are being appropriately managed (see PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.5). The WDMMP will consider the conservation status and proximity of wetlands to the proposal.

Consolidated issue 83: What engineering solutions will be used to maintain maximum groundwater levels and flow?

Contributing issues:

145: Wetlands are already dry and construction dewatering, as well as subsurface compaction, must be minimised.

167: What engineering solutions will be used to maintain maximum groundwater levels and flow during construction and operation, and prevent pollution of groundwater by inevitable fuel and chemical spills?

A detailed infrastructure plan will be prepared for each stage of the development prior to construction to ensure that the proposal is designed and constructed in accordance with the drainage strategy. The detailed infrastructure plan will consider the location, design and construction of infrastructure such as culverts, bridges, bio-retention swales and infiltration basins. This will ensure that hydraulic connectivity is maintained across the proposal, groundwater dewatering is minimised and impacts to wetlands and water quality are reduced. The location and design of drainage structures will also consider the effect of compaction on groundwater flow where clay underlies the proposal (i.e., northern section).

Compaction impacts will be minimal and limited to 1 to 2 m below ground level. A sand layer at the bottom of the highway embankment combined with culverts will ensure that the flow of groundwater near the surface is not restricted where it occurs close to, or at the surface.

Impacts on groundwater levels, flow and quality will be managed through implementation of the construction EMP and development and implementation of a WDMMP. The construction EMP will include measures for the transport, storage, handling and disposal of hazardous materials including fuel and chemicals. Spill response procedures will be captured in an Emergency Response Plan. Laydown areas with fuel and chemical storage will be located at least 50 m from WHPZs, CCWs, Mound Springs SCP TECs and Claypans of the SCP TEC. Fuel and chemicals will be stored in protected tanks or cabinets and bunds.

12.10 Amenity (Noise and Vibration)

12.10.1 Façade Treatment for Noise

Consolidated issue 56: What does the noise façade treatment involve?

Contributing issues:

12: Will the noise mitigation packages be fitted prior to the start of construction?

47: What does the noise façade treatment involve?

207: Our lifestyle will be severely impacted by noise from PDNH. What does façade treatment for noise involve?

PER Appendix O, Transportation Noise Assessment, Appendix E provides examples of treatment packages specified in the Implementation Guidelines for State Planning Policy 5.4 Road and Rail Transport Noise and

Freight Considerations in Land Use Planning (WAPC, 2014). Treatment packages include specifications for window glazing, thick solid timber doors with acoustic seals, roof/ceiling insulation and mechanical ventilation. The level and type of treatment required will be determined on a case-by-case basis in consultation with affected property owners. Building mitigation to affected residences will be installed prior to opening the highway to traffic.

Consolidated issue 57: How were properties chosen for noise mitigation works? Can other properties be included?

Contributing issues:

6: How were properties chosen for noise mitigation works? Can other properties be included?

178: Will our property be eligible for the Package B Architectural Treatment Package for noise control?

207: Our lifestyle will be severely impacted by noise from PDNH. What does façade treatment for noise involve?

Noise modelling was undertaken to determine road traffic noise levels resulting from the proposal. Where noise levels are predicted to exceed the day-time noise limit of 60 dB L_{Aeq}, noise mitigation measures are required to reduce noise levels. Noise walls are effective in residential areas and will be installed adjacent to residential areas south of Maralla Road. In rural and bushland settings north of Maralla Road, building treatments will be used to reduce indoor noise at affected residences. The noise limit (60 dB $L_{Aeq\ (Day)}$) is predicted to be exceeded at sixteen properties north of Maralla Road (see Appendix I, Revised Transportation Noise Assessment, Table 5-1 and Figures 5-5 and 5-6).

Where a resident is concerned that the noise limit is not being met at their property once operation has commenced, MRWA will investigate noise levels at the affected property and determine if additional treatments are required. Any requirement for additional treatment will be discussed and agreed with the affected property owner and arranged by MRWA.

Consolidated issue 58 (contributing issue 177): What is the impact of fitting 6 mm glazing? Glazing does nothing to reduce external noise.

Noise mitigation will be provided through screening walls and building treatments for residences north of Maralla Road where noise levels exceed the noise limit of 60 dB $L_{Aeq\ (Day)}$.

Glazing can reduce indoor noise levels upwards of 10 dB provided the windows are closed (VicRoads, 2010). The type of 6 mm glass (e.g. float or laminated) and building construction will determine the noise reduction achievable using this form of treatment.

Residents may experience the predicted noise levels when outdoors; however, the predicted noise levels assume worst case meteorological conditions (slight breeze from noise source to receiver). Meteorological conditions including wind speed and direction, cloud cover and inversions will change noise propagation and its level at affected residences.

12.10.2 Management and Monitoring of Noise

Consolidated issue 59: How will the proponent manage noise at Maralla Road?

Contributing issues:

48: Will noise abatement include planted vegetation? What other noise reduction measures will be used at Maralla Road?

208: How will noise be managed at properties given that PDNH will be at a high elevation at Maralla Road?

Noise at Maralla Road will be managed through the installation of visual screening walls where practicable and building treatments as mitigation to residences where the noise limit of 60 dB $L_{Aeq\ (Day)}$ is exceeded. Treatments will be discussed and agreed with the affected property owners.

Consolidated issue 60 (contributing issue 7): Noise mitigation for properties north of Ellenbrook will not reduce noise outdoors.

Outdoor noise levels at some properties north of Ellenbrook are likely to exceed the noise limit of 60 dB $L_{Aeq\ (Day)}$ (see Chapter 4, Amenity (Noise and Vibration), Section 4.2.2). Residents may experience the predicted noise levels when outdoors; however, the predicted noise levels assume worst case meteorological conditions (slight breeze from noise source to receiver). Meteorological conditions including wind speed and direction, cloud cover and inversions will change noise propagation and its level at affected residences.

Consolidated issue 61: If an acceptable level of noise mitigation isn't achieved by the strategies will they be rectified and additional treatments added? Will funds be available to undertake this?

Contributing issues:

13: If an acceptable level of noise mitigation isn't achieved by the strategies will they be rectified and additional treatments added? Will funds be available to undertake this?

14: Will noise monitoring continue once the highway has been completed?

Monitoring will be undertaken following the commencement of highway operation to demonstrate that the proposal does not exceed the SPP 5.4 noise limit of 60 dB $L_{Aeq\ (day)}$, excluding the properties north of Ellenbrook which are likely to exceed this limit.

Where a resident is concerned that the noise limit is not being met once operation has commenced, MRWA will investigate noise levels at the affected property and determine if additional treatments are required. Any requirement for additional treatment will be discussed and agreed with the affected property owner and arranged by MRWA.

Consolidated issue 187 (contributing issue 174): Will the impacted residential properties north of Ellenbrook receive noise walls?

Noise walls will not be installed north of Ellenbrook. Where practicable, 2.4-m-high visual screening walls will be installed adjacent to properties north of Maralla Road. The screening walls will provide some noise mitigation for rural residential properties.

Where the noise limit of 60 dB $L_{Aeq\ (Day)}$ is exceeded at residences north of Maralla Road, noise mitigation set out in the Implementation Guidelines for SPP 5.4 (WAPC, 2014) will be applied in discussion, and with the agreement of affected property owners.

Consolidated issue 188 (contributing issue 245): Can the noise wall be thicker or trees planted to reduce the noise level to below 50 dB?

Provided the noise wall meets the minimum density (15 kg/m^2), it will have sufficient acoustic properties to achieve the 60 dB L_{Aeq} noise limit.

Vegetation is not an effective noise mitigation measure on its own. It complements other more effective forms of noise mitigation including noise walls and earth mounds. Visual screening in the form of planting will be provided in road reserves to mitigate the visual impact of the highway.

The revised transportation noise assessment has shown that the noise level limit of 60 dB $L_{Aeq\ (Day)}$ can be achieved between Reid Highway/Tonkin Highway interchange and Hepburn Avenue.

Consolidated issue 189 (contributing issue 41): What noise and light management measures are in place to reduce the impact on local residents?

Noise mitigation will be provided by noise walls south of Maralla Road, and screening walls and building treatments for residences north of Maralla Road where noise levels exceed the noise limit of 60 dB $L_{Aeq\ (Day)}$.

Light spill or glare will be reduced by the following management measures:

- Lights will be directed towards construction activities to limit the amount of light spill to surrounding residences during construction.
- Where practicable, low-level lighting will be used during construction.
- Glare screens will also be provided on all temporary lighting during the construction stages to minimise light pollution.

Road lighting will consider Australian Standard AS 4282 'Control of the Obtrusive Effects of Outdoor Lighting' and comply with AS 1158 'Road Lighting'.

12.10.3 Modelling and Impact Assessment of Noise

Consolidated issue 54 (contributing issue 1): The monitored noise at Madura Close (50.3 dBA) is lower than Fewson Turn (55 dBA) despite being near a highway. Ballajura noise levels will increase by only 10 dBA despite traffic increasing from 30,000 to 100,000 which is an underestimation.

The measured noise at 21 Madura Close, Ballajura is lower than at Fewson Turn. Monitoring results at Madura Close were 49.4 dB $L_{Aeq\ (Day)}$ and 47.0 dB $L_{Aeq\ (Night)}$. At 12 Fewson Turn, Ellenbrook it was 49.1 dB $L_{Aeq\ (Day)}$ and 44.1 dB $L_{Aeq\ (Night)}$ (Appendix I, Revised Transportation Noise Assessment, Table 4-1 and 4.2). These measurements are reflective of the roads in the vicinity of the properties: 12 Fewson Turn is a through road as is the adjacent road; 21 Madura Close is a suburban road adjacent to Hepburn Ave, which is an arterial road.

Noise modelling has shown that the noise target of 60 dB $L_{Aeq\ (Day)}$ will be met at residences in Ballajura with the installation of 5-m-high noise walls. The noise modelling has been revised using forecast 2040 traffic volumes.

Noise is measured on a logarithmic scale; i.e., an increase of 10 dBA is perceived by people to be approximately twice as loud. Typical noise levels experienced by people are shown in Appendix I, Revised Transportation Noise Assessment, Appendix D, Typical noise levels.

Consolidated issue 55 (contributing issue 98): Statement that Stock Road has one of the highest noise levels during monitoring is difficult to believe. Will there be much of an increase in noise in the area?

PER Executive Summary, Table ES-5 incorrectly states "existing daytime noise levels were highest at the Stock Road West site in Bullsbrook (54.2 dB $L_{Aeq\ (Day)}$)" with respect to monitoring undertaken between Bayswater and Muchea. The monitoring site at Abbey Road, Morley recorded the highest noise levels during monitoring (59 dB $L_{Aeq\ (Day)}$).

Noise modelling predicts noise levels in the vicinity of the Stock Road interchange will exceed 60 dB $L_{Aeq\ (Day)}$ due to the previously cleared flat terrain. Affected residences are listed in the revised transportation noise assessment (Appendix I, Table 5-1 and Figure 5-5).

12.10.4 Damage from Vibration

Consolidated issue 50: What compensation will be available for damage to properties caused by vibration? What is involved in dilapidation surveys that may be conducted prior to construction?

Contributing issues:

42: Will repairs or compensation be provided to landowners if property damage occurs due to construction?

173: What compensation is available for residence with vibration damage such as inevitable cracks in bricks?

176: What is involved in dilapidation surveys that may be conducted prior to construction?

211: What compensation will be made to correct any damage caused by vibration?

As detailed in PER Chapter 11, Amenity (Noise and Vibration), Section 11.6, the Construction Noise and Vibration Management Plan will include a requirement to conduct dilapidation surveys.

A qualified assessor will conduct dilapidation surveys of properties within 50 m of construction activities prior to the commencement of construction. This dilapidation survey involves the inspection of a building's interior and exterior for existing damage, such as cracks, for use as a baseline. A second survey is undertaken following construction and the results of both surveys are compared to determine if construction works cause any damage.

Any damage to buildings and property due to the construction works associated with the proposal will be rectified by MRWA. The details of repairs or compensation will be assessed on a case by case basis.

Consolidated issue 51 (contributing issue 175): What does 'taking precautionary measures to avoid vibration damage to buildings near work sites' entail?

Precautionary measures to avoid vibration damage to buildings include selecting equipment and designing construction activities to ensure vibration does not exceed a particle velocity of 5 mm/s. This will include using non-vibrating rollers where practicable.

Damage caused by construction activities will be monitored by a dilapidation report of buildings prepared pre- and post-construction. A Construction Noise and Vibration Management Plan (CNVMP) to be developed to the satisfaction of DER and relevant local government authorities (see PER Chapter 11, Amenity (Noise and Vibration), Section 11.6.1) will include a requirement for noise and vibration monitoring in response to complaints.

12.11 Rehabilitation and Decommissioning

Consolidated issue 44 (contributing issue 159): Will the use of soils infected with dieback or infested with weeds near bushland be avoided?

Management of the risk of introduction and spread of weeds and dieback will be addressed through the preparation and implementation of a weed and dieback hygiene management plan, which will set out the hygiene measures to avoid the introduction and/or spread of weeds and dieback into protectable and dieback free areas, for example soils within the proposal footprint will not be moved between dieback occurrence categories. PER Chapter 8, Flora and Vegetation, Section 8.4.6 and 8.4.7 assesses the potential risk to native vegetation located adjacent to the proposal footprint associated with the introduction and spread of weeds and dieback. A detailed dieback survey of the alignment has been undertaken (PER Appendix D). The study identified current areas of infection and areas considered free from dieback infection.

Consolidated issue 45: Will revegetation works use local native provenance species and be representative of the existing neighbouring vegetation?

Contributing issues:

129: Will revegetation (including next to fauna underpasses) use local provenance plants not just local species?

158: Banksia Woodland species should be planted along verges adjacent to native vegetation, not only dry grassing and trees. Will the planting of out-of-place trees, shrubs and grasses be avoided?

Revegetation works will utilise local native provenance species. The species mix used in revegetation works will be representative of the existing neighbouring vegetation. PER Chapter 12, Rehabilitation and Decommissioning discusses the revegetation strategy for three separate zones across the proposal footprint – urban, transition and rural. As discussed in this chapter revegetation will focus on using local native provenance species in each of these zones that are suited to the surrounding land use and landscape characteristics, including the floristic formation of adjacent vegetation. This will include revegetation close to fauna underpass openings (see PER Chapter 9, Terrestrial Fauna, Section 9.5.8).

This strategy will be developed and supported by a detailed revegetation plan (PER Chapter 12, Rehabilitation and Decommissioning, Section 12.5).

Consolidated issue 47 (contributing issue 84): The rehabilitation chapter is superficial and is unacceptable.

PER Chapter 12, Rehabilitation and Decommissioning details the revegetation strategies for the proposal. This strategy will be developed and supported by a Detailed Revegetation Plan (PER Chapter 12, Rehabilitation and Decommissioning, Section 12.5).

As discussed in PER Chapter 12, Rehabilitation and Decommissioning, revegetation will focus on using local native provenance species in each of these zones that are suited to the surrounding land use and landscape characteristics, including the floristic formation of adjacent vegetation and so will contribute to maintaining biodiversity. While not inclusive of a full plant list this chapter does provide a preliminary list of species that may be used in each revegetation zone, for example the species suggested for revegetation in the transition zone (south of Maralla Road) include *Xanthorrhoea preissii, Melaleuca rhaphiophylla, Corymbia calophylla, Banksia attenuata* and *Banksia menziesii*.

The Detailed Revegetation Plan will include completion criteria, full species planting list and will take into consideration the translocation of suitable native species, including Balga (*Xanthorrhoea preissii*), Cycads (*Zamia* spp.) and Western Australia Christmas Trees (*Nuytsia* spp.).

MRWA will consider translocation of species which are identified suitable for use in feature planting of landscaping. It should be noted that translocation of mature species is extremely difficult to successfully complete and requires a significant amount of maintenance to result in successful translocations.

Consolidated issue 48 (contributing issue 157): Revegetation designed for the transition zone should be extended to Warbrook Road, or at least beyond 108 Halden Road.

PER Chapter 12, Rehabilitation and Decommissioning details the revegetation strategies for the proposal. This strategy will be developed and supported by a Detailed Revegetation Plan (PER Chapter 12, Rehabilitation and Decommissioning, Section 12.5). Revegetation will focus on using local native provenance species in each of the revegetation zones that reflect the surrounding land use and landscape characteristics, including the floristic formation of adjacent vegetation.

The suggested list of species for revegetation in the rural zone (PER Chapter 12, Rehabilitation and Decommissioning, Section 12.3.1) include species common to the vegetation associations described in PER Chapter 8, Flora and Vegetation, Table 8.3 and shown in Figure 8.2 for the section of highway between Maralla Road and Warbrook Road. The merits of extending transition zone revegetation north of Maralla Road where the proposed highway is adjacent to remnant vegetation will be considered in the detailed revegetation plan (PER Chapter 12, Rehabilitation and Decommissioning, Section 12.5).

Consolidated issue 49 (contributing issue 76): Why do table drains need to be 6 m wide overall? Native vegetation should be used for water flow control in drains, the back slopes at a minimum.

PER Chapter 4, Detailed Description of Proposal, Figure 4.2 shows a typical arrangement of the proposed highway including table drains to ensure the potential impacts of the proposal are understood. The width of table drains is determined by the catchment and expected rainfall and runoff. They are designed to prevent flooding of the highway carriageways. Table drains are revegetated with 'soft plants', typically sedges to prevent scouring, assist with filtration of runoff and avoid creating a safety hazard for motor vehicles leaving the carriageway. Revegetation with trees would pose a road safety hazard.

12.12 Aboriginal Heritage

Consolidated issue 43: Aboriginal heritage sites with significance should be avoided and protected in a manner acceptable to the local Nyungah people.

Contributing issues:

160: Aboriginal heritage sites with significance should be avoided and protected in a manner acceptable to the local Nyungah people.

179: Any potential impacts to Aboriginal heritage from the proposal can be addressed through the proposed Aboriginal Heritage management Plan and the provisions of the *Aboriginal Heritage Act 1972* (e.g. Section 18 consent).

(Repeated from Section 11.1)

Where possible, Aboriginal heritage sites will be avoided and protected. However where disturbance of Aboriginal heritage sites is required consent to disturb an Aboriginal site under Section 18 of the *Aboriginal Heritage Act 1972* will be obtained.

Members of the Nyungah (Noongar) community were involved in field surveys for Aboriginal cultural heritage (see PER Appendix Q, Ethnographical Aboriginal Heritage Survey and PER Appendix R, Aboriginal Archaeological Assessment).

The management process developed to monitor and minimise impacts to Aboriginal archaeological records is supported by the Noongar people (see PER Appendix R, Aboriginal Archaeological Assessment).

PER Chapter 13, Aboriginal Heritage, Section 13.4 sets out the measures to be incorporated in an Aboriginal Heritage Management Plan. The measures incorporate the recommendations set out in PER Appendix R, Aboriginal Archaeological Assessment.

12.13 European Heritage

Consolidated issue 33 (contributing issue 8): Heritage of Bulls Brook has not been considered despite being significant to history of Bullsbrook district.

Aboriginal and European cultural heritage were investigated and are addressed in PER Chapter 13, Aboriginal Heritage and PER Chapter 14, European Heritage, respectively. Historic sites in the Bulls Brook district were investigated in the European heritage study (PER Appendix S, European Heritage Desktop Assessment).

The study identified two protected places and several sites that might contribute to the history of the district. The protected places listed in PER Appendix S, European Heritage Desktop Assessment, Section 4.1.2 are adjacent to the proposal but will be avoided by the highway and proposed activities.

Historical sites associated with the township of Bullsbrook and the Bullsbrook railway siding, which is adjacent to Bulls Brook, are remote from the proposal.

The proposal crosses Bulls Brook at approximately chainage 28.1 km, downstream of the Bulls Brook Biodiversity Corridor established by the North Swan Landcare Group. Several culverts and fauna underpasses will be installed under the highway on the Bulls Brook floodplain to maintain hydrological and ecological connectivity.

12.14 Amenity (Reserves)

Consolidated issue 35 (contributing issue 161): Why is Nature Reserve R46919 not extended into the remainder of Bush Forever site 300? Is it owned by someone else / has it been vested in the state government?

The full extent of Nature Reserve R46919 is shown in PER Chapter 15, Amenity (Reserves), Figure 15.3B. The remainder of Bush Forever Site 300 is owned by the Western Australian Planning Commission.

Consolidated issue 36 (contributing issue 2): Money from sale of Whiteman Park should be reinvested into Whiteman Park.

MRWA will acquire that part of Whiteman Park required for the proposal. The land is vested in the WAPC and managed by the DOP. They are responsible for the management of the park's funding and maintenance. MWRA has no control over how payment for the land required is allocated in relation to management of the park.

12.15 Environmental Offsets

Consolidated issue 14: The proposal (including offsets) will still result in a net loss of biodiversity. Acquisition does not replace bushland, and MRWA should implement a revegetation offset.

Contributing issues:

10: Can offsets package include purchase of cleared/degraded land for rehabilitation to address net loss of important habitat associated with bushland and wetlands?

82: The net loss of black cockatoo habitat requires habitat replacement in the long term through acquisition and revegetation of degraded habitat to avoid continued cumulative losses. This also applies to all other fauna habitats.

85: While the implementation of Offset 1 is supported, the proposal will still result in a net loss of biodiversity at the species, population and community level.

87: The acquisition of properties does not sufficiently offset the impacts of the proposal. MRWA must be required to undertake a revegetation offset to actually replace lost bushland, even if attempts to do so do not completely succeed.

291: The acquisition of Ioppolo Road protects existing foraging habitat for black cockatoos but does not increase availability of habitat. Losses of habitat in the development envelope are therefore not mitigated.

292: The proponent should take into consideration rehabilitation and revegetation when proposing offsets, particularly regarding the EPA's recent strategic advice for the Perth and Peel regions.

(Repeated from Section 7.6)

MRWA's offset strategy (see Chapter 6) has been developed in accordance with the Commonwealth Environmental Offsets Policy (Government of Australia, 2012), WA Environmental Offsets Policy (Government of Western Australia, 2011) and WA Environmental Offsets Guideline (Government of Western Australia, 2014).

Land acquisition is recognised as an appropriate form of offset under these policies and guidelines:

- WA Environmental Offsets Policy: "Direct offsets vary... and include acquisition… of natural areas outside the project area."
- WA Environmental Offsets Guideline: "Land acquisition offsets… involve the protection of environmental values through improved security of tenure or restricting the use of the land."
- Commonwealth Environmental Offsets Policy: "The securing of existing unprotected habitat as an offset only provides a conservation gain if that habitat was under some level of threat of being destroyed or degraded, and as a result of offsetting will instead be protected in an enduring way and actively managed to maintain or improve the viability of the protected matter."

As detailed in Chapter 6, Environmental Offsets MRWA has purchased a parcel of land in the Chittering area (Ioppolo Road) for the purpose of offsetting impacts to Black Cockatoos from the proposal. This offset protects existing high quality habitat for Black Cockatoo species that was otherwise under threat of clearing and degradation from third party access and exploration and agricultural activities. It is an important ecological linkage to existing reserves to the west. The details of activities and funding arrangements for ongoing management will be included in the Land Acquisition and Management Plan in consultation with DPAW.

MRWA acquired the Ioppolo Road site prior to the release of the OEPA's strategic advice 'Perth and Peel @ 3.5 million Environmental impacts, risks and remedies' (EPA, 2015a). While EPA acknowledged that acquisition of bushland provides immediate value and certainty, it is recommended that in future greater emphasis is placed on rehabilitation and revegetation of degraded areas to achieve a net improvement in habitat and other environmental values.

Offset proposal 1 does not completely satisfy the offset requirement for Black Cockatoos. The proposal will also require offsets for a variety of other values, including SCP20a, a number of under-represented vegetation and CCWs, as discussed in Chapter 6. MRWA is considering the opportunity to include rehabilitation and revegetation in addressing these other offset requirements.

MRWA are currently developing a restoration offset plan for up to 31.5 ha across several properties adjacent to the alignment. The restoration plan will be aimed at wetlands, under-represented vegetation and Black Cockatoo habitat. The restoration plan is still in development and further details are not available at this stage.

Consolidated issue 16 (contributing issue 135): Offsets do not add to black cockatoo conservation effort and other management should be used. Will MRWA assist with ongoing monitoring of hollow nesting logs for black cockatoos?

MRWA is considering the opportunity to include rehabilitation and revegetation in addressing its offset requirements. It is also considering opportunities to involve community groups in the delivery/management of the proposal's rehabilitation and offsets.

The Ioppolo Road offset site protects valuable Black Cockatoo foraging and roosting habitat with mature eucalypt trees providing potential breeding habitat that will now be actively managed for conservation by DPAW. The need for an additional 60 ha of Forest Red-tailed Cockatoo habitat provides an opportunity to explore rehabilitation and revegetation of degraded habitat.

MRWA are currently developing a restoration offset plan for up to 31.5 ha across several properties adjacent to the alignment. The restoration plan will be aimed at wetlands, under-represented vegetation and Black Cockatoo habitat. The restoration plan is still in development and further details are not available at this stage.

Consolidated issue 19 (contributing issue 86): Offsets should be required to be implemented before environmental approval is given, particularly Offsets 2, 3 and 4, which have not yet been located.

MRWA will fund all land acquisition prior to the commencement of construction, unless otherwise agreed with DOTE and EPA. Where restoration is proposed, these plans will be submitted and approved prior to the commencement of construction. More detail on the proposed offsets is provided in Chapter 6, Environmental Offsets.

Consolidated issue 20 (contributing issue 17): Was Lot 5892 Maralla Road Bullsbrook considered as a potential offset? If not, can it be?

Lot 5892 Maralla Road, Bullsbrook was considered as an offset site. However, the owner is not interested in selling the property.

Consolidated issue 90 (contributing issue 250): Will MRWA consider the installation and monitoring of next boxes for Carnaby's Black Cockatoo?

The proposal will not result in the removal of any known breeding trees for Black Cockatoos. The Ioppolo Road offset site contains mature eucalypt trees which could provide breeding habitat for Black Cockatoos. MRWA will consider the provision of Black Cockatoo nest boxes in consultation with the DPAW to

encourage use of the Ioppolo Road site and maintain use of remnant vegetation in and adjacent to Dick Perry Reserve and Whiteman Park.

12.16 Other Issues

Consolidated issue 7 (contributing issue 46): Will air pollution from exhausts be monitored and controlled?

An assessment of air quality (vehicle emissions) was not a requirement of the ESD and not required by DER. Emissions from exhausts will not be monitored during construction or operation. Dust will be monitored during construction through inspection and in response to complaints. Measures to limit and suppress dust are set out in PER Appendix F, Environmental Management Plan, Chapter 5, Performance Monitoring, Table 5.1, Performance monitoring.

The DOT is responsible for the implementation of the Road Traffic (Vehicle Standards) Rules 2002 and Road Traffic (Vehicles) Regulations 2014, which include requirements on vehicle emissions

Consolidated issue 8 (contributing issue 56): Please advise which local roads will be accessible between Halden Road and Stock Road in order to get to PDNH.

The highway will sever all existing local roads that it crosses between Maralla Road and Stock Road. Access from local roads to the west of the highway will be via the Stock Road interchange. Halden Road will be constructed north of Maralla Road to connect to existing local roads, which provide access to Stock Road.

Consolidated issue 9: How will rubbish dumping around Maralla Road and Halden Road and other areas be prevented, controlled, monitored and/or cleaned up, during both construction and operation?

Contributing issues:

44: Rubbish dumping along Maralla Road and Halden Road is a concern. What monitoring will there be to prevent illegal dumping? Will there be signage? Who will clean up rubbish dumping to prevent continued dumping in the same location?

119: Will every such area be fenced to prevent impacts such as rubbish dumping, trail biking, off road driving and fires?

152: How will uncontrolled access, rubbish and fires be managed?

162: How will uncontrolled access, rubbish dumping, weeds, dieback and the degradation of vegetation through off-road activities be managed?

221: Existing rubbish dumping and unauthorised access and destruction around Maralla Road will worsen with PDNH. How will illegal activities be managed during and after construction?

Uncontrolled access and illegal dumping of rubbish within the proposal area will be monitored during construction. Temporary fencing during construction and permanent fencing post construction (see PER Chapter 9, Terrestrial Fauna, Figure 9.5) will restrict access from the highway. Fauna underpasses have also been designed to limit human use (see PER Chapter 9, Terrestrial Fauna, Section 9.5.8).

This proposal provides for the upgrade of Maralla Road and Halden Road for local road users, as Maralla Road will be severed by the highway. There will be no access to Maralla Road or Halden Roads from the highway once operational. It is not anticipated that this proposal will significantly increase traffic movements and any associated rubbish dumping along these local roads.

Maralla and Halden roads are local roads administered by the City of Swan. Illegal dumping of rubbish on public land including road reserves is regulated under the *Litter Act 1979*.

No funding arrangements to support ongoing third party access, rubbish dumping or weed management (e.g., by DPAW at Maralla Road Nature Reserve) has been considered as part of this proposal. However, MRWA will liaise with relevant agencies to discuss measures to prevent and manage access from the highway.

Consolidated issue 10: How will local utilities and services be interrupted or continued during construction and operation? Will there be any compensation?

Contributing issues:

51: Will utilities (e.g. electricity) be interrupted during construction? If so, how will it be minimised or compensated?

55: How will services like mail delivery and rubbish collection be continued in Maralla Road [assumed to mean west of PDNH alignment]?

Utilities will be relocated if they cross the highway. Connections to affected properties will be maintained except for limited times when utilities are disconnected to facilitate connection modifications. This will be carried out in consultation with property owners to limit impacts.

No changes to mail or rubbish services are proposed as part of the proposal. If mail is currently delivered, then this service will be maintained.

Consolidated issue 12: How will emergency access for properties west of PDNH on Maralla Road be addressed?

Contributing issues:

43: Severance of local roads will reduce emergency access west of PDNH. What is the emergency access strategy during fires? Who will maintain emergency accesses? How will locked emergency access gates be controlled? Increased fire risk is a major concern.

200: A second/alternative access for residents in the Maralla Road area west of PDNH should be provided in case of emergencies such as fire.

224: PDNH will increase emergency response times in western Maralla Road. How will emergency access be addressed for properties west of PDNH in case of bushfire?

Emergency access provision will be included across the highway at Maralla Road and Warbrook Road. In an emergency, residents will be able to use the emergency access for the highway if directed to do so by emergency services. Emergency access arrangements and revision of emergency response plans are currently being discussed and agreed with DFES and the State Emergency Service (SES). The highway will provide a high speed link into this area for emergency response vehicles improving general response times.

Emergency access to/from the highway reserve will be maintained by MRWA, emergency access to/from local government road reserves will be maintained by the relevant local government authority. Gates will be locked to ensure general access to/from highway is not permitted. Keys to these gates will be provided to the local government, DFES and SES. These gates will also be designed to be removed in an emergency.

Consolidated issue 13 (contributing issue 156): Will MRWA provide fire brigades with extra water sources to fight bushfires?

No additional water sources will be provided as part of the proposal. MRWA is working with DFES to minimise fire risk and provide improvements through additional firebreaks and provision for emergency access. The highway itself will create a firebreak.

13 CONSOLIDATED LIST OF ENVIRONMENTAL OUTCOMES AND PROPOSED MANAGEMENT MEASURES

Consistent with Environmental Assessment Guideline 11 for Recommending Environmental Conditions (EPA, 2013), MRWA is committed to achieving environmental outcomes through the implementation of appropriate management measures that are relevant to specific site conditions. MRWA has proposed management measures to achieve the desired outcomes. The measures are based on conceptual design and will be effective in managing the identified impacts. Alternative management strategies may arise during detailed design, investigations and as a result of construction contractor experience. Focus on achieving the environmental outcomes will enable the listed management measures to be reviewed, revised and, where appropriate, replaced by more effective measures.

A number of changes to the environmental outcomes and proposed management measures within the PER have been proposed within this document in response to submissions, the results of additional surveys and changes to the development envelope.

This chapter presents a consolidated list of the current environmental outcomes and proposed management measures to address the impacts of the proposal (Table 13.1). Where proposed management measures address more than one environmental factor, they have not been repeated. This list has been annotated as to whether each outcome/measure is unchanged from the PER, new, revised or deleted (e.g., it is no longer required because the commitment has been fulfilled).

This consolidated list also includes updated information on MRWA's commitments for offsetting unavoidable significant impacts on Threatened ecological communities, flora and fauna habitat.

Table 13.1 Consolidated list of environmental outcomes and proposed management measures

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
Flora and vegetation			
Environmental outcomes	FV01 – Avoid Mound Springs SCP TEC at Gaston Road.		Unchanged.
	FVC02 – Avoid Claypans of the SCP TEC adjacent to the existing Great Northern Highway.		Unchanged.
	FVC03 – Avoid known locations of *Caladenia huegelii*, *Grevillea curviloba* subsp. *incurva* and *Darwinia foetida* threatened flora.		Unchanged.
	FVC04 – Avoid known locations of *Cyathochaeta teretifolia* (P3), *Ornduffia submersa* (P4) and *Stylidium striatum* (P4) priority flora.		Unchanged.
	FVC05 – Avoid any direct impact to Bush Forever site 13, including Conservation Category Wetland UFI 8926.	Avoid any direct impact to Bush Forever site 13 (west of Sawpit Road, Bullsbrook), including Conservation Category Wetland UFI 8926.	Revised. Removed unnecessary location detail.
	FVC06 – A maximum of 206 ha of intact native vegetation will be cleared.	A maximum of 205 ha of intact native vegetation will be cleared.	Revised. The area of intact native vegetation to be cleared has been revised (see consolidated issue 178 in Section 7.3.2).
	FVC07 – A maximum of 49.6 ha of GDEs will be cleared.		Unchanged.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	FVC08 – A maximum of 129.9 ha of intact native vegetation within Bush Forever sites will be cleared.	A maximum of 128.5 ha of intact native vegetation within Bush Forever sites will be cleared.	Revised. The area of intact native vegetation within Bush Forever sites has been revised (see consolidated issue 182 in Section 7.3.2).
	FVC09 – A maximum of 4.0 ha of State-listed TEC SCP20a will be cleared.	A maximum of 4.4 ha of State listed TECs (SCP02 and SCP20a) will be cleared.	Revised. SCP02 is no longer considered to exist in the development envelope (see Section 3.3).
	FVC10 – A maximum of 145.5 ha of State-listed PECs (SCP21c, SCP22, SCP23b, SCP24 and Banksia dominated woodlands of the Swan Coastal Plain) will be cleared.		Unchanged.
	FVC11 – A maximum of 30 ha of critical habitat for *Caladenia huegelli* will be cleared.	(No previous outcome.)	New. Not captured previously as an 'environmental outcome'. The area of *Caladenia huegelii* critical habitat presented in the PER was revised following additional surveys (see Section 3.1).
	FVC12 – Edge effects do not extend more than 10 m from the new vegetation edge.	(No previous outcome.)	New. Not captured previously as an 'environmental outcome'.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
Proposed management strategies	(No current commitment.)	Additional targeted surveys for Threatened and Priority listed flora will be undertaken prior to vegetation clearing to clearly define population boundaries, and to identify any additional populations within and adjacent to the proposal.	Deleted. Additional targeted surveys have now been completed (see Chapter 3, Spring Ecological Surveys).
	(No current commitment.)	Additional targeted surveys of the known populations of *Millotia tenuifolia* var. *laevis* and *Meeboldina decipiens* subsp. *decipiens* ms to clearly define populations and known individuals. The survey results will be provided to the EPA as part of the response to submissions process to inform the EPA's assessment of the proposal.	Deleted. Additional targeted surveys have now been completed (see Chapter 3, Spring Ecological Surveys).
	FVM01 – Progressive clearing and revegetation will occur through the life of the construction phase of the proposal.		Unchanged.
	FVM02 – Delineation of the clearing boundary prior to clearing.	Delineation of an approved clearing boundary	Revised. Removed 'approved' as the clearing boundary will not be defined until after this assessment is complete.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	FVM03 – Preparation and implementation of an EMP to limit risk of fire, the introduction and/or spread of weeds (i.e. WONS and declared pests) and/or dieback, littering and unauthorised access. The EMP will also include measures for hot work and the transport, generation, storage, handling, use and disposal of pollutants (including total suspended solids (TSS), ASS, hydrocarbons and chemicals), including an emergency spill response procedure.	Preparation and implementation of an EMP to limit risk of fire, the introduction and/or spread of weeds and/or dieback and litter to protect ecosystems that supports Threatened and Priority taxa. This EMP will include a monitoring program to monitor the condition of environmentally significant vegetation along the edge of the proposal footprint (i.e. TECs, PECs and threatened flora buffers) for any indirect impacts, including significant environmental weed incursions (i.e. WONS and declared pests) and refuse.	Revised. Removed unnecessary justification text. Management and monitoring of environmentally significant vegetation removed as this is now addressed under new management measure FVM04. Revised to amalgamate various commitments with regard to the EMP.
	FVM04 – Preparation and implementation of a Flora and Vegetation Management and Monitoring Plan to manage impacts on environmentally significant flora and vegetation, including TECs, PECs and Threatened and Priority flora including *Caladenia huegelii*, *Grevillea curviloba* subsp. *incurva* and *Darwinia foetida*. The plan will include establishing baseline condition, undertaking monitoring and implementing remedial actions should changes to vegetation health and condition be detected.	(No previous management measure.)	New. This commitment has been split off from a previous management measure regarding an EMP (FVM03). *Darwinia foetida* has been added following its recent discovery in the proposal footprint (see Section 3.5).

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	FVM05 – Develop a detailed infrastructure plan for each stage of the development prior to construction to ensure the proposal is: • Designed, and the clearing boundary defined, within the approved development envelope (and the impact limits set by the 'proposal footprint'). • Identifies areas of native vegetation/habitat to be retained. • Designed and constructed in accordance with the drainage strategy. • Identifies any areas of CCW and REW to be retained.	Develop a detailed infrastructure plan for each stage of the development prior to construction to ensure the proposal is designed within the approved development boundary ('proposal footprint') and identifies areas of native vegetation to be retained.	Revised. The commitment's wording has been made consistent with other language in the PER. Amalgamates various commitments with regard to the detailed infrastructure plan.
	FVM06 – Design and installation of culverts in accordance with the drainage strategy.	Design and installation of culverts to reduce shadowing and ponding.	Revised. Minor change to wording to link to drainage strategy. Removed unnecessary justification text.
	(No current commitment.)	Threatened and Priority listed flora and ecological communities will be demarcated outside of the proposal footprint.	Deleted. This is addressed under management measure FVM10.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	FVM07 – Preparation and implementation of a weed and dieback hygiene management plan including: • A risk assessment of potential sources and activities. • The identification of 'protectable' areas adjacent to the proposal footprint. • Requirements for hygiene washdown locations that consider risk in the surrounding landscape. • A program to monitor and report on compliance and corrective actions where non-compliance has occurred. • Quarterly auditing of washdown sites to identify weed incursions. • Regular walk-overs at strategic locations along the proposal footprint (i.e. in association with native vegetation) to identify and ameliorate weed incursions. • An auditable hygiene inspection form will be prepared to detail inspection results at the hygiene locations.		Unchanged.
	FVM08 – Educational and induction material will include information on significant flora and ecological communities to reduce the risk of accidental clearing.	Educational and induction material will be provided about the significant flora and ecological communities to contractors working on the construction to reduce the risk of accidental clearing.	Revised. Minor change to wording.
	FVM09 – Revegetation will occur at the earliest opportunity within designated revegetation areas and corridors to maintain ecological linkages.		Unchanged.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	FVM10 – A temporary fence will be installed during construction along environmentally sensitive areas. Environmentally sensitive areas include, but are not limited to, conservation estate, Bush Forever sites, Cullacabardee, Whiteman Park, Lexia wetlands, Dick Perry Reserve and locations of Threatened and Priority listed flora and ecological communities and their buffers.	A fence will be installed along environmentally sensitive areas to reduce the risk of unauthorised or uncontrolled access impacting on the sensitive features. Environmentally sensitive areas will include, but not limited to conservation estate, Bush Forever sites, Cullacabardee, Whiteman Park, Lexia wetlands, Dick Perry Reserve and locations of Threatened and Priority listed flora and ecological communities.	Revised. Removed unnecessary justification text. Specified the temporary nature/timing of this commitment.
	FVM11 – No movement of plant, vehicles or equipment outside of the clearing boundary during construction, unless within existing areas of disturbance.	No movement of plant (construction) or vehicles outside of the designated clearing line during construction.	Revised. The commitment's wording has been made consistent with other language in the PER. Amended to allow movement of vehicle/machinery/equipment within existing areas of disturbance (i.e., tracks).
	(No current commitment.)	Additional vegetation surveys and analysis of the vegetation inferred to be consistent with the TEC SCP02 to determine if the vegetation is consistent with the TEC SCP02. The surveys and analysis will occur in spring 2015 with the analysis and FCT determination available shortly after the survey completion.	Deleted. Additional targeted surveys have now been completed (see Chapter 3, Spring Ecological Surveys).

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	FVM12 – Locate access points and PSP away from environmentally significant vegetation, where practicable. If this is unavoidable, then the access points and paths will be designed to minimise the risk of uncontrolled access.	Access points and the PSP will be located away from extant native vegetation, where possible. If this is unavoidable, then the access points and paths will be designed to minimise the risk of uncontrolled access into significant native vegetation (i.e. Maralla Nature Reserve).	Revised. The commitment's wording has been made consistent with other language in the PER and generalised to refer to all environmentally significant vegetation.
	FVM13 – Species used by Thynnid wasps as food sources will be incorporated in revegetation of the road reserve adjacent to *Caladenia huegelii* critical habitat in the vicinity of Ellenbrook.	(No previous management measure.)	New. This management measure has been added in Section 5.1.1.1 in response to consolidated issue 135 (see Section 12.7.1).
Terrestrial fauna			
Environmental outcomes	TFC01 – A maximum of 207.2 ha of Carnaby's Black Cockatoo foraging habitat, 120.5 ha of Forest Red-tailed Black Cockatoo foraging habitat, and 120.5 ha of breeding habitat (inclusive of 763 potential breeding trees) and 56.5 ha of roosting habitat for both species will be removed.	A maximum of 201.8 ha of Carnaby's Cockatoo foraging habitat; 120.1 ha of Forest Red-tailed Black Cockatoo foraging habitat; and 120.1 ha of breeding habitat (inclusive of 737 potential breeding trees) and 58.6 ha of roosting habitat for both Black Cockatoo species will be removed.	Revised. The area of Black Cockatoo habitat has been revised (see Table 6.2 and response to consolidated issue 88 in Section 12.8.1).
	TFC02 – A maximum of 160.1 ha of natural fauna habitat will be removed.	A maximum of 159.3 ha of natural fauna habitat will be removed.	Revised. The area of natural fauna habitat to be cleared has been revised (see consolidated issue 118 in Section 12.8.3).

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	TFC03 – Maintain ecological connectivity across the proposal where practicable.	Ecological connectivity will be maintained across the PDNH alignment.	Revised. The commitment's wording has been made consistent with other language in the PER. The revision also recognises that maintenance of ecological connectivity across the entire proposal is not possible given the nature of linear infrastructure projects.
	TFC04 – Minimise the occurrence of fauna mortality associated with vegetation clearing and vehicle interaction during construction and operation.	The occurrence of fauna mortality, associated with vegetation clearing, vehicle interaction will be minimised during construction and operation.	Revised. Minor change to wording.
Proposed management measures	TFM01 – A total of 21 underpasses and two bridges will be constructed in key locations along the proposal. Multiple underpasses will be installed in close proximity at each key location. The effectiveness of fauna underpasses will be assessed via a monitoring program.	A total of 21 underpasses and two bridges are planned to be constructed in key locations along the proposal. The use of multiple fauna underpasses close to each other to reduce the risk of predators taking advantage of the funnelling effect of underpasses on fauna. Fauna underpass monitoring program will be developed.	Revised. Rephrased to combine three management measures.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	(See FVM02.)	Boundary fencing or flagging will be used to delineate extent of clearing so clearing outside of the specified boundary will not occur.	Deleted. This is addressed under management measure FVM02.
	(See FVM05.)	Clearing to occur only within construction footprint in Maralla Road Bushland and Whiteman Park/Cullacabardee Bushland where ecological connectivity is paramount.	Deleted. This is addressed under management measure FVM05.
	(See FVM03.)	An environmental management plan will be implemented to limit the risk of fire, spread of weeds, rubbish and vehicle tracks caused during construction.	Deleted. This is addressed under management measure FVM03.
	(See Offset Proposal 1.)	An offset site in Chittering has been purchased to offset the impacts of habitat loss from the proposal and includes 673.5 ha of Black Cockatoo habitat. A summary of the fauna values of the offset site is contained in Chapter 17.	Deleted. This is addressed by Offset Proposal 1.
	(See FVM05 and FVM09.)	Retain or rehabilitate roadside vegetation, especially along the Reid Highway section of the proposal footprint to help facilitate fauna movement between local habitats.	Deleted. Delineation of clearing boundary and areas to be retained are addressed under management measure FVM05. Rehabilitation and maintenance of ecological corridors is addressed under management measure FVM09.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	TFM02 – Retain and translocate hollow logs from cleared area to surrounding habitats.	Retain and translocate hollow logs to surrounding habitats. Logs are an important refuge site for many animal species and provide shelter against predation and provide shelter against predation.	Revised. Minor change to wording. Removed unnecessary justification text.
	TFM03 – Furniture (objects to provide shelter) and revegetation will be used in and around fauna underpasses.	The use of furniture (objects to provide shelter) in fauna underpasses to reduce risk of predation. Revegetation as close to fauna underpasses as possible to reduce risk of predation.	Revised. Rephrased to combine two management measures. Removed unnecessary justification text.
	(See TFM01).	The use of multiple fauna underpasses close to each other to reduce the risk of predators taking advantage of the funnelling effect of underpasses on fauna.	Deleted. This is addressed under management measure TFM01.
	TFM04 – Limit the use of *Banksia* and other Black Cockatoo foraging resources as part of revegetation activities within 10 m of the road.	The use of Banksia and other Black Cockatoo foraging resources will be limited as part of revegetation activities within 10 m of the road. Having foraging resources close to the road will create a higher chance of vehicle impact on these species.	Revised. Minor change to wording. Removed unnecessary justification text.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	TFM05 – Clearing of vegetation will be conducted outside spring where possible.	Clearing to occur outside of spring wherever possible, to minimise impacts to the breeding cycle of resident fauna e.g. nesting birds. If clearing is conducted during spring fauna spotters must be present.	Revised. Minor change to wording. Removed unnecessary justification text. Fauna spotters are addressed under management measure TFM07.
	TFM06 – A trapping and relocation program will be conducted for ground dwelling fauna in areas of native vegetation prior to clearing in accordance with a licence to take fauna for education or public purpose issued by the DPAW under section 15 of the *Wildlife Conservation Act 1950*.	A trapping and translocation program will be conducted for ground dwelling fauna in areas of native vegetation prior to clearing. Fauna will be released in comparable habitat outside of the construction footprint.	Revised. Minor text change to refer to the relevant licencing process.
	TFM07 – Fauna spotters will be present during clearing of native vegetation to help relocate any fauna to adjacent comparable habitat.	Fauna spotters will be present during the clearing of native vegetation to help translocate any fauna to adjacent suitable habitat and minimise any mortalities.	Revised. Minor change to wording. Removed unnecessary justification text.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	TFM08 – Fauna fencing will be installed on both sides of the road in areas north of Hepburn Avenue along the alignment to at least 100 m north of Maralla Road to restrict fauna access to the road. The fauna fence design will be consistent with MRWA Drawing No. 200331-110.	Fauna fencing will be installed on both sides of the road in areas north of Hepburn Avenue along the alignment to a minimum of 100 m north of Maralla Road to restrict fauna access to the road. The fauna fence design will be consistent with MRWA Drawing No. 200331-110 (1,800 mm high and dug into the ground 500 mm). The design of fauna fencing restricts medium to large ground dwelling fauna from obtaining access to the road and guides them to safe crossing points at the fauna underpass locations.	Revised. Removed fence dimensions as these are specified in the drawing. Removed unnecessary justification text.
	TFM09 – Fauna escape ramps or gates will be installed every 200 m along fauna fencing to allow trapped animals safe egress from the road reserve while preventing ingress.	Fauna escape ramps will be installed a minimum of every 200 m in sections containing fauna fencing. Fauna escape ramps are one-way devices that allow trapped animals safe egress from the road reserve. The ramps are required to be a 1,500 mm high to prevent fauna access in the wrong direction.	Revised. Minor change to wording to allow flexibility in design by contractor whilst ensuring the environmental outcomes can be achieved.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	TFM10 – A 40 km/h speed limit will be enforced when travelling through vegetation within the road reserve (e.g., Whiteman Park and Maralla Road Nature Reserve) until clearing has been completed and fauna fencing has been installed.	A 40 km/h speed limit will be enforced within the construction zone to mitigate against animal strikes.	Revised. Removed unnecessary justification text. The speed limit is unnecessary in areas that are already cleared (including existing roads) and following installation of fauna fencing.
	TFM11 – All fauna injured during the construction period will be taken to an authorised veterinarian or wildlife carer.		Unchanged.
	TFM12 – Fauna warning signs will be installed, if required, in areas not protected by fauna fencing.	Fauna warning signs will be installed in areas where native vegetation occurs next to the roadside.	Revised. Fauna fences are designed to eliminate fauna access to the highway, obviating the need for warning signs in fenced areas. Warning signs are most effective if used only in areas of actual risk.
	(See FVM03.)	The risk of fire will be managed by minimising fuel load and controlling ignition sources through the implementation of an EMP and an emergency response procedure.	Deleted. This is addressed under management measure FVM03.
	TFM13 – Impacts from fire during the operation phase of the proposal will be managed by the inclusion and maintenance of firebreaks.		Unchanged.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	(No current commitment.)	The proposal will act as a firebreak and the footpaths and access tracks will allow greater access for fire fighters.	Deleted. This is a natural outcome of the proposal rather than a specific management measure.
	TFM14 – Light spill to surrounding fauna habitat will be reduced by directing lighting into construction areas, using low-level lighting and fitting screens/shrouds where practicable.	Lights will be directed towards construction activities to limit the amount of light spill to surrounding habitats. Where possible low level lighting will be used during the construction phase of the proposal. Artificial screening will be employed along areas adjacent to native vegetation.	Revised. Rephrased to combine two management measures.
	TFM15 – Road lighting will consider AS 4282 'Control of the Obtrusive Effects of Outdoor Lighting' and comply with AS 1158 'Road Lighting'.	The road lighting will consider AS 4282 'Control of the Obtrusive Effects of Outdoor Lighting' and road lighting will comply with AS 1158 'Road Lighting' to reduce impacts from light pollution.	Revised. Minor change to wording. Removed unnecessary justification text.
	TFM16 – Evidence of nesting Rainbow Bee-eaters will be recorded, demarcated and temporarily avoided during clearing until the birds have left the nest.	(No previous management measure.)	New. This management measure has been added in response to consolidated issue 111 (see Section 12.8.5).

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
Hydrological processes and inland waters environmental quality			
Environmental outcomes	HPC01 – A maximum of 16 ha of CCW and 14 ha of REW will be removed.	A maximum of 14.8 ha of CCW (including 0.04 ha of EPP Lake 450) and 14.0 ha of REW will be removed.	Revised. The impact to CCW has been increased to account for indirect impacts to severed portion of CCW 15260 (see Table 7.3 in consolidated issue 154 in Section 7.3.2). Reference to EPP Lake 450 has been removed following revocation of the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 on 20 November 2015.
	HPC02 – No adverse hydrological change in the condition to remaining wetlands, Ellen Brook, Mound Springs SCP TEC and Claypans of the SCP TEC.		Unchanged.
	HPC03 – No adverse impact on groundwater quality or availability of the Gnangara Mound.		Unchanged.
Proposed management measures	(See FVM03.)	An EMP will be developed and implemented during construction and will include measures for mitigating and managing hydrological impacts particularly in regard to the generation, storage, handling and release of pollutants (including total suspended solids (TSS), ASS, hydrocarbons and chemicals), including an emergency spill response procedure.	Deleted. This is addressed under management measure FVM03.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	HPM01 – A wetland and drainage management and monitoring plan will be developed and implemented, including groundwater monitoring to ensure impacts to wetlands and the Gnangara Mound are appropriately managed and there are no unforeseen impacts.	A drainage management and monitoring plan will be developed and implemented, including a groundwater monitoring procedure to ensure impacts to Gnangara Mound are being appropriately managed.	Revised. Rephrased to combine two management measures (i.e., single hydrological management and monitoring plan rather than two).
	(See HPM01.)	A wetland management and monitoring plan will be developed and implemented, including groundwater monitoring to ensure impacts to wetlands (including Ellen Brook) are appropriately managed and there are no unforeseen impacts.	Deleted. This is addressed under management measure HPM01.
	(See FVM05.)	A detailed infrastructure plan will be prepared for each stage of the development prior to construction to ensure that the proposal is designed and constructed in accordance with the drainage strategy. This will include details of key proposal elements including locations and dimensions (e.g. culverts, bioretention swales, infiltration basins) and, where possible, identify any areas of CCW and REW that can be retained following final design.	Deleted. This is addressed under management measure FVM05.
	HPM02 – The road surface will be constructed above the design maximum groundwater level.		Unchanged.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	HPM03 – Design and construct culverts in accordance with the drainage strategy to maintain surface water flows, including maintaining hydraulic connectivity between areas of wetland intersected/fragmented by the proposal.	Design and locate culverts to maintain surface water flows, including maintaining hydraulic connectivity between areas of wetland intersected/fragmented by the proposal.	Revised. Minor change to wording. A reference to the drainage strategy has been included.
	HPM04 – Maintain hydraulic connectivity of groundwater upstream and downstream of the road embankment where clay is present within 0.5 m of the road embankment foundation through the installation of culverts where surface flows are anticipated.		Unchanged.
	HPM05 – Design and construct the proposal in accordance with the drainage strategy including promoting runoff for small rainfall events onto the ground as close to the source as possible for infiltration through the most appropriate infiltration drainage mechanism (i.e. vegetated/grassed swales/verge, bio-retention swales, soak well type pits and retention/detention basins).	Promote runoff for small rainfall events onto the ground as close to the source as possible for infiltration, through the most appropriate infiltration drainage mechanism (i.e. vegetated/grassed swales/verge, bioretention swales, soak well type pits and retention/detention basins).	Revised. Minor change to wording. A reference to the drainage strategy has been included.
	HPM06 – Construction laydown areas and stockpiles (including storage of hazardous materials and refuelling activities) will be located outside the WHPZs and 50 m from all CCWs, Mound Springs SCP TECs and Claypans of the SCP TEC to mitigate potential water quality impacts.		Unchanged.
	HPM07 – Undertake bridge construction at Ellen Brook during low flows and outside the low flow channel. Bridge footings will be piled.	Bridge construction at Ellen Brook will be undertaken during periods when Ellen Brook is at low flow. All construction works will be completed outside the low flow area to prevent impacts to surface water flow during construction and bridge footings will be piled.	Revised. Minor change to wording. Removed unnecessary justification text.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	HPM08 – A detailed ASS investigation will be undertaken to inform the development of an ASS Management Plan.	Following final design and the definition of likely soil disturbance, a detailed ASS investigation will be undertaken to inform the development of an ASS Management Plan.	Revised. The timing link is a constraint and does not provide any practical benefit. A sufficient ASS investigation can be conducted using a near-final design.
	HPM09 – Following final design and identification of appropriate water abstraction locations (where not in accordance with an existing bore/licence) an investigation into water abstraction requirements will be undertaken to understand the extent and scale of associated impacts on groundwater.		Unchanged.
	HPM10 – Construction water abstraction bores will be sited and operated such that drawdown impacts to environmentally sensitive receptors are within the usual seasonal variations of groundwater levels for those receptors, unless further studies into those receptors' ecological water requirements (EWRs) show impacts to be insignificant. Monitoring bores may be used to monitor groundwater levels and verify hydrogeological modelling.		Unchanged.
	HPM11 – Where practical, construction of bridge footings will be scheduled during summer to avoid dewatering requirements. If dewatering is required, dewatering methods (e.g. well-point spears) that minimise the radius of influence in confirmed areas of ASS and on sensitive receptors (e.g. wetlands) will be utilised.		Unchanged.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	HPM12 – Any dewatering and abstraction of construction water will be undertaken in accordance with approved licences under the *Rights in Water and Irrigation Act 1914*. A dewatering management plan (including ASS management) will be developed and implemented in support of any application for dewatering and a groundwater licence operating strategy will be developed and implemented as necessary to support the supply of construction water.		Unchanged.
	HPM13 – The use of spread footings in final design will be considered where sands are deemed suitable to support structures at raised interchanges, to minimise the extent of any anticipated disturbance to ASS.		Unchanged.
	HPM14 – Interference with Ellen Brook bed and banks during bridge construction and direct impacts to wetlands from road construction will be undertaken in accordance with a permit under the *Rights in Water and Irrigation Act 1914*.	Interference with beds and banks associated with bridge construction over Ellen Brook and direct impacts to wetlands from road construction will be undertaken in accordance with an approved permit under the *Rights in Water and Irrigation Act 1914*.	Revised. Minor change to wording.
	HPM15 – The EMP will emphasise the importance of the Gnangara UWPCA and refer to the appropriate policies and Water Quality Protection Notes.	(No previous management measure.)	New. This management measure has been added in response to consolidated issue 79 (see Chapter 9, Response to Department of Water Issues) and following consultation with Department of Water.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	HPM16 – All fuel and chemicals will be stored in a double skin tank and placed in bunds capable of storing 125% of the capacity of the largest tank.	(No previous management measure.)	New. This management measure has been added in response to consolidated issue 79 (see Chapter 9, Response to Department of Water Issues) and following consultation with Department of Water.
	HPM17 – Spill response kits will be available during refuelling which will only be conducted outside WHPZs. Individual fuel storage tanks will not exceed 5,000 L capacity within the P1 area.	(No previous management measure.)	New. This management measure has been added in response to consolidated issue 79 (see Chapter 9, Response to Department of Water Issues) and following consultation with Department of Water.
Amenity (noise and vibration)			
Environmental outcomes	NVC01 – Construction noise will comply with the prescribed standards for noise emissions under the Environmental Protection (Noise) Regulations 1997.	(No previous outcome.)	New. Although mentioned in PER Table 11.3 (Noise and Vibration), Section 11.7, this was not explicitly stated as a commitment.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	NVC02 – Operational noise will not exceed the noise limit of 60 dB L_{Aeq} as prescribed in State Planning Policy 5.4 between Reid Highway and Ellenbrook.	(No previous outcome.)	New. Although mentioned in PER Table 11.3 (Noise and Vibration), Section 11.7, this was not explicitly stated as a commitment.
Proposed management measures	NVM01 – A Construction Noise and Vibration Management Plan (CNVMP) will be developed for any out of hours works (outside of 7.00 a.m. to 7.00 p.m. Monday to Saturday) in accordance with the Environmental Protection (Noise) Regulations 1997, to the satisfaction of DER and relevant local government authorities. The CNVMP will be developed prior to construction to ensure all works are carried out in accordance with AS 2436:2010 - Guide to Noise and Vibration control on Construction, Demolition and Maintenance sites, and will include the following mitigation/management measures: • Using equipment with low noise levels and maintaining noise control devices on equipment. • Using broadband reversing alarms on construction equipment. • Taking precautionary measures to avoid vibration damage to buildings near work sites. • Vibration will not exceed a particle velocity of 5 mm/s during construction.		Unchanged.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	• A dilapidation survey will be undertaken prior to construction. • Providing a 24-hour noise and vibration complaint hotline during construction and maintaining a complaints register. • Obtaining necessary approval to work outside of normal working hours, if required. • Providing public notification where receptors may be impacted by construction noise and/or vibration, particularly when works will occur outside normal working hours. • Minimising the amount of night-time traffic and construction adjacent to residential areas. • Undertaking noise and vibration monitoring during construction in response to complaints or at potentially affected locations to alert operators of exceedances of noise and vibration limits.		
	NVM02 – Locate road infrastructure as far as practicable to the west within the road reserve in the vicinity of Ellenbrook to minimise noise impacts.	Locating the road infrastructure as far to the west within the road reserve as far as is practicable, in the vicinity of Ellenbrook, to minimise noise impacts.	Revised. Minor change to wording.
	NVM03 – Use the quietest practical road surface.	Using the quietest practical road surface.	Revised. Minor change to wording.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	NVM04 – Construct noise walls to a maximum height of 5 m adjacent to noise sensitive premises between Reid Highway and Ellenbrook and of a material with a surface density exceeding 15 kg/m^2 to achieve the noise limit of 60 dB $L_{Aeq\ (Day)}$.	Constructing noise walls to a maximum height of 5 m at noise sensitive premises adjacent to the alignment between Hepburn Avenue and Ellenbrook with the aim to ensure noise levels do not exceed the noise target of 55 dB L_{Aeq} at these premises, as far is reasonably practicable. Noise walls will be a constructed of material with a surface density exceeding 15 kg/m^2.	Revised. The revised transportation noise assessment (see Chapter 4, Amenity (Noise and Vibration)) has shown that the noise limit of 60 dB $L_{Aeq\ (Day)}$ can be met at noise sensitive receivers south of Maralla Road. While modelling shows that the noise target of 55 dB $L_{Aeq\ (Day)}$ will be achieved at most residences in Ellenbrook, it is not practicable to achieve this noise level at some locations due to the 5 m cap on noise wall height.
	(See NVM04.)	Should the construction of noise walls not result in achieving the noise target of 55 dB L_{Aeq} at noise sensitive receptors between Hepburn Avenue and Ellenbrook, efforts will be made to achieve the noise limit of 60 dB L_{Aeq}.	Deleted. The revised transportation noise assessment shows that the noise limit of 60 dB L_{Aeq} will be met for these sensitive receptors (see Chapter 4, Amenity (Noise and Vibration), Table 4.2). This is addressed under management measure NVM04.
	NVM05 – Construct screening walls of a maximum height of 2.4 m at noise sensitive premises north of Ellenbrook where they are within 100 m of the road.	Where the road is located within 100 m of residential properties north of Ellenbrook, a visual screening wall will be constructed of 2.4 m in height.	Revised. Minor change to wording.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	NVM06 – Where the SPP 5.4 noise limit (60 dB $L_{Aeq\ (Day)}$) is unable to be achieved at rural residential properties north of Ellenbrook, indoor noise levels at these properties will be reduced to as low as reasonably practicable through the application of noise mitigation, set out in the Implementation Guidelines for SPP 5.4 (WAPC, 2014), as discussed and agreed with the affected property owners.	Façade protection packages will be implemented at identified properties north of Ellenbrook where noise levels are likely to exceed the day limit criteria of 60 dB L_{Aeq}. The level of treatment provided will be determined on a case-by-case basis in consultation with affected property owners and is likely to consist of 6 mm thick glazing to windows.	Revised. Minor change to wording. This management measures now aligns with EAG 13. Specific reference to 6 mm glazing has been removed as building mitigation will be determined in consultation with affected residents (see Chapter 4, Amenity (Noise and Vibration), Table 4.2).
	NVM07 – Noise monitoring will be undertaken to confirm the as built and operating highway achieves the SPP 5.4 noise limit (60 dB $L_{Aeq\ (Day)}$) at residences south of Maralla Road. Based on the results of the monitoring, MRWA may implement additional noise mitigation.	(No previous management measure.)	New. This management measure has been added in response to submissions on noise and consultation with affected residents. It will verify the results of the transportation noise assessment.
Rehabilitation and decommissioning			
Environmental outcomes	RDC01 – All areas of temporary disturbance will be revegetated by the re-establishment of a cover of vegetation suited to the location.		Unchanged.
	RDC02 – Rehabilitation of the road verge will improve the amenity of the site, improve the stability of unpaved surfaces and promote ecological sustainability.	Rehabilitation of the road verge will improve the amenity of the site, the stability of unpaved surfaces and promote ecological sustainability.	Revised. Minor change to wording.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
Proposed management measures	(See FVM03.)	An EMP will be developed and implemented during construction.	Deleted. This is addressed under management measure FVM03.
	RDM01 – A detailed revegetation plan will be developed outlining a clear timeframe for mitigation and management measures, monitoring actions and completion targets.		Unchanged.
	RDM02 – Retain topsoil for placement on areas where revegetation will be undertaken. In the absence of adequate topsoil, suitable growth medium will be used. If additional topsoil is required, materials must be contaminant and weed free.		Unchanged.
	(See FVM03.)	Dieback hygiene procedures will be implemented to ensure no cross-contamination of dieback free material occurs.	Deleted. This is addressed under management measure FVM03.
	(See FVM03.)	Weed hygiene procedures will be implemented to minimise the risk of introducing weeds into rehabilitated areas.	Deleted. This is addressed under management measure FVM03.
	RDM03 – Conserve and where possible chip good quality vegetation during clearing for reuse as mulch.	Conserving and where possible chipping good quality vegetation, during clearing, for reuse as mulch.	Revised. Minor change to wording.
	RDM04 – Unsuitable topsoil and cleared vegetation will be treated or disposed during the clearing works	Treating or disposing unsuitable topsoil and cleared vegetation during the clearing works.	Revised. Minor change to wording.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	RDM05 – Landscaping will be undertaken in accordance with the landscaping types and extent present in the proposal footprint (rural zone, transition zone and urban zone).		Unchanged.
	RDM06 – Local provenance native species that represent the floristic formations of the proposal footprint will be selected for revegetation.		Unchanged.
	RDM07 – Rehabilitation will be scheduled progressively where practicable. Timing of activities will, however, be dependent on optimal seasons.	Scheduling rehabilitation progressively where practicable. Timing of activities will, however, be dependent on optimal seasons.	Revised. Minor change to wording.
	RDM08 – Ongoing maintenance will be performed as part of a maintenance program.	Ongoing maintenance will form part of the regional Maintenance Program and will be the responsibility of the Asset Manager.	Revised. Minor change to wording and removal of specific role titles/program names.
Aboriginal heritage			
Environmental outcomes	AHC01 – No disturbance to any Aboriginal heritage site outside of that approved under Section 18 of the *Aboriginal Heritage Act 197*2.		Unchanged.
	AHC02 – Minimise impacts to unknown Aboriginal heritage sites.		Unchanged.
Proposed management measures	AHM01 – An EMP will be developed and implemented during construction and will include measures for mitigating and managing impacts to known and unknown Aboriginal heritage sites. It will include induction requirements for contractors, protection of known and potential (e.g., NorthLink 14-01 and 14-02) Aboriginal heritage sites and procedures to be followed if a previously unknown Aboriginal heritage site is found.	Prepare and implement an Aboriginal Heritage Management Plan.	Revised. The EMP will address management of impacts to Aboriginal heritage sites during construction.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	AHM02 – Obtain the necessary Section 18 consent under the *Aboriginal Heritage Act 197*2 prior to disturbing any Aboriginal heritage site within the proposal footprint.	An application under Section 18 of the AH Act will be submitted to the DAA to obtain approval from the Minister of Aboriginal Affairs to disturb these sites within the proposal footprint.	Revised. Minor change to wording.
	(See AHM01.)	All relevant staff/contractors will be informed about the presence and location of Aboriginal archaeological sites NorthLink 14-01 and NorthLink 14-02, which may be considered Aboriginal sites under Section 5(a) of the AH Act.	Deleted. This is addressed under management measure AHM01.
	(No proposed commitment.)	Other stakeholders such as landowners will be informed about any sites on their property.	Deleted. All landowners are made aware of the presence of Aboriginal sites on their property through the application process under Section 18 of the AHA Act (see AHM02).
	AHM03 – Prior to nearby ground disturbance, sites NorthLink 14-01 and NorthLink 14-02 will be clearly delineated using physical markers and/or fencing. Physical barriers will be inspected periodically to ensure they are maintained throughout construction.	Prior to nearby ground disturbance, sites NorthLink 14-01 and NorthLink 14-02 will be clearly delineated using physical markers and/or fencing and existing induction programmes/materials altered to alert staff in the area about the restrictions in entering or working near these heritage areas. Physical barriers may require periodic maintenance to ensure effectiveness.	Revised. Minor change to wording. Removed unnecessary justification text. The applicable timeframe (i.e., construction) has been specified.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	AHM04 – South-West Aboriginal Land and Sea Council (SWALSC) and other relevant Aboriginal people will be consulted before commencing work within the boundaries of Stored (archaeological) place 3552.		Unchanged.
	AHM05 – Should any ground disturbance be proposed for Registered (archaeological) sites, Lodged Places DAA Place ID 3692, DAA Place ID 20058, DAA Place ID 21393, DAA Place ID 21620, NorthLink 14-01 and NorthLink 14-02: • MRWA will seek formal, written advice from the DAA as to whether Ministerial consent is required under Section 18 of the *Aboriginal Heritage Act 1972* for the proposed works. • Consultation with SWALSC and other relevant Aboriginal people will take place. • An application will be made under Section 18 of the *Aboriginal Heritage Act 1972* to disturb ground on which these sites are located, where necessary.		Unchanged.
	AHM06 – Monitoring by archaeologists and/or appropriately trained members of the Noongar community will take place in areas that have high potential for sites with some archaeological integrity.		Unchanged.
	AHM07 – MRWA will continue to consult with SWALSC and other relevant Aboriginal people on the documentation and management of Aboriginal sites.		Unchanged.
European heritage			
Environmental outcomes	EHC01 –No disturbance to any European heritage site outside of the proposal footprint.		Unchanged.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
Proposed management measures	EHM01 – A site visit will be undertaken to enable external photographs to be taken of the Ellenbrook Estate Area, Muchela and Drainage/Irrigation Channel that may be subject to the Government Heritage Property Disposal Process (GHPDP). The site visit should enable an understanding of the nature and extent of original/historic fabric remaining on site.	A site visit will be undertaken to enable external photographs to be taken of the Ellenbrook Estate Area, Muchela and the Drainage/Irrigation Channel that may be subject to the GHPDP. The site visit should enable an understanding of the nature and extent of original/historic fabric remaining on-site.	Revised. Minor change to wording.
	EHM02 – Comply with the Government Heritage Property Disposal Process with regard to the Ellenbrook Estate Area, Muchela, the Drainage/Irrigation Channel and the Forestry Department's Divisional Headquarters' and Fire Lookout site.	Comply with the GHPDP through preparing a letter to the State Heritage Office advising of further clearance of the Ellenbrook Estate Area, Muchela, the Drainage/Irrigation Channel and the Forestry Department's Divisional Headquarters' and Fire Lookout site.	Revised. Minor change to wording.
	EHM03 –Inform the City of Swan, Shire of Chittering and City of Bayswater that the proposal is occurring in close proximity to, and may have an impact on, locally listed heritage places and confirm the requirement for any further planning approval (e.g., planning approval under the Shire of Chittering's Local Planning Scheme No. 6).	Inform the Shire of Chittering and advise that the proposal is occurring and will directly impact on two locally listed heritage places: Muchela and the Drainage/Irrigation Channel. Clarification is required on the status of these places on the Shire's Heritage List and what process is required to enable the further clearance of this site.	Revised. Minor change to wording. Rephrased to combine two management measures.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	EHM04 – Site inductions will include information on European Heritage values identified within and adjacent to the development envelope (including maps) and will ensure that all construction personnel are aware of their location and the need for care during construction.	Clearly mark the European heritage values identified adjacent to the study area on future mapping for the proposal in order to ensure that all construction personnel are aware of their location and the need for care during construction or with any future boundary changes.	Revised. Minor change to wording. The commitment's wording has been made consistent with other language in the PER.
	(No new commitment.)	Inform the City of Swan, Shire of Chittering and City of Bayswater that the proposal is occurring and that it is occurring in close proximity to locally listed heritage places.	Deleted. This is addressed under management measure EHM03.
Amenity (Reserves)			
Environmental outcomes	ARC01 – Minimise impacts to Dick Perry Reserve and Whiteman Park.	(No previous outcome.)	New. Although mentioned in PER Chapter 15, Amenity (Reserves), this was not explicitly stated as a commitment.
Proposed management measures	ARM01 – Re-establishment of a barrier fence along the western side of the proposal to ensure access to the Dick Perry Reserve is controlled. Access gates for fire management activities will be established at regular intervals as agreed with DPAW.	Re-establishment of a barrier fence along the western side of the proposal to ensure access to the reserve is controlled. Gates for access for fire management activities will be established at regular intervals as agreed with DPAW.	Revised. Minor change to wording.
	ARM02 – Linking of walk trails with PSP at the interchanges on Gnangara Road and at Ellenbrook to ensure continuity of the trails within Dick Perry Reserve.	Linking of walk trails with PSP at the interchanges on Gnangara Road and at Ellenbrook to ensure continuity of the trails.	Revised. Minor change to wording.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	ARM03 – To ensure safe exit in the event of fire, a vehicle underpass will be provided at the crossing of Baal Street in Whiteman Park. Additionally, an access road parallel to the alignment will be constructed in the vicinity to provide access for the Cullacabardee community.	To ensure safe exit in the event of fire, a vehicle underpass will be provided further south at the crossing of Baal Street. Additionally, an access road parallel to the alignment will be constructed in this vicinity to provide access for the Cullacabardee community.	Revised. Minor change to wording.
	ARM04 – MRWA will continue to work with DPAW in the preparation of an agreement, including detailed site plans and specifications, for construction of the length of the proposed highway through Dick Perry Reserve. The agreement may include removal and provision of an alternative water source for Black Cockatoos.	(No previous management measure.)	New. This commitment has been added following the submission from and further consultation with DPAW (see consolidated issue 34 in Section 8.4) and a submission from a member of the public (see consolidated issue 85 in Section 12.8.1).
	ARM05 – MRWA will retain and translocate heritage cork trees in Dick Perry Reserve.	(No previous management measure.)	New. This commitment has been added following a submission from and further consultation with DPAW (see consolidated issue 34 in Section 8.4).
	ARM06 – MRWA will provide additional planting in the vicinity of Cyrenian House for screening and amenity.	(No previous management measure.)	New. This commitment has been added following further consultation with Cyrenian House (see consolidated issue 3 and Table 12.1 in Section 12.5).

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
Matters protected under the EPBC Act			
Environmental outcomes	(See FVC01, FVC02, FVC03, FVC11, TFC01 and HPC02.)	(No previous outcome.)	No environmental outcomes were explicitly stated in PER Chapter 16, Matters Protected Under the EPBC Act. However, environmental outcomes relating to MNES are addressed under management measures FVC01, FVC02, FVC03, FVC11, TFC01 and HPC02.
Proposed management measures (Threatened flora)	MPM01 – Establish, clearly demarcate and maintain a 50 m vegetated buffer around known locations of *Caladenia huegelii*.	A vegetated buffer will be maintained around the known locations of threatened flora [*Caladenia huegelii*]. The buffer will be a minimum of 50 m where possible.	Revised. Minor change to wording. Rephrased to combine two management measures. Management and monitoring is addressed under management measure FVM04.
	(See MPM01.)	Vegetation to be retained as a buffer for Threatened flora will be clearly demarcated.	Deleted. This is addressed under management measures FVM10 and MPM01.
	(See FVM03 and FVM04.)	Preparation and implementation of an EMP and monitoring program prior to construction to ensure impacts to Threatened flora and their vegetated buffers are being appropriately managed.	Deleted. This is addressed under management measures FVM03 and FVM04.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	(No new commitment.)	If clearing occurs within the [Threatened flora] buffer, the impacted vegetation will be immediately rehabilitated and revegetated.	Deleted. Management measures are in place to prevent clearing within Threatened flora buffers.
	(No new commitment.)	Additional targeted surveys [for *Caladenia huegelii*] will be undertaken prior to vegetation clearing to clearly define population boundaries and to identify any additional populations within and adjacent to the proposal footprint, to inform the final design and construction.	Deleted. Additional targeted surveys have now been completed (see Chapter 3, Spring Ecological Surveys).
	(No new commitment.)	If populations of Grand Spider Orchid are identified as occurring within the proposal footprint, the merits of translocation will be researched. If feasible, the plants will be translocated to adjacent populations.	Deleted. Additional targeted surveys have now been completed- no population were identified within the proposal footprint (see Chapter 3, Spring Ecological Surveys).
	(No new commitment.)	Habitat surveys [for *Caladenia huegelii*] will occur in spring 2015 to further define the extent of critical habitat within the proposal footprint.	Deleted. Additional targeted surveys have now been completed (see Chapter 3, Spring Ecological Surveys).
	MPM02 – Establish, clearly demarcate and maintain a 10 m vegetated buffer around known locations of *Grevillea curviloba* subsp. *incurva*.	A vegetated buffer will be maintained around the known locations of [*Grevillea curviloba* subsp. *incurva*]. The buffer will be a minimum of 10 m.	Revised. Minor change to wording.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
	MPM03 – Avoid direct impact to and maintain the continuity of *Grevillea curviloba* subsp. *incurva* habitat in the Brand Highway road reserve by using a bridge structure.	Vegetation located along the Brand Highway road reserve will be maintained during final design of the proposal with the aid of a bridge structure. The construction of a bridge will ensure continuity in the habitat along Brand Highway.	Revised. Minor change to wording.
	MPM04 – Establish, clearly demarcate and maintain a 10 m buffer in existing vegetation around known locations of *Darwinia foetida*	(No previous management measure.)	New. *Darwinia foetida* has been added following its recent discovery in the proposal footprint (see Section 3.5).
Proposed management measures	(See FVM02 and FVM05.)	Disturbance will be restricted to the proposal footprint.	Deleted. This is addressed under management measures FVM02 and FVM05.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
(TECs)	(See FVC01 and FVC02.)	The Commonwealth TEC Claypans of the SCP will be avoided. The Commonwealth TEC Mound Springs SCP will be avoided. The Commonwealth TEC Muchea Limestone on the SCP will be avoided.	Deleted. TEC Muchea Limestone on the SCP does not occur within the development envelope and is not at risk of being directly impacted by the proposal. Claypans of the SCP is addressed under environmental outcomes FVO01. Mounds Springs SCP is addressed under environmental outcomes FVO02.
	(See HPM09 and HPM10.)	An investigation into dewatering and water abstraction requirements will be undertaken to understand the extent and scale of impacts on the groundwater and the TEC.	Deleted. This is addressed under management measures HPM09 and HPM10.
	(See HPM10.)	Groundwater abstraction will not adversely impact the groundwater levels that influence the TEC.	Deleted. This is addressed under management measure HPM10.
	(See FVM03 and FVM04.)	Preparation and implementation of an EMP and monitoring program prior to construction to ensure there are no indirect impacts to the functionality of the TEC.	Deleted. This is addressed under management measures FVM03 and FVM04.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
Proposed management measures (Threatened and migratory fauna species)	(See FVM02 and FVM05.)	Avoidance of vegetated areas in design (49.6 ha) and keep clearing to a minimum during construction.	Deleted. Delineation of clearing boundary and areas to be retained are addressed under management measures FVM02 and FVM05.
	(See FVM02 and FVM05.)	Reduce design footprint to minimise impact on suitable breeding trees (68 trees avoided) and foraging habitat.	Deleted. Delineation of clearing boundary and areas to be retained are addressed under management measures FVM02 and FVM05.
	(See Offset Proposal 1.)	Offsetting of lost [Black Cockatoo] habitat.	Deleted. This is addressed by Offset Proposal 1.
	(See TFM04.)	Landscaping design to avoid foraging species planted on road verge.	Deleted. This is addressed under management measure TFM04.
	(See FVM03.)	Implementation of management measures in the EMP.	Deleted. This is addressed under management measure FVM03.
Proposed management measures	(See FVM03 and FVM04.)	An EMP will be prepared and implemented, including management and monitoring of intact native vegetation.	Deleted. This is addressed under management measures FVM03 and FVM04.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
(Commonwealth land)	(See FVM02 and FVM05.)	Disturbance will be restricted to the proposal footprint.	Deleted. Delineation of clearing boundary and areas to be retained are addressed under management measures FVM02 and FVM05.
	(See FVM02 and FVM05.)	Finalisation of design will endeavour to avoid and minimise impacts to CCW and REWs within the proposal footprint. Where any areas of CCW and REW can be retained these will be identified within a detailed infrastructure plan prior to construction.	Deleted. This is addressed under management measure FVM05.
	(See HPM01.)	A wetland management and monitoring plan will be prepared and implemented.	Deleted. This is addressed under management measure HPM01.
	(See FVM02.)	During construction use boundary fencing or flagging will be used.	Deleted. This is addressed under management measure FVM02.
	(See Offset Proposal 1)	Offsetting of lost [Black Cockatoo] habitat.	Deleted. This is addressed by Offset Proposal 1.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
Offsets			
Offset Proposal 1	MRWA will fund the Acquisition of 673.5 ha of land at Lot M2091 (Plan 6457) Ioppolo Road, Chittering to be vested with the Conservation Commission for conservation purposes in perpetuity, and subsequent management by DPAW to offset the loss of Black Cockatoo habitat.	MRWA will vest 673.5 ha of land with the Conservation Commission, and subsequent management by the DPAW for conservation purposes.	Revised. The proposal's offset strategy has been amended – see Chapter 6, Environmental Offsets.
Offset Proposal 2	MRWA will prepare a restoration offset plan that will include the acquisition and covenanting of several properties to be managed for conservation, including restoration and management funding for a period of 7 years (or until restoration completion criteria are met), to offset the loss of CCWs, Black Cockatoo habitat and under-represented vegetation.	MRWA will fund the acquisition or covenanting of a property or properties to be managed for conservation, or for improved management or rehabilitation to offset the loss of CCW. The properties will contain at least 32 ha of CCW.	Revised. The proposal's offset strategy has been amended – see Chapter 6, Environmental Offsets.
Offset Proposal 3	MRWA will provide funding for a period of up to 10 years for the ongoing management of potential critical *Caladenia huegelii* habitat within existing reserves 46919 and 46875, Bush Forever site 300 and Whiteman Park.	MRWA will undertake further surveys of the site that potentially represents TEC SCP02 Southern Wet Shrublands. These surveys will be conducted in spring 2015. If the TEC is confirmed, MRWA will commit to acquire or covenant the location of one ha of land representative of this TEC or a TEC of similar of greater threat	Revised. The proposal's offset strategy has been amended – see Chapter 6, Environmental Offsets.

Aspect	Proposed environmental outcomes and management measures	Previous environmental outcome/management measure (if different)	Status and reason for change (if any)
Offset Proposal 4	MRWA will fund the acquisition or covenanting of a property or properties to be managed for conservation, including management funding for a period of 7 years to offset the loss of SCP20a.	MRWA will fund the acquisition or covenanting of a property or properties to be managed for conservation or for improved management or rehabilitation to offset the loss of Forest Red-tailed Black Cockatoo habitat in addition to the offset area proposed in Offset Proposal 1. Offset Proposal 1 does not contain sufficient Forest Red-tailed Black Cockatoo habitat to offset the impacts of the proposal and an additional 60 ha of habitat in similar condition to Offset Proposal 1 is required.	Revised. The proposal's offset strategy has been amended – see Chapter 6, Environmental Offsets.

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14 GLOSSARY

14.1 Abbreviations

Term	Definition
AH Act	*Aboriginal Heritage Act 1972*
ASS	acid sulfate soils
CCTV	closed-circuit television
CCW	Conservation Category Wetland
CEMP	Construction Environmental Management Plan
CNVMP	Construction Noise and Vibration Management Plan
CR	Critically Endangered
CS Act	*Contaminated Sites Act 2003*
DAA	Department of Aboriginal Affairs
DBNGP	Dampier to Bunbury Natural Gas Pipeline
DEC	Department of Environment and Conservation
DER	Department of Environment Regulation
DFES	Department of Fire and Emergency Services
DOD	Department of Defence
DOL	Department of Lands
DOP	Department of Planning
DOT	Department of Transport
DOTE	Department of the Environment
DOW	Department of Water
DPAW	Department of Parks and Wildlife
DRF	Declared Rare Flora
EAG	Environmental Assessment Guideline
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EN	Endangered
EP Act	*Environmental Protection Act 1986*
EPA	Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPP Lakes	*Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* Note: this policy was revoked 20 November 2015.

Term	Definition
ESD	Environmental Scoping Document
EWR	ecological water requirements
FCT	floristic community type
FVMMP	Flora and Vegetation Management and Monitoring Plan
GDEs	groundwater dependent ecosystems
GHPDP	Government Heritage Property Disposal Process
GNH	Great Northern Highway
GSS	Gnangara Sustainability Strategy
IBRA	Interim Biogeographic Regionalisation of Australia
ISCA	Infrastructure Sustainability Council of Australia
M	Migratory
MNES	Matters of National Environmental Significance
MRS	Metropolitan Region Scheme
MRWA	Main Roads Western Australia
MUW	Multiple Use Wetland
OEPA	Office of the Environmental Protection Authority
P1	Priority 1
P2	Priority 2
P3	Priority 3
P4	Priority 4
P5	Priority 5
PDNH	Perth–Darwin National Highway
PEC	Priority Ecological Community
PER	Public Environmental Review
PPR	Perth-Peel Region
PSP	Principal Shared Path
RAP	Recycled Asphalt Planings
REW	Resource Enhancement Wetland
RIWI Act	*Rights in Water and Irrigation Act 1914*
ROM	Regional Operations Model
SAPPR	Strategic Assessment of the Perth and Peel Regions
SCP	Swan Coastal Plain
SES	State Emergency Service
SRE	short-range endemic

Term	Definition
SWA02	Perth subregion 2 in IBRA
SWALSC	South-West Aboriginal Land and Sea Council
T	Threatened
TEC	Threatened Ecological Community
TSS	Total Suspeneded Soilds
UFI	unique feature identifier
UWPCA	Underground Water Pollution Control Area
VU	Vulnerable
WA	Western Australia
WAH	Western Australian Herbarium
WAPC	Western Australia Planning Commission
WC Act	*Wildlife Conservation Act 1950*
WDMMP	Wetland and Drainage Managament and Monitoring Plan
WHPZ	Wellhead Protection Zone
WONS	weeds of national significance
WPP	weed prioritisation process
WQPN	Water Quality Protection Notes

14.2 Units and Symbols

°	degrees
%	percentage
°C	degrees Celsius
dB	decibel
dBA	A-weighted decibel
ha	hectare
km	kilometre
kg	kilogram
L_{Aeq}	average noise energy
$L_{A10,18\ hour}$	the average of the hourly L_{a10} (noise level exceeded for 10% of the measuring period) levels between 6.00 a.m. and midnight
$L_{Aeq\ (Day)}$	the average of the hourly L_{Aeq} levels between 6.00 a.m. and 10.00 p.m.
$L_{Aeq\ (Night)}$	the average of the hourly L_{Aeq} levels between 10.00 p.m. and 6.00 a.m.
m	metre
m^2	square metre

mm millimetre

14.3 Definitions

A

Amenity *n.* features, facilities, or services of a house, estate, district, etc., which make for a comfortable and pleasant life.

B

Bush Forever sites *n.* a plan designed to identify, protect and manage regionally significant bushland in metropolitan Perth.

C

Carriageway *n.* each of the two sides of a dual carriageway or motorway, each of which usually have two or more lanes.

Controlled action *adj.* a proposed action that is likely to have a significant impact on: a matter of national environmental significance; the environment of Commonwealth land (even if taken outside Commonwealth land); or the environment anywhere in the world (if the action is undertaken by the Commonwealth).

Congestion *adj.* condition on road networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increased vehicular queueing. The most common example is the physical use of roads by vehicles.

Constrained area *n*. an area where there is an expectation that development will be able to proceed, this may include urban, urban deferred or industrial zoned land or land with existing development approvals.

D

Dampland *n.* a type of vegetation characterised by occasional *Eucalyptus rudis* trees over *Melaleuca preissiana* and/or *Melaleuca rhaphiophylla* low woodland over occasional heath scrub dominated by *Pericalymma spp., Astartea spp*. and *Melaleuca spp*. over sedges and rushes. This habitat type is an area where moisture collects and during the winter months becomes seasonally waterlogged.

Dieback *n.* a condition of plants observed to start at the outer leaf tips causing gradual yellowing, loss of leaves and progressive lifelessness; may be caused by a variety of agents including salinity, drought, insect damage or plant pathogens such as the fungus *Phytophthora cinnamomi*.

Development envelope *n.* the area for which MRWA is seeking approval to implement the proposal within.

E

Edge effect *n.* refers to the changes in population or community structures that occur at the boundary of two habitats.

Ephemeral creek *adj*. a creek or portion of a creek which flows briefly in direct response to precipitation in the immediate vicinity and whose channel is at all times above the ground water reservoir.

Environmental offset *n.* is an offsite action or actions to address significant residual environmental impacts of a development or activity.

F

Flyovers *n.* a high-level overpass, built above main overpass lanes, or a bridge built over what had been an at-grade separation.

Foraging *n.* the seeking or obtaining of food.

G

Grade separation *n.* is the method of aligning a junction of two or more surface transport axes at different heights (grades) so that they will not disrupt the traffic flow on other transit routes when they cross each other.

H

Habitat fragmentation *n.* is the process by which habitat loss results in the division of large, continuous habitats into smaller, more isolated remnants.

P

Precautionary principle *n*. an ethical and political principle, applying particularly in the environmental context, which states that if there is the risk of serious or irreversible harm occurring to people or to the environment, lack of full scientific certainty about the existence of the risk should not be used as a reason for failing to take or for postponing measures to prevent it.

Predation *n.* the killing of an individual of another species as a habitual source of food.

Proposal footprint *n.* the area required to be disturbed based on the proposal's current design.

R

Rehabilitation *adj.* is the repair of ecosystem processes and includes the management of weeds, disease or feral animals.

S

Short-range endemic *n.* species of animal (predominantly Invertebrates) that have a restricted distribution, less than 10,000 km^2.

Study area *n.* is the survey area identified in the initial design footprint and will differ depending on the specialist study.

T

Topographical *adj*. relating to the arrangement or accurate representation of the physical features of an area.

V

Vegetation association *n.* a concept that covers two or more plant communities with similar structure and dominant species. May vary significantly in associated species but all stands referred to it will have some visual similarity.

Vegetation complex *n.* a concept that covers a range of structural types that occur in a related pattern with borders defined by major geomorphological units with some subdivision on floristics between southern and northern parts of the geomorphological units.

W

Wetland *n.* an area in which the soil is frequently or permanently saturated with or under water, as a swamp, marsh.

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15 REFERENCES

Publications

360 Environmental. 2014. Swan Valley Bypass, Perth–Darwin National Highway: Level 2 Flora and Vegetation Survey. February. Draft report prepared for Main Roads Western Australia by 360 Environmental Pty Ltd.

Bamford. 2011. Roads and Wildlife. A Review of Purpose-Built Fauna Underpasses. July. Report prepared by M.J. and A.J. Bamford Consulting Ecologist for City of Armadale.

Bissonette, J and Hammer, M., 2000. Effectiveness of Earthen Return Ramps in Reducing Big Game Highway Mortality in Utah. November. USGS Utah Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife, College of Natural Resources, Utah State University, Utah.

Coffey. 2015a. Public Environmental Review: Perth-Darwin National Highway (Swan Valley Section). Volume 1: Main text. September. Report prepared for NorthLink WA by Coffey Environments Pty Ltd, Burswood, Western Australia.

Coffey. 2015b. Level 2 Flora and Vegetation Assessment: Perth–Darwin National Highway. May. Prepared for NorthLink WA by Coffey Environments Australia Pty Ltd, Burswood, Western Australia.

Coffey. 2015c. NorthLink WA: Perth-Darwin National Highway – Preliminary Black Cockatoo Offset Consideration. Memorandum. 13 July 2015.

Coffey. 2015d. Flora, Vegetation and Fauna Assessment. Lot M2091 Ioppolo Road, Chittering. Perth–Darwin National Highway. April. Report prepared for NorthLink WA by Coffey Environments Australia Pty Ltd, Burswood, Western Australia.

Coffey. 2015e. Perth-Darwin National Highway: Targeted Forest Red-tailed Black Cockatoo Survey of the Ioppolo Road Offset Site. Memorandum. 31 August 2015.

DEC. 2009. Grand Spider Orchid (Caladenia huegelii) Recovery Plan. Department of Environment and Conservation, Kensington, Western Australia.

DOP. 2015. Bush Forever dataset. Metropolitan_Region_Scheme_Bush_Forever_Areas_DOP_20151203. Current 3 December 2015. Department of Planning, Perth, Western Australia.

DOTE. 2004. Water Quality Protection Note No. 25. Land use compatibility in Public Drinking Water Source Areas. July. Prepared by the Department of the Environment.

DOTE. 2013. Matters of National Environmental Significance. Significant Impact guidelines 1.1. Department of the Environment, Canberra, Australian Capital Territory.

DOTE. 2016. *Darwinia foetida* in Species Profile and Threats Database. A WWW publication accessed on 25 February 2016 at http://www.environment.gov.au. Department of the Environment, Canberra, Australian Capital Territory.

DOW. 2004. Stormwater Management Manual. February. Department of Water, Perth, Western Australia.

DOW. 2009. Decision process for stormwater management in WA. August. Department of Water, Perth, Western Australia.

DOW. 2011. Perth Shallow Groundwater Systems Investigation. Lexia Wetlands. Hydrogeological record series. May. Department of Water, Perth, Western Australia.

DPAW. 2013a. A methodology for the evaluation of specific wetland types on the Swan Coastal Plain, Western Australia. August. Draft report prepared by Department of Parks and Wildlife, Bentley, Western Australia.

DPAW. 2013b. Weed Prioritisation Process for DPAW (formerly DEC) - "An integrated approach to Weed Management on DPAW-managed lands in WA". November. Department of Parks and Wildlife, Western Australia.

DPAW. 2015. Corporate Guideline No. 14: Environmental Offsets – Proponent Land Management Contributions. August. Department of Parks and Wildlife, Western Australia.

DSEWPAC. 2012. EPBC Act referral guidelines for three threatened black cockatoo species. Department of Sustainability, Environment, Water, Population and Communities.

EPA. 2004a. Guidance for the Assessment of Environmental Factors – Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia No. 56. June. Environmental Protection Authority, Western Australia.

EPA. 2004b. Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia No. 51. June. Environmental Protection Authority, Western Australia.

EPA. 2006. Guidance for the Assessment of Environmental factors – Level of Assessment for Proposal Affecting Natural Areas within the System 6 Region and Swan Coastal Plain Portion of the System 1 Region No. 10. June. Environmental Protection Authority, Perth, Western Australia.

EPA. 2008. Environmental Guidance for Planning and Development. Guidance Statement No. 33. May. Environmental Protection Authority, Western Australia.

EPA. 2013. Environmental Assessment Guideline for Recommending environmental conditions. September. EAG 11. Environmental Protection Authority, Western Australia.

EPA. 2014. Environmental Assessment Guideline for Consideration of environmental impacts from noise. EAG 13. September. Environmental Protection Authority, Western Australia.

EPA. 2015a. Perth and Peel @ 3.5 Million. Environmental impacts, risks and remedies. July. Environmental Protection Authority, Western Australia.

EPA. 2015b. Environmental Assessment Guideline for Environmental principles, factors and objectives. EAG 8. January. Environmental Protection Authority, Western Australia.

Finn, H., Barrett, G., Groom, C., Blythmann, M. and Williams, M. 2014. The 2014 Great Cocky Count: a community-based survey for Carnaby's Black Cockatoos (*Calyptorhynchus latirostris*) and Forest Red-tailed Black Cockatoos (*Calyptorhynchus banksii naso*). June. Report prepared by Birdlife Australia and Department of Parks and Wildlife, Western Australia.

Froend, R., Loomes, R., Horwitz, P., Bertuch, M., Storey, A. and Bamford, M. 2004a. Study of Ecological Water Requirements on the Gnangara and Jandakot Mounds under Section 46 of the Environmental Protection Act. Task 2: Determination of Ecological Water Requirements. Prepared for Waters and Rivers Commission by Centre for Ecosystem Management, Edith Cowan University, Joondalup, Western Australia.

Froend, R., Loomes, R., Horwitz, P., Rogan, R., Lavery, P., How, J. Storey, A., Bamford, M. and Metcalf, B. 2004b. Study of Ecological Water Requirements on the Gnangara and Jandakot Mounds under Section 46 of the Environmental Protection Act. Task 1: Identification and Re-evaluation of Ecological Values. September. Prepared for Waters and Rivers Commission by Centre for Ecosystem Management, Edith Cowan University, Joondalup, Western Australia.

GHD. 2013a. Mitchell Freeway extension. Flora and fauna assessment report. November. Prepared for Main Roads Western Australia by GHD Pty Ltd.

GHD. 2013b. Perth–Darwin National Highway – Tonkin Highway Link Alignment Definition Study: Environmental Impact Assessment and Biological Survey. October. Report prepared for Main Roads Western Australia, by GHD Pty Ltd.

Gibson, N., Keighery, B. J., Keighery, G. J., Burbidge, A. H. and Lyons, M. N. 1994. A Floristic Survey of the southern Swan Coastal Plain. Unpublished report for the Australian Heritage Commission prepared by Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc.).

Golder. 2015a. Design Groundwater Level for Central Section of NorthLink WA Road Alignment. NorthLink WA Perth–Darwin National Highway. April. Report prepared for NorthLink WA by Golder Associates.

Golder. 2015b. Design Groundwater Level for Northern Section of NorthLink WA Road Alignment. NorthLink WA Perth–Darwin National Highway. August. Report prepared for NorthLink WA by Golder Associates.

Golder. 2015c. Design Groundwater Level for Southern Section of NorthLink WA Road Alignment. NorthLink WA Perth–Darwin National Highway. May. Report prepared for NorthLink WA by Golder Associates.

Government of Western Australia. 2000. State Planning Policy 1: State Planning Framework Policy. May. Prepared under Section 5AA of the Town Planning and Development Act 1928 by Western Australia Planning Commission, Perth, Western Australia.

Government of Western Australia. 2009. State Planning Policy 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning. September. Prepared under Section 26 of the Planning and Development Act 2005 by Western Australia Planning Commission, Perth, Western Australia.

Government of Western Australia. 2011. WA Environmental Offsets Policy. September. Environmental Protection Authority, Western Australia.

Government of Australia. 2012. *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy. October. Department of Sustainability, Environment, Water, Population and Communities, Canberra, Australian Capital Territory."

Government of Western Australia. 2014. WA Environmental Offsets Guidelines. August. Environmental Protection Authority, Western Australia.

Griffin, E. A. and Trudgen, M. E. 2015. Analysis of floristic data from Ioppolo Road and Hepburn Avenue to assign sites to floristic community types. December. Report prepared for Coffey Environments by E. A. Griffin & Associates with M. E. Trudgen & Associates.

Hill, A. L., Semeniuk, C. A., Semeniuk, V. and Del Marco, A. 1996. Wetlands of the Swan Coastal Plain. Vol. 2b. Wetland Mapping, Classification and Evaluation, Wetland Atlas. Water and Rivers Commission and Department of Environment Protection, Western Australia.

Johnstone, R. E., and Storr, G. M. 1998. Handbook of Western Australian Birds. Vol. 1 - Non-Passerines (Emu to Dollarbird). Western Australian Museum, Perth, Western Australia.

Keighery, B. J. Keighery, G. J. Longman, V. M. and Clarke, K. A. 2012. Native and Weed Flora of the Southern Swan Coastal Plain: 2005 Dataset. Department of Environment and Conservation, Kensington, Western Australia.

MRWA. 2004. Environmental Policy Statement. June. Prepared by Main Roads Western Australia.

MRWA. 2010. Design of Fauna Underpasses. A WWW publication accessed on 23 January 2015 at https://www.mainroads.wa.gov.au/BuildingRoads/StandardsTechnical/RoadandTrafficEngineering/RoadsideItems/Pages/Design_of_Fauna_Underpasses.aspx. Main Roads Western Australia, East Perth, Western Australia.

MWH. 2016. Muchea Bell (*Darwinia foetida*) population located adjacent to the Perth-Darwin National Highway. February. Report prepared by MWH Australia Pty Ltd, Subiaco, Western Australia.

QDMR. 2000. Fauna Sensitive Road Design. Queensland Department of Main Roads, Planning, Design and Environment Division, Brisbane, Queensland.

Phoenix Environmental. 2015. Flora and fauna assessment for Muchea North and Chittering study area. Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project. December. Final report prepared for Muchea to Wubin Integrated Project Team (Main Roads WA, Jacobs and Arup) by Phoenix Environmental Sciences Pty Ltd, Balcatta, Western Australia.

Roe 7 Alliance. 2004. *Caladenia huegelii* Conservation and Management Plan. Rev C. May. Prepared by the Roe 7 Alliance.

South Metro Connect. 2011. Roe Highway Extension: Public Environmental Review. Prepared for Main Roads Western Australia.

The University of Western Australia. 2013. The Factors Affecting the Use of Fauna Underpasses by Quenda and Bobtail Lizards. October. Report prepared for Main Roads Western Australia.

Van Etten, E. J. 2014. Assessment of edge effects and other indirect impacts of the proposed Keane Road Strategic Link. March. Report prepared for Enviroworks and City of Armadale.

VicRoads. 2010. Interpretation and applicable of VicRoads Traffic Noise Reduction Policy 2005. VicRoads, Victoria. July 2010.

WAPC. 2005. Guideline for the Determination of Wetland Buffer Requirements. December. Prepared for the Department for Planning and Infrastructure. Western Australian Planning Commission, Perth, Western Australia.

WAPC. 2014. Implementation Guidelines for State Planning Policy 5.4 - Road and Rail Transport Noise and Freight Considerations in Land Use Planning. Published by Department of Planning, Western Australia.

WAPC. 2015. May 2015 Draft Perth and Peel@3.5million. May. Western Australian Planning Commission, Perth, Western Australia.

Woodman Environmental. 2015a. Perth-Darwin National Highway (Swan Valley Section) - Supplementary Biological Studies 2015: Assessment and Refinement of Potential Critical Habitat for *Caladenia huegelii* (T-DRF) within the Development Envelope. November. Report prepared for Coffey Environments Pty Ltd on behalf of Main Roads Western Australia by Woodman Environmental Consulting Pty Ltd.

Woodman Environmental. 2015b. Perth-Darwin National Highway (Swan Valley Section) - Supplementary Bioloigcal Studies 2015: Spring surveys for *Meeboldina decipiens* subsp. *decipiens* (P3) and *Millotia tenuifolia* var. *laevis (*P2). November. Report prepared for Coffey Environments Pty Ltd on behalf of Main Roads Western Australia by Woodman Environmental Consulting Pty Ltd.

Woodman Environmental. 2015c. Perth-Darwin National Highway (Swan Valley Section) - Supplementary Biological Studies 2015: Spring Surveys and Analysis to Investigate SCP02 Presence. November. Report prepared for Coffey Environments Pty Ltd on behalf of Main Roads Western Australia by Woodman Environmental Consulting Pty Ltd.

Woodman Environmental. 2015d. Perth-Darwin National Highway (Swan Valley Section) - Supplementary Biological Studies 2015: Assessment of the Presence of the TEC SCP20a at Ioppolo Rd, Chittering. November. Report prepared for Coffey Environments Pty Ltd on behalf of Main Roads Western Australia by Woodman Environmental Consulting Pty Ltd.

Personal Communications

Chambers, B. Research Fellow, School of Animal Biology, University of Western Australia. Telephone conversation. Late 2014.

Errington, A. Land Tenure Project Officer, Department of Parks and Wildlife, Perth, Western Australia. Email. 25 August 2015.

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APPENDIX A

OEPA Summary



Government of **Western Australia**
Office of the **Environmental Protection Authority**

Mr Rob Arnott
Project Director
Main Roads Western Australia
PO Box 6202
EAST PERTH WA 6892

Your Ref: *13/1616*
Our Ref: *AC01-2014-0005*
Enquiries: *Peta Hayward, 6145 0856*
Email: *peta.hayward@epa.wa.gov.au*

Dear Mr Arnott

PERTH-DARWIN NATIONAL HIGHWAY – PUBLIC ENVIRONMENTAL REVIEW – ASSESSMENT NO. 1994

Please find enclosed matters raised by the Office of the Environmental Protection Authority (OEPA) regarding your Public Environmental Review (PER) document (Attachment 1) for the above proposal. The OEPA has also summarised the main issues that were raised in the submissions (Attachment 2). A copy of the public submissions was provided to Main Roads Western Australia via email on 13 October 2015.

You are required to address these issues and provide a response to the OEPA. The Environmental Protection Authority (EPA), in seeking your response, does not necessarily endorse the issues raised but asks you to respond to them as you see fit and to modify your proposal, or its environmental management, accordingly.

Please note, the submissions from Government agencies including the Department of Parks and Wildlife (Parks and Wildlife), Department of Water (DoW), Department of Aboriginal Affairs (DAA), Department of Planning (DoP), Department of Environment Regulation (DER) and the Department of Lands (DoL) have been included separately in Attachment 3. Please ensure you address all the issues raised by Parks and Wildlife, DoW and DER and have consideration for the issues raised by DAA, DoP and DoL.

The OEPA considers that the key issues for the proposal include:

Flora and Vegetation
It is understood that the proponent is in the process of finalising a number of biological studies and investigations which would increase the level of confidence in the predicted environmental impacts to significant flora and threatened communities. This information will need to be presented in the response to submissions in order to finalise

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the significant residual impacts of the proposal and demonstrate that the EPA's objective can be met.

It is noted that a number of public submissions have suggested that there are still further opportunities to avoid and minimise impacts to native vegetation and flora. This also applies to Bush Forever Site 480, Victoria Road. It is recommended that these suggestions are given due consideration in the proponent's response to submissions. If there are any changes to the proposal characteristics and/or commitments with respect to the design of the proposal, then these should be clearly set out in the response to submissions.

Terrestrial fauna

Further information is required in relation to using the Swan Coastal Plain region as the basis for assessing impacts on native fauna at the regional scale. Further information in relation to this is provided in Appendix 1.

Similar to comments regarding the Flora and Vegetation, some submitters consider that there are still further opportunities to avoid and minimise impacts to Black Cockatoo breeding habitat (potential nesting trees).

Environmental Offsets

To demonstrate the proposed offsets in the PER document meet the environmental offsets policy and the EPA's objective, further information will need to be provided in relation to the following issues:

1. It is understood that the proponent is in the process of finalising a number of biological surveys on Offset Proposal 1 which will assist in determining whether this site contains the environmental values and attributes to be lost. Both the OEPA and the Parks and Wildlife notes that should the further surveys indicate that the offset site is not suitable then an alternative offset may need to be proposed for threatened species and communities.
2. Offset proposals must consider the need for ongoing management. This is particularly the case for offsets that include a land acquisition component where the Parks and Wildlife is expected to be the future management agency.
3. Further work to account for and reconcile the residual impacts with the values and attributes that need to be offset. This also includes providing further justification for some of the proposed offset ratios.
4. Consideration to including a rehabilitation of cleared/disturbed areas component to address the net loss of the Black Cockatoo habitat, as suggested in a number of submissions.

Details of the further information requested in relation to the proposed environmental offsets is set out in the Attachment 1.

Amenity (Noise and Vibration)

The OEPA requests that the technical matters raised in the Department of Environment Regulation's advice of 14 October 2015 (in Attachment 3) be resolved in

the proponent's response to submissions to ensure that the potential impacts on noise amenity are not under predicted and that the mitigation measures are appropriate.

Inland Waters Environmental Quality
Prior to finalising the response to submissions, the OEPA requests that the proponent discuss with the Department of Water the matters raised in their advice of 5 October 2015 (in Attachment 3), in order to confirm the management measures required for the construction of the proposal, to minimise impacts to the Priority 1 Underground Water Pollution Control Area and therefore be consistent with the relevant policies for this issue.

A copy of the summary of the public submissions and your responses will be included as an appendix in the EPA's Report and Recommendations. Under the *Environmental Protection Act 1986*, the EPA's report is subject to a 14 day appeal period. During this period the public may appeal the EPA's Report and Recommendations. An incomplete answer to any of the issues raised could cause the public to appeal and this would delay the setting of Ministerial Conditions. Accordingly, please ensure that you give a full and reasoned answer to each issue.

Should you require further information please contact Peta Hayward on phone number (08) 6145 0856 in the first instance. Please advise by 13 November 2015 when you will submit the Response to Submissions document, or to discuss any matters. Please quote the above "Our ref" on any further correspondence.

Yours sincerely



Anthony Sutton
Director
Assessment and Compliance Division

23 October 2015

Encl: Attachment 1: OEPA comments on the proposal
Attachment 2: Summary of Public Submissions
Attachment 3: Government agency comments

Government of **Western Australia**
Office of the **Environmental Protection Authority**

Attachment 1

Perth-Darwin National Highway

PUBLIC ENVIRONMENTAL REVIEW
ASSESSMENT NO. 1994

SUMMARY OF THE OFFICE OF THE ENVIRONMENTAL PROTECTION AUTHORITY COMMENTS

This document forms a summary of the Office of the Environmental Protection Authority comments regarding the Public Environmental Review document for the Perth-Darwin National Highway proposed by Main Roads WA.

The public review period for the proposal commenced on 7 September 2015 for a period of 4 weeks, ending on 6 October 2015.

OEPA Comment	Proponent Response
Flora and Vegetation	
The Office of the Environmental Protection Authority (OEPA) notes that further targeted 2015 spring surveys are to be undertaken. These surveys are proposed to address the following: • confirmation of the presence of *Caladenia huegelii* critical habitat on the Offset Proposal 1 - Iopollo Road site; • confirmation of the extent of the inferred occurrence of Threatened Ecological Community (TEC) SCP20a on the Offset Proposal 1 - Iopollo Road site; • confirmation of the presence of TEC SCP02 within the proposal development envelope; • confirmation of the population size of *Millotia tenuifolia* var. *laevis;* • confirmation of the population size of *Meeboldina decipiens* subsp. *decipiens* ms. Please provide a discussion on the outcomes of these surveys (include technical data as an appendix), including final residual impacts, any revised management, monitoring and mitigation measures and any amendments to the offset proposals.	
It is not clear from the Public Environmental Review (PER) document whether the clearing of 205 hectares (ha) of native vegetation is in addition to or, includes the following environmental values: • 49.6 ha of Groundwater Dependent Ecosystems (GDE); • 128.5/171.5 ha of Bush Forever (see comments below regarding inconsistencies in area to be cleared); • 4.4 ha of two State TECs;	

OEPA Comment	Proponent Response
• 145.5 ha of five State Priority Ecological Communities (PEC); • 39.2 ha of *Caladenia huegelii* critical habitat; and • 2 ha of *Grevillea curviloba* subsp. *incurva* critical habitat. Further to the above it is also not clear how the 205 ha was derived. The PER document describes intact vegetation as vegetation in degraded to pristine condition. However, when adding up the vegetation in degraded to pristine condition to be cleared in the proposal footprint from Table 8.9, this does not equate to 205 ha. The OEPA also notes in the PER document that revegetated and rehabilitated sites have not been included in the 205 ha of native vegetation to be directly impacted. In accordance with section 51A of the *Environmental Protection Act 1986* (EP Act) and section 4 of the EP Act Clearing Regulations, which defines native vegetation to include vegetation that was sown, planted or propagated as a requirement under the EP Act or another written law or, was funded (wholly or partly) by a person who was not the owner of the land for the purpose of biodiversity conservation or land conservation. Please provide further analysis of whether the areas of revegetation and rehabilitation to be directly impacted fit within the criteria of the legislation mentioned above and adjust the total area of clearing of native vegetation, accordingly. Further detail should also be provided on how the extent of 205 ha to be cleared was derived and clarify whether the areas of environmental values listed above to be impacted are included in the 205 ha or whether they are in addition to.	
The OEPA notes that Bush Forever Site 480 Victoria Road Bushland would be significantly impacted from the proposal, with only 15.9% of this site remaining. The PER document states that the proposal is	

OEPA Comment	Proponent Response
constrained in this area with few opportunities for avoidance of clearing of vegetation within this Bush Forever site. Please provide a discussion on how the proponent has tried to avoid and mitigate this significant impact, by describing the different interchange designs that were initially considered.	
The proposal would remove 20% of the total extent of SCP23b Northern *Banksia attenuata – Banksia menziesii* woodlands. The PER document states that this community is known from only one occurrence and the extent of this occurrence is not available, and thus the overall impact cannot be assessed. Based on the information presented in the PER document, the proposal impact is likely to be significant. Please provide additional detail to demonstrate that the impacts from the proposal are not likely to be significant. The OEPA has checked the publically available data (Keighery *et al.* (2012) database on NatureMap 2015) which lists 79 locations of SCP23b.	
The OEPA notes a single occurrence of *Caladenia huegelii* recorded in the study area would not be directly impacted, but would remain within the development envelope. The PER document does not state how this occurrence will be managed and protected. The OEPA also notes that 39.2 ha of critical habitat for the threatened *Caladenia huegelii* would be impacted. However, the PER document does not state what proportion of the known critical habitat this represents, therefore the significance of this impact cannot be assessed. Please provide additional detail on the significance of the impact of the proposal on the critical habitat for the threatened *Caladenia huegelii.* Please also provide details on the management, monitoring and mitigation measures to be implemented to demonstrate that the	

OEPA Comment	Proponent Response
indirect impacts of the proposal will not impact the threatened *Caladenia huegelii*.	
The Environmental Protection Authority (EPA) recently released updated figures for the remaining extent of vegetation complexes on the Swan Coastal Plain (EPA, 2015). Table 8.2 of the PER document overstates the remaining extent of the five vegetation complexes occurring across the proposal development envelope. The proposal occurs within the constrained area for the Perth and Peel regions which has a reduced target for retention of 10%. Please provide a revised table in the Response to Submissions using the updated regional figures of the remaining extent within the Perth Peel Region portion of the Swan Coastal Plain. It should also be noted that the final paragraph on page 8-13 incorrectly states that the SWA IBRA bioregion is considered a constrained area, portions of the Swan Coastal Plain are considered constrained not the Swan Coastal Plain IBRA bioregion in its entirety.	
It is not clear whether the 10 metre (m) buffer proposed around the *Grevillea curviloba* subsp. *incurva* is adequate to protect the individuals from indirect impacts. The PER document states a 50 m buffer is proposed around the threatened *Caladenia huegelii* and a 10 m buffer has been proposed around the threatened *Grevillea curviloba* subsp. *incurva.* The PER document does not provide adequate justification that the 10 m buffer is sufficient to mitigate indirect impacts to the *Grevillea curviloba* subsp. *incurva.* Please provide further detail that the proposed 10 m buffer is sufficient to mitigate indirect impacts to the threatened *Grevillea curviloba* subsp. *incurva* given that a 50 m buffer is proposed for the *Caladenia huegelii*.	
Local vegetation units are defined and analysed relative to regional datasets, where available, to determine the conservation status of the vegetation and the significance of impacts. This proposal occurs within	

OEPA Comment	Proponent Response
a region where there is a good understanding of the conservation status of vegetation, and where regional datasets for statistical comparison are available. It is important for proponents to define local vegetation units for this purpose, but they are not the scale that the EPA will consider impacts in this region. Table 8.10 in the PER document shows that four local vegetation units appear to be significantly impacted because the proposal would clear more than 90% of their mapped extent (AsMIEvCl 98.1%, Ba 94.5% and CcMp 90%). This is misleading because local vegetation units have been compared to the available regional dataset and no assessment is required at this local scale in this case. Please provide additional information to respond to the matter raised above, particularly in relation to those local vegetation units which appear to be significantly impacted by the proposal.	
Fauna	
While mention has been made of local or regionally significant species, the PER document discusses a few species that have statutory listing and still does not adequately justify the impact of the proposal on local or regionally significant species. In addition, it is unclear if the report has consolidated the results from all surveys in the study area or if the proponent has based their assessment only on the results from the *Level 2 Targeted Fauna Assessment Perth-Darwin National Highway* (Coffey, 2015). Consequently, the assessment focuses on impacts to terrestrial species, and wetland fauna and wetland fauna habitat appear to have been overlooked. Please provide additional detail to demonstrate that the EPA's objective for Terrestrial Fauna can be met for those species that are locally or regionally significant including wetland fauna.	
It appears that the proponent has incorrectly applied the use of regional scale to assess impacts. For example, impacts to the Carpet Python, Southern Brown Bandicoot and Brush Wallaby appear to have	

OEPA Comment	Proponent Response
been assessed at a broader southwest scale. Although these species are widespread in the southwest of Western Australia, they are in decline and rare on the Swan Coastal Plain. The Southwest is too broad to be used to assess impacts of this proposal. Impacts at the regional level should be assessed over the Swan Coastal Plain region. Please provide further analysis in the Response to Submissions that addresses the impacts to fauna from the proposal using the Swan Coastal Plain region as the regional scale.	
Offsets	
The offset section focuses mainly on direct impacts and does not include consideration of indirect impacts, particularly the issue of fragmentation. The OEPA considers that the PER document does not provide adequate information to inform the assessment of whether the environmental values being fragmented will be indirectly impacted and cease to persist post construction of the proposal. Some examples include (not an exhausted list): • the proposal dissects two occurrences of TEC SCP20a, it is not clear whether the remaining fragmented portions will persist long term; • the proposal would directly impact 0.4 of the TEC SCP02 (dependent on the outcome of the targeted 2015 spring surveys), it is not clear whether the remaining portion of the TEC would persist long term; and • Bush Forever site 97 - the proposal will result in a small portion (4.3 ha) of very good to good bushland to being fragmented from the main bushland and is surround by areas of degraded to completely degraded. It is not clear whether this remaining portion will persist in the same condition long term. Please provide further analysis on the issue of indirect impacts, particularly the likely persistence of TECs, threatened flora and fauna,	

OEPA Comment	Proponent Response
conservation areas and wetlands that will remain after construction of the proposal. If these are unlikely to persist in the long term, the assessment of the significance of the impact should be considered as the whole occurrence, not just the area directly impacted by the proposal.	
There appears to be a number of inconsistencies between the offsets in Chapter 17 and other sections of the document. The main inconsistencies include: • the direct impact on Bush Forever sites in Chapter 8 and the Executive Summary is stated as being 128.5 ha, however, Chapter 17 states the removal of 171.5 ha of Bush Forever sites; • the Executive Summary states the proposed offset for impacts to TEC SCP02 is 0.2 ha, however, Chapter 17 states 1 ha of TEC SCP02 as part of Proposed Offset 3 (see comments below regarding the adequacy of this offset). It is noted this Proposed Offset is subject to change dependent on the outcome of the 2015 spring targeted survey; and • the direct impact on the number of Conservation Category Wetlands (CCWs) varies between five and six throughout the PER document. Please provide confirmation on the following: • the area of Bush Forever that will be directly and indirectly impacted; • the final area of TEC SCP02 that will be offset; and • the number of CCWs that would be directly impacted from the proposal.	
The OEPA notes that the TEC SCP02 could also be classed as SCP11 (not listed) and that a targeted 2015 spring survey will be undertaken to confirm if the site is consistent with SCP02. Offsets Proposal 3	

OEPA Comment	Proponent Response
commits to acquiring 1 ha of the TEC SCP02, which represents >2:1 offset. It is not clear how this ratio was determined. The proponent should use the Commonwealth Offsets calculator to determine an appropriate offset for the TEC SCP02 if it is confirmed as SCP02 and considered to be a significant residual impact. Information provided by Department of Parks and Wildlife is that there are no areas of the TEC SCP02 available for acquisition and that other occurrences of the TEC are already within conservation tenure. The proponent should not knowingly propose an offset that is unlikely to be obtained. Please provide the details and outcome of the survey mentioned above in the Response to Submissions. Should the targeted spring 2015 survey confirm the TEC SCP02 will be impacted by the proposal, the proponent will need to provide a suitable offset in consultation with the OEPA, including the rationale to calculate the offset.	
Table 17.3 of the PER document states that 4 ha of TEC SCP20a would be impacted by the proposal and that an offset of 8 ha is required. This equates to a ratio of 2:1 and it is unclear how this offset ratio has been determined. As mentioned above the indirect impacts of fragmentation of the TEC will also need to be considered. The Offset Proposal 1 site contains 78 ha of inferred TEC SCP20a. The OEPA notes that targeted spring 2015 surveys are to be undertaken to confirm the presence of the inferred TEC SCP20a. Please provide the details and outcome of the survey mentioned above in the Response to Submissions. Should the proposed Iopollo Rd offset site not be found suitable to offset the residual impact on TEC SCP20a an alternative offset will need to be provided. Please provide details of the rationale behind using a 2:1 offset ratio. The Commonwealth Offsets calculator should be used to determine an appropriate offset for TEC SCP20a.	

OEPA Comment	Proponent Response
The technical reports state that the 'entire area was adequately surveyed' but no Black Cockatoos or feeding evidence were observed during the targeted fauna assessment. Please provide any evidence in the Response to Submissions to provide additional confidence that the proposed offset site Iopollo Road is suitable to counterbalance any significant residual impacts to both species of Black Cockatoo's. It should also be noted that the final paragraph in section 2.4 of Appendix V states that the OEPA confirms suitability of the Iopollo Road as an offset for both species of Black Cockatoo. Please note the EPA will determine the suitability of any offsets for the proposal.	
The conservation areas being impacted by the proposal include Class A Nature Reserve (8 ha), Bush Forever (see comment above regarding inconsistencies with the area of impact), and State Forest (106 ha). Table 17.3 states that the offset area required for conservation areas is 253 ha. This equates to a 1:1 ratio, it is unclear how this offset ratio has been determined and the OEPA advises it is likely to be inadequate. Table 17.3 and Figure 17.2 refers to 673.5 ha for Offset Proposal 1 being used to offset residual impacts to the conservation areas. An offset for conservation areas should be representative of the environmental values being impacted and the associated attributes which may be lost. There is no consideration of how the Offset Proposal 1 site represents the values being impacted in the conservation areas. Class A Nature Reserves are the highest level of conservation reservation and a much higher offset ratio is likely to be required, if approval is granted. See Gorgon Gas Development (Ministerial Statement 800) and Cape Lambert to Emu Siding Rail Duplication in Millstream Chichester National Park (Ministerial Statement 918).	

OEPA Comment	Proponent Response
Bush Forever has a target to protect at least 10% of every vegetation complex, offsets need to be representative of the Bush Forever complexes being impacted in order to maintain representation. The EPA's recent strategic advice for the Perth and Peel (EPA, 2015) considers Bush Forever areas as being highly constrained due to the extent of clearing on the Swan Coastal Plain. It is noted that the Offset Proposal 1 site does not have the same vegetation complexes as the conservation areas being impacted. It is noted that Bush Forever areas overlap with Class A Nature Reserve and State Forest (31.5 ha, the PER document does not state what portion of this is Class A Nature Reserve and what portion is State Forest). Bush Forever areas that overlap with Class A Nature Reserves should be considered as part of the offset for the Class A Nature Reserve. Bush Forever areas which overlap State Forest should be considered as part of the Bush Forever offset. A 1:1 ratio may be appropriate for impacts to State Forest if the vegetation is of the same quality and represents the values being impacted. Please provide additional discussion on the comparison of vegetation quality, environmental values and attributes of the proposed offset site for Offset Proposal 1 and the conservation areas proposed to be impacted by the proposal. The discussion should include the rationale behind the proposed offset ratio's and the suitability of Offset Proposal 1 site to offset residual impacts to conservation areas taking into account the above comments. A revision of the proposed offsets in the PER document may be necessary and provided in the Response to Submissions to address the residual impacts to conservation areas as outlined above.	
The PER document states that a targeted spring 2015 survey of the Offset Proposal 1 - Iopollo Road site will be conducted to determine the presence of critical habitat for the *Caladenia huegelii.*	

OEPA Comment	Proponent Response
The PER states that 39.2 ha of critical habitat for the threatened flora *Caladenia huegelii* would be impacted. An offset ratio of 1:1 is proposed as part of Offset Proposal 1, this species was not included in the quantification of offsets table (Table 17.4) and as such no rationale has been provided for this ratio. Please provide the details and outcome of the survey mentioned above in the Response to Submissions. Should the proposed Iopollo Rd offset site not be found suitable to offset the impact on critical habitat for *Caladenia huegelii* an alternative offset will need to be provided. Please provide details of the rationale behind using a 1:1 offset ratio. The Commonwealth Offsets calculator should be used to determine an appropriate offset for *Caladenia huegelii* critical habitat.	
In accordance with the *WA Environmental Offsets Guidelines* (Government of Western Australia, 2014) land acquisition offsets must consider the need for ongoing management. As the land is proposed to be ceded and managed by the Department of Parks and Wildlife, the EPA generally expects the proposed offset should include contribution for the management (up to 20 years) plus the upfront conversion costs. Given that Main Roads Western Australia (MRWA) has purchased the property on Iopollo Road Chittering and have made mention of some required ongoing management measures in Appendix V (rubbish removal, prevention of third parties, existing weeds and dieback to be actively managed) it is expected MRWA can provide some detail of the ongoing management and associated costs. Please provide detailed information on the proposed on-going management activities for the Iopollo Road proposed offset site, including funding arrangements. Consideration of the funding arrangements for on-going management for each of the offset proposals where land acquisition is proposed should also be outlined.	
The acquisition of Offset Proposal 1 site is protecting existing foraging habitat. The protection of this land under covenant does not increase	

OEPA Comment	Proponent Response
the availability of foraging habitat for black cockatoo species, and therefore does not mitigate the loss of 201.8 ha for Carnaby's Cockatoo and 120.1 ha for Red-tailed Black Cockatoo habitat. Furthermore, the EPA's recently released strategic advice for the Perth and Peel region (EPA, 2015) has a preference for the rehabilitation of areas to improve natural environments. The proponent should take into consideration rehabilitation and revegetation when proposing offsets.	
The PER document states that 14.8 ha from six CCWs will be directly impacted and 1.2 ha from one CCW will be indirectly impacted. An offset ratio of 2:1 is proposed as part of Offset Proposal 2, however, no rationale has been provided for this ratio. The Roe Highway Extension (Ministerial Statement 1008) proposal had a ratio of 3:1 applied for CCWs. Please provide details of the rationale behind the ratio of 2:1 for offsetting CCWs.	

References

1. Environmental Protection Authority 2015, *Perth and Peel @ 3.5 Million Environmental impacts, risks and remedies*, Interim Strategic Advice, Perth, WA.

2. Government of Western Australia 2014, *WA Environmental Offsets Guidelines,* Perth, WA.

Government of **Western Australia**
Office of the **Environmental Protection Authority**

Attachment 2

Perth-Darwin National Highway

PUBLIC ENVIRONMENTAL REVIEW
ASSESSMENT NO. 1994

SUMMARY OF PUBLIC SUBMISSIONS

This document forms a summary of public submissions and advice received regarding the Public Environmental Review document for the Perth-Darwin National Highway proposed by Main Roads WA.

The public review period for the proposal commenced on 7 September 2015 for a period of 4 weeks, ending on 6 October 2015. A total of 11 public submissions were received.

The principle issues raised in the submissions and advice received included environmental and social issues as well as issues focussed on questions of fact and technical aspects of the proposal. Although not all of the issues raised in the submissions are environmental, the proponent is asked to address all issues, comments and questions, as they are relevant to the proposal.

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1. The proposal – General comments

Submitter	Submission and/or issue	Response to comment
Maralla Land Syndicate	The submitter considers that an additional entrance and exit point to the Perth Darwin National Highway (PDNH) from Maralla Road is appropriate, stating that an entrance point on Maralla Road would be easy to connect straight to the Great Northern Highway and act as an enabler of future development north of Maralla Road. Please advise whether consideration has been given to the provision of an additional entrance and exit point in this location. See submission ANON-FD3J-U7KD-2 for further details.	
Wildflower Society of WA and 1 Anonymous Submitter	The submitters raise matters in relation to the potential for the implementation of additional mitigation measures to further reduce the amount of clearing proposed. It is considered that there is opportunity for further changes to the alignment that could further minimise impacts of the proposal. Please provide a discussion as to whether the following measures could assist in further reducing clearing, have been considered: • installing wire rope barriers to reduce the pavement batter/recovery zone width; • following the contour more closely rather than using cut and fill extensively; • not clearing all the vegetation, especially on the back slopes of drains; • reducing size and depth of table drains; • reducing the need for any fire access tracks, or wind the tracks around significant vegetation; • routing the Principal Shared Path through cleared or degraded areas and adjacent to residential areas; and	

Submitter	Submission and/or issue	Response to comment
	• changes to the development envelope and alignment. See submissions ANON-FD3J-U7KG-5 and ANON-FD3J-U7KT-J for further details.	
Anonymous	The submitter considers that it is not necessary to excise 8 hectares (ha) from Whiteman Park Northwest Corner as opportunity exists for the PDNH to follow the existing Beechboro North road alignment and cross Gnangara Road at a right angle. This would eliminate the Y shape road alignment. Please provide an explanation as to the need for the Y interchange and consequent excision of Whiteman Park. Refer to submission ANON-FD3J-U7KS-H for further details.	
Anonymous	The submitter raises concern in relation to the demarcation of the highway alignment. Please advise whether the surveying of areas to be cleared would be independently audited and whether the local landowners would be consulted on the highway boundary prior to construction. See submission ANON-FD3J-U7KT-J for further details.	
Bullsbrook Residents and Ratepayers Association	The submitter raises matters in relation to the endorsement of the Department of Defence on the proposed alignment. Please advise whether the Department of Defence has endorsed the proposed alignment, and if endorsement is not provided, the implications this may have on the alignment. Refer to submission ANON-FD3J-U7K8-P for further details.	
Wildflower Society of WA and 2 Anonymous	The submitters raise matters in relation to the proposed upgrade of Maralla and Halden Roads and the potential impacts on very good quality Banksia woodland vegetation. It is also suggested that the proposal will improve the general traffic congestion, in particular, in the Swan Valley. The decision to upgrade these	

Submitter	Submission and/or issue	Response to comment
Submitters	roads does not seem necessary in the context of anticipated traffic levels. Please provide justification, in the context of anticipated traffic levels, in regards to the following: • the decision to upgrade Maralla Road and Halden Road, and the extent of the upgrade; and • evidence that the PDNH will significantly decrease traffic through the Swan Valley. See submissions ANON-FD3J-U7KG-5, ANON-FD3J-U7KT-J and ANON-FD3J-U7KB-Z for further details.	

2. Flora and vegetation

Submitter	Submission and/or issue	Response to comment
Bullsbrook Residents and Ratepayers Association Inc. Wildflower Society of WA and 1 Anonymous Submitter	With regards to the Maralla Road/Halden Road Bushland the submitters have identified that Appendix C of the Public Environmental Review (PER) document states that: "*Additional surveys in the spring or optimal flowering periods (should be) undertaken for the purpose of identifying TECs and PECs, and Threatened and Priority flora, focusing on annual species in Site 4 (Maralla Road and Halden Road).*" Please provide responses to the following questions raised in regards to these proposed additional flora surveys: • when are the additional surveys likely to be undertaken and who will be commissioned to complete them; • will the scope of the additional surveys include searching for the presence of *Millotia tenuifoloa* var. *laevis* and *Meeboldina decipiens* subsp. *decipiens* and also characterise the diversity of non-vascular	

Submitter	Submission and/or issue	Response to comment
	plants and fungi in the area; • how will the results of the additional survey work be incorporated into the proposed management plan; and • will management measures such as translocation be implemented to protect impacted individuals. Refer to submissions ANON-FD3J-U7K8-P, ANON-FD3J-U7KG-5 and ANON-FD3J-U7KT-J for further details.	
Bullsbrook Residents and Ratepayers Association Inc.	The submitter raises matters in relation to the limited survey period for the flora surveys. Limiting surveys to springtime could preclude the identification of any new species that flowers at other times of the year. Please provide an explanation as to why flora surveys where only undertaken during short periods in springtime. Refer to submission ANON-FD3J-U7K8-P for further details.	
Anonymous	The submitter raises matters in relation to the classification of vegetation at Lot 9 Maralla Road. The land has not been previously used for agricultural or residential purposes and remains in an unmodified state. Please provide justification as to why the habitat located at Lot 9 Maralla Road has been classified as 'modified vegetation'. Refer to submission ANON-FD3J-U7KB-Z for further details.	
3 Anonymous Submitters	The submitters raise matters in relation to the potential impacts of the proposal on the thynnid wasp (*Zaspilothynnus sp.)* which is responsible for the pollination of *Caladenia huegelii.* Given the close proximity of the *Caladenia huegelii* populations to the development area it is not clear what impacts the road construction and ongoing use of the PDNH will have on the thynnid wasp. Please provide a discussion on whether the potential impacts to the thynnid wasp have been considered in relation to the ecology of *Caladenia huegelii.*	

Submitter	Submission and/or issue	Response to comment
	Refer to submissions ANON-FD3J-U7KW-N, ANON-FD3J-U7KB-Z and ANON-FD3J-U7KT-J for further details.	
3 Anonymous Submitters	The submitters raise concerns that the indirect impacts to *Caladenia huegelii* have not been addressed appropriately as properties adjacent to the proposal were not surveyed to identify the presence of *Caladenia huegelii.* Were there any properties that were not surveyed in close proximity to the proposal that may contain *Caladenia huegelii?* Refer to submissions ANON-FD3J-U7KT-J, ANON-FD3J-U7KB-Z and ANON-FD3J-U7KW-N for further details.	
2 Anonymous Submitters	The submitters raise matters in relation to the potential for the spread of *Phytophthora cinnamomi* (Dieback). During construction it is probable that *Phytophthora cinnamomi* dieback will be transported to unaffected areas by machinery and workers. Please provide details on what measures will be put in place to minimise the risk of spreading this disease, including making sure that no infested or infected soils are used near bushland, and any post-construction treatment regimes. Refer to submissions ANON-FD3J-U7KB-Z and ANON-FD3J-U7KT-J for further details.	
Wildflower Society of WA and 2 Anonymous Submitters	The submitters raise matters in relation to the management of weeds along road verges and the potential for incursion of weeds into adjacent bushland. Weed management should seek to eradicate weeds from, or prevent incursion of weeds into, the adjacent bushland. Please provide further details on the proposed ongoing measures that will be implemented to prevent the spread of invasive weeds. Refer to submissions ANON-FD3J-U7KB-Z, ANON-FD3J-U7KG-5 and ANON-FD3J-U7KT-J for further details.	

Submitter	Submission and/or issue	Response to comment
Wildflower Society of WA	The submitter raises matters in relation to the impacts of the proposal on *Cyanthochaeta teretifolia* (P3). The PER document is inconsistent particularly in regard to the clearing/removal of this species. Please provide a discussion to clarify whether this taxa will be impacted, and any proposed management and mitigation measures that will be implemented. Refer to submissions ANON-FD3J-U7KG-5 for further details.	
Wildflower Society of WA and 1 Anonymous Submitter	The following Priority flora species are listed on Page 8.2 as 'recorded from the flora study area' yet they are not mentioned in Table 8.1: *Millotia tenuifolia* var. *laevis* (P2), *Meeboldina decipiens* subsp. *decipiens* ms (P3), *Ornduffia submersa* (P4) and *Stylidium striatum* (P4). *Eryngium pinnatifidum* subsp. *palustre* PN on the other hand was recorded to occur in the study area in Table 8.1 but was not listed on Page 8.2. Please advise whether these species have undergone name changes or whether this is the first occurrence of these species in the area. Refer to submissions ANON-FD3J-U7KG-5 and ANON-FD3J-U7KT-J for further details.	
Anonymous	The submitter raises matters in relation to the implementation of a list of recommendations provided by the environmental consultants who undertook the Level 2 Flora survey (Appendix C - Page 105). Please identify which of these recommendations Main Roads Western Australia (MRWA) will undertake. Refer to submission ANON-FD3J-U7KT-J for further details.	

3. Terrestrial fauna

Submitter	Submission and/or issue	Response to comment
Bullsbrook Residents and Ratepayers Association and 4 Anonymous Submitters	The submitters raise matters relating to the implementation of fauna underpasses. The proposed underpasses size and design appear very limiting to the types of fauna that will actively utilise them. Please provide responses to the following matter raised: • what methodology was used to determine the number of underpasses required; • has consideration been given to installing additional underpasses in cleared areas; • details on what ongoing monitoring and maintenance will be carried out during operation to determine if the underpasses, escape ramps, fences, retained logs, furniture and revegetation are successful; • justification that 1.2 metre (m) high, 3 m wide and 70 m long fauna underpasses will be utilised by Western Grey Kangaroos; • details of any proposed natural lighting to ensure diurnal species utilise the underpasses; • discussion of the rational for the installation of the 1.2 m cyclone fence along the majority of borders of the highway, with only areas around underpasses being at a height of 1.8 m, considering that 1.2 m is unlikely to be tall enough to limit access from kangaroos, foxes, cats or wallabies; • clarification over the design, of the roadside fences proposed through the Maralla Road Bushland, and adjacent to bushland north of Maralla Road; • details of any fencing monitoring and management program; • further discussion on what extent wildlife underpasses are successfully used by wildlife and whether they would be utilised by all species in the	

Submitter	Submission and/or issue	Response to comment
	area use them, particularly an underpass subject to noise and vibration from a highway being used by heavy traffic like the PDNH and • details of methods to prevent unwanted vehicle access, e.g. trail bikes. Refer to submissions ANON-FD3J-U7K8-P, ANON-FD3J-U7KB-Z and ANON-FD3J-U7KT-J, ANON-FD3J-U87KW-N and ANON-FD3J-U7K7-R for further details.	
Wildflower Society of WA	The submitters raise matters in relation to the potential impacts of noise and vibration on sensitive fauna. The PER document dismisses the potential impacts of noise and vibration on fauna with the statement "the extent of effect of these impacts is difficult to assess as the impact from these is relatively unknown". Whilst it is acknowledged that the extent of impact may be unknown, further consideration should be given to the potential impacts particularly to wallabies, and some birds, which are known to be sensitive to disturbance. Refer to submission ANON-FD3J-U7KG-5 for further details.	
Wildflower Society of WA and 4 Anonymous Submitters	The submitters raise matters in relation to the loss of Black Cockatoo habitat that will occur as a result of implementation of the proposal. The amount of Black Cockatoo habitat that will be lost/cleared is of considerable concern. Potential breeding trees, whilst individually may be considered insignificant, cumulatively become significant. The impact on 737 potential cockatoo breeding sites is highly significant and considered by some submitters to be environmentally unacceptable. Please provide further information regarding the following: • any proposed mitigation measures such as erecting extra high fences, with bird-visible attachments, along the PDNH, especially where it intersects the Maralla Road Nature Reserve, in order to force birds to fly higher; • any proposed measures to eliminate any Dandelions (*Taraxacum*	

Submitter	Submission and/or issue	Response to comment
	officinale) that germinate along the road verge to prevent Cockatoos foraging on these weeds close to the road; • details of any surveys and consultation that have been done during the breeding season of the Black Cockatoos to determine if any suitable trees along the project route have been used by these birds; • details of any assistance, in addition to offsets, that MRWA will provide to the ongoing monitoring of Black Cockatoos in the area; • plans to gradually relocate and replace the existing watering site for the Black Cockatoos to a safe area and the original dam gradually phased out; and • any potential to adjust the road alignment to avoid a stand of trees slightly northwest from Gulf Cove which is home to a group of Black Cockatoos. Refer to submissions ANON-FD3J-U7KG-5, ANON-FD3J-U7KB-Z, ANON-FD3J-U7KT-J, ANON-FD3J-U7KV-M and ANON-FD3J-U7KZ-R for further details.	
Wildflower Society of WA	Please provide an explanation as to why fauna escape ramps are being used, instead of the alternative of one-way fauna gates that have been installed on some projects. Refer to submission ANON-FD3J-U7KG-5 for further details.	
Bullsbrook Residents and Ratepayers Association and 2 Anonymous submitters	The submitters raise matters relating to the management of fauna during the construction and operation of the proposal to minimise and manage injuries to fauna. Consideration should be given to measures to monitor and remove species that can be relocated to a safe area during construction. Please provide response to the following questions raised by the submitters: • who will be responsible for the trapping and translocation;	

Submitter	Submission and/or issue	Response to comment
	• how will appropriate translocation sites be determined; • details of any support that will be provided by MRWA for ongoing monitoring of relocated fauna to determine the success of relocation; • will any staging measures be implemented to prevent the halting of fauna movement at all times; • will roadside signs be erected to inform drivers of wildlife crossing, and provide contact details for wildlife carers; and • will MRWA provide support, including funding, to wildlife carers who have to care for injured and orphaned animals that result from implementation of the proposal. • will the breeding habits of species be considered during translocation, for example, *Tiliqua rugosa*, which pairs with the same mate each year; and • how will the spread of faunal diseases be minimised during trapping and translocation efforts. Refer to submission ANON-FD3J-U7KB-Z, ANON-FD3J-U7K8-P, and ANON-FD3J-U7KT-J for further details.	
Anonymous	The submitter raises matters in relation to the occurrence of Wedge-tailed Eagles in the vicinity of the proposal footprint. These birds are attracted to road kill. Please provide details of the measures that MRWA will employ in removing animal carcasses from the road in order to prevent vehicle impacts on this species. Refer to submission ANON-FD3J-U7KT-J for further details.	
Anonymous	The submitter raises matters in relation to the potential impacts on the Rainbow Bee-eater active nesting sites which occur on road verges and within bushland	

Submitter	Submission and/or issue	Response to comment
	adjacent to the proposed road alignment. Please provide details of any specific management and mitigation actions proposed by MRWA for the Rainbow Bee-eaters along Maralla Road and other sites in the Maralla Road Nature Reserve. Refer to submission ANON-FD3J-U7KT-J for further details.	
4 Anonymous Submitters	The submitters raise matters in relation to the adequacy of fauna surveys undertaken to date. There does not appear to have been any comprehensive surveys of birds, reptiles or invertebrates undertaken. Numerous species have been overlooked or failed to be included because of the very limited scope of surveys that were conducted. The timing and duration of the surveys seem to provide a mere snapshot of the fauna species present over a very limited period of time and during a single portion of the season. There does not appear to have been enough invertebrate or bird surveys undertaken to provide adequate information about the number of important invertebrate species that exist within the footprint. Please provide details on any additional invertebrate and bird surveys proposed to be undertaken or justification as to why no additional surveys will be undertaken. Please provide an explanation on why the fauna trapping surveys were not conducted across all four seasons. Refer to submissions ANON-FD3J-U7KB-Z, ANON-FD3J-U7KT-J, ANON-FD3J-U7KW-N and ANON-FD3J-U7KZ-R for further details.	

4. Hydrological processes and Inland waters environmental quality

Submitter	Submission and/or issue	Response to comment
Wildflower Society of WA and 2 Anonymous Submitters	The submitters raise matters in relation to the importance of the role of native vegetation and soil type in respect to drainage. Please provide a response to the following questions raised: • will the impact of native vegetation on flow be examined; and • how will drainage be managed according to the soil profile. Refer to submissions ANON-FD3J-U7KG-5, ANON-FD3J-U7KT-J and ANON-FD3J-U7KZ-R for further details.	
Anonymous	The submitters raises matters in relation to the potential impacts of the proposal on the winter mound springs in the area. If the natural hydrology of the area is disturbed the recharge of the springs may be altered. Please advise whether consideration was given to the potential implications of the proposal on springs in the area, including disruption to natural hydrology and the proposed mitigation of this. Refer to submission ANON-FD3J-U7KM-B for further details.	
Anonymous	The submitters raise matters in relation to the potential for the proposal to further disrupt hydrological regimes and water quality on wetlands in the area. The PER document states that additional piezometers should be installed across the study area in close proximity to sensitive receptors. Please provide details on whether this additional work will be undertaken by MRWA, the likely timing of installation of the piezometers, and ongoing monitoring that will occur. Refer to submission ANON-F3J-U7KT-J for further details.	
2 Anonymous Submitters	The submitters raise matters in relation to the potential impacts of drawdown on local groundwater levels. The local groundwater levels, dependent	

Submitter	Submission and/or issue	Response to comment
	vegetation, wetlands and local residents who rely solely on groundwater, will be severely impacted by any further drawdown especially during summer. Please provide a discussion on what measures will be undertaken during construction, to monitor and address the following: • rates of water abstraction; • bore operating regimes and durations; • hydrogeology of bore locations; • expected groundwater drawdown and resulting indirect impacts to environmental values (e.g. wetlands); • existing groundwater license allocations and details on whether the water allocation for use during highway construction has occurred through the proper channels of local water allocation. Refer to submission ANON-FD3J-U7KM-B and ANON-FD3J-U7KT-J for further details.	
2 Anonymous Submitters	Submitters raise matters in relation to dewatering that will be undertaken as part of the proposal. During construction local bores and creeks may be affected by dewatering due to changes in groundwater levels. Please provide a response to the following questions: • what are the implications of dewatering on local residents who rely on the ground water for domestic water and stock use; and • has the potential impacts of dewatering near Maralla Road on nearby populations of *Caladenia Huegelii* and adjacent EPP wetlands been considered. Refer to submissions ANON-FD3J-U7KW-M and ANON-FD3J-U7KM-B for further details.	
2 Anonymous	Submitters raise matters in relation to the maintenance of the function and	

Submitter	Submission and/or issue	Response to comment
Submitters	quality of groundwater and Conservation Category Wetland's (CCWs) within and adjacent to the project footprint. Consideration of alternative engineering solutions, to avoid the partial destruction of CCWs 8773, 8909, 8792, 13096, 15033 and 8416 may be appropriate. Please provide an explanation of the engineering/best practice solutions that will be implemented to maintain maximum groundwater levels and flow, and minimise impacts to CCW's, during construction and operation, and prevent ongoing runoff, accidental spills and potential pollution of groundwater and CCW's. Refer to submissions ANON-FD3J-U7KB-Z and ANON-FD3J-U7KT-J for further details.	
Anonymous	The submitter raises matters in relation to the potential impacts to wetlands within the development envelope. The road reserve in the vicinity of Maralla Road appears to sever a section of EPP wetland (CCW) 8800. The PER document is vague regarding the potential impacts and justification for impacts to this wetland. Please provide details on how MRWA proposes to provide the recommended buffer zone to CCW 8800 and manage the key threatening processes of the proposal to CCW's. Refer to submission ANON-FD3J-U7KT-J for further details.	
2 Anonymous Submitters	The submitters raise matters in relation to the proposed separation distances between construction and wetland areas. It is unclear how it was determined that a 50 m separation distance between construction laydown areas and stockpiles (including storage of hazardous materials and refuelling activities) and sensitive wetlands and vegetation was acceptable. Please provide justification on how this separation distance was determined as appropriate to avoid and minimise potential impacts to these sensitive areas.	

Submitter	Submission and/or issue	Response to comment
	Refer to submissions ANON-FD3J-U7KB-Z and ANON-FD3J-U7KT-J for further details.	
Anonymous	The submitter raises matters in relation to the susceptibility of wetland areas to exposure of Acid Sulphate Soils (ASS) during construction. Figure 10.5B identifies the wetlands adjacent to Maralla Road as areas susceptible to high a risk of ASS during soil disturbance. Please provide details on what measures will be taken to mitigate the effect of ASS and protect the wetlands during construction. Refer to submission ANON-FD3J-U7KB-Z for further details.	
Anonymous	The submitter raises matters in relation to suggestions in the Drainage Strategy document that Saw Pit Gully could be used as a possible outlet flow for flood over-topping events. Saw Pit Gully feeds the Saw Pit Gully conservation reserve and eventually into Ellen Brook. Please provide details on whether this is a definite plan and what measures will be taken to prevent pollution and maintain water quality in Saw Pit Gully should this eventuate. Refer to submission ANON-FD3J-U7KB-Z for further details.	

5. Amenity (Noise and Vibration)

Submitter	Submission and/or issue	Response to comment
2 Anonymous Submitters	The submitter raised matters in relation to the accuracy of the noise predictions at Stock Road and the Ballajura area. The noise predictions within the Ballajura area seem to under estimate the potential noise impacts overall and do not appear to consider the most up to date traffic volumes. Installation of a noise wall built of a thicker mass to lower dB rating below 50dB may be appropriate to mitigate potential impacts.	

Submitter	Submission and/or issue	Response to comment
	The PER document states Stock Road has one of the highest noise levels attributed to weather conditions and local dogs. This is a rural road with little traffic. Please discuss the matters raised by the submitters with relation to whether: • the noise modelling has utilised the most up to date traffic volumes when determining the dimensions of the noise wall; and • there will be an increase in noise on Stock Road. Refer to submission ANON-FD3J-U7K7-N and ANON-FD3J-U7KM-B for further details.	
Bullsbrook Residents and Ratepayers Association and 2 Anonymous Submitters	The submitters raised matters in relation to the adequacy and implementation of the proposed noise mitigation measures. Please provide a response to the following questions raised by submitters: • how will the proposed noise mitigation measures benefit residents and how will MRWA determine which package a residence should receive; • when will the noise mitigation packages be fitted; • if the proposed noise mitigation measures do not achieve the target 55dB LAeq how will this be rectified and will additional treatments be added; • how will the issue of external noise be addressed given the lifestyle of property owners is generally outdoors and the fauna utilising these properties; • will funding be available should additional mitigation measures be required; and • will noise monitoring occur during both construction and operation of the highway. Refer to submissions ANON-FD3J-U7KT-J, ANON-FD3J-U7K8-P and ANON-	

Submitter	Submission and/or issue	Response to comment
	FD3J-U7KB-Z.	
2 Anonymous Submitters	Submitters raise matters in relation to the potential impacts of vibrations caused during construction on the adjacent homes. Please provide a response to the following questions: • what precautionary measures that will be undertaken to avoid vibration damage to buildings near site works; and • will any compensation be provided for damage that occurs to homes during construction. Refer to submission ANON-FD3J-U7KT-J and ANON-FD3J-U7KW-N for further details.	

6. Heritage

Submitter	Submission and/or issue	Response to comment
Bullsbrook Residents and Ratepayers Association	The submitter raises matters in relation to the Bulls Brook having been overlooked as significant historical feature of the Bullsbrook district. Please advise how the potential impacts of the proposal on the Bulls Brook have been considered. Refer to submission ANON-FD3J-U7K8-P for further details.	

7. Offsets

Submitter	Submission and/or issue	Response to comment
Bullsbrook Residents and Ratepayers	The submitters raises matters in relation to the suitability of Lot 5892 Maralla Road Bullsbrook as a potential offset site. The site contains a CCW, significant vegetation and also provides linkages to the Maralla Road bushland.	

Submitter	Submission and/or issue	Response to comment
Association	Please identify whether the acquisition of this site as an offset has been considered. Refer to submission ANON-FD3J-U7K8-P for further details.	
Wildflower Society of WA and Bullsbrook Residents and Ratepayers Association	The submitters raise matters in relation to the proposals overall net loss of bushland. Whilst offsets are proposed, the overall net loss of bushland, which includes important fauna habitat, including Black Cockatoo foraging and breeding habitat is of concern. There is a need to replace this habitat through long term acquisition and revegetation of degraded habitat, such as, areas within or adjacent to ecological linkages identified in Figure 8.5 or the CCW on Lot 800. The offset package does not include any proposed rehabilitation to address the net loss. It is also noted that locations for Offsets 2, 3 and 4 have not yet been identified. Please advise whether the purchase and rehabilitation of degraded areas has been considered to help address the overall net loss of bushland and provide details on the likely timing for the identification of the remaining offset sites. Refer to submissions ANON-FD3J-U7KG-5 and ANON-FD3J-U7K8-P for further details.	

8. Rehabilitation and decommissioning

Submitter	Submission and/or issue	Response to comment
Wildflower Society of WA and 1 Anonymous Submitter	The submitters raise matters in relation to the suitability of the rehabilitation/revegetation project. The rehabilitation/revegetation project does not appear to include an objective to maintain biodiversity, which is a major omission, particularly in the section south of Maralla Rd west of Ellenbrook. Consequently there are no completion criteria for revegetation of the road reserve following construction, and no species planting list. Please provide further details on the proposed rehabilitation/revegetation project to address the following:	

Submitter	Submission and/or issue	Response to comment
	• objectives for maintaining biodiversity; • justification for planting only dry grass and trees along any verges adjacent to native vegetation; • species planting list, and consideration of not just local species but local provenance plants as well; and • implementation of best practices measures in regards to rescuing, recovering or transplanting plants prior to clearing. Refer to submissions ANON-FD3J-U7KG-5 and ANON-FD3J-U7KT-J for further details.	

9. Consultation

Submitter	Submission and/or issue	Response to comment
Wildflower Society of WA	The submitter raises matters in relation to how the PER document addresses stakeholder concerns raised during previous consultative processes. Table 6.2 does not address each stakeholder issue other than in a very general way, which in no way satisfies stakeholders who raised these issues. Please provide a more detailed response to the issues raised during stakeholder consultation. Refer to submission ANON-FD3J-U7KG-5 for further details.	

10. Other

Submitter	Submission and/or issue	Response to comment
Anonymous	The submitter considers that the money from the sale of the land within Whiteman Park should be reinvested into the future management of the remainder of the park.	

Submitter	Submission and/or issue	Response to comment
	Please advise whether this has been considered. Refer to submission ANON-FD3J-U7K7-N for further details.	
Bullsbrook Residents and Ratepayers Association	The submitter raises matters in relation to the lack of consideration given to cumulative impacts. Further consideration and discussion of the potential of cumulative impacts, of this project and other current and proposed activities in the area should be undertaken. Please advise whether the impacts of nearby activities has been taken into consideration in regards to the context of cumulative impacts to flora and fauna. Please refer to submissions ANON-FD3J-U7K8-P for further details.	
Wildflower Society of WA	The submitter raises matters in regard to the adequacy of the discussion relating to the impacts of the proposal on the Environmental Principles of the *Environmental Protection Act 1986*. In particular, the PER document does not adequately discuss the proposal in relation to Principle 4 (Improved valuation, pricing and incentives) and Principle 5 (waste minimisation). Please provide further details on the measures that will be implemented throughout the entire proposal to address these principles. Refer to submission ANON-FD3J-U7KG-5 for further details.	
Anonymous	The submitter raises matters in relation to the tenure of the area west of Nature Reserve R46919. Whilst Figure 15.3B identifies this area as part of Bush Forever site 300, it is not shown as part of either the adjacent State Forrest or Nature Reserve. Please advise the current ownership and/or vesting of this area. Refer to submission ANON-FD3J-U7KT-J for details.	

2 Anonymous Submitters	The submitters raise matters in relation to the provision of fire and emergency access in the design of the proposal. Fire and other emergency access is not mentioned in the PER document particularly in remote locations such as the Maralla Road cul-de-sac. Without emergency access at this location, response time to fires will dramatically increase, and local resident safety will also be affected. Please provide a discussion on what specific measures will be put in place to assist in fire prevention, management and safety during construction and operation of the proposal, particularly in remote areas. Please also clarify if more clearing is necessary to address emergency access matters. Refer to submissions ANON-FD3J-U7KB-Z and for further details.	
4 Anonymous Submitters	The submitters raise matters in relation to the degradation of bushland through illegal activities. There has been visible effects of degradation as a result of rubbish that has been dumped, vandalism of trees, arson attempts as well as frequent destructive movements of vehicles. Please provide details on how these activities will be managed including responsibility, mitigation and ongoing monitoring. Refer to submissions ANON-FD3J-U7KB-Z ANON-FD3J-U7KT-J ANON-FD3J-U7KW-N and ANON-FD3J-U7KZ-R.	

Government of **Western Australia**
Office of the **Environmental Protection Authority**

Attachment 3

Perth-Darwin National Highway

PUBLIC ENVIRONMENTAL REVIEW
ASSESSMENT NO. 1994

COPY OF SUBMISSIONS FROM GOVERNMENT AGENCIES

This document provides a copy of the submissions received from Government agencies regarding the Public Environmental Review document for the Perth-Darwin National Highway proposed by Main Roads WA.

The public review period for the proposal commenced on 7 September 2015 for a period of 4 weeks, ending on 6 October 2015. A total of six submissions were received from Government agencies.

Government of Western Australia
Department of Environment Regulation

Your ref: AC01-2014-0005
Our ref. CEO1998/15
Enquiries: Teresa Gepp
Phone: 6467 5383
Email: advice.coordinator@der.wa.gov.au

Dr Paul Vogel
Chairman
Environmental Protection Authority
Locked Bag 10
EAST PERTH WA 6892

Attention: Peta Hayward

Dear Dr Vogel

PERTH-DARWIN NATIONAL HIGHWAY – PUBLIC ENVIRONMENTAL REVIEW (ASSESSMENT NO. 1994)

I refer to the letter dated 2 September 2015 from Mr Anthony Sutton, Acting General Manager, to the Department of Environment Regulation (DER) inviting comment by the Department on the above Public Environmental Review (PER).

Technical advice on the Traffic Noise Assessment has been prepared and is attached. The interpretation of this technical expert advice, and decisions about how the advice it contains should be considered in undertaking regulatory functions, are matters for the recipient organisation to determine. DER accepts no responsibility for the use or misuse of the attached advice, or the consequences of decisions made in reference to it.

I note that the PER includes a Preliminary Acid Sulfate Soils Investigation, which is generally consistent with DER's guideline *'Identification and investigation of acid sulfate soils and acidic landscapes'* (DER 2015). Recommendations in the PER regarding further investigations to inform specific management of acid sulfate soils are generally consistent with DER guidelines as applicable to large-scale linear projects.

The PER documentation does not appear to identify potential risks associated with known or suspected contaminated sites that may be located within, or in close proximity to, the project area. A search of DER's contaminated sites register has identified sites classified under the *Contaminated Sites Act 2003* as *possibly contaminated – investigation required* located within close proximity to, or within, the proposed alignment.

Should your staff require any further information, please contact DER's Planning and Advice Coordinator, Ms Teresa Gepp, on 6467 5383 or by email at advice.coordinator@der.wa.gov.au.

Yours sincerely

Jason Banks
DIRECTOR GENERAL

14 October 2015

Att.

Government of **Western Australia**
Department of **Environment Regulation**

REPORT

Technical Expert

Advice/Report on Noise – Perth-Darwin National Highway – Public Environmental Review – Assessment No: 1994 - Office of Environmental Protection Authority

Version: Final

September 2015

Infobase number

Document control

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Date	Expert name / position	Version	Role
23/9/2015	Jingnan Guo Senior Noise Regulation Officer	Draft	Author
23/9/2015	Peter Popoff-Asotoff Senior Manger Noise Regulation	Final	Reviewer

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File number and/or name	File owner or custodian	File location
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Accessibility This document is available in alternative formats and languages upon request.

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Expert's details

Personal details: Author

Name	Jingnan Guo
Employer	Department of Environment Regulation
Position title	Senior Noise Regulation Officer
Field of expertise	Noise and vibration

Qualifications and experience

The qualifications and experience and technical capability relevant to the provision of this advice are as follows:

Qualification

Qualification	Year obtained	Additional comments
Ph.D. - UWA	1998	Noise Control
MSc. - Curtin University	2005	Public Health
BSc. - Nanjing University	1982	Acoustics

Relevant professional experience

Employer	Position	Tenure
Department of Environment Regulation	Senior Officer	2014 - present
Department of Environment and Conservation	Senior Officer	2006 - 2014
WorkSafe WA	Noise Officer	2003 - 2006
University of WA	Research Fellow	2000 - 2003
University of British Columbia	Post Doctoral Fellow	1998 - 2000

Other – Publications/memberships/associations etc.

Publications:

Selected Journal Publications

- Jingnan Guo and Pam Gunn, "Noise and noise exposure in Western Australian entertainment venues", *Journal of Occupational Health Safety* **23** (1), 69-78 (2007).
- Murray Hodgson and Jingnan Guo, "Active local control of propeller-aircraft run-up noise," *Noise & Vibration Worldwide* **37** (3), 9-13 (2006).
- Jingnan Guo and Pam Gunn, "Occupational Noise Control in Australia – Its Policy and Management" *Canadian Acoustics* **32** (4), 39-48 (2004).
- Jingnan Guo, Jie Pan, and Murray Hodgson, "Active control of a moving noise source - effect of off-axis source position", *J. Sound Vib.* **251**(3), 457-475 (2002).
- Jingnan Guo, Murray Hodgson, and Jie Pan, "Active control of an off-axis noise source", *Canadian Acoustics* **29** (1), 13-18 (2001).
- Pierre Germain, Jingnan Guo and Murray Hodgson, "Experimental study of

propeller-aircraft run-up noise," *Canadian Acoustics* **29** (2), 21-27 (2001).

- Jingnan Guo & Jie Pan, "Actively created quiet zones for broad band noise using multiple control sources," *J. Acoust. Soc. Am.* **105** (4), 2294-2303 (1999).
- Jingnan Guo & Jie Pan, "Increasing the insertion loss of noise barriers using active control system," *J. Acoust. Soc. Am.* **104** (6), 3408-3416 (1998).
- Jingnan Guo & Jie Pan, "Effects of Reflective Ground on the Actively Created Quiet Zones," *J. Acoust. Soc. Am.* **103** (2), 944-952 (1998).
- Jingnan Guo & Jie Pan, "Further Investigation on Actively Created Quiet Zones by Multiple Control Sources in Free Space," *J. Acoust. Soc. Am.* **102** (5), 3050-3053 (1997).
- Jingnan Guo & Jie Pan, "Application of Active Noise Control to Noise Barriers," *Acoustics Australia* **25** (1), 11-16 (1997).
- Jingnan Guo, Jie Pan & Chaoying Bao, "Actively Created Quiet Zones by Multiple Control Sources in Free Space," *J. Acoust. Soc. Am.* **101** (3), 1492-1501 (1997).
- Jingnan Guo & Xioulan Guo, "Analysis of environmental noise pollution in urban areas," *China Environmental Science* **14**(5), 366-369 (1994).
- Jingnan Guo & Jianping Zhu, "Some problems with environmental noise monitoring in China," China Environmental Monitoring **7**(2), 39-41 (1991).
- Jingnan Guo & Xioulan Guo, "Analysis of losses due to urban traffic noise pollution," *China Environmental Science* **9**(6), 415-418 (1989).

Over 30 papers presented and published in **International Conferences**. Copies of the paper are available at request.

Memberships and associations:

1. Adjunct Associate Professor – University of WA.
2. Member of Australian Acoustical Society.
3. Member of Safety Institute of Australia.

Purpose of this report, limitations and disclaimer

This is technical expert advice prepared by experts employed within the Department of Environment Regulation for the purposes set out in the "Advice summary details" and should not be used for any other purpose.

The State of Western Australia and Department of Environment Regulation and their servants and agents expressly disclaim liability, in negligence or otherwise, for any act or omission occurring in reliance on the information contained in this document, or for any incident or consequential loss or damage of such act or omission.

In preparing this report the technical experts have considered the request made, the information and materials provided in support of the request, literature relevant to the field, and other evidence the expert is aware of and can access through their expert capacity.

The report is based on the information provided to the experts, which is summarised in the "Advice summary details". Relevant materials that were not provided could materially change the advice. The requesting organisation needs to use appropriate judgement about the information that is relevant to the request, and the possible implications of any information that was not provided.

Where requests made require input from more than one area of technical expertise, the advice will be provided separately. Each advice will consider technical issues relevant to the specific field of expertise. No effort is made to integrate the issues raised by different technical fields. It is the responsibility of the regulatory organisation requesting the advice to determine how to weight the various matters they need to consider, and the relevance of the advice on any particular matter to making their decisions.

The interpretation of this technical expert report, and decisions about how the advice it contains should be considered in undertaking regulatory functions are matters for the recipient organisation to determine. The Department of Environment Regulation accepts no responsibility for the use or misuse of the attached advice, or the consequences of decisions made in reference to it.

The advice provided is limited to technical expert advice, and author(s) **have not** considered any aspect of regulatory matters that could come within the scope of legislation administered by the Department of Environment Regulation, either currently or at some time in the future. As such, the report does not purport to represent the Department of Environment Regulation's views on how such matters may be considered by the Department of Environment Regulation in its regulatory capacity. If advice is required on the Department of Environment Regulation's position on how it would consider matters relevant to its regulatory functions, a separate request for advice must be made.

Advice summary details

TO:	Office of the Environmental Protection Authority
PREPARED BY:	Dr Jingnan Guo
REVIEWED BY:	Peter Popoff-Asotoff
SUBJECT	Perth-Darwin National Highway – Assessment No: 1994

The details of these experts is summarised under Expert's details.

This advice was prepared for the Office of the Environmental Protection Authority (OEPA) in response to the request dated 2 September 2015. I have provided advice according to the scope below.

Scope of advice
Technical advice to the OEPA on the Public Environment Review (PER) document for the proposed Perth-Darwin National Highway (EPA Assessment No: 1994).

The OEPA made the following materials and documents available, which form the basis of this technical expert advice.

Material / document name	Type of resource / description	Date prepared
Transportation Noise Assessment – Perth-Darwin National Highway Project (#13122263-01PDNH)	Assessment report by Lloyd George Acoustics (LGA)	29 June 2015
Public Environmental Review – Perth-Darwin National Highway	PER document prepared by Coffey	September 2015

In preparing this advice I have considered the information provided with the request.

My expert advice is as below:

I previously reviewed the draft PER document for this proposal and its associated Transportation Noise Assessment and my expert advice was provided to the OEPA on 15 May 2015. I have now reviewed the final PER document and the revised Transportation Noise Assessment report dated 29 June 2015 (Report). I have identified that the traffic noise impact from this proposed project may have been underestimated due to the method adopted for the traffic noise modelling calibration in the revised Transportation Noise Assessment report.

I note that LGA revised its Transportation Noise Assessment report in June 2015, which introduced the method LGA used to calibrate the noise model. According to LGA, the model calibration was conducted by comparing the measured noise levels and the modelled noise levels at 12 locations along the existing Tonkin Highway. The comparison results are given in Table 4-2 of the Report and reproduced below. As described by LGA, there is a large variation in the differences between the measured and modelled noise levels, which are in the range of 5.2 to 11.1 dB. The modelled noise levels are consistently higher than the measured noise levels for all 12 locations along the existing Tonkin Highway.

According to LGA, the large variation may be the result of the congestion experienced along the existing Tonkin Highway. By using the 5th percentile (quoted as the 95th percentile in the report) of the differences as the calibration value for the model, a calibration factor of 5.4 dB was used to adjust the modelled results for all road sections of the proposed project.

Table 4-2 Comparison Between Measured and Predicted Noise Levels at Monitoring Locations

Rec ID	Address	Measured $L_{Aeq\,(Day)}$	Predicted $L_{Aeq\,(Day)}$	Difference
A	2 Redlands St, Bayswater	54.2	60.9	-6.7
B	16 Harvest Rd, Morley	58.8	68.3	-9.5
C	28A Bruce Rd, Morley	58.5	67.2	-8.7
D	2A Abbey Street, Morley	59	67.5	-8.5
E	9 Clandon Way, Morley	57.9	64.2	-6.3
F	48 Alfreda Ave, Morley	57.1	64.9	-7.8
G	100 Alfreda Ave, Morley	56.9	64.5	-7.6
H	8 Wells Court, Noranda	49.9	60.6	-10.7
I	15 Davis Court, Morley	50.1	61.2	-11.1
J	6 Acacia Court, Beechboro	54.9	60.1	-5.2
K	11 Willow Place, Beechboro	52.2	60.8	-8.6
L	8 Jarrah Court, Beechboro	50.6	56.2	-5.6

In my opinion, the model calibration method used by LGA for this project is not appropriate, and may result in an underestimation of the traffic noise impact. My opinion is based on the reasons below:

1. The large differences between the modelled results and the measured levels could be due to the congestion along the existing Tonkin Highway, as suggested by LGA. Because of the congestion, the parameters chosen for the modelling, such as the traffic volume and traffic speed, can be quite different from the true values. This will likely lead to significant variations of the modelled results. In such a situation, the appropriate way to minimise the variations is to modify the input parameters for the noise modelling to reflect the actual situation under which the measurements were made, rather than simply adjust the modelled results by introducing such a calibration factor.
2. The Austroads Research Report: *Modelling, Measuring and Mitigation Road Traffic Noise* (AR-R277/05) allows the calibration of the noise model to reflect local conditions. My understanding is that this calibration is only to accommodate small variations, due to the difficulties in accurately assessing some model parameters, such as the ground absorption(s) and vegetation. It is not designed for such large variations as shown in Table 4-2.
3. In AR-R277/05, the model calibration only applies "*in an upgrade or extension where the ground properties and relationship of the residences to the road are essentially the same for the extended section as for the existing section.*" The proposed project involves 38 kilometres (km) of new dual carriage highway, connecting the intersection of Tonkin Highway and Reid Highway in the south with Great Northern Highway and Brand Highway in the north. It passes through built areas, as well as quite large rural areas. The ground properties and the residences' distances to the proposed road can be quite different along this 38 km section to the measurement locations near the Tonkin Highway. Therefore, even in the situation that the noise model can be calibrated in the way that LGA used for this project, the calibration results may only apply to the Tonkin Highway section and not the whole 38 km road section of the project.

Due to the above reasons concerning the model calibration, I do not agree that the calibration value of 5.4 dB can be used to adjust the modelled results. This adjustment is likely to lead to the underestimation of the traffic noise impact.

Except for the parameter inputs and model calibration, the methodology of the traffic noise modelling seems acceptable as supplied.

In addition to the information in the "Purpose of this report, limitations and disclaimer" section, important limitations relevant to this specific advice are detailed under "Specific limitations of this advice" below.

Specific limitations of this advice

Technical expert advice in any field is subject to various limitations. Important limitations to the attached advice include:

- I have not verified the noise modelling and its results by rerunning the computer model.

Expert's details

Personal details: Reviewer

Name	Peter Popoff-Asotoff
Employer	Department of Environment Regulation
Position title	Senior Manager Noise Regulation
Field of expertise	Environmental noise.

Qualifications and experience

The qualifications and experience and technical capability relevant to the provision of this advice are as follows:

Qualification

Qualification	Year obtained	Additional comments
Grad. Dip. – Curtin University		Computing
BSc. – Murdoch University		Physics

Relevant professional experience

Employer	Position	Tenure
Department of Environment Regulation	Senior Manager	2015 – present
Department of Environment Regulation	Manager	2013 – 2015
Department of Environment and Conservation	Manager	2012 – 2013
Department of Environment and Conservation	Acting Manager	2008 – 2011
Department of Environment and Conservation	Environmental Noise Officer	2006 – 2008
Department of Environment	Environmental Noise Officer	2003 – 2006
Department of Environmental Protection	Environmental Noise Officer	1997 – 2003

Other – Publications/memberships/associations etc.

Publications:

- Peter Popoff-Asotoff, Jonathan Holgate and John Macpherson, "Which is Safer – Tonal or Broadband Reversing Alarms?" *Proc. of Acoustics 2012 Fremantle* 126, 1-7, (2012)
- Jingnan Guo, John Macpherson and Peter Popoff-Asotoff, "Further Investigations of Low-Frequency Noise Problems Generated by Freight Trains" *Proc. of Acoustics 2012 Fremantle* 64, 1-8, (2012)
- Sun Hongmei, Rhys Fenton, Peter Popoff-Asotoff, Jingnan Guo, and John Macpherson, "Evaluation of noise emissions from an evaporative air conditioning unit and their environmental impact" *Proc. of Acoustics 2012 Fremantle* 132, 1-6, (2012)

Memberships and associations:

Member of Australian Acoustical Society.

Signatures

Author Name Jingnan Guo	Signature
Position Senior Noise Regulation Officer	Date 19/10/2015
Reviewer Name Peter Popoff-Asotoff	Signature
Position Senior Manager Noise Regulation	Date 19/10/2015

Government of **Western Australia**
Department of **Planning**

Your ref: C01-2014-0005
Our ref: 402-2-1-205
Enquiries: Nanette Garland (6551 9322)

Dr Paul Vogel
Chairman
Environmental Protection Authority
Locked Bag 10
EAST PERTH WA 6892

Dear Dr Vogel

PERTH-DARWIN NATIONAL HIGHWAY
PUBLIC ENVIRONMENTAL REVIEW – ASSESSMENT NO: 1994

Thank you for the opportunity to comment on the Public Environmental Review (PER) for the construction of the southern section of the Perth-Darwin National Highway (PDNH).

The proposal is supported as the alignment is consistent with the *Draft Perth and Peel @ 3.5 million* and the *Draft North-East Sub-regional Planning Framework,* and the mitigation measures proposed as a result of the road construction are consistent with Western Australian Planning Commission (WAPC) State Planning Policy.

During the Metropolitan Region Scheme and subsequent planning phases, the Department of Planning, on behalf of the WAPC, will address the following with Main Roads WA and the Department of Transport:

- Reconciliation of the public transport network in the north metropolitan area to ensure adequate coverage exists in the future to accommodate the population growth anticipated in *Perth and Peel @ 3.5 million*;
- Consideration of zoning changes to allow development of land no longer required for transport purposes or fragmented from adjoining land uses; and
- Consideration of noise mitigation measures along the sections of the PDNH that are identified within the Draft North-East Sub-regional Planning Framework as Urban Expansion and Urban Investigation areas.

Yours sincerely

Gail McGowan
Director General

..2../10/2015

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Government of **Western Australia**
Department of **Water**

looking after all our water needs

Your ref: AC01-2014-0005
Our ref: RF13882
Enquiries: James Mackintosh, 6250 8043

Office of the Environmental Protection Authority
File:
09 OCT 2015
For Information ☐ For Discussion ☐ For Action ☐ Response please:
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Dir.AC ☐ Dir. Bus Ops ☐ Dir. SPPD ☐ Dir. Strat Sup ☐
GM Signature ☐ Dir for GM (copy to GM) ☐ Dir Signature (copy to GM) ☐ Mgr Direct (copy to GM) ☐

Hans Jacob
Manager
Infrastructure Assessments Branch
Office of the Environmental Protection Authority
Locked Bag 10
EAST Perth, WA 6892

Dear Mr Jacob

PERTH-DARWIN NATIONAL HIGHWAY – PUBLIC ENVIRONMENTAL REVIEW – ASSESSMENT NO: 1994

Thank you for the above referral dated 2 September 2015. The Department of Water (DoW) appreciates the opportunity to comment on the Peth-Darwin National Highway Public Environmental Review (PER).

The DoW's assessment included a review of the following reports:

- *Public Environmental Review – Perth-Darwin National Highway (Swan Valley Section), September 2015;*
- *Appendix F – Draft Environmental Management Plan – Perth-Darwin National Highway, July 2015;*
- *Appendix H – Drainage Strategy – Perth-Darwin National Highway, May 2015;*

The DoW is generally satisfied with the information provided in the PER. However, the DoW has identified a number of matters that require additional information or clarification:

Construction Management

The DoW has concerns with regards to the future construction requirements for construction laydown areas, stockpiles, storage of hazardous materials and refuelling activities. The PER and draft Environmental Management Plan (EMP) have stated that

> "*Construction laydown areas and stockpiles (including storage of hazardous materials and refuelling activities) will be located outside the Wellhead Protection Zones (WHPZs) and 50 m from all CCWs, Mound Springs SCP TECs and Claypans of the SCP TEC to mitigate potential water quality impacts*".

The proposal has not acknowledged that under *State Planning Policy 2.2 - Gnangara Groundwater Protection (WAPC, Aug 2005)* and *State Planning Policy 2.7 - Public Drinking Water Source (WAPC, June 2003)* and the associated *Water Quality Protection Note No. 25 – Land use compatibility in Public Drinking Water Source Areas (DoW, July 2004)*, many of these activities are incompatible in a Priority 1 (P1) Underground Water Pollution Control Area (UWPCA). The DoW also notes that this issue had not been discussed at either the Environmental Reference Group or the Drainage Reference Group Project Team meetings.

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XDWAL014

The exclusion of many of these activities from P1 areas will need to be considered by Mainroads WA, preferably as part of the PER, as it will likely have impact on construction activities, the location of laydown areas, stockpiles and hazardous materials storage, and therefore potential contamination issues, land requirements for these sites and environmental impacts.

However, while these construction laydown areas are prohibited in P1 areas under current policy, the DoW is prepared to negotiate with Mainroads WA on potential management measures required to potentially allow this temporary land use.

Environmental Management Plan

This EMP does not clearly state the importance of the Gnangara UWPCA in terms of supplying Perth's drinking water, and relevant requirements under *State Planning Policy 2.2 - Gnangara Groundwater Protection (WAPC, Aug 2005)* and the Gnangara Land Use and Water Management Strategy (WAPC, Jan 2001), as well as the *Water Quality Protection Note No. 25 – Land use compatibility in Public Drinking Water Source Areas (DoW, July 2004)*. In addition, the EMP should refer to more specific best management practices to ensure the protection of this important drinking water source, such as the DoW's *Water Quality Protection Note (WQPN) No. 44 - Roads near sensitive water resources (DoW, Oct 2006)*, *WQPN No. 36 – Protecting Public Drinking Water Source Areas (DoW, Feb 2009)*, and *WQPN No. 6 Vegetation buffers to sensitive water resources (DoW, Feb 2006)*. The EMP should be revised to appropriately acknowledge these policies.

Management of dust during construction

There is no mention in the EMP of what quality of water should be used for dust suppression. In a P1 UWPCA this water needs to be of the highest quality and the source of this water will need to be considered by Mainroads WA.

Inspections

The Water Corporation is operating the bore field on the Gnangara UWPCA and has delegated powers from the DoW to undertake surveillance in public drinknng water source areas. The EMP should commit to working closely with the Water Corporation when constructing the proposed section in the UWPCA P1 and P3 areas. Regular joint inspections (Water Corporation/Main Roads) should be encouraged, and any accidental spill should also be reported to Water Corporation.

Drainage Management Plan

The Drainage Management Plan should commit to future consultation with the DoW provide further input into the final location of bio-retention basins and other water quality mitigation measures to protect the drinking water production bores. The DoW's preference is to keep them outside the WHPZs. However, a minimum of 100 m separation distance should be maintained between production bore and bio-retention basin, wherever possible and the stormwater should drain away from these production bores.

If you wish to discuss the matter further, please contact James Mackintosh at james.mackintosh@water.wa.gov.au or on 6250 8043.

Government of **Western Australia**
Department of **Water**

looking after all our water needs

Yours sincerely

Don Cummins
Regional Manager
Swan Avon Region

5 October 2015

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XDWAL014

Government of Western Australia
Department of Parks and Wildlife

Your ref: AC01-2014-0005
Our ref: CEO2009/15
Enquiries: Sue Osborne
Phone: 9219 8641
Fax: 9334 0140
Email: sue.osborne@dpaw.wa.gov.au

Mr Anthony Sutton
Director Assessments and Compliance Division
Office of the Environmental Protection Authority
Locked Bag 10
EAST PERTH WA 6892

Attention: Peta Hayward

Dear Anthony

PERTH-DARWIN NATIONAL HIGHWAY - PUBLIC ENVIRONMENTAL REVIEW - ASSESSMENT NO. 1994

I refer to your letter received on 8 September 2015 advising that the Public Environmental Review document for the Perth-Darwin National Highway Project is available for comment.

The Department of Parks and Wildlife provides the attached advice and comments on matters relevant to the department's *Conservation and Land Management Act 1984* and *Wildlife Conservation Act 1950* related responsibilities.

Should you wish to discuss this advice, please contact Sue Osborne, Environmental Management Branch by telephone on 9219 8641 or email at sue.osborne@dpaw.wa.gov.au.

Yours sincerely

Jim Sharp
DIRECTOR GENERAL

6 October 2015

Att

Department of Parks and Wildlife

Document Review Comments Sheet

Reviewer:	Sue Osborne
Document Title:	Public Environmental Review Perth-Darwin National Highway (Swan Valley Section)
Document Revision:	Revision 4
Date of Review:	6 October 2015

Item No.	Section No./Title	Reviewer Comment / Advice
1	Chapter 8 Flora and Vegetation Appendix C Level 2 Flora and Vegetation Assessment	***Recommendation 1: That the proponent fulfil its commitments to undertake additional targeted surveys for Threatened and Priority flora, in particular for Meeboldina decipiens subsp. decipiens ms (Priority 3), and Millotia tenuifolia var. laevis (Priority 2), and provide survey results in the context of flora distributions within secure conservation reserves to the EPA to facilitate an informed assessment of impacts.*** **Discussion** Parks and Wildlife previously advised the OEPA (May 2015) in its draft Public Environmental Review (PER) advice that determining impacts on the conservation reserve system based on the reduction in areal extent does not adequately address the effect of the proposal on the level of protection of conservation values (flora, fauna, communities) within class A nature reserves (46919 and 46920) and Gnangara-Moore River State Forest No. 65. In Parks and Wildlife's comments on the draft PER, the department recommended that "*the PER address the extent to which the important conservation values protected within the affected reserves, and the conservation reserve system overall, will be affected by the proposal. E.g. X% of Priority flora taxon A will be removed from Reserve 46919 and the % of reservation of this taxon in reserves overall will be reduced from Y% to Z%*". The level to which a species is protected by its occurrence within secure conservation reserves is a significant factor in determining the conservation status assigned to listed flora. However, this recommendation does not appear to have been addressed and the approach previously recommended by Parks and Wildlife to describe impacts on specially listed species and communities does not appear to have

Item No.	Section No./Title	Reviewer Comment / Advice
		been adopted in the PER. Parks and Wildlife notes the following proponent commitments outlined in the PER: • *"Additional targeted surveys for Threatened and Priority flora will be undertaken prior to vegetation clearing to clearly define population boundaries, and to identify any additional populations within and adjacent to the proposal.* • *Additional targeted surveys of the known populations of Millotia tenuifolia var. laevis and Meeboldina decipiens subsp. decipiens ms* [will be undertaken] *to clearly define populations and known individuals. The survey results will be provided to the EPA as part of the response to submissions process to inform the EPA's assessment of the proposal".* The department supports these commitments and recommends that the results of all targeted surveys for Threatened and Priority flora be presented in the context of understanding the distributions of specially protected flora species within and outside secure conservation reserves, as outlined above and in the department's previous advice. Parks and Wildlife recognises that the proponent has taken a precautionary approach in determining potential impacts on *M. decipiens* subsp. *decipiens* (Priority 3) and *M. tenuifolia* var. *laevis* (Priority 2), by assuming that where the population sizes of recorded occurrences have not been recorded, that they consist of single plants only. However, based on this approach, impacts on these species are potentially significant at both local and regional scales. *M. decipiens* subsp. *decipiens* is not well represented by records within conservation reserves overall and there are no records within CALM Act lands (reserves or State forest) on the Swan Coastal Plain. The eleven plants recorded within the proposed development footprint are located approximately 25km north-west of the nearest other confirmed record of this species, and the removal of all individuals would therefore reduce its known range. Conservation category wetland habitats in Lightning Swamp Bushland, an A class reserve located approximately 150m south of the nearest recorded *M. decipiens* subsp. *decipiens* plant, may provide suitable habitat (*Astartea* tall shrubland to open tall shrubland / dampland). Given the potential significance of the proposed (assumed) removal of all known individuals of this species from its northern extent, and the current lack of records of this species within conservation estate on the Swan Coastal Plain, it is recommended that the proponent's targeted survey for this species include potential habitat within Lightning Swamp Bushland. *M. tenuifolia* var. *laevis* is known from five locations, but there have been no previous confirmed records of this species on the Swan Coastal Plain. While recognising the potential for this cryptic species to be under

Item No.	Section No./Title	Reviewer Comment / Advice
		recorded, the proposal would result in the removal of approximately half of the known individuals of this taxon on the Swan Coastal Plain. It is noted that individuals recorded outside the footprint were found in Whiteman Park, which is managed by the Department of Planning for conservation, recreation and education. It is therefore recommended that the proponent focus further targeted surveys for this species on potential habitat in Whiteman Park to clarify its local extent. Following completion of targeted surveys, the department requests that the proponent forward Threatened and Priority flora report forms, or equivalent information, to communities.data@dpaw.wa.gov.au (Parks and Wildlife Species and Communities Branch).
2	Chapter 17 Offsets	***Recommendation 2: That should the proposed survey of the Ioppolo Road offset site shows that it does not comprise critical habitat for the threatened flora species Caladenia huegelii, an alternative offset package should focus on the management and protection of existing populations or critical habitat, rather than on translocation options.*** **Discussion** In relation to offsetting the loss of critical habitat for *Caladenia huegelii* (grand spider orchid), the PER includes the following statement: *"If surveys show that the Ioppolo Road site does not comprise suitable habitat, then MRWA commits to offsetting the amount of critical habitat impacted by the proposal through a package that may comprise protection of habitat through acquisition or covenant, and contributions to the recovery plan such as a cultivation and translocation program."* Based on experience gained from flora conservation and recovery actions in WA, Parks and Wildlife advises that cultivation and translocation programs often have limited success and should be implemented only when other options that focus on the protection and management of existing populations and critical habitat have been exhausted.

Item No.	Section No./Title	Reviewer Comment / Advice
3	**Appendix F** Environmental Management Plan	***Recommendation 3: That the Environmental Management Plan incorporates monitoring and performance criteria for Threatened and Priority flora.*** **Discussion** Parks and Wildlife supports the operational management frameworks outlined in the draft Environmental Management Plan to protect Threatened and Priority flora from accidental disturbance, and the introduction and spread of weeds and dieback, and would support the addition of performance criteria and associated commitments to monitor Threatened and Priority flora. In particular, the department recommends the inclusion of performance criteria and monitoring commitments in relation to ***M. tenuifolia*** var. *laevis* individuals occurring within 50m of the project footprint.
4	Chapter 8 – Flora and Vegetation, and **Appendix I** – Wetland **Assessment**	***Recommendation 4: That commitments to protect the Communities of the Tumulus Springs (Organic Mound Springs, Swan Coastal Plain) Threatened Ecological Community adjacent to the development footprint include water balance studies for pre- and post-development situations, and highway design measures to mitigate effects of significant chemical spills.*** **Discussion** While recognising that the road has been aligned to avoid direct impacts on the Communities of the Tumulus Springs (Organic Mound Springs, Swan Coastal Plain) Threatened Ecological Community (Mound Springs SCP TEC), this TEC occurs in close proximity to the development footprint and is therefore vulnerable to indirect impacts during both construction and operational phases of the development. Parks and Wildlife notes that **Appendix I.** Wetland **Assessment** (May 2015) includes a recommendation that Groundwater **Dependant** Ecosystems (including the Mound Springs SCP TEC) be monitored pre- and post-construction, and that monitoring includes existing, and additional piezometers across the study area. The department supports this recommendation, but also recommends the development of a robust water balance analysis to increase confidence and reduce uncertainty in relation to risks associated with potential changes in the hydrology. The incorporation of strategically located highway design measures to facilitate **effective** pollution response; e.g. that allow for the rapid establishment of enhanced containment or diversion capabilities, would provide further protection for the Mound Spring SCP TEC and other high value conservation assets at risk from significant chemical, including hydrocarbon, spills.

Item No.	Section No./Title	Reviewer Comment / Advice
5	Chapter 8 – Flora and Vegetation, and Chapter 17 Offset	***Recommendation 5: If Offset Proposal 3; 'Conservation of TEC' proves difficult to implement, alternative offset options for the loss of 0.4 ha of the Southern wet shrublands, Swan Coastal Plain Threatened Ecological Community should be developed and implemented, in consultation with Parks and Wildlife.*** **Discussion** Land containing the Southern wet shrublands, Swan Coastal Plain Threatened Ecological Community (TEC SCP02) may not be available for purchase or covenanting. If supplementary surveys confirm the presence of TEC SCP02 within the development footprint, Offset Proposal 3 'Conservation of TEC', may require further consideration. Following completion of site surveys and final determination of TECs/PECs present in the vicinity of the proposal, the department requests that shape files of identified areas be provided to communities.data@dpaw.wa.gov.au (Parks and Wildlife Species and Communities Branch).
6	Chapter 9 – Terrestrial Fauna	***Recommendation 6: That Parks and Wildlife be provided an opportunity to contribute to, and comment on, the planned development of an Environmental Management Plan (EMP) relating to fauna management.*** **Discussion** Parks and Wildlife supports the proponent's commitment to prepare and implement an EMP for fauna management relating to the loss of fauna habitat from vegetation clearing. As the agency responsible for protection of, and licensing actions involving, native fauna, it is considered appropriate that the proposed fauna management components of the EMP be developed in consultation with Parks and Wildlife.

<table>
<tr><th>Item No.</th><th>Section No./Title</th><th>Reviewer Comment / Advice</th></tr>
<tr><td>7</td><td>Chapter 10 Hydrological Processes and Inland Waters Environmental Quality</td><td>

Recommendation 7: That the estimated residual loss of wetland values, and the extent of wetlands to be monitored during and post construction, include wetlands that, while not mapped as Conservation Category, may retain values commensurate with Conservation Category wetlands.

Discussion

Parks and Wildlife previously advised in its draft PER advice that some areas within the disturbance footprint currently mapped as Multiple Use category wetlands, may retain values commensurate with Conservation Category wetlands (CCWs). As described previously, these include:

<table>
<tr><th>Wetland UFI</th><th>Wetland type</th><th>Vegetation condition</th><th>Other values</th></tr>
<tr><td>15200</td><td>Sumpland</td><td>Excellent to Very Good</td><td></td></tr>
<tr><td>15030</td><td>Sumpland</td><td>Excellent</td><td>Significant veg association: AsMIEv</td></tr>
<tr><td>8464</td><td>Sumpland</td><td>Pristine</td><td>Significant veg association: AsMIEv</td></tr>
<tr><td>15732</td><td>Palusplain</td><td>Very Good to Good</td><td></td></tr>
</table>

The proponent has not addressed these possible mapping / classification anomalies in the PER.

Parks and Wildlife has not requested that the *Geomorphic Wetlands Swan Coastal Plain* dataset be formally modified. However, an accurate estimation of wetland values lost through proposal implementation (and therefore used as the basis for considering significant residual impacts on wetlands) should take these potential mapping anomalies into account.

Parks and Wildlife supports the proposed preparation and implementation of a wetland management and monitoring plan. However, as a review of the wetland mapping within and adjacent to the disturbance footprint has not been undertaken and some potential mapping anomalies have already been identified, the department advises that monitoring should include all wetland areas that may potentially meet the criteria for Conservation Category and that retain intact native vegetation in good or better condition.

</td></tr>
</table>

Item No.	Section No./Title	Reviewer Comment / Advice
8	**Section 10.4.6.1 Permanent Loss and/or Degradation of Wetlands** **and** **Chapter 17 Offsets**	***Recommendation 8: That Offset Proposal 2; 'Conservation of Land Comprising CCWs', be refined to align as far as practicable with the types of impacted wetlands within each consanguineous suite.*** **Discussion** Classification of a wetland as Conservation Category is based on assessment of attributes relating to the condition, conservation values and significance of a wetland and does not describe the wetland type or consanguineous suite. Offset Proposal 2 'Conservation of Land Comprising CCWs' involves securing protection for approximately twice the area of CCWs impacted by the development. The department supports this proposal and suggests that to ensure that the range of wetland types lost during development are represented, the offset should aim to incorporate, as far as practicable, protection of a similar set of wetland types within each consanguineous suite, to those impacted by the development. (With reference to Recommendation 7 above, the set of protected wetland types within each consanguineous suite should also take account of potential wetland category mapping anomalies for the impacted wetlands). The conclusion in the PER that "*as the proportion of CCWs within the Jandakot consanguineous suite is well above 10%, clearing of CCWs within the Jandakot consanguineous suite is not considered to be significant from the perspective of regional representation*"... is based on an incorrect interpretation of the Parks and Wildlife evaluation methodology for determining wetland Conservation Category classification (Department of Parks and Wildlife 2013). The evaluation methodology indicates that an individual wetland is more likely to be allocated a high Conservation Category classification if less than 20 per cent of wetlands in that consanguineous suite remain in Conservation Category condition.

Item No.	Section No./Title	Reviewer Comment / Advice
9	Chapter 10 Hydrological Processes and Inland Waters Environmental Quality and Appendix L Drawdown Position Paper	***Recommendation 9: That the potential for indirect impacts on wetland values from lowering the water table be minimised by:*** • ***restricting to summer months, the construction of footings for bridges and utility services at locations where dewatering would be likely to lower the water table in CCWs; and*** • ***managing drawdown associated with extraction bores in the vicinity of CCWs to maintain groundwater at depths that will not result in significant impacts on wetland values.*** **Discussion** Parks and Wildlife supports the proponent's stated intention to construct deep footings for bridge and utility services located near wetlands during summer months when seasonal groundwater levels are naturally below the required excavation depths. Summer excavation will avoid the requirement for dewatering that may have the potential to lower the water table in CCWs, and other wetlands with CCW equivalent values below seasonally normal levels. It is noted that drawdown from abstraction wells during construction may exceed 6m within hydrological domains 1 and 2, and 8m within hydrological domain 3 depending on pumping rates, and while seasonal fluctuations of 1 to 1.5m are expected in Bassendean Sands, fluctuations of 2 to 3m are expected in areas of clay. In recognition of this, the **PER** includes a statement indicating that: "*...the operating parameters of bores will be limited such that modelled changes to groundwater levels at wetlands remain within usual seasonal variations for those wetlands*". The term "*usual seasonal variations*" could be interpreted in more than one way; e.g. the difference between the winter maximum and summer minimum groundwater levels; or the variation between maximum and minimum groundwater levels taken over several years during the same season. Further explanation is considered necessary to clarify the meaning of this statement and how it is intended to be applied to the establishment of trigger levels. Such levels are considered critical to the design and implementation of an adaptive management program to protect wetland values from the effects of groundwater drawdown. Monitoring of depths to groundwater should include monthly evaluations and comparisons with expected seasonal depths. Contingency actions to address significant impacts on groundwater levels should include vegetation condition monitoring and the cessation of abstraction from any bores not meeting agreed thresholds within time frames that will prevent the significant loss of wetland values. (With reference to recommendation 7 above, the identification of wetlands to be protected from dewatering and extraction activities should take account of the identified potential wetland category mapping anomalies).

Item No.	Section No./Title	Reviewer Comment / Advice
10	Chapter 14 European Heritage and Chapter 15 Amenity (Reserves)	***Recommendation 10: That the proponent continues to work with the Swan Coastal District office of the Department of Parks and Wildlife regarding the translocation of heritage cork trees and the reestablishment of fencing and accessways associated with Parks and Wildlife managed lands.*** Discussion Parks and Wildlife supports the proponent's intention to translocate heritage cork trees from the site of the old Forestry Department's Divisional Headquarters, and re-establish boundary fencing and public access ways located within the project footprint. Continued liaison with the department's district office will facilitate the preparation of detailed site plans and design specifications to minimise impacts on heritage and amenity values.

References

Department of Parks and Wildlife (2013) Draft - A methodology for the evaluation of specific wetland types on the Swan Coastal Plain, Western Australia. http://www.dpaw.wa.gov.au/management/wetlands/publications-and-links

End of Document **Review** Sheet

Government of Western Australia
Department of Aboriginal Affairs

Environmental Protection Authority
File:
15 SEP 2015
A:
fA:
- [ ] General Manager
- [ ] Dir.AC
- [ ] Dir. SPPD
- [ ] Dir. Bus Ops
- [ ] Exec Assist
- [ ] For Information
- [ ] For Discussion
- [ ] For Consideration/ Advice
- [ ] Draft Response
- [ ] No Further Action

ENQUIRIES : Cesar Rodriguez- Ph 6551 8092

OUR REF: 2015/0624-01

YOUR REF: AC01-2014-0005

Chairman
Environmental Protection Authority
Locked Bag 10
EAST PERTH WA 6892

Dear Dr Vogel

RE: PERTH - DARWIN NATIONAL HIGHWAY - PUBLIC ENVIRONMENTAL REVIEW - ASSESSMENT NO: 1994

I refer to the letter sent by Mr Hans Jacob on 2 September 2015 to the Department of Aboriginal Affairs (DAA) requesting comment on the Perth-Darwin National Highway Public Environmental Review Assessment No. 1994 (the PER). Thank you for providing the opportunity to comment on the PER.

DAA has reviewed the relevant information and can confirm that there are currently a number of Registered Aboriginal Sites and other Aboriginal heritage places that overlap with the area of proposed development. It is understood that the PER also indicates that a number of newly recorded heritage places have been located following recent heritage surveys over the area.

It is noted on page 13-6 of the PER that Main Roads WA (the Proponent) intends to incorporate a number of management measures into an Aboriginal Heritage Management Plan (AHMP) for the project area. It is also noted that those measures include consultation with the South West Aboriginal Land and Sea Council (SWALSC) and the intention to apply for consent under section 18 of the *Aboriginal Heritage Act* (1972) (the AHA) to impact Aboriginal sites where necessary.

DAA advises that any potential impacts to Aboriginal heritage from the project can be addressed through the proposed AHMP and the provisions of the AHA.

It is suggested that the Proponent contact Mr Cesar Rodriguez, Manager Advice and Approvals Officer DAA on (08) 6551 8092 or via email at Cesar.Rodriguez@daa.wa.gov.au should they have any further heritage concerns.

Yours sincerely

Kathryn Przywolnik
DIRECTOR, APPROVALS AND ADVICE

10 September 2015

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Government of **Western Australia**
Department of **Lands**

Land Asset Management and Projects

Your ref: AC01-2014-0005
Our ref: 00009-2015, A5477267.
Enquiries: Matt Pestell, ph 08 6552 4625

Mr Hans Jacob
Manager – Infrastructure Assessments Branch
Office of the Environmental Protection Authority
Locked Bag 10
EAST PERTH WA 6892

Dear Mr Jacob

PERTH-DARWIN NATIONAL HIGHWAY – PUBLIC ENVIRONMENTAL REVIEW – ASSESSMENT NO: 1994

Thank you for your letter dated 2 September 2015 regarding the Public Environmental Review (PER) for the Perth-Darwin National Highway.

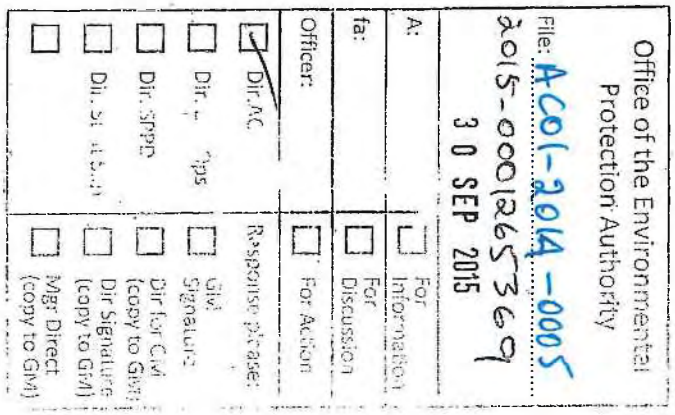
I note that the proposed area for the Perth Darwin National Highway includes land within the Dampier to Bunbury Natural Gas Pipeline (DBNGP) corridor. On that basis, I provide the following advice for consideration by the applicant:

- Prior to the commencement of any development works within the DBNGP corridor, the applicant must seek written approval from the DBNGP Land Access Minister;
- Registration of new interests within the DBNGP corridor is considered contrary to the intention of the *Dampier to Bunbury Pipeline Act 1997* and will not be allowed; and
- The applicant must ensure major water flows do not impact the DBNGP corridor.

For further enquiries please contact Mr Matt Pestell, Manager – Infrastructure Corridors, Land Asset Management and Projects, Department of Lands on telephone 08 6552 4625.

Yours sincerely

Antoine Macmath
A/Executive Director
Land Asset Management and Projects



23 September 2015

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Government of **Western Australia**
Office of the **Environmental Protection Authority**

Mr Rob Arnott
Project Director
Main Roads Western Australia
PO Box 6202
EAST PERTH WA 6892

Our Ref: *AC01-2014-0005*
Enquiries: *Leanne Thompson, 6145 0820*
Email: *leanne.thompson@epa.wa.gov.au*

Dear Mr Arnott

RESPONSE TO SUBMISSIONS DOCUMENT – PERTH-DARWIN NATIONAL HIGHWAY – PUBLIC ENVIRONMENTAL REVIEW – ASSESSMENT NO. 1994

Thank you for your Response to Submissions document (Revision 0, 31 March 2015) that was received by the Environmental Protection Authority (EPA) on 8 December 2015.

The Office of the Environmental Protection Authority (OEPA) has reviewed the Response to Submissions document. Please revise the document to incorporate the attached comments and advice (Attachment 1).

The OEPA has also consulted with relevant Decision Making Authorities (DMAs) regarding the Response to Submissions. Specific comments from DMAs have been incorporated into the OEPA comments. The Commonwealth Department of the Environment has yet to provide comments on the Response to Submissions document. These will be forwarded once received by the OEPA.

Please note that the comments in Attachment 1 under offsets are provided to ensure consistency with the WA Environmental Offsets Policy and WA Environment Offsets Guidelines, noting that the EPA has yet to consider the level of significant residual impact and whether an offset can be applied to counter balance the impact.

Please contact Leanne Thompson on (08) 6145 0820 for any further queries. Please advise the OEPA by 10 February 2016 when you intend to submit the revised Response to Submissions document. Please quote the above "Our ref" on any further correspondence.

Yours sincerely

Anthony Sutton
Director
Assessment and Compliance Division

2 February 2016

cc: Katie Foxley, Commonwealth Department of the Environment

Attachment 1: OEPA comments and advice on the Response to Submissions document

Attachment 1

OEPA Comment	Proponents Response
EPA policy and guidance	
The EPA is obliged to consider its policy and guidance during assessments. Please show in the Response to Submissions document how you have considered the relevant EPA policies. This should be done for sections 3-12 for those issues that has a corresponding EPA policy. The list of EPA policies that the OEPA considers relevant for this assessment are outlined in Attachment 2.	
General Comments	
Table 13.1 consolidates management measures for the proposal and notes whether the measures are unchanged from the Public Environmental Review (PER) (except for minor grammatical changes) or whether they have been revised, added or deleted (commitment has been filled). A review of this table has found that discrepancies exist between the proposed management measures in Table 13.1 and those proposed management measures identified in the PER. The OEPA has found examples where the commitment has changed but no explanation has been provided as well as cases where the commitment has changed but the status has not been updated. Using the preliminary key environmental factor Amenity (noise and vibration) as an example: • the status for the outcomes for operational noise is listed as "unchanged" however, the PER states noise mitigation measures should ensure noise levels do not exceed the noise limit of 60 dB L_{Aeq} between Reid Highway and Hepburn Avenue and aim to ensure noise levels do not exceed 55 dB L_{Aeq} between Hepburn Avenue and Ellenbrook, however this management commitment has been changed. The status column should reflect that this commitment has been revised. • the status for the proposed management measure for the Construction Noise and Vibration Management Plan is listed as "unchanged" however, the proposed management measure "*taking precautionary measures to avoid vibration damage to buildings near work sites*" has been removed with no explanation for the removal or correct listing of the status; and	

• the proposed management measure for constructing walls to a maximum height of 2.4 metres (m) north of Ellenbrook now includes an extra criteria of "*within 100 m of the road*", but the status is listed as "unchanged". Please review Table 13.1 to ensure these discrepancies are addressed for all preliminary key environmental factors and amend as required and provide explanations for any amendments, new and deleted management measures.	
Flora and Vegetation	
The OEPA has analysed the spatial data provided as part of the Response to Submissions, plotting the provided data against key environmental assets datasets. This analysis has found the proposal footprint intersects 188.6 hectares (ha) of Bush Forever sites, however, the Response to Submissions lists impacts to Bush Forever sites as being 130 ha. Please provide additional information to clarify the difference between the above inconsistent areas of impact to Bush Forever sites.	
Terrestrial Fauna	
The PER states on page 9-28 that a total of 159.3 ha of natural fauna habitats will be impacted by the proposal. The OEPA notes that minor amendments to the footprint have occurred since the PER. Please confirm the impact to natural fauna habitats.	
Amenity (noise and vibration)	
On page 34 and Tables 4.2, 4.3 and 13.1 of the Response to Submissions Main Roads has amended the proposed management measure to reduce indoor noise to "acceptable level" for the residences north of Ellenbrook where the noise limit cannot be met. The PER stated the proposal would "achieve indoor noise targets". An explanation will need to be provided to explain the above taking into account indoor noise targets are provided for in *State Planning Policy 5.4 – Road and Rail Transport Noise and Freight Considerations in Land Use Planning*. The proponent will need to further demonstrate if these indoor targets cannot be met how the noise levels will not have a significant detrimental impact on surrounding sensitive receivers and meet the EPA's objective.	

Offsets	
Offset proposal 1: In recent assessments, the EPA has recommended 15-20 years of funding should be provided where the proponent is not undertaking the offset. The OEPA has also previously advised during this assessment generally 20 years of funding for ongoing management is required in addition to any upfront conversion costs (pages 48 offset 1; page 49 offset 2; page 50 offset 3 and 4; page 93). Main Roads should provide justification based on sound information and knowledge for the number of years that have been proposed for ongoing management.	
Offset proposal 2: • As per the OEPA comments for Offset proposal 1, Main Roads should provide justification based on sound information and knowledge for the number of years that have been proposed for ongoing management. This should take into consideration the likely time lag before ongoing management and restoration measures provide the proposed environmental benefit. For example, will seven years provide for adequate time given the delay between planting and trees growing to productivity capacity or allow for the restoration of a degraded wetland to a functioning Conservation Category Wetland (CCW). • The Response to Submissions refers to the use of the commonwealth calculator to determine an offset ratio for impacts to CCWs. The commonwealth calculator cannot be used for CCWs as they are not considered matters of national environmental significance. Please remove references to the commonwealth calculator. The EPA has recommended an offset of 3:1 for other recent assessments. The OEPA notes that the likely subject sites for offsets are of a lower value than those being lost. The OEPA therefore recommends that a greater than 3:1 offset be provided. The offset should include funding for rehabilitation and specify the standards to which these areas will be restored, noting that detailed completion criteria would be the subject of a management plan should the EPA consider the proposal acceptable.	
Offset proposal 3: *Caladenia huegelii* habitat	

Main Roads should propose suitable quantum of funding in order to achieve the objectives. This should be based on advice from DPaW.	
Offset proposal 4: TEC SCP20a The proponent has incorporated impacts to TEC SCP20a with the forest red-tailed black cockatoo calculations in Appendix J. TEC SCP20a is an endangered community while the forest red-tailed black cockatoo is listed as vulnerable. This may affect the offsets calculated. The OEPA also notes that the condition of the property to be acquired is required to properly determine the offset metric, as outlined in the offsets policy. It would be preferable if the sites to be acquired are known as this will inform whether there is an increased risk of offsets not achieving the environmental benefit. The offsets calculation for SCP20a should be resubmitted, using the Commonwealth calculator and using the correct information.	
Minor amendments	
Page 32, Figure No. 3.1D – Inconsistent/incorrect map, it should be 3.2D and represent Threatened and Priority Ecological Communities.	
Page 48 – Third dot point references inferred TEC SCP20a at Offset Proposal 1. This should be removed.	
Page 45, Table 6.2 – In reference to the Conservation areas for the partial and complete removal of nine Bush Forever sites, the relevant offset proposal should include Offset Proposal 4 - SCP20a as 3.8 ha of TEC SCP20a is listed as a significant residual impact.	
Page 60 – Reference to EPP Lakes should be removed as this policy has been revoked.	
Page 69, Table 7.2 – In reference to Nature Reserves – Class A Nature Reserve 46920 it appears this area is fragmented into three sections (see Figure 7.1D) but only two have been identified. The section to the south of the footprint abutting Bush Forever site 399 Fragment C has been missed.	
Page 69, Table 7.2 – In reference to Threatened Ecological Communities – SCP20a the proponent states that Bush Forever site 198 is contiguous with Bush Forever site 300, however this should be Bush Forever site 304. There is also no discussion about the persistence of Fragment A.	

Page 81 – Reference to the Bassendean Complex – Central and North is incorrect should be Bassendean Complex – Central and South.	
Page 82, Table 7.5 – Pre-European extent figures differ from those listed in the EPA s16e advice (Perth and Peel @ 3.5 million Environmental impacts, risks and remedies). A footnote is also missing from this table.	
Page 192 – Reference to DPaW (2015) document titled incorrectly should be "Corporate Guideline No. 14: Environmental Offsets – Proponent Land Management Contributions."	

Attachment 2

EPA policy and guidance relevant to the proposal

Flora and Vegetation
- GS 51 – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in WA
- Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment
- PS 2 – Environmental Protection of Native Vegetation in WA
- PS 3 – Terrestrial Biological Surveys as an Element of Biodiversity Protection
- EPB 20 – Protection of naturally vegetated areas through planning and development

Terrestrial Fauna
- GS 56 – Terrestrial Fauna Surveys for Environmental Impact Assessment in WA
- PS 3 – Terrestrial Biological Surveys as an Element of Biodiversity Protection
- Technical Guide on Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment
- EPB 20 – Protection of naturally vegetated areas through planning and development

Hydrological processes and Inland Waters Environmental Quality'
- PS 4 – Environmental Protection of Wetlands
- EPP – Western Swamp Tortoise Habitat
- GS 7 – Protection of the Western Swamp Tortoise Habitat, Upper Swan/Bullsbrook

Amenity (noise and vibration)
- EAG 13 – Consideration of environmental impacts from noise

Heritage
- GS 41 – Assessment of Aboriginal Heritage

Offsets
- WA Environmental Offsets Guidelines
- EPB 1 – Environmental Offsets
- WA Environmental Offsets Policy

Rehabilitation and decommissioning
- GS 6 – Rehabilitation of Terrestrial Ecosystems

APPENDIX B

Index to Submission Issues



SUBMITTER ISSUES INDEX

This appendix provides cross-referencing between issues raised by individual submissions and the section of the report in which they are responded to.

Issues listed below have been summarised from the original submission. Issues are linked to consolidated issues, which represent groups of similar issues. A small number of issues are linked to more than one consolidated issue where several responses address the issue raised.

Submissions are identified by the organisation name. If no organisation name was provided, the submission identifier assigned by the Office of the Environmental Protection Authority is used.

Issues raised by ANON-FD3J-U7K7-N

Issue	Addressed in consolidated issue	Location in report
1. Traffic predictions are an underestimate. Noise in Ballajura will be too great.	54. The monitored noise at Madura Close (50.3 dBA) is lower than Fewson Turn (55 dBA) despite being near a highway. Ballajura noise levels will increase by only 10 dBA despite traffic increasing from 30,000 to 100,000 which is an underestimation.	Section 12.10.3
2. Money from sale of Whiteman Park should be reinvested into Whiteman Park.	36. Money from sale of Whiteman Park should be reinvested into Whiteman Park.	Section 12.14
160. Aboriginal heritage sites with significance should be avoided and protected in a manner acceptable to the local Nyungah people.	43. Aboriginal heritage sites with significance should be avoided and protected in a manner acceptable to the local Nyungah people.	Section 11.1 and repeated in Section 12.12
245. Noise walls should be made thicker and/or more trees planted on road verge.	188. Can the noise wall be thicker or trees planted to reduce the noise level to below 50 dB?	Section 12.10.2

Issues raised by ANON-FD3J-U7KB-Z

Issue	Addressed in consolidated issue	Location in report
19. Public review period was too short and didn't allow proper time to read and respond to PER.	1. PER review period was too short.	Section 12.6

20. Why is habitat at Lot 9 Maralla Road classified as 'modified' when it hasn't been used for agricultural or residential purposes?	106. Why is habitat at Lot 9 Maralla Road classified as 'modified' when it hasn't been used for agricultural or residential purposes?	Section 12.8.3
21. Fauna habitats should be preserved as much as possible.	118. How is it possible to justify the removal of '159 ha of natural fauna habitat'?	Section 12.8.3
22. Caladenia huegelii on a private property is not identified in PER. Will monitoring during construction and operation focus include Caladenia huegelii, and who will be responsible for identifying it correctly?	132. Impacts to known Caladenia huegelii from construction.	Section 12.7.1
23. What procedures will be in place to reduce dieback risk? Will effective spraying and treatment regimes be implemented prior to construction to control dieback?	140. How will weeds and dieback be managed?	Section 12.7.3
24. What controls will be in place to limit weeds? Will weed control be ongoing?	140. How will weeds and dieback be managed?	Section 12.7.3
25. Fauna assessment is inadequate because it does not consider arboreal and bird species, underestimating species diversity. Some species of reptiles, micro bats, invertebrates, birds not properly considered. Local extinctions could result.	97. Study, survey and trapping procedures were inadequate. Richness of extant fauna is not captured in surveys.	Section 7.4 and repeated in Section 12.8.8
26. Desktop fauna survey records only 4 invertebrate species. Invertebrates should have been considered properly.	96. Surveys for invertebrates were not extensive enough.	Section 12.8.8
27. Study, survey and trapping procedures were likely inadequate. Why were trapping nights not conducted across all four seasons?	97. Study, survey and trapping procedures were inadequate. Richness of extant fauna is not captured in surveys.	Section 7.4 and repeated in Section 12.8.8
28. What is the impact to species already noted as in decline?	107. What is the impact to species already noted as in decline?	Section 12.8.3
29. Provide details on fauna translocations prior to construction, viz. who will do it, where will animals be relocated to, what is the minimum distance, what about other animals, what about injured fauna?	102. Fauna translocations during the construction phase.	Section 12.8.10

30. Who is responsible for detecting and reducing disease in fauna? Will trapping personnel identify diseased animals and prevent its spread?	104. Who is responsible for detecting and reducing disease in fauna? Will trapping personnel identify diseased animals and prevent its spread?	Section 12.8.10
31. Will the relocation of fauna account for breeding patterns, e.g. the monogamous nature of the lizard Tiliqua rugosa?	103. Will the relocation of fauna account for breeding patterns, e.g. the monogamous nature of the lizard Tiliqua rugosa?	Section 12.8.10
32. Black cockatoo habitat preservation is of utmost importance. The removal of 13 breeding trees should absolutely be avoided.	88. Minimisation of clearing of black cockatoo habitat.	Section 12.8.1
33. What measures will be put in place to assess the extent of impact to Black Cockatoos?	89. What measures will assess the extent of impacts to black cockatoos?	Section 12.8.1
34. Fauna underpass size may be limiting to larger animals. Can they be used by large kangaroos? Are there previous examples of successful implementation?	92. Suitability of design of underpasses relative to target species.	Section 12.8.2
35. What is the likelihood that 100% of target species will use fauna underpasses?	91. Effectiveness of fauna underpasses.	Section 12.8.2
	92. Suitability of design of underpasses relative to target species.	Section 12.8.2
36. Will all fauna underpasses include natural lighting throughout to ensure use by diurnal species?	92. Suitability of design of underpasses relative to target species.	Section 12.8.2
37. Will fauna underpasses be monitored for illegal use such as trail bikes and rubbish dumping?	93. Unauthorised uses of fauna underpasses such as rubbish dumping and illegal motorbike riding.	Section 12.8.2
38. Will fauna underpasses restrict access for motorbikes while allowing access for fauna?	93. Unauthorised uses of fauna underpasses such as rubbish dumping and illegal motorbike riding.	Section 12.8.2
39. Why were impacts to an (unidentifiable) property outside the study area not considered? Why was the owner not approached for a survey of the land?	100. Why were properties outside the study area not surveyed?	Section 12.8.9
40. How will the impact of light and noise emissions on fauna be managed? Has the potential impact to wildlife in the area been assessed?	95. Impacts and management of light, noise and vibration on fauna.	Section 12.8.4

41. How will the impact of light and noise emissions on nearby residences be managed?	189. What noise and light management measures are in place to reduce the impact on local residents?	Section 12.10.2
42. Will repairs or compensation be provided to landowners if property damage occurs due to construction?	50. What compensation will be available for damage to properties caused by vibration? What is involved in dilapidation surveys that may be conducted prior to construction?	Section 12.10.4
43. Severance of local roads will reduce emergency access west of PDNH. What is the emergency access strategy during fires? Who will maintain emergency accesses? How will locked emergency access gates be controlled? Increased fire risk is a major concern.	12. How will emergency access for properties west of PDNH on Maralla Road be addressed?	Section 12.16
44. Rubbish dumping along Maralla Road and Halden Road is a concern. What monitoring will there be to prevent illegal dumping? Will there be signage? Who will clean up rubbish dumping to prevent continued dumping in the same location?	9. How will rubbish dumping around Maralla Road and Halden Road and other areas be prevented, controlled, monitored and/or cleaned up, during both construction and operation?	Section 12.16
45. What measures will be implemented to minimise pollutant runoff to wetlands 8800 and 8801?	64. How will spills and runoff be managed to protect wetlands and groundwater during construction and operation phases?	Section 12.9.5
46. Will air pollution from exhausts be monitored and controlled?	7. Will air pollution from exhausts be monitored and controlled?	Section 12.16
47. What does the noise façade treatment involve?	56. What does the noise façade treatment involve?	Section 12.10.1
48. Will noise abatement include planted vegetation? What other noise reduction measures will be used at Maralla Road?	59. How will the proponent manage noise at Maralla Road?	Section 12.10.2
49. How close to wetlands 8800 and 8801 will dewatering take place? What limits will there be on dewatering? How will dewatering impacts to wetlands be managed?	77. Impacts from and management of dewatering and groundwater abstraction.	Section 8.3 and repeated in Section 12.9.2

50. Maralla Road interchange is opposed. If interchange is required between Promenade and Stock Road, it should be located at Warbrook Road.	29. There should/shouldn't be an interchange at Maralla Road.	Section 12.3.2
51. How will services like mail delivery and rubbish collection be continued in Maralla Road [assumed to mean west of PDNH alignment]?	10. How will local utilities and services be interrupted or continued during construction and operation? Will there be any compensation?	Section 12.16
52. Will Halden Road extension to Maralla Road be sealed bitumen?	31. When will Halden Road extension begin construction? Will it be sealed bitumen?	Section 12.3.3
53. Will Maralla Road west of PDNH alignment retain its name?	30. Will Maralla Road west of PDNH alignment retain its name?	Section 12.3.3
54. When will Halden Road extension begin construction?	31. When will Halden Road extension begin construction? Will it be sealed bitumen?	Section 12.3.3
55. Will utilities (e.g. electricity) be interrupted during construction? If so, how will it be minimised or compensated?	10. How will local utilities and services be interrupted or continued during construction and operation? Will there be any compensation?	Section 12.16
56. Please advise which local roads will be accessible between Halden Road and Stock Road in order to get to PDNH.	8. Please advise which local roads will be accessible between Halden Road and Stock Road in order to get to PDNH.	Section 12.16
250. Monitored Carnaby's black cockatoo nesting boxes should be installed to offset habitat loss.	90. Will MRWA consider the installation and monitoring of next boxes for Carnaby's Black Cockatoo?	Section 12.10

Issues raised by ANON-FD3J-U7KM-B

Issue	Addressed in consolidated issue	Location in report
94. Dewatering during construction doesn't mention the impact to local residents that rely on groundwater for domestic/stock water.	77. Impacts from and management of dewatering and groundwater abstraction.	Section 8.3 and repeated in Section 12.9.2
	64. How will spills and runoff be managed to protect wetlands and groundwater during construction and operation phases?	Section 12.9.5

95. How will accidental chemical spills be managed prior to construction of settlement basins and silt curtains?	64. How will spills and runoff be managed to protect wetlands and groundwater during construction and operation phases?	Section 12.9.5
96. We have 2 unsurveyed Mound Springs on our property and these are fed from springs to west along Cooper Rd and adjacent properties. How will these be impacted by PDNH? If something goes wrong during construction, who will fix the problem?	71. How will unsurveyed Mound Springs on property be impacted by PDNH? Who will fix any impacts?	Section 12.9.4
97. Wetland/drainage management and monitoring plan referred to in PER is not available for comment. Who will review and monitor these plans?	70. Who will review and monitor the Wetland and Drainage Management and Monitoring Plan referred to in PER?	Section 12.9.5
98. Statement that Stock Road has one of the highest noise levels during monitoring is difficult to believe. Will there be much of an increase in noise in the area?	55. Statement that Stock Road has one of the highest noise levels during monitoring is difficult to believe. Will there be much of an increase in noise in the area?	Section 12.10.4

Issues raised by ANON-FD3J-U7KS-H

Issue	Addressed in consolidated issue	Location in report
76. Why do table drains need to be 6 m wide overall? Native vegetation should be used for water flow control in drains, the back slopes at a minimum.	49. Why do table drains need to be 6 m wide overall? Native vegetation should be used for water flow control in drains, the back slopes at a minimum.	Section 12.11
99. The Whiteman to Yanchep Highway bifurcation should be relocated immediately north of Gnangara Road to avoid excision of 8 ha from Whiteman Park and reduce number of interchanges from 2 to 1.	28. The Whiteman to Yanchep Highway bifurcation should be relocated immediately north of Gnangara Road to avoid unnecessary excision of 8 ha from Whiteman Park and reduce number of interchanges from 2 to 1.	Section 12.3.2

Issues raised by ANON-FD3J-U7KT-J

Issue	Addressed in consolidated issue	Location in report
100. PER review period was too short.	1. PER review period was too short.	Section 12.6

101. Our property was not surveyed for flora/vegetation. How can we be sure more significant species weren't missed?	128. Clarifications regarding flora and vegetation surveys and results.	Section 12.7.5
102. 357 species of vascular flora taxa is probably an underestimation. Will MRWA fund additional surveys to characterise diversity of non-vascular plants and fungi, especially in the Maralla Road nature reserve?	128. Clarifications regarding flora and vegetation surveys and results.	Section 12.7.5
103. What additional targeted surveys will be conducted to 'further define the population size and extent' of Caladenia huegelii?	131. Further surveys for Caladenia huegelii.	Section 12.7.1
104. How can the proponent guarantee that Caladenia huegelii will be fully protected?	133. Impacts to unknown Caladenia huegelii from construction.	Section 12.7.1
105. Caladenia huegelii habitat loss is completely unacceptable, especially given vehicular impacts to the wasp Zaspilothynnus sp. that pollinates this species.	135. Commentary on fungi and Zaspilothynnus wasp supporting Caladenia huegelii are omitted.	Section 12.7.1
106. The statement that 'there are no direct impacts to [Caladenia huegelii]' is wrong. How is the impact on unknown populations of C. huegelii considered?	133. Impacts to unknown Caladenia huegelii from construction.	Section 12.7.1
107. What endangered and priority species other than Caladenia huegelii have their impact understated or denied?	137. What endangered and priority species other than Caladenia huegelii have their impact understated or denied?	Section 12.7.2
108. Why has the location of declared rare flora been published in the PER despite DPAW requesting it to be kept in confidence?	130. Confidentiality of threatened flora locations.	Section 12.7.1
109. Why has declared rare flora at Maralla Road been disregarded in planning the PDNH?	132. Impacts to known Caladenia huegelii from construction.	Section 12.7.1
110. Millotia tenuifolia var. laevis (P2), Meeboldina decipiens subsp. decipiens ms (P3), Ornduffia submersa (P4) and Stylidium striatum (P4) aren't mentioned in Table 8.1. Have they not been previously found? Or are they name changes?	128. Clarifications regarding flora and vegetation surveys and results.	Section 12.7.5

111. Will the spring surveys recommended for TECs, PECs, Threatened and Priority flora focusing on annual species at Maralla Road and Halden Road be conducted? When and by whom?	125. Will future/recommended surveys be conducted at Maralla Road and Halden Road?	Section 12.7.5
112. Should Threatened and Priority listed flora locations be kept confidential?	130. Confidentiality of threatened flora locations.	Section 12.7.1
113. How does MRWA intend to protect the four Priority species found at Maralla Rd / Ellenbrook area?	146. Protection and management of Priority flora species.	Section 12.7.4
114. The starflower species Calytrix fraseri Ellenbrook Form is a special form of the species and should be protected.	149. The starflower species Calytrix fraseri Ellenbrook Form is a special form of the species and should be protected.	Section 12.7.4
115. It is difficult to justify clearing yet another 205 ha of native vegetation. When will the continued clearing of native vegetation on the Swan Coastal Plain stop?	122. Clearing of remnant intact native vegetation on the Swan Coastal Plain, particularly good to pristine native vegetation and vegetation in association with a Bush Forever site is unacceptable.	Section 12.7.2
116. Will MRWA conduct a phosphorus acid spraying program in the proposal footprint to protect healthy vegetation from the likely spread of dieback?	140. How will weeds and dieback be managed?	Section 12.7.3
117. Clearing of good to pristine native vegetation is completely unacceptable. Clearing of Bush Forever is unacceptable. Does 'forever' mean only if it suits development proposals?	122. Clearing of remnant intact native vegetation on the Swan Coastal Plain, particularly good to pristine native vegetation and vegetation in association with a Bush Forever site is unacceptable.	Section 12.7.2
118. The removal of 280 ha of TECs and PECs should be avoided. What measures will be put in place to protect TECs and PECs impacted by the proposal?	142. The removal of 280 ha of TECs and PECs should be avoided. What measures will be put in place to protect TECs and PECs impacted by the proposal?	Section 12.7.3
119. Will every such area be fenced to prevent impacts such as rubbish dumping, trail biking, off road driving and fires?	9. How will rubbish dumping around Maralla Road and Halden Road and other areas be prevented, controlled, monitored and/or cleaned up, during both construction and operation?	Section 12.16

120. How is it possible to justify the removal of 159 ha of natural fauna habitat?	118. How is it possible to justify the removal of '159 ha of natural fauna habitat'?	Section 12.8.3
121. Clearing should be able to avoid mortalities in local vertebrates. Clearing should be done slowly and carefully to prevent mortalities.	109. Clearing should be able to avoid mortalities in local vertebrates. Clearing should be done slowly and carefully to prevent mortalities.	Section 12.8.5
122. Will MRWA erect warning signs along the roadside about wildlife crossing, and provide wildlife rescue contact details?	112. Will MRWA erect warning signs along the roadside about wildlife crossing, and provide wildlife rescue contact details?	Section 12.8.6
123. What measures will be adopted during construction to monitor and remove species that can be relocated? What support will MRWA provide for ongoing monitoring of relocated fauna to determine relocation success?	102. Fauna translocations during the construction phase.	Section 12.8.10
124. What support will MRWA give to wildlife carers who have to care for injured and orphaned animals that result from extensive habitat destruction and relocation of adult females?	102. Fauna translocations during the construction phase.	Section 12.8.10
125. What maintenance during operations will exist for underpasses, escape ramps, fences, logs, furniture and revegetation?	101. What maintenance during operations will exist for underpasses, escape ramps, fences, logs, furniture and revegetation?	Section 12.8.7
126. What evidence demonstrates that 1.2 m x 3 m x 70 m fauna underpasses work for Western Grey Kangaroos, which can be 2 m tall?	92. Suitability of design of underpasses relative to target species.	Section 12.8.2
127. What staging measures will be put in place during construction to prevent the halting of fauna movements at all times?	110. What staging measures will be put in place during construction to prevent the halting of fauna movements at all times?	Section 12.8.5
128. Will the roadside fencing be kangaroo proof?	113. Roadside fencing.	Section 12.8.6
129. Will revegetation (including next to fauna underpasses) use local provenance plants not just local species?	45. Will revegetation works use local native provenance species and be representative of the existing neighbouring vegetation?	Section 12.11

130. In Appendix G, column 9 in the previously recorded fauna list doesn't seem to match the location and results of trap sites list.	108. In Appendix G, the column 9 in the previously recorded fauna list doesn't seem to match the location and results of trap sites list.	Section 12.8.3
131. There is no comprehensive lists of birds in the survey site. Some species are not mentioned. Will MRWA fund bird surveys in the proposal area?	98. There are no comprehensive lists of birds in the survey site. Some species are not mentioned. Will MRWA fund bird surveys in the proposal area?	Section 12.8.9
132. Will MRWA be proactive in removing animal carcasses from the PDNH to prevent impacts to carrion predators such as the Wedge-tailed Eagle?	116. Will MRWA be proactive in removing animal carcasses from the PDNH to prevent impacts to carrion predators such as the Wedge-tailed Eagle?	Section 12.8.6
133. Will MRWA consider other options to reduce occurrence of black cockatoos at road height along PDNH? e.g. extra high fauna fences near Maralla Rd, or removal of roadside foraging resources such as dandelions?	87. Other options for reducing occurrences of black cockatoos at highway height.	Section 12.8.1
134. Have field surveys been done during breeding season to determine black cockatoo roosting sites? Were landowners asked for local information?	86. Black cockatoo surveys may have underestimated numbers due to timing and not asking local landholders.	Section 12.8.1
135. Offsets do not add to black cockatoo conservation effort and other management should be used. Will MRWA assist with ongoing monitoring of hollow nesting logs for black cockatoos?	16. Offsets do not add to black cockatoo conservation effort and other management should be used. Will MRWA assist with ongoing monitoring of hollow nesting logs for black cockatoos?	Section 12.15
136. Black cockatoo watering sites near PDNH need to be replaced with new sites away from PDNH to lessen chance of mortalities. Will this be done?	85. Black cockatoo watering sites within Dick Perry Reserve near PDNH needs to be replaced with new sites away from PDNH to lessen chance of mortalities.	Section 12.8.1
137. Merops ornatus is likely to occur but the nests will be at risk from construction. Will construction cease if nesting birds are noticed along or near Maralla Road?	111. Merops ornatus (Rainbow Bee-eater) is likely to occur but the nests will be at risk from construction. Will construction cease if nesting birds are noticed along or near Maralla Road?	Section 12.8.5

138. Jewelled Sandplain Ctenotus (Ctenotus gemmula), Black striped snake (Neelaps calonotos) and Western Brush Wallaby (Macropus irma) do occur within the proposal footprint, despite being stated as 'likely' to occur.	99. Jewelled Sandplain Ctenotus (Ctenotus gemmula), Black striped snake (Neelaps calonotos) and Western Brush Wallaby (Macropus irma) do occur within the proposal footprint, despite being stated as 'likely' to occur.	Section 12.8.9
139. Invertebrates have not been surveyed extensively enough in the proposal footprint. Will MRWA help fund an extensive invertebrate survey?	96. Surveys for invertebrates were not extensive enough.	Section 12.8.8
140. [redacted] Maralla Road should be included in the ecological linkage corridor.	105. [address redacted] Maralla Rd should be included in the ecological linkage corridor.	Section 12.8.3
141. Wetlands are already impacted by other factors and PDNH will further disrupt hydrological regimes. Will MRWA help fund more frequent and thorough wetland monitoring?	81. Wetlands are already impacted and PDNH will further disrupt hydrological regimes. Will MRWA help fund more frequent and thorough wetland monitoring?	Section 12.9.6
142. How is the partial loss of wetland EPP Lake No. 450 justified?	74. How is the partial loss of wetland EPP Lake No. 450 justified?	Section 12.9.4
143. The loss of CCWs is unacceptable. Impacts could be lessened through use of bridges or diverting the PDNH alignment around the wetlands.	84. The loss of CCWs is unacceptable. Impacts could be lessened through use of bridges or diverting the PDNH alignment around the wetlands.	Section 12.9.4
144. The Water Corporation bores impacted by PDNH should be decommissioned.	66. The Water Corporation bores impacted by PDNH should be decommissioned.	Section 12.9.2
145. Wetlands are already dry and construction dewatering, as well as subsurface compaction, must be minimised.	77. Impacts from and management of dewatering and groundwater abstraction.	Section 8.3 and repeated in Section 12.9.2
	83. What engineering solutions will be used to maintain maximum groundwater levels and flow?	Section 12.9.6
146. What specific management of key threatening processes to wetland CCW 8800 will be put in place?	75. Impacts to and management of CCW 8800.	Section 12.9.4

147. The indirect impacts to fauna habitats discussed in Section 9.3 are unacceptable. Alterations to hydrology resulting in habitat destruction should be mitigated to prevent damage to wetlands.	115. The indirect impacts to fauna habitats discussed in Section 9.3 are unacceptable. Alterations to hydrology resulting in habitat destruction should be mitigated to prevent damage to wetlands.	Section 12.8.6
148. How is the correct surveying of construction/clearing footprint assured, given inaccuracies in spatial data for EPP lakes?	25. Accuracy of information used in decision-making processes and surveying for clearing.	Section 12.3.4
149. What evidence shows that 50 m is a large enough buffer between laydown areas and wetlands?	73. What evidence shows that 50 m is a large enough buffer between laydown areas and wetlands?	Section 12.9.4
150. Will wetland CCW 8800 be considered as a special case to ensure it is fully protected or ignored because it is 'not in the proposal area'?	75. Impacts to and management of CCW 8800.	Section 12.9.4
151. When will piezometer monitoring as recommended in the wetlands study commence?	81. Wetlands are already impacted and PDNH will further disrupt hydrological regimes. Will MRWA help fund more frequent and thorough wetland monitoring?	Section 12.9.6
152. How will uncontrolled access, rubbish and fires be managed?	9. How will rubbish dumping around Maralla Road and Halden Road and other areas be prevented, controlled, monitored and/or cleaned up, during both construction and operation?	Section 12.16
153. How will the weeds Victorian Tea Tree (Leptospermum laevigatum), Arum Lily (Zantedeschia aethiopica) and Bridal Creeper (Asparagus asparagoides) be managed?	140. How will weeds and dieback be managed?	Section 12.7.3
154. How will ASS be managed?	62. Management of acid sulfate soils (ASS).	Chapter 10 and repeated in Section 12.9.1
155. How will dewatering and water abstraction be monitored and addressed? In particular: abstraction rates, bore operating regimes, hydrogeology of bores, impacts to environmental values from drawdown, and existing groundwater licences.	77. Impacts from and management of dewatering and groundwater abstraction.	Section 8.3 and repeated in Section 12.9.2

156. Will MRWA provide fire brigades with extra water sources to fight bushfires?	13. Will MRWA provide fire brigades with extra water sources to fight bushfires?	Section 12.16
157. Revegetation designed for the transition zone should be extended to Warbrook Road, or at least beyond 108 Halden Road.	48. Revegetation designed for the transition zone should be extended to Warbrook Road, or at least beyond 108 Halden Road.	Section 12.11
158. Banksia Woodland species should be planted along verges adjacent to native vegetation, not only dry grassing and trees. Will the planting of out-of-place trees, shrubs and grasses be avoided?	45. Will revegetation works use local native provenance species and be representative of the existing neighbouring vegetation?	Section 12.11
159. Will the use of soils infected with dieback or infested with weeds near bushland be avoided?	44. Will the use of soils infected with dieback or infested with weeds near bushland be avoided?	Section 12.11
161. Why is Nature Reserve R46919 not extended into the remainder of Bush Forever site 300? Is it owned by someone else / has it been vested in the state government?	35. Why is Nature Reserve R46919 not extended into the remainder of Bush Forever site 300? Is it owned by someone else / has it been vested in the state government?	Section 12.14
162. How will uncontrolled access, rubbish dumping, weeds, dieback and the degradation of vegetation through off-road activities be managed?	140. How will weeds and dieback be managed?	Section 12.7.3
	9. How will rubbish dumping around Maralla Road and Halden Road and other areas be prevented, controlled, monitored and/or cleaned up, during both construction and operation?	Section 12.16
163. Which recommendations made by botanical environmental consultants will be implemented?	143. Which recommendations made by botanical environmental consultants will be implemented?	Section 12.7.3
164. Will roadside fences be built into the ground and at a height of 1.8 m as recommended?	113. Roadside fencing.	Section 12.8.6
165. Figure 3 of Appendix H demonstrates an arbitrary division of the project site into different zones. The southern border of the palusplain section should not start until the actual palusplain starts.	68. Use of infiltration systems in palusplain zone and just north of Maralla Road.	Section 12.9.3

166. Effects of climate change and Ellenbrook drawdown on local wetland vegetation was underestimated by R. Froend et al. More caution should be exercised using this reference source.	72. Credibility of referencing R. Froend et al. in estimating effects of climate change and Ellenbrook drawdown on local wetland vegetation.	Section 12.9.4
167. What engineering solutions will be used to maintain maximum groundwater levels and flow during construction and operation, and prevent pollution of groundwater by inevitable fuel and chemical spills?	64. How will spills and runoff be managed to protect wetlands and groundwater during construction and operation phases?	Section 12.9.5
	83. What engineering solutions will be used to maintain maximum groundwater levels and flow?	Section 12.9.6
168. How will the area just north of Maralla Road be treated in terms of drainage in order to filter runoff and protect wetlands?	82. Sensitive bushland and wetland areas in the palusplain zone each require a special strategy to ensure their conservation.	Section 12.9.6
169. What will be done to prevent ongoing runoff and spill incidents polluting the local potable groundwater supply?	64. How will spills and runoff be managed to protect wetlands and groundwater during construction and operation phases?	Section 12.9.5
170. Will Saw Pit Gully definitely be used for outlet flow during flood overtopping events?	67. Will Saw Pit Gully definitely be used for outlet flow during flood overtopping events?	Section 12.9.3
171. The generalisation about infiltration systems not being appropriate for the palusplain zone does not apply just north of Maralla Road. Should infiltration systems be considered for this area instead?	68. Use of infiltration systems in palusplain zone and just north of Maralla Road.	Section 12.9.3
172. Façade treatment will not reduce exterior noise and will impact fauna. Can thick vegetative buffers be considered?	95. Impacts and management of light, noise and vibration on fauna.	Section 12.8.4
173. What compensation is available for residence with vibration damage such as inevitable cracks in bricks?	50. What compensation will be available for damage to properties caused by vibration? What is involved in dilapidation surveys that may be conducted prior to construction?	Section 12.10.4
174. Will we (as residents north of Ellenbrook) receive screen walls? How effective are screen walls inside and outside a house?	187. Will the impacted residential properties north of Ellenbrook receive noise walls?	Section 12.10.2

175. What does 'taking precautionary measures to avoid vibration damage to buildings near work sites' entail? What precautions are possible?	51. What does 'taking precautionary measures to avoid vibration damage to buildings near work sites' entail?	Section 12.10.4
176. What is involved in dilapidation surveys that may be conducted prior to construction?	50. What compensation will be available for damage to properties caused by vibration? What is involved in dilapidation surveys that may be conducted prior to construction?	Section 12.10.4
177. What is the impact of fitting 6 mm glazing? Glazing does nothing to reduce external noise.	58. What is the impact of fitting 6 mm glazing? Glazing does nothing to reduce external noise.	Section 12.10.1
178. Will our property be eligible for the Package B Architectural Treatment Package for noise control?	57. How were properties chosen for noise mitigation works? Can other properties be included?	Section 12.10.1
180. Areas proposed to be cleared should be independently audited and local landowners should be allowed to check it before construction begins.	139. Areas proposed to be cleared should be independently audited and local landowners should be allowed to check it before construction begins.	Section 12.7.3
181. What evidence shows that PDNH will significantly decrease traffic through the Swan Valley?	37. What evidence shows that PDNH will significantly decrease traffic through the Swan Valley?	Section 12.1
182. The upgrading of Great Northern Highway (GNH) has been overlooked although it presents fewer environmental constraints.	40. The upgrading of Great Northern Highway (GNH) has been overlooked although it presents fewer environmental constraints.	Section 12.1
183. Number of vegetation associations to be lost is too great. Mapping should have occurred at an earlier stage so they could be avoided during route selection.	41. Mapping and surveying of vegetation associations and good quality vegetation should have occurred at an earlier stage so it could be avoided during route selection.	Section 12.2
184. There is an opportunity in Beechboro Road to move the alignment into some degraded vegetation instead of through excellent/very good vegetation.	42. There is an opportunity in Beechboro Road to move the alignment into some degraded vegetation instead of through excellent/very good vegetation.	Section 12.3.1
185. Earlier surveys would have resulted in avoiding areas of native vegetation good and above to the west of Ellenbrook.	41. Mapping and surveying of vegetation associations and good quality vegetation should have occurred at an earlier stage so it could be avoided during route selection.	Section 12.2

186. Do the benefits of this proposal outweigh the costs?	38. Do the benefits of this proposal outweigh the costs?	Section 12.1
247. How will pollution from spills be prevented?	64. How will spills and runoff be managed to protect wetlands and groundwater during construction and operation phases?	Section 12.9.5
248. How will pollution be prevented and water quality in Saw Pit Gully be maintained?	67. Will Saw Pit Gully definitely be used for outlet flow during flood overtopping events?	Section 12.9.3
294. What monitoring of fauna underpasses will there be, what will the performance criteria be and how will they be measured?	184. What monitoring and maintenance during operations will exist for revegetation? What will the measures of success be?	Section 12.8.2

Issues raised by ANON-FD3J-U7KV-M

Issue	Addressed in consolidated issue	Location in report
187. Approximately 10 large trees slightly northwest of the end of Gulf Cove in Ellenbrook should be retained. The alignment can be moved around these trees.	88. Minimisation of clearing of black cockatoo habitat.	Section 12.8.1

Issues raised by ANON-FD3J-U7KW-N

Issue	Addressed in consolidated issue	Location in report
188. Four weeks is not long enough for the public review period. Quality of feedback is compromised as a result.	1. PER review period was too short.	Section 12.6
189. Caladenia huegelii should have been discussed in more detail without revealing its location. The importance at [address redacted] Maralla Road as stated may be misleading.	130. Confidentiality of threatened flora locations.	Section 12.7.1
191. A Caladenia huegelii orchid [address redacted, but assumed to be on private property] exists within 50 m of the study boundary and will be subject to the impacts of road construction and ongoing operation.	132. Impacts to known Caladenia huegelii from construction.	Section 12.7.1

193. The impacts to the Zaspilothyunnus wasp responsible for pollinating Caladenia huegelii are unclear.	135. Commentary on fungi and Zaspilothynnus wasp supporting Caladenia huegelii are omitted.	Section 12.7.1
194. The timing and duration of the surveys do not adequately represent the richness of fauna that longitudinal studies would have provided.	97. Study, survey and trapping procedures were inadequate. Richness of extant fauna is not captured in surveys.	Section 7.4 and repeated in Section 12.8.8
195. Extent of invertebrate studies was non-existent or extremely limited. Invertebrates have a role in other processes, e.g. pollination. The view that insects are unimportant is unacceptable and outdated.	96. Surveys for invertebrates were not extensive enough.	Section 12.8.8
196. Bollards or other devices should be installed in fauna underpasses to limit unauthorised access, e.g. from motorbikes.	93. Unauthorised uses of fauna underpasses such as rubbish dumping and illegal motorbike riding.	Section 12.8.2
198. Our land is an important contributor to the ecological linkages described in the PER. It should have been considered even though it is outside the study area.	105. [address redacted] Maralla Rd should be included in the ecological linkage corridor.	Section 12.8.3
199. Rubbish dumping is a problem around Maralla Road. Fauna underpasses will attract more dumping. Who will be responsible for cleaning up rubbish?	93. Unauthorised uses of fauna underpasses such as rubbish dumping and illegal motorbike riding.	Section 12.8.2
200. A second/alternative access for residents in the Maralla Road area west of PDNH should be provided in case of emergencies such as fire.	12. How will emergency access for properties west of PDNH on Maralla Road be addressed?	Section 12.16
201. Underpasses will create additional problems for residents due to motorbikes using them and rubbish being dumped in them.	93. Unauthorised uses of fauna underpasses such as rubbish dumping and illegal motorbike riding.	Section 12.8.2
202. Are fauna underpasses successful? Would all species in the area use them?	91. Effectiveness of fauna underpasses.	Section 12.8.2
203. Will there be natural lighting in fauna underpasses for daytime migrating species? If underpasses are in darkness they may not be used by all species.	92. Suitability of design of underpasses relative to target species.	Section 12.8.2

204. During construction will there be dewatering near Maralla Road? If so, how will dewatering be managed especially with regard to wetland CCW 8800 and Caladenia huegelii?	77. Impacts from and management of dewatering and groundwater abstraction.	Section 8.3 and repeated in Section 12.9.2
205. The impacts to wetland CCW 8800 are opposed. There should be a buffer of 50 to 100 m from the PDNH road reserve. There does not appear to be a buffer.	75. Impacts to and management of CCW 8800.	Section 12.9.4
207. Our lifestyle will be severely impacted by noise from PDNH. What does façade treatment for noise involve?	57. How were properties chosen for noise mitigation works? Can other properties be included?	Section 12.10.1
	56. What does the noise façade treatment involve?	Section 12.10.1
208. How will noise be managed at properties given that PDNH will be at a high elevation at Maralla Road?	59. How will the proponent manage noise at Maralla Road?	Section 12.10.2
209. Is there any evidence that wildlife will use an underpass subject to noise and vibration from a highway being used by heavy traffic like the PDNH?	91. Effectiveness of fauna underpasses.	Section 12.8.2
210. It is not clear what impact ground vibration will have on wildlife in the area.	95. Impacts and management of light, noise and vibration on fauna.	Section 12.8.4
211. What compensation will be made to correct any damage caused by vibration?	50. What compensation will be available for damage to properties caused by vibration? What is involved in dilapidation surveys that may be conducted prior to construction?	Section 12.10.4
212. How will spills from trucks on PDNH be managed to prevent contamination and pollution of groundwater and wetlands?	64. How will spills and runoff be managed to protect wetlands and groundwater during construction and operation phases?	Section 12.9.5
213. The proposed interchanges are supported, however any suggestion by developers to include an interchange at Maralla Road should be refused on grounds of Maralla Road's environmental and heritage values.	29. There should/shouldn't be an interchange at Maralla Road.	Section 12.3.2

Issues raised by ANON-FD3J-U7KZ-R

Issue	Addressed in consolidated issue	Location in report
214. Future public review period length should be commensurate with the size and detail of the PER so it can be responded to in full.	1. PER review period was too short.	Section 12.6
215. Surveys for flora and fauna, but especially birds, reptiles and invertebrates, was not comprehensive enough. Species have been overlooked because of the limited scope of surveys. How can the real impacts be known?	97. Study, survey and trapping procedures were inadequate. Richness of extant fauna is not captured in surveys.	Section 7.4 and repeated in Section 12.8.8
216. Surveys for Caladenia huegelii would likely have missed individuals due to their flowering patterns and the limited nature of surveys. The accuracy of the information presented is therefore concerning.	134. Accuracy and completeness of survey information for Caladenia huegelii.	Section 12.7.1
218. Why have no surveys been done for fungi and invertebrates that support Caladenia huegelii given their essential role in its survival?	135. Commentary on fungi and Zaspilothynnus wasp supporting Caladenia huegelii are omitted.	Section 12.7.1
220. Sensitive bushland and wetland areas in the palusplain zone each require a special strategy to ensure their conservation.	82. Sensitive bushland and wetland areas in the palusplain zone each require a special strategy to ensure their conservation.	Section 12.9.6
221. Existing rubbish dumping and unauthorised access and destruction around Maralla Road will worsen with PDNH. How will illegal activities be managed during and after construction?	9. How will rubbish dumping around Maralla Road and Halden Road and other areas be prevented, controlled, monitored and/or cleaned up, during both construction and operation?	Section 12.16
222. How will dieback be managed during construction so it does not worsen? Will phosphite treatments be used and, if so, how? Will relevant landowners be consulted?	140. How will weeds and dieback be managed?	Section 12.7.3
224. PDNH will increase emergency response times in western Maralla Road. How will emergency access be addressed for properties west of PDNH in case of bushfire?	12. How will emergency access for properties west of PDNH on Maralla Road be addressed?	Section 12.16

225. Given that fire management is essential for conservation, what fire management measures will be put in place during and after construction?	123. Given that fire management is essential for conservation, what fire management measures will be put in place during and after construction?	Section 12.7.3
226. Black Cockatoos have been sighted in increasing numbers very close to the proposal footprint. Given the PER surveys don't reflect this, the surveys appear not to have provided an accurate assessment of the species' presence. The impact may be greater.	86. Black cockatoo surveys may have underestimated numbers due to timing and not asking local landholders.	Section 12.8.1
228. Roadside fencing height of 1.2 m is inadequate to prevent kangaroos and other animals getting past. Fencing should be 1.8 m minimum in all areas along bushland and wetlands. Fencing repair and monitoring must be ongoing.	113. Roadside fencing.	Section 12.8.6
229. How will unauthorised human access into fauna underpasses be prevented to avoid discouraging use by fauna?	93. Unauthorised uses of fauna underpasses such as rubbish dumping and illegal motorbike riding.	Section 12.8.2
230. How has construction water allocation been licensed properly? How has existing local overallocation of water been accounted for?	77. Impacts from and management of dewatering and groundwater abstraction.	Section 8.3 and repeated in Section 12.9.2
231. Will there be monitoring of the environments likely to be affected by water abstraction during construction?	81. Wetlands are already impacted and PDNH will further disrupt hydrological regimes. Will MRWA help fund more frequent and thorough wetland monitoring?	Section 12.9.6
	77. Impacts from and management of dewatering and groundwater abstraction.	Section 8.3 and repeated in Section 12.9.2
233. Previous decisions and discussions have been made on the basis of incorrect information.	25. Accuracy of information used in decision-making processes and surveying for clearing.	Section 12.3.4
234. Any future interchanges must be done with more consultation with local landholders and residents as consultation has been substandard in the past.	5. Any future interchanges must be done with more consultation with local landholders and residents as consultation has been substandard in the past.	Section 12.5

236. Any future interchanges must be subject to thorough environmental review with surveys for flora/fauna to be more in depth than was done for PDNH.	129. Any future interchanges must be subject to thorough environmental review with surveys for flora/fauna to be more in depth than was done for PDNH.	Section 12.7.5

Issues raised by Bullsbrook Residents and Ratepayers Association Inc

Issue	Addressed in consolidated issue	Location in report
3. General support for proposal.	39. The proposal is supported.	Section 11.3 and repeated in Section 12.1
4. Additional flora and vegetation surveys for Maralla Road. Were additional surveys undertaken? How will results be incorporated into project management documentation?	125. Will future/recommended surveys be conducted at Maralla Road and Halden Road?	Section 12.7.5
5. Timing of flora surveys for spring means flora surveys are limited.	126. Timing of flora surveys for spring means flora surveys are limited.	Section 12.7.5
6. How were properties chosen for noise mitigation works? Can other properties be included?	57. How were properties chosen for noise mitigation works? Can other properties be included?	Section 12.10.1
7. Noise mitigation for properties north of Ellenbrook will not reduce noise outdoors.	60. Noise mitigation for properties north of Ellenbrook will not reduce noise outdoors.	Section 12.10.2
8. Heritage of Bulls Brook has not been considered despite being significant to history of Bullsbrook district.	33. Heritage of Bulls Brook has not been considered despite being significant to history of Bullsbrook district.	Section 12.13
10. Can offsets package include purchase of cleared/degraded land for rehabilitation to address net loss of important habitat associated with bushland and wetlands?	14. The proposal (including offsets) will still result in a net loss of biodiversity. Acquisition does not replace bushland, and MRWA should implement a revegetation offset.	Section 7.6 and repeated in Section 12.15
11. Cumulative impacts have not been addressed but would be useful for future documents to do so. A more holistic approach is needed.	2. Future projects should consider cumulative impacts.	Section 12.6
12. Will the noise mitigation packages be fitted prior to the start of construction?	56. What does the noise façade treatment involve?	Section 12.10.1

13. If an acceptable level of noise mitigation isn't achieved by the strategies will they be rectified and additional treatments added? Will funds be available to undertake this?	61. If an acceptable level of noise mitigation isn't achieved by the strategies will they be rectified and additional treatments added? Will funds be available to undertake this?	Section 12.10.2
14. Will noise monitoring continue once the highway has been completed?	61. If an acceptable level of noise mitigation isn't achieved by the strategies will they be rectified and additional treatments added? Will funds be available to undertake this?	Section 12.10.2
15. Will funds be available to support wildlife carers with animals injured as a result of the construction of the proposal?	102. Fauna translocations during the construction phase.	Section 12.8.10
16. Can fauna underpasses also be placed in cleared areas?	94. Can fauna underpasses also be placed in cleared areas?	Section 12.8.2
17. Was Lot 5892 Maralla Road Bullsbrook considered as a potential offset? If not, can it be?	20. Was Lot 5892 Maralla Road Bullsbrook considered as a potential offset? If not, can it be?	Section 12.15
18. What impact could DOD lack of endorsement for the final alignment have on the project?	22. What impact could DOD lack of endorsement for the final alignment have on the proposal?	Section 12.4

Issues raised by Department of Aboriginal Affairs

Issue	Addressed in consolidated issue	Location in report
179. Any potential impacts to Aboriginal heritage from the proposal can be addressed through the proposed Aboriginal Heritage Management Plan and the provisions of the Aboriginal Heritage Act 1972 (e.g. Section 18 consent).	43. Aboriginal heritage sites with significance should be avoided and protected in a manner acceptable to the local Nyungah people.	Section 11.1 and repeated in Section 12.12

Issues raised by Department of Environment Regulation

Issue	Addressed in consolidated issue	Location in report
238. Recommendations in the PER regarding further investigations to inform specific management of acid sulfate soils are generally consistent with DER guidelines as applicable to large-scale linear projects.	62. Management of acid sulfate soils (ASS).	Chapter 10 and repeated in Section 12.9.1

239. Contaminated sites do not appear to have been addressed in the PER. However, the contaminated sites register suggests one or more possibly contaminated sites may be in close proximity to, or within, the proposed alignment.	11. Contaminated sites do not appear to have been addressed in the PER. However, the contaminated sites register suggests one or more possibly contaminated sites may be in close proximity to, or within, the proposed alignment.	Chapter 10
241. The calibration model used for the noise modelling is not appropriate and is likely to result in an underestimation of the traffic noise impact. The parameter inputs should have been adjusted instead. The remainder of the methodology seems acceptable.	53. The noise modelling calibration value is not appropriate and likely results in an underestimation of the traffic noise impact.	Chapter 10

Issues raised by Department of Lands

Issue	Addressed in consolidated issue	Location in report
59. Proponent must seek approval to develop within Dampier to Bunbury Natural Gas Pipeline (DBNGP) corridor. Registration of new interests in corridor is not allowed.	21. Proponent must seek approval to develop within Dampier to Bunbury Natural Gas Pipeline (DBNGP) corridor. Registration of new interests in corridor is not allowed.	Section 11.2
60. Proponent must ensure major water flows do not impact the DBNGP corridor.	63. Proponent must ensure major water flows do not impact the DBNGP corridor.	Section 11.2

Issues raised by Department of Parks and Wildlife

Issue	Addressed in consolidated issue	Location in report
197. MRWA should fulfil its commitments to undertake additional targeted surveys for Threatened and Priority flora.	127. DPAW supports MRWA's commitments for additional targeted surveys (described in PER Chapter 8, Section 8.5) and recommends the results be presented in the context of protected flora species distributions within and outside secure conservation reserves.	Section 8.1
206. Targeted survey for Meeboldina decipiens subsp. decipiens (Priority 3) should include potential habitat within Lightning Swamp Bushland and targeted surveys for Millotia tenuifolia var. laevis should include potential habitat in Whiteman Park.	148. How will the EPA's objectives be met for Priority taxa Meeboldina decipiens subsp. decipiens and Millotia tenuifolia var. laevis? More work should be done on surveying and/or translocating these taxa.	Section 8.1 and repeated in Section 12.7.4

217. Should Ioppolo Road not comprise critical habitat for Caladenia huegelii, an alternative offset package should focus on the management and protection of existing populations or critical habitat, rather than on translocation options.	15. Should Ioppolo Road not comprise critical habitat for Caladenia huegelii, an alternative offset package should focus on the management and protection of existing populations or critical habitat, rather than on translocation options.	Section 7.6 and repeated in Section 8.5
219. Recommends that the EMP incorporates monitoring and performance criteria for Threatened and Priority flora, particularly in relation to M. tenuifolia var. laevis individuals occurring within 50m of the project footprint.	147. Recommends that the EMP incorporates monitoring and performance criteria for Threatened and Priority flora, particularly in relation to M. tenuifolia var. laevis individuals occurring within 50 m of the proposal footprint.	Section 8.1
223. That commitments to protect the Mound Springs SCP TEC adjacent to the development footprint include water balance studies for pre- & post-development situations, and highway design and measures to mitigate effects of significant chemical spills.	186. Impacts to GDEs (including Mound Springs SCP TEC) and management of those impacts	Section 8.1
227. If Offset Proposal 3 proves difficult to implement, alternative offset options for the loss of 0.4 ha of SCP02 should be developed and implemented, in consultation with DPAW.	170. Please discuss outcome of additional surveys for TEC SCP02 in development envelope, including final residual impacts, revised management, monitoring, mitigations and any amendments to offset proposals.	Section 7.3.4 and repeated in Section 8.1
232. DPAW request that shape files of confirmed PEC and TEC areas be provided to communities.data@dpaw.wa.gov.au (Parks and Wildlife Species and Communities Branch).	120. DPAW request that shape files of confirmed PEC and TEC areas be provided to communities.data@dpaw.wa.gov.au (Parks and Wildlife Species and Communities Branch).	Section 8.1
235. DPAW should be provided an opportunity to contribute to, and comment on, the planned development of an EMP relating to fauna management.	117. DPAW should be provided an opportunity to contribute to, and comment on, the planned development of an EMP relating to fauna management.	Section 8.2
237. The estimated residual loss of wetland values, and the extent of wetlands to be monitored, should include wetlands that, while not mapped as CCW, may retain values commensurate with CCWs.	76. The estimated loss of wetland values and the extent of wetlands to be monitored should include wetlands that may retain values commensurate with CCWs despite not being mapped as CCWs.	Section 8.3

240. Offset Proposal 2 'Conservation of Land Comprising CCWs' should be refined to align as far as practicable with the types of impacted wetlands within each consanguineous suite.	17. Offset Proposal 2 'Conservation of Land Comprising CCWs' should be refined to align as far as practicable with the types of impacted wetlands within each consanguineous suite.	Section 8.5
242. That the potential for indirect impacts on wetlands be minimised by restricting to summer months, the construction of footings for bridges and utility services at locations where dewatering would be likely to lower the water table in CCWs.	77. Impacts from and management of dewatering and groundwater abstraction.	Section 8.3 and repeated in Section 12.9.2
243. The potential for indirect impacts on wetlands should be minimised by managing drawdown associated with extraction bores in the vicinity of CCWs to maintain groundwater at depths that will not result in significant impacts on wetlands.	77. Impacts from and management of dewatering and groundwater abstraction.	Section 8.3 and repeated in Section 12.9.2
244. That the proponent continues to work with the Swan Coastal District office of the DPAW regarding the translocation of heritage cork trees and the reestablishment of fencing and accessways associated with DPAW managed lands.	34. MRWA should continue to work with the Swan Coastal District office of DPAW regarding the translocation of heritage cork trees and the reestablishment of fencing and accessways associated with DPAW managed lands.	Chapter 8, Response to Department of Parks and Wildlife Issues, Section 8.5
295. MRWA should quantify the environmental values of conservation estates and identify the % remaining in each estate.	185. MRWA should quantify the environmental values of conservation estates and identify the % remaining in each estate.	Section 8.1

Issues raised by Department of Planning

Issue	Addressed in consolidated issue	Location in report
190. The proposal is supported.	39. The proposal is supported.	Section 11.3 and repeated in Section 12.1
192. During the Metropolitan Region Scheme and subsequent planning phases, the DoP will work with MRWA and DoT to address the public transport network, zoning changes and noise mitigation measures.	4. During the Metropolitan Region Scheme and subsequent planning phases, the DoP will work with MRWA and DoT to address the public transport network, zoning changes and noise mitigation measures.	Section 11.3

Issues raised by Department of Water

Issue	Addressed in consolidated issue	Location in report
89. The proposal has not properly considered the impacts to the P1 UWPCA. MRWA will need to consider the location of laydown areas, stockpiles and hazardous materials storage and negotiate with DoW for approval in the P1 area.	80. Impacts to the P1 UWPCA have not been properly considered. Construction impacts need to be considered further in consultation with the Department of Water, and approval may be required.	Chapter 9
90. The EMP does not clearly state the importance of the Gnangara UWPCA. It should be revised to do so and also to refer to the appropriate policies and Water Quality Protection Notes (WQPNs).	79. Consideration of Gnangara UWPCA and how potential impacts and management are addressed in EMP.	Chapter 9
91. The EMP omits details on the quality of water used for dust suppression. The water should be of the highest quality.	79. Consideration of Gnangara UWPCA and how potential impacts and management are addressed in EMP.	Chapter 9
92. The EMP should commit to working closely with Water Corporation in the P1 and P3 areas. Regular joint inspections between Water Corp and MRWA should be included. Accidental spills should be reported to Water Corp.	79. Consideration of Gnangara UWPCA and how potential impacts and management are addressed in EMP.	Chapter 9
93. The Drainage Management Plan should commit to future consultation with DoW on bio-retention basin locations and other water quality mitigation measures.	69. Location of bio-retention basins with respect to production bores.	Chapter 9
246. A minimum of 100 m distance should separate production bores and bio-retention basins.	69. Location of bio-retention basins with respect to production bores.	Chapter 9

Issues raised by Maralla Land Syndicate Pty Ltd

Issue	Addressed in consolidated issue	Location in report
57. Submission supports PDNH and believes it will reduce traffic congestion on GNH.	39. The proposal is supported.	Section 11.3 and repeated in Section 12.1

58. Maralla Road interchange should be added to reduce distance between interchanges at The Promenade and Neaves Road. It would also enable future development north of Ellenbrook.	29. There should/shouldn't be an interchange at Maralla Road.	Section 12.3.2

Issues raised by Office of the Environmental Protection Authority

Issue	Addressed in consolidated issue	Location in report
251. Please discuss outcome of additional surveys for Caladenia huegelii critical habitat at Ioppolo Road, including final residual impacts, revised management, monitoring, mitigations and any amendments to offset proposals.	162. Please provide further details relating to the 1:1 ratio chosen for the Caladenia huegelii critical habitat offset.	Section 7.6
252. Please discuss outcome of additional surveys for TEC SCP20a at Ioppolo Road, including final residual impacts, revised management, monitoring, mitigations and any amendments to offset proposals.	157. Please provide further details relating to the offset for TEC SCP20a.	Section 7.6
253. Please discuss outcome of additional surveys for TEC SCP02 in development envelope, including final residual impacts, revised management, monitoring, mitigations and any amendments to offset proposals.	170. Please discuss outcome of additional surveys for TEC SCP02 in development envelope, including final residual impacts, revised management, monitoring, mitigations and any amendments to offset proposals.	Section 7.3.4 and repeated in Section 8.1
254. Please discuss outcome of additional regional surveys for Millotia tenuifolia var. laevis and Meeboldina decipiens subsp. decipiens, including final residual impacts, revised management, monitoring, mitigations and any amendments to offset proposals.	176. Please discuss outcome of additional regional surveys for Millotia tenuifolia var. laevis and Meeboldina decipiens subsp. decipiens, including final residual impacts, revised management, monitoring, mitigations and any amendments to offset proposals.	Section 7.3.3
255. It is not clear whether the 205 ha of native vegetation to be cleared includes or is separate from values of GDEs, Bush Forever, TECs, PECs, Caladenia huegelii critical habitat and Grevillea curviloba subsp. incurva critical habitat.	179. It is not clear whether the 205 ha of native vegetation to be cleared includes or is separate from values of GDEs, Bush Forever, TECs, PECs, Caladenia huegelii critical habitat and Grevillea curviloba subsp. incurva critical habitat.	Section 7.3.2

256. Please provide detail on how the 205 ha extent of native vegetation was calculated and whether it accords with the definitions of native vegetation in the EP Act and regulations.	178. Please provide detail on how the 205 ha extent of native vegetation was calculated and whether it accords with the definitions of native vegetation in the EP Act and regulations.	Section 7.3.2
257. Bush Forever site 480 at Victoria Road will be significantly impacted. How has the proponent tried to avoid and mitigate this significant impact through consideration of other interchange designs?	156. Bush Forever site 480 at Victoria Road will be significantly impacted. How has the proponent tried to avoid and mitigate this significant impact through consideration of other interchange designs?	Section 7.1
258. Please provide additional information to demonstrate that impacts to SCP23b are not likely to be significant despite the proposal removing 20% of its known extent.	177. Please provide additional information to demonstrate that impacts to SCP23b are not likely to be significant despite the proposal removing 20% of its known extent.	Section 7.3.2
259. Please provide additional detail on the significance of the impact to Caladenia huegelii critical habitat.	172. Please provide additional detail on the significance of the impact to Caladenia huegelii critical habitat.	Section 7.3.1
260. Please provide additional detail on the management, monitoring and mitigation measures to be implemented to demonstrate that indirect impacts of the proposal will not impact C. huegelii.	171. Please provide additional detail on the management, monitoring and mitigation measures to be implemented to demonstrate that indirect impacts of the proposal will not impact C. huegelii.	Section 7.3.1
261. Please revise Table 8.2 with the recently updated remaining extents of vegetation complexes on the Swan Coastal Plain.	174. Please revise PER Table 8.2 with the recently updated remaining extents of vegetation complexes on the Swan Coastal Plain.	Section 7.3.2
262. The SWA IBRA bioregion is incorrectly stated as being a constrained area, when it is portions of the Swan Coastal Plain that are considered constrained.	173. The SWA IBRA bioregion is incorrectly stated as being a constrained area, when it is portions of the Swan Coastal Plain that are considered constrained.	Section 7.3.2
263. Please provide justification as to why a 10 m buffer is sufficient for avoiding indirect impacts to Grevillea curviloba subsp. incurva given that a 50 m buffer is proposed for Caladenia huegelii.	152. Risk from proposal to Grevillea curviloba subsp. incurva is understated. The PDNH needs to be moved further from individuals. Every effort needs to be taken to protect, and if possible re-introduce, this species in its critical habitat area.	Section 7.3.1 and repeated in Section 12.7.4

264. Assessment of local vegetation units is not at the appropriate scale for considering impacts in the region. Significance of impacts to four local vegetation units may be overstated. Please provide additional information in this regard.	180. Assessment of local vegetation units is not at the appropriate scale for considering impacts in the region. Significance of impacts to four local vegetation units may be overstated. Please provide additional information in this regard.	Section 7.3.2
265. Please provide additional detail to demonstrate that the EPA's objective for terrestrial fauna can be met for those species that are locally or regionally significant, including wetland fauna (and wetland fauna habitats).	169. Provide detail to demonstrate that the EPA's objective for terrestrial fauna can be met for locally or regionally significant species including wetland fauna/ habitats. Is the assessment based on the results from all the surveys in the study area?	Section 7.4
266. It is unclear if all fauna records from all surveys in the study area have been considered, or if only the results in the Level 2 Targeted Fauna Assessment by Coffey have been considered.	97. Study, survey and trapping procedures were inadequate. Richness of extant fauna is not captured in surveys.	Section 7.4 and repeated in Section 12.8.8
267. The incorrect regional scale has been used to assess impacts to fauna. Please provide further analysis that addresses the impacts to fauna using the Swan Coastal Plain region as the regional scale.	168. The incorrect regional scale has been used to assess impacts to fauna. Provide further analysis that addresses the impacts to fauna using the Swan Coastal Plain region as the regional scale.	Section 7.4
268. Please provide further analysis on indirect impacts, particularly relating to TECs and threatened flora that will remain after construction. If long-term persistence is unlikely, the significance should be considered as the whole occurrence of the value.	154. Please provide further analysis on indirect impacts to wetlands, TECs, threatened flora/fauna and reserves remaining after construction. If long-term persistence is unlikely, the significance should be considered as the whole occurrence of the value.	Section 7.3.2
269. Please provide further analysis on indirect impacts, particularly with regards to threatened fauna that will remain after construction. If long-term persistence is unlikely, the significance should be considered as the whole occurrence of the value.	154. Please provide further analysis on indirect impacts to wetlands, TECs, threatened flora/fauna and reserves remaining after construction. If long-term persistence is unlikely, the significance should be considered as the whole occurrence of the value.	Section 7.3.2
270. Please provide further analysis on indirect impacts, particularly with regards to wetlands that will remain after construction. If long-term persistence is unlikely, the significance should be considered as the whole occurrence of the value.	154. Please provide further analysis on indirect impacts to wetlands, TECs, threatened flora/fauna and reserves remaining after construction. If long-term persistence is unlikely, the significance should be considered as the whole occurrence of the value.	Section 7.3.2

271. Please provide further analysis on indirect impacts, particularly with regards to conservation reserves that will remain after construction. If long-term persistence is unlikely, the significance should be considered as the whole occurrence of the value.	154. Please provide further analysis on indirect impacts to wetlands, TECs, threatened flora/fauna and reserves remaining after construction. If long-term persistence is unlikely, the significance should be considered as the whole occurrence of the value.	Section 7.3.2
272. Please resolve inconsistencies in extent of direct impact to Bush Forever sites.	182. Please resolve inconsistencies in extent of direct impact to Bush Forever sites.	Section 7.3.2
273. Please resolve inconsistencies in extent of direct impact to TEC SCP02.	170. Please discuss outcome of additional surveys for TEC SCP02 in development envelope, including final residual impacts, revised management, monitoring, mitigations and any amendments to offset proposals.	Section 7.3.4 and repeated in Section 8.1
274. Please resolve inconsistencies in extent of direct impact to CCWs.	153. Please resolve inconsistencies in extent of direct impact to CCWs.	Section 7.5
275. It is not clear how the >2:1 ratio for TEC SCP02 was determined. The proponent should use the Commonwealth offsets calculator to determine an appropriuate offset if SCP02 is confirmed present in the development envelope.	170. Please discuss outcome of additional surveys for TEC SCP02 in development envelope, including final residual impacts, revised management, monitoring, mitigations and any amendments to offset proposals.	Section 7.3.4 and repeated in Section 8.1
276. Please provide details of the TEC SCP02 spring survey. The proponent will need to provide a suitable offset for SCP02 and justify the rationale used if SCP02 is confirmed.	170. Please discuss outcome of additional surveys for TEC SCP02 in development envelope, including final residual impacts, revised management, monitoring, mitigations and any amendments to offset proposals.	Section 7.3.4 and repeated in Section 8.1
277. Please provide details of the spring survey for TEC SCP20a. If the Ioppolo Road offset site is not suitable then an alternative offset will need to be provided for SCP20a.	157. Please provide further details relating to the offset for TEC SCP20a.	Section 7.6
278. Please provide details of the rationale behind using a 2:1 offset ratio for TEC SCP20a. The Commonwealth Offsets calculator should be used to determine an appropriate offset for SCP20a.	157. Please provide further details relating to the offset for TEC SCP20a.	Section 7.6

279. Please provide evidence that Ioppolo Road is suitable for black cockatoos given that the technical report stated the "entire area was adequately surveyed" while not finding any evidence of cockatoos.	164. Please provide evidence that Ioppolo Road is suitable for black cockatoos given that the technical report stated the "entire area was adequately surveyed" while not finding any evidence of cockatoos.	Section 7.6
280. The EPA will confirm the suitability of Ioppolo Road as an offset for both species of black cockatoos, not the OEPA.	163. The EPA will confirm the suitability of Ioppolo Road as an offset for both species of black cockatoos, not the OEPA.	Section 7.6
281. It is unclear how the 1:1 ratio of offsets proposed for conservation estate has been determined. It is also likely to be inadequate.	158. Please provide further details relating to the offset for conservation areas.	Section 7.6
282. The offset for conservation areas should be representative of the values being impacted and the associated attributes that may be lost. There is no consideration of how Offset Proposal 1 addresses this.	158. Please provide further details relating to the offset for conservation areas.	Section 7.6
283. Class A Nature Reserves are the highest level of conservation reservation and a much higher offset ratio is likely to be required, if approval is granted.	158. Please provide further details relating to the offset for conservation areas.	Section 7.6
284. Please provide details on the comparison of vegetation quality and composition between Bush Forever sites proposed to be impacted and proposed offsets to Bush Forever.	158. Please provide further details relating to the offset for conservation areas.	Section 7.6
285. Overlaps between Bush Forever, Class A Nature Reserves and State Forest should be individually quantified. For offsetting purposes, State Forest < Bush Forever < Class A Nature Reserve. Indicate suitability of Offset Proposal 1.	158. Please provide further details relating to the offset for conservation areas.	Section 7.6
286. A 1:1 offset ratio for State Forest may be appropriate if vegetation quality and values are the same. Please indicate the rationale behind the ratios chosen and the suitability of Offset Proposal 1.	158. Please provide further details relating to the offset for conservation areas.	Section 7.6

287. A revision of the proposed offsets may be necessary to address residual impacts to conservation areas and should be provided if this is the case.	158. Please provide further details relating to the offset for conservation areas.	Section 7.6
288. Please provide details of the spring survey at Ioppolo Road to determine presence of Caladenia huegelii critical habitat. If Ioppolo Road is not suitable, an alternative offset will need to be provided.	15. Should Ioppolo Road not comprise critical habitat for Caladenia huegelii, an alternative offset package should focus on the management and protection of existing populations or critical habitat, rather than on translocation options.	Section 7.6 and repeated in Section 8.5
289. Please provide details of the rationale behind using a 1:1 offset ratio for Caladenia huegelii critical habitat. The Commonwealth Offsets calculator should be used to determine an appropriate offset for Caladenia huegelii critical habitat.	162. Please provide further details relating to the 1:1 ratio chosen for the Caladenia huegelii critical habitat offset.	Section 7.6
290. Please provide detailed information on the proposed on-going management activities for the Iopollo Road proposed offset site, including funding arrangements.	166. Please provide detailed information on the proposed on-going management activities for the Ioppolo Road proposed offset site, including funding arrangements.	Section 7.6
291. The acquisition of Ioppolo Road protects existing foraging habitat for black cockatoos but does not increase availability of habitat. Losses of habitat in the development envelope are therefore not mitigated.	14. The proposal (including offsets) will still result in a net loss of biodiversity. Acquisition does not replace bushland, and MRWA should implement a revegetation offset.	Section 7.6 and repeated in Section 12.15
292. The proponent should take into consideration rehabilitation and revegetation when proposing offsets, particularly regarding the EPA's recent strategic advice for the Perth and Peel regions.	14. The proposal (including offsets) will still result in a net loss of biodiversity. Acquisition does not replace bushland, and MRWA should implement a revegetation offset.	Section 7.6 and repeated in Section 12.15
293. Please provide details of the rationale behind the ratio of 2:1 for offsetting CCWs.	160. Please provide details of the rationale behind the ratio of 2:1 for offsetting CCWs.	Section 7.6
296. Please show how the relevant EPA policies shown in Attachment 2 have been considered.	190. Please show how EPA policies relevant to the proposal have been considered.	

297. Please provide detailed maps defining boundaries of Class A Nature Reserves 46919 and 46920, the areas impacted by the proposal and the distinction between pine plantations and native vegetation in these reserves.	158. Please provide further details relating to the offset for conservation areas.	Section 7.6

Issues raised by Wildflower Society of Western Australia Inc.

Issue	Addressed in consolidated issue	Location in report
61. Clearing of vegetation needs to be minimised especially in areas such as the interchange at The Promenade and behind Ellenbrook. Width of fragmented vegetation is excessive. Noise walls and wire rope barriers should be used to reduce road width.	27. Clearing footprint should be minimised further through placement of proposal components such that fragmentation of vegetation and habitats is minimised.	Section 12.3.1
62. Clearing of black cockatoo habit needs to be minimised especially in areas such as the interchange at The Promenade and behind Ellenbrook. Width of fragmented habitat is excessive. Noise walls and wire rope barriers should be used to reduce highway width.	88. Minimisation of clearing of black cockatoo habitat.	Section 12.8.1
63. Why are Maralla Road and Halden Road being upgraded and to what extent? Good quality vegetation will be damaged.	32. Why are Maralla Road and Halden Road being upgraded and to what extent? Good quality vegetation will be damaged.	Section 12.3.3
64. Which side of the PDNH will the PSP be? It should be located so as to minimise fragmentation.	27. Clearing footprint should be minimised further through placement of proposal components such that fragmentation of vegetation and habitats is minimised.	Section 12.3.1
65. An intermodal road/rail transfer hub near Muchea is required to reduce road freight. This planning failure needs to be rectified as part of this project.	26. An intermodal road/rail transfer hub near Muchea is required to reduce road freight. This planning failure needs to be rectified a s part of this proposal.	Section 12.3.4
66. Principle 4 (improved valuation, pricing and incentive mechanisms) under Section 4A of EP Act has not been properly addressed. Sections on ISCA are light on detail and are inadequate.	23. Principle 4 (improved valuation, pricing and incentive mechanisms) under Section 4A of EP Act has not been properly addressed. Sections on ISCA are light on detail and are inadequate.	Section 12.4

67. Principle 5 (waste minimisation) under Section 4A of EP Act has not been addressed. Waste minimisation does not appear to have been thought about at all.	24. Principle 5 (waste minimisation) under Section 4A of EP Act has not been addressed. Waste minimisation does not appear to have been thought about at all.	Section 12.4
68. Eryngium pinnatifidum subsp. palustre (G.J. Keighery 13459) PN (P3) and Verticordia serrata var. linearis are not listed despite occurring in/near the area.	128. Clarifications regarding flora and vegetation surveys and results.	Section 12.7.5
69. Discussion on SCP21c is confusing and internally inconsistent.	124. Discussion on SCP21c is confusing and internally inconsistent.	Section 12.7.2
70. Caladenia huegelii is even more threatened than it was previously, and hasn't been found in some regional locations listed. Every effort needs to be taken to protect/re-introduce C. huegelii in its critical habitat area.	138. Caladenia huegelii is even more threatened than it was previously, and hasn't been found in some regional locations listed. Every effort needs to be taken to protect/re-introduce C. huegelii in its critical habitat area.	Section 12.7.1
71. Risk from proposal to Grevillea curviloba subsp. incurva is understated. The PDNH needs to be moved further from individuals. Every effort needs to be taken to protect, and if possible re-introduce, this species in its critical habitat area.	152. Risk from proposal to Grevillea curviloba subsp. incurva is understated. The PDNH needs to be moved further from individuals. Every effort needs to be taken to protect, and if possible re-introduce, this species in its critical habitat area.	Section 7.3.1 and repeated in Section 12.7.4
72. Likely impacts to Millotia tenuifolia var. laevis and Meeboldina decipiens subsp. decipiens are potentially significant. As well as extra surveys proposed, M. decipiens needs to be translocated e.g. to wetlands. More work needs doing. [refer orig. comm.]	148. How will the EPA's objectives be met for Priority taxa Meeboldina decipiens subsp. decipiens and Millotia tenuifolia var. laevis? More work should be done on surveying and/or translocating these taxa.	Section 8.1 and repeated in Section 12.7.4
73. Statement in Section 8.4.5 regarding clearing/removal of Cyathochaeta teretifolia (P3) is confusing.	145. Statement is confusing regarding clearing/removal of Cyathochaeta teretifolia (P3). [refer original comment]	Section 12.7.4
74. MRWA weed control should be less procedural and more focused on outcomes, e.g. preventing weed incursion into adjacent vegetation and/or removing weeds from adjacent vegetation.	141. MRWA weed control should be less procedural and more focused on outcomes, e.g. preventing weed incursion into adjacent vegetation and/or removing weeds from adjacent vegetation.	Section 12.7.6

75. Clearing footprint can be further reduced through use of wire rope barriers, increasing batter slopes, following natural contours, not clearing all vegetation, reducing table drain sizes, reducing fire track requirement, routing PSP through cleared area.	27. Clearing footprint should be minimised further through placement of proposal components such that fragmentation of vegetation and habitats is minimised.	Section 12.3.1
77. Clarification is sought on how the mitigation measures for Threatened flora will result in the proposal being likely to meet the EPA's objectives.	136. Clarification is sought on how the mitigation measures for Threatened flora will result in the proposal being likely to meet the EPA's objectives.	Section 12.7.1
78. Clarification is sought on how the successful implementation of the EMP regarding Priority taxa Meeboldina decipiens subsp. decipiens and Millotia tenuifolia var. laevis will result in the proposal being likely to meet the EPA's objectives.	148. How will the EPA's objectives be met for Priority taxa Meeboldina decipiens subsp. decipiens and Millotia tenuifolia var. laevis? More work should be done on surveying and/or translocating these taxa.	Section 8.1 and repeated in Section 12.7.4
79. There are no measures described regarding how to prevent, reduce or restore fragmentation.	144. There are no measures described regarding how to prevent, reduce or restore fragmentation.	Section 12.7.3
80. Potential impacts of noise and vibration on fauna has been dismissed. Many fauna are sensitive and the impact could be greater than thought.	95. Impacts and management of light, noise and vibration on fauna.	Section 12.8.4
81. The loss of 737 trees with a DBH over 500 mm and associated habitats is of considerable concern, highly significant and is not acceptable.	88. Minimisation of clearing of black cockatoo habitat.	Section 12.8.1
82. The net loss of black cockatoo habitat requires habitat replacement in the long term through acquisition and revegetation of degraded habitat to avoid continued cumulative losses. This also applies to all other fauna habitats.	14. The proposal (including offsets) will still result in a net loss of biodiversity. Acquisition does not replace bushland, and MRWA should implement a revegetation offset.	Section 7.6 and repeated in Section 12.15
83. Are the proposed fauna escape ramps better than one-way fauna gates as found on some other projects?	114. Are the proposed fauna escape ramps better than one-way fauna gates as found on some other projects?	Section 12.8.6

84. The rehabilitation chapter is superficial and is unacceptable. It omits proper completion criteria, e.g. discussion on ecological linkages, maintaining biodiversity, species planting lists, transplanting, committing to high ISCA rating, etc.	47. The rehabilitation chapter is superficial and is unacceptable.	Section 12.11
85. While the implementation of Offset 1 is supported, the proposal will still result in a net loss of biodiversity at the species, population and community level.	14. The proposal (including offsets) will still result in a net loss of biodiversity. Acquisition does not replace bushland, and MRWA should implement a revegetation offset.	Section 7.6 and repeated in Section 12.15
86. Offsets should be required to be implemented before environmental approval is given, particularly Offsets 2, 3 and 4, which have not yet been located.	19. Offsets should be required to be implemented before environmental approval is given, particularly Offsets 2, 3 and 4, which have not yet been located.	Section 12.15
87. The acquisition of properties does not sufficiently offset the impacts of the proposal. MRWA must be required to undertake a revegetation offset to actually replace lost bushland, even if attempts to do so do not completely succeed.	14. The proposal (including offsets) will still result in a net loss of biodiversity. Acquisition does not replace bushland, and MRWA should implement a revegetation offset.	Section 7.6 and repeated in Section 12.15
88. Stakeholder issues have only been addressed generally in the PER and should be addressed more directly.	3. Stakeholder issues have only been addressed generally in the PER and should be addressed more directly.	Section 12.5
249. Proposal should include measures to create/restore ecological linkages in Figure 8.5.	144. There are no measures described regarding how to prevent, reduce or restore fragmentation.	Section 12.7.3

APPENDIX C

Assessment & Refinement of Potential Critical Habitat for *Caladenia Huegelii* (T-DRF) within the Development Envelope



Perth–Darwin National Highway (Swan Valley Section) – Supplementary Biological Studies 2015

Assessment & Refinement of Potential Critical Habitat for *Caladenia huegelii* (T-DRF) within the Development Envelope

COFFEY

NOVEMBER 2015



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Perth–Darwin National Highway (Swan Valley Section) – Supplementary Biological Studies 2015: Assessment & Refinement of Potential Critical Habitat for *Caladenia huegelii* (T) within the Development Envelope

Prepared for: Coffey

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Cover Photograph: *Banksia* low woodland within the Study area - potential *Caladenia huegelii* habitat (Coffey Environments)

DOCUMENT REVISION AND STATUS

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C	Coffey Edits	BL	GW	17/11/2015	D. Morley Main Roads	26/11/2015
0	Final report	BL	GW	26/11/2015		

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FIGURES

Figure 1: Perth–Darwin National Highway (Swan Valley Section) - Refinement of *Caladenia huegelii* Potential Critical Habitat within Proposal Footprint

DEFINITIONS

Term	Definition
ArcGIS	GIS mapping product
BGPA	Botanic Gardens and Parks Authority
DEC	Department of Environment and Conservation (now DPaW)
DPaW	Department of Parks and Wildlife
GIS	Geographical Information System
GPS	Global Positioning System
Ltd	Limited
Pty	Proprietary
SLIP	Shared Land Information Portal
T-DRF	Threatened – Declared Rare Flora

1 INTRODUCTION

Coffey Environments Australia Pty Ltd (Coffey) conducted a Level 2 Assessment of the flora and vegetation of Main Roads Western Australia's Perth–Darwin National Highway (Swan Valley Section) (the project) during spring 2014 (Coffey 2015a). A single location of the State and Commonwealth listed Threatened species, *Caladenia huegelii* (Grand Spider Orchid), was recorded within the Study Area. This location, including surrounding similar habitat encompassing 184.6 ha, was considered to be potential critical habitat for this species.

The individual recorded is approximately 60 m east of the proposal footprint and within 20 m of the existing Ellenbrook estate and occurs within a portion of native bushland (in excess of 8.5 ha) that will be retained. However approximately 39.2 ha of the potential critical habitat (comprising 17.2% of the potential critical habitat mapped within the Study Area) will be removed by the project.

Woodman Environmental Pty Ltd (Woodman Environmental) was commissioned by Coffey to undertake the supplementary studies in spring 2015 to confirm the project's impact on potential critical habitat for *Caladenia huegelii.*

1.1 Aim and Objectives

The aim of the study was to assess and refine the extent of potential critical habitat for *C. huegelii* (T-DRF) mapped within the development envelope and proposal footprint located to the West of Ellenbrook, to accurately quantify the area of habitat that may be impacted and require offsetting under State and Commonwealth environmental offset policies.

The objectives required to achieve this encompassed the following:

- Review information on *C. huegelii* and liaise with Department of Parks and Wildlife (DPaW) and Botanic Gardens and Parks Authority (BGPA) regarding critical habitat requirements for this species.
- Review vegetation descriptions and boundaries presented in the PER and identify vegetation types known to be optimum habitat for *C. huegelii* based on published data.
- Ground truth vegetation types and presumed critical habitat boundaries in the development envelope and proposal footprint located to the West of Ellenbrook to determine whether vegetation present is suitable (soils, vegetation condition etc.) to be classified as critical habitat.
- Map critical habitat area as determined from ground-truthing and information provided by DPaW and BGPA.

2 BACKGROUND AND LITERATURE REVIEW

2.1. Literature

The Recovery Plan for *C. huegelii* (Department of Environment and Conservation (DEC) 2009), provides the following habitat description:

- Mixed woodland of *Eucalyptus marginata*, *Banksia attenuata*, *B. ilicifolia* and *B. menziesii* with scattered *Allocasuarina fraseriana* and *Corymbia calophylla* over dense shrubs of *Stirlingia latifolia*, *Hypocalymma robustum*, *Hibbertia hypericoides*, *H. subvaginata*, *Xanthorrhoea preissii*, *Adenanthos cuneatus* and *Conostylis* species.
- Tends to favour areas of dense undergrowth.
- Soil is usually deep grey-white sand associated with the Bassendean sand-dune system.

The Recovery Plan states the critical habitat to be the area of occupancy of important populations, areas of similar habitat surrounding important populations, and additional occurrences of similar habitat (DEC 2009).

Hoffman and Brown (2011) states that *C. huegelii* grows in deep sandy soil in mixed *E. marginata*, *Banksia* woodland on the Swan Coastal Plain.

2.2. External Advice

The advice of native orchid experts Andrew Brown (DPaW) and Kingsley Dixon (BGPA) was sought during the desktop phase of this study to obtain detailed descriptions of *C. huegelii* habitat preferences.

Andrew Brown (pers. comm. 2015) indicated that *C. huegelii* occurs on Bassendean sands of the Swan Coastal Plain in *Banksia* woodland anywhere in undulating land. *C. huegelii* can grow in association with but not always, *C. arenicola, C. paludosa, C. longicauda* subsp. *calcigena*.

Kingsley Dixon (pers. comm. 2015) stated that, in its northern range the habitat that *C. huegelii* occurs in tends to be woodland, varying from open to fairly closed *Banksia* dominated woodland. Plants may be found anywhere within the landscape of this habitat type. Vegetation types that can conclusively be excluded as potential habitat are lowland (damp land) vegetation communities, where the vegetation composition is composed of species that are not normally associated with *C. huegelii*.

2.3. Previous Experience

Woodman Environmental has conducted numerous searches for *C. huegelii* over the past 12 years, and has a thorough understanding of the variable vegetation and topographical habitat preferences of the orchid, including the recording of plants within degraded vegetation.

3 METHODS

3.1. Desktop/GIS Assessment

Based on literature reviews, external advice and previous experience, the following criteria were determined as being components of potential critical habitat of *C. huegelii*:

- Any dry woodland vegetation;
- Vegetation condition ranging from Degraded to Pristine;
- Various topographical positions (low lying to upland areas, undulating dunes); and
- Sandy soils.

Those areas that were determined as not being potential critical habitat of *C. huegelii* include:

- Completely Degraded areas that do not support naturally occurring native vegetation;
- Wetland vegetation types;
- Damp woodland areas unlikely to support *C. huegelii*; and
- Non-sandy soils.

Taking these criteria into consideration the following actions were undertaken in a desktop environment:

- Review of vegetation types (descriptions/species composition) in which the critical habitat was mapped (Coffey 2015a);
- Review of vegetation type mapping boundaries (Coffey 2015a) in GIS to determine accuracy;
- Review of vegetation condition mapping and boundaries (Coffey 2015a) to assess in the field for accuracy and determine likelihood of presence of potential habitat based on its condition and ability to support *C. huegelii*;
- Review of tracks and cleared areas that could be excised; and
- Selection of specific areas to assess in the field for appropriateness and confirmation of suitability.

3.2. Field Assessment

The field assessment was undertaken on 18 September 2015 by experienced botanists David Coultas and Alison Saligari. Mr Coultas in particular, has undertaken numerous targeted searches for *C. huegelii* (some of which were successful) and is very familiar with the habitat of the taxon. A Regulation 4 Authority permit (no. CE005070) under *Regulation 8(1) of the Conservation and Land Management Regulations 2002* was sought from DPaW to gain permission to access State Forest and Nature Reserves in which the critical habitat occurs.

The field assessment targeted mapped areas of potential critical habitat within the development envelope and proposal footprint located to the West of Ellenbrook in order to exclude areas of habitat that were considered non-critical habitat. The assessment was conducted by traversing the vegetation on foot and utilising existing tracks by vehicle. Vegetation mapping and boundaries were verified, particularly where polygons had been mapped based on aerial photography interpretation in the absence of quadrat data, and assessed for suitability as potential *C. huegelii* habitat. Particular areas or polygons evident

on aerial photography that consisted of dark dense vegetation were walked to determine if they were wetland or dry woodland vegetation. During the field assessment it was decided that extending of the field verification out to encompass the critical habitat identified within the study area at this location was feasible in the time allowed. The survey was therefore extended to include the study area west of Ellenbrook.

Ground-truthing involved the recording of waypoints and tracks using a hand-held GPS (Global Positioning System). Photographs were taken of the vegetation in the areas investigated along with field notes detailing the observations at each point. The actual boundaries of vegetation types were walked, tracking by GPS, in order to delineate specific boundaries for use in GIS.

The survey was conducted during the peak flowering period for this species, and opportunistic searching for this species was undertaken during this assessment. Where any individuals were identified a GPS record was made and a photograph of the specimen taken.

The waypoints and tracks from the field assessment were uploaded and overlain on 2015 aerial photography imagery sourced through the Landgate SLIP (Shared Land Information Platform) portal, to ArcGIS (GIS mapping product). The potential critical habitat boundary was adjusted and clipped as per the field observations.

Further refinement was undertaken in ArcGIS, zooming into vegetation boundaries and features (to a scale of approximately 1:1000 or less) to ensure the accuracy of the critical habitat boundary being defined. Using this method and taking into account the criteria identified in the background review of critical habitat requirements, inappropriate vegetation types, well-used vehicle tracks, significant bare or cleared areas, and Completely Degraded areas of vegetation were removed from the original critical habitat boundary. In addition to the field observations, other vegetation boundaries were reviewed and adjusted where required through interpretation of the aerial imagery of vegetation characteristics and field-knowledge of the habitats.

4 RESULTS

The review of the original potential critical habitat boundary mapped within the Study Area and the vegetation types described by Coffey (2015a) were confirmed as suitable habitat for *C. huegelii* with the exception of:

- Areas that appeared to be damp depressions (for example, damp areas consisting of *Melaleuca preissiana*, *Banksia littoralis*, *Astartea scoparia*, *Hypocalymma angustifolium* and *Taxandria linearis* that would not support *C. huegelii*);
- Other areas of possibly unsuitable vegetation (not comprising Banksia dominated woodlands on grey Bassendean sand dunes;
- Areas that were Completely Degraded (cleared, degraded through access or disease and weeds).

The area of potential critical habitat originally mapped (Coffey 2015a) west of Ellenbrook was confirmed and refined as described in section 3 and is mapped on Figure 1.

The extent of critical habitat that may potentially be impacted was originally determined as being approximately 39.2 ha (Coffey 2015b). The refinement process reduced this to 29.9 ha of potential critical habitat within the proposal footprint.

No plants of *C. huegelii* were observed during opportunistic survey while traversing habitat during the field assessment of this study.

5 DISCUSSION

This project has confirmed that the area of potential critical habitat for *C. huegelii* mapped by Coffey (Coffey 2015a) conservatively incorporated appropriate vegetation types and habitat. Refinements included the removal of small areas of vegetation type/topography not considered critical habitat for *C. huegelii* and also removal of areas of habitat that had been degraded through human activity and subsequent deterioration through weed and disease invasion.

Despite no individuals of the orchid being observed during the field assessment, additional plants may be present in the habitat but either did not emerge this year or did not support flowers during the assessment period.

The remaining habitat for *C. huegelii* in the Study Area appears to be in relatively good condition, however given the level of existing public access to the area and presence of other factors that may lead to its degradation (Phytophthora dieback), the long term persistence of the orchid in this area will require appropriate management to protect habitat viability.

6 REFERENCES

Andrew Brown (2015)

Species and Communities Branch, Department of Parks and Wildlife, Kensington. Personal communication via email, 11 September 2015.

Coffey (2015a)

Level 2 Flora and Vegetation Assessment, Perth – Darwin National Highway. Unpublished report prepared for Main Roads Western Australia, Doc No. NLWA-03-EN-RP-0016 (Rev 1), 29 May 2015.

Coffey (2015b)

Public Environmental Review Perth-Darwin National Highway (Swan Valley Section). Unpublished report prepared for Main Roads Western Australia, Doc No. NLWA-03-EN-RP-0025 (Rev 4), 4 September 2015.

Department of Environment and Conservation (2009)

Grand Spider Orchid (*Caladenia huegelii*) Recovery Plan. Commonwealth Department of the Environment, Water, Heritage and the Arts, Canberra.

Hoffman, N. and Brown, A. (2011)

Orchids of the South-West Australia. Third edn, published by Noel Hoffman.

Kingsley Dixon (2015)

Visiting Professor, Kings Park and Botanic Garden, Perth. Personal communication via email, 12 September 2015.

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Legend

- *Caladenia huegelii* Location
- Development Envelope
- Proposal Footprint
- Coffey Environments Critical Habitat
- WEC Revised Critical Habitat
- WEC Critical Habitat in Development Envelope

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This map should only be used in conjunction with WEC report Coffey15-28-04

Perth–Darwin National Highway (Swan Valley Section) Refinement of *Caladenia huegelii* Potential Critical Habitat within Development Envelope

Revision: C - 22 November 2015

Author: Bethea Loudon

WEC Ref: Coffey15-28-04

Filename: Coffey15-28-Scope-4.mxd

Scale: 1:10,500 (A3) Grid: MGA Zone 50

Figure

1

APPENDIX D

Spring Surveys for *Meeboldina decipiens* subsp. *decipiens* (P3) and *Millotia tenuifolia* var. *laevis* (P2)



Perth–Darwin National Highway (Swan Valley Section) – Supplementary Biological Studies 2015

Spring surveys for Meeboldina decipiens subsp. decipiens (P3) and Millotia tenuifolia var. laevis (P2)

COFFEY

NOVEMBER 2015



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Perth–Darwin National Highway (Swan Valley Section) – Supplementary Biological Studies 2015: Spring surveys for Meeboldina decipiens subsp. decipiens (P3) and Millotia tenuifolia var. laevis (P2)

Prepared for: Coffey

Job Number: Coffey15-28

Report Number: Coffey15-28-02

DOCUMENT REVISION AND STATUS

Revision	Status	Originator	Internal Reviewer	Internal Review Date	Client Reviewer	Client Review Date
A	Draft report	AS	GW	20/10/2015	N. Raymond	5/11/2015
B	Client comments incorporated	AS	GW	16/11/2015	Main Roads D. Morley	20/11/2015
0	Final report	AS	GW	23/11/2015		

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APPENDICES

Appendix A: Definitions, Categories and Criteria for Threatened and Priority Ecological Communities (DPaW 2010)
Appendix B: Locations to Assess for Field Survey for *Millotia tenuifolia* var. *laevis* (P2) and *Meeboldina decipiens* subsp. *decipiens* (P3)
Appendix C: Results of *Millotia tenuifolia* var. *laevis* (P2) and *Meeboldina decipiens* subsp. *decipiens* (P3) Field Assessment

DEFINITIONS

Term	Definition
ArcGIS	GIS mapping product
BGPA	Botanic Gardens and Parks Authority
DEC	Department of Environment and Conservation (now DPaW)
DPaW	Department of Parks and Wildlife
GIS	Geographical Information System
GPS	Global Positioning System
Ltd	Limited
PER	Public Environmental Review
Pty	Proprietary
SLIP	Shared Land Information Portal
senesced / dehisced	Process of aging in plants / bursting open – (pod or seed vessel)
T-DRF	Threatened – Declared Rare Flora
P3	Priority listed flora. Priority levels defined in Appendix A

1 INTRODUCTION

Coffey Environments Australia Pty Ltd (Coffey) conducted a Level 2 Assessment (EPA 2004) of the flora and vegetation of Main Roads Western Australia's Perth–Darwin National Highway (Swan Valley Section) (the Project) during spring 2014 (Coffey 2015a).

Eight priority species as defined by the Department of Parks and Wildlife (DPaW) (Appendix A) were recorded from the study area including *Meeboldina decipiens* subsp. *decipiens* (P3) and *Millotia tenuifolia* var. *laevis* (P2). The anticipated project impacts to both these species were considered to be potentially significant. *Millotia tenuifolia* var. *laevis* (P2) "has never been recorded from the Swan Coastal Plain bioregion prior to this study and represents a range extension of over 50 km from the Jarrah Forest bioregion, and is therefore locally and regionally significant" (Coffey 2015b). *Meeboldina decipiens* subsp. *decipiens* (P3) "is widespread from Nannup in the south to Gosnells in the north. The locations within the Victoria Road bushland represent a range extension (approximately 15 km) to the north and the most northerly extent. These records represent the most northerly known location, and as such are considered locally and regionally significant" (Coffey 2015b).

Existing DPaW records of *Meeboldina decipiens* subsp. *decipiens* and *Millotia tenuifolia* var. *laevis* did not indicate the number of individuals recorded at each known location. The proposed impact on these taxa was documented within the PER assuming a single plant existed at each location in the project area where it was recorded and at each previously recorded occurrence of these taxa (Coffey 2015a). This potentially provided an inaccurate percentage of impact on all known individuals for these taxa. MRWA proposed an additional survey to provide clarification on the proposed project impacts on each taxon.

Woodman Environmental Pty Ltd (Woodman Environmental) was commissioned by Coffey to undertake supplementary spring surveys for *Meeboldina decipiens* subsp. *decipiens* and *Millotia tenuifolia* var. *laevis* to assist in clarifying the potential impacts of the project on these species.

1.1 Aim and Objectives

The aim of the study was to clarify the potential impacts of the Project to *Meeboldina decipiens* subsp. *decipiens* and *Millotia tenuifolia* var. *laevis*.

The objectives required to achieve this were to:

- Visit where possible each known location for each taxon outside of the proposal footprint to verify plant numbers (locations to be sourced from NatureMap and WaHerb records).
- Increase the search area outward from known locations within the local extent of each taxon's habitat, recording any new location by GPS and numbers of individuals.
- Provide regional context to proposed impacts of the project on these species, based on the outcomes of the above two objectives.

2 METHODS

2.1 Desktop Assessment

DPaW databases including NatureMap (DPaW 2015a) and FloraBase (DPaW 2015b) were interrogated for known records of *Meeboldina decipiens* subsp. *decipiens* and *Millotia tenuifolia* var. *laevis*. *Meeboldina decipiens* subsp. *decipiens* (P3) (Sep/Oct) has approximately 13 known locations between Perth and Augusta, some of which are in State Forest, some in private property and other

tenures. Additional sites identified as containing *Meeboldina decipiens* in the vicinity of other search areas were also selected for survey.*Millotia tenuifolia* var. *laevis* (P2) (Sept/Oct) is known from five locations between Dowerin and Cape Naturaliste. The locality descriptions for each record were cross-checked with the co-ordinates presented on NatureMap. In cases where the co-ordinates didn't match the locality details, co-ordinates were altered to match the location. The list of locations to visit was checked against the land tenure to identify any potential access issues. Field maps were then generated and used in combination with the list of locations to target areas to search. The list of areas targeted for survey is presented in Appendix B.

2.2 Field Assessment

The field assessment was undertaken over two field trips. The first was undertaken from the 6th to the 9th of October 2015 by experienced botanists Bethea Loudon and David Coultas. The second field trip was undertaken on the 15th of October by experienced botanists David Coultas and Alison Saligari. Table 1 lists the personnel involved in both fieldwork and plant identifications for the field survey. All personnel have had previous field experience in the Swan Coastal Plain region, with personnel involved in plant identifications having taxonomic experience with the flora of Swan Coastal Plain region. All plant material was collected under the scientific licences (pursuant to *Wildlife Conservation Act 1950* (WC Act) Section 23C and Section 23F) as listed in Table 1.

Table 1: Personnel Licensing Information

Personnel	Role	Flora Collecting Permit / Permit to take T-DRF
David Coultas	Fieldwork	SL011384 / 147-1415
Bethea Loudon	Fieldwork / Plant identifications	SL011382 / 149-1415
Alison Saligari	Fieldwork	SL011380 / 148-1415

Searches for each species was undertaken at all locations identified in Appendix B as having received survey including searches conducted in the project area and at the Main Roads owned proposed offset property on Iopollo Road, Chittering. Each location and the surrounding area were traversed on foot. When *Meeboldina decipiens* subsp. *decipiens* and *Millotia tenuifolia* var. *laevis* were found, GPS location, number of plants and site notes were recorded. Specimens which could not be identified in the field were collected and pressed for later identification at the WAHerb.

2.3 Plant Collection and Identification

Specimens which could not be identified in the field were collected and pressed for later identification at the WAHerb. Identifications were undertaken by experienced senior botanist Bethea Loudon. Taxon nomenclature generally follows *Florabase* (DPaW 2015b) with all names checked against the current DPaW Max database to ensure their validity. However, in cases where names of plant taxa have been published recently in scientific literature but have not been adopted on *Florabase* (DPaW 2015b), nomenclature in the published literature is followed. The conservation status of each taxon was checked against *Florabase*, which provides the most up-to-date information regarding the conservation status of flora taxa in Western Australia.

Specimens of interest, including significant flora taxa, will be sent to the WAHerb for consideration for vouchering as soon as practicable. However as this process is via donation, the WAHerb may not voucher all such specimens, in accordance with its own requirements. The specimen vouchering will be supported by completed Threatened and Priority Flora Report Forms (TPRFs) submitted to DPaW (Species and Communities Branch) in the case of listed significant flora (e.g. Threatened and Priority

flora taxa). All other specimens are kept in-house for reference for a period of one year after finalisation of project.

3 RESULTS

3.1 Millotia tenuifolia var. laevis

A total of 5222 *Millotia tenuifolia* var. *laevis* individuals consisting of eight populations were recorded during the regional survey (Table 2). This included two populations north-west of Jarrahdale, one population south-east of Goomalling, three populations north-east of Muchea and two populations adjacent to the proposal footprint in Beechboro. Appendix B contained 11 target regional locations for searches for this species at which plants were found in 5 excluding the single Julimar State Forest location, the single location at Cape Naturaliste National Park which was an inaccurate database record, the 2 locations in the Meelup Regional Park, a location near Collie that proved to be inaccurate and an unspecified location between Dunsborough and Cape Naturaliste mapped in private property and therefore an inaccurate record. New locations were discovered at the Main Roads owned proposed offset property on Iopollo Road, Chittering and also adjacent to the project development envelope. The results of the survey, including GPS locations and plant counts, are presented in Appendix C. Figure 1 presents the locations of these populations.

Table 2: *Millotia tenuifolia* var. *laevis* population data

Sites	In conservation estate?	Existing records		Woodman records	
		Populations	Individuals	Populations	Individuals
Hagboom Lake	-	1	1*	1	225
Serpentine South	Jarrahdale State Forest	1	1*	1	540
Serpentine North	Jarrahdale State Forest	1	1*	1	625
Cape Naturaliste	Cape Naturaliste National Park	1	1*	Not re-located	0
Meelup	Meelup Regional Park	1	1*	Not re-located	0
Meelup	Meelup Regional Park	1	1*	Not re-located	0
Near Collie	-	1	1*	Not re-located	0
Between Dunsborough and Cape Naturaliste	-	1	1*	Not re-located	0
Chittering	Offset Property	0	0	1	2180
Dewars Pool Road	Julimar State Forest	1	1*	Not re-located	0
Beechboro	-	0	0	2	1652

* Note: No plant numbers recorded in DPaW records and assumed population of 1 used in PER (Coffey 2015a)

3.2 Meeboldina decipiens subsp. decipiens

A total of 3730 *Meeboldina decipiens* subsp. *decipiens* individuals consisting of three populations were recorded during the regional survey. This included one population within the Brickwood

Reserve near Byford, one population within private property adjacent to Ranford Road and another at the Waterloo State School Site near Bunbury. However, eight other locations were investigated where *Meeboldina decipiens* have been previously located but have not been resolved to the infra taxa level and are presumed to be *Meeboldina decipiens* subsp. *decipiens*. From these surveys a further eight populations consisting of 3407 plants were recorded during the regional survey. This included four populations from rail and road reserves within the Waroona area, one from road reserve near Pinjarra, and three near Busselton. The results of the survey, including GPS locations and plant counts, are presented in Appendix C. Figure 1 presents the locations of these populations.

During the regional field survey, collections of *Meeboldina decipiens* subsp. *decipiens* were found to differ from the specimen collected within the study area. A subsequent visit was undertaken to the known populations of *Meeboldina decipiens* subsp. *decipiens* within the Proposal footprint (Coffey 2015a) to collect additional material and determine whether the original identification was valid. The original collection identified as *Meeboldina decipiens* subsp. *decipiens* (P3) was re-identified by WA Herbarium staff and found to be *Lepyrodia muirii.* Therefore *Meeboldina decipiens* subsp. *decipiens* is no longer known from the study area.

4 DISCUSSION

The regional survey for *Millotia tenuifolia* var. *laevis* identified a relatively large number of individuals outside of the proposal footprint. However, the majority of the *Millotia tenuifolia* var. *laevis* individuals recorded during the field survey had flowering material that had senesced / dehisced making verification identification difficult and also indicating that some individuals may have been missed during the survey. Therefore, it is important to note that it is highly likely that there would have been a greater number of individuals present earlier in the season than were actually counted. In addition, *Millotia tenuifolia* var. *laevis* co-occurs with *Millotia tenuifolia* var. *tenuifolia* (not conservation significant). *Millotia tenuifolia* var. *tenuifolia* was found at a number of locations searched while *Millotia tenuifolia* var. *laevis* was not found. Therefore at such locations it is possible that *Millotia tenuifolia* var. *laevis* is also present nearby and was not located in the field.

Of the 5222 *Millotia tenuifolia* var. *laevis* individuals recorded across 8 populations during the survey, 1652 individuals occur within the two populations located adjacent to the development envelope (labelled Beechboro Road North in Figure 1 and Figure 8.1A in Coffey 2015a). Impacts are currently proposed to 2 of 8 known locations (2 populations) in Cullacabardee bushland (Bush Forever) and Maralla Nature Reserve within the study area, with these two locations to be impacted potentially representing plants within the same population. Therefore the impact of clearing plants within the proposal footprint is likely to be negligible in the local context and therefore also the regional context, given the high number of plants located nearby (including those in conservation estate) and also across the known range of the taxon.

As discussed in Section 3, the original collection of *Meeboldina decipiens* subsp. *decipiens* was incorrectly identified during studies for the PER. This species was not recorded from the development envelope and is unlikely to be impacted by the proposal footprint.

5 REFERENCES

Coffey Environments (2015a)

Level 2 Flora and Vegetation Assessment, Perth – Darwin National Highway. Unpublished report prepared for Main Roads Western Australia, Doc No. NLWA-03-EN-RP-0016 (Rev 1), 29 May 2015.

Coffey Environments (2015b)

Public Environmental Review Perth-Darwin National Highway (Swan Valley Section). Unpublished report prepared for Main Roads Western Australia, Doc No. NLWA-03-EN-RP-0025 (Rev 4), 4 September 2015.

Department of Parks and Wildlife (2015a)

Naturemap. Available: http://naturemap.dpaw.wa.gov.au. Sourced October 2015

Department of Parks and Wildlife (2015b)

FloraBase. Available: http://florabase.dpaw.wa.gov.au. Sourced October 2015

Environmental Protection Authority (2004)

Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation surveys for Environmental Impact Assessment in Western Australia, No. 51. Unpublished report produced by the Environmental Protection Authority, Western Australia, June 2004.

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11 8 17 18 4 3 10 9 19 20 21 22 23 24 15 6 1 5 16 13 12 25 7 26 2

Legend

Locations Surveyed by WEC 2015

- *Millotia tenuifolia* var. *laevis* (P2)
- *Meeboldina decipiens* subsp. *decipiens* (P3)
- *Meeboldina decipiens*

Department of Parks and Wildlife Records

- *Millotia tenuifolia* var. *laevis* (P2)
- *Meeboldina decipiens* subsp. *decipiens* (P3)
- *Meeboldina decipiens*

Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

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This map should only be used in conjunction with WEC report Coffey15-28-02

Perth-Darwin National Highway (Swan Valley Section)
Spring Surveys for
***Millotia tenuifolia* var. *laevis* (P2) and**
***Meeboldina decipiens* subsp. *decipiens* (P3)**

Revision: 0 - 11 November 2015

Author: Bethea Loudon

WEC Ref: Coffey15-28-02

Filename: Coffey15-28-Scope-2.mxd

Scale: 1:900,000 (A3) Grid: MGA Zone 50

Figure

1

Appendix A: Definitions, Categories and Criteria for Threatened and Priority Ecological Communities (DPaW 2010)

1. GENERAL DEFINITIONS

Ecological Community
A naturally occurring biological assemblage that occurs in a particular type of habitat.

Note: The scale at which ecological communities are defined will often depend on the level of detail in the information source, therefore no particular scale is specified.

A **threatened ecological community** (TEC) is one which is found to fit into one of the following categories; "presumed totally destroyed", "critically endangered", "endangered" or "vulnerable".

Possible threatened ecological communities that do not meet survey criteria are added to DEC's Priority Ecological Community Lists under Priorities 1, 2 and 3. Ecological Communities that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

An **assemblage** is a defined group of biological entities.

Habitat is defined as the areas in which an organism and/or assemblage of organisms lives. It includes the abiotic factors (eg. substrate and topography), and the biotic factors.

Occurrence: a discrete example of an ecological community, separated from other examples of the same community by more than 20 metres of a different ecological community, an artificial surface or a totally destroyed community.

By ensuring that every discrete occurrence is recognised and recorded future changes in status can be readily monitored.

Adequately Surveyed is defined as follows:
"An ecological community that has been searched for thoroughly in most likely habitats, by relevant experts."

Community structure is defined as follows:
"The spatial organisation, construction and arrangement of the biological elements comprising a biological assemblage" (eg. *Eucalyptus salmonophloia* woodland over scattered small shrubs over dense herbs; structure in a faunal assemblage could refer to trophic structure, eg. dominance by feeders on detritus as distinct from feeders on live plants).

Definitions of Modification and Destruction of an ecological community:

Modification: "changes to some or all of ecological processes (including abiotic processes such as hydrology), species composition and community structure as a
direct or indirect result of human activities. The level of damage involved could be ameliorated naturally or by human intervention."

Destruction: "modification such that reestablishment of ecological processes, species composition and community structure within the range of variability exhibited by the original community is unlikely within the foreseeable future even with positive human intervention."

Note: Modification and destruction are difficult concepts to quantify, and their application will be determined by scientific judgement. Examples of modification and total destruction are cited below:

Modification of ecological processes: The hydrology of Toolibin Lake has been altered by clearing of the catchment such that death of some of the original flora has occurred due to dependence on fresh water. The system may be bought back to a semblance of the original state by redirecting saline runoff and pumping waters of the rising underground watertable away to restore the hydrological balance. Total destruction of downstream lakes has occurred due to hydrology being altered to the point that few of the original flora or fauna species are able to tolerate the level of salinity and/or water logging.

Modification of structure: The understorey of a plant community may be altered by weed invasion due to nutrient enrichment by addition of fertiliser. Should the additional nutrients be removed from the system the balance may be restored, and the original plant species better able to compete. Total destruction may occur if additional nutrients continue to be added to the system causing the understorey to be completely replaced by weed species, and death of overstorey species due to inability to tolerate high nutrient levels.

Modification of species composition: Pollution may cause alteration of the invertebrate species present in a freshwater lake. Removal of pollutants may allow the return of the original inhabitant species. Addition of residual highly toxic substances may cause permanent changes to water quality, and total destruction of the community.

Threatening processes are defined as follows:
"Any process or activity that threatens to destroy or significantly modify the ecological community and/or affect the continuing evolutionary processes within any ecological community."

Examples of some of the continuing threatening processes in Western Australia include: general pollution; competition, predation and change induced in ecological communities as a result of introduced animals; competition and displacement of native plants by introduced species; hydrological changes; inappropriate fire regimes; diseases resulting from introduced microorganisms; direct human exploitation and disturbance of ecological communities.

Restoration is defined as returning an ecological community to its pre-disturbance or natural state in terms of abiotic conditions, community structure and species composition.

Rehabilitation is defined as the re-establishment of ecological attributes in a damaged ecological community although the community will remain modified.

2. DEFINITIONS AND CRITERIA FOR PRESUMED TOTALLY DESTROYED, CRITICALLY ENDANGERED, ENDANGERED AND VULNERABLE ECOLOGICAL COMMUNITIES

Presumed Totally Destroyed (PD)
An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.

An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B):

A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or

B) All occurrences recorded within the last 50 years have since been destroyed

Critically Endangered (CR)
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.

An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more** of the following criteria (A, B or C):

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% **and either or both** of the following apply (i or ii):

i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years);

ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years);

ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;

iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.

C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

Endangered (EN)
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.

An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting **any one or more** of the following criteria (A, B, or C):

A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement **and either or both** of the following apply (i or ii):

i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);

ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);

ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;

iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.

C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

Vulnerable (VU)
An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured

and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting **any one or more** of the following criteria (A, B or C):

A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.

B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

3. DEFINITIONS AND CRITERIA FOR PRIORITY ECOLOGICAL COMMUNITIES

PRIORITY ECOLOGICAL COMMUNITY LIST

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community, and evaluation of conservation status, so that consideration can be given to their declaration as threatened ecological communities. Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Priority One: Poorly-known ecological communities

Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly-known ecological communities

Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Priority Three: Poorly known ecological communities

(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:
(ii) communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or;
(iii) communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.

Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.

(a) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.

(b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.

(c) Ecological communities that have been removed from the list of threatened communities during the past five years.

Priority Five: Conservation Dependent ecological communities

Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Appendix B: Target Locations for Field Survey for *Meeboldina decipiens* subsp. *decipiens* (P3) and *Millotia tenuifolia* var. *laevis* (P2)

Site No.	Species	Location	Source	Tenure	Easting	Northing	Habitat	WAHerb Lat/long	Date of Record	Land Manager	Targeted in Field Survey
1	*Meeboldina decipiens* subsp. *decipiens* (P3)	Riverdale Road, ca 3 km E of Coast Road, SW of Yarloop	WAHerb	Myalup State Forest (F16)	384619	6348775	Small trees of Melaleuca on grey peaty sand, seasonally waterlogged. Landform = slight swampy depression	32° 59' 36.0" S 115° 45' 54.0" E (GDA94)	18-Nov-07	DPaW	Y
2	*Meeboldina decipiens* subsp. *decipiens* (P3)	Poison Gully, SW of Nannup	WAHerb	Milyeanup State Forest (F58)	366362	6224777	Eucalyptus rudis, Cyathochaeta teretifolia. Landform = creekside	34° 6' 33.5" S 115° 33' 3.9" E (GDA94)	1-Dec-04	DPaW	Y
3	*Meeboldina decipiens* subsp. *decipiens* (P3)	Brickwood Reserve, Byford, between Turner and Soldier Roads	WAHerb	Shire of Serpentine -Jarrahdale (Shire Reserve)	406130	6433586	Low Corymbia calophylla woodland A (Muir, 77). Kingia australis, Xanthorrhoea preissii, Pericalymma spongicaule, Mesomelaena tetragona, Tricostularia neesii on seasonally wet, grey loamy sand. Landform = wetland	32° 13' 49.6" S 116° 0' 13.4" E (GDA94)	14-Nov-03	Shire	Y
4	*Meeboldina decipiens* subsp. *decipiens* (P3)	Ranford Road, 2.9 km S of Warton Road	WAHerb	Private Property	401143	6445867	Small shrubs of Melaleuca on swampy flat	32° 5' S 116° 0' E (GDA94)	8-Oct-95	Laura Fullin	Y
5	*Meeboldina decipiens* subsp. *decipiens* (P3)	Waterloo, 0.3 km W of school site	WAHerb	Un-named Nature Reserve (R46108)	384237	6311298	Melaleuca - restiad swamp, flat site, clay soils	33° 20' S 115° 45' E (GDA94)	17-Oct-92	DPaW	Y

Site No.	Species	Location	Source	Tenure	Easting	Northing	Habitat	WAHerb Lat/long	Date of Record	Land Manager	Targeted in Field Survey
6	*Meeboldina decipiens* subsp. *decipiens* (P3)	McNeill Road, ca 50 m S of Mayfield Road, Waroona	WAHerb	Shire of Waroona road reserve	397614	6368387		32° 51′ S 115° 55′ E (GDA94)	17-Oct-92	Shire	Y
7	*Meeboldina decipiens* subsp. *decipiens* (P3)	2 km E of Wonnerup on Ruabon Road	WAHerb	Shire of Busselton	361689	6276559	Dense heath with small trees of Melaleuca. Area surrounded by Eucalyptus marginata woodland on yellow sandy clay. Landform = small lake, swampy ground	33° 38′ S 115° 58′ E (GDA94)	6-Oct-84	Shire	Y
8	*Millotia tenuifolia* var. *laevis* (P2)	Location No. 26758, E of Hagboom Lake in small remnant, entry off Hagboom S Road, S of Dowerin	WAHerb	Private Property within Shire of Goomallin g	497856	6523918	Open low woodland of Banksia prionotes and Banksia attenuata over shrubland of Eremaea pauciflora, Melaleuca sp. and Leptospermum erubescens over sedges on yellow sand. Landform = plain. 'Quadrat One'	31° 25′ 9.8″ S 116° 58′ 38.8″ E (GDA94)	10-Oct-07	Private (Gavin Hagboom)	Y
9	*Millotia tenuifolia* var. *laevis* (P2)	Serpentine – South (WA Bluemetal Quarry Survey Area)	DEFL WAHerb	Jarrahdale State Forest (F22)	409281	6428120	Dryandra lindleyana, Hypocalymma angustifolia, Trichocline spathulata, Gompholobium knightianum on sand-gravel-laterite. Landform: slope	32° 16′ 48.0″ S 116° 2′ 11.9″ E (GDA94)	18-Oct-05	DPaW	Y
10	*Millotia tenuifolia* var. *laevis* (P2)	Serpentine – North (WA Bluemetal Quarry Survey Area)	WAHerb	Jarrahdale State Forest (F22)	409685	6428900	Lomandra hermaphrodita, Stylidium piliferum, Macrozamia riedlei, Platysace compressa, Tetraria capillaris on sand-gravel. Landform = outcrop	32° 16′ 22.8″ S 116° 2′ 27.6″ E (GDA94)	18-Oct-05	DPaW	Y

Site No.	Species	Location	Source	Tenure	Easting	Northing	Habitat	WAHerb Lat/long	Date of Record	Land Manager	Targeted in Field Survey
11	*Millotia tenuifolia* var. *laevis* (P2)	15.9 km SE of Great Northern Highway along Dewars Pool Road, Bindoon	DEFL WAHerb	Julimar State Forest (F61)	432283	6527820	Open forest Jarrah/Marri on red-brown lateritic soil	31° 23′ S 116° 19′ E (GDA94)	20-Sep-83	DPaW	Y
12	*Millotia tenuifolia* var. *laevis* (P2)	Meelup Regional Park	NA	City of Busselton	322101	6282317	Forest	NA		City of Busselton	Y
13	*Millotia tenuifolia* var. *laevis* (P2)	Meelup Regional Park	NA	City of Busselton	321777	6283101	Forest	NA		City of Busselton	Y
14	*Millotia tenuifolia* var. *laevis* (P2)	Cape Nat NP	NA	National Park	316605	6286562	Forest	NA		DPaW	N – Locality unclear
15	*Millotia tenuifolia* var. *laevis* (P2)	Near Collie	WAHerb		404700	6365806		32° 50′ 30.0″ S 115° 58′ 54.0″ E (GDA94)			N
16	*Millotia tenuifolia* var. *laevis* (P2)	Between Dunsborough and Cape Naturaliste	WAHerb		318999	6284186		33° 34′ S 115° 3′ 0.0″ E (GDA94)			N
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road	NA	MRWA Offset Property	404737	6516405					Y
18	*Millotia tenuifolia* var. *laevis* (P2)	Beechboro Road North	NA	WA Planning Commissio n	397321	6478441					Y
19	*Meeboldina decipiens*	Pinjarra - Hampton Road	WAHerb	Shire of Murray	393220	6388366	Seasonal Wetland, flat, clay, poor drainage, wet during	32° 38′ 11.5″ S	2-Nov-10	Shire of Murray	Y

Site No.	Species	Location	Source	Tenure	Easting	Northing	Habitat	WAHerb Lat/long	Date of Record	Land Manager	Targeted in Field Survey
							winter/spring.	115° 51′ 45.7″ E (GDA94)			
20	*Meeboldina decipiens*	Waroona - Browne's Road	WAHerb	Shire of Waroona	390559	6379450	Hakea varia, Pericalymma ellipticum, Xanthorrhaea preissei. Low shrubland.	32° 42′ 59.2″ S 115° 49′ 53.7″ E (GDA94)	18-Sep-07	Shire of Waroona	Y
21	*Meeboldina decipiens*	Waroona - N of Storey Road	WAHerb	Shire of Waroona	396581	6371308	Marri, Melaleuca sp., Semaphore sedge, Hakea sp., Dryandra lindleyana, Grevillea bipinnatifida, G. pilulifera.	32° 47′ 28.6″ S 115° 53′ 44.4″ E (GDA94)	29-Aug-00	Shire of Waroona	Y
22	*Meeboldina decipiens*	Waroona - Adjacent to Railway Road	WAHerb	Shire of Waroona	396983	6370127	Sedgeland.	32° 48′ 6.6″ S 115° 53′ 58.4″ E (GDA94)	2-Nov-10	Shire of Waroona	Y
23	*Meeboldina decipiens*	Waroona - Rail Reserve N of Mayfield Road	WAHerb	Brookfield Rail	397083	6369756	Sedgeland.	32° 48′ 6.6″ S 115° 53′ 58.4″ E (GDA94)	2-Nov-10	Brookfield Rail	Y
24	*Meeboldina decipiens*	Waroona - SW Highway N of Mayfield Road	WAHerb	Main Roads	397686	6368699	Sedgeland.	32° 48′ 6.6″ S 115° 53′ 58.4″ E (GDA94)	2-Nov-10	Main Roads	Y
25	*Meeboldina decipiens*	Ruabon Road	WAHerb	Shire of Busselton	358501	6276958	With Melaleuca shrubs, Leptospermum and Hakea, in heathy swamp.	33° 38′ S 115° 30′ E (GDA94)	10-Oct-76	Shire of Busselton	Y
26	*Meeboldina decipiens*	Fish Road Nature Reserve	WAHerb	Fish Road Nature Reserve	350813	6266525	Melaleuca viminea, M. cuticularis Low Scrub A over mixed Open Herbs over Leptocarpus coangustatus	33° 43′ 47.7″ S 115° 23′ 25.5″ E	9-Nov-92	DPaW	Y

Site No.	Species	Location	Source	Tenure	Easting	Northing	Habitat	WAHerb Lat/long	Date of Record	Land Manager	Targeted in Field Survey
							Open Tall Sedges over Meeboldina denmarkia, Centrolepis aristata Low Sedges.	(GDA94)			

Appendix C: Results of *Meeboldina decipiens* subsp. *decipiens* (P3) and *Millotia tenuifolia* var. *laevis* (P2) Field Assessment

Site No.	Species	Location	Source	Tenure	Easting	Northing	Date	Plant Count
3	*Meeboldina decipiens* subsp. *decipiens (P3)*	Brickwood Reserve	Known location: WAHerb	Shire of Serpentine-Jarrahdale (Shire Reserve)	406126	6433576	6/10/2015	50
3	*Meeboldina decipiens* subsp. *decipiens (P3)*	Brickwood Reserve	Known location: WAHerb	Shire of Serpentine-Jarrahdale (Shire Reserve)	406163	6433574	6/10/2015	100
3	*Meeboldina decipiens* subsp. *decipiens (P3)*	Brickwood Reserve	Known location: WAHerb	Shire of Serpentine-Jarrahdale (Shire Reserve)	406189	6433577	6/10/2015	100
3	*Meeboldina decipiens* subsp. *decipiens (P3)*	Brickwood Reserve	Known location: WAHerb	Shire of Serpentine-Jarrahdale (Shire Reserve)	406169	6433595	6/10/2015	200
3	*Meeboldina decipiens* subsp. *decipiens (P3)*	Brickwood Reserve	Known location: WAHerb	Shire of Serpentine-Jarrahdale (Shire Reserve)	406170	6433618	6/10/2015	500
3	*Meeboldina decipiens* subsp. *decipiens (P3)*	Brickwood Reserve	Known location: WAHerb	Shire of Serpentine-Jarrahdale (Shire Reserve)	406149	6433634	6/10/2015	200
3	*Meeboldina decipiens* subsp. *decipiens (P3)*	Brickwood Reserve	Known location: WAHerb	Shire of Serpentine-Jarrahdale (Shire Reserve)	406123	6433650	6/10/2015	100
3	*Meeboldina decipiens* subsp. *decipiens (P3)*	Brickwood Reserve	Known location: WAHerb	Shire of Serpentine-Jarrahdale (Shire Reserve)	406092	6433648	6/10/2015	50
3	*Meeboldina decipiens* subsp. *decipiens (P3)*	Brickwood Reserve	Known location: WAHerb	Shire of Serpentine-Jarrahdale (Shire Reserve)	406063	6433640	6/10/2015	50
3	*Meeboldina decipiens* subsp. *decipiens (P3)*	Brickwood Reserve	Known location: WAHerb	Shire of Serpentine-Jarrahdale (Shire Reserve)	406043	6433635	6/10/2015	20
3	*Meeboldina decipiens* subsp. *decipiens (P3)*	Brickwood Reserve	Known location: WAHerb	Shire of Serpentine-Jarrahdale (Shire Reserve)	405983	6433606	6/10/2015	10
3	*Meeboldina decipiens* subsp. *decipiens (P3)*	Brickwood Reserve	Known location: WAHerb	Shire of Serpentine-Jarrahdale (Shire Reserve)	405959	6433566	6/10/2015	200
3	*Meeboldina decipiens* subsp. *decipiens (P3)*	Brickwood Reserve	Known location: WAHerb	Shire of Serpentine-Jarrahdale (Shire Reserve)	405937	6433541	6/10/2015	500
3	*Meeboldina decipiens* subsp. *decipiens (P3)*	Brickwood Reserve	Known location: WAHerb	Shire of Serpentine-Jarrahdale (Shire Reserve)	405918	6433519	6/10/2015	500
4	*Meeboldina decipiens*	Ranford Road	Known location:	Private Property	401044	6445733	6/10/2015	50

Site No.	Species	Location	Source	Tenure	Easting	Northing	Date	Plant Count
	subsp. *decipiens (P3)*		WAHerb					
4	*Meeboldina decipiens* subsp. *decipiens (P3)*	Ranford Road	Known location: WAHerb	Private Property	401019	6445700	6/10/2015	20
4	*Meeboldina decipiens* subsp. *decipiens (P3)*	Ranford Road	Known location: WAHerb	Private Property	401025	6445663	6/10/2015	10
4	*Meeboldina decipiens* subsp. *decipiens (P3)*	Ranford Road	Known location: WAHerb	Private Property	401011	6445627	6/10/2015	20
4	*Meeboldina decipiens* subsp. *decipiens (P3)*	Ranford Road	Known location: WAHerb	Private Property	400988	6445611	6/10/2015	50
4	*Meeboldina decipiens* subsp. *decipiens (P3)*	Ranford Road	Known location: WAHerb	Private Property	400986	6445607	6/10/2015	50
4	*Meeboldina decipiens* subsp. *decipiens (P3)*	Ranford Road	Known location: WAHerb	Private Property	400969	6445631	6/10/2015	200
5	*Meeboldina decipiens* subsp. *decipiens* (P3)	Waterloo State School Site	Known location: WAHerb	Un-named Nature Reserve (R46108)	384524	6311473	6/10/2015	50
5	*Meeboldina decipiens* subsp. *decipiens (P3)*	Waterloo State School Site	Known location: WAHerb	Un-named Nature Reserve (R46108)	384517	6311457	6/10/2015	50
5	*Meeboldina decipiens* subsp. *decipiens (P3)*	Waterloo State School Site	Known location: WAHerb	Un-named Nature Reserve (R46108)	384475	6311476	6/10/2015	50
5	*Meeboldina decipiens* subsp. *decipiens (P3)*	Waterloo WSW of State School Site	Known location: WAHerb	Un-named Nature Reserve (R46108)	384206	6311283	6/10/2015	100
5	*Meeboldina decipiens* subsp. *decipiens (P3)*	Waterloo WSW of State School Site	Known location: WAHerb	Un-named Nature Reserve (R46108)	384198	6311302	6/10/2015	200
5	*Meeboldina decipiens* subsp. *decipiens (P3)*	Waterloo WSW of State School Site	Known location: WAHerb	Un-named Nature Reserve (R46108)	384158	6311277	6/10/2015	300
26	**Meeboldina decipiens*	Fish Road Nature Reserve	Known location: WAHerb	Fish Road Nature Reserve	350746	6266586	7/10/2015	50
26	**Meeboldina decipiens*	Fish Road Nature Reserve	Known location: WAHerb	Fish Road Nature Reserve	350787	6266516	7/10/2015	10
26	**Meeboldina decipiens*	Fish Road Nature Reserve	Known location: WAHerb	Fish Road Nature Reserve	350813	6266525	7/10/2015	40
25	**Meeboldina decipiens*	Ruabon Townsite Nature Reserve	Known location: WAHerb	Ruabon Townsite Nature Reserve (R33269)	361637	6276556	7/10/2015	30

Site No.	Species	Location	Source	Tenure	Easting	Northing	Date	Plant Count
25	*Meeboldina decipiens	Ruabon Townsite Nature Reserve	Known location: WAHerb	Ruabon Townsite Nature Reserve (R33269)	361651	6276563	7/10/2015	100
25	*Meeboldina decipiens	Ruabon Townsite Nature Reserve	Known location: WAHerb	Ruabon Townsite Nature Reserve (R33269)	361678	6276564	7/10/2015	200
25	*Meeboldina decipiens	Ruabon Townsite Nature Reserve	Known location: WAHerb	Ruabon Townsite Nature Reserve (R33269)	361696	6276578	7/10/2015	200
25	*Meeboldina decipiens	Ruabon TownsiteNature Reserve	Known location: WAHerb	Ruabon Townsite Nature Reserve (R33269)	361720	6276593	7/10/2015	500
7	*Meeboldina decipiens	Ruabon Road	Known location: WAHerb	Shire of Busselton	358502	6276935	8/10/2015	10
7	*Meeboldina decipiens	Ruabon Road	Known location: WAHerb	Shire of Busselton	358501	6276958	8/10/2015	100
7	*Meeboldina decipiens	Ruabon Road	Known location: WAHerb	Shire of Busselton	358357	6276976	8/10/2015	5
23	*Meeboldina decipiens	Waroona - rail reserve N of Mayfield Road	Known location: WAHerb	Brookfield Rail	397083	6369756	8/10/2015	100
24	*Meeboldina decipiens	Waroona - SW Highway N of Mayfield Road	Known location: WAHerb	Main Roads	397711	6368772	8/10/2015	50
24	*Meeboldina decipiens	Waroona - SW Highway N of Mayfield Road	Known location: WAHerb	Main Roads	397686	6368699	8/10/2015	50
22	*Meeboldina decipiens	Waroona - adjacent to Railway Road	Known location: WAHerb	Shire of Waroona	396983	6370127	8/10/2015	250
22	*Meeboldina decipiens	Waroona - adjacent to Railway Road	Known location: WAHerb	Shire of Waroona	397016	6370135	8/10/2015	5
21	*Meeboldina decipiens	Waroona - N of Storey Road	Known location: WAHerb	Shire of Waroona	396581	6371308	8/10/2015	7
20	*Meeboldina decipiens	Waroona - Browne's Road	Known location: WAHerb	Shire of Waroona	390566	6379106	8/10/2015	500
20	*Meeboldina decipiens	Waroona - Browne's Road	Known location: WAHerb	Shire of Waroona	390559	6379450	8/10/2015	150
20	*Meeboldina decipiens	Waroona - Browne's Road	Known location: WAHerb	Shire of Waroona	390518	6379615	8/10/2015	50
19	*Meeboldina decipiens	Pinjarra - Hampton Road	Known location:	Shire of Murray	393220	6388366	8/10/2015	1000

Site No.	Species	Location	Source	Tenure	Easting	Northing	Date	Plant Count
			WAHerb					
9	*Millotia tenuifolia* var. *laevis* (P2)	State Forest – NW of Jarrahdale	Known location: WAHerb	Jarrahdale State Forest (F22)	409668	6428897	6/10/2015	20
9	*Millotia tenuifolia* var. *laevis* (P2)	State Forest – NW of Jarrahdale	Known location: WAHerb	Jarrahdale State Forest (F22)	409659	6428912	6/10/2015	15
9	*Millotia tenuifolia* var. *laevis* (P2)	State Forest – NW of Jarrahdale	Known location: WAHerb	Jarrahdale State Forest (F22)	409657	6428931	6/10/2015	100
9	*Millotia tenuifolia* var. *laevis* (P2)	State Forest – NW of Jarrahdale	Known location: WAHerb	Jarrahdale State Forest (F22)	409646	6428943	6/10/2015	20
9	*Millotia tenuifolia* var. *laevis* (P2)	State Forest – NW of Jarrahdale	Known location: WAHerb	Jarrahdale State Forest (F22)	409650	6428980	6/10/2015	300
9	*Millotia tenuifolia* var. *laevis* (P2)	State Forest – NW of Jarrahdale	Known location: WAHerb	Jarrahdale State Forest (F22)	409690	6428972	6/10/2015	50
9	*Millotia tenuifolia* var. *laevis* (P2)	State Forest – NW of Jarrahdale	Known location: WAHerb	Jarrahdale State Forest (F22)	409702	6428976	6/10/2015	50
9	*Millotia tenuifolia* var. *laevis* (P2)	State Forest – NW of Jarrahdale	Known location: WAHerb	Jarrahdale State Forest (F22)	409719	6428951	6/10/2015	50
9	*Millotia tenuifolia* var. *laevis* (P2)	State Forest – NW of Jarrahdale	Known location: WAHerb	Jarrahdale State Forest (F22)	409722	6428916	6/10/2015	20
10	*Millotia tenuifolia* var. *laevis* (P2)	State Forest – NW of Jarrahdale	Known location: DEFL WAHerb	Jarrahdale State Forest (F22)	409289	6428254	6/10/2015	50
10	*Millotia tenuifolia* var. *laevis* (P2)	State Forest – NW of Jarrahdale	Known location: DEFL WAHerb	Jarrahdale State Forest (F22)	409258	6428176	6/10/2015	200
10	*Millotia tenuifolia* var. *laevis* (P2)	State Forest – NW of Jarrahdale	Known location: DEFL WAHerb	Jarrahdale State Forest (F22)	409276	6428113	6/10/2015	100
10	*Millotia tenuifolia* var. *laevis* (P2)	State Forest – NW of Jarrahdale	Known location: DEFL WAHerb	Jarrahdale State Forest (F22)	409266	6428094	6/10/2015	50
10	*Millotia tenuifolia* var. *laevis* (P2)	State Forest – NW of Jarrahdale	Known location: DEFL WAHerb	Jarrahdale State Forest (F22)	409296	6428125	6/10/2015	20
10	*Millotia tenuifolia* var. *laevis* (P2)	State Forest – NW of Jarrahdale	Known location: DEFL WAHerb	Jarrahdale State Forest (F22)	409293	6428157	6/10/2015	50
10	*Millotia tenuifolia* var. *laevis* (P2)	State Forest – NW of Jarrahdale	Known location: DEFL WAHerb	Jarrahdale State Forest (F22)	409268	6428266	6/10/2015	50

Site No.	Species	Location	Source	Tenure	Easting	Northing	Date	Plant Count
10	*Millotia tenuifolia* var. *laevis* (P2)	State Forest – NW of Jarrahdale	Known location: DEFL WAHerb	Jarrahdale State Forest (F22)	409284	6428298	6/10/2015	20
8	*Millotia tenuifolia* var. *laevis* (P2)	Hagbooom Lake - SE of Goomalling	Known location: WAHerb	Private Property	497849	6523924	9/10/2015	10
8	*Millotia tenuifolia* var. *laevis* (P2)	Hagbooom Lake - SE of Goomalling	Known location: WAHerb	Private Property	497854	6523923	9/10/2015	100
8	*Millotia tenuifolia* var. *laevis* (P2)	Hagbooom Lake - SE of Goomalling	Known location: WAHerb	Private Property	497861	6523892	9/10/2015	15
8	*Millotia tenuifolia* var. *laevis* (P2)	Hagbooom Lake- SE of Goomalling	Known location: WAHerb	Private Property	497870	6523885	9/10/2015	70
8	*Millotia tenuifolia* var. *laevis* (P2)	Hagbooom Lake - SE of Goomalling	Known location: WAHerb	Private Property	497851	6523879	9/10/2015	30
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	404798	6516426	9/10/2015	1000
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	404768	6516419	9/10/2015	200
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	404804	6516387	9/10/2015	100
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	406276	6516741	9/10/2015	50
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	406222	6516740	9/10/2015	50
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	406209	6516740	9/10/2015	50
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	406222	6516734	9/10/2015	50
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	406235	6516755	9/10/2015	50
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	406231	6516772	9/10/2015	50
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	406248	6516768	9/10/2015	50
17	*Millotia tenuifolia* var.	Ioppolo Road – NNE of	New population	MRWA owned offset property	406263	6516766	9/10/2015	20

Site No.	Species	Location	Source	Tenure	Easting	Northing	Date	Plant Count
	laevis (P2)	Muchea						
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	406262	6516756	9/10/2015	50
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	404845	6517327	9/10/2015	200
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	404839	6517281	9/10/2015	20
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	404835	6517249	9/10/2015	20
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	404832	6517251	9/10/2015	50
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	404820	6517294	9/10/2015	20
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	404813	6517309	9/10/2015	50
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	404817	6517325	9/10/2015	50
17	*Millotia tenuifolia* var. *laevis* (P2)	Ioppolo Road – NNE of Muchea	New population	MRWA owned offset property	404822	6517321	9/10/2015	50
18	*Millotia tenuifolia* var. *laevis* (P2)	Beechboro – adjacent to North Link development footprint	New population - North Link Project	WA Planning Commission managed	397363	6478118	15/10/2015	20
18	*Millotia tenuifolia* var. *laevis* (P2)	Beechboro – adjacent to North Link development footprint	New population - North Link Project	WA Planning Commission managed	397344	6478164	15/10/2015	10
18	*Millotia tenuifolia* var. *laevis* (P2)	Beechboro – adjacent to North Link development footprint	New population - North Link Project	WA Planning Commission managed	397322	6478180	15/10/2015	500
18	*Millotia tenuifolia* var. *laevis* (P2)	Beechboro – adjacent to North Link development footprint	New population - North Link Project	WA Planning Commission managed	397289	6478224	15/10/2015	100
18	*Millotia tenuifolia* var. *laevis* (P2)	Beechboro – adjacent to North Link development footprint	New population - North Link Project	WA Planning Commission managed	397284	6478406	15/10/2015	2

Site No.	Species	Location	Source	Tenure	Easting	Northing	Date	Plant Count
18	*Millotia tenuifolia* var. *laevis* (P2)	Beechboro – adjacent to North Link development footprint	New population - North Link Project	WA Planning Commission managed	397333	6478416	15/10/2015	150
18	*Millotia tenuifolia* var. *laevis* (P2)	Beechboro – adjacent to North Link development footprint	New population - North Link Project	WA Planning Commission managed	397345	6478367	15/10/2015	50
18	*Millotia tenuifolia* var. *laevis* (P2)	Beechboro – adjacent to North Link development footprint	New population - North Link Project	WA Planning Commission managed	397361	6478308	15/10/2015	20
18	*Millotia tenuifolia* var. *laevis* (P2)	Beechboro – adjacent to North Link development footprint	New population - North Link Project	WA Planning Commission managed	396942	6479692	15/10/2015	300
18	*Millotia tenuifolia* var. *laevis* (P2)	Beechboro – adjacent to North Link development footprint	New population - North Link Project	WA Planning Commission managed	396943	6479653	15/10/2015	500

*: not currently determined as *Meeboldina decipiens* subsp. *decipiens* (P3)

APPENDIX E

Spring Surveys and Analysis to Investigate SCP02 Presence



Perth–Darwin National Highway (Swan Valley Section) – Supplementary Biological Studies 2015

Spring Surveys and Analysis to Investigate SCP02 Presence

COFFEY

NOVEMBER 2015



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Perth–Darwin National Highway (Swan Valley Section) – Supplementary Biological Studies 2015: Spring Surveys and Analysis to Investigate SCP02 Presence

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DEFINITIONS

Term	Definition
ALOC	A module within PATN that is a non-hierarchal classification which includes an option of matching new sites to existing classifications
DPaW	Department of Parks and Wildlife
FCT	Floristic Community Type
GDA	Geocentric Datum of Australia
GPS	Global Positioning System
ha	Hectare
IBRA	Interim Biogeographic Regionalisation for Australia
INDVAL	A system of indicator taxon analysis
Ltd	Limited
m	Metre
MS-DOS	Microsoft Disk Operating System
NNB	A module within PATN that determines the nearest neighbour of a site (that it is most similar to)
PATN	Software package for pattern analysis of complex multivariate data
PC-ORD	Software package for multivariate statistical analysis of ecological communities
PEC	Priority Ecological Community
Pty	Proprietary
SCP	Swan Coastal Plain
TEC	Threatened Ecological Community

1 INTRODUCTION

Coffey Environments Australia Pty Ltd (Coffey) conducted a Level 2 Assessment of flora and vegetation of Main Roads Western Australia's Perth–Darwin National Highway (Swan Valley Section) (the Project) during spring 2014 (Coffey 2015). Floristic analysis of the quadrat data collected during the spring survey identified a potential occurrence of 1.4 hectares (ha) of SCP02 (Southern wet shrublands) from a single quadrat (SVB011) to the west of Hepburn Avenue near the intersection with Marshall Road (the Study Area).

SCP02 is a State-listed Threatened Ecological Community (TEC) due to its limited distribution and limited number of occurrences, with each being small or isolated and vulnerable to threatening processes.

Previously identified occurrences of SCP02 have been recorded at the southern end of the Swan Coastal Plain (SCP) inland from Busselton, with a single potential occurrence identified recently near the Perth International Airport. Some of the indicator species identified in the original southern locations (type locations) have not been recorded north of Perth, making an occurrence of this community within the Project's development envelope unlikely.

The analysis of the Floristic Community Type (FCT) for quadrat SVB011 (Coffey 2015) could not clearly differentiate the community between SCP02 and SCP11 from the Swan Coastal Plain dataset (Gibson et al. 1994):

- The analysis dendrogram grouped the quadrat with quadrats belonging to SCP11;
- The nearest neighbour analysis, which assessed the percentage of species in common without addressing indicator species, aligned the quadrat with quadrats belonging to SCP11 and SCP03c;
- While the single site insertion analysis could not clearly separate the quadrat grouping between SCP02 and SCP11 (Coffey 2015).

Inspection of species occurrence records indicates the quadrat does not represent SCP03c based on the known distribution and the floristic description of SCP03c. The quadrat is likely to be consistent with SCP11 (Wet forests and shrublands) based on all three analyses. SCP11 is not listed as a TEC or a Priority Ecological Community (PEC). However, for the purposes of the impact assessment, and following the precautionary principle, the site was considered TEC SCP02 to ensure maximum protection until further assessments could be completed to confirm if the site represents TEC SCP02 (Coffey 2015).

Woodman Environmental Pty Ltd (Woodman Environmental) was commissioned by Coffey to implement the required studies to aid determination of this issue.

1.1 Aim and Objectives

The aim of this study was to investigate the presence of TEC SCP02 within the suspected location via analysis of floristic data.

The objectives required to achieve this encompassed the following:

- Establish and assess additional quadrats within the suspected location near Hepburn Avenue (minimum of 3).
- Combine the data with the existing Department of Parks and Wildlife (DPaW) data for the

Swan Coastal Plain and analyse utilising PATN and selecting multiple analysis pathways including the ALOC function within PATN.

- Interpret the analysis outputs to determine the FCT that the site quadrats most closely resemble.

2 METHODS

2.1 Field Assessment

The field assessment was undertaken on the 17 September 2015 by experienced botanists David Coultas and Alison Saligari. Table 1 lists the personnel involved in both fieldwork and plant identifications for the field survey. All personnel have had previous field experience in the Swan Coastal Plain region, with personnel involved in plant identifications having taxonomic experience with the flora of Swan Coastal Plain region. All plant material was collected under the scientific licences (pursuant to the *Wildlife Conservation Act 1950* Section 23C and Section 23F) as listed in Table 1.

Table 1: Personnel Licensing Information

Personnel	Role	Flora Collecting Permit / Permit to take T-DRF
David Coultas	Fieldwork	SL011384 / 147-1415
Bethea Loudon	Plant identifications	SL011382 / 149-1415
Alison Saligari	Fieldwork	SL011380 / 148-1415

A total of three permanent flora quadrats were established within the Study Area (Figure 1). All quadrats measured 10 m by 10 m and were marked with a fence-dropper at the north-west corner. All vascular flora taxa that were visually identifiable within each quadrat were recorded.

The following information was recorded at each quadrat:

- Personnel;
- Unique quadrat number;
- Date of survey;
- GPS (Global Positioning System) coordinates (Geocentric Datum of Australia (GDA)94);
- Site photograph;
- Topography (including landform type and aspect);
- Soil colour and type (including the presence of any rock outcropping and surface stones);
- Vegetation condition - South West Botanical Province (Keighery 1994);
- Approximate time since fire;
- Presence of disturbance (if any);
- Percentage foliage cover (for each taxon); and
- Height (metre (m)) (for each taxon, excluding climbers/aerial shrubs).

Mapping notes of the FCT boundary and condition were also taken.

2.2 Plant Collection and Identification

Specimens of unknown taxa were collected and pressed for later identification at the Western Australian Herbarium. Identifications were undertaken by experienced senior botanist Bethea Loudon.

Taxon nomenclature generally follows *FloraBase* (DPaW 2015a) with all names checked against the

current DPaW Max database to ensure their validity. However, in cases where names of plant taxa have been published recently in scientific literature but have not been adopted on *FloraBase* (DPaW 2015a), nomenclature in the published literature is followed. The conservation status of each taxon was checked against *FloraBase*, which provides the most up-to-date information regarding the conservation status of flora taxa in Western Australia. Specimens are kept in-house for reference for a period of one year after finalisation of the project.

2.3 Statistical Analysis

Classification analysis of quadrat data from the Study Area was conducted using the four quadrats established in the Study Area, three established during this survey and one quadrat established in 2014 by Coffey (Coffey 2015) (SVB011). These quadrats were analysed with 1098 quadrats from the updated version of the SCP dataset (Keighery *et al.* 2012) (compared to 509 quadrats from the original SCP dataset (Gibson *et al.* 1994)).

The updated version of the SCP dataset, sourced through *NatureMap* (DPaW 2015b), contains weed and native flora quadrat data compiled between 1990 through to 1996 for the southern SCP. This dataset is derived from a database that has been compiled and maintained over many years, combining the results of a number of floristic studies conducted on plant communities of the IBRA (Interim Biogeographic Regionalisation for Australia) SCP Bioregion, south of the Moore River. It includes sampling site details, the native and introduced (weed) flora collected at these sampling sites and the FCT assigned to these sampling sites. The taxonomy of the flora in the database has been updated regularly as determined by Greg Keighery and Bronwen Keighery. This dataset lists the taxonomy (including family names) which was current in this database on 23 June 2005 when the dataset was compiled (DPaW 2015b).

The combined analysis consisted of 1815 vascular taxa entities. Taxa belonging to several categories were removed or altered prior to analysis, as listed below:

- Taxa that are now considered to not occur in Western Australia by the Western Australian Herbarium – such taxa were removed from the analysis due to the inability to determine their current name.
- Taxa where the recorded name is not listed on the census of Western Australian flora and a current name could not be determined.
- Taxa that are not known from the South West land division.
- Supplementary names where the genus is a known to contain only weed species in Western Australia were changed to reflect this status (so as not to be assessed as a native taxon).

Some taxa and infra-taxa were amalgamated where taxonomy was unclear or could not be determined in all cases. In addition, genus/species entities were combined with entities that went to subspecies or varietal level. All taxa removed and amalgamated from the classification analysis are presented in Appendix A.

Initially, the ALOC function of PATN was proposed to be used in order to “lock” the original groupings of the SCP dataset, as it has the option of "no-reallocation" of the existing classification. ALOC is a non-hierarchal classification that includes an option of matching new sites to existing classifications, and creating new classes when the new sites do not "fit". However as there are many issues with using ALOC, including having to use MS-DOS (Microsoft Disk Operating System) to run it and difficulties in detecting real differences between existing classes and new ones (Ted Griffin pers. comm. 2015) this analysis pathway was not pursued.

With ALOC discounted as an analysis pathway, the use of OptimClass (Tichý *et al*. 2010) analysis was

considered in order to determine the most suitable approach to classification based on the available data. OptimClass evaluates the quality of a set of different partitions of the same dataset, based on the number of taxa that are faithful to clusters of that partition. Faithful taxa are identified using the Fisher's exact test for the right-tailed hypothesis, which is a suitable measure of statistical fidelity of taxa to clusters of quadrats (Sokal & Rohlf 1995; Chytrý *et al*. 2002). However as OptimClass runs off percent foliage cover data, this analysis was unable to be undertaken as the SCP dataset only contains presence/absence data.

Following these findings, the standard classification analysis using PATN (V3.1.2) (Belbin & Collins 2009) as used in the previous analysis by Gibson et al. (1994) was undertaken to analyse the dataset. Classification results of the analysis were produced as a dendrogram. The placement of the Study Area quadrats within the dendrogram were then reviewed, along with their relationship to quadrats from the SCP dataset that represent the TEC SCP02. Two separate analyses were run, one containing weed species and one with weeds excluded, to see how the absence of weeds affected the placement of quadrats within the dendrogram. The results and discussion are based on the analysis containing weeds, as per the methods of the SCP study (Gibson *et al.* 1994).

Nearest neighbour analysis (NNB) was also undertaken using PATN, to determine which SCP quadrats the Study Area quadrats were most similar to, based on the number of species they have in common. Indicator taxon analysis (INDVAL) was then conducted using PC-Ord (McCune & Mefford 2011) using the method of Dufrene & Legendre (1997), to determine the indicator taxa for the FCT(s) of the Study Area quadrats and SCP02. A Monte Carlo permutation test was used to test for the significance of the indicator taxa. Indicator taxon analysis identifies faithful taxa i.e. those species that consistently represent the FCT.

3 RESULTS

The vegetation of the Study Area consists of *Melaleuca preissiana* low isolated clumps of trees to low open forest over *Hypocalymma angustifolia* and *Xanthorrhoea preissii* mid shrubland over low isolated clumps of sedges to low sedgeland of *Cyathochaeta avenacea* and *Schoenus efoliatus*. A full list of taxa recorded in the Study Area is presented in Appendix B, with raw quadrat and detailed site data presented in Appendix C. A total of 38 taxa were recorded, including 13 weed species. Average species richness per quadrat was 22. The vegetation condition of the Study Area was Very Good, with the presence of weeds contributing to the lower condition score (Appendix C).

The section of the dendrogram (analysis with weeds included) in which the SCP02 and the Study Area quadrats were located is presented in Appendix D. Examination of the classification dendrogram found that the Study Area quadrats grouped with quadrats representing SCP04 and the supplementary FCT S02. This result was supported by the results of Nearest Neighbour analysis, which found the PERTH10 quadrat of the SCP dataset (Keighery *et al.* 2012), which is representative of SCP04 (Appendix E), to have the most species in common with the Study Area quadrats.

SCP04 is described as *M. preissiana* damplands, which was originally documented as having a mean species richness of 36.9 (Gibson *et al.* 1994). FCT S02 is described as Northern *Pericalymma ellipticum* dense low shrublands. Neither community is considered to be of conservation significance (PEC or TEC) (DPaW 2015c; 2015d). S02 is a supplementary FCT that was created following a revised analysis of the updated SCP dataset with data from surveys subsequent to the original SCP dataset of Gibson *et al.* (1994). Any quadrats that did not fit within the descriptions of the original FCTs were added as Supplementary Types. No published documentation including description or potential distribution exists for FCT S02 (Val English, pers. comm. 2015).

Indicator species analysis showed that only *Adenanthos obovatus* is recognised as a faithful taxon to

SCP04, indicating SCP04 is closely related to other FCTs with many taxa in common. Similarly, no taxa are recognised as indicator species for S02 (Appendix F). SCP02 was originally documented as having a mean species richness of 51 (Gibson *et al.* 1994), with 12 taxa recognised as indicator species (Appendix F) which is a significantly larger number of taxa than recorded in the Study Area quadrat. (mean number of taxa 22) .

Typical species associated with SCP04 include *M. preissiana*, *H. angustifolium*, *P. ellipticum* and *X. preissii*; all of which were recorded in the Study Area quadrats while species typical of SCP02 include *Calothamnus lateralis*, *Eutaxia virgata*, *Hakea ceratophylla*, *Isopogon scaber*, *Kingia australis*, *P. ellipticum*, *Synaphea petiolaris* and *X. preissii* (Gibson *et al.* 1994), of which only 2 were recorded in the Study Area quadrats.

Removal of weed species from the analysis had the effect of moving the Study Area quadrats to the very bottom of the dendrogram, with an even greater separation from the SCP02 quadrats, but still grouping with SCP04 and S02 quadrats thus increasing confidence in the initial analysis results and confirming that the Study Area is more representative of SCP04 or SO2 and not of SCP02.

4 DISCUSSION

Analysis of the Study Area quadrats with the SCP data was conducted with weeds retained in the dataset in order to replicate the original SCP analysis parameter and provide an initial indication of relationship between the Study Area quadrats and the larger regional dataset. This analysis was then repeated with the weeds removed to minimise any effects of gradients in weed invasion patterns on the SCP and provide clarification of relationships between quadrats based solely on native species composition. These gradients, related to surrounding landuses climatic factors and available vectors of weed invasion have the potential to affect grouping of quadrats based on vegetation condition and weed presence rather than native species composition. While the quadrats from the Study Area, when analysed with and without weeds, occurred in the same supergroup as SCP02 due to the presence of some common taxa, they occurred in different subgroups and while not a direct match, the Study Area was found to be most closely related to SCP04, a common vegetation community of the SCP.

Furthermore, impacts from introduced flora, fragmentation and disturbance associated with past historical activities and landuse has potentially contributed to a loss of species within the Study Area quadrats (average species richness of 22, compared to 51 of SCP02). However given the present condition of the vegetation of the Study Area and the very different species composition recorded in comparison to that recorded for SCP02 it is concluded that the vegetation of the Study Area does not currently, or has not previously represented the State-listed TEC SCP02.

5 REFERENCES

Belbin. L. and Collins, A. (2009)
PATN. Blatant Fabrications Pty Ltd.

Chytrý, M., Tichý, L., Holt, J. and Botta-Dukát, Z. (2002)
Determination of diagnostic species with statistical fidelity measures. Journal of Vegetation Science 13 (1): 79-90.

Coffey Environments (2015)
Level 2 Flora and Vegetation Assessment, Perth – Darwin National Highway. Unpublished report prepared for Main Roads Western Australia, Doc No. NLWA-03-EN-RP-0016 (Rev 1), 29 May 2015.

Department of Parks and Wildlife (2015a)
FloraBase. Available: http://florabase.dpaw.wa.gov.au. Sourced October 2015

Department of Parks and Wildlife (2015b)
NatureMap. Available: http://naturemap.dpaw.wa.gov.au. Sourced October 2015

Department of Parks and Wildlife (2015c)
Priority Ecological Communities for Western Australia Version 22. Species and Communities Branch, Department of Parks and Wildlife (Correct to 6 June 2015). Available: http://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Priority_ecological_communities_list.pdf

Department of Parks and Wildlife (2015d)
List of Threatened Ecological Communities endorsed by the Western Australian Minister for the Environment. Species and Communities Branch, Department of Parks and Wildlife (Correct to 25 June 2015). Available: http://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Threatened_ecological_communities_list.pdf

Dufrene, M. and Legendre, P. (1997)
Species Assemblages and Indicator Species: The need for a flexible asymmetrical approach. In: Ecological Monographs 67: 345-366.

English, V. (2015)
Species and Communities Branch, Department of Parks and Wildlife. Personal communication via email 14 October 2015.

Gibson, N., Keighery, B., Keighery, G., Burbidge, A., and Lyons, M. (1994)
A Floristic Survey of the southern Swan Coastal Plain. Unpublished report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management.

Griffin E. A. (Ted) (2015)
Consultant Botanist (numerical analyses, report writing). Personal communication via email 5 October 2015.

Keighery, B.J. (1994)
Bushland Plant Survey: a Guide to Plant Community Survey for the Community. Wildflower Society of WA (Inc.), Nedlands, Western Australia.

Keighery, B., Keighery, G., Longman, V.M., and Clarke, K.A. (2012)
Swan Coastal Plain Survey Dataset. Updated version (Version 6), compiled and edited for the Department of Environmental Protection and Conservation and Land Management.

McCune, B. and Mefford, M.J. (2011)
PC-Ord. Multivariate Analysis of Ecological Data, Version 6.08. MjM Software, Gleneden Beach, Oregon U.S.A.

Sokal, R.R. and Rohlf, F.J. (1995)
Biometry: The Principles and Practice of Statistics in Biological Research, 3rd ed. W.H. Freeman, New York.

Tichý, L., Chytrý, M., Hájek, M., Talbot, S.S. & Botta-Dukát, Z. (2010)
OptimClass: Using species-to-cluster fidelity to determine the optimal partition in classification of ecological communities. *Journal of Vegetation Science* 21: 287–290.

397500 397600

6475500 6475500

6475400 6475400

6475300 6475300

6475200 6475200

BaBm3

BaBm2

HA-02

HA-01

SVB-11

Cl(Road)

HA-03

Mp3

Mp3

Cl

MpAl

Legend

- Quadrat Locations (HA prefix denotes WEC 2015 Quadrats)
- Coffey Environments Vegetation Mapping
- Coffey Environments SCP02 Boundary

397500 397600

WOODMAN ENVIRONMENTAL

N

This map should only be used in conjunction with WEC report Coffey15-28-01

Perth–Darwin National Highway (Swan Valley Section) Supplementary Biological Studies 2015 : Spring Surveys and Analysis to Investigate SCP02 Presence

Revision: B - 22 November 2015

Author: Bethea Loudon

WEC Ref: Coffey15-28-01

Filename: Coffey15-28-Scope-1.mxd

Scale: 1:1,000 (A3) Grid: MGA Zone 50

Figure

1

Appendix A: Vascular Plant Taxa Amalgamated and Omitted During Statistical Analysis

Taxon	Amalgamation/Deletion
Acacia lasiocarpa	Amalgamated
Acacia lasiocarpa var. *bracteolata* long peduncle variant (G.J. Keighery 5026) (P1)	
Acacia lasiocarpa var. *lasiocarpa*	
Acacia lasiocarpa (Pinjarra form) (BJ Keighery 2230)	
Acacia pulchella	Amalgamated
Acacia pulchella var. *glaberrima*	
Acacia pulchella var. *glaberrima* (Variant 2) (GJ Keighery 9188)	
Acacia pulchella var. *pulchella*	
Acacia pulchella var. *reflexa*	
Anigozanthos manglesii	Amalgamated
Anigozanthos manglesii subsp. *manglesii*	
Austrodanthonia acerosa	Amalgamated
Rytidosperma acerosum	
Banksia dallanneyi var. *dallanneyi*	Amalgamated
Dryandra lindleyana	
Billardiera ?*fraseri*	Amalgamated
Pronaya fraseri	
Boronia ramosa	Amalgamated
Boronia ramosa subsp. *anethifolia*	
Boronia ramosa subsp. *ramosa*	
Caladenia flava	Amalgamated
Caladenia flava subsp. *flava*	
Conostylis aculeata	Amalgamated
Conostylis aculeata subsp. *aculeata*	
Conostylis aculeata subsp. *breviflora*	
Conostylis aculeata subsp. *bromelioides*	
Conostylis aculeata subsp. *cygnorum*	
Conostylis aculeata subsp. *preissii*	
Conostylis crassinervia subsp. *crassinervia*	
Drosera erythrorhiza	Amalgamated
Drosera erythrorhiza subsp. *erythrorhiza*	
Drosera erythrorhiza subsp. *magna*	
Drosera erythrorhiza subsp. *squamosa*	
Drosera menziesii	Amalgamated
Drosera menziesii subsp. *menziesii*	
Drosera menziesii subsp. *penicillaris*	
Epilobium billardiereanum	Amalgamated

Taxon	Amalgamation/Deletion
Eremaea asterocarpa	Amalgamated
Eremaea asterocarpa subsp. *asterocarpa*	
Eremaea pauciflora	Amalgamated
Eremaea pauciflora var. *pauciflora*	
Eremophila glabra	Amalgamated
Eremophila glabra subsp. *albicans*	
Isolepis cernua	Amalgamated
Isolepis setiformis	
Jacksonia decumbens	Amalgamated
Jacksonia floribunda	
Lepidobolus preissianus	Amalgamated
Lepidobolus preissianus subsp. *preissianus*	
Lomandra micrantha	Amalgamated
Lomandra micrantha subsp. *micrantha*	
Melaleuca incana subsp. *incana*	Amalgamated
Melaleuca polygaloides	
Melaleuca systena	Amalgamated
Melaleuca sp. Yanchep (G.J. Keighery 11242)	
Melaleuca thymoides	Amalgamated – *M. thyoides* not found in Perth
Melaleuca thyoides	
Myriocephalus isoetes	Amalgamated
Myriocephalus rhizocephalus	
Myriocephalus occidentalis	
Orobanche australiana	Amalgamated
Orobanche minor	
Patersonia occidentalis	Amalgamated
Patersonia occidentalis var. *occidentalis*	
Pericalymma ellipticum	Amalgamated
Pericalymma ellipticum var. *floridum*	
Platysace juncea	Amalgamated
Platysace teres	
Pterostylis nana	Amalgamated
Pterostylis pyramidalis	
Pterostylis vittata	Amalgamated
Pterostylis ?vittata	
Romulea rosea	Amalgamated
Romulea rosea var. *australis*	
**Silene gallica*	Amalgamated
**Silene gallica* var. *gallica*	
Stylidium araeophyllum	Amalgamated
Stylidium ?araeophyllum	

Taxon	Amalgamation/Deletion
Stylidium calcaratum	Amalgamated
Stylidium mimeticum	
Stylidium piliferum	Amalgamated
Stylidium piliferum subsp. *piliferum*	
Stylidium saxifragoides	
Stylidium rigidifolium	Amalgamated
Stylidium striatum	
Synaphea petiolaris	Amalgamated
Synaphea petiolaris subsp. *petiolaris*	
Tribonanthes longipetala	Amalgamated
Tribonanthes uniflora	
Triglochin muelleri subsp. *muelleri*	Amalgamated
Triglochin muelleri subsp. *recurvum*	
Verticordia plumosa var. *brachyphylla*	Amalgamated
Verticordia plumosa var. *pleiobotrya*	
Vicia sativa	Amalgamated
Vicia sativa subsp. *sativa*	
Xanthosia huegelii	Amalgamated
Xanthosia huegelii subsp. *huegelii*	
Xanthosia pusilla	
**Pseudognaphalium luteoalbum*	Name changed to *Helichrysum luteoalbum* in dataset
Mentha x spicata	Status changed from native to introduced
Verbascum sp.	Status changed from native to introduced
Vulpia sp.	Status changed from native to introduced
Cassytha sp.	Deleted – insufficient material for identification
Grevillea sp.	Deleted – insufficient material for identification
Haemodorum sp.	Deleted – insufficient material for identification
Lepidosperma sp.	Deleted – insufficient material for identification
Marianthus parviflora	Deleted – invalid name
Polymeria sericea	Deleted – invalid name
Prasophyllum sp.	Deleted – insufficient material for identification
Psoralea aff. *graveolens*	Deleted – invalid name
Schoenus brevifolius	Deleted – excluded name
Thelymitra pauciflora	Deleted – excluded name
?*Tricoryne elatior*	Deleted – insufficient material for identification
Triglochin incurva	Deleted – invalid name
Veronica sp.	Deleted – insufficient material for identification
Veronica stolonifera	Deleted – invalid name

Appendix B: Vascular Plant Taxa Recorded in the Study Area

Apiaceae

Xanthosia huegelii

Asparagaceae

Chamaescilla versicolor

Asteraceae

**Arctotheca calendula*
**Hypochaeris glabra*
Podotheca gnaphalioides
**Sonchus oleraceus*
**Ursinia anthemoides*

Colchicaceae

Burchardia bairdiae
Burchardia congesta

Cyperaceae

Cyathochaeta avenacea
Schoenus efoliatus

Dasypogonaceae

Dasypogon bromeliifolius

Fabaceae

**Acacia longifolia* subsp. *longifolia*
Acacia pulchella var. *pulchella*
Acacia stenoptera
Aotus gracillima
Euchilopsis linearis
Gompholobium tomentosum
**Lotus subbiflorus*

Iridaceae

**Gladiolus caryophyllaceus*
Patersonia occidentalis var. *occidentalis*

Juncaceae

Juncus pallidus

Lauraceae

Cassytha sp.

Loranthaceae

Nuytsia floribunda

Myrtaceae

Astartea scoparia
Hypocalymma angustifolium
Melaleuca preissiana
Pericalymma ellipticum

Orchidaceae

Diuris magnifica
Pterostylis sanguinea

Poaceae

**Aira cupaniana*
**Avena barbata*
**Briza maxima*
**Briza minor*
**Ehrharta calycina*

Restionaceae

Hypolaena exsulca

Solanaceae

**Solanum nigrum*

Xanthorrhoeaceae

Xanthorrhoea preissii

Total number of taxa: 38 (includes 25 native taxa)

Note: * indicates introduced (weed) taxa

Appendix C: Raw Data Recorded within Quadrats in the Study Area

Site Name:	HA-01
Site Type:	QUADRAT
Dimensions:	10m x 10m
Survey Date:	17/09/2015
GPS Location:	GDA94 Zone 50 397497E 6475345N
Landform Type:	Closed Depression
Slope Class:	Level (0 degrees)
Soil Type:	Sandy Loam
Soil Colour:	Grey/Brown
Rock Outcrop:	No bedrock exposed
Vegetation Condition:	3 - Very Good
Disturbance:	Exotic Weeds
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
**Acacia longifolia* subsp. *longifolia*	4	5
Acacia pulchella var. *pulchella*		0.1
Acacia stenoptera		0.1
**Arctotheca calendula*		0.1
Astartea scoparia		0.1
**Briza maxima*	3	0.3
**Briza minor*		0.1
Cyathochaeta avenacea		0.1
**Ehrharta calycina*		0.1
Euchilopsis linearis		0.1
**Gladiolus caryophyllaceus*		0.1
Gompholobium tomentosum		0.1
Hypocalymma angustifolium	1.5	40
**Hypochaeris glabra*		0.1
Hypolaena exsulca		0.1
Juncus pallidus		0.1
Melaleuca preissiana	6	30
Patersonia occidentalis var. *occidentalis*		0.1
Pericalymma ellipticum	1.8	2
Schoenus efoliatus	0.5	2

**Solanum nigrum*		0.1
**Sonchus oleraceus*		0.1
**Ursinia anthemoides*		0.1
Xanthorrhoea preissii	2	2

PHOTO



Site Name:	HA-02
Site Type:	QUADRAT
Dimensions:	10m x 10m
Survey Date:	17/09/2015
GPS Location:	GDA94 Zone 50 397502E 6475360N
Landform Type:	Closed Depression
Slope Class:	Level
Soil Type:	Sandy Loam
Soil Colour:	Grey/Brown
Rock Outcrop:	No bedrock exposed
Vegetation Condition:	3 - Very Good
Disturbance:	Exotic Weeds
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
**Acacia longifolia* subsp. *longifolia*	2	6
Acacia pulchella var. *pulchella*		0.1
Aotus gracillima		0.1
Astartea scoparia	1.8	5
**Briza maxima*		0.1
Burchardia bairdiae		0.1
Cassytha sp.		0.1
Cyathochaeta avenacea	0.5	2
Dasypogon bromeliifolius		0.1
Diuris magnifica		0.1
**Ehrharta calycina*		0.1
Euchilopsis linearis	0.3	1
**Gladiolus caryophyllaceus*		0.1
Hypocalymma angustifolium	1.5	20
**Hypochaeris glabra*		0.1
Juncus pallidus		0.1
Melaleuca preissiana	6	50
Patersonia occidentalis var. *occidentalis*	0.5	1
Schoenus efoliatus	0.5	2
**Solanum nigrum*		0.1
**Sonchus oleraceus*		0.1
Xanthorrhoea preissii	1.5	2

Xanthosia huegelii		0.1

PHOTO



Site Name:	HA-03
Site Type:	QUADRAT
Dimensions:	10m x 10m
Survey Date:	17/09/2015
GPS Location:	GDA94 Zone 50 397594E 6475335N
Landform Type:	Closed Depression
Slope Class:	Level (0 degrees)
Soil Type:	Sandy Loam with slight Peat
Soil Colour:	Grey/Brown
Rock Outcrop:	No bedrock exposed
Vegetation Condition:	3 - Very Good
Disturbance:	Exotic Weeds
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
**Acacia longifolia* subsp. *longifolia*		0.1
Acacia pulchella var. *pulchella*		0.1
Astartea scoparia		0.1
**Avena barbata*		0.1
**Briza maxima*		0.1
**Briza minor*		0.1
Burchardia bairdiae		0.1
Dasypogon bromeliifolius		0.1
**Ehrharta calycina*		0.1
**Gladiolus caryophyllaceus*		0.1
Hypocalymma angustifolium	0.7	50
**Hypochaeris glabra*		0.1
Hypolaena exsulca	0.3	3
Melaleuca preissiana	5	5
Nuytsia floribunda		0.1
Patersonia occidentalis var. *occidentalis*		0.1
Podotheca gnaphalioides		0.1
Schoenus efoliatus	0.4	6
**Ursinia anthemoides*		0.1
Xanthorrhoea preissii	1.5	8

PHOTO



Site Name: SVB-11

Site Type: QUADRAT

Dimensions: 10m x 10m

Survey Date: 24/09/2014

GPS Location: GDA94 Zone 50 397503E 6475322N

Vegetation Condition: 3 - Very Good

DOMINANT TAXA IN VEGETATION STRATA

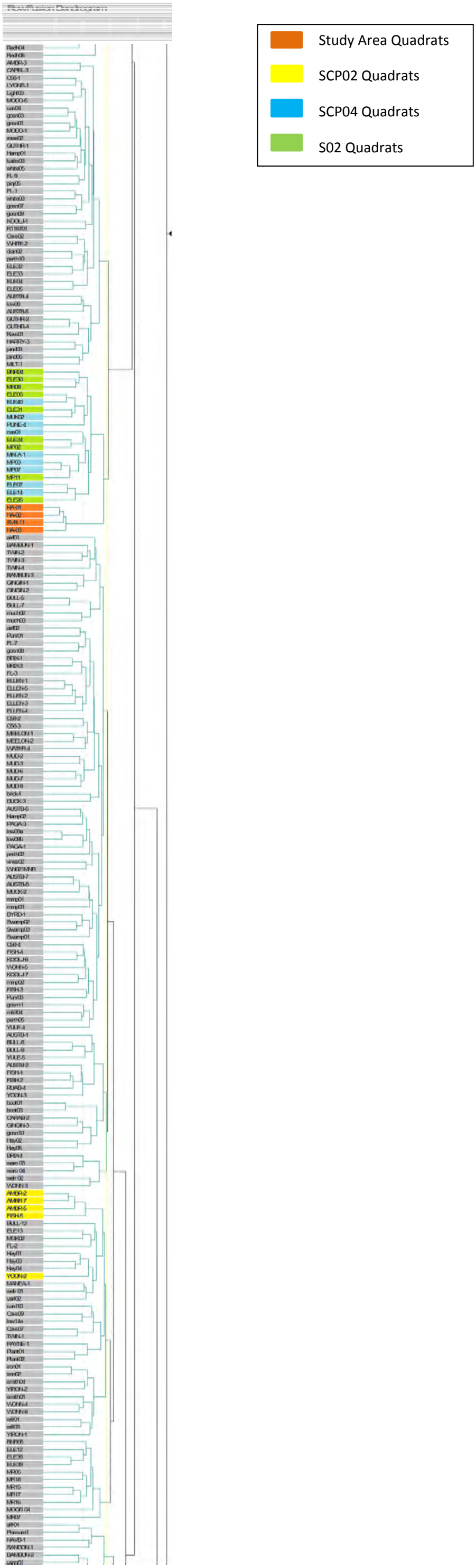
SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
**Acacia longifolia* subsp. *longifolia*	2.5	15
Acacia pulchella var. *pulchella*		0.1
Acacia stenoptera		0.1
**Aira cupaniana*		0.1
Astartea scoparia	1.4	2
**Briza maxima*	0.3	1
**Briza minor*	0.1	1
Burchardia congesta		0.1
Chamaescilla versicolor		0.1
Cyathochaeta avenacea	0.8	40
**Ehrharta calycina*		0.1
**Gladiolus caryophyllaceus*		0.1
Hypocalymma angustifolium	1.2	50
**Hypochaeris glabra*		0.1
Juncus pallidus		0.1
**Lotus subbiflorus*		0.1
Melaleuca preissiana	6	40
Pterostylis sanguinea		0.1
Schoenus efoliatus		0.1
**Sonchus oleraceus*		0.1
Xanthorrhoea preissii	0.8	1

PHOTO



Appendix D: Section of Classification Analysis Dendrogram Showing Proximity of SCP02 and Study Area Quadrats



Appendix E: Results of Nearest Neighbour Analysis of Quadrat Data from the Study Area

Study Area Quadrat	Nearest Neighbour	Level of Similarity	SCP FCT
HA-01	PERTH10	0.4915	4
HA-02	PERTH10	0.5789	4
HA-03	PERTH10	0.5273	4
SVB-11	PERTH10	0.6786	4

Appendix F: Results of Indicator Species Analysis of Quadrat Data from the Study Area

Taxon	FCT		
	2	4	S02
*Calothamnus lateralis***	24	4	2
*Comesperma virgatum***	21	0	2
Conospermum flexuosum subsp. *laevigatum**	83	0	0
*Dampiera linearis****	9	5	1
*Eutaxia virgata**	16	4	4
Grevillea brachystylis subsp. *brachystylis**	84	0	0
*Hakea ceratophylla****	55	0	0
Isopogon formosus subsp. *dasylepis***	62	0	0
*Kingia australis***	22	0	1
*Leptocarpus tenax***	59	5	0
*Stylidium crassifolium**	54	0	0
*Thysanotus multiflorus***	21	9	0
*Adenanthos obovatus**	25	25	4

Note: Shading denotes highest indicator values per taxon;
Indicator values (%) are shown only for taxa which were significant at P<0.05 (* = p <0.05; ** = p<0.01; *** = p <0.001)

APPENDIX F

Analysis to Investigate TEC SCP20a Presence



Perth–Darwin National Highway (Swan Valley Section)– Supplementary Biological Studies 2015

Assessment of the Presence of the TEC SCP20a at Ioppolo Rd, Chittering

COFFEY

NOVEMBER 2015



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Perth–Darwin National Highway (Swan Valley Section) – Supplementary Biological Studies 2015: Assessment of the presence of the TEC SCP20a at Ioppolo Rd, Chittering

Prepared for: Coffey

Job Number: Coffey15-28

Report Number: Coffey15-28-03

Cover Photograph: Lot M2019 - Ioppolo Road, waypoint 82 (Woodman Environmental)

DOCUMENT REVISION AND STATUS

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B	Client Comments Incorporated	BL	GW	19/11/2015	D. Morley Main Roads	26/11/2015
0	Final report	BL	GW	26/11/2015		

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FIGURES

Figure 1: Perth–Darwin National Highway (Swan Valley Section) – Assessment of the Presence of TEC SCP20a at Ioppolo Road, Chittering

TABLES

Table 1: Personnel Licensing Information

APPENDICES

Appendix A: Vascular Plant Taxa Amalgamated and Omitted During Statistical Analysis

Appendix B: Vascular Plant Taxa Recorded in the Proposed Offset Site

Appendix C: Raw Data Recorded within Quadrats in the Proposed Offset Site

Appendix D: Section of Classification Analysis Dendrogram Showing Proximity of SCP20a and Proposed Offset Site Quadrats (including weeds)

Appendix E: Results of Nearest Neighbour Analysis of Quadrat Data from the Proposed Offset Site

Appendix F: Results of Indicator Species Analysis of Quadrat Data from the Proposed Offset Site

DEFINITIONS

Term	Definition
ALOC	A module within PATN that is a non-hierarchal classification which includes an option of matching new sites to existing classifications
DPaW	Department of Parks and Wildlife
FCT	Floristic Community Type
GDA	Geocentric Datum of Australia
GIS	Geographical Information System
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation for Australia
INDVAL	A system of indicator taxon analysis
Ltd	Limited
MRWA	Main Roads Western Australia
m	Metre
MS-DOS	Microsoft Disk Operating System
NNB	A module within PATN that determines the nearest neighbour of a site (that it is most similar to)
PATN	Software package for pattern analysis of complex multivariate data
PC-ORD	Software package for multivariate statistical analysis of ecological communities
PEC	Priority Ecological Community
Pty	Proprietary
SCP	Swan Coastal Plain
TEC	Threatened Ecological Community

1 INTRODUCTION

Coffey Environments Australia Pty Ltd (Coffey) conducted a Level 2 assessment of flora and vegetation of Main Roads Western Australia's (MRWA) Perth–Darwin National Highway (Swan Valley Section) (the project) during spring 2014. The survey identified potential areas of the Threatened Ecological Community (TEC) SCP20a within the project's development envelope (Coffey 2015a). SCP20a (*Banksia attenuata* woodland over species rich dense shrublands) is currently listed by the Department of Parks and Wildlife (DPaW) as Endangered (EN) in accordance with criterion B ii of DEC (2010), due to a current limited known distribution, with a total area being very small with most occurrences being small and/or isolated and very vulnerable to threatening processes. This TEC is not listed under the Commonwealth legislation (*Environmental Protection and Biodiversity Protection Act 1999*).

MRWA is also investigating the suitability of a portion of land located on Ioppolo Road, Chittering (the proposed offset site) as an offset for ecological values potentially impacted by the project, including SCP20a. The DPaW have previously mapped two areas of SCP20a within this site. Coffey undertook a Level 1 assessment in winter 2014, of the proposed offset site, which inferred the potential for this TEC to be present based on relevee data collected out of the spring flowering period, however the areas mapped by Coffey were incongruous with the boundaries mapped by DPaW (Coffey Environments 2015b).

Woodman Environmental Pty Ltd (Woodman Environmental) was commissioned by Coffey to undertake a supplementary spring quadrat based survey and investigate the presence and extent of SCP20a within the proposed offset site

1.1 Aim and Objectives

The aim of the study was to confirm the presence and extent of SCP20a within the proposed offset site.

The objectives required to achieve this encompassed the following:

- Establish and assess quadrats within vegetation of the proposed offset site with species composition similar to that recorded for SCP20a (Gibson et al. 1994) (minimum of 3 quadrats depending on extent to be verified). Quadrat locations chosen in the field utilising previous mapping and data from Coffey and also DPaW, and assessing species composition on the ground.
- Combine the data with the existing DPaW data for the Swan Coastal Plain (SCP) and analyse utilising PATN and selecting multiple analysis pathways including the ALOC function within PATN.
- Interpret the analysis outputs to determine which quadrats may represent SCP20a.
- Where SCP20a confirmed to be present, map potential boundary/extent using field notes, DPaW inferred boundary information, aerial photo interpretation and GIS (Geographic Information System).

2 METHODS

2.1 Desktop/GIS Assessment

Prior to the field assessment, a number of Coffey's vegetation association polygons (Coffey 2015b) were identified to target for the SCP20a assessment. Areas which were targeted for assessment were based on:

- Limited descriptions and photographs of SCP20a provided by DPaW (DPaW 2014, Gibson *et al.* 1994).
- Communications with Jill Pryde, DPaW (pers. comm. 2015).
- Areas within Ioppolo Road which were previously mapped as SCP20a (DPaW).
- Areas identified by Coffey to be potentially representative of SCP20a on the proposed offset site (Coffey Environments 2015b).
- Review of Coffey's vegetation associations and their species composition (Coffey Environments 2015b).
- Similar areas of vegetation (to that mapped as SCP20a by DPaW and Coffey Environments) within the proposed offset site based on aerial photography interpretation.

2.2 Field Assessment

The field assessment was undertaken on the 15 – 16 of September 2015 by experienced botanists David Coultas and Alison Saligari. Table 1 lists the personnel involved in both fieldwork and plant identifications for the field survey. All personnel have had previous field experience in the Swan Coastal Plain region, with personnel involved in plant identifications having taxonomic experience with the flora of Swan Coastal Plain region. All plant material was collected under the scientific licences (pursuant to the *Wildlife Conservation Act 1950* Section 23C and Section 23F) as listed in Table 1.

Table 1: Personnel Licensing Information

Personnel	Role	Flora Collecting Permit / Permit to take T-DRF
David Coultas	Fieldwork	SL011384 / 147-1415
Bethea Loudon	Plant identifications	SL011382 / 149-1415
Alison Saligari	Fieldwork	SL011380 / 148-1415

A total of seven permanent flora survey quadrats were established within areas suspected to be representative of SCP20a, and both within and outside of polygons mapped by Coffey Environments and DPaW (Figure 1). All quadrats measured 10 m by 10 m and were marked with a fence-dropper within the north-west corner. All vascular flora taxa that were visually identifiable within each quadrat were recorded.

The following information was recorded at each quadrat:

- Personnel;
- Unique quadrat number;
- Date of survey;
- GPS (Global Positioning System) coordinates (Geocentric Datum of Australia (GDA)94);
- Site photograph;
- Topography (including landform type and aspect);
- Soil colour and type (including the presence of any rock outcropping and surface stones);
- Vegetation condition - South West Botanical Province (Keighery 1994);

- Approximate time since fire;
- Presence of disturbance (if any);
- Percentage foliage cover (for each taxon); and
- Height (metre (m)) (for each taxon, excluding climbers/aerial shrubs).

The field assessment targeted areas that had the potential to represent SCP20a (discussed in Section 2.1), by traversing areas on foot and utilising existing tracks by vehicle. Polygons which were not identified as having potential to be representative of SCP20a were not assessed. Vegetation mapping and boundaries were verified, and assessed for their potential to represent SCP20a vegetation. Ground-truthing involved the recording of waypoints and tracks using a hand-held GPS (Global Positioning System). Photographs were taken of the vegetation of areas investigated along with field notes detailing the observations at each point.

2.3 Plant Collection and Identification

Specimens of unknown taxa were collected and pressed for later identification at the Western Australian Herbarium. Identifications were undertaken by experienced senior botanist Bethea Loudon.

Taxon nomenclature generally follows *FloraBase* (DPaW 2015a) with all names checked against the current DPaW Max database to ensure their validity. However, in cases where names of plant taxa have been published recently in scientific literature but have not been adopted on *FloraBase* (DPaW 2015a), nomenclature in the published literature is followed. The conservation status of each taxon was checked against *FloraBase*, which provides the most up-to-date information regarding the conservation status of flora taxa in Western Australia. Specimens are kept in-house for reference for a period of one year after finalisation of the project.

2.4 Statistical Analysis

Classification analysis of quadrat data from the proposed offset site was conducted using seven quadrats established at the Study Area (IR-01 – IR-07), with 1098 quadrats from the updated version of the SCP dataset (Keighery *et al.* 2012).

The updated version of the SCP dataset, sourced through *NatureMap* (DPaW 2015b), contains weed and native flora quadrat data compiled between 1990 and 1996 for the southern SCP. This dataset is derived from a database that has been compiled and maintained over many years, combining the results of a number of floristic studies conducted on plant communities of the IBRA (Interim Biogeographic Regionalisation for Australia) SCP Bioregion, south of the Moore River. It includes sampling site details, the native and introduced (weed) flora collected at these sampling sites and the floristic community type (FCT) assigned to these sampling sites. The taxonomy of the flora in the database has been updated regularly as determined by Greg and Bronwen Keighery. This dataset lists the taxonomy (including family names) which was current in this database on 23 June 2005 when the dataset was compiled (DPaW 2015b).

The combined analysis consisted of 1815 vascular taxa entities. Taxa belonging to several categories were removed or altered prior to analysis, as listed below:

- Taxa that are now considered to not occur in Western Australia by the Western Australian Herbarium – such taxa were removed from the analysis due to the inability to determine their current name.

- Taxa where the recorded name is not listed on the census of Western Australian flora and a current name could not be determined.
- Taxa that are not known from the South West land division.
- Supplementary names where the genus is a known weed species were changed to reflect this status (so as not to be assessed as a native taxon).

Some taxa and infra-taxa were amalgamated where taxonomy was unclear or could not be determined in all cases. In addition, genus/species entities were combined with entities that went to subspecies or varietal level. All taxa removed and amalgamated from the classification analysis are presented in Appendix A.

Initially, the ALOC function of PATN was proposed to be used in order to “lock” the original groupings of the SCP dataset, as it has the option of "no-reallocation" of the existing classification. ALOC is a non-hierarchal classification that includes an option of matching new sites to existing classifications, and creating new classes when the new sites do not "fit". However, as there are many issues with using ALOC, including having to use MS-DOS (Microsoft Disk Operating System) to run it and difficulties in detecting real differences between existing classes and new ones (Ted Griffin pers. comm. 2015), this analysis pathway was not pursued.

With ALOC discounted as an analysis pathway, the use of OptimClass (Tichý et al. 2010) analysis was considered in order to determine the most suitable approach to classification based on the available data. OptimClass evaluates the quality of a set of different partitions of the same dataset, based on the number of taxa that are faithful to clusters of that partition. Faithful taxa are identified using the Fisher’s exact test for the right-tailed hypothesis, which is a suitable measure of statistical fidelity of taxa to clusters of quadrats (Sokal & Rohlf 1995; Chytrý *et al*. 2002). However as OptimClass runs off percent foliage cover data, this analysis was unable to be undertaken as the SCP dataset only contains presence/absence data.

Classification analysis using PATN (V3.1.2) (Belbin & Collins 2009) as used in the previous analysis by Gibson *et al.* (1994) was undertaken to analyse the dataset. Classification results of the analysis were produced as a dendrogram. The placement of the proposed offset site quadrats within the dendrogram were then reviewed, along with their relationship to quadrats from the SCP dataset that represent the TEC SCP020a. Two separate analyses were run, one containing weed species and one with weeds excluded, to see how the absence of weeds affected the placement of quadrats within the dendrogram.

Nearest neighbour analysis (NNB) was also undertaken using PATN, to determine which SCP quadrats the proposed offset site quadrats were most similar to, based on the number of species they have in common. Indicator taxon analysis (INDVAL) was then conducted using PC-Ord (McCune & Mefford 2011) using the method of Dufrene & Legendre (1997), to determine the indicator taxa for the FCT(s) of the proposed offset site quadrats and SCP20a. A Monte Carlo permutation test was used to test for the significance of the indicator taxa. Indicator taxon analysis identifies faithful taxa i.e. those species that consistently represent the FCT.

3 RESULTS

A full list of taxa recorded in quadrats from the proposed offset site is presented in Appendix B, with raw quadrat and detailed site data presented in Appendix C. A total of 194 taxa were recorded, including 13 weed species. Average species richness per quadrat was 49.6. The vegetation of the proposed offset site was in Excellent to Pristine condition (Appendix C).

The Study Area quadrats consist of the following vegetation:

- IR-01 – Low open woodland of *Corymbia calophylla*, *Banksia attenuata* and *B. grandis* over mid open shrubland of *Allocasuarina humilis* and *Xanthorrhoea preissii* over low open shrubland of *Calothamnus sanguineus*, *Eremaea pauciflora* and *Hibbertia hypericoides* over low open rushland of *Mesomelaena pseudostygia.*
- IR-02 – Low woodland of *C. calophylla* and *Eucalyptus marginata* over tall isolated clumps of shrubs of *Adenanthos cygnorum* subsp. *cygnorum* over mid isolated clumps of shrubs of *Stirlingia latifolia* over low open shrubland of *Astroloma xerophyllum*, *H. hypericoides* and *Leucopogon conostephiodies* over low open rushland of *M. pseudostygia.*
- IR-03 – Low woodland of *E. marginata* over mid sparse shrubland *Macrozamia fraseri* and *X. preisii* over low open shrubland of *Conostephium pendulum*, *H. hypericoides* and *L. conostephiodies.*
- IR-04 – Tall shrubland of *Jacksonia sternbergiana* and *X. preisii* over mid open shrubland of *A. humilis* and *Chamelaucium* sp. Gingin (N.G. Marchant 6).
- IR-05 – Low woodland of *E. marginata* over mid isolated clumps of shrubs of *X. preisii* over low open shrubland of *Banksia dallanneyi* subsp. *dallanneyi* and *H. hypericoides* over low open rushland of *M. pseudostygia*.
- IR-06 – Low woodland of *E. marginata* over mid sparse shrubland of *X. preisii* over low open shrubland of *A. xerophyllum* and *H. hypericoides* over low isolated clumps of herbs of *Patersonia occidentalis* over low isolated clumps of rushes of *M. pseudostygia.*
- IR-07 – Low open woodland of *Eucalyptus todtiana*, *B. attenuata* and *B. menziesii* over mid sparse shrubland of *A. humilis* and *X. preissii* over low open shrubland of *E. pauciflora*, *H. hypericoides* and *Melaleuca trichophylla* over low open rushland of *M. pseudostygia*.

The section of the dendrogram (analysis with weeds included) in which the SCP20a and proposed offset site quadrats occurred is presented in Appendix D. Examination of the classification dendrogram found that the proposed offset site quadrats grouped in close association with quadrats representing SCP28; quadrats from SCP20a (and 20b and 20c) were represented on adjacent arms of the dendrogram, indicating a lower level of similarity between these quadrats and those within the proposed offset site. The results of nearest neighbour analysis found that the individual quadrats of the proposed offset site had the most species in common with quadrats representing various SCP FCTs, including SCP20a (quadrats IR-01, IR-05), SCP21a (quadrat IR-03), SCP23a (quadrat IR-04), SCP23b (quadrats IR-02, IR-07) and SCP28 (quadrat IR-06) of the SCP dataset (Keighery *et al.* 2012) (Appendix E). However this analysis is less conclusive as it does not take into account indicator taxa for each group.

Descriptions of these various FCTS are as follows (Gibson *et al.* 1994):

SCP20a: *Banksia attenuata* woodlands over species rich dense shrublands (originally documented as having a mean species richness of 67.4);
SCP21a: Central *Banksia attenuata-Eucalyptus marginata* woodlands (54.6);
SCP23a: Central *Banksia attenuata-B. menziesii* woodlands (62.8);
SCP23b: Northern *Banksia attenuata-B. menziesii* woodlands (53.8); and

SCP28: Spearwood *Banksia attenuata* or *Banksia attenuata-Eucalyptus* woodlands (55.2)

SCP20a is a TEC, and SCP23b is a Priority Ecological Community (PEC), as listed by DPaW. The remaining communities are not considered to be threatened (DPaW 2015c; 2015d).

Indicator species analysis showed that the following species are faithful taxa to each of the FCTs listed above (Appendix F) (with p <0.001):

- SCP20a – *Alexgeorgea nitens*; *Bossiaea eriocarpa*; *Burchardia congesta*; *Conospermum undulatum*; *Hibbertia huegelii*; *Hibbertia hypericoides*; *Mesomelaena pseudostygia*; *Stirlingia latifolia;*
- SCP21a – No indicator taxa recognised;
- SCP23a – *Banksia menziesii*; *Gompholobium tomentosum*; *Lomandra hermaphrodita*; *Patersonia occidentalis*;
- SCP23b – *Banksia attenuata*; *Eremaea pauciflora*; and
- SCP28 – No indicator taxa recognised.

Typical species of these FCTs include (Gibson *et al.* 1994):

- SCP20a – *B. attenuata*, *Bossiaea eriocarpa*, *Conostephium pendulum, Hibbertia huegelii, H. hypericoides, Petrophile linearis, Scaevola repens* subsp. *repens, S. latifolia*.
- SCP21a – *B. attenuata*, *B. eriocarpa*, *Gompholobium tomentosum, H. hypericoides, P. linearis*.
- SCP23a – *B. attenuata*, *B. menziesii*, *B. eriocarpa*, *G. tomentosum, P. linearis, Scholtzia involucrata*.
- SCP23b – *B. attenuata*, *B. menziesii*, *B. eriocarpa*, *Calytrix flavescens, E. pauciflora, Philotheca spicata, Hibbertia subvaginata, Jacksonia floribunda, P. linearis, S. involucrata.*
- SCP28 – *B. attenuata*, *H. hypericoides*, *Desmocladus flexuosus*, *M. pseudostygia*.

Removal of weed species from the analysis (second analysis dendrogram not presented) had the effect of grouping the proposed offset site quadrats with quadrats representing SCP23c and SCP28, with no variation in the placement of these quadrats and their proximity to SCP20a quadrats. SCP23c is a supplementary FCT that was created following a revised analysis of the updated SCP dataset with data from surveys subsequent to the original SCP dataset of Gibson *et al.* (1994). Any quadrats that did not fit within the descriptions of the original FCTs were added as Supplementary Types. SCP23c is described as North-eastern *Banksia attenuata-B. menziesii* woodlands and is not considered to be threatened. No published documentation exists for SCP23c (Val English, pers. comm. 2015).

4 DISCUSSION

The results of the analysis of the proposed offset site quadrats indicates that understorey species strongly influence the outcomes, almost to the exclusion of the dominant tree layer. This is evident particularly in quadrat IR-05 where *B. attenuata* is absent and the community is dominated by *E. marginata*.

Analysis of the Study Area quadrats with the SCP data was conducted with weeds retained in the dataset in order to replicate the original SCP analysis parameter and provide an initial indication of relationship between the Study Area quadrats and the larger regional dataset. This analysis was then repeated with the weeds removed to minimise any effects of gradients in weed invasion patterns on the SCP and provide clarification of relationships between quadrats based solely on native species composition. These gradients, related to surrounding landuses climatic factors and

available vectors of weed invasion have the potential to affect grouping of quadrats based on vegetation condition and weed presence rather than native species composition.

The vegetation of the proposed offset site was found to be most closely related to FCT SCP28 in both analyses, a common vegetation community of the SCP. The second analysis excluding weeds identified a close relationship between the proposed offset site quadrats and both SCP 28 and also SCP23c. The grouping with SCP23c in the second analysis (in the absence of weeds), would indicate that the original quadrats assessed as SCP23a (Gibson et al. 1994) were potentially located in areas of elevated weed presence.

The quadrats from the proposed offset site occurred in the same supergroup as SCP20a within both analyses however were situated on separate branches within the same subgroup, with reasonable separation between these branches. The average species richness of the proposed offset site quadrats (49.6) was reasonably lower than the SCP20a quadrats (67.4) indicating that the proposed offset site quadrats are unlikely to represent FCT SCP 20a (*Banksia attenuata* woodland over **species rich** dense shrublands).

Although SCP20a was previously indicated as occurring within the proposed offset site by DPaW, the current analysis indicates that the vegetation within the proposed offset site has a closer relationship with SCP28 and a less close relationship with existing SCP20a quadrats in the SCP dataset. Although the use of near neighbour analysis, which does not take into account any assessment of faithful taxa, indicates that quadrats IR-01 (which correlates to the indicative SCP20a polygon mapped by DPaW) and IR-05 show some affiliation with SCP20a, the dendrogram result from the PATN analysis show they are most closely related to SCP28 which is considered to be well reserved and not of any conservation significance.

The historical quadrats at Ioppolo Road, used by DPaW to originally indicate the presence of SCP20a are not contained in the updated SCP dataset (Keighery *et al.* 2012) and were not used in the Bushforever analysis used to determine supplementary FCTs to those originally published for the Swan Coastal Plain by Gibson *et al.* (1994). Although there are similarities between vegetation of the proposed offset site and SCP20a based on the nearest neighbour results, when all the current data is utilised, the vegetation of the proposed offset site is demonstrated to not be closely related to SCP20a and is most likely to represent SCP28. As a result of this analysis it is recommended that the potential presence of SCP20a at Ioppolo Road be reviewed by DPaW.

In conclusion, the vegetation of the proposed offset site (the vegetation of Ioppolo Road sampled during this study) that were considered to be SCP20a based on the 2014 survey (Coffey Environments 2015a), is not representative of SCP20a as indicated by this study. Confusion or uncertainty around allocating new quadrats to existing FCTs from the original Swan Coastal Plain analysis (Gibson *et al.* 1994) arises from the requirement by DPaW to maintain results of historical floristic analyses (and FCTs) which may be inappropriate in the context of more recent data and analysis findings.

5 REFERENCES

Belbin. L. and Collins, A. (2009)
PATN. Blatant Fabrications Pty Ltd.

Chytrý, M., Tichý, L., Holt, J. and Botta-Dukát, Z. (2002)
Determination of diagnostic species with statistical fidelity measures. *Journal of Vegetation Science* 13 (1): 79-90.

Coffey Environments (2015a)
Level 2 Flora and Vegetation Assessment, Perth – Darwin National Highway. Unpublished report prepared for Main Roads Western Australia, Doc No. NLWA-03-EN-RP-0016 (Rev 1), 29 May 2015.

Coffey Environments (2015b)
Flora, Vegetation and Fauna Assessment, Perth – Lot M2091 Ioppolo Road, Chittering. Unpublished report prepared for Main Roads Western Australia, Doc No. NLWA-00-EN-RP-0009 (Rev 0), 15 April 2015.

Department of Environment and Conservation 2010
Definitions, Categories and Criteria for Threatened and Priority Ecological Communities. Department of Environment and Conservation December 2010

Department of Parks and Wildlife (2014)
Banksia Woodlands. PowerPoint presentation – Val English, March 2014, Available: http://www.bushlandperth.org.au/images/stories/banksias/banksiawoodlandsve_5march2014final_pdf.pdf.

Department of Parks and Wildlife (2015a)
FloraBase. Available: http://florabase.dpaw.wa.gov.au. Sourced October 2015

Department of Parks and Wildlife (2015b)
NatureMap. Available: http://naturemap.dpaw.wa.gov.au. Sourced October 2015

Department of Parks and Wildlife (2015c)
Priority Ecological Communities for Western Australia Version 22. Species and Communities Branch, Department of Parks and Wildlife (Correct to 6 June 2015). Available: http://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Priority_ecological_communities_list.pdf

Department of Parks and Wildlife (2015d)
List of Threatened Ecological Communities endorsed by the Western Australian Minister for the Environment. Species and Communities Branch, Department of Parks and Wildlife (Correct to 25 June 2015). Available: http://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Threatened_ecological_communities_list.pdf

Dufrene, M. and Legendre, P. (1997)
Species Assemblages and Indicator Species: The need for a flexible asymmetrical approach. In: *Ecological Monographs* 67: 345-366.

English, V. (2015)
Species and Communities Branch, Department of Parks and Wildlife. Personal communication via email 14 October 2015.

Gibson N., Keighery B.J., Keighery G.J., Burbidge A.H. & Lyons M.N. (1994)
A floristic survey of the southern Swan Coastal Plain. Unpublished report prepared by Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc.), July 1994.

Griffin E. A. (Ted) (2015)
Consultant Botanist (numerical analyses, report writing). Personal communication via email 5 October 2015.

Keighery, B.J. (1994)
Bushland Plant Survey: a Guide to Plant Community Survey for the Community. Wildflower Society of WA (Inc.), Nedlands, Western Australia.

Keighery, B., Keighery, G., Longman, V.M., and Clarke, K.A. (2012)
Swan Coastal Plain Survey Dataset. Updated version (Version 6), compiled and edited for the Departments of Environmental Protection and Conservation and Land Management.

McCune, B. and Mefford, M.J. (2011)
PC-Ord. Multivariate Analysis of Ecological Data, Version 6.08. MjM Software, Gleneden Beach, Oregon U.S.A.

Sokal, R.R. and Rohlf, F.J. (1995)
Biometry: The Principles and Practice of Statistics in Biological Research, 3rd ed. W.H. Freeman, New York.

Tichý, L., Chytrý, M., Hájek, M., Talbot, S.S. & Botta-Dukát, Z. (2010)
OptimClass: Using species-to-cluster fidelity to determine the optimal partition in classification of ecological communities. *Journal of Vegetation Science* 21: 287–290.

Pryde, J. (2015)
Species and Communities branch, Department of Parks and Wildlife. Personal communication via phone conversation, 15 September 2015.

403000 404000 405000 406000

6518000 6517000 6516000 6515000 6514000 6513000

IR-04 IR-03 IR-02 IR-07 IR-01 IR-06 IR-05

BaBmNf BaBm2 BaBmNf Em2 EmCc1 Em2 Em3 CcEm Et BaBm1 Em BaBmNf Em4 Cc2 Et EtNf Et Em BaBmNf Em4 EtNf Cc3 EmCc2 Em3 Em3 BaBmNf CcEm Cc1 Et EtNf Cc1 EmCc1 Ba

Legend

- WEC Quadrat Locations
- Property Boundary
- Coffey Environments Vegetation Associations
- Coffey Environments SCP20a Boundary
- Dept of Parks & Wildlife SCP20a Boundary

403000 404000 405000 406000

WOODMAN ENVIRONMENTAL

N

This map should only be used in conjunction with WEC report Coffey15-28-03

Perth-Darwin National Highway (Swan Valley Section) Assessment of the Presence of TEC SCP20a at Ioppolo Road, Chittering

Revision: 0 - 25 November 2015

Author: Bethea Loudon

WEC Ref: Coffey15-28

Filename: Coffey15-28-Scope-3.mxd

Scale: 1:16,000 (A3) Grid: MGA Zone 50

Figure

1

403000 404000 405000 406000

6518000 6517000 6516000 6515000 6514000 6513000

IR-04 IR-03 IR-02 IR-01 IR-05 IR-06 IR-07

BaBmNf BaBm2 BaBmNf Em2 EmCc1 Em2 Em3 CcEm Et Em3 BaBm1 Em BaBmNf IR-07

Cc2 Em4 IR-06

Et EtNf Et Em BaBmNf Em4 EtNf Cc3 EmCc2

Em3 Em3 BaBmNf CcEm Cc1 Et EtNf Cc1 Ba EmCc1

403000 404000 405000 406000

Legend

- WEC Quadrat Locations
- Property Boundary
- Coffey Environments Vegetation Associations
- Dept of Parks & Wildlife SCP20a Boundary
- Potential Additional Area of SCP20a

WOODMAN ENVIRONMENTAL

N

This map should only be used in conjunction with WEC report Coffey15-28-03

Perth-Darwin National Highway (Swan Valley Section) Assessment of the Presence of TEC SCP20a at Ioppolo Road, Chittering

Revision: 0 - 25 November 2015

Author: Bethea Loudon

WEC Ref: Coffey15-28

Filename: Coffey15-28-Scope-3.mxd

Scale: 1:16,000 (A3) Grid: MGA Zone 50

Figure

2

Appendix A: Vascular Plant Taxa Amalgamated and Omitted During Statistical Analysis

Taxon	Amalgamation/Deletion
Acacia lasiocarpa	Amalgamated
Acacia lasiocarpa var. *bracteolata* long peduncle variant (G.J. Keighery 5026) (P1)	
Acacia lasiocarpa var. *lasiocarpa*	
Acacia lasiocarpa (Pinjarra form) (BJ Keighery 2230)	
Acacia pulchella	Amalgamated
Acacia pulchella var. *glaberrima*	
Acacia pulchella var. *glaberrima* (Variant 2) (GJ Keighery 9188)	
Acacia pulchella var. *pulchella*	
Acacia pulchella var. *reflexa*	
Anigozanthos manglesii	Amalgamated
Anigozanthos manglesii subsp. *manglesii*	
Austrodanthonia acerosa	Amalgamated
Rytidosperma acerosum	
Banksia dallanneyi var. *dallanneyi*	Amalgamated
Dryandra lindleyana	
Billardiera ?fraseri	Amalgamated
Pronaya fraseri	
Boronia ramosa	Amalgamated
Boronia ramosa subsp. *anethifolia*	
Boronia ramosa subsp. *ramosa*	
Caladenia flava	Amalgamated
Caladenia flava subsp. *flava*	
Conostylis aculeata	Amalgamated
Conostylis aculeata subsp. *aculeata*	
Conostylis aculeata subsp. *breviflora*	
Conostylis aculeata subsp. *bromelioides*	
Conostylis aculeata subsp. *cygnorum*	
Conostylis aculeata subsp. *preissii*	
Conostylis crassinervia subsp. *crassinervia*	
Drosera erythrorhiza	Amalgamated
Drosera erythrorhiza subsp. *erythrorhiza*	
Drosera erythrorhiza subsp. *magna*	
Drosera erythrorhiza subsp. *squamosa*	
Drosera menziesii	Amalgamated
Drosera menziesii subsp. *menziesii*	
Drosera menziesii subsp. *penicillaris*	
Epilobium billardiereanum	Amalgamated

Taxon	Amalgamation/Deletion
Eremaea asterocarpa	Amalgamated
Eremaea asterocarpa subsp. *asterocarpa*	
Eremaea pauciflora	Amalgamated
Eremaea pauciflora var. *pauciflora*	
Eremophila glabra	Amalgamated
Eremophila glabra subsp. *albicans*	
Isolepis cernua	Amalgamated
Isolepis setiformis	
Jacksonia decumbens	Amalgamated
Jacksonia floribunda	
Lepidobolus preissianus	Amalgamated
Lepidobolus preissianus subsp. *preissianus*	
Lomandra micrantha	Amalgamated
Lomandra micrantha subsp. *micrantha*	
Melaleuca incana subsp. *incana*	Amalgamated
Melaleuca polygaloides	
Melaleuca systena	Amalgamated
Melaleuca sp. Yanchep (G.J. Keighery 11242)	
Melaleuca thymoides	Amalgamated – *M. thyoides* not found in Perth
Melaleuca thyoides	
Myriocephalus isoetes	Amalgamated
Myriocephalus rhizocephalus	
Myriocephalus occidentalis	
Orobanche australiana	Amalgamated
Orobanche minor	
Patersonia occidentalis	Amalgamated
Patersonia occidentalis var. *occidentalis*	
Pericalymma ellipticum	Amalgamated
Pericalymma ellipticum var. *floridum*	
Platysace juncea	Amalgamated
Platysace teres	
Pterostylis nana	Amalgamated
Pterostylis pyramidalis	
Pterostylis vittata	Amalgamated
Pterostylis ?vittata	
Romulea rosea	Amalgamated
Romulea rosea var. *australis*	
**Silene gallica*	Amalgamated
**Silene gallica* var. *gallica*	
Stylidium araeophyllum	Amalgamated
Stylidium ?araeophyllum	

Taxon	Amalgamation/Deletion
Stylidium calcaratum	Amalgamated
Stylidium mimeticum	
Stylidium piliferum	Amalgamated
Stylidium piliferum subsp. *piliferum*	
Stylidium saxifragoides	
Stylidium rigidifolium	Amalgamated
Stylidium striatum	
Synaphea petiolaris	Amalgamated
Synaphea petiolaris subsp. *petiolaris*	
Tribonanthes longipetala	Amalgamated
Tribonanthes uniflora	
Triglochin muelleri subsp. *muelleri*	Amalgamated
Triglochin muelleri subsp. *recurvum*	
Verticordia plumosa var. *brachyphylla*	Amalgamated
Verticordia plumosa var. *pleiobotrya*	
Vicia sativa	Amalgamated
Vicia sativa subsp. *sativa*	
Xanthosia huegelii	Amalgamated
Xanthosia huegelii subsp. *huegelii*	
Xanthosia pusilla	
**Pseudognaphalium luteoalbum*	Name changed to *Helichrysum luteoalbum* in dataset
Mentha x spicata	Status changed from native to introduced
Verbascum sp.	Status changed from native to introduced
Vulpia sp.	Status changed from native to introduced
Cassytha sp.	Deleted – insufficient material for identification
Grevillea sp.	Deleted – insufficient material for identification
Haemodorum sp.	Deleted – insufficient material for identification
Lepidosperma sp.	Deleted – insufficient material for identification
Marianthus parviflora	Deleted – invalid name
Polymeria sericea	Deleted – invalid name
Prasophyllum sp.	Deleted – insufficient material for identification
Psoralea aff. *graveolens*	Deleted – invalid name
Schoenus brevifolius	Deleted – excluded name
Thelymitra pauciflora	Deleted – excluded name
?*Tricoryne elatior*	Deleted – insufficient material for identification
Triglochin incurva	Deleted – invalid name
Veronica sp.	Deleted – insufficient material for identification
Veronica stolonifera	Deleted – invalid name

Appendix B: Vascular Plant Taxa Recorded in the Proposed Offset Site

Anarthriaceae

Lyginia imberbis

Apiaceae

Xanthosia huegelii

Araliaceae

Trachymene pilosa

Asparagaceae

Laxmannia grandiflora subsp. *grandiflora*
Lomandra caespitosa
Lomandra hermaphrodita
Lomandra preissii
Lomandra sericea
Sowerbaea laxiflora
Thysanotus dichotomus
Thysanotus manglesianus
Thysanotus sparteus

Asteraceae

Brachyscome iberidifolia
**Hypochaeris glabra*
Millotia tenuifolia var. *laevis*
Podotheca gnaphalioides
**Ursinia anthemoides*

Casuarinaceae

Allocasuarina humilis

Celastraceae

Stackhousia monogyna
Tripterococcus brunonis

Colchicaceae

Burchardia congesta

Cyperaceae

Caustis dioica
Lepidosperma pubisquameum
Lepidosperma sp.
Lepidosperma squamatum
Mesomelaena pseudostygia
Tetraria octandra

Dasypogonaceae

Calectasia narragara

Dilleniaceae

Hibbertia hibbertioides var. *hibbertioides*
Hibbertia huegelii
Hibbertia hypericoides
Hibbertia sericosepala
Hibbertia subvaginata

Droseraceae

Drosera erythrorhiza
Drosera menziesii
Drosera pallida

Elaeocarpaceae

Tetratheca nuda

Ericaceae

Astroloma pallidum
Astroloma xerophyllum
Conostephium minus
Conostephium pendulum
Leucopogon conostephioides
Leucopogon sp. D Perth Flora (aff. polymorphus)
Leucopogon sp. Murdoch (M. Hislop 1037)

Fabaceae

Acacia applanata
Acacia pulchella
Acacia sessilis
Bossiaea eriocarpa
Daviesia incrassata subsp. *incrassata*
Gastrolobium capitatum
Gompholobium knightianum
Gompholobium marginatum

Fabaceae (cont.)

Gompholobium tomentosum
Hovea trisperma
Isotropis cuneifolia
Jacksonia floribunda
Jacksonia sternbergiana
Sphaerolobium medium

Goodeniaceae

Dampiera linearis
Scaevola canescens

Haemodoraceae

Anigozanthos humilis subsp. *humilis*
Anigozanthos manglesii
Conostylis aculeata subsp. *aculeata*
Conostylis aurea
Conostylis juncea
Conostylis setigera subsp. *setigera*
Conostylis teretifolia subsp. *teretifolia*
Haemodorum laxum
Haemodorum sp.

Hemerocallidaceae

Johnsonia pubescens subsp. *pubescens*
Tricoryne elatior
?*Tricoryne elatior*

Iridaceae

**Gladiolus caryophyllaceus*
Patersonia juncea
Patersonia occidentalis var. *occidentalis*

Lauraceae

Cassytha flava

Loganiaceae

Phyllangium divergens

Myrtaceae

Calothamnus sanguineus
Calytrix flavescens
Calytrix sylvana

Myrtaceae (cont.)

Chamelaucium sp. Gingin (N.G. Marchant 6)
Corymbia calophylla
Eremaea pauciflora
Eucalyptus marginata
Eucalyptus todtiana
Hypocalymma xanthopetalum
Melaleuca trichophylla

Orchidaceae

Caladenia flava
Elythranthera brunonis
Leporella fimbriata
Prasophyllum sp.
Pterostylis recurva
Pterostylis sp. short sepals (W. Jackson BJ259)
Pterostylis ?*vittata*

Phyllanthaceae

Phyllanthus calycinus

Poaceae

Amphipogon turbinatus
**Briza maxima*
Neurachne alopecuroidea

Proteaceae

Adenanthos cygnorum subsp. *cygnorum*
Banksia attenuata
Banksia dallanneyi var. *dallanneyi*
Banksia grandis
Banksia menziesii
Grevillea pilulifera
Hakea ruscifolia
Persoonia saccata
Petrophile linearis
Petrophile macrostachya
Stirlingia latifolia
Synaphea spinulosa subsp. *spinulosa*

Restionaceae

Alexgeorgea nitens
Desmocladus fasciculatus
Desmocladus flexuosus
Hypolaena exsulca
Lepidobolus preissianus subsp. *preissianus*

Rutaceae

Boronia ramosa
Philotheca spicata

Stylidiaceae

Stylidium albolilacinum
Stylidium ?*araeophyllum*
Stylidium cygnorum
Stylidium ?*diuroides*
Stylidium eriopodum
Stylidium neurophyllum ms
Stylidium piliferum
Stylidium repens
Stylidium schoenoides

Violaceae

Hybanthus calycinus
Hybanthus floribundus subsp. *floribundus*

Xanthorrhoeaceae

Xanthorrhoea preissii

Zamiaceae

Macrozamia fraseri

Total number of taxa: 128 (includes 124 native taxa)

Note: * indicates introduced (weed) taxa

Appendix C: Raw Data Recorded within Quadrats in the Proposed Offset Site

Site Name:	IR-01 (Woodman Environmental)
Site Type:	QUADRAT
Dimensions:	10m x 10m
Survey Date:	15/09/2015
GPS Location:	GDA94 Zone 50 404737E 6516405N
Landform Type:	Upper Slope
Slope Class:	Level (0 degrees)
Soil Type:	Sand
Soil Colour:	Yellow
Rock Outcrop:	No bedrock exposed
Vegetation Condition:	1 - Pristine
Disturbance:	Dieback
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia applanata		0.1
Acacia sessilis		0.1
Alexgeorgea nitens		0.1
Allocasuarina humilis	1.6	2
Amphipogon turbinatus		0.1
Anigozanthos humilis subsp. *humilis*		0.1
Astroloma pallidum		0.1
Banksia attenuata	4	2
Banksia grandis	1	2
Billardiera ?fraseri		0.1
Bossiaea eriocarpa		0.1
Burchardia congesta		0.1
Calectasia narragara		0.1
Calothamnus sanguineus	0.4	8
Calytrix sylvana		0.1
Cassytha flava		0.1
Conostephium pendulum		0.1
Conostylis aculeata subsp. *aculeata*		0.1
Conostylis aurea		0.1

Conostylis setigera subsp. *setigera*		0.1
Corymbia calophylla	4	2
Desmocladus fasciculatus		0.1
Desmocladus flexuosus		0.1
Drosera erythrorhiza		0.1
Drosera menziesii		0.1
Elythranthera brunonis		0.1
Eremaea pauciflora	0.6	6
**Gladiolus caryophyllaceus*		0.1
Gompholobium knightianum		0.1
Haemodorum sp.		0.1
Hakea ruscifolia		0.1
Hibbertia huegelii		0.1
Hibbertia hypericoides	0.5	15
Hibbertia sericosepala		0.1
Hibbertia subvaginata		0.1
Hovea trisperma		0.1
**Hypochaeris glabra*		0.1
Hypolaena exsulca		0.1
Jacksonia floribunda		0.1
Lepidosperma sp.		0.1
Leucopogon sp. D Perth Flora (aff. *polymorphus*)		0.1
Lomandra hermaphrodita		0.1
Mesomelaena pseudostygia	0.4	15
Millotia tenuifolia var. *laevis*		0.1
Patersonia occidentalis var. *occidentalis*		0.1
Petrophile linearis		0.1
Philotheca spicata		0.1
Phyllangium divergens		0.1
Prasophyllum sp.		0.1
Pterostylis recurva		0.1
Scaevola canescens		0.1
Sphaerolobium medium		0.1
Stirlingia latifolia	0.4	1
Stylidium cygnorum		0.1
Stylidium ?diuroides		0.1
Synaphea spinulosa subsp. *spinulosa*		0.1
Tetraria octandra		0.1
Tetratheca nuda		0.1
Thysanotus sparteus		0.1
Trachymene pilosa		0.1
?Tricoryne elatior		0.1
Xanthorrhoea preissii	1.5	8

Xanthosia huegelii		0.1

PHOTO



Site Name:	IR-02 (Woodman Environmental)
Site Type:	QUADRAT
Dimensions:	10m x 10m
Survey Date:	15/09/2015
GPS Location:	GDA94 Zone 50 404824E 6517258N
Landform Type:	Upper Slope
Slope Class:	Gently Inclined (3 degrees)
Soil Type:	Sand
Soil Colour:	Yellow
Rock Outcrop:	No bedrock exposed
Vegetation Condition:	1 - Pristine
Disturbance:	Dieback
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia applanata		0.1
Adenanthos cygnorum subsp. *cygnorum*	3	5
Alexgeorgea nitens		0.1
Anigozanthos humilis subsp. *humilis*		0.1
Astroloma pallidum		0.1
Astroloma xerophyllum	0.5	3
Boronia ramosa		0.1
Bossiaea eriocarpa		0.1
Burchardia congesta		0.1
Caladenia flava		0.1
Calothamnus sanguineus		0.1
Calytrix flavescens		0.1
Calytrix sylvana		0.1
Cassytha flava		0.1
Conostephium minus		0.1
Conostephium pendulum		0.1
Conostylis aurea		0.1
Conostylis juncea		0.1
Conostylis setigera subsp. *setigera*		0.1
Corymbia calophylla	6	1
Daviesia incrassata subsp. *incrassata*		0.1
Desmocladus fasciculatus		0.1

Desmocladus flexuosus		0.1
Drosera erythrorhiza		0.1
Drosera menziesii		0.1
Eucalyptus marginata	10	15
Gompholobium knightianum		0.1
Haemodorum sp.		0.1
Hibbertia huegelii		0.1
Hibbertia hypericoides	0.5	20
Hibbertia subvaginata		0.1
Hypocalymma xanthopetalum		0.1
Hypolaena exsulca		0.1
Isotropis cuneifolia		0.1
Jacksonia floribunda		0.1
Johnsonia pubescens subsp. *pubescens*		0.1
Lepidosperma sp.		0.1
Leporella fimbriata		0.1
Leucopogon conostephioides	0.5	3
Leucopogon sp. D Perth Flora (aff. *polymorphus*)		0.1
Lomandra hermaphrodita		0.1
Lomandra sericea		0.1
Lyginia imberbis		0.1
Mesomelaena pseudostygia	0.4	10
Millotia tenuifolia var. *laevis*		0.1
Neurachne alopecuroidea		0.1
Patersonia occidentalis var. *occidentalis*		0.1
Petrophile linearis		0.1
Philotheca spicata		0.1
Stirlingia latifolia	0.7	3
Stylidium ?araeophyllum		0.1
Stylidium cygnorum		0.1
Stylidium eriopodum		0.1
Stylidium piliferum		0.1
Stylidium repens		0.1
Synaphea spinulosa subsp. *spinulosa*		0.1
Tetraria octandra		0.1
Trachymene pilosa		0.1
**Ursinia anthemoides*		0.1
Xanthorrhoea preissii		0.1
Xanthosia huegelii		0.1

PHOTO



Site Name:	IR-03 (Woodman Environmental)
Site Type:	QUADRAT
Dimensions:	10m x 10m
Survey Date:	15/09/2015
GPS Location:	GDA94 Zone 50 403382E 6517157N
Landform Type:	Mid Slope
Slope Class:	Moderately Inclined (10 degrees)
Aspect:	NW
Soil Type:	Sand
Soil Colour:	Grey
Rock Outcrop:	No bedrock exposed
Vegetation Condition:	2 - Excellent
Disturbance:	Historical logging
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Alexgeorgea nitens		0.1
Bossiaea eriocarpa		0.1
Brachyscome iberidifolia		0.1
Caladenia flava		0.1
Calytrix flavescens		0.1
Conostephium minus		0.1
Conostephium pendulum	0.5	2
Conostylis aculeata subsp. *aculeata*		0.1
Desmocladus flexuosus		0.1
Drosera pallida		0.1
Eucalyptus marginata	8	10
Gompholobium tomentosum		0.1
Hibbertia hypericoides	0.5	20
Hibbertia subvaginata		0.1
**Hypochaeris glabra*		0.1
Leucopogon conostephioides	0.5	2
Lomandra caespitosa		0.1
Lomandra hermaphrodita		0.1
Lomandra preissii		0.1
Lyginia imberbis		0.1
Macrozamia fraseri	1.5	3

Patersonia occidentalis var. *occidentalis*		0.1
Persoonia saccata		0.1
Phyllanthus calycinus		0.1
Pterostylis ?vittata		0.1
Sowerbaea laxiflora		0.1
Stylidium neurophyllum ms		0.1
Stylidium schoenoides		0.1
Synaphea spinulosa subsp. *spinulosa*		0.1
Thysanotus manglesianus		0.1
**Ursinia anthemoides*		0.1
Xanthorrhoea preissii	1.5	4

PHOTO



Site Name:	IR-04 (Woodman Environmental)
Site Type:	QUADRAT
Dimensions:	10m x 10m
Survey Date:	15/09/2015
GPS Location:	GDA94 Zone 50 402244E 6517396N
Landform Type:	Mid Slope
Slope Class:	Gently Inclined (3 degrees)
Aspect:	S
Soil Type:	Sand
Soil Colour:	Yellow/Orange (other)
Rock Outcrop:	No bedrock exposed
Vegetation Condition:	2 - Excellent
Disturbance:	Exotic weeds, possible historical ground disturbance
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia sessilis		0.1
Allocasuarina humilis	2	10
Anigozanthos humilis subsp. *humilis*		0.1
Boronia ramosa		0.1
Bossiaea eriocarpa		0.1
Brachyscome iberidifolia		0.1
**Briza maxima*		0.1
Caladenia flava		0.1
Calectasia narragara		0.1
Caustis dioica		0.1
Chamelaucium sp. Gingin (N.G. Marchant 6) (T-DRF)	1.5	20
Conostephium pendulum		0.1
Desmocladus flexuosus		0.1
Hibbertia hibbertioides var. *hibbertioides*		0.1
Hibbertia huegelii		0.1
Hibbertia hypericoides		0.1
Hybanthus calycinus		0.1
**Hypochaeris glabra*	0.1	15
Jacksonia sternbergiana	4	40
Laxmannia grandiflora subsp. *grandiflora*		0.1

Lepidobolus preissianus subsp. *preissianus*		0.1
Lomandra caespitosa		0.1
Lomandra hermaphrodita		0.1
Macrozamia fraseri		0.1
Mesomelaena pseudostygia		0.1
Patersonia occidentalis var. *occidentalis*		0.1
Phyllangium divergens		0.1
Phyllanthus calycinus		0.1
Podotheca gnaphalioides		0.1
Pterostylis sp. short sepals (W. Jackson BJ259)		0.1
Sowerbaea laxiflora		0.1
Stackhousia monogyna		0.1
Stylidium neurophyllum ms		0.1
Thysanotus manglesianus		0.1
Trachymene pilosa		0.1
**Ursinia anthemoides*		0.1
Xanthorrhoea preissii	2.5	8

PHOTO



Site Name:	IR-05 (Woodman Environmental)
Site Type:	QUADRAT
Dimensions:	10m x 10m
Survey Date:	15/09/2015
GPS Location:	GDA94 Zone 50 404933E 6515803N
Landform Type:	Dune Crest
Slope Class:	Level (0 degrees)
Soil Type:	Sand
Soil Colour:	Yellow
Rock Outcrop:	No bedrock exposed
Vegetation Condition:	1 - Pristine
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia applanata		0.1
Alexgeorgea nitens		0.1
Astroloma pallidum		0.1
Banksia dallanneyi var. *dallanneyi*	0.2	2
Bossiaea eriocarpa		0.1
Burchardia congesta		0.1
Calectasia narragara		0.1
Calytrix flavescens		0.1
Calytrix sylvana		0.1
Conostephium pendulum	0.4	3
Conostylis aurea		0.1
Conostylis setigera subsp. *setigera*		0.1
Daviesia incrassata subsp. *incrassata*		0.1
Drosera erythrorhiza		0.1
Drosera pallida		0.1
Eucalyptus marginata	10	20
Gastrolobium capitatum		0.1
**Gladiolus caryophyllaceus*		0.1
Gompholobium knightianum		0.1
Gompholobium marginatum		0.1
Grevillea pilulifera		0.1
Haemodorum sp.		0.1
Hibbertia huegelii		0.1
Hibbertia hypericoides	0.5	25

Hibbertia subvaginata		0.1
Hovea trisperma		0.1
Lepidobolus preissianus subsp. *preissianus*		0.1
Lepidosperma pubisquameum		0.1
Leucopogon sp. D Perth Flora (aff. polymorphus)		0.1
Lomandra hermaphrodita		0.1
Lomandra sericea		0.1
Mesomelaena pseudostygia	0.4	15
Patersonia occidentalis var. *occidentalis*		0.1
Petrophile linearis		0.1
Philotheca spicata		0.1
Scaevola canescens		0.1
Stirlingia latifolia		0.1
Synaphea spinulosa subsp. *spinulosa*		0.1
Tetraria octandra		0.1
Thysanotus sparteus		0.1
Tricoryne elatior		0.1
Xanthorrhoea preissii	1.5	5
Xanthosia huegelii		0.1

PHOTO



Site Name:	IR-06 (Woodman Environmental)
Site Type:	QUADRAT
Dimensions:	10m x 10m
Survey Date:	16/09/2015
GPS Location:	GDA94 Zone 50 406209E 6516376N
Landform Type:	Crest
Slope Class:	Very Gently Inclined (1 degree)
Soil Type:	Sand
Soil Colour:	Yellow
Rock Outcrop:	No bedrock exposed
Vegetation Condition:	1 - Pristine
Disturbance:	Historical logging
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia applanata		0.1
Acacia pulchella		0.1
Acacia sessilis		0.1
Alexgeorgea nitens		0.1
Anigozanthos manglesii		0.1
Astroloma pallidum		0.1
Astroloma xerophyllum	0.4	3
Bossiaea eriocarpa		0.1
Brachyscome iberidifolia		0.1
Burchardia congesta		0.1
Calectasia narragara		0.1
Calytrix sylvana		0.1
Conostephium minus		0.1
Conostephium pendulum		0.1
Conostylis aculeata subsp. *aculeata*		0.1
Conostylis setigera subsp. *setigera*		0.1
Dampiera linearis		0.1
Daviesia incrassata subsp. *incrassata*		0.1
Desmocladus flexuosus		0.1
Eucalyptus marginata	6	15
Gastrolobium capitatum		0.1
**Gladiolus caryophyllaceus*		0.1

Gompholobium knightianum		0.1
Gompholobium tomentosum		0.1
Haemodorum laxum		0.1
Hibbertia huegelii		0.1
Hibbertia hypericoides	0.4	10
Hibbertia sericosepala		0.1
Hibbertia subvaginata		0.1
**Hypochaeris glabra*		0.1
Hypolaena exsulca		0.1
Lepidosperma pubisquameum		0.1
Lepidosperma squamatum		0.1
Leucopogon sp. D Perth Flora (aff. polymorphus)		0.1
Leucopogon sp. Murdoch (M. Hislop 1037)		0.1
Lomandra hermaphrodita		0.1
Lomandra sericea		0.1
Mesomelaena pseudostygia	0.4	4
Patersonia juncea		0.1
Patersonia occidentalis var. *occidentalis*	0.4	5
Petrophile macrostachya		0.1
Philotheca spicata		0.1
Phyllanthus calycinus		0.1
Sowerbaea laxiflora		0.1
Stylidium cygnorum		0.1
Tetraria octandra		0.1
Tricoryne elatior		0.1
Tripterococcus brunonis		0.1
**Ursinia anthemoides*		0.1
Xanthorrhoea preissii	1.5	7
Xanthosia huegelii		0.1

PHOTO



Site Name:	IR-07 (Woodman Environmental)
Site Type:	QUADRAT
Dimensions:	10m x 10m
Survey Date:	16/09/2015
GPS Location:	GDA94 Zone 50 406229E 6516753N
Landform Type:	Crest
Slope Class:	Very Gently Inclined (1 degree)
Aspect:	S
Soil Type:	Sand
Soil Colour:	Yellow
Rock Outcrop:	No bedrock exposed
Vegetation Condition:	1 - Pristine
Disturbance:	Exotic weeds
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia sessilis		0.1
Alexgeorgea nitens		0.1
Allocasuarina humilis	1.8	8
Anigozanthos humilis subsp. *humilis*		0.1
Astroloma xerophyllum		0.1
Banksia attenuate	1.5	1
Banksia dallanneyi var. *dallanneyi*		0.1
Banksia menziesii	2.5	1.5
Boronia ramose		0.1
Bossiaea eriocarpa		0.1
Burchardia congesta		0.1
Caladenia flava		0.1
Calothamnus sanguineus		0.1
Calytrix flavescens		0.1
Calytrix sylvana		0.1
Cassytha flava		0.1
Conostephium pendulum		0.1
Conostylis aculeata subsp. *aculeata*		0.1
Conostylis setigera subsp. *setigera*		0.1
Dampiera linearis		0.1
Desmocladus flexuosus		0.1

Drosera erythrorhiza		0.1
Eremaea pauciflora	0.6	4
Eucalyptus todtiana	6	7
Gastrolobium capitatum		0.1
**Gladiolus caryophyllaceus*		0.1
Gompholobium tomentosum		0.1
Hibbertia huegelii		0.1
Hibbertia hypericoides	0.4	4
Hibbertia subvaginata		0.1
Hybanthus floribundus subsp. *floribundus*		0.1
**Hypochaeris glabra*		0.1
Jacksonia floribunda		0.1
Lepidobolus preissianus subsp. *preissianus*		0.1
Lepidosperma sp.		0.1
Leucopogon conostephioides		0.1
Lomandra caespitosa		0.1
Lomandra hermaphrodita		0.1
Melaleuca trichophylla	0.3	3
Mesomelaena pseudostygia	0.4	15
Millotia tenuifolia var. *laevis*		0.1
Neurachne alopecuroidea		0.1
Patersonia occidentalis var. *occidentalis*		0.1
Petrophile macrostachya		0.1
Philotheca spicata		0.1
Podotheca gnaphalioides		0.1
Pterostylis sp. short sepals (W. Jackson BJ259)		0.1
Scaevola canescens		0.1
Stylidium albolilacinum		0.1
Stylidium cygnorum		0.1
Stylidium ?diuroides		0.1
Stylidium piliferum		0.1
Stylidium schoenoides		0.1
Synaphea spinulosa subsp. *spinulosa*		0.1
Tetratheca nuda		0.1
Thysanotus dichotomus		0.1
Trachymene pilosa		0.1
**Ursinia anthemoides*		0.1
Xanthorrhoea preissii	1.5	1.5
Xanthosia huegelii		0.1

PHOTO



Appendix D: Section of Classification Analysis Dendrogram Showing Proximity of SCP20a and Proposed Offset Site Quadrats (including weeds)



Appendix E: Results of Nearest Neighbour Analysis of Quadrat Data from the Proposed Offset Site

Study & Project Area Quadrat	Nearest Neighbour	Level of Similarity	SCP FCT
IR-01	KOON-1	0.536	20a
IR-02	MR09	0.5146	23b
IR-03	CAVS10	0.5844	21a
IR-04	GNAN03	0.6311	23a
IR-05	5C03	0.5699	20a
IR-06	SHENT-1	0.5833	28
IR-07	ELE24	0.4951	23b

Appendix F: Results of Indicator Species Analysis of Quadrat Data from the proposed Offset Site

Taxon	FCT				
	20a	21a	23a	23b	28
*Alexgeorgea nitens****	16	2	8	14	7
*Bossiaea eriocarpa****	8	6	8	7	4
*Burchardia congesta****	6	5	6	4	5
*Calectasia narragara**	19	1	4	6	6
*Conostylis aurea***	21	0	4	6	2
Conostylis setigera subsp. *setigera**	14	0	4	1	9
*Conospermum undulatum****	100	0	0	0	0
*Cyathochaeta equitans***	33	1	2	0	0
*Dasypogon obliquifolius***	55	0	2	1	1
Daviesia divaricata subsp. *divaricata* ms**	21	3	2	5	5
*Daviesia triflora**	17	2	15	9	9
*Hibbertia huegelii****	15	1	7	5	6
*Hibbertia hypericoides****	5	4	4	3	5
Lambertia multiflora var. *darlingensis***	37	0	0	0	0
*Mesomelaena pseudostygia****	11	1	3	3	11
*Monotaxis grandiflora***	33	3	4	4	7
Scaevola repens var. *repens***	24	1	9	5	4
*Stirlingia latifolia****	10	3	6	7	3
*Banksia menziesii****	5	4	13	12	6
*Gompholobium tomentosum****	5	7	9	5	6
*Laxmannia squarrosa**	5	7	22	4	3
*Lomandra hermaphrodita****	7	5	9	5	5
Patersonia occidentalis var. *occidentalis*, *Patersonia occidentalis****	5	4	6	5	2
*Schoenus curvifolius***	8	1	16	14	2
*Tricoryne tenella**	20	11	26	3	3
*Astroloma xerophyllum**	0	0	8	24	2
*Banksia attenuata****	6	7	8	9	6
*Beaufortia elegans**	0	0	7	31	1
*Conostephium minus**	8	3	6	44	9
Eremaea pauciflora var. *pauciflora*, *Eremaea pauciflora****	8	1	7	15	1
*Hibbertia subvaginata***	1	3	6	14	3
Jacksonia floribunda, *Jacksonia decumbens***	11	0	8	18	2
*Scholtzia involucrata****	0	3	16	16	1

Note: Shading denotes highest indicator values per taxon;
Indicator values (%) are shown only for taxa which were significant at P<0.05 (* = p <0.05; ** = p<0.01; *** = p <0.001)

APPENDIX G

Analysis of Floristic Data from Ioppolo Road and Hepburn Avenue to Assign Sites to Floristic Community Types



Analysis

of floristic data

from Ioppolo Road

and Hepburn Avenue

to assign sites to

floristic community types

Prepared for

Coffey Environments

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1.0 Introduction

This report presents and discusses floristic analyses aimed at assigning sites recorded at Ioppolo Road on the southern end of the Dandaragan Plateau and at Hepburn Avenue on the Swan Coastal Plain to a system of units produced by earlier studies (Gibson *et al* 1994 and the "System Six update" to that study).

Gibson *et al* 1994 includes a pattern analysis of flora lists from quadrats recorded in vegetation on the Swan Coastal Plain. As the data used in such analyses is lists of flora species, it is also referred to as a "floristic analysis". Subsequent to the 1994 publication, an "update" incorporating additional data (including about 100 sites from the Dandaragan Plateau from which no sites where included in Gibson *et al* 1994) was carried out (cited in *Perth's Bushplan* (Gov. W.A. 1998) as DEP1996) but is not published. The two studies (the latter incorporating the 509 sites from the former and adding a similar number of new sites) defined a series of "floristic community types", or groups of sites with similar species composition that are inferred to have similar conservation values.

The floristic community types defined in the two studies discussed above are used as a major factor in determination of conservation value for vegetation on the Swan Coastal Plain by both the Department of Parks and Wildlife (DPaW) and the Environmental Protection Authority (EPA). As the System Six update included sites from the Dandaragan Plateau, there are also some floristic community types that are known from there.

2.0 Gibson *et al* study, the System Six update, and the current analysis

To understand the analysis presented and discussed in this report, it is important to understand the basis and relevant attributes of the floristic community types defined in Gibson *et al* 1994 and the System 6 Update (DEP 1996). The area covered by the 1994 analysis (based on 509 sites) was the Swan Coastal Plain from the Gingin area to the southern end of that Plain. The System 6 Update added significantly more sites (so the combined data set has 1,098 sites) including about 100 from the Dandaragan Plateau. The Gibson *et al* (1994) survey covered a very large area with a diverse array of soil and habitat types and a large flora (ca. 2,000 species). Therefore, with 509 sites the 1994 survey is in one regard a very large amount of work and in another is data poor to document the variation in the floristic composition of the vegetation of the area surveyed.

The authors of Gibson *et al* (1994) chose to define thirty (30) floristic community types, nine of which had two or three subtypes (giving a total of 43 units). Thirty is a quite small number of floristic community types for the area surveyed and means that they are high order units; that is, they have a high level of synthesis. Appendix 1 is a table that attempts to put this in context and very strongly indicates that the 30 floristic community types are defined at a high level of synthesis; the subtypes (e.g. 1a, 1b) are also still high order units. It is also important to appreciate that the analysis is based on the presence and absence of flora species, without any weighting for the abundance of individual species. This is a common approach for analysing data from large areas, but also contributes to the limited number of floristic community types defined being rather abstract, as they can include a range of vegetation types with different species dominant and with different structure. This method (and the limited number of floristic community types defined in this case) necessarily limits the meaning of the results for understanding environmental aspects of vegetation that are important for using vegetation as a surrogate for other values, as dominance and structure are very important for environmental values (such as fauna habitat) dependent on vegetation type.

The Gibson *et al* (1994) study and the System Six update both used classifications produced using the pattern analysis program PATN (Belbin 1987). If the System Six update analysis had been carried out in exactly the same way as the 1994 study, it would have produced an entirely new classification, as the large amount of new data added would have created different possibilities for the formation of groups of sites (floristic community types) at the level (number of floristic community types) of the 1994 analysis (this can be seen in the larger segments of the Single Site insertion dendrogram reproduced in Appendix 2). To avoid this, the System Six update analysis was run using a component of PATN called "ALOC" with no "reallocation". This was used to maintain the previous classification into floristic community types and create new FCTs where new sites were "different". It could be inferred that many of the original FCTs were poorly defined; more than half (22) of the 43 FCTs were represented by less than 10 sites and a sixth had less than 5 sites. Other analyses have shown that when new sites are added to the Gibson et al 1994 dataset, significant changes in classifications can occur (e.g. Trudgen 1999). Therefore, it should be considered that

the allocation of floristic community types through the update process is tentative and not absolute. To clarify this, forcing the System Six Update sites into floristic community types defined in the Gibson *et al* (1994) classification is likely to have false positives, that is placing sites in floristic community types where they do not belong. Consequently, allocation of new sites (e.g. the new Ioppolo Road sites) based on comparison to the allocation of sites to floristic community types in the update should be treated with caution. Appendix 3 shows a comparison of the similarity of sites placed in FCT 20a to other sites placed in FCT 20a and sites from other floristic community types selected using the nearest neighbours method. It shows that some FCT 20a sites are in fact closer (more similar using PATN) to sites from FCT 23a and 23b. As a site (site 5c03) used in the System 6 Update from the Ioppolo Road area was placed in FCT 20a in that study, it became important for the for the purposes of this report to ascertain if this was a good allocation.

Inherently, if an original analysis is data poor for the area and environmental variation sampled, then adding more sites to the classification will mean that sites will be allocated into poorly defined units (floristic community types). In cases such as the present analysis, where the aim is to assign more newly recorded sites to the previously defined floristic community types then some difficulty must be anticipated.

The process of adding new sites to the existing classification can also be affected by the quality of new data. Factors such as the number of visits to the new quadrats (ideally at least two), the timing of visits, the experience of the survey botanists in searching the quadrats for flora species, the level of disturbance (including weed invasion, which displaces native species) of the sites sampled, and the accuracy of both field and herbarium identifications all affect data quality. It is noted in this context, that the nearly 300 sites recorded by E. A. Griffin that were included in the "update" were only visited once (but note, that fact that some of the new Ioppolo Road sites geographically close to some of these sites also come out close to some of them in the analyses indicates that the data is reasonably compatible).

Bearing all these factors in mind, new sites may or may not fit the existing classification well. In such cases it may be because of the constraints of the classification (i.e. sites may not fit well because there is no appropriate place for them) or because the new data is not of ideal quality.

3.0 Methods used

Three methods using different approaches based on the PATN pattern analysis package were used to investigate what floristic community types the new sites from Ioppolo Road and Hepburn Avenue should be assigned to. These were firstly using PATN to construct a dendrogram using all the new sites and the reference data set (the Gibson *et al* 1994 data and the System Six update data). This method is known to have problems if the new data has differences in quality from the reference data set. The second method used was the Nearest Neighbours approach, where sites are compared to see which sites have the most similar species lists. As not all species have the same influence in group formation using PATN, nearest neighbours can be skewed by species in common between sites that do not have as much influence on group formation as other species. The third approach used was "Single Site Insertion", in this technique a dendrogram is produced using PATN but only one new site at a time is compared to the reference data set. This avoids the problem of new sites grouping together because of survey characteristics (e.g. only one site visit, or timing of visits different to the timing of visits to the reference data sites).

The results of the three approaches were then compared to synthesise an overall result.

As three of the Ioppolo Road quadrats joined in the single site insertion method with a reference site (site 5c03, which was assigned to FCT 20a in the Update) recorded nearby in the Ioppolo Road bushland, the correct placement of this site was also investigated. This was necessary, as FCT 20a was originally defined based on sites recorded on the Swan Coastal Plain, making its occurrence on the Dandaragan Plateau unlikely (also see the section above). If site 5c03 was incorrectly assigned to FCT 20a, then comparing new sites to investigate their allocation to FCT 20a would be fundamentally flawed.

The new sites were compared to a reference data set made up of the Gibson *et al* (1994) sites and the sites used for the System 6 Update (DEP 1996). To make the use of species names in the reference data set as up to date as possible, an extensive updating of the names used in this data had been carried out. The names in the new (Ioppolo Road and Hepburn Avenue) data were carefully compared to those in the reference data set to make them as compatible as reasonably possible and where necessary reference was made to Florabase and other resources.

The analyses were made excluding weed species, as these taxa are not considered by the authors of this report to be at equilibrium in the areas concerned and thus can distort analyses. Also, most of the reference sites were chosen to be in areas of better condition, whereas some of the new sites (especially the Hepburn Avenue sites) have significant weed invasion. In such cases, including weeds would make interpreting the analyses more difficult.

4.0 Results

The results of the three approaches for the new quadrats are shown in Table 1 and are discussed for each quadrat below.

As site 5c03 (allocated to FCT 20a in the System 6 Update) was an outlying record of FCT 20a (on the Dandaragan Plateau, whereas all other records are on the Swan Coastal Plain), its allocation to FCT 20 needed to be examined prior to using this site as a reference site for FCT 20a (also see section above). The results of the investigation of site 5c03 using an analysis without using ALOC indicated that this site should be assigned to floristic community type 23b rather than to FCT 20a. The Nearest Neighbours method also suggested this assignment, but with less certainty (see Table 1). This is an important result, as it indicates that the assignment of this site to floristic community type 20a in the System Six update analysis was the result of the use of the ALOC function in PATN forcing this site to an inappropriate place (i.e., it was a false positive). As this site should not be considered to be a member of floristic community type 20a, this means that sites that are similar to it are also not floristic community type 20a.

Figure 1 is a section of the single site insertion dendrogram investigating the placement of site IR-01. It joins to site 5c03 and they join in the centre of nine sites that belong to FCT23b (and one site allocated to site s09 which may also be mis-allocated). The figure very strongly indicates that site 5c03 should be re-allocated to FCT 23b and that therefore site IR-01 should also be allocated to FCT 23b.

Figure1. A section of a single site insertion dendrogram including site 5c03
Note: Site 5c03 falls within a group of sites that with one exception have been placed in FCT 23b and the new site IR-01 is closest to 5c03.

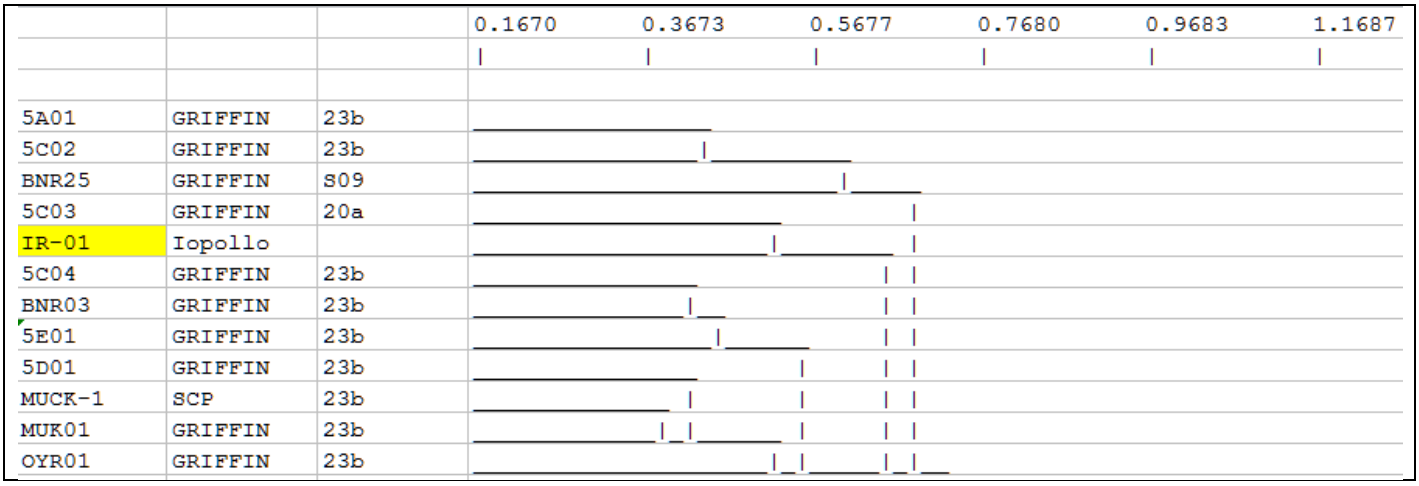


Table 1 (see below) shows the interpretation of the results of each of the three analyses carried out for each of the new sites and also for site 5c03. The analyses are single site insertion (each new site included by itself with the reference data), a dendrogram of all the new sites with the reference data and a nearest neighbours analysis. The single site insertion method avoids a the problem with the dendrogram of all sites

whereby new sites can cluster together because of a survey specific factor such as time of survey and therefore usually provides a better indication of best placement. As single site insertion uses the same algorithm as was used for the Gibson *et al* (1994) analysis, it also avoids the issue with nearest neighbours where species that do not have much impact in the analysis may indicate sites are nearest neighbours, when they are not placed closest in the dendrogram. For these reasons somewhat more weight is placed on the single site insertion method than on the other two methods, but each case needs to be judged individually.

For example, Appendix 2 has extracts from the single site insertion dendrograms for each of the new sites, one is also reproduced her as figure 2. Figure 2 shows how the new site HA-02 joins in a section of the dendrogram that has a mixture of sites from FCT 4 and FCT S02. Table 1 shows that a similar interpretation was made from the dendrogram for all sites and that the nearest neighbours method shows relationship to FCT SO2. The combined interpretation (see below Table 1) is that this site should be placed in FCT S02, but with some qualification.

A contrasting example is that the new site HA-01 was placed in the single site insertion dendrogram in a large group of sites from FCT 4 (see top of Appendix 2), was most likely FCT 4 from the dendrogram with all sites but also near FCTs S02 and S17, and from nearest neighbours was nearest FCT S02. In this case, the preponderance of sites from FCT4 in the block of the single site insertion dendrogram was interpreted as meaning site HA-01 should be placed in FCT 4. Similar judgements were made to place the other new sites.

Figure2. A section of a single site insertion dendrogram including site HA-02

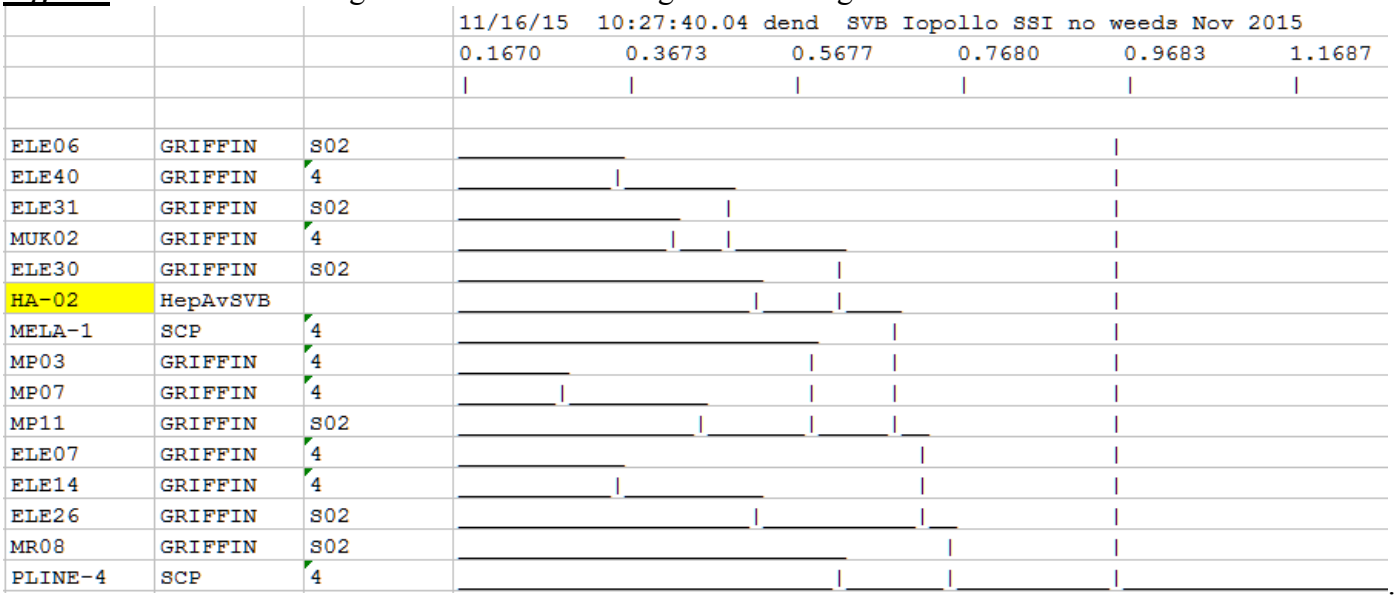


Table 1: Results of three methods of investigating assignment of the new sites to floristic community types.
Notes: References in the table to site 5c03 as FCT 20a should now be read as FCT23a and references to 20a in the Single Site insertion column to FCT 20 should be read as FCT23b as they are based on Site 5c03. The use of ? or ?? indicates the degree of uncertainty in some allocations. SSI means the results of the Single Site Insertion dendrogram. FCT-den means the results of the dendrogram for all sites. NNB means the results for the nearest Neighbours analysis. Where more than one possible FCT is given from a method, the order from left to right indicates the most strong relationship.

PROJ	SITE	SSI	FCT_den	NNB	NNB note
HepAvSVB	HA-01	4	4/S02/S17	S02/4	
HepAvSVB	HA-02	S02/4	4/S02/S17	S02	
HepAvSVB	HA-03	4/S02	4/S02/S17	S02/4	
Iopollo	IR-01	20a[sic 23b]/23b	??S09/S10	23b/20a	20a: LAND-1,5C03
Iopollo	IR-02	20d/?20a[sic 23b]/?23b	??S09/S10	23a/23b	
Iopollo	IR-03	?28	??S09/S10	?21a/23b	
Iopollo	IR-04	?28	??S09/S10	??23b/23a	
Iopollo	IR-05	20a [sic 23b]	??S09/S10	20a	20a:5C03
Iopollo	IR-06	?20b/3b	??S09/S10	?28/20a	20a:KOON-1,5C03
Iopollo	IR-07	?23b	??S09/S10	23a/23b	
	5C03		23b	?23b	related to sites nearby
	KOON-1		20a	20a	
	LAND-1		20a	20a	

From Table 1 (see also Appendix 2), the following interpretations for placing the new sites in floristic community types can be made:

- **HA-01** should be placed in FCT 4, with relationship to FCT S02.
- **HA-02** should be placed in FCT S02, with relationship to FCT 4 (it may be intermediate, or the data may not be adequate to properly place it (due to weed invasion) and it may be better placed in FCT 4.
- **HA-03** should be placed in in FCT 4, with relationship to FCT S02.
- **IR-01** should be placed in in FCT 23b, but with some tendency to FCT 20a. It may be that there is an analogue of FCT 20a (that is a similar type to FCT 20a, but with differences due to the different environment on the Dandaragan Plateau to on the Swan Coastal Plain) in the Ioppolo Road area, or that some vegetation there is intermediate between these two floristic community types.
- **IR-02** Cannot be placed readily in a floristic community type, but has some relationship to FCT 23 and FCT 20.
- **IR-03** should probably be placed in in FCT 28, but has some relationship to FCT23.
- **IR-04** should probably be placed in in FCT 28, but has some relationship to FCT23.
- **IR-05** should be placed in FCT 23a, with some relationship to Supplementary FCTs S09 and S10.
- **IR-06** is somewhat difficult to place, but seems to have some relationship to FCT 20a as on nearest neighbours it comes nearest FCT 28 then site KOON-1 (from Koondoola) that is FCT20a but the next nearest site is 5c03 (which we have moved to FCT 23b), however in the single site insertion dendrogram (see Appendix 2) it joins with sites from FCT20b before it joins with sites from FCT 20a. So it is probably best placed as FCT 20b/23b, with some (small) possibly of a Dandaragan Plateau analogue of 20a (i.e., there is some similarity to FCT20a, but it is low).
- **IR-07** should be placed in in FCT 23a, but with some relationship to other floristic community types.

5.0 REFERENCES

Belbin, L. (1987). PATN Reference Manual, Users Guide, Command Manual, and Example Manual. CSIRO Division of Wildlife and Ecology, Lynham.

DEP (1996). System Six and Part System 1 Update Program. Unpublished bushland plot and area records and analysis. Department of Environmental Protection, Perth, Western Australia.

Gibson, N., Keighery, B.J., Keighery, G.J., Burbidge, A.H., and Lyons, M.N. (1994). *A Floristic Survey of the Southern Swan Coastal Plain*. Unpublished report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc.).

Government of Western Australia (1998). *Perth's Bushplan*. Western Australian Planning Commission, Perth.

Trudgen, M.E. (1999). *A flora and vegetation survey of Lots 46 and 47 Maralla Road and Lexia Avenue, Ellenbrook*. Volumes 1-4. Unpublished report prepared for the Crown Solicitors Office, Government of Western Australia. December 1999.

6.0 APPENDICES

Appendix 1: Comparison of some studies of vegetation on the Swan Coastal Plain and adjoining areas to the commonly accepted structural/dominance classification of vegetation to indicate the approximate relationship of level of synthesis of these examples of various approaches used to describe vegetation.

Notes: Definitions of *alliance* and *society* follow Aplin (1979), the definition of *association* used is similar in meaning to that of Aplin. The definition of *biome* by various authors varies significantly, use here it is somewhat more restricted than by some authors (see Allaby 1998, p 54 for example) who would equate it to all examples of a particul formation or a climatic type, arguably could be above or below formation in the left hand column of this table (or in the column to the right at a higher level than land system (bioregion). Alliance and society are rarely used. Table adapted from Table 3 of Trudgen (1999) and later. The increase in level of synthesis from bottom to top approaches exponential. The left hand column is explanatory with general examples; the others give examples from the Swan Coastal Plain and Whicher Scarp.

Vegetation divided on structure only at the two upper level(s) and on structure and dominant genera or species at the lower levels **Biome**: A concept that is partly distinguished on structure and partly on being a geographical entity. For example, the tropical rainforests of the Amazon Basin are a biome. Obviously, such as a large entity would not be entirely one formation but would have inclusions of others that would occur in a related fashion. This concept therefore straddles the conceptual boundary between the units in this column and the next	**Vegetation divided on broad geomorphological boundaries (+/- land system) with some subdivision on structure and dominant species into ecologically associated groups of types**	**Vegetation divided on less broad geomorphological boundaries (+/- land unit) with subdivision on structure and dominant species into ecologically associated groups of types**	**Floristic analysis: vegetation divided on the basis of the presence or absence of flora species. Sometimes extended to include structure (dominance)** [Uses a concept that divides flora records for sites into a number of groups of sites on the basis of species presence and absence using programs such as PATN. The number of groups used being selected by the person doing the analysis. That is, level of units (floristic community types) varies from study to study.]
Vegetation Formation: A concept that covers vegetation of the same structure of the upper layer without reference to dominant species. While stands referred to a particular formation may have similar structure, they may have different dominant and associated species. For example a Banksia woodland with two shrub layers and a herb layer and a Casuarina woodland with virtually no understorey are both simply woodlands at the formation level. Aplin's (1979) modification of Specht provides a list of 29 formations	**Vegetation complex on the Swan Coastal Plain** A concept that covers a range of structural types that occur in a related pattern with borders defined by major geomorphological units with some subdivision on floristics between southern and northern parts of the geomorphological units. As mapped, fairly similar to CSIRO/ AGWA use of land systems with some subdivision. Co-incidentally, Heddle *et al* (1980) describe 29 vegetation complexes for the Swan CP, this would include vegetation from many of the formations listed by Aplin (1979)	**Vegetation complex on the Darling Plateau** A concept that covers a range of vegetation that occurs on one part of the range of geomorphology of the Plateau and the valleys incised into it, with subdivisions based on changes in vegetation related to broad climatic para meters. (Note: this reflects the fact that the Plateau/ Scarp complex has a higher range of topography and is older than the coastal plain, meaning that more diverse ecological situations have *developed. The result (with exceptions) is that there is less structural diversity in P/S vegetation complexes (Heddle *et al* 1980 gives 30 veg complexes for the Northern Jarrah Forest) (Variable? Possibly to sub-formation.)	**Swan Coastal Plain Survey (Gibson *et al* 1994) floristic community types**) 36 Floristic community types for the southern Swan Coastal Plain (Variable? Individual floristic community types possibly to sub-formation or even alliance level.)
Vegetation Sub-formation: At the sub-formation level, the genus of the dominant of the upper layer is included to group examples of the same formation with related species as the dominant(s). For example, *Eucalyptus* woodland.		**Mapping by McArthur and Mattiske** (1985) of the Bassendean Dunes of the Gnangara Mound. (Variable? Possibly to alliance (individual types).)	**Whicher Scarp Survey (Keighery *et al* 2008) level floristic community types**. Variable? At least some at vegetation alliance level. Those with one quadrat lower? (It depends on whether you look at how different they are from each other or how much variation they include: those with one site are very different from most others, but obviously don't have much variation in them)
Vegetation Alliance: This level groups vegetation associations that have the same dominant species. For example, *Eucalyptus marginata* (Jarrah) forest and may have the same or related species important in the understorey			↓
Vegetation Association: A concept that covers two or more plant communities with similar structure and dominant species. May vary significantly in associated species, but all stands referred to it will have some visual similarity. Some definitions require similar species lists.			
Society: A series of plant communities with the same structure and the same species dominant in the different strata			
Plant Community: The basic unit of vegetation classification. Standing at one place looking at a stand of vegetation one is looking at a physical example of a plant community. Extending this to several very similar stands introduces some variation and it becomes a plant community concept.			
Stand: A particular example of a plant community			

Note: The postion of surveys in the three columns right of the left had column indicates the aproximate relationship (level of synthesis) of their units to the structure/dominance units in the left hand column.

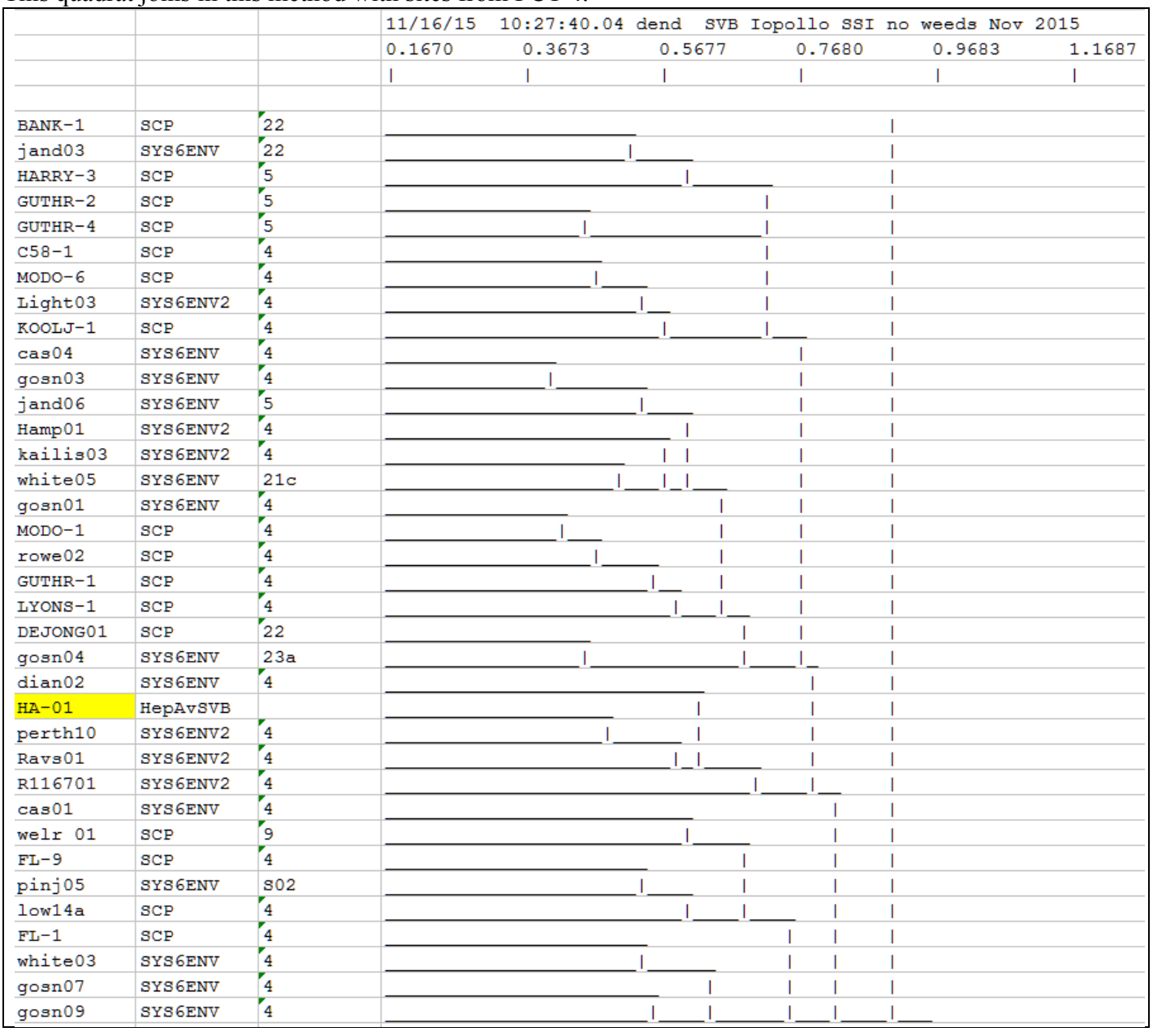
Appendix 2. Extracts from single site insertion dendrograms

One at a time, each of the new sites was included with the reference data set and PATN run to produce a dendrogram (Single Site Insertion). An extract from each run is provided to show where the new sites joined. As some of the new sites are from the Dandaragan Plateau, it was relevant to include the System Six update sites in the reference data. Where the new sites (highlighted in yellow) join is an indication of which floristic community type it should be assigned to, but other information also has to be taken into account.

The first column in the dendrogram extract is a site designation, the second indicates if the site is from the Gibson *et al* (1994) Southern Swan Coastal Plain (SCP) survey or the System Six update data (sites indicated as "Griffin" are sites recorded by EA. Griffin and used in the update). The third column indicates which floristic community type sites were referred to in those studies.

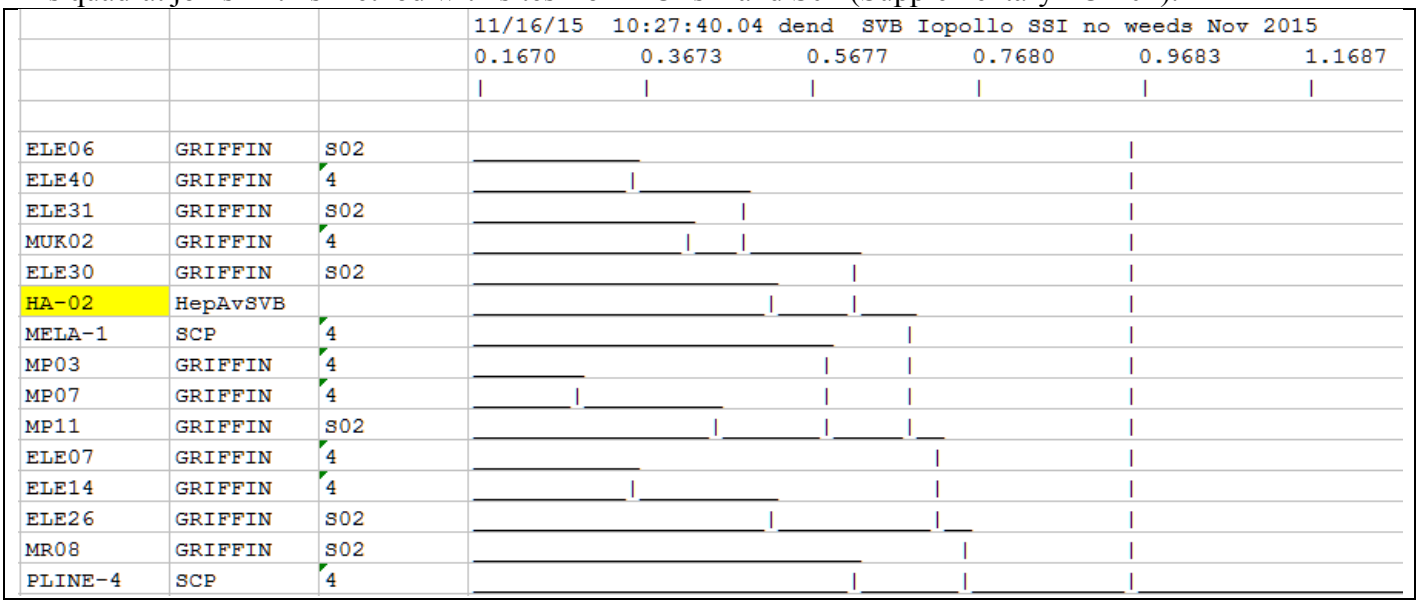
Quadrat HA-01

This quadrat joins in this method with sites from FCT 4.



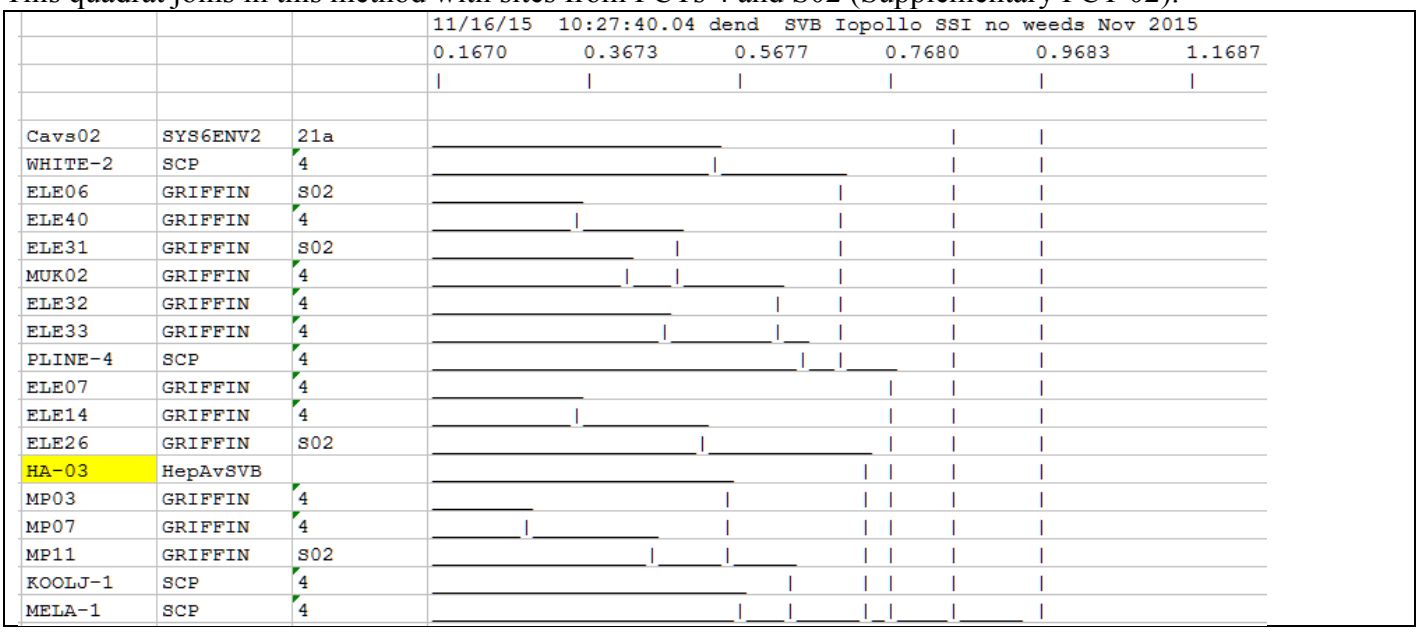
Quadrat HA-02

This quadrat joins in this method with sites from FCTs 4 and S02 (Supplementary FCT 02).



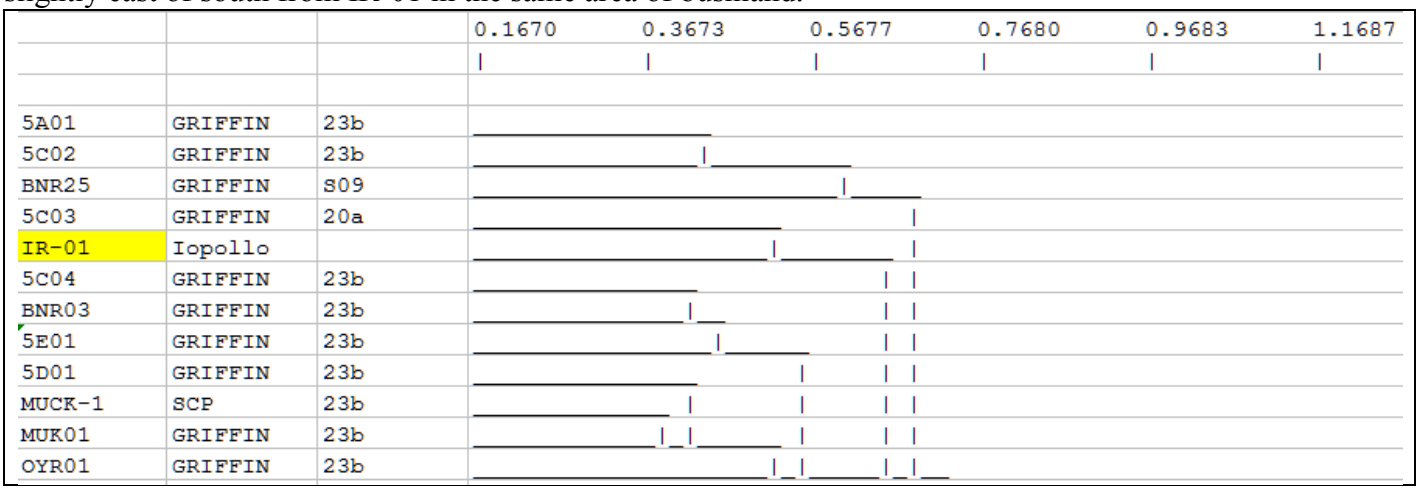
Quadrat HA-03

This quadrat joins in this method with sites from FCTs 4 and S02 (Supplementary FCT 02).



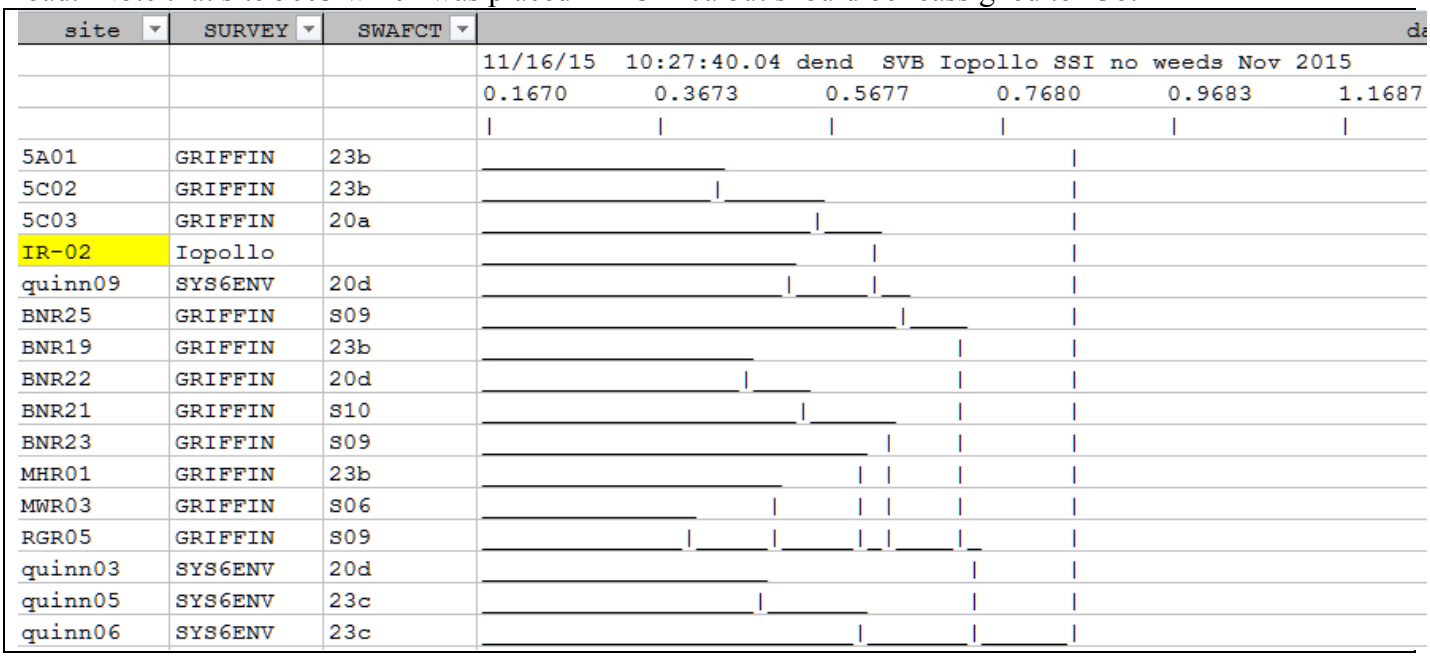
Quadrat IR-01

This quadrat joins in this method with site 5c03 which was placed in FCT20a but should be reassigned to FCT 23b and with less similarity with other sites from FCT 23b. Site 5c03 is located some 750 metres slightly east of south from IR-01 in the same area of bushland.



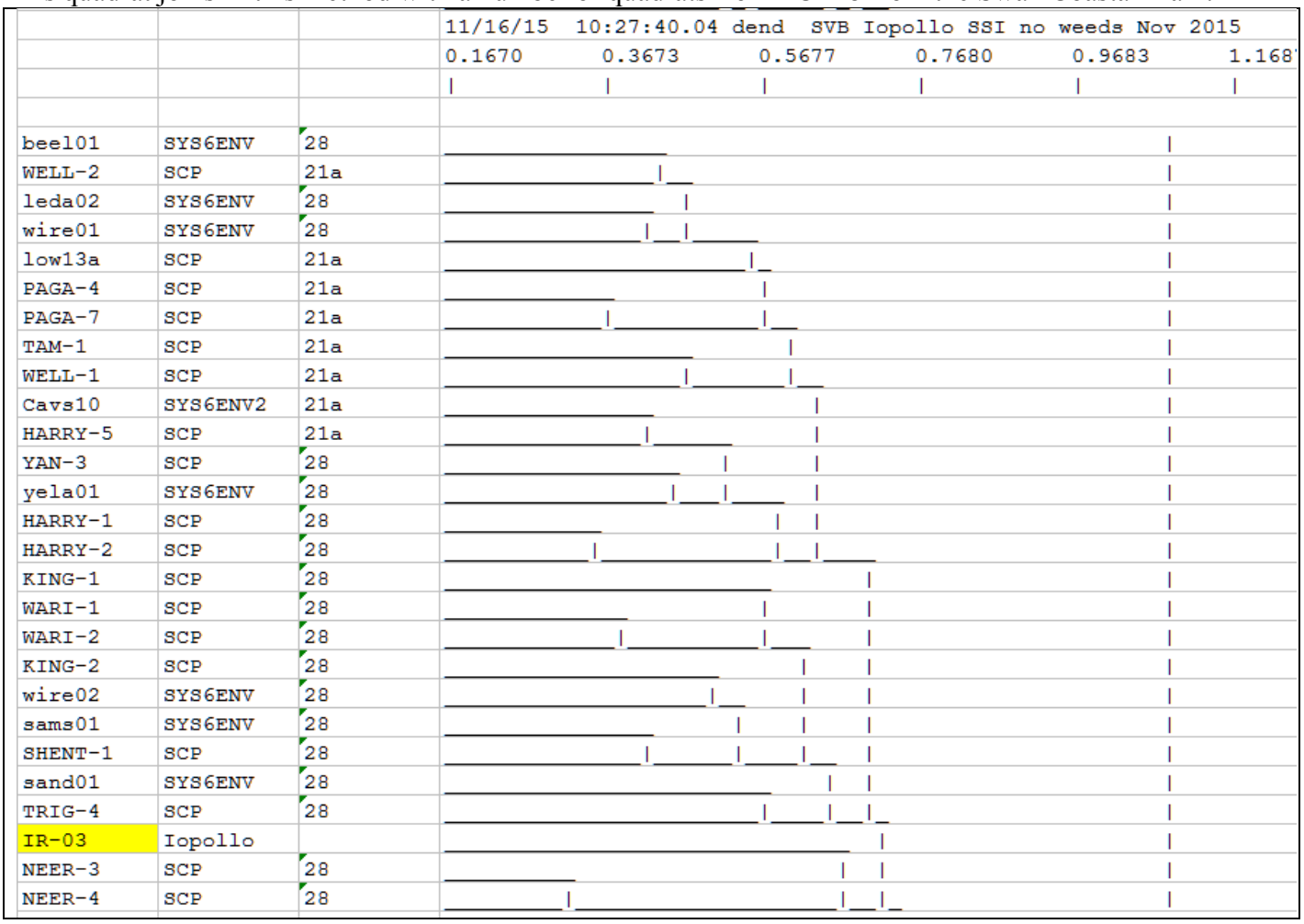
Quadrat IR-02

This quadrat joins in this method with a site (quinn09) from FCT 20d and at lesser similarity with sites from FCT 23b. Site quinn09 is located on the Dandaragan Plateau some 50 km slightly west of north of Ioppolo Road. Note that site 5c03 which was placed in FCT20a but should be reassigned to 23b.



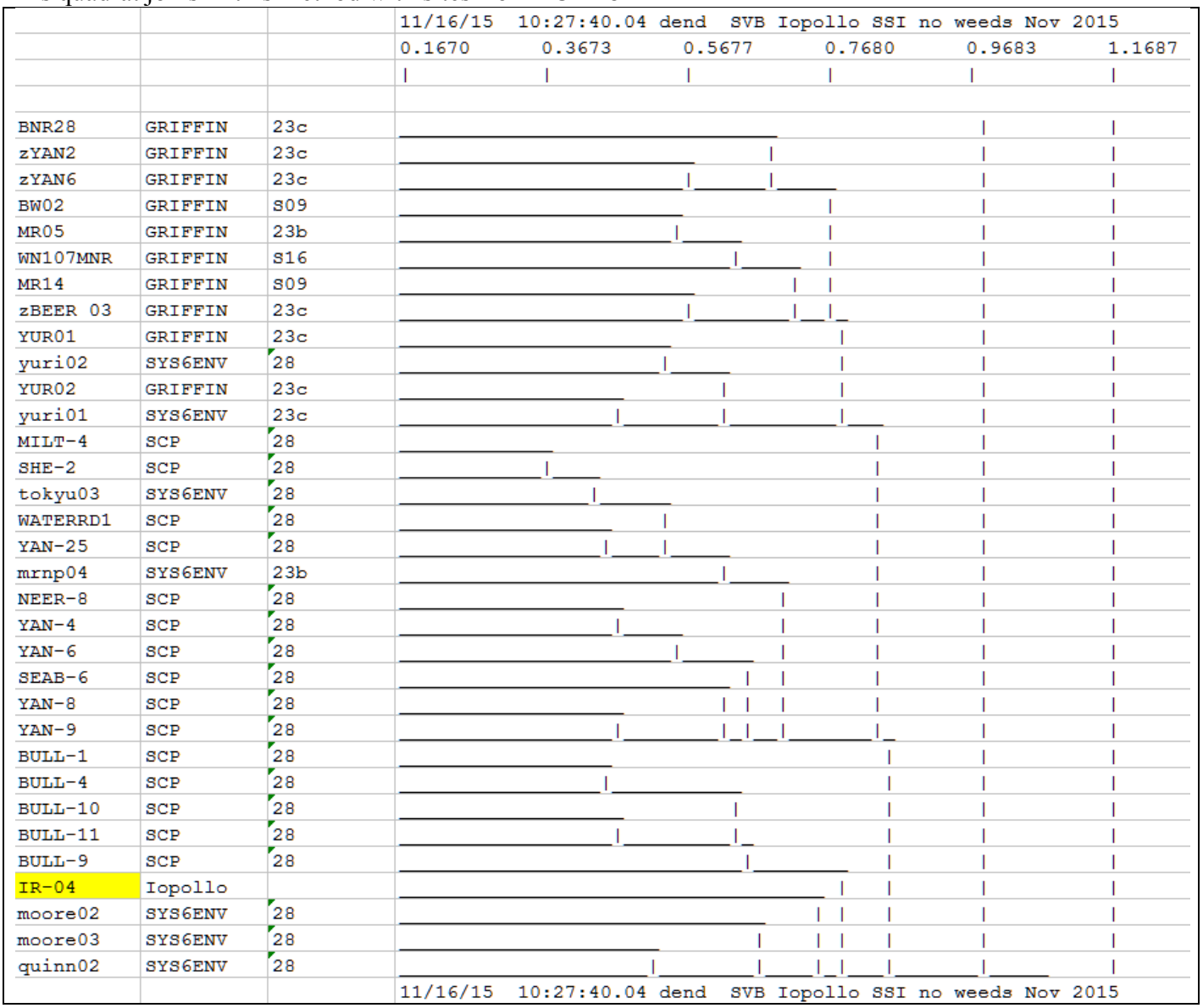
Quadrat IR-03

This quadrat joins in this method with a number of quadrats from FCT28 from the Swan Coastal Plain.



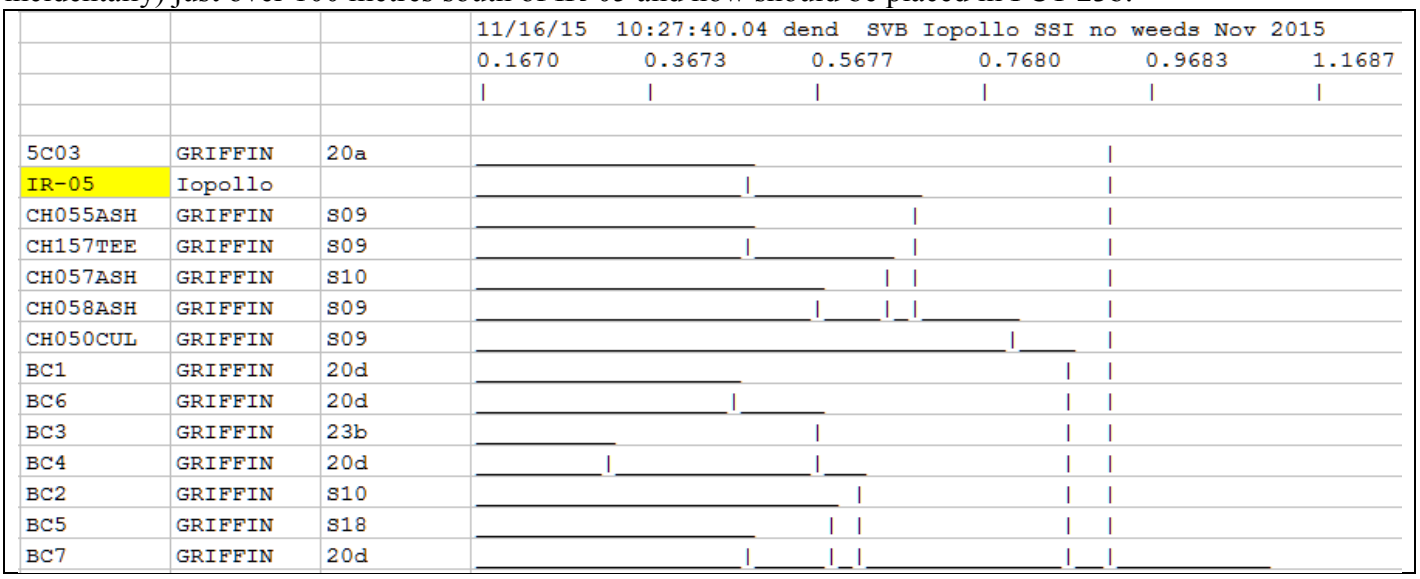
Quadrat IR-04

This quadrat joins in this method with sites from FCT 28



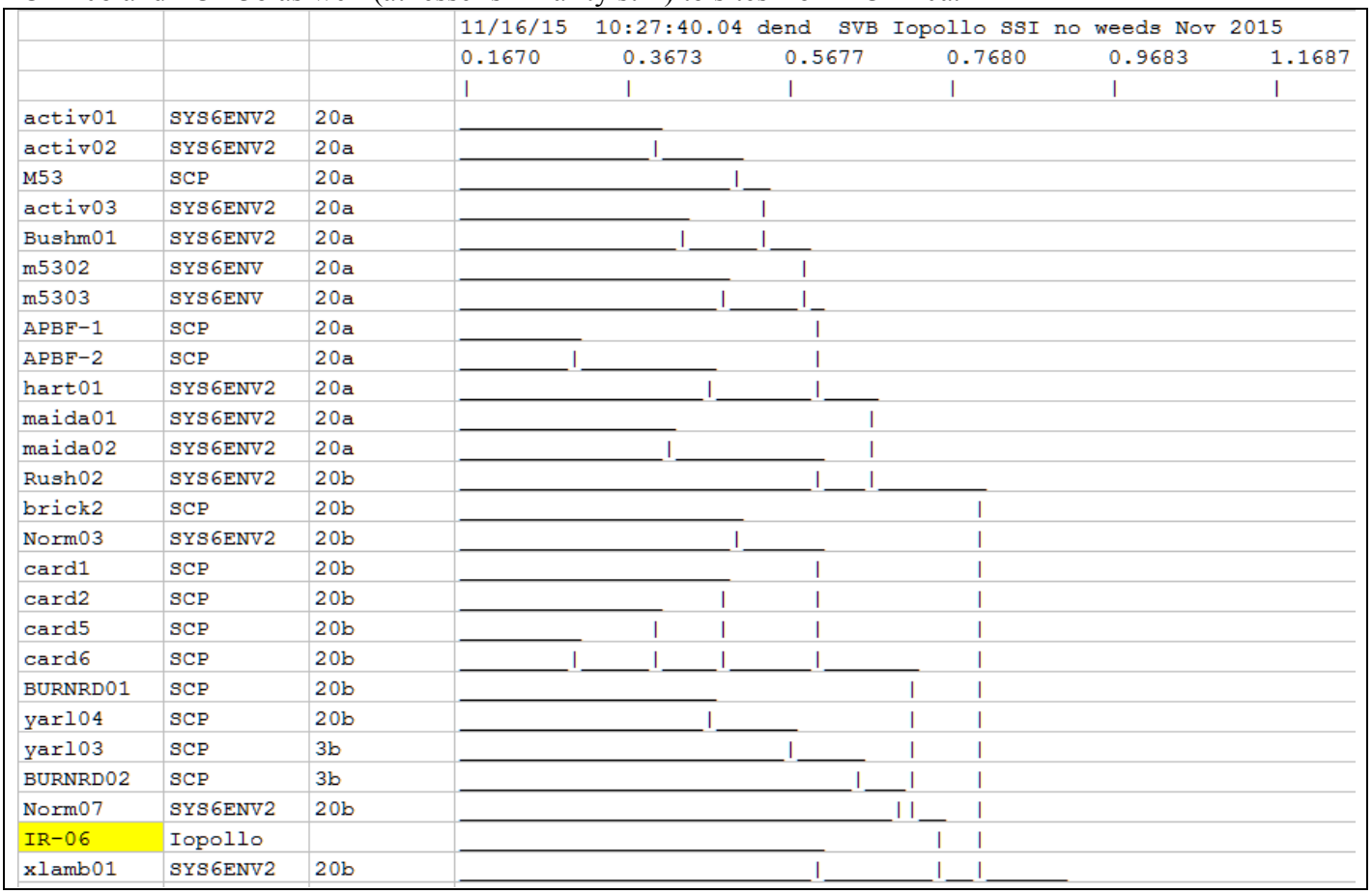
Quadrat IR-05

This quadrat joins in this method with site 5cO3 that was previously assigned to FCT 20a but now is assigned to FCT 23b and with less similarity to sites from FCT S09 and FCT S010. Site 5c03 is located (co-incidentally) just over 100 metres south of IR-05 and now should be placed in FCT 23b.



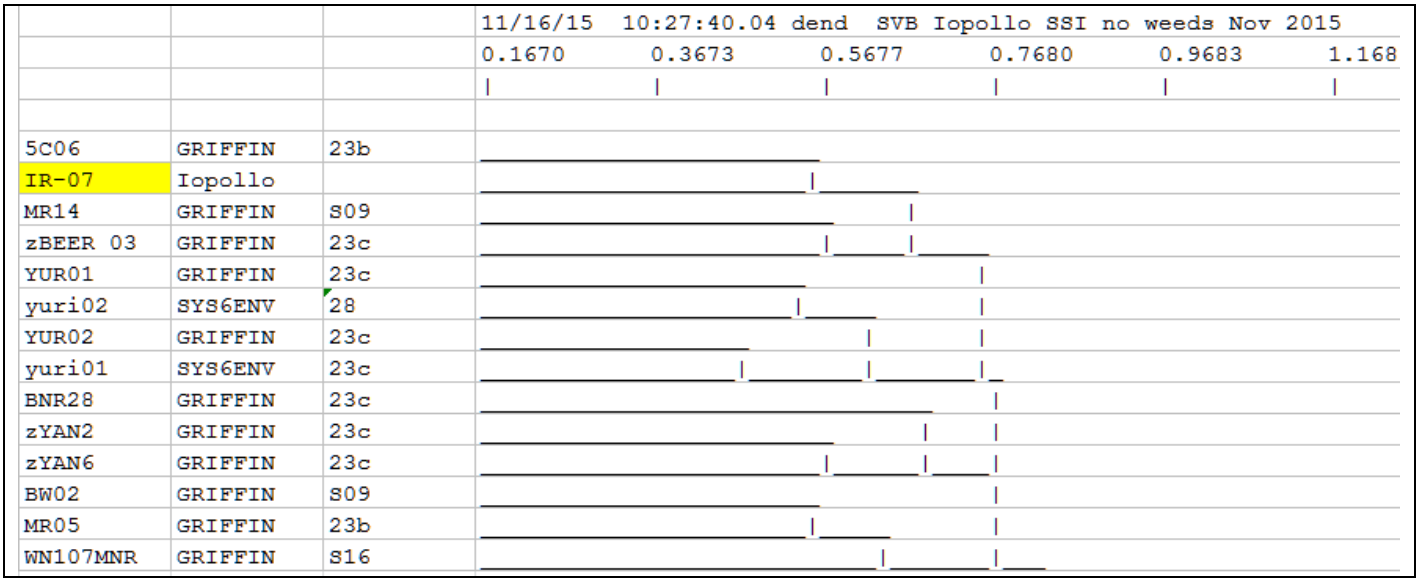
Quadrat IR-06

This quadrat joins in this method with a site from FCT 20b, and at lesser similarity with other sites from FCT 20b and FCT 3b as well (at lesser similarity still) to sites from FCT 20a.



Quadrat IR-07

This quadrat joins in this method with a site (5c06) from FCT23b and then at lesser similarity to sites from FCTs S09 and 23c. Site 5c06 is located in the same area of bushland as site IR-07



Appendix 3. Comparison of sites placed in FCT 20a to selected other sites

The numbers in the cells are a measure of dissimilarity (coloured from green to red on increase in dissimilarity).

SURVEY	S_ID	g50	FCT	GRIFFII BNR01 1 S09	GRIFFII SA01 1 23b	GRIFFII SC03 1 20a	GRIFFII BNR19 1 23b	SYS6EI activ01 4 20a	SYS6EI activ02 4 20a	SYS6EI MS3 4 20a	SYS6EI activ03 4 20a	SYS6EI Bushm01 4 20a	SYS6EI MS302 4 20a	SYS6EI MS303 4 20a	SYS6EI APBF-1 4 20a	SCP APBF-2 4 20a	SYS6EI hart01 4 20a	SYS6EI maida01 4 20a	SYS6EI maida02 4 20a	SYS6EI Norm03 4 20b	SCP MILT-4 10 28	GRIFFII 5E01 13 23b	SCP YAN-20 13 23b	SYS6EI jand08 13 23a	SYS6EI dian01 13 23a	SYS6EI Tele01 13 23a	SCP BULL-3 13 23a	SYS6EI perth06 13 23a	SYS6EI perth08 13 23a	SYS6EI Light02 13 23a	SYS6EI perth04 13 23a	SYS6EI perth07 13 20a	SCP GOLF-1 13 20a	SCP KOON-1 13 20a	SCP KOON-2 13 20a	SCP LAND-1 13 20a
GRIFFIN	BNR01	1	S09		0.596	0.5	0.57	0.603	0.686	0.652	0.664	0.667	0.731	0.741	0.656	0.683	0.635	0.774	0.76	0.742	0.565	0.478	0.586	0.727	0.608	0.495	0.509	0.628	0.592	0.643	0.619	0.694	0.663	0.55	0.6	0.597
GRIFFIN	5A01	1	23b	0.596		0.5	0.527	0.552	0.62	0.583	0.645	0.667	0.654	0.741	0.721	0.65	0.654	0.757	0.74	0.742	0.613	0.522	0.604	0.636	0.608	0.515	0.527	0.529	0.49	0.661	0.562	0.612	0.624	0.532	0.655	0.597
GRIFFIN	5C03	1	20a	0.5	0.5		0.474	0.61	0.626	0.59	0.615	0.638	0.623	0.678	0.629	0.656	0.642	0.744	0.765	0.768	0.635	0.511	0.611	0.679	0.615	0.525	0.571	0.596	0.6	0.649	0.626	0.6	0.612	0.504	0.607	0.586
GRIFFIN	BNR19	1	23b	0.57	0.527	0.474		0.635	0.667	0.649	0.736	0.735	0.67	0.739	0.669	0.698	0.709	0.79	0.778	0.87	0.659	0.495	0.655	0.651	0.66	0.571	0.578	0.624	0.608	0.712	0.673	0.67	0.66	0.618	0.762	0.664
SYS6ENV 2	activ01	4	20a	0.603	0.552	0.61	0.635		0.399	0.475	0.504	0.574	0.556	0.464	0.417	0.423	0.476	0.591	0.639	0.67	0.616	0.509	0.579	0.667	0.612	0.521	0.53	0.597	0.533	0.582	0.528	0.533	0.642	0.474	0.485	0.515
SYS6ENV 2	activ02	4	20a	0.686	0.62	0.626	0.667	0.399		0.493	0.418	0.532	0.573	0.483	0.544	0.51	0.588	0.563	0.591	0.65	0.616	0.647	0.594	0.591	0.567	0.587	0.533	0.628	0.568	0.568	0.561	0.584	0.594	0.493	0.518	0.489
SCP	M53	4	20a	0.652	0.583	0.59	0.649	0.475	0.493		0.469	0.6	0.552	0.577	0.594	0.575	0.664	0.662	0.686	0.632	0.6	0.628	0.591	0.603	0.5	0.567	0.496	0.594	0.462	0.654	0.571	0.613	0.59	0.53	0.573	0.556
SYS6ENV 2	activ03	4	20a	0.664	0.645	0.615	0.736	0.504	0.418	0.469		0.433	0.539	0.519	0.482	0.564	0.521	0.516	0.558	0.642	0.62	0.638	0.565	0.675	0.467	0.571	0.594	0.635	0.514	0.616	0.593	0.64	0.649	0.516	0.529	0.559
SYS6ENV 2	Bushm0 1	4	20a	0.667	0.667	0.638	0.735	0.574	0.532	0.6	0.433		0.613	0.529	0.563	0.629	0.548	0.482	0.517	0.611	0.653	0.643	0.649	0.692	0.559	0.597	0.6	0.656	0.559	0.591	0.6	0.627	0.703	0.588	0.6	0.567
SYS6ENV 2	m5302	4	20a	0.731	0.654	0.623	0.67	0.556	0.573	0.552	0.539	0.613		0.476	0.561	0.615	0.597	0.587	0.525	0.651	0.687	0.706	0.669	0.683	0.607	0.578	0.633	0.696	0.593	0.672	0.617	0.556	0.64	0.636	0.617	0.645
SYS6ENV	m5303	4	20a	0.741	0.741	0.678	0.739	0.464	0.483	0.577	0.519	0.529	0.476		0.5	0.507	0.587	0.533	0.525	0.583	0.671	0.754	0.654	0.697	0.643	0.603	0.682	0.677	0.667	0.612	0.669	0.633	0.707	0.639	0.652	0.603
SCP	APBF-1	4	20a	0.656	0.721	0.629	0.669	0.417	0.544	0.594	0.482	0.563	0.561	0.5		0.311	0.409	0.594	0.594	0.669	0.632	0.617	0.655	0.768	0.63	0.606	0.623	0.708	0.603	0.657	0.579	0.651	0.69	0.511	0.522	0.62
SCP	APBF-2	4	20a	0.683	0.65	0.656	0.698	0.423	0.51	0.575	0.564	0.629	0.615	0.507	0.311		0.477	0.589	0.667	0.698	0.653	0.627	0.664	0.75	0.654	0.6	0.588	0.641	0.645	0.652	0.588	0.645	0.685	0.562	0.544	0.6
SYS6ENV 2	hart01	4	20a	0.635	0.654	0.642	0.709	0.476	0.588	0.664	0.521	0.548	0.597	0.587	0.409	0.477		0.536	0.546	0.651	0.716	0.686	0.686	0.783	0.675	0.633	0.667	0.75	0.704	0.672	0.635	0.722	0.694	0.57	0.533	0.677
SYS6ENV 2	maida01	4	20a	0.774	0.757	0.744	0.79	0.591	0.563	0.662	0.516	0.482	0.616	0.533	0.594	0.589	0.536		0.405	0.561	0.669	0.77	0.667	0.741	0.75	0.7	0.695	0.805	0.647	0.624	0.651	0.731	0.721	0.652	0.649	0.659
SYS6ENV 2	maida02	4	20a	0.76	0.74	0.765	0.778	0.639	0.591	0.686	0.558	0.517	0.691	0.525	0.594	0.667	0.546	0.405		0.535	0.723	0.796	0.692	0.707	0.717	0.695	0.707	0.815	0.654	0.678	0.676	0.712	0.682	0.641	0.603	0.65
SYS6ENV 2	Norm03	4	20b	0.742	0.742	0.768	0.87	0.67	0.65	0.632	0.642	0.611	0.651	0.583	0.669	0.698	0.651	0.561	0.535		0.61	0.758	0.618	0.633	0.623	0.674	0.688	0.762	0.629	0.604	0.692	0.691	0.7	0.655	0.596	0.611
SCP	MILT-4	10	28	0.565	0.613	0.635	0.659	0.616	0.616	0.6	0.62	0.653	0.687	0.671	0.632	0.653	0.716	0.669	0.723	0.61		0.557	0.362	0.471	0.547	0.504	0.443	0.53	0.563	0.563	0.556	0.641	0.557	0.489	0.543	0.417
GRIFFIN	5E01	13	23b	0.478	0.522	0.511	0.495	0.509	0.647	0.628	0.638	0.643	0.706	0.754	0.617	0.627	0.686	0.77	0.796	0.758	0.557		0.578	0.519	0.581	0.464	0.519	0.5	0.5	0.546	0.573	0.563	0.616	0.486	0.574	0.554
SCP	YAN-20	13	23b	0.586	0.604	0.611	0.655	0.579	0.594	0.591	0.565	0.649	0.669	0.654	0.655	0.664	0.686	0.667	0.692	0.618	0.362	0.578		0.496		0.517	0.465	0.46	0.5	0.566	0.607	0.617	0.576	0.438	0.559	0.435
SYS6ENV	jand08	13	23a	0.727	0.636	0.679	0.651	0.667	0.591	0.603	0.675	0.692	0.683	0.697	0.768	0.75	0.783	0.741	0.707	0.633	0.471	0.519	0.496		0.529	0.478	0.46	0.525	0.526	0.484	0.57	0.561	0.47	0.606	0.635	0.554
SYS6ENV	dian01	13	23a	0.608	0.608	0.615	0.66	0.612	0.567	0.5	0.467	0.559	0.607	0.643	0.63	0.654	0.675	0.75	0.717	0.623	0.547	0.581	0.516	0.529		0.464	0.447	0.496	0.46	0.552	0.525	0.604	0.544	0.452	0.529	0.496
SYS6ENV 2	Tele01	13	23a	0.495	0.515	0.525	0.571	0.521	0.587	0.567	0.571	0.597	0.578	0.603	0.606	0.6	0.633	0.7	0.695	0.674	0.504	0.464	0.517	0.478	0.464		0.426	0.439	0.437	0.47	0.436	0.495	0.453	0.397	0.496	0.445
SCP	BULL-3	13	23a	0.509	0.527	0.571	0.578	0.53	0.533	0.496	0.594	0.6	0.633	0.682	0.623	0.588	0.667	0.695	0.707	0.688	0.443	0.519	0.465	0.46	0.447	0.426		0.39	0.404	0.5	0.488	0.561	0.487	0.433	0.492	0.446
SYS6ENV	perth06	13	23a	0.628	0.529	0.596	0.624	0.597	0.628	0.594	0.635	0.656	0.696	0.677	0.708	0.641	0.75	0.805	0.815	0.762	0.53	0.5	0.546	0.525	0.496	0.439	0.39		0.491	0.517	0.487	0.528	0.596	0.563	0.61	0.557
SYS6ENV 2	perth08	13	23a	0.592	0.49	0.6	0.608	0.533	0.568	0.462	0.514	0.559	0.593	0.667	0.603	0.645	0.704	0.647	0.654	0.629	0.563	0.5	0.53	0.526	0.46	0.437	0.404	0.491		0.535	0.431	0.51	0.562	0.478	0.526	0.559
SYS6ENV 2	Light02	13	23a	0.643	0.661	0.649	0.712	0.582	0.568	0.654	0.616	0.591	0.672	0.612	0.657	0.652	0.672	0.624	0.678	0.604	0.563	0.546	0.566	0.484	0.552	0.47	0.5	0.517	0.535		0.48	0.517	0.445	0.519	0.531	0.485
SYS6ENV	perth04	13	23a	0.619	0.562	0.626	0.673	0.528	0.561	0.571	0.593	0.6	0.617	0.669	0.579	0.588	0.635	0.651	0.676	0.692	0.556	0.573	0.607	0.57	0.525	0.436	0.488	0.487	0.431	0.48		0.413	0.589	0.541	0.537	0.6
SYS6ENV	perth07	13	20a	0.694	0.612	0.6	0.67	0.533	0.584	0.613	0.64	0.627	0.556	0.633	0.651	0.645	0.722	0.731	0.712	0.691	0.641	0.563	0.617	0.561	0.604	0.495	0.561	0.528	0.51	0.517	0.413		0.619	0.548	0.597	0.593
SCP	GOLF-1	13	20a	0.663	0.624	0.612	0.66	0.642	0.594	0.59	0.649	0.703	0.64	0.707	0.69	0.685	0.694	0.721	0.682	0.7	0.557	0.616	0.576	0.47	0.544	0.453	0.487	0.596	0.562	0.445	0.589	0.619		0.492	0.539	0.388
SCP	KOON-1	13	20a	0.55	0.532	0.504	0.618	0.474	0.493	0.53	0.516	0.588	0.636	0.639	0.511	0.562	0.57	0.652	0.641	0.655	0.489	0.486	0.438	0.606	0.452	0.397	0.433	0.563	0.478	0.519	0.541	0.548	0.492		0.291	0.328
SCP	KOON-2	13	20a	0.6	0.655	0.607	0.762	0.485	0.518	0.573	0.529	0.6	0.617	0.652	0.522	0.544	0.533	0.649	0.603	0.596	0.543	0.574	0.559	0.635	0.529	0.496	0.492	0.61	0.526	0.531	0.537	0.597	0.539	0.291		0.415
SCP	LAND-1	13	20a	0.597	0.597	0.586	0.664	0.515	0.489	0.556	0.559	0.567	0.645	0.603	0.62	0.6	0.677	0.659	0.65	0.611	0.417	0.554	0.435	0.554	0.496	0.445	0.446	0.557	0.559	0.485	0.6	0.593	0.388	0.328	0.415	

APPENDIX H

Further information on *Darwinia foetida*



MWH.

BUILDING A BETTER WORLD

Client Ref: ENAUPERT04483AA

26 February 2016

Coffey Environments Australia Pty Ltd
Suite2, 53 Burswood Road
BURSWOOD, WA 6100
AUSTRALIA

Attention: **David Morley**
Senior Environmental Consultant

Muchea Bell (*Darwinia foetida*) population located adjacent to the proposed Perth-Darwin National Highway

Dear David

This letter report provides information on the population of the Endangered *Darwinia foetida* located within the Great Northern Highway drain near Muchea. The report details the known extent of *Darwinia foetida* in the Muchea/Bullsbrook region, preferred habitat and determines if the proposed Perth-Darwin National Highway (PDNH) Project will have a significant impact to the population, based on the significant impact criteria for Matters of National Environmental Significance (DoE 2013).

Background

The NorthLink WA Project is a program of road projects proposed to be undertaken by Main Roads Western Australia (Main Roads), which form vital components of a wider series of improvements to the PDNH. The NorthLink WA Project comprises two constituent parts:

- Perth–Darwin National Highway (Swan Valley Section) (herein referred to as the PDNH project) – a new 37 km highway link between the junction of Reid Highway and Tonkin Highway in Malaga and Great Northern Highway and Brand Highway in Muchea.
- Tonkin Grade Separations (TGS project) – the grade separation of the intersections of Tonkin Highway with Collier Road, Morley Drive and Benara Road, together with associated works.

TGS has received Commonwealth and State environmental approval and will not be discussed further within this letter report. The PDNH project is currently being assessed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as a Public Environment Report and under the Western Australian *Environmental Protection Act 1986* (EP Act) as a Public Environmental Review (PER) level of assessment.

Phoenix Environmental Services Pty Ltd (Phoenix) completed a Level 2 flora and vegetation survey of a portion of the Great Northern Highway for a separate project on behalf of Main Roads. The area surveyed by Phoenix, incorporated a portion of the PDNH Project north of the current Brand Highway intersection.

Phoenix identified seven individuals of the EPBC Act listed and State listed threatened *Darwinia foetida* or Muchea Bell within a portion of the PDNH Project. The location of the seven individuals is from a small road drain on the northern end of a rest stop approximately 600 m to the north of the Brand Highway intersection. *Darwinia foetida* has not previously been recorded from within the PDNH Project (Coffey 2015).

Based on the current design of the PDNH Project and the location of the seven individuals, it is anticipated that there will be no direct impacts to the population, however the indirect impacts need to be determined based on current design and the known local and regional extent of the threatened flora.

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Coffey Environments Australia Pty Ltd (Coffey) commissioned MWH Australia Pty Ltd (MWH) to undertake a site visit to accurately identify the location of the seven individuals with respect to the current PDNH Project design and search for any additional individuals in close proximity to the seven plants. In addition, Coffey has requested MWH to prepare a short letter report (this report) detailing the known extent and the habitat that could be considered critical to the long-term survival of the threatened taxon at the location near the PDNH Project. The PDNH Project in relation to the population of *Darwinia foetida* has also been assessed against the significant impact criteria for Matters of National Environmental Significance (DoE 2013).

Darwinia foetida

Darwinia foetida is listed as a Schedule 2 (Endangered) taxon under the Western Australian *Wildlife Conservation Act 1950* (WC Act). Schedule 2 flora are considered to be threatened species facing a high risk of extinction in the wild. In addition, *Darwinia foetida* is listed as Critically Endangered under the EPBC Act, having met the category for Criterion 2, which is, having a very restricted geographic distribution which is precarious for the survival of the species.

Darwinia foetida is an erect, or spreading, shrub to 0.7 m high, often using other shrubs for support (**Plate 1**) (Keighery 2009). Young branches are slender, green-brown with prominent, decurrent leaf bases, becoming grey and woody (Keighery 2009). *Darwinia foetida* produces green-brown flowers in late spring, from October to November (Keighery 2009, WAH 2016). The habitat consists of grey-black sandy rises in winter-damp to wet clay flats under *Regelia inops– Kunzea recurva* tall shrubland over *Hypocalymma angustifolium* low shrubland or low *Melaleuca* shrubland (Keighery 2009).



Plate 1: *Darwinia foetida* located within the Great Northern Highway road culvert/drain

Methods and Approach

The field survey was undertaken on 23 February 2016, and involved traversing the known location of the seven individuals to accurately record, photograph and note their location with relation to the current PDNH Project design. The Great Northern Highway road reserve was traversed to the north (approximately 400 m) of the rest stop on both sides of the road, while an adjacent property with vegetation and habitat that may support the species was also searched. The field survey was undertaken by Clinton van den Bergh, a senior ecologist with MWH. All specimens collected from the field were taken under a flora collecting licence (SL011498), pursuant to the WC Act Section 23C and a Declared Rare Flora permit (8-1516), pursuant to the WC Act Section 23F.

To support the information recorded from the field, a literature review was undertaken to identify the known habitat requirements and the local and regional extent of all known individuals. To support the literature

review, advice was sought from the Department of Parks and Wildlife (DPaW) on known habitat. The documents and online resources reviewed during the literature review included:

- Keighery (2009), Six new and rare species of *Darwinia* (Myrtaceae) in Western Australia;
- WAH (2016), FloraBase; the Western Australian Flora;
- DPaW (2015); Threatened and Priority flora database custom search results;
- DoE (2016), *Darwinia foetida* species profile and threats database; and
- Phoenix (2015), Flora and fauna assessment for Muchea North and Chittering study area.

Discussion

Known records

Prior to the work completed by Phoenix (2015) along the Great Northern Highway, only four populations were known to exist in the Muchea/Bullsbrook area. One population is known to occur within a Nature Reserve and adjacent road reserve, while another is from a water reserve (DoE 2016). The remaining two populations are located on private property (DoE 2016, WAH 2016). In 2009, the area of occupancy was estimated to be 0.03 km^2 with an estimated population size of 1,300 mature individuals, with an additional 185 seedlings recorded from one population (DoE 2016). The work undertaken in 2009 consisted of only the first three populations (Populations 1a and b, 2 and 3a and b), as the fourth population had not yet been confirmed.

A population census for *Darwinia foetida* was undertaken in 2006 at three of the locations (i.e. Populations 1a and b, 2 and 3a and b, **Table 1**) to further define the extent and health of the threatened taxon. In 2007, an additional population was recorded from private property in Bullsbrook, which was later confirmed by DPaW in 2010, bringing the total known extent to four populations.

The additional records made by Phoenix, one located adjacent to the PDNH Project and the other a significant distance away (greater than 1 km) from the PDNH Project, increases the known populations to six. However, both Phoenix populations are located within the Great Northern Highway road reserve and are currently impacted by introduced grasses and other weeds.

Based on the information available (DPaW 2015, Phoenix 2015) and review of specimen information (WAH 2016), there is currently in excess of 1,890 mature individuals with an additional 469 seedlings (**Table 1**). As discussed above, there has not been a population census for *Darwinia foetida* since 2006, so actual mature individuals and seedling numbers may differ substantially.

Table 1: **Darwinia foetida *known records***

Source	Population	Vesting/purpose	Mature	Seedlings
DPaW (2015)	1a	Nature Reserve	250	0
	1b	Road verge	0	469
	2	Unallocated crown land	500	0
	3a	Private (Bush Forever)	1,000	0
	3b	Private (Bush Forever)	100	0
	4	Private	25	0
Phoenix (2015)	5	Road verge	7	0
	6	Road verge	10	0
Total			1,892	469

Note: Population 5 is located adjacent to the PDNH Project and the subject of this letter report.
Note: population numbering for the Phoenix records have been created by the author and may not match actual population numbering held by DPaW

Known Habitat

Keighery (2009) noted that *Darwinia foetida* occurs on grey-black sandy rises in winter-damp to wet clay flats under *Regelia inops– Kunzea recurva* tall shrubland over *Hypocalymma angustifolium* low shrubland or low

Melaleuca shrubland. A review of the Western Australian Herbarium (WAH) specimen database indicates that plants are found alongside a sumpland wetland (WAH 2016).

The four known records have all been recorded from the Muchea area, approximately 70 km north of Perth (DoE 2016, Keighery 2009). The estimated area of occupancy based on the information known in 2009 was 0.03 km^2 (DoE 2016)

All four previously known populations have been recorded from either palusplain or sumpland wetlands, as mapped by the *Geomorphic Wetlands Swan Coastal Plain dataset*. Populations 1, 3 and 4 are from palusplain wetland, while Population 2 is from (or adjacent to) a sumpland (**Table 2**).

As a result of the wetlands, the supporting vegetation consists of wetland species with the presence of transitional species (i.e. *Corymbia calophylla*) where the habitat allows (**Table 2**).

Table 2: Habitat details for the four known populations

Population	Wetland type	Wetland category	Soil	Landform	Vegetation
1a 1b	Palusplain	Multiple Use	Grey sand, peaty sandy clay	Low plain	*Regelia inops, Melaleuca incana, Kunzea recurva, Hypocalymma angustifolia, Xanthorrhoea preissii, Allocasuarina humilis, Hibbertia hypericoides, Patersonia occidentalis, Bossiaea eriocarpa, Banksia dallanneyi*
2	Sumpland	Conservation	Grey Sand	Wetland	*Pericalymma ellipticum, Astartea* aff. *fascicularis, Melaleuca rhaphiophylla, Banksia littoralis*
3a 3b	Palusplain	Conservation	Brown loamy sand, grey sand	Wetland	*Melaleuca* sp., *Banksia menziesii, Viminaria juncea, Xanthorrhoea* sp., *Nuytsia floribunda*
4	Palusplain	Multiple Use	Dark grey sand	Wetland	*Melaleuca rhaphiophylla, Hypocalymma angustifolia, Acacia pulchella* shrubland beneath marri, with invasion by blackberry, brazilian peppertrees, weedy grasses.

Site records

Phoenix (2015) identified seven individuals from Population 5 within the road drain located adjacent to the PDNH Project. Following the site visit and further refinement of the population, it is considered that approximately 16 mature individuals and one seedling occur within this small area of occupancy. It was noted that several individuals were hidden by large clumps of **Eragrostis curvula* and **Watsonia meriana*. It was also difficult to discern individuals as the majority of them were growing as a large clump. As a result there may be additional individuals not accounted for which were obscured by weeds at the time of the site visit. This may also explain why Phoenix only recorded seven individuals at the time of their survey.

Although the timing of the February site visit is not considered to be optimal and outside of the known flowering time for *Darwinia foetida*, the plants located during the site visit match with the Phoenix GPS coordinates. A specimen collected at the time of the site visit included an old flower, and based on the description of the taxon from Keighery (2009) the population is considered to match *Darwinia foetida* with a high confidence.

The 16 individuals expands on the previous seven individuals recorded by Phoenix (2015) (**Table 3**), however the area of occupancy within the drain does not increase as all individuals were recorded within the bounds of the Phoenix GPS coordinates.

A stretch of 400 m to the north of the rest stop within the road drain on either side of the Great Northern Highway was traversed, with no further individuals recorded. The rest stop was also traversed with no individuals recorded.

The additional population (nominally Population 6) identified by Phoenix (2015) (located to the south along Great Northern Highway) was also searched on foot. Phoenix (2015) had previously recorded ten individuals, however following the site visit, the total count is approximately 20 mature individuals with three dead adults and no seedlings (**Table 3**). The increase in the number of individuals at the nominal Populations 5 and 6 increases the total known extent from 1,892 mature individuals and 469 seedlings to 1,911 mature individuals and 470 seedlings.

Table 3: Population count for Great Northern Highway locations

Population	Mature		Seedlings		Dead	
	Phoenix	MWH	Phoenix	MWH	Phoenix	MWH
5 (Northern)	7	16	0	1	0	0
6 (Southern)	10	20	0	0	0	3

Site description and habitat

The individuals of *Darwinia foetida* within Population 5 were recorded within the Great Northern Highway road drain (**Attachment A** and **Attachment B**). The base of the road drain was dominated by **Watsonia meriana*, while the *Darwinia foetida* individuals were located on the slope of the drain nearest the highway and the rest stop. The slopes, in addition to *Darwinia foetida*, consisted of **Eragrostis curvula* clumps and scattered **Briza maxima* (**Plate 2**). The surrounding vegetation had isolated clumps of *Regelia ciliata* with scattered *Callitris pyramidalis* and *Hypocalymma angustifolium* (**Plate 2**). A cleared paddock was located on the western side of the road drain.

The vegetation recorded within the road drain had similarities to habitat previously recorded to occur in association with *Darwinia foetida* (Keighery 2009), as described above.



Plate 2: *Darwinia foetida* localised habitat

Known threats and potential PDNH Project threats

The major threats to Muchea Bell include grazing by rabbits, weed invasion, changes in hydrology, inappropriate fire regimes, land clearing and dieback caused by *Phytophthora cinnamomi* (DoE 2016).

Population 5 recorded by Phoenix (2015) within the road verge is currently being impacted by invasive weeds (**Plate 2**). The supporting vegetation was dominated by **Watsonia meriana* and **Eragrostis curvula*. In addition, the plants are located in close proximity to other potential threats, i.e. within a road drain between the Great Northern Highway and cleared paddock, while a rest stop is located along the southern boundary of the plants. Additional threats, though not noted in the field, would include grazing by rabbits and potential changes to the local hydrology. The natural hydrology would have changed significantly over time through land clearing and the creation of drains along the Great Northern Highway.

Habitat that may be considered critical

An interim recovery plan has not been developed for *Darwinia foetida*, resulting in no formal description of critical habitat for the Endangered species. However, it has been assumed that critical habitat for *Darwinia foetida* would include the area of occupancy for all known populations, areas of similar habitat surrounding known populations and vegetation that links populations. In addition, as the taxon occurs within wetland habitats, the local catchment and hydrology would also be considered critical for the long-term survival of a population.

Based on the information presented above, habitat that could be deemed as critical for the population would include an area of approximately 0.12 ha of roadside vegetation located adjacent to the Great Northern Highway. The critical habitat extends from the end of the rest stop, where the 16 individuals are located, north approximately 80 m to a major drain that passes under the Great Northern Highway.

The main reasons for the determination of the critical habitat are:

- The supporting vegetation, including *Regelia ciliata* and *Hypocalymma angustifolium*, are present within the area;
- The habitat includes a sumpland (in this case a man-made drain that collects water) with upland slopes, as described by WAH (2016);
- The hydrology across the critical habitat is similar as it is all located within the same road drain. On the northern boundary of the critical habitat, the hydrology changes from a sumpland to a creek/channel that funnels all surface and underground water west along the creek/channel towards Ellen Brook;
- North of the critical habitat the soil changes to more clay based, while the vegetation changes significantly, with native sedges being the dominant understorey, with *Melaleuca concreta* in the upper stratum; and
- The population is fragmented from the remaining populations with major highways, cleared paddocks and infrastructure present.

Significant Impact Criteria

The proposed action (i.e. construction of the PDNH Project adjacent to the population) is not considered to have a significant impact (**Attachment C**) to the Commonwealth (Critically Endangered) and State (Endangered) listed *Darwinia foetida*, according to the description of the PDNH Project and the Significant Impact Criteria (DoE 2013).

The habitat supporting the *Darwinia foetida* individuals is located within the road drain which is a highly degraded strip of vegetation dominated by invasive weeds. The habitat is highly altered and disturbed through ongoing impacts associated with weeds, altered hydrology and the potential altered changes to the fire regime resulting from an increase in fuel load from the weeds and the refuse and waste located along the verge from the users of the Highway.

It is assumed that the construction of the PDNH Project will be undertaken in accordance with Environmental Management Plans that will identify management measures to reduce the likelihood of spreading weeds, diseases (*Phytophthora* Dieback) and igniting fires, while also ensuring there is no deviation away from the approved clearing boundary. Additionally, it is understood that in line with current designs for the project, the

current site hydrology will be maintained with the retention of the road drains. As a result, the local catchment and hydrology will, at the least, be maintained ensuring the local conditions do not alter significantly.

Provided that indirect impacts (i.e. introduction and/or spread of weeds, hydrological changes, diseases) are minimised, the population may persist for the medium to long-term future, assuming routine road reserve maintenance takes into account the significant environmental values.

Conclusion

The population of *Darwinia foetida* recorded by Phoenix (2015) and further refined in this document (Population 5, located to the north of the rest stop on Great Northern Highway in Muchea) is considered to be a new record of the threatened flora on the Swan Coastal Plain. Previous knowledge on the threatened taxon indicated that only four populations were known to occur, totalling approximately 1,875 mature individuals and 469 seedlings. The new population, along with an additional population recorded further south by Phoenix (2015) within the road verge of the Great Northern Highway (located approximately 500 m north of the Wandena Road turnoff) increases the known extent to 1,911 mature individuals and 470 seedlings.

Based on the current design, the PDNH Project will not directly impact the new population located within the road verge, however indirect impacts may affect the population and habitat if not appropriately managed. The indirect impacts may include an increase in and/or introduction of weeds, diseases, altered fire regime and altered hydrology. The population is currently under threat from an altered hydrology and a high density of weeds, thus potentially increasing the likelihood of fire.

The PDNH Project is unlikely to have a significant impact to the population, based on the significant impact guidelines (DoE 2013), if appropriate management measures are implemented. It is assumed that the construction of the PDNH Project will occur in accordance with an appropriate Environmental Management Plan.

If you wish to discuss any aspect of this document, please do not hesitate to contact the undersigned.

Yours sincerely



Clinton van den Bergh
Senior Ecologist
MWH Australia Pty Ltd

Attachment A: Population, habitat and site photos
Attachment B: Field Sketch of Darwinia foetida individuals from Population 5
Attachment C: Significant impact criteria for *Darwinia foetida*

References

Coffey, Environments Australia. (2015) *Public Environmental Review: Perth-Darwin National Highway (Swan Valley Section)*.

DoE, Department of the Environment. (2013) *Significant Impact Guidelines 1.1: Matters of National Environmental Significance* Department of the Environment, Canberra, Western Australia.

DoE, Department of the Environment (2016) *Darwinia foetida in Species Profile and Threats Database*. Department of the Environment. Available online at http://www.environment.gov.au/sprat.

DPaW, Department of Parks and Wildlife (2015) *Threatened and Priority Flora Database (custom search)*. Available online at http://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants.

Keighery, G. J. (2009) Six new and rare species of *Darwinia* (Myrtaceae) from Western Australia. *Nuytsia* 19(1): 37-52.

Phoenix, Environmental Services. (2015) *Flora and fauna assessment for Muchea North and Chittering study area: Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project*.

Terratree. (2014) *Phytophthora Dieback Linear Assessment: Perth Darwin National Highway Project Corridor*.

WAH, Western Australian Herbarium (2016) *FloraBase: the Western Australian Flora*. Department of Parks and Wildlife. Available online at https://florabase.dpaw.wa.gov.au/.

Attachment A

Population, habitat and site photos



Darwinia foetida habit.



Darwinia foetida habit and the location to the road edge



Darwinia foetida individual being smothered by **Eragrostis curvula* (the individual is difficult to see but is located within the centre of the image)



Note the dominance of weeds (**Eragrostis curvula* and **Watsonia meriana*)



Darwinia foetida showing domed shape



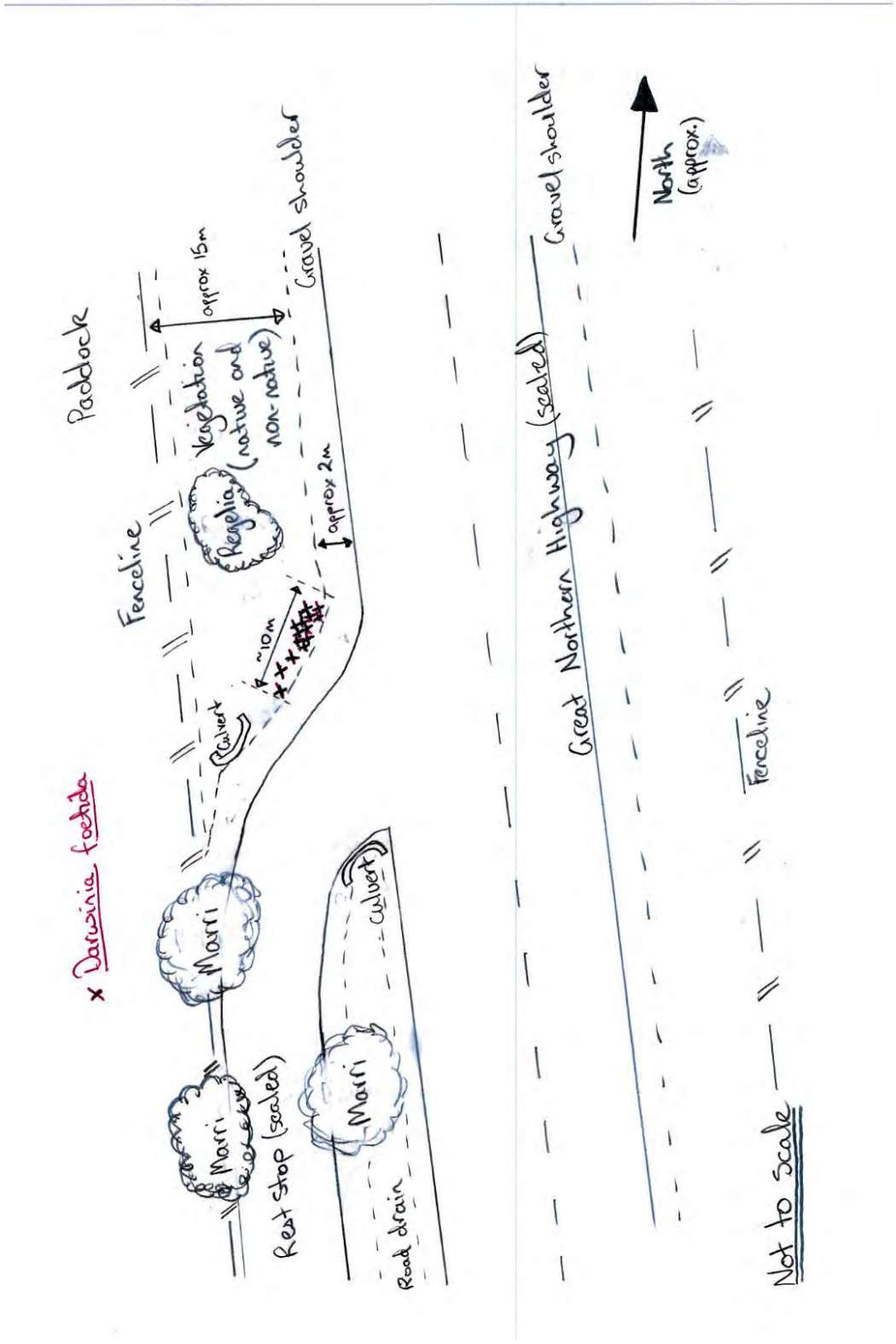
Close-up of old flower on *Darwinia foetida*



Annotated photo showing location of *Darwinia foetida* individuals in relation to the gravel shoulder and sealed rest stop

Attachment B

Field Sketch of* Darwinia foetida *individuals from Population 5



Attachment C

***Significant Impact Criteria for Population 5 of* Darwinia foetida**

An action is likely to have a significant impact on a critically endangered species if there is a real chance or possibility that it will	Significant Impact?	Comment
Lead to a long-term decrease in the size of a population	No	The PDNH Project will not lead to a long-term decrease in the size of the population. The individuals are currently persisting in a highly altered environment with significant threats associated with weeds and hydrology (resulting from the current Great Northern Highway). The PDNH Project may provide a positive influence to the population with the implementation of appropriate management measures during construction, including the maintenance and improvement of the current hydrology. The population is fragmented and under significant, ongoing threats, if left unchecked, the population may decrease naturally in the short to medium-term future.
Reduce the area of occupancy of the species	No	The current estimated area of occupancy is 0.03 km^2 (DoE 2016) or 3 ha. With the addition of the two new population identified by Phoenix (2015) and further refined by this document, the area of occupancy is not considered to increase significantly (approximately 0.03 ha increase) as the new populations are small and restricted. The PDNH Project will avoid directly impacting the population, as such the area of occupancy will not be reduced. The PDNH Project has been designed to avoid any direct impacts, with all disturbances to be located within the current road alignment and rest stop. The potential indirect impacts from the PDNH Project (i.e. weeds, changed hydrology, introduced diseases) are considered to already be present and the construction may reduce the severity of the indirect impacts through appropriate construction management.

An action is likely to have a significant impact on a critically endangered species if there is a real chance or possibility that it will	Significant Impact?	Comment
Fragment an existing population into two or more populations	No	The PDNH Project will not fragment the population located within the Great Northern Highway road drain. The population itself is highly fragmented from all other known populations. The nearest population is located over 2 km to the south-west.
Adversely affect habitat critical to the survival of a species	No	Habitat that may be considered critical for the species is estimated to be 0.12 ha in size and extends approximately 80 m north of the rest stop (on the western side of the Great Northern Highway) within the road drain. The current project design will not directly impact the critical habitat. The habitat that may be considered critical is already under threat through introduced weeds, hydrology changes, changes to the fire regime (as a result of the significant fuel load present from the introduced grasses) and the degradation of the habitat through waste and refuse from the highway. Management measures implemented during construction may reduce the severity of these ongoing threats and provide a more stable habitat for long-term survival.
Disrupt the breeding cycle of a population	No	The breeding cycle of *Darwinia foetida* is not currently known, however, the majority of *Darwinia* species are pollinated by insects and possibly birds for some species. Insects will remain present during and after the construction of the PDNH Project. It is not known whether a unique insect (e.g. native wasp) is required for pollination. The PDNH Project will not disrupt the breeding cycle of the population, as no direct impacts will occur. Provided that indirect impacts are minimised, the habitat quality will remain stable or may improve following implementation of management measures related to weeds, diseases and hydrology.

An action is likely to have a significant impact on a critically endangered species if there is a real chance or possibility that it will	Significant Impact?	Comment
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No	Based on the current design, the PDNH Project will not directly impact on the availability of habitat for *Darwinia foetida* within the road drain. The PDNH Project may indirectly modify or decrease the availability of habitat through alterations to the hydrology. However based on the PDNH Project design, impacts to hydrology that would affect the habitat for *Darwinia foetida* are considered to be minimal. The current quality of the habitat would be considered to be low due to the dense coverage of introduced weeds, including **Eragrostis curvula* and **Watsonia meriana* (**Attachment A**). Through appropriate weed and hygiene management measures the likelihood of introducing new species is considered to be low. The availability and quality of habitat is expected to remain the same following implementation of management measures to reduce indirect impacts.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	No	The location of the population within the road verge is already heavily impacted by invasive weeds, including **Watsonia meriana, *Eragrostis curvula, *Avena barbata* and **Briza maxima*. The proposed action would be undertaken in accordance with specific weed hygiene management measures to reduce the likelihood of introduction and spread of invasive weeds. Additionally, the population is located adjacent to a rest stop and a major highway, which would have a large number of current potential vectors (i.e. trucks and cars). The implementation of appropriate weed management measures could reduce this existing threat.

An action is likely to have a significant impact on a critically endangered species if there is a real chance or possibility that it will	Significant Impact?	Comment
Introduced disease that may cause the species to decline	No	The road verge has been subjected to a dieback assessment in 2014 (Terratree 2014) and was mapped as 'Excluded'. As such, the current presence of introduced diseases is unknown. However, any disturbances associated with the PDNH Project should be undertaken in accordance with specific management measures to reduce the spread and/or introduction of *Phytophthora* Dieback and other introduced diseases.
Interfere with the recovery of the species	No	The potential direct and indirect impacts to the population are not considered to interfere with the recovery of the species. Critical habitat for the species is located outside of the project footprint. The population is located within a highly disturbed and altered road drain. The majority of the known populations are within larger, less disturbed blocks of native vegetation, which would form the main populations for recovery actions.

APPENDIX I

Revised Transportation Noise Assessment



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Revised Transportation Noise Assessment

Perth-Darwin National Highway Project

Reference: 13122263-01

Prepared for:
Main Roads WA

Member Firm of Association of Australian Acoustical Consultants

Report: 13122263-01 PDNH

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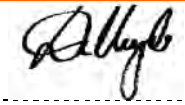
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A Road Surfaces, Posted Speeds and Future Traffic Volumes
B Detailed Measurement Results
C Predicted Noise Levels Without Noise Barriers
D Terminology

1 INTRODUCTION

Main Roads Western Australia (Main Roads) is currently planning for delivery of the NorthLink WA project, as shown in *Figure 1-1*, which comprises the following two components:

- Perth Darwin National Highway (PDNH) – construction of a new 37km highway link between the junction of Reid Highway/Tonkin Highway and Great Northern Highway/Brand Highway at Muchea; and
- Tonkin Grade Separations – the grade separation of Tonkin Highway with Collier Road, Morley Drive and Benara Road together with associated works including potential widening of the Tonkin Highway.

The NorthLink WA project seeks to deliver a transport corridor that can accommodate the predicted growth in the regional freight task to the State's North West, as well as accommodating the urban traffic demand in the future.

The Perth Darwin National Highway, which is the subject of this noise assessment, will form part of the Australian National Land Freight Network, which aims to provide an interconnected network of freight corridors to the nation's major seaports, airports and freight generating areas, maximising Australia's international competitiveness. The PDNH will connect Perth to the Pilbara and North West WA.

Within the Perth metropolitan region, Tonkin Highway and PDNH will form part of the strategic freight network, linking strategic industrial centres to the Kewdale/Welshpool intermodal terminal. The route will also support further development along the northeast metropolitan corridor, and allow planning provision for a heavy passenger rail line within the Highway median (between Morley Drive and Whiteman to Yanchep Highway).

This report considers the potential noise impacts associated with the Perth Darwin National Highway section by:

- Measuring existing noise levels along the project route;
- Constructing a noise model of the existing road network and calibrating the predicted noise levels against the measured noise levels;
- Using the calibration from the existing model, calculate the noise levels for the year 2040.
- Determine appropriate noise mitigation options to achieve compliant noise levels at surrounding noise sensitive premises.

Appendix D contains a description of some of the terminology used throughout this report.

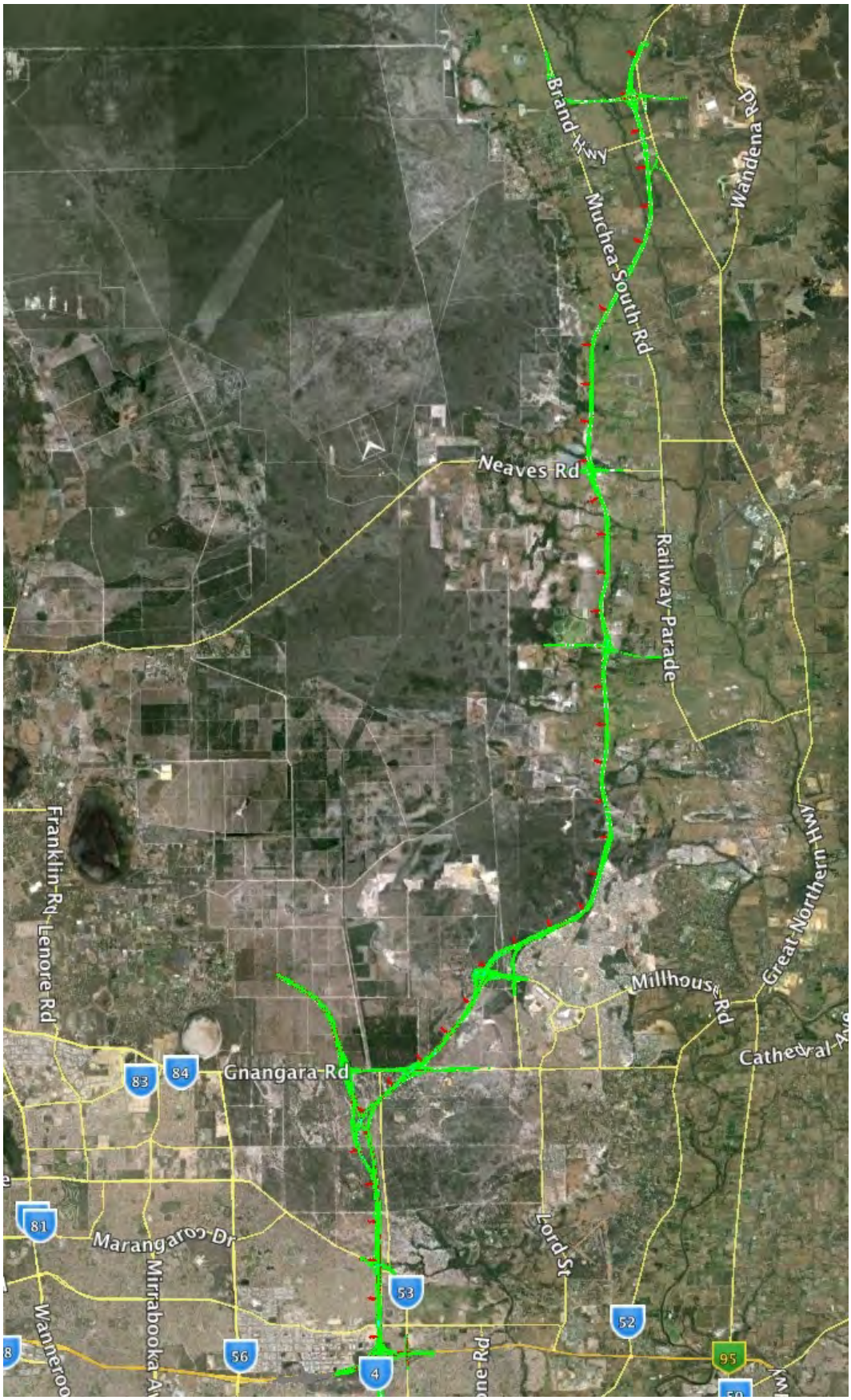


Figure 1-1 Road Project Locality

2 CRITERIA

The criteria relevant to this assessment is the *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning* (hereafter referred to as the Policy) produced by the Western Australian Planning Commission (WAPC). The objectives in the Policy are to:

- Protect people from unreasonable levels of transport noise by establishing a standardised set of criteria to be used in the assessment of proposals;
- Protect major transport corridors and freight operations from incompatible urban encroachment;
- Encourage best practice design and construction standards for new development proposals and new or redevelopment transport infrastructure proposals;
- Facilitate the development and operation of an efficient freight network; and
- Facilitate the strategic co-location of freight handling facilities.

When considering the noise levels, the Policy's outdoor noise criteria are shown below in *Table 2-1.* These criteria apply at any point 1-metre from the façade of a habitable ground floor of a noise sensitive premise.

Table 2-1 Outdoor Noise Criteria

Period	Target	Limit
Day (6am to 10pm)	55 dB $L_{Aeq(Day)}$	60 dB $L_{Aeq(Day)}$
Night (10pm to 6am)	50 dB $L_{Aeq(Night)}$	55 dB $L_{Aeq(Night)}$

Note: The 5 dB difference between the target and limit is referred to as the margin.

The Policy's outdoor noise criteria:

- provide an acceptable level of acoustic amenity for existing noise-sensitive land uses and for the planning of new noise-sensitive developments;
- are consistent with other planning policies and community expectations; and
- are practicably achievable.

Where a transport infrastructure project will emit transport noise levels that meet the noise target, no further measures are required under this policy.

Otherwise transport infrastructure providers should design mitigation measures to achieve the noise *limit* of $L_{Aeq\ (Day)}$ 60dB and $L_{Aeq\ (Night)}$ 55dB, when assessed at 1m from the façade at ground floor level.

Transport infrastructure providers are also required to consider design measures to meet the noise target of $L_{Aeq\ (Day)}$ 55dB and $L_{Aeq\ (Night)}$ 50dB, and to implement these measures where reasonable and practicable.

Based on the above, it is considered appropriate to use the Day *limit* criterion of $L_{Aeq\ (Day)}$ 60 dB, when designing the noise mitigation measures. This is consistent with other Main Roads projects.

3 METHOD

Noise measurements and modelling have been undertaken to determine the existing and future noise levels associated with the Project. This section details the method and assumptions used to undertake this assessment.

3.1 Site Measurements

Noise monitoring was undertaken at 20 locations in order to quantify the existing noise levels to determine if day or night period is dominant and to calibrate the noise model. Monitoring sites along Tonkin Highway and in the rural areas were not used in the calibration, as they did not reflect traffic conditions (and noise) expected to be generated by the proposal. For example, congestion on Tonkin Highway and local road traffic are not reflective of free-flowing traffic on the proposed road. Location T on the Great Northern Highway, south of Muchea is more reflective of the traffic conditions (and noise) expected for the proposed road and was therefore used to calibrate the noise model.

The instruments used were ARL Type 316 and ARL Type Ngara noise data loggers. The loggers were positioned at one metre from the façade of interest. Each logger was placed at least one metre from any corner of the building and the microphone height was 1.4 metres above ground floor level.

The loggers were programmed to record hourly L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels. From the hourly measurements, the $L_{A10,18\ hour}$, $L_{Aeq,24\ hour}$, $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ values were determined for each complete measurement day. These results were averaged and the mean level reported.

The instruments comply with the instrumentation requirements of *Australian Standard 2702-1984 Acoustics – Methods for the Measurement of Road Traffic Noise*. The loggers were field calibrated before and after the measurement session and found to be accurate to within +/- 1 dB. Lloyd George Acoustics also holds current laboratory calibration certificates for the loggers.

The noise data collected was verified by inspection and professional judgement. Where hourly data was considered atypical, an estimated value based on professional judgement, consistent with normal road traffic noise profiles, was inserted and highlighted by bold italic lettering.

The weather conditions during the measurement period were obtained from the Bureau of Meteorology's Perth Metro (Mount Lawley) and Pearce RAAF stations. This data was compared against the Main Roads specifications for measurement conditions and any unacceptable conditions commented on (*Appendix B*). Where data is significantly affected by weather conditions e.g., rain or high winds, it has been excluded from the results for the measurement period.

The locations of the monitoring are provided in *Figures 3-1 to 3-3,* and were chosen to reflect the changing conditions along the project route. The full noise monitoring report is attached at *Appendix B*.



Figure 3-1 Monitoring Locations A to L

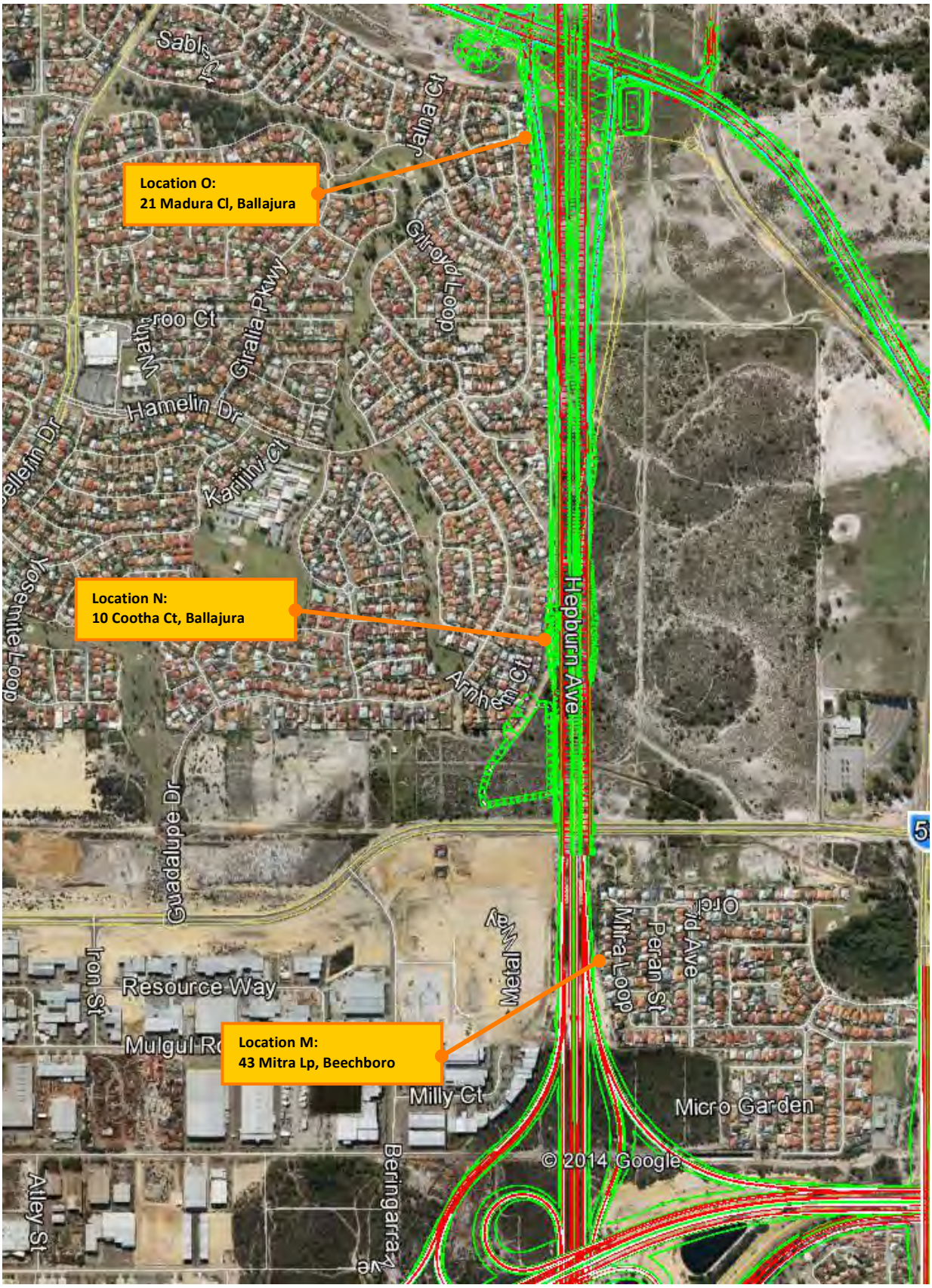


Figure 3-2 Monitoring Locations M to O



Figure 3-3 Monitoring Locations P to T

3.2 Noise Modelling

3.2.1 Noise Model and Set-up

The computer programme *SoundPLAN 7.3* was utilised incorporating the *Calculation of Road Traffic Noise* (CoRTN) algorithms, modified to reflect Australian conditions. The modifications included the following:

- Vehicles were separated into heavy (Austroads Class 3 upwards) and non-heavy (Austroads Classes 1 & 2) with non-heavy vehicles having a source height of 0.5 metres above road level and heavy vehicles having two sources, at heights of 1.5 metres and 3.6 metres above road level, to represent the engine and exhaust respectively. By splitting the noise source into three, allows for less barrier attenuation for high level sources where barriers are to be considered. Note that corrections are applied to the exhaust of –8.0 dB (based on *Transportation Noise Reference Book, Paul Nelson, 1987*) and to the engine source of –0.8 dB, so as to provide consistent results with the CoRTN algorithms; and
- An adjustment of –1.7 dB has been applied to the predicted levels based on the findings of An Evaluation of the U.K. DoE Traffic Noise Prediction; Australian Road Research Board, Report 122 ARRB – NAASRA Planning Group 1982.

Predictions are made at heights of 1.4 metres above ground floor level and at 1.0 metre from an assumed building façade (resulting in a + 2.5 dB correction due to reflected noise).

3.2.2 Topography, Road Design, Barriers & Cadastral Data

Topographical data, was based on that provided by BG&E, with the contours being in 1.0 metre intervals. The new road design has been integrated into the existing topography. Existing solid property fences located along the project route have been included in the model for the existing scenario. These fences are not considered as noise barriers for future scenarios. Noise barriers for the future scenario would need to be constructed using materials with a surface density exceeding 15 kg/m^2.

Buildings have also been included as these can provide barrier attenuation when located between a source and receiver, in much the same way as a hill or wall provides noise shielding. This is particularly relevant to receivers located behind the first row of buildings adjacent to the corridor. All buildings are assumed to have a height of 4.0 metres.

3.2.3 Traffic Data and Modelling Scenario

Regional traffic models for the Perth Metropolitan area to account for predicted changes in land use and population are periodically developed/updated by Main Roads and the Department of Planning. The 2050 regional traffic model was developed as part of this proposal and updates the 2031 model. The Policy requires the assessment of traffic noise impacts assuming future conditions, being 15 to 20 years from project completion. The 2031 model is not far enough into the future and the 2050 model is too far into the future. For this project, traffic volumes for the year 2040 have been used to represent future conditions.

The road surfaces, traffic volumes, percentage of heavy vehicles and posted speeds for each section of the project were provided by Main Roads and are shown at *Appendix A*. The noise relationship

between the various road surfaces is provided in *Table 3-1*. As a guide, 14mm Chip Seal would be the noisiest surface and Open Graded Asphalt the quietest.

Table 3-1 Noise Relationship between Different Road Surfaces

Road Surfaces						
Chip Seal			Asphalt			
14mm	10mm	5mm	Dense Graded	Novachip	Stone Mastic	Open Graded
+3.5 dB	+2.5 dB	+1.5 dB	0.0 dB	-0.2 dB	-1.0 dB	-2.5 dB

3.2.4 Ground Attenuation

The ground attenuation has been assumed to be 0.0 (0%) for the roads and 1.0 (100%) between the roads and the receivers. Note 0.0 represents hard reflective surfaces such as water and 1.00 represents absorptive surfaces such as grass. This is considered to be a reasonable approach for assessment.

3.2.5 Parameter Conversion

The CoRTN algorithms used in the *SoundPLAN* modelling package were originally developed to calculate the $L_{A10,18hour}$ noise level. The WAPC Policy however uses $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$. The relationship between the parameters varies depending on the composition of traffic on the road (volumes in each period and percentage heavy vehicles) and this is calculated within the SoundPLAN model.

As noise monitoring was undertaken, the $L_{Aeq(Day)}$ levels are based on the results of the monitoring (refer *Section 4.1)*.

4 NOISE MODEL CALIBRATION

The results of the noise monitoring used to establish existing ambient noise levels and to determine if the day or night period is dominant are summarised below in *Table 4-1*. Detailed measurement results are provided at *Appendix B*.

Table 4-1 Measured Average Noise Levels – Monitoring Locations

No.	Address	Average Weekday Noise Level, dB		
		$L_{A10,18hour}$	$L_{Aeq\ (Day)}$	$L_{Aeq\ (Night)}$
A	2 Redlands St, Bayswater	55.3	54.2	48.8
B	16 Harvest Rd, Morley	60.8	58.8	54.4
C	28A Bruce Rd, Morley	60.5	58.5	53.3
D	2A Abbey Street, Morley	61.6	59.0	52.5
E	9 Clandon Way, Morley	59.4	57.9	52.9
F	48 Alfreda Ave, Morley	59.3	57.1	53.4

Table 4-1 (cont') Measured Average Noise Levels – Monitoring Locations

No.	Address	Average Weekday Noise Level, dB		
		$L_{A10,18hour}$	$L_{Aeq\ (Day)}$	$L_{Aeq\ (Night)}$
G	100 Alfreda Ave, Morley	59.3	56.9	54.6
H	8 Wells Court, Noranda	51.5	49.9	45.5
I	15 Davis Court, Morley	48.3	50.1	44.3
J	6 Acacia Court, Beechboro	57.1	54.9	50.9
K	11 Willow Place, Beechboro	53.9	52.2	48.0
L	8 Jarrah Court, Beechboro	51.6	50.6	45.5
M	43 Mitra Loop, Beechboro	50.9	50.1	52.8
N	10 Cootha Court, Ballajura	47.8	47.4	43.2
O	21 Madura Close, Ballajura	50.3	49.4	47.0
P	12 Fewson Turn, Ellenbrook	45.6	49.1	44.1
Q	32 Stock Road West, Bullsbrook	51.1	54.2	48.2
R	144 Strachan Road, Bullsbrook	45.6	47.7	43.2
S	591 Muchea South Road, Muchea	52.1	50.7	49.3
T	3362 Great Northern Highway	64.5	61.5	58.2

As described in *Section 3.2.4*, the measurement data is used to determine the difference between the $L_{A10,18hour}$ and $L_{Aeq(Day)}$ or $L_{Aeq\ (Night)}$ noise descriptors, as well as to determine if the day or night period traffic noise is dominant when compared to the Policy criteria.

From the measurement results relating to areas adjacent to the existing road network (Locations A to L and T), the average difference between the $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ levels is 4.6 dB. Generally, as traffic volumes increase into the future, the day noise levels increase greater than the night noise levels. Therefore, for this project it is assumed that for future traffic volumes, the day traffic noise levels will be more than 5 dB above the night traffic noise levels and it will be the day levels that would be compared against the Policy criteria.

The measurement results are also used to calibrate the noise model by comparing the predicted existing noise levels to the measured levels at relevant noise logger locations. As described in *Section 3-1*, for this project, following consultation with the Department of Environment and Regulation, the measurement location on the Great Northern Highway (Location T) is considered the most appropriate location to calibrate the noise model. This comparison is shown in *Table 4-2*.

Table 4-2 Comparison between Measured and Predicted Noise Levels at Monitoring Locations

Rec ID	Address	Measured $L_{Aeq\ (Day)}$	Predicted $L_{Aeq\ (Day)}$	Difference
T	3362 Great Northern Highway	61.5	62.1	-0.6

For the measurement location adjacent to the Great Northern Highway, the calibration factor is -0.6 dB, which shows good correlation with the noise prediction model.

5 RESULTS

5.1 Noranda, Ballajura and Ellenbrook

The results of the noise prediction for the 2040 traffic volumes, together with the location and height of noise barriers, are shown in *Figures 5-1 to 5-4*.

For the Tonkin Highway / Reid Highway Interchange and the section of the PDNH between Reid Highway and Hepburn Avenue, the noise barriers have been designed to ensure, where practicable, all noise sensitive premises receive a traffic noise level below $L_{Aeq\ (Day)}$ 60 dB, assuming forecast or predicted 2040 traffic volumes.

In the vicinity of the residential area of Ellenbrook, which is considered to be a quiet environment, the noise barriers have been designed such that all noise sensitive premises receive a traffic noise level below $L_{Aeq\ (Day)}$ 55 dB, or as low as reasonably practicable. This assumes a maximum noise barrier height of 5.0m and predicted 2040 traffic volumes.

For information purposes, the predicted noise levels for the 2040 traffic volumes assuming no noise barriers are provided in *Appendix C.*

5.2 Rural residential properties north of Ellenbrook

For the rural residential properties north of Ellenbrook, the proposed 2.4 m screen walls will provide some noise mitigation. Where noise levels exceed $L_{Aeq\ (Day)}$ 60 dB, further mitigation will be provided by noise mitigation packages consistent with the Policy Guidelines. This is a common strategy for rural areas where very long barriers would be required to protect a small number of properties.

The predicted noise levels to receivers north of Ellenbrook are provided in *Table 5-1,* with property locations shown in *Figures 5-5 and 5-6*. *Table 5-1* identifies those properties where the predicted noise levels exceed $L_{Aeq\ (Day)}$ 60 dB and noise control would be considered to achieve acceptable internal noise levels. The actual level of protection, which may include facade treatment and/or localised noise barriers within properties, will be determined following negotiations with the property owner and a detailed site investigation.

Table 5-1 Predicted Noise Levels to Noise Sensitive Receivers North of Ellenbrook

Rec No	Address	Predicted Future Noise Level $L_{Aeq\ (Day)}$ dB	Limit Criterion Exceeded?
1	458 Maralla Road, Bullsbrook	61	Y
2	43 Sawpit Road, Bullsbrook	57	N
3	215 Sawpit Road, Bullsbrook	55	N
4	539 Warbrook Road, Bullsbrook	58	N
5	515 Warbrook Road, Bullsbrook	58	N
6	547 Warbrook Road, Bullsbrook	66	Y
7	595 Warbrook Road, Bullsbrook	65	Y
8	25 Raphael Road, Bullsbrook	65	Y

Table 5-1 (cont') Predicted Noise Levels to Noise Sensitive Receivers North of Ellenbrook

Rec No	Address	Predicted Future Noise Level $L_{Aeq\ (Day)}$ dB	Limit Criterion Exceeded?
9	41 Raphael Road, Bullsbrook	65	Y
10	46 Chitty Road, Bullsbrook	56	N
11	207 Raphael Road, Bullsbrook	61	Y
12	68 Stock Road, Bullsbrook	58	N
13	60 Stock West Road, Bullsbrook	59	N
14	32 Stock West Road, Bullsbrook	64	Y
15	916 Cooper Road, Bullsbrook	56	N
16	312 Raphael Road, Bullsbrook	59	N
17	464 Raphael Road, Bullsbrook	61	Y
18	99 Gully Road, Bullsbrook	57	N
19	80 Gully Road, Bullsbrook	55	N
20	80 Gully Road, Bullsbrook	56	N
21	112 Gully Road, Bullsbrook	58	N
22	614 Raphael Road, Bullsbrook	61	Y
23	81 Strachan Road, Bullsbrook	55	N
24	99 Strachan Road, Bullsbrook	56	N
25	654 Raphael Road, Bullsbrook	65	Y
26	667 Raphael Road, Bullsbrook	64	Y
27	144 Strachan Road, Bullsbrook	63	Y
28	84 Strachan Road, Bullsbrook	55	N
29	Lot 3 West Road, Bullsbrook	59	N
30	190 West Road, Bullsbrook	62	Y
31	Lot 2136 Neaves Road, Bullsbrook	55	N
32	47 Davidson Street, Bullsbrook	64	Y
33	491 Muchea South Road, Muchea	56	N
34	518 Muchea South Road, Bullsbrook	55	N
35	591 Muchea South Road, Muchea	62	Y
36	3421 Great Northern Highway, Muchea	57	N
37	43 Brand Highway, Muchea	59	N
38	3599 Brand Highway, Muchea	64	Y
39	299 Brand Highway, Muchea	47	N

Indicates *limit* criteria exceeded.

Perth Darwin National Highway Project - South of Reid Highway

$L_{Aeq,Day}$ Noise Level Contours - With Recommended Noise Walls - 2040 Traffic Voumes

Figure 5-1

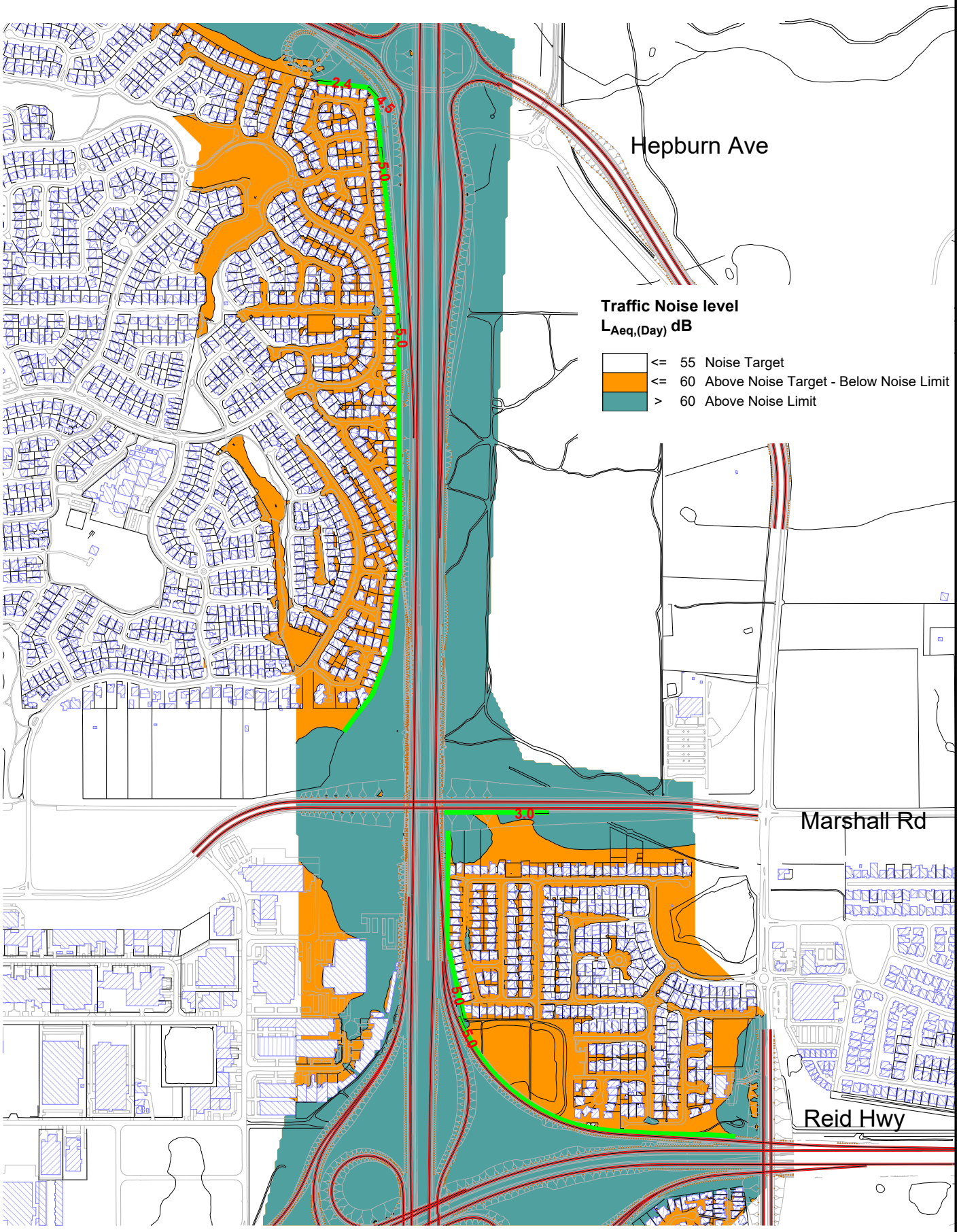


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Perth Darwin National Highway Project - Reid Hwy to Hepburn Ave

$L_{Aeq,Day}$ Noise Level Contours - With Recommended Noise Walls - 2040 Traffic Volumes

Figure 5-2



Scale

0 50 100 200 300 m

N

Signs and symbols

- Road Source
- Building
- Noise Wall

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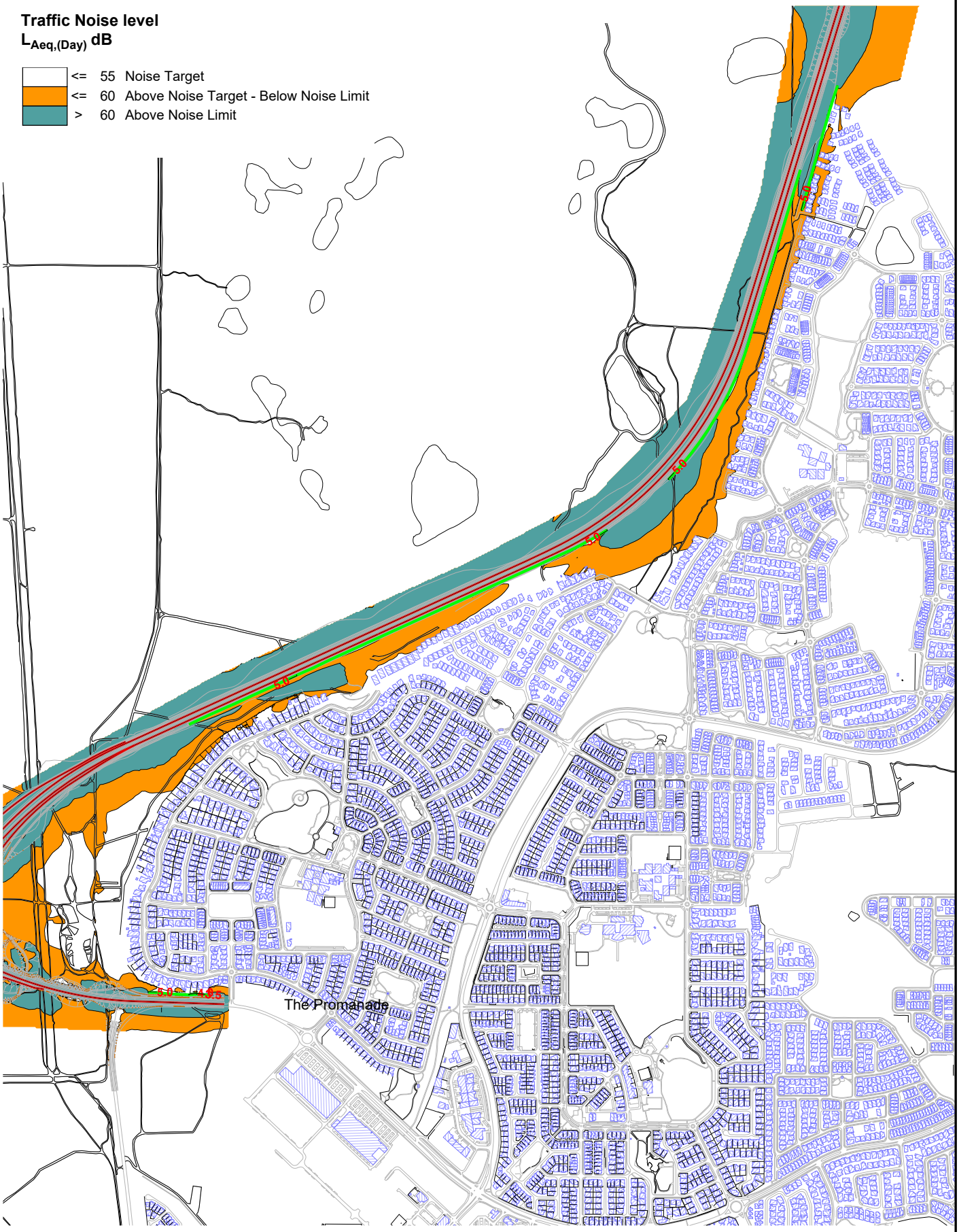
Figure 5-3

Perth Darwin National Highway Project - North of The Promenade

$L_{Aeq,Day}$ Noise Level Contours - With Recommended Noise Walls - 2040 Traffic Volumes

Traffic Noise level
$L_{Aeq,(Day)}$ dB

<=	55	Noise Target
<=	60	Above Noise Target - Below Noise Limit
>	60	Above Noise Limit



Scale
0 100 200 400 600 m

N

Signs and symbols
- Road Source
- Building
- Noise Wall

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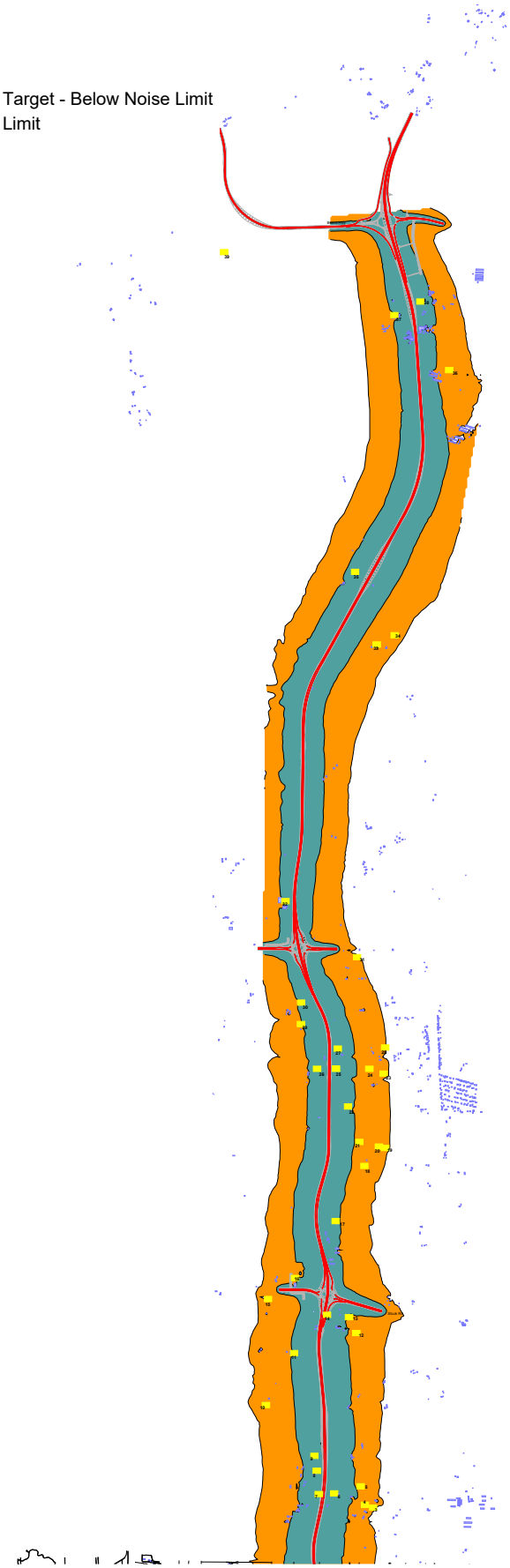
Figure 5-4

Perth Darwin National Highway Project - North of Ellenbrook

$L_{Aeq,Day}$ Noise Level Contours - 2040 Traffic Volumes

Traffic Noise level
$L_{Aeq,(Day)}$ dB

	<=	55	Noise Target
	<=	60	Above Noise Target - Below Noise Limit
	>	60	Above Noise Limit



Scale
0 500 1000 2000 3000 m

N

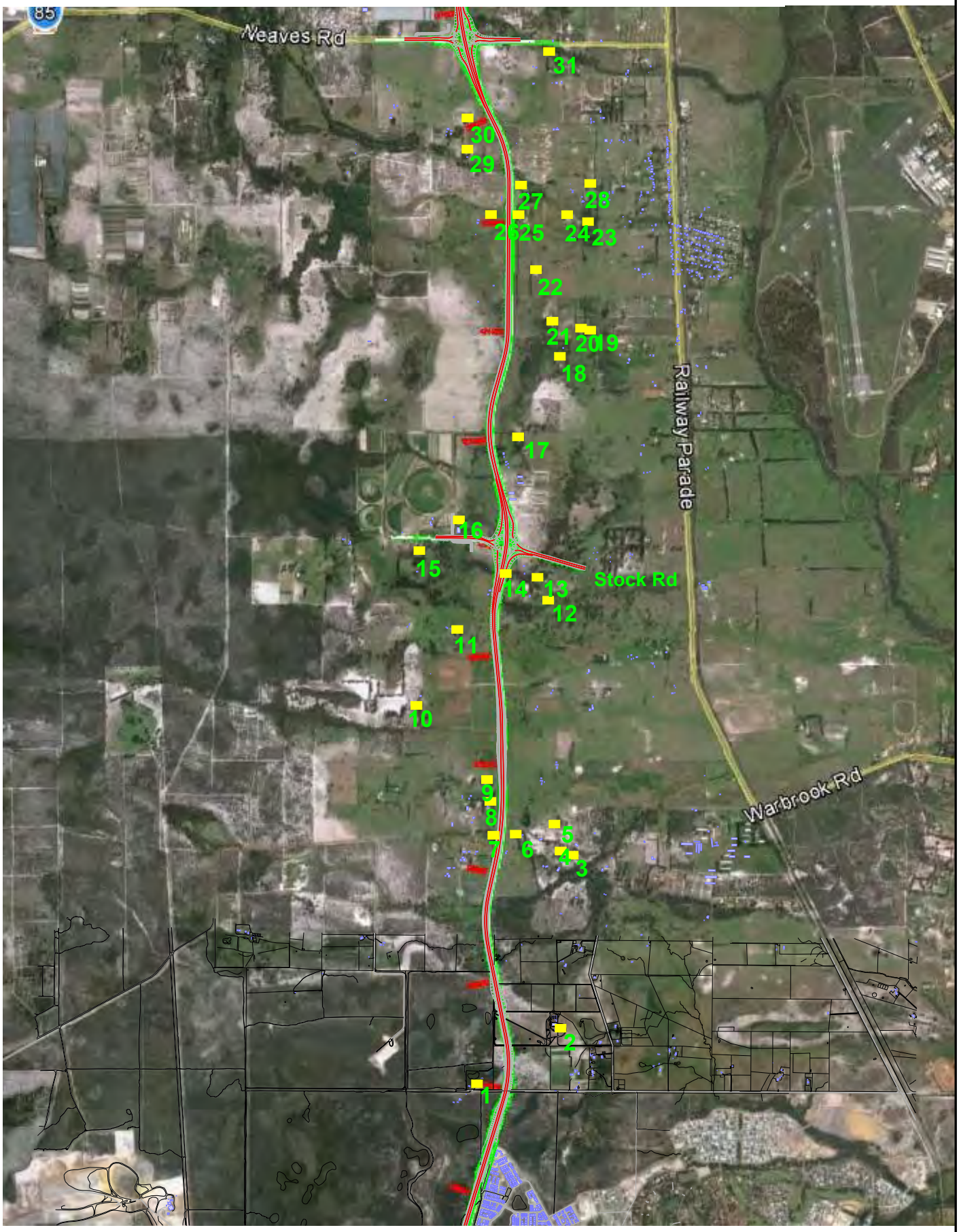
Signs and symbols
- Road Source
- Building
- Point receiver

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Perth Darwin National Highway Project - North of Ellenbrook

Reciever Locations

Figure 5-5



Scale

0 250 500 1000 1500 m

Signs and symbols

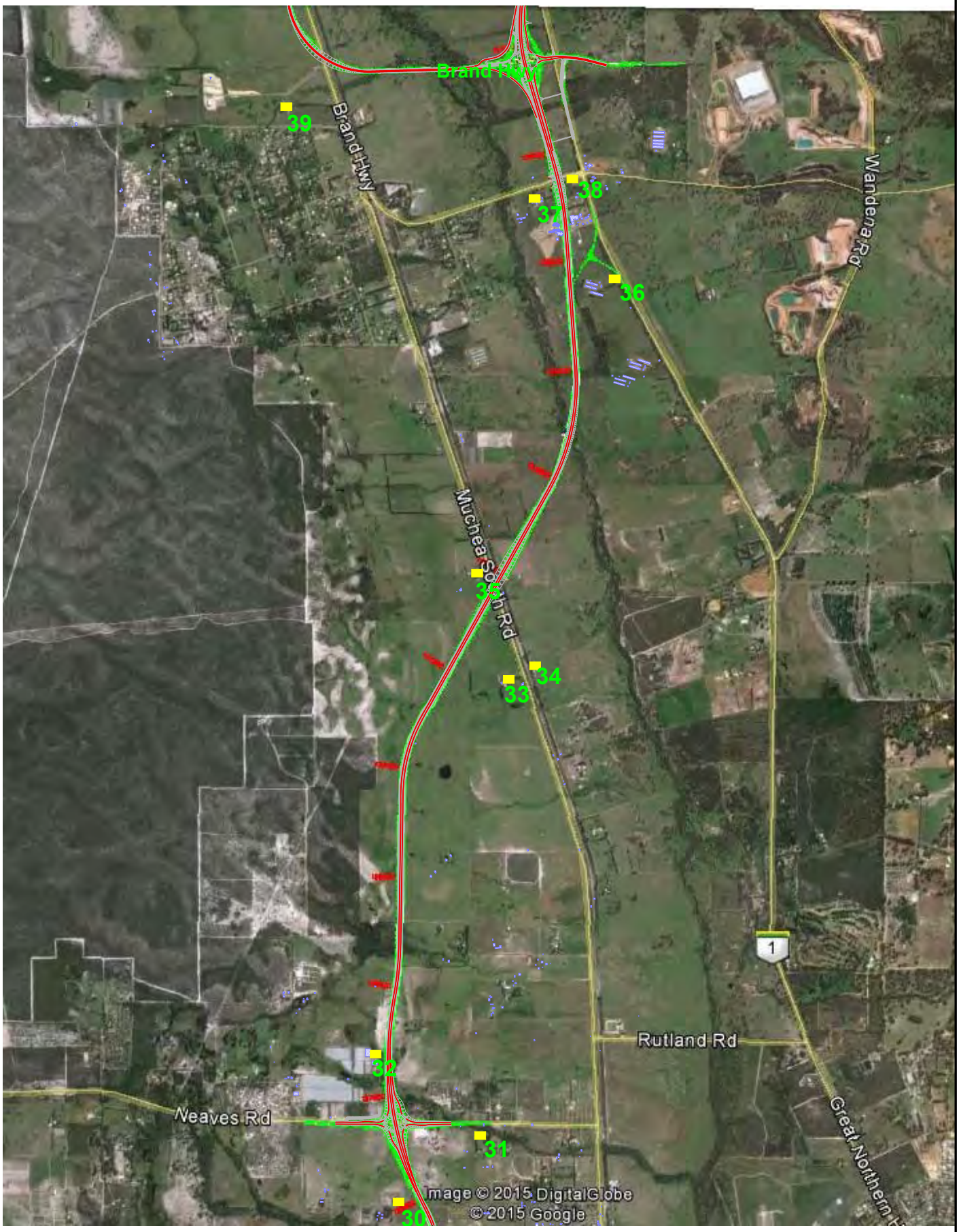
- Road Source
- Building
- Point receiver

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Figure 5-6

Perth Darwin National Highway Project - South of Brand Hwy

Reciever Locations



Scale

0 250 500 1000 1500 m

N

Signs and symbols

- Road Source
- Building
- Point receiver

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6 CONCLUSION

The results of this noise assessment have shown that predicted 2040 traffic volumes can achieve the Policy "*limit*" criterion of $L_{Aeq\ (Day)}$ 60 dB at all noise sensitive premises south of Maralla Road (northern extent of Ellenbrook) by incorporating noise mitigation measures in the form of noise barriers, ranging from 2.4 m to 5.0 m high, into the design of the project.

It should be noted that while it is desirable to achieve the "*target*" criterion of $L_{Aeq\ (Day)}$ 55 dB for noise sensitive premises within Ellenbrook, it is not practicable to achieve this noise level at some locations due to a noise barrier height restriction of 5.0m.

For rural residential properties north of Ellenbrook, noise mitigation will be in accordance with the Policy Guidelines. It may consist of building facade upgrades or localised noise barriers, or a combination of both, to achieve acceptable internal noise levels. The extent of noise control required would need to be individually assessed for each property following a building survey and negotiations with the property owner.

Appendix A

Road Surfaces, Posted Speeds and Traffic Volumes

	AAWT 2050	2050 % Heavies	AAWT 2031	2031 Heavies%	Speed	Pavement	AAWT 2040	2040 Heavies%
North of Reid Hwy								
North	81000	11.30%	55000	13%	100	OGA	68000	12.00%
South	82000	11.50%	55000	13%	100	OGA	68500	12.00%
North of Marshall Rd								
Off Ramp N	11500	6.00%	11000	6%	70	DGA	11250	6.00%
On Ramp South	10500	7.00%	10200	8%	70	DGA	10350	8.00%
Marshall Rd								
East	16000	11.70%	16000	10%	60	DGA	16000	11.00%
West	16000	11.70%	17000	10%	60	DGA	16500	11.00%
Hepburn Ave								
West EB	17800	8.00%	15200	10%	70	DGA	16500	9.00%
West WB	17800	8.00%	15600	7%	70	DGA	16700	8.00%
East EB	10800	11.50%	11200	13%	70	DGA	11000	12.00%
East WB	10800	11.50%	9900	10%	70	DGA	10350	11.00%
North of Hepburn Ave								
North	77500	12.50%	51000	15%	100	OGA	64250	14.00%
South	81000	12.70%	52100	15%	100	OGA	66550	14.00%
On Ramp from Hep	8000	16.00%	6500	20%	100	OGA	7250	18.00%
Off Ramp to Hep	9000	16.00%	7500	19%	100	OGA	8250	18.00%
At Split								
NB to PDNH	38000	17.50%	24200	18%	100	OGA	31100	18.00%
SB from PDNH	43000	17.80%	27000	18%	100	OGA	35000	18.00%
NB to EWNS	39000	8.00%	26000	11%	100	OGA	32500	10.00%
SB from EWNS	38000	7.00%	25300	10%	100	OGA	31650	9.00%
South of Gnangara Rd								
Off ramp EWNS	5500	11.70%	6400	13%	70	DGA	5950	12.00%
On ramp EWNS	4500	10.00%	5400	12%	70	DGA	4950	11.00%
Off ramp PDNH	9500	21.00%	6500	21%	70	DGA	8000	21.00%
On ramp PDNH	10000	12.90%	7500	13%	70	DGA	8750	13.00%
EWNS								
Gnangara Rd								
East EB	17800	10.50%	12500	13%	90	OGA	15150	12.00%
East WB	17800	10.50%	12000	12%	90	OGA	14900	11.00%
North of Gnangara Rd								
North	40800	8.00%	23500	10%	100	OGA	32150	9.00%
South	41300	7.00%	24000	9%	100	OGA	32650	8.00%
on Ramp	7300	6.00%	3900	9%	70	DGA	5600	8.00%
of ramp	7800	6.00%	4050	9%	70	DGA	5925	8.00%
PDNH								
North of Gnangara Rd								
North	34000	15.30%	20800	17%	100	OGA	27400	16.00%
South	38000	18.80%	23000	20%	100	OGA	30500	19.00%
on Ramp	5000	10.00%	3200	12%	70	DGA	4100	11.00%
off ramp	5500	14.50%	3500	16%	70	DGA	4500	15.00%
South of The Promanade								
Off Ramp	8000	13.00%	7000	10%	100	OGA	7500	12.00%
OnRamp	13000	15.00%	9600	18%	100	OGA	11300	17.00%
The Promanade								
Both Dir	22600	10.00%	20200	16%	60	DGA	21400	13.00%
North of The Promanade								
On Ramp	3500	9.50%	1600	11%	70	DGA	2550	10.00%
Off Ramp	5000	10.50%	2100	12%	70	DGA	3550	11.00%
North	29500	15.00%	15400	19%	110	OGA	22450	17.00%
South	30000	15.00%	15500	20%	110	OGA	22750	18.00%
North of Maralla Rd								
North	29500	15.00%	15400	19%	110	Chip	22450	17.00%
South	30000	15.00%	15500	20%	110	Chip	22750	18.00%
South of Stock Rd								
Off Ramp	13500	12.60%	5800	20%	70	DGA	9650	16.00%
On Ramp	14000	13.00%	5700	22%	70	DGA	9850	18.00%
Stock Rd								
West Both Dir	5500	18.00%	1300	18%	70	DGA	3400	18.00%
East Both Dir	17000	13.00%	7000	18%	70	DGA	12000	16.00%
North of Stock Rd								
On Ramp	5000	13.00%	1500	17%	70	DGA	3250	15.00%
Off Ramp	5500	11.50%	1700	20%	70	DGA	3600	16.00%
South of Neaves Rd								
North	20500	16.60%	11200	19%	110	Chip	15850	18.00%
South	21000	16.10%	11400	20%	110	Chip	16200	18.00%
Off Ramp	9000	10.20%	4100	11%	70	DGA	6550	11.00%
On Ramp	5000	9.30%	1800	12%	70	DGA	3400	11.00%
Neaves Rd								
West Both Dir	14000	11.20%	6000	12%	70	DGA	10000	12.00%
East Both Dir	10500	8.00%	6700	8%	70	DGA	8600	8.00%
North of Neaves Rd								
On ramp	3500	13.00%	1500	15%	70	DGA	2500	14.00%
Off ramp	3000	14.00%	1000	18%	70	DGA	2000	16.00%
South of Brand Hwy								
North	15300	19.00%	8600	22%	110	Chip	11950	21.00%
South	14500	20.00%	7500	24%	110	Chip	11000	22.00%
Off Ramp	10600	19.00%	4900	24%	70	DGA	7750	22.00%
On Ramp	9800	18.00%	3700	24%	70	DGA	6750	21.00%
North of Brand								
On Ramp	100	20.00%	500	20%	70	DGA	300	20.00%
Off Ramp	100	20.00%	500	24%	70	DGA	300	22.00%
North	4700	19.00%	3900	20%	80	DGA	4300	20.00%
South	5000	24.00%	4000	24%	80	DGA	4500	24.00%
Brand Hwy								
West Both	4300	26.00%	3300	25%	80	DGA	3800	26.00%
East Both	5600	11.20%	4400	14%	80	DGA	5000	12.00%

Appendix B

Detailed Measurement Results

Table A1 – Results of Noise Logging 2 Redlands Street, Bayswater

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
1 September 2014	40.1	37.6	38.8	33.3
2 September 2014	43.3	40.7	42.0	35.3
3 September 2014	41.0	39.4	40.2	37.2
4 September 2014	38.7	36.2	37.3	32.4
5 September 2014	38.3	36.3	37.6	31.0
Weekday Average	**40.3**	**38.1**	**39.2**	**33.8**



Photograph A1 – Noise Logger at 2 Redlands Street, Bayswater

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 2 Redlands St.
Locality	Bayswater
Occupier	Kathleen Johnson
Dates	1/9/2014 to 5/9/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	75m to road
Height of the road in relation to the ground	+1m
Road surface type	OGA
Speed zone	90 km/hr
Absorbing ground	60%
Angle of view	100
Road gradient	flat
Traffic flow	Vehicles per day. Main Roads tp provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	West
Carriageways & lanes.	2,5
COMMENT	
Comment	Solid noise wall between microphone and road Logger placed at front of house, near bedroom window.
REFERENCES	
AMG Z50 E/N	
Road name	Tonkin Highway.
EXCEL file	2 Redlands St MRWA Logger Sheet.xlsx
Raw data file	2 Redlands.csv
EQUIPMENT	
Analyser number	15-203-505
Microphone number	15-203-505
Calibrator number	34883971
Calibrator values	94.1, 93.8
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Mt Lawley Data 1/09/14 - Neg Winds 11-17 km/h from 10am 5pm 2/09/14 - Calm conditions Variable winds under 9km/h 3/09/14 - Variable winds up to 11km/h 4/09/14 - Neg winds 9-15km/h for 13 hours of day 5/09/14 - Variable winds up to 15km/h

Hourly Noise Level Data

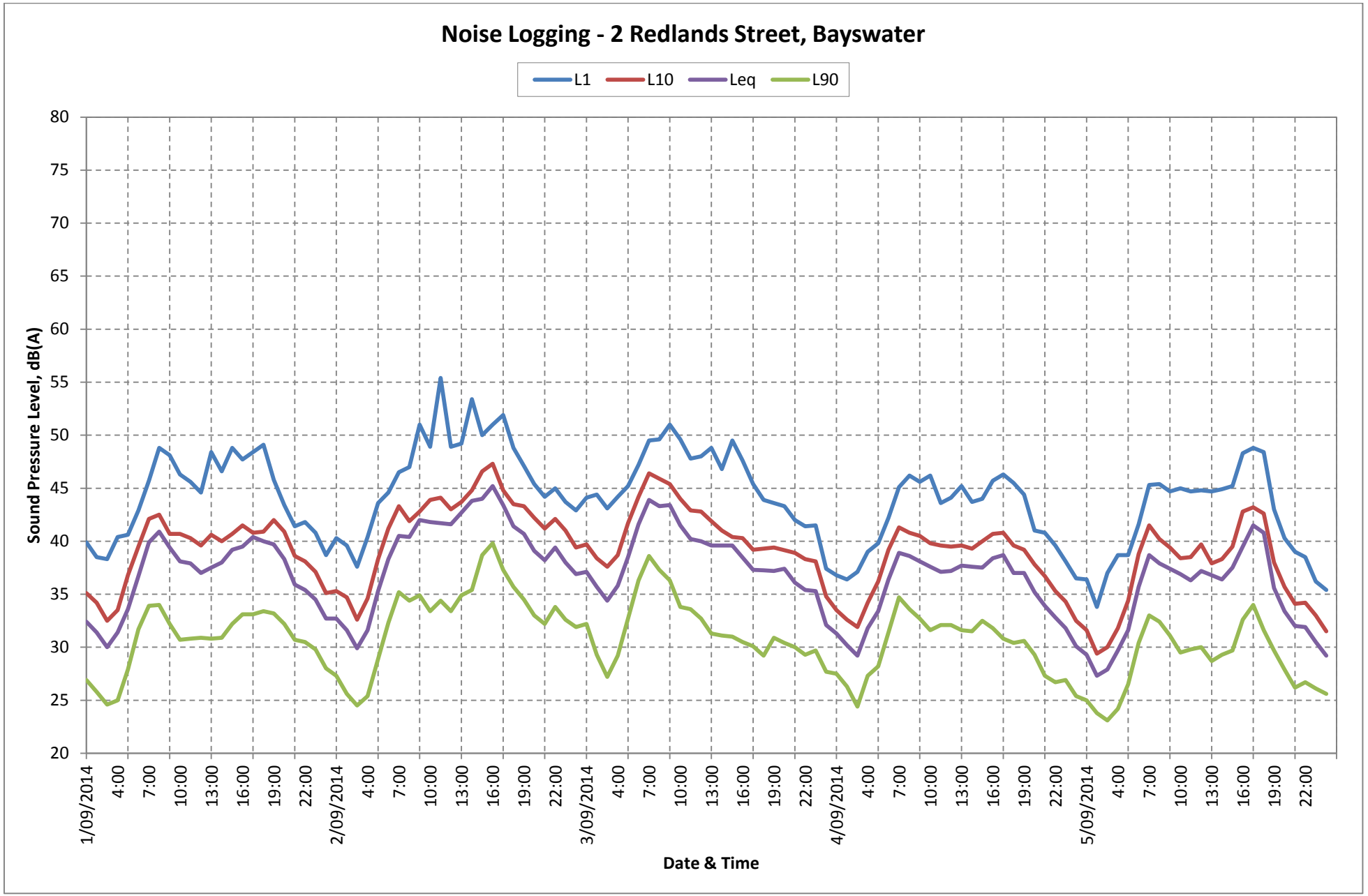
2 Redlands St, Bayswater

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
1/09/2014	1/09/2014	39.9	35.1	32.4	26.9	0	0	0
1/09/2014	2:00	38.5	34.2	31.4	25.8	0	0	0
1/09/2014	3:00	38.3	32.5	30	24.6	0	170	5
1/09/2014	4:00	40.4	33.5	31.4	25	0	0	0
1/09/2014	5:00	40.6	36.8	33.6	27.9	0	170	5
1/09/2014	6:00	42.9	39.5	36.7	31.7	0	80	5
1/09/2014	7:00	45.7	42.1	39.9	33.9	0	60	8
1/09/2014	8:00	48.8	42.5	40.9	34	0	90	8
1/09/2014	9:00	48.1	40.7	39.4	32.2	0	80	5
1/09/2014	10:00	46.3	40.7	38.1	30.7	0	80	11
1/09/2014	11:00	45.6	40.3	37.9	30.8	0	50	17
1/09/2014	12:00	44.6	39.6	37	30.9	0	70	13
1/09/2014	13:00	48.4	40.6	***37.5***	30.8	0	50	15
1/09/2014	14:00	46.6	40	38	30.9	0	60	15
1/09/2014	15:00	48.8	40.7	39.2	32.2	0	60	15
1/09/2014	16:00	47.7	41.5	39.5	33.1	0	30	13
1/09/2014	17:00	48.4	40.8	40.4	33.1	0	70	13
1/09/2014	18:00	49.1	40.9	40	33.4	0	70	9
1/09/2014	19:00	45.8	42	39.7	33.2	0	100	8
1/09/2014	20:00	43.4	40.9	38.3	32.2	0	100	4
1/09/2014	21:00	41.4	38.6	35.9	30.7	0	90	2
1/09/2014	22:00	41.8	38.1	35.4	30.5	0	0	0
1/09/2014	23:00	40.8	37.1	34.5	29.8	0	90	4
1/09/2014	0:00	38.7	35.1	32.7	28	0	80	5
2/09/2014	2/09/2014	40.3	35.3	32.7	27.3	0	80	5
2/09/2014	2:00	39.6	34.7	31.6	25.6	0	80	4
2/09/2014	3:00	37.6	32.6	29.9	24.5	0	150	5
2/09/2014	4:00	40.4	34.6	31.6	25.4	0	100	8
2/09/2014	5:00	43.6	38.3	35.3	28.9	0	100	8
2/09/2014	6:00	44.6	41.2	38.3	32.3	0	90	5
2/09/2014	7:00	46.5	43.3	40.5	35.2	0	90	2
2/09/2014	8:00	47	41.9	40.4	34.4	0	360	4
2/09/2014	9:00	51	42.8	42	34.9	0	90	8
2/09/2014	10:00	48.9	43.9	41.8	33.4	0	90	5
2/09/2014	11:00	55.4	44.1	***41.7***	34.4	0	90	5
2/09/2014	12:00	48.9	43	41.6	33.4	0	90	2
2/09/2014	13:00	49.2	43.7	42.7	34.9	0	90	4
2/09/2014	14:00	53.4	44.8	43.8	35.4	0	40	9
2/09/2014	15:00	50	46.6	44	38.7	0	340	8
2/09/2014	16:00	51	47.3	45.2	39.8	0	280	8
2/09/2014	17:00	51.9	44.8	43.4	37.3	0	260	8
2/09/2014	18:00	48.8	43.5	41.4	35.7	0	260	5
2/09/2014	19:00	47.1	43.3	40.7	34.5	0	250	8
2/09/2014	20:00	45.4	42.2	39.1	33	0	250	5
2/09/2014	21:00	44.2	41.2	38.2	32.2	0	240	5
2/09/2014	22:00	45	42.1	39.4	33.8	0	0	0
2/09/2014	23:00	43.7	41	38	32.6	0	0	0
2/09/2014	0:00	42.9	39.4	36.9	31.9	0	0	0
3/09/2014	3/09/2014	44.1	39.7	37.1	32.2	0	0	0
3/09/2014	2:00	44.4	38.4	35.7	29.3	0	0	0
3/09/2014	3:00	43.1	37.6	34.4	27.2	0	0	0
3/09/2014	4:00	44.2	38.7	35.8	29.2	0	230	5
3/09/2014	5:00	45.2	41.7	38.5	32.7	0	180	9
3/09/2014	6:00	47.2	44.2	41.6	36.3	0	180	9
3/09/2014	7:00	49.5	46.4	43.9	38.6	0	170	11
3/09/2014	8:00	49.6	45.9	43.3	37.3	0	170	8
3/09/2014	9:00	51	45.4	43.4	36.3	0	150	9
3/09/2014	10:00	49.6	44	41.5	33.8	0	170	11
3/09/2014	11:00	47.8	42.9	40.2	33.6	0	120	8
3/09/2014	12:00	48	42.8	40	32.7	0	90	8
3/09/2014	13:00	48.8	41.9	39.6	31.3	0	140	5
3/09/2014	14:00	46.8	41	39.6	31.1	0	130	5
3/09/2014	15:00	49.5	40.4	***39.6***	31	0	120	8
3/09/2014	16:00	47.6	40.3	***38.5***	30.5	0	60	9
3/09/2014	17:00	45.4	39.2	37.3	30.1	0	60	11
3/09/2014	18:00	43.9	***39.3***	***37.3***	29.2	0	70	11
3/09/2014	19:00	43.6	39.4	37.2	30.9	0	70	8
3/09/2014	20:00	43.3	***39.2***	37.4	30.4	0	0	0
3/09/2014	21:00	42	38.9	36.1	30	0	0	0
3/09/2014	22:00	41.4	38.3	35.4	29.3	0	0	0
3/09/2014	23:00	41.5	38.1	35.3	29.7	0	60	4
3/09/2014	0:00	37.4	34.8	32.1	27.7	0	60	5

Hourly Noise Level Data

2 Redlands St, Bayswater

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
4/09/2014	4/09/2014	36.8	33.5	31.3	27.5	0	0	0
4/09/2014	2:00	36.4	32.6	30.2	26.3	0	70	5
4/09/2014	3:00	37.1	31.9	29.2	24.4	0	90	8
4/09/2014	4:00	39	34.2	31.8	27.3	0	90	11
4/09/2014	5:00	39.8	36.2	33.4	28.2	0	90	13
4/09/2014	6:00	42.2	39.2	36.4	31.4	0	90	9
4/09/2014	7:00	45.1	41.3	38.9	34.7	0	90	11
4/09/2014	8:00	46.2	40.8	38.6	33.6	0	100	13
4/09/2014	9:00	45.6	40.5	38.1	32.7	0	90	11
4/09/2014	10:00	46.2	39.8	***37.6***	31.6	0	90	13
4/09/2014	11:00	43.6	39.6	37.1	32.1	0	100	13
4/09/2014	12:00	44.1	39.5	37.2	32.1	0	100	15
4/09/2014	13:00	45.2	39.6	37.7	31.6	0	110	15
4/09/2014	14:00	43.7	39.3	***37.6***	31.5	0	110	11
4/09/2014	15:00	44	40	37.5	32.5	0	100	11
4/09/2014	16:00	45.7	40.7	38.4	31.8	0	130	13
4/09/2014	17:00	46.3	40.8	38.7	30.8	0	110	9
4/09/2014	18:00	45.5	39.6	37	30.4	0	110	8
4/09/2014	19:00	44.4	39.2	37	30.6	0	90	5
4/09/2014	20:00	41	37.8	35.2	29.3	0	100	5
4/09/2014	21:00	40.8	36.7	33.9	27.3	0	0	0
4/09/2014	22:00	39.6	35.3	32.8	26.7	0	100	5
4/09/2014	23:00	38.1	34.3	31.8	26.9	0	130	5
4/09/2014	0:00	36.5	32.5	30.1	25.4	0	70	9
5/09/2014	5/09/2014	36.4	31.6	29.3	25	0	110	8
5/09/2014	2:00	33.8	29.4	27.3	23.8	0	60	13
5/09/2014	3:00	37	30	27.9	23.1	0	80	8
5/09/2014	4:00	38.7	31.8	29.7	24.2	0	90	8
5/09/2014	5:00	38.7	34.4	31.6	26.5	0	70	9
5/09/2014	6:00	41.6	38.8	35.7	30.4	0	60	4
5/09/2014	7:00	45.3	41.5	38.7	33	0	60	5
5/09/2014	8:00	45.4	40.2	37.9	32.4	0	60	2
5/09/2014	9:00	44.7	39.4	37.4	31.1	0	50	8
5/09/2014	10:00	45	38.4	36.9	29.5	0	40	13
5/09/2014	11:00	44.7	38.5	36.3	29.8	0	60	15
5/09/2014	12:00	44.8	39.7	37.2	30	0	50	13
5/09/2014	13:00	44.7	37.9	***36.8***	28.7	0	50	15
5/09/2014	14:00	44.9	38.3	36.4	29.3	0	30	13
5/09/2014	15:00	45.2	39.5	37.5	29.7	0	30	11
5/09/2014	16:00	48.3	42.8	***39.5***	32.6	0	270	11
5/09/2014	17:00	48.8	43.2	41.5	34	0	290	11
5/09/2014	18:00	48.4	42.6	40.8	31.6	0	280	11
5/09/2014	19:00	43	38	35.6	29.7	0	290	8
5/09/2014	20:00	40.3	35.7	33.4	27.9	0	0	0
5/09/2014	21:00	39	34.1	32	26.2	0	290	5
5/09/2014	22:00	38.5	34.2	31.9	26.7	0	290	8
5/09/2014	23:00	36.2	33	30.5	26.1	0	290	5
5/09/2014	0:00	35.4	31.5	29.2	25.6	0	290	5



Reference: 13122623

Table A2 – Results of Noise Logging 16 Harvest Road, Morley

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
1 September 2014	59.9	56.9	57.8	54.1
2 September 2014	61.6	58.5	59.7	54.6
3 September 2014	61.3	58.3	59.2	55.4
4 September 2014	60.4	57.7	58.8	54.1
5 September 2014	60.5	57.6	58.7	53.9
Weekday Average	**60.8**	**57.8**	**58.8**	**54.4**



Photograph A2 – Noise Logger at 16 Harvest Road, Morley

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 16 Harvest St.
Locality	Morley
Occupier	Debra Hallen
Dates	1/9/2014 to 5/9/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	45m to road
Height of the road in relation to the ground	+2m
Road surface type	OGA
Speed zone	90 km/hr
Absorbing ground	60%
Angle of view	170
Road gradient	flat
Traffic flow	Vehicles per day. Main Roads tp provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	West
Carriageways & lanes.	2,4
COMMENT	
Comment	Solid noise wall (Fibre Cement) between microphone and road Logger placed at front of house, near bedroom window.
REFERENCES	
AMG Z50 E/N	
Road name	Tonkin Highway.
EXCEL file	16 Harvest Rd MRWA Logger Sheet.xlsx
Raw data file	16 Harvest_sta.csv
EQUIPMENT	
Analyser number	16-004-041
Microphone number	16-004-041
Calibrator number	34883971
Calibrator values	93.9, 93.8
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Mt Lawley Data 1/09/14 - Neg Winds 11-17 km/h from 10am 5pm 2/09/14 - Calm conditions Variable winds under 9km/h 3/09/14 - Variable winds up to 11km/h 4/09/14 - Neg winds 9-15km/h for 13 hours of day 5/09/14 - Variable winds up to 15km/h

Hourly Noise Level Data

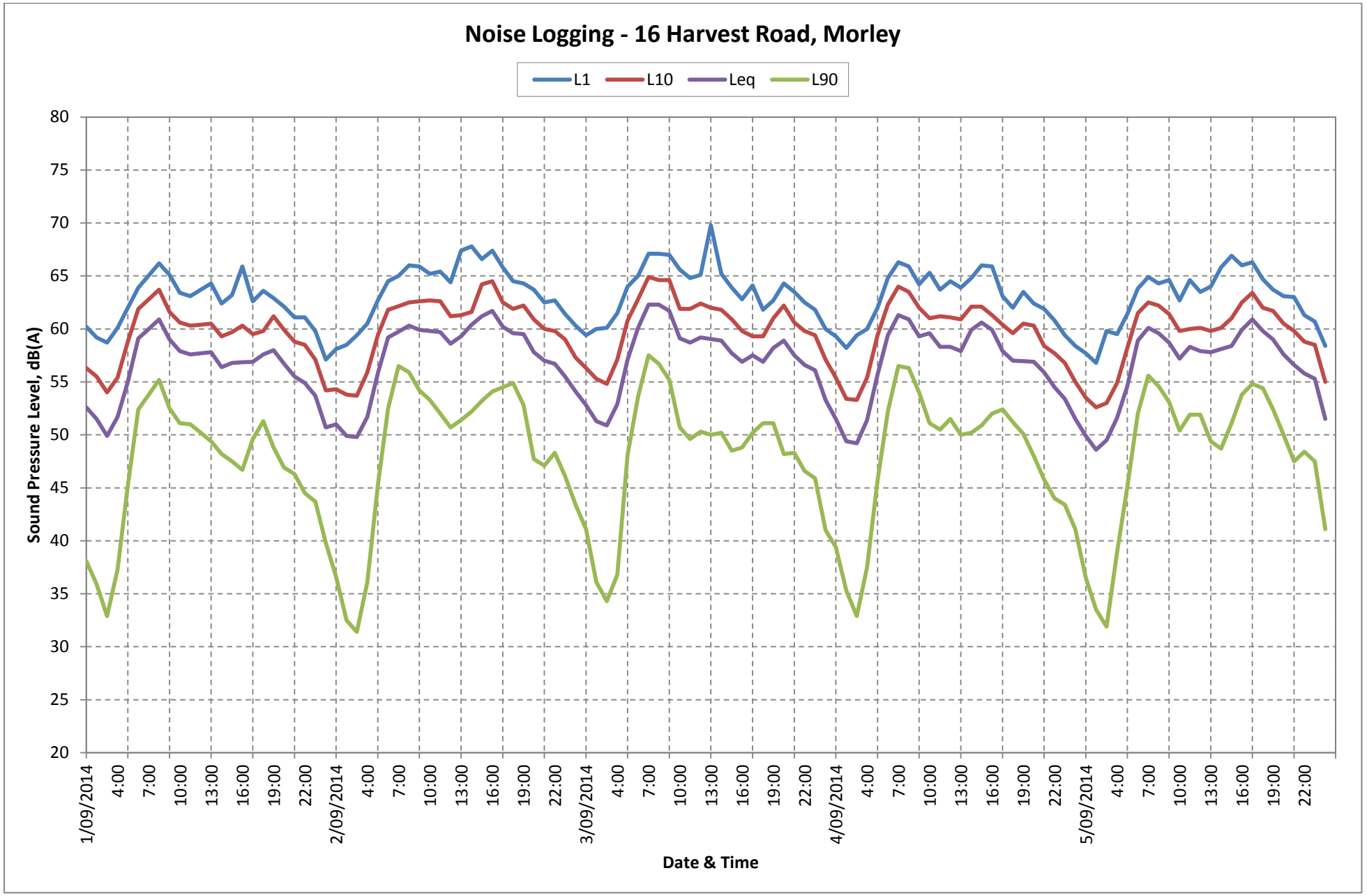
16 Harvest Road, Morley

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
1/09/2014	1/09/2014	60.2	56.3	52.6	38.1	0	0	0
1/09/2014	2:00	59.2	55.5	51.5	35.9	0	0	0
1/09/2014	3:00	58.7	54	49.9	32.9	0	170	5
1/09/2014	4:00	60.1	55.4	51.7	37.3	0	0	0
1/09/2014	5:00	62	58.8	55	45.2	0	170	5
1/09/2014	6:00	63.9	61.9	59.1	52.4	0	80	5
1/09/2014	7:00	***65.05***	***62.8***	***60***	***53.8***	0	60	8
1/09/2014	8:00	66.2	63.7	60.9	55.2	0	90	8
1/09/2014	9:00	65.1	61.6	59	52.5	0	80	5
1/09/2014	10:00	63.4	60.6	57.9	51.1	0	80	11
1/09/2014	11:00	63.1	60.3	57.6	51	0	50	17
1/09/2014	12:00	***63.7***	***60.4***	***57.7***	50.2	0	70	13
1/09/2014	13:00	64.3	60.5	57.8	49.4	0	50	15
1/09/2014	14:00	62.4	59.3	56.4	48.2	0	60	15
1/09/2014	15:00	63.2	59.7	56.8	47.5	0	60	15
1/09/2014	16:00	65.9	60.3	***56.9***	46.7	0	30	13
1/09/2014	17:00	62.6	59.5	56.9	49.6	0	70	13
1/09/2014	18:00	63.6	59.8	57.6	51.3	0	70	9
1/09/2014	19:00	62.9	61.2	58	48.8	0	100	8
1/09/2014	20:00	62.1	59.9	56.7	46.9	0	100	4
1/09/2014	21:00	61.1	58.8	55.5	46.3	0	90	2
1/09/2014	22:00	61.1	58.5	54.9	44.5	0	0	0
1/09/2014	23:00	59.8	57.1	53.7	43.7	0	90	4
1/09/2014	0:00	57.1	54.2	50.7	39.8	0	80	5
2/09/2014	2/09/2014	58.1	54.3	51	36.6	0	80	5
2/09/2014	2:00	58.5	53.8	49.9	32.5	0	80	4
2/09/2014	3:00	59.4	53.7	49.8	31.4	0	150	5
2/09/2014	4:00	60.5	55.9	51.7	36.1	0	100	8
2/09/2014	5:00	62.7	59.4	55.8	45.2	0	100	8
2/09/2014	6:00	64.5	61.8	59.2	52.5	0	90	5
2/09/2014	7:00	65	***62.2***	***59.8***	56.5	0	90	2
2/09/2014	8:00	66	62.5	60.3	55.9	0	360	4
2/09/2014	9:00	65.9	62.6	59.9	54.2	0	90	8
2/09/2014	10:00	65.2	62.7	59.8	53.3	0	90	5
2/09/2014	11:00	65.4	62.6	59.7	52	0	90	5
2/09/2014	12:00	64.4	61.2	58.6	50.7	0	90	2
2/09/2014	13:00	67.4	61.3	59.3	51.4	0	90	4
2/09/2014	14:00	67.8	61.6	60.4	52.2	0	40	9
2/09/2014	15:00	66.6	64.2	61.2	53.2	0	340	8
2/09/2014	16:00	67.4	64.5	61.7	54.1	0	280	8
2/09/2014	17:00	65.8	62.5	60.2	54.5	0	260	8
2/09/2014	18:00	64.5	61.9	59.6	54.9	0	260	5
2/09/2014	19:00	64.3	62.2	59.5	52.8	0	250	8
2/09/2014	20:00	63.7	60.9	57.8	47.7	0	250	5
2/09/2014	21:00	62.5	60	57	47.1	0	240	5
2/09/2014	22:00	62.7	59.8	56.7	48.3	0	0	0
2/09/2014	23:00	61.4	59	55.5	46.1	0	0	0
2/09/2014	0:00	60.3	57.3	54.1	43.4	0	0	0
3/09/2014	3/09/2014	59.4	56.3	52.8	41.1	0	0	0
3/09/2014	2:00	60	55.3	51.3	36.1	0	0	0
3/09/2014	3:00	60.1	54.8	50.9	34.3	0	0	0
3/09/2014	4:00	61.5	57.1	52.9	36.8	0	230	5
3/09/2014	5:00	64	60.8	57.1	48.1	0	180	9
3/09/2014	6:00	65	62.8	60.1	53.6	0	180	9
3/09/2014	7:00	67.1	64.9	62.3	57.5	0	170	11
3/09/2014	8:00	67.1	64.6	62.3	56.7	0	170	8
3/09/2014	9:00	67	64.6	61.7	55.2	0	150	9
3/09/2014	10:00	65.6	61.9	59.1	50.7	0	170	11
3/09/2014	11:00	64.8	61.9	58.7	49.6	0	120	8
3/09/2014	12:00	65.1	62.4	59.2	50.3	0	90	8
3/09/2014	13:00	69.8	62	***59.1***	50	0	140	5
3/09/2014	14:00	65.2	61.8	58.9	50.2	0	130	5
3/09/2014	15:00	63.9	60.9	57.7	48.5	0	120	8
3/09/2014	16:00	62.8	59.8	56.9	48.8	0	60	9
3/09/2014	17:00	64.1	59.3	57.5	50.2	0	60	11
3/09/2014	18:00	61.8	59.3	56.9	51.1	0	70	11
3/09/2014	19:00	62.7	61	58.2	51.1	0	70	8
3/09/2014	20:00	64.3	62.2	58.9	48.2	0	0	0
3/09/2014	21:00	63.5	60.6	57.5	48.3	0	0	0
3/09/2014	22:00	62.5	59.8	56.6	46.6	0	0	0
3/09/2014	23:00	61.8	59.4	56.1	45.9	0	60	4
3/09/2014	0:00	60	57.1	53.3	41	0	60	5

Hourly Noise Level Data

16 Harvest Road, Morley

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
4/09/2014	4/09/2014	59.3	55.4	51.5	39.4	0	0	0
4/09/2014	2:00	58.2	53.4	49.4	35.3	0	70	5
4/09/2014	3:00	59.4	53.3	49.2	32.9	0	90	8
4/09/2014	4:00	60	55.4	51.4	37.5	0	90	11
4/09/2014	5:00	62	59.4	55.7	45.7	0	90	13
4/09/2014	6:00	64.8	62.3	59.4	52.2	0	90	9
4/09/2014	7:00	66.3	64	61.3	56.5	0	90	11
4/09/2014	8:00	65.9	63.5	60.9	56.3	0	100	13
4/09/2014	9:00	64.2	62	59.3	54	0	90	11
4/09/2014	10:00	65.3	61	59.6	51.1	0	90	13
4/09/2014	11:00	63.7	61.2	58.3	50.5	0	100	13
4/09/2014	12:00	64.5	61.1	58.3	51.5	0	100	15
4/09/2014	13:00	63.9	60.9	57.9	50	0	110	15
4/09/2014	14:00	64.8	62.1	59.9	50.2	0	110	11
4/09/2014	15:00	66	62.1	60.6	50.9	0	100	11
4/09/2014	16:00	65.9	61.3	59.9	52	0	130	13
4/09/2014	17:00	63.1	60.4	57.9	52.4	0	110	9
4/09/2014	18:00	62	59.6	57	51.2	0	110	8
4/09/2014	19:00	63.5	60.5	***57.0***	50.1	0	90	5
4/09/2014	20:00	62.4	60.3	56.9	48	0	100	5
4/09/2014	21:00	61.9	58.4	55.9	45.8	0	0	0
4/09/2014	22:00	60.8	57.7	54.5	44	0	100	5
4/09/2014	23:00	59.4	56.8	53.4	43.4	0	130	5
4/09/2014	0:00	58.4	55	51.5	41.1	0	70	9
5/09/2014	5/09/2014	57.7	53.5	49.9	36.5	0	110	8
5/09/2014	2:00	56.8	52.6	48.6	33.5	0	60	13
5/09/2014	3:00	59.8	53	49.5	31.9	0	80	8
5/09/2014	4:00	59.5	54.9	51.6	38.9	0	90	8
5/09/2014	5:00	61.4	58.2	54.6	45.1	0	70	9
5/09/2014	6:00	63.8	61.5	58.9	52	0	60	4
5/09/2014	7:00	64.9	62.5	60.1	55.6	0	60	5
5/09/2014	8:00	64.3	62.2	59.6	54.6	0	60	2
5/09/2014	9:00	64.6	61.4	58.7	53.1	0	50	8
5/09/2014	10:00	62.7	59.8	57.2	50.4	0	40	13
5/09/2014	11:00	64.6	60	58.3	51.9	0	60	15
5/09/2014	12:00	63.5	60.1	57.9	51.9	0	50	13
5/09/2014	13:00	64	59.8	57.8	49.4	0	50	15
5/09/2014	14:00	65.8	60.1	***58.1***	48.7	0	30	13
5/09/2014	15:00	66.9	61	58.4	51.1	0	30	11
5/09/2014	16:00	66	62.5	59.9	53.8	0	270	11
5/09/2014	17:00	66.3	63.4	60.9	54.8	0	290	11
5/09/2014	18:00	64.7	62	59.8	54.4	0	280	11
5/09/2014	19:00	63.7	61.7	59	52.4	0	290	8
5/09/2014	20:00	63.1	60.5	57.6	50	0	0	0
5/09/2014	21:00	63	59.8	56.6	47.5	0	290	5
5/09/2014	22:00	61.3	58.8	55.8	48.4	0	290	8
5/09/2014	23:00	60.7	58.5	55.3	47.5	0	290	5
5/09/2014	0:00	***58.4***	***55***	***51.5***	***41.1***	0	290	5



Reference: 13122623

Table A3 – Results of Noise Logging 28A Bruce Road, Morley

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
1 September 2014	60.9	57.7	59.1	51.9
2 September 2014	59.9	56.8	57.9	53.2
3 September 2014	60.6	57.3	58.5	53.4
4 September 2014	60.9	58.0	59.0	54.5
5 September 2014	60.1	57.1	58.2	53.3
Weekday Average	**60.5**	**57.4**	**58.5**	**53.3**



Photograph A3 – Noise Logger at 28A Bruce Road, Morley

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 28A Bruce Rd.
Locality	Morley
Occupier	Kaye Bailey 0408082068
Dates	1/9/2014 to 5/9/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	25m to Tonkin Hwy
Height of the road in relation to the ground	0m
Road surface type	DGA,
Speed zone	80 km/hr (Near Intersection)
Absorbing ground	70%
Angle of view	150
Road gradient	flat
Traffic flow	Vehicles per day. Main Roads to provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	East to Tonkin Hwy
Carriageways & lanes.	2,6;
COMMENT	
Comment	Microphone placed on west façade. Logger placed at Side (South East) of house, away from pool. Rear Property fence between Microphone and Road.
REFERENCES	
AMG Z50 E/N	
Road name	Tonkin Highway.
EXCEL file	2A Abbey St MRWA Logger Sheet.xlsx
Raw data file	2A Abbey St_sta.csv
EQUIPMENT	
Analyser number	15-203-999
Microphone number	15-203-999
Calibrator number	34883971
Calibrator values	94.0, 93.8
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Mt Lawley Data 1/09/14 - Pos Winds 11-17 km/h from 10am 5pm 2/09/14 - Calm conditions Variable winds under 9km/h 3/09/14 - Variable winds up to 11km/h 4/09/14 - Pos winds 9-15km/h for 13 hours of day 5/09/14 - Variable winds up to 15km/h

Hourly Noise Level Data

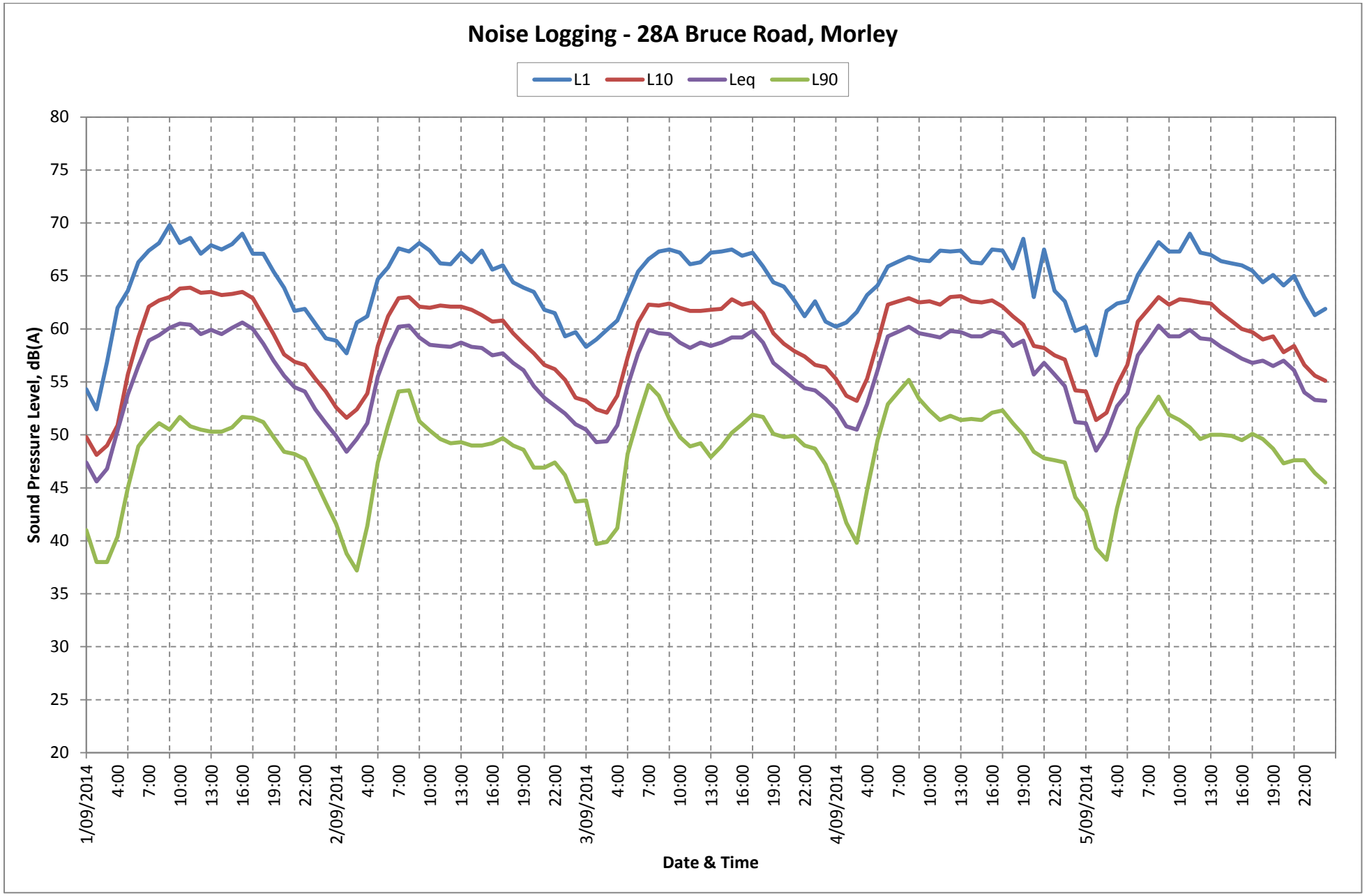
28A Bruce Road, Morley

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
1/09/2014	1/09/2014	54.3	49.8	47.4	41	0	0	0
1/09/2014	2:00	52.4	48.1	45.6	38	0	0	0
1/09/2014	3:00	56.9	49	46.8	38	0	170	5
1/09/2014	4:00	62	50.9	50.4	40.4	0	0	0
1/09/2014	5:00	63.6	55.7	53.8	45	0	170	5
1/09/2014	6:00	66.3	59.2	56.5	48.9	0	80	5
1/09/2014	7:00	67.4	62.1	58.9	50.2	0	60	8
1/09/2014	8:00	68.1	62.7	59.4	51.1	0	90	8
1/09/2014	9:00	69.8	63	60.1	50.5	0	80	5
1/09/2014	10:00	68.1	63.8	60.5	51.7	0	80	11
1/09/2014	11:00	68.6	63.9	60.4	50.8	0	50	17
1/09/2014	12:00	67.1	63.4	59.5	50.5	0	70	13
1/09/2014	13:00	67.9	63.5	59.9	50.3	0	50	15
1/09/2014	14:00	67.5	63.2	59.5	50.3	0	60	15
1/09/2014	15:00	68	63.3	60.1	50.7	0	60	15
1/09/2014	16:00	69	63.5	60.6	51.7	0	30	13
1/09/2014	17:00	67.1	62.9	60	51.6	0	70	13
1/09/2014	18:00	67.1	61.2	58.6	51.2	0	70	9
1/09/2014	19:00	65.4	59.5	57	49.8	0	100	8
1/09/2014	20:00	63.9	57.6	55.6	48.4	0	100	4
1/09/2014	21:00	61.7	56.9	54.5	48.2	0	90	2
1/09/2014	22:00	61.9	56.6	54.1	47.7	0	0	0
1/09/2014	23:00	60.5	55.3	52.4	45.7	0	90	4
1/09/2014	0:00	59.1	54.1	51.1	43.6	0	80	5
2/09/2014	2/09/2014	58.9	52.6	49.9	41.6	0	80	5
2/09/2014	2:00	57.7	51.6	48.4	38.8	0	80	4
2/09/2014	3:00	60.6	52.4	49.6	37.2	0	150	5
2/09/2014	4:00	61.2	53.9	51.1	41.4	0	100	8
2/09/2014	5:00	64.7	58.4	55.5	47.4	0	100	8
2/09/2014	6:00	65.8	61.2	58.1	50.9	0	90	5
2/09/2014	7:00	67.6	62.9	60.2	54.1	0	90	2
2/09/2014	8:00	67.3	63	60.3	54.2	0	360	4
2/09/2014	9:00	68.1	62.1	59.2	51.3	0	90	8
2/09/2014	10:00	67.4	62	58.5	50.4	0	90	5
2/09/2014	11:00	66.2	62.2	58.4	49.6	0	90	5
2/09/2014	12:00	66.1	62.1	58.3	49.2	0	90	2
2/09/2014	13:00	67.2	62.1	58.7	49.3	0	90	4
2/09/2014	14:00	66.3	61.8	58.3	49	0	40	9
2/09/2014	15:00	67.4	61.3	58.2	49	0	340	8
2/09/2014	16:00	65.6	60.7	57.5	49.2	0	280	8
2/09/2014	17:00	66	60.8	57.7	49.7	0	260	8
2/09/2014	18:00	64.4	59.6	56.8	49	0	260	5
2/09/2014	19:00	63.9	58.6	56.1	48.6	0	250	8
2/09/2014	20:00	63.5	57.7	54.6	46.9	0	250	5
2/09/2014	21:00	61.8	56.6	53.5	46.9	0	240	5
2/09/2014	22:00	61.5	56.2	***52.8***	47.4	0	0	0
2/09/2014	23:00	59.3	55.2	52	46.2	0	0	0
2/09/2014	0:00	59.7	53.5	51	43.7	0	0	0
3/09/2014	3/09/2014	58.3	53.2	50.5	43.8	0	0	0
3/09/2014	2:00	59	52.4	49.3	39.7	0	0	0
3/09/2014	3:00	59.9	52.1	49.4	39.9	0	0	0
3/09/2014	4:00	60.8	53.7	50.9	41.2	0	230	5
3/09/2014	5:00	63.1	57.3	54.6	48.2	0	180	9
3/09/2014	6:00	65.4	60.6	57.7	51.6	0	180	9
3/09/2014	7:00	66.6	62.3	59.9	54.7	0	170	11
3/09/2014	8:00	67.3	62.2	59.6	53.7	0	170	8
3/09/2014	9:00	67.5	62.4	59.5	51.5	0	150	9
3/09/2014	10:00	67.2	62	58.7	49.8	0	170	11
3/09/2014	11:00	66.1	61.7	58.2	48.9	0	120	8
3/09/2014	12:00	66.3	61.7	58.7	49.2	0	90	8
3/09/2014	13:00	67.2	61.8	58.4	47.9	0	140	5
3/09/2014	14:00	67.3	61.9	58.7	48.9	0	130	5
3/09/2014	15:00	67.5	62.8	59.2	50.2	0	120	8
3/09/2014	16:00	66.9	62.3	59.2	51	0	60	9
3/09/2014	17:00	67.2	62.5	59.8	51.9	0	60	11
3/09/2014	18:00	65.9	61.5	58.7	51.7	0	70	11
3/09/2014	19:00	64.4	59.6	56.8	50.1	0	70	8
3/09/2014	20:00	64	58.6	56	49.8	0	0	0
3/09/2014	21:00	62.7	57.9	55.2	49.9	0	0	0
3/09/2014	22:00	61.2	57.4	54.4	49	0	0	0
3/09/2014	23:00	62.6	56.6	54.2	48.7	0	60	4
3/09/2014	0:00	60.7	56.4	53.4	47.2	0	60	5

Hourly Noise Level Data

28A Bruce Road, Morley

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
4/09/2014	4/09/2014	60.2	55.3	52.4	44.8	0	0	0
4/09/2014	2:00	60.6	53.7	50.8	41.7	0	70	5
4/09/2014	3:00	61.6	53.2	50.5	39.8	0	90	8
4/09/2014	4:00	63.2	55.3	52.9	44.8	0	90	11
4/09/2014	5:00	64.1	58.7	56.1	49.5	0	90	13
4/09/2014	6:00	65.9	62.3	59.3	52.9	0	90	9
4/09/2014	7:00	***66.4***	***62.6***	***59.8***	***54.1***	0	90	11
4/09/2014	8:00	66.8	62.9	60.2	55.2	0	100	13
4/09/2014	9:00	66.5	62.5	59.6	53.4	0	90	11
4/09/2014	10:00	66.4	62.6	59.4	52.3	0	90	13
4/09/2014	11:00	67.4	62.3	59.2	51.4	0	100	13
4/09/2014	12:00	67.3	63	59.8	51.8	0	100	15
4/09/2014	13:00	67.4	63.1	59.7	51.4	0	110	15
4/09/2014	14:00	66.3	62.6	59.3	51.5	0	110	11
4/09/2014	15:00	66.2	62.5	59.3	51.4	0	100	11
4/09/2014	16:00	67.5	62.7	59.8	52.1	0	130	13
4/09/2014	17:00	67.4	62.1	59.6	52.3	0	110	9
4/09/2014	18:00	65.7	61.2	58.4	51.1	0	110	8
4/09/2014	19:00	68.5	60.4	58.9	50	0	90	5
4/09/2014	20:00	63	58.4	55.7	48.4	0	100	5
4/09/2014	21:00	67.5	58.2	56.8	47.8	0	0	0
4/09/2014	22:00	63.6	57.5	55.7	47.6	0	100	5
4/09/2014	23:00	62.6	57.1	54.6	47.4	0	130	5
4/09/2014	0:00	59.8	54.2	51.2	44.1	0	70	9
5/09/2014	5/09/2014	60.2	54.1	51.1	42.8	0	110	8
5/09/2014	2:00	57.5	51.4	48.5	39.3	0	60	13
5/09/2014	3:00	61.7	52.1	50.1	38.2	0	80	8
5/09/2014	4:00	62.4	54.7	52.7	43.1	0	90	8
5/09/2014	5:00	62.6	56.6	53.9	46.8	0	70	9
5/09/2014	6:00	65.1	60.7	57.5	50.6	0	60	4
5/09/2014	7:00	***66.7***	***61.9***	***58.9***	***52.1***	0	60	5
5/09/2014	8:00	68.2	63	60.3	53.6	0	60	2
5/09/2014	9:00	67.3	62.3	59.3	51.9	0	50	8
5/09/2014	10:00	67.3	62.8	59.3	51.4	0	40	13
5/09/2014	11:00	69	62.7	59.9	50.7	0	60	15
5/09/2014	12:00	67.2	62.5	59.1	49.6	0	50	13
5/09/2014	13:00	67	62.4	59	50	0	50	15
5/09/2014	14:00	66.4	61.5	58.3	50	0	30	13
5/09/2014	15:00	***66.2***	***60.8***	***57.8***	49.9	0	30	11
5/09/2014	16:00	66	60	57.2	49.5	0	270	11
5/09/2014	17:00	65.5	59.7	56.8	50.1	0	290	11
5/09/2014	18:00	64.4	59	57	49.6	0	280	11
5/09/2014	19:00	65.1	59.3	56.5	48.7	0	290	8
5/09/2014	20:00	64.1	57.8	57	47.3	0	0	0
5/09/2014	21:00	65	58.4	56.1	47.6	0	290	5
5/09/2014	22:00	63	56.6	54	47.6	0	290	8
5/09/2014	23:00	61.3	55.6	53.3	46.4	0	290	5
5/09/2014	0:00	61.9	55.1	53.2	45.5	0	290	5



Reference: 13122623

Table A4 – Results of Noise Logging 2A Abbey St, Morley

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
1 September 2014	61.0	57.2	58.5	52.1
2 September 2014	62.0	58.2	59.6	52.4
3 September 2014	61.8	57.8	59.0	53.5
4 September 2014	61.6	57.7	59.0	52.1
5 September 2014	61.8	57.9	59.2	52.6
Weekday Average	**61.6**	**57.7**	**59.0**	**52.5**



Photograph A4 – Noise Logger at 2A Abbey St, Morley

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 2A Abbey St.
Locality	Morley
Occupier	Warren Fayers (Tenant)
Dates	1/9/2014 to 5/9/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	140m to Tonkin Hwy, 15m to Morley Dr
Height of the road in relation to the ground	+2m
Road surface type	OGA on Tonkin Hwy, DGA on Morley Dr
Speed zone	90 km/hr (Tonkin Hwy), 70 km/hr (Morley Hwy)
Absorbing ground	60%,30%
Angle of view	150 (Tonkin Hwy), 80 (Morley Dr)
Road gradient	flat
Traffic flow	Vehicles per day. Main Roads to provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	West to Tonkin Hwy, South to Morley Dr
Carriageways & lanes.	2,6 (Tonkin); 2,4 (Morley)
COMMENT	
Comment	Microphone placed on west façade. Logger placed at front of house, near bedroom window.
REFERENCES	
AMG Z50 E/N	
Road name	Tonkin Highway.
EXCEL file	2A Abbey St MRWA Logger Sheet.xlsx
Raw data file	2A Abbey St_sta.csv
EQUIPMENT	
Analyser number	87803E
Microphone number	87803E
Calibrator number	34883971
Calibrator values	94.0, 94
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Mt Lawley Data 1/09/14 - Neg Winds 11-17 km/h from 10am 5pm 2/09/14 - Calm conditions Variable winds under 9km/h 3/09/14 - Variable winds up to 11km/h 4/09/14 - Variable winds 9-15km/h for 13 hours of day 5/09/14 - Variable winds up to 15km/h

Hourly Noise Level Data

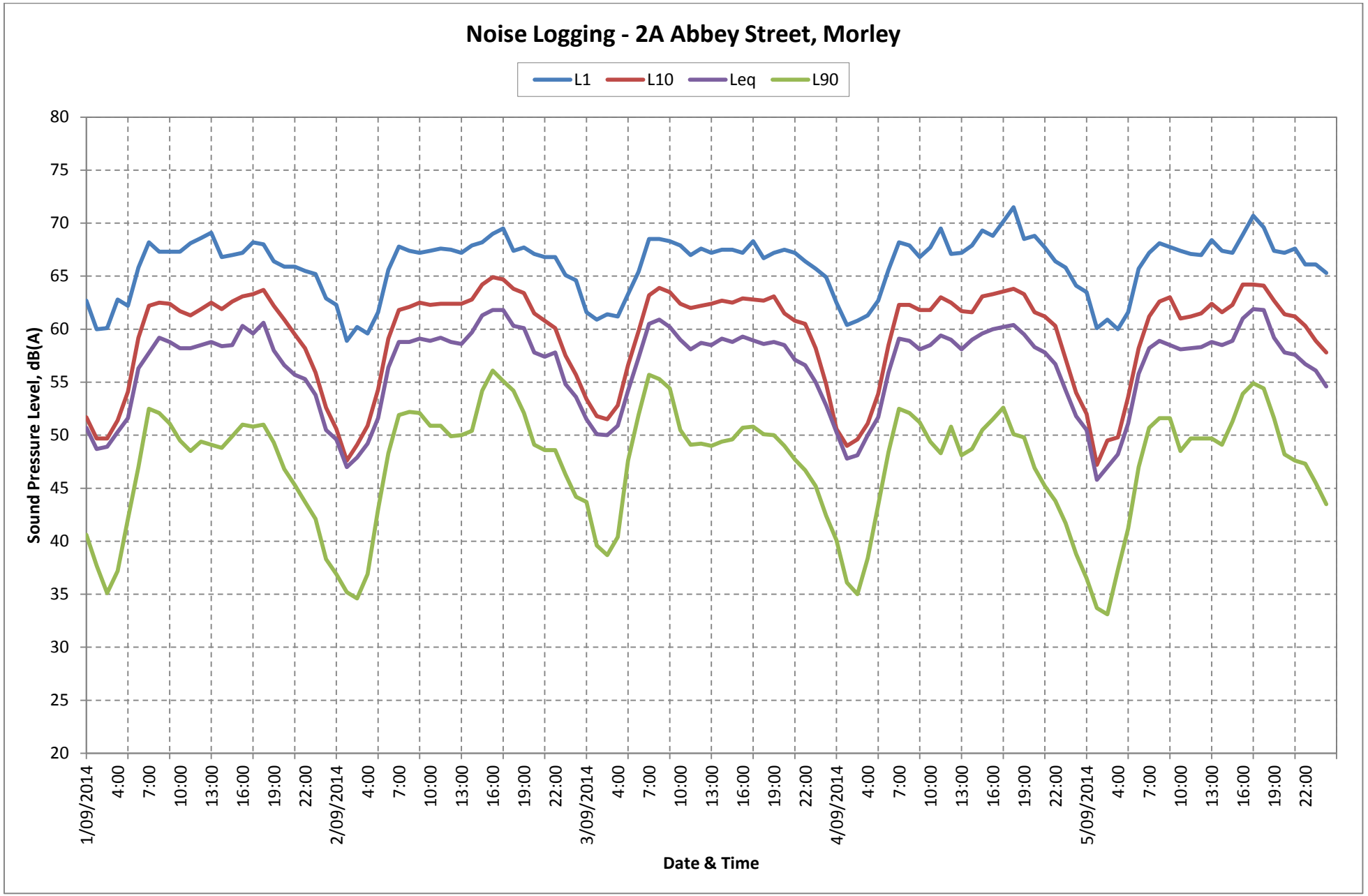
2A Abbey Street, Morley

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
1/09/2014	1/09/2014	62.7	51.7	50.7	40.6	0	0	0
1/09/2014	2:00	60	49.7	48.7	37.7	0	0	0
1/09/2014	3:00	60.1	49.7	48.9	35.1	0	170	5
1/09/2014	4:00	62.8	51.4	50.3	37.2	0	0	0
1/09/2014	5:00	62.2	54.1	51.6	42.1	0	170	5
1/09/2014	6:00	65.8	59.2	56.3	47	0	80	5
1/09/2014	7:00	68.2	62.2	***57.8***	52.5	0	60	8
1/09/2014	8:00	67.3	62.5	59.2	52.1	0	90	8
1/09/2014	9:00	67.3	62.4	58.8	51.1	0	80	5
1/09/2014	10:00	67.3	61.7	58.2	49.5	0	80	11
1/09/2014	11:00	68.1	61.3	58.2	48.5	0	50	17
1/09/2014	12:00	***68.6***	***61.9***	***58.5***	49.4	0	70	13
1/09/2014	13:00	***69.1***	***62.5***	***58.8***	***49.1***	0	50	15
1/09/2014	14:00	66.8	61.9	58.4	48.8	0	60	15
1/09/2014	15:00	67	62.6	58.5	49.9	0	60	15
1/09/2014	16:00	67.2	63.1	60.3	51	0	30	13
1/09/2014	17:00	68.2	63.3	59.6	50.8	0	70	13
1/09/2014	18:00	68	63.7	60.6	51	0	70	9
1/09/2014	19:00	66.4	62.2	58	49.3	0	100	8
1/09/2014	20:00	65.9	60.9	56.6	46.8	0	100	4
1/09/2014	21:00	65.9	59.5	55.7	45.3	0	90	2
1/09/2014	22:00	65.5	58.2	55.3	43.7	0	0	0
1/09/2014	23:00	65.2	55.9	53.8	42.1	0	90	4
1/09/2014	0:00	62.9	52.6	50.5	38.3	0	80	5
2/09/2014	2/09/2014	62.3	50.6	49.6	36.9	0	80	5
2/09/2014	2:00	58.9	47.6	47	35.2	0	80	4
2/09/2014	3:00	60.2	49.1	47.9	34.6	0	150	5
2/09/2014	4:00	59.6	50.9	49.2	36.9	0	100	8
2/09/2014	5:00	61.6	54.3	51.6	43	0	100	8
2/09/2014	6:00	65.6	59.1	56.4	48.3	0	90	5
2/09/2014	7:00	67.8	61.8	58.8	51.9	0	90	2
2/09/2014	8:00	67.4	62.1	58.8	52.2	0	360	4
2/09/2014	9:00	67.2	62.5	59.1	52.1	0	90	8
2/09/2014	10:00	67.4	62.3	58.9	50.9	0	90	5
2/09/2014	11:00	67.6	62.4	59.2	50.9	0	90	5
2/09/2014	12:00	67.5	62.4	58.8	49.9	0	90	2
2/09/2014	13:00	67.2	62.4	58.6	50	0	90	4
2/09/2014	14:00	67.9	62.8	59.7	50.4	0	40	9
2/09/2014	15:00	68.2	64.2	61.3	54.2	0	340	8
2/09/2014	16:00	69	64.9	61.8	56.1	0	280	8
2/09/2014	17:00	69.5	64.7	61.8	55.1	0	260	8
2/09/2014	18:00	67.4	63.8	60.3	54.2	0	260	5
2/09/2014	19:00	67.7	63.4	60.1	52.1	0	250	8
2/09/2014	20:00	67.1	61.5	57.8	49.1	0	250	5
2/09/2014	21:00	66.8	60.8	57.4	48.6	0	240	5
2/09/2014	22:00	66.8	60.1	57.8	48.6	0	0	0
2/09/2014	23:00	65.1	57.5	54.8	46.3	0	0	0
2/09/2014	0:00	64.6	55.7	53.6	44.2	0	0	0
3/09/2014	3/09/2014	61.6	53.4	51.5	43.7	0	0	0
3/09/2014	2:00	60.9	51.8	50.1	39.6	0	0	0
3/09/2014	3:00	61.4	51.5	50	38.7	0	0	0
3/09/2014	4:00	61.2	52.8	50.9	40.4	0	230	5
3/09/2014	5:00	63.3	56.6	54.2	47.6	0	180	9
3/09/2014	6:00	65.4	59.8	57.3	51.9	0	180	9
3/09/2014	7:00	68.5	63.2	60.5	55.7	0	170	11
3/09/2014	8:00	68.5	63.9	60.9	55.3	0	170	8
3/09/2014	9:00	68.3	63.5	60.2	54.4	0	150	9
3/09/2014	10:00	67.9	62.4	59	50.5	0	170	11
3/09/2014	11:00	67	62	58.1	49.1	0	120	8
3/09/2014	12:00	67.6	62.2	58.7	49.2	0	90	8
3/09/2014	13:00	67.2	62.4	58.5	49	0	140	5
3/09/2014	14:00	67.5	62.7	59.1	49.4	0	130	5
3/09/2014	15:00	67.5	62.5	58.8	49.6	0	120	8
3/09/2014	16:00	67.2	62.9	59.3	50.7	0	60	9
3/09/2014	17:00	68.3	***62.8***	***59.0***	50.8	0	60	11
3/09/2014	18:00	66.7	62.7	58.6	50.1	0	70	11
3/09/2014	19:00	67.2	63.1	58.8	50	0	70	8
3/09/2014	20:00	67.5	61.5	58.5	49	0	0	0
3/09/2014	21:00	67.2	60.8	57.1	47.7	0	0	0
3/09/2014	22:00	66.4	60.5	56.6	46.7	0	0	0
3/09/2014	23:00	65.7	58.2	55	45.2	0	60	4
3/09/2014	0:00	64.9	54.8	52.8	42.4	0	60	5

Hourly Noise Level Data

2A Abbey Street, Morley

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
4/09/2014	4/09/2014	62.5	50.6	***50.3***	40.1	0	0	0
4/09/2014	2:00	60.4	49	47.8	36.1	0	70	5
4/09/2014	3:00	60.8	49.6	48.1	35	0	90	8
4/09/2014	4:00	61.3	51.1	50	38.4	0	90	11
4/09/2014	5:00	62.7	53.9	51.7	43.4	0	90	13
4/09/2014	6:00	65.6	58.5	55.9	48.4	0	90	9
4/09/2014	7:00	68.2	62.3	59.1	52.5	0	90	11
4/09/2014	8:00	67.9	62.3	58.9	52.1	0	100	13
4/09/2014	9:00	66.8	61.8	58.1	51.2	0	90	11
4/09/2014	10:00	67.7	61.8	58.5	49.4	0	90	13
4/09/2014	11:00	69.5	63	59.4	48.3	0	100	13
4/09/2014	12:00	67.1	62.5	59	50.8	0	100	15
4/09/2014	13:00	67.2	61.7	58.1	48.1	0	110	15
4/09/2014	14:00	67.9	61.6	59	48.7	0	110	11
4/09/2014	15:00	69.3	63.1	59.6	50.5	0	100	11
4/09/2014	16:00	68.8	63.3	60	51.5	0	130	13
4/09/2014	17:00	***70.2***	***63.6***	***60.2***	52.6	0	110	9
4/09/2014	18:00	***71.5***	***63.8***	***60.4***	50.1	0	110	8
4/09/2014	19:00	68.5	63.3	59.5	49.8	0	90	5
4/09/2014	20:00	68.8	61.6	58.3	46.9	0	100	5
4/09/2014	21:00	67.7	61.2	57.8	45.2	0	0	0
4/09/2014	22:00	66.4	60.3	56.7	43.8	0	100	5
4/09/2014	23:00	65.8	57.2	***54.3***	41.7	0	130	5
4/09/2014	0:00	64.1	54	51.8	38.8	0	70	9
5/09/2014	5/09/2014	63.5	52	***50.5***	36.5	0	110	8
5/09/2014	2:00	60.1	47.2	***45.8***	33.7	0	60	13
5/09/2014	3:00	60.9	49.5	***47.0***	33.1	0	80	8
5/09/2014	4:00	60	49.8	48.2	37.3	0	90	8
5/09/2014	5:00	61.6	53.6	51.1	41.2	0	70	9
5/09/2014	6:00	65.7	58.2	55.8	47	0	60	4
5/09/2014	7:00	67.2	61.2	58.2	50.7	0	60	5
5/09/2014	8:00	68.1	62.6	58.9	51.6	0	60	2
5/09/2014	9:00	***67.8***	63	***58.5***	51.6	0	50	8
5/09/2014	10:00	67.4	61	58.1	48.5	0	40	13
5/09/2014	11:00	67.1	61.2	***58.2***	49.7	0	60	15
5/09/2014	12:00	67	61.5	58.3	49.7	0	50	13
5/09/2014	13:00	68.4	62.4	58.8	49.7	0	50	15
5/09/2014	14:00	67.4	61.6	58.5	49.1	0	30	13
5/09/2014	15:00	67.2	62.3	58.9	51.3	0	30	11
5/09/2014	16:00	68.9	64.2	61	53.9	0	270	11
5/09/2014	17:00	70.7	64.2	61.9	54.9	0	290	11
5/09/2014	18:00	69.6	64.1	61.8	54.4	0	280	11
5/09/2014	19:00	67.4	62.7	59.2	51.6	0	290	8
5/09/2014	20:00	67.2	61.4	57.8	48.2	0	0	0
5/09/2014	21:00	67.6	61.2	57.6	47.6	0	290	5
5/09/2014	22:00	66.1	60.3	56.7	47.3	0	290	8
5/09/2014	23:00	66.1	58.9	56.1	45.5	0	290	5
5/09/2014	0:00	65.3	57.8	54.6	43.5	0	290	5



Reference: 13122623

Table A5 – Results of Noise Logging 9 Clandon Way, Morley

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
1 September 2014	59.3	56.7	57.8	52.7
2 September 2014	59.1	56.3	57.5	52.1
3 September 2014	59.8	57.1	58.2	53.9
4 September 2014	59.8	57.2	58.3	53.7
5 September 2014	59.1	56.5	57.7	52.2
Weekday Average	**59.4**	**56.8**	**57.9**	**52.9**



Photograph A5 – Noise Logger at 9 Clandon Way, Morley

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 9 Clandon Way.
Locality	Morley
Occupier	Mike Williamson 92767107
Dates	1/9/2014 to 5/9/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	35m to Morley Dr
Height of the road in relation to the ground	0m
Road surface type	DGA
Speed zone	70 km/hr (Near Intersection)
Absorbing ground	50%
Angle of view	170
Road gradient	flat
Traffic flow	Vehicles per day. Main Roads to provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	South to Morley Dr
Carriageways & lanes.	2,4;
COMMENT	
Comment	Microphone placed on South façade at front of house Clear line of sight to Road.
REFERENCES	
AMG Z50 E/N	
Road name	Tonkin Highway.
EXCEL file	9 Clandon Way MRWA Logger Sheet.xlsx
Raw data file	9 Clandon 16-707-043_sta.csv
EQUIPMENT	
Analyser number	16-707-043
Microphone number	16-707-043
Calibrator number	34883971
Calibrator values	93.9, 93.8
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Mt Lawley Data 1/09/14 - Negative Winds 11-17 km/h from 10am 5pm 2/09/14 - Calm conditions Variable winds under 9km/h 3/09/14 - Variable winds up to 11km/h 4/09/14 - Variable winds 9-15km/h for 13 hours of day 5/09/14 - Negative winds up to 15km/h

Hourly Noise Level Data

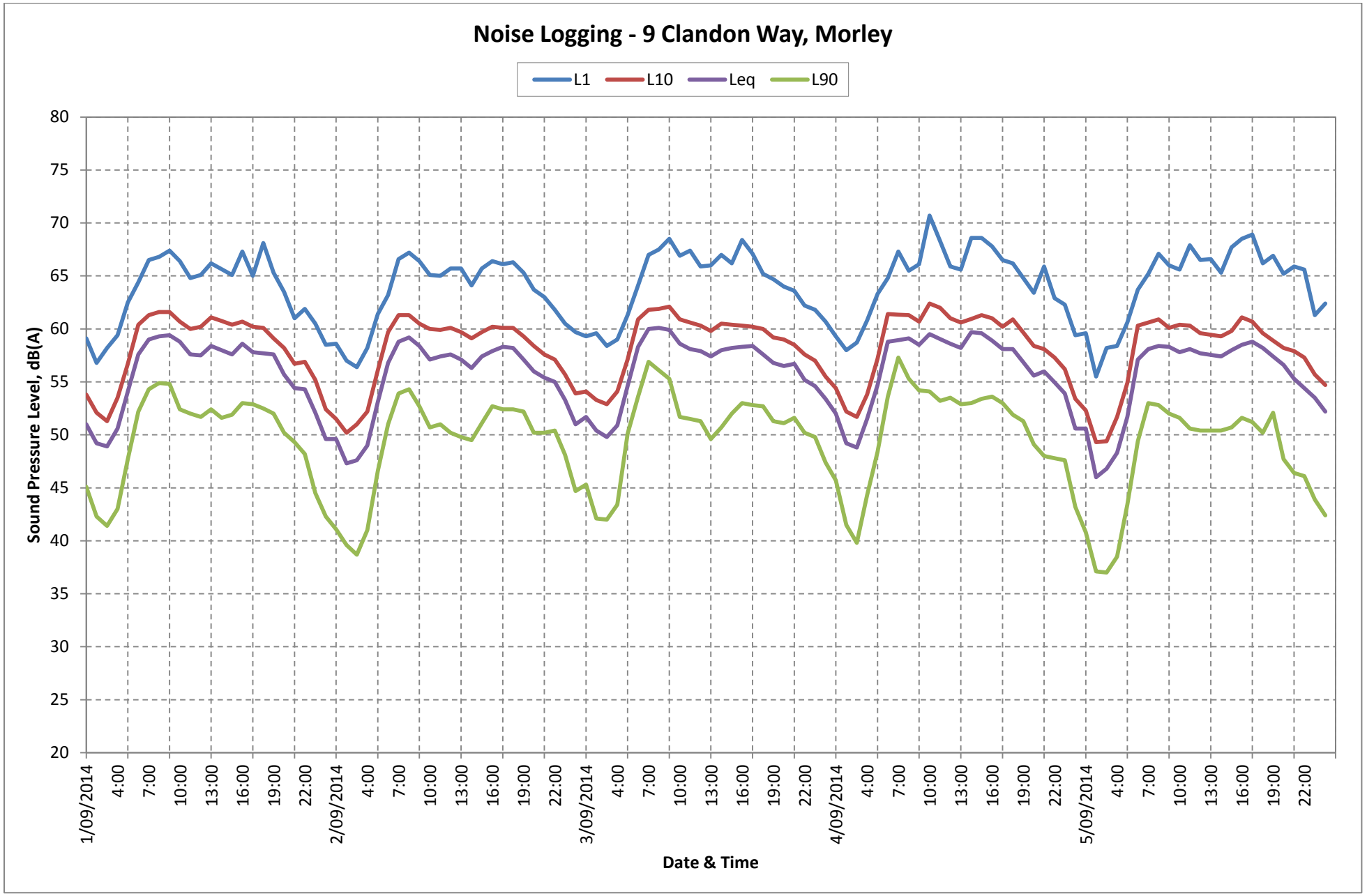
9 Clandon Way, Morley

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
1/09/2014	1/09/2014	59.1	53.8	51	45.1	0	0	0
1/09/2014	2:00	56.8	52.1	49.2	42.3	0	0	0
1/09/2014	3:00	58.2	51.3	48.9	41.4	0	170	5
1/09/2014	4:00	59.4	53.5	50.6	43	0	0	0
1/09/2014	5:00	62.5	56.7	54.1	47.7	0	170	5
1/09/2014	6:00	64.4	60.4	57.6	52.2	0	80	5
1/09/2014	7:00	66.5	61.3	59	54.3	0	60	8
1/09/2014	8:00	66.8	61.6	59.3	54.9	0	90	8
1/09/2014	9:00	67.4	61.6	59.4	54.8	0	80	5
1/09/2014	10:00	66.4	60.7	58.8	52.4	0	80	11
1/09/2014	11:00	64.8	60	57.6	52	0	50	17
1/09/2014	12:00	65.1	60.2	57.5	51.7	0	70	13
1/09/2014	13:00	66.2	61.1	***58.4***	52.4	0	50	15
1/09/2014	14:00	***65.7***	***60.8***	***58.0***	51.6	0	60	15
1/09/2014	15:00	65.1	60.4	57.6	51.9	0	60	15
1/09/2014	16:00	67.3	60.7	58.6	53	0	30	13
1/09/2014	17:00	65	60.2	57.8	52.9	0	70	13
1/09/2014	18:00	68.1	60.1	***57.7***	52.5	0	70	9
1/09/2014	19:00	65.3	59.1	57.6	52	0	100	8
1/09/2014	20:00	63.5	58.2	55.7	50.2	0	100	4
1/09/2014	21:00	61	56.7	54.4	49.3	0	90	2
1/09/2014	22:00	61.9	56.9	54.3	48.2	0	0	0
1/09/2014	23:00	60.5	55.2	52.1	44.5	0	90	4
1/09/2014	0:00	58.5	52.4	49.6	42.3	0	80	5
2/09/2014	2/09/2014	58.6	51.5	49.6	41.1	0	80	5
2/09/2014	2:00	57	50.2	47.3	39.6	0	80	4
2/09/2014	3:00	56.4	51	47.6	38.7	0	150	5
2/09/2014	4:00	58.2	52.2	49	41	0	100	8
2/09/2014	5:00	61.4	56.1	53.1	46.6	0	100	8
2/09/2014	6:00	63.2	59.7	56.8	51	0	90	5
2/09/2014	7:00	66.6	61.3	58.8	53.9	0	90	2
2/09/2014	8:00	67.2	61.3	59.2	54.3	0	360	4
2/09/2014	9:00	66.4	60.5	58.4	52.7	0	90	8
2/09/2014	10:00	65.1	60	57.1	50.7	0	90	5
2/09/2014	11:00	65	59.9	57.4	51	0	90	5
2/09/2014	12:00	65.7	60.1	57.6	50.2	0	90	2
2/09/2014	13:00	65.7	59.7	57.1	49.8	0	90	4
2/09/2014	14:00	64.1	59.1	56.3	49.5	0	40	9
2/09/2014	15:00	65.7	59.7	57.4	51.1	0	340	8
2/09/2014	16:00	66.4	60.2	57.9	52.7	0	280	8
2/09/2014	17:00	66.1	60.1	58.3	52.4	0	260	8
2/09/2014	18:00	66.3	60.1	58.2	52.4	0	260	5
2/09/2014	19:00	65.3	59.3	57.1	52.2	0	250	8
2/09/2014	20:00	63.7	58.4	56	50.2	0	250	5
2/09/2014	21:00	63	57.6	55.4	50.2	0	240	5
2/09/2014	22:00	61.8	57.1	55	50.4	0	0	0
2/09/2014	23:00	60.5	55.7	53.3	48.1	0	0	0
2/09/2014	0:00	59.7	53.9	51	44.7	0	0	0
3/09/2014	3/09/2014	59.3	54.1	51.7	45.3	0	0	0
3/09/2014	2:00	59.6	53.3	50.4	42.1	0	0	0
3/09/2014	3:00	58.4	52.9	49.8	42	0	0	0
3/09/2014	4:00	59	54.1	50.9	43.4	0	230	5
3/09/2014	5:00	61.3	57.1	54.6	50.1	0	180	9
3/09/2014	6:00	64.1	60.9	58.3	53.6	0	180	9
3/09/2014	7:00	67	61.8	60	56.9	0	170	11
3/09/2014	8:00	67.5	61.9	60.1	56.1	0	170	8
3/09/2014	9:00	68.5	62.1	59.9	55.3	0	150	9
3/09/2014	10:00	66.9	60.9	58.6	51.7	0	170	11
3/09/2014	11:00	67.4	60.6	58.1	51.5	0	120	8
3/09/2014	12:00	65.9	60.3	57.9	51.3	0	90	8
3/09/2014	13:00	66	59.8	57.4	49.6	0	140	5
3/09/2014	14:00	67	60.5	58	50.7	0	130	5
3/09/2014	15:00	66.2	60.4	58.2	52	0	120	8
3/09/2014	16:00	68.4	***60.3***	***58.3***	53	0	60	9
3/09/2014	17:00	67.1	60.2	58.4	52.8	0	60	11
3/09/2014	18:00	65.2	60	57.6	52.7	0	70	11
3/09/2014	19:00	64.7	59.2	56.8	51.3	0	70	8
3/09/2014	20:00	64	59	56.5	51.1	0	0	0
3/09/2014	21:00	63.6	58.5	56.7	51.6	0	0	0
3/09/2014	22:00	62.2	57.6	55.2	50.2	0	0	0
3/09/2014	23:00	61.8	57	54.6	49.8	0	60	4
3/09/2014	0:00	60.7	55.5	53.4	47.4	0	60	5

Hourly Noise Level Data

9 Clandon Way, Morley

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
4/09/2014	4/09/2014	59.3	54.4	52	45.7	0	0	0
4/09/2014	2:00	58	52.2	49.2	41.5	0	70	5
4/09/2014	3:00	58.7	51.7	48.8	39.8	0	90	8
4/09/2014	4:00	60.8	53.8	51.5	44.3	0	90	11
4/09/2014	5:00	63.3	57.2	54.7	48.4	0	90	13
4/09/2014	6:00	64.8	61.4	58.8	53.6	0	90	9
4/09/2014	7:00	67.3	***61.4***	***59.0***	57.3	0	90	11
4/09/2014	8:00	65.5	61.3	59.1	55.3	0	100	13
4/09/2014	9:00	66.1	60.7	58.5	54.2	0	90	11
4/09/2014	10:00	70.7	62.4	***59.5***	54.1	0	90	13
4/09/2014	11:00	***68.3***	62	***59.1***	53.2	0	100	13
4/09/2014	12:00	65.9	61	58.6	53.5	0	100	15
4/09/2014	13:00	65.6	60.6	58.2	52.9	0	110	15
4/09/2014	14:00	68.6	***61.0***	59.7	53	0	110	11
4/09/2014	15:00	68.6	61.3	59.6	53.4	0	100	11
4/09/2014	16:00	67.8	61	58.9	53.6	0	130	13
4/09/2014	17:00	66.5	60.2	58.1	53	0	110	9
4/09/2014	18:00	66.2	60.9	58.1	51.9	0	110	8
4/09/2014	19:00	***64.8***	***59.7***	***56.9***	51.3	0	90	5
4/09/2014	20:00	63.4	58.4	55.6	49.1	0	100	5
4/09/2014	21:00	65.9	58.1	***56***	48	0	0	0
4/09/2014	22:00	62.9	57.3	***55.0***	47.8	0	100	5
4/09/2014	23:00	62.3	56.2	53.9	47.6	0	130	5
4/09/2014	0:00	59.4	53.4	50.6	43.2	0	70	9
5/09/2014	5/09/2014	59.6	52.3	50.6	40.8	0	110	8
5/09/2014	2:00	55.5	49.3	46	37.1	0	60	13
5/09/2014	3:00	58.2	49.4	46.8	37	0	80	8
5/09/2014	4:00	58.4	51.7	48.3	38.5	0	90	8
5/09/2014	5:00	60.6	54.9	51.7	43.4	0	70	9
5/09/2014	6:00	63.7	60.3	57.1	49.4	0	60	4
5/09/2014	7:00	65.2	60.6	58.1	53	0	60	5
5/09/2014	8:00	67.1	60.9	58.4	52.8	0	60	2
5/09/2014	9:00	66	60.1	58.3	52	0	50	8
5/09/2014	10:00	65.6	60.4	57.8	51.6	0	40	13
5/09/2014	11:00	67.9	60.3	58.1	50.6	0	60	15
5/09/2014	12:00	66.5	59.6	57.7	50.4	0	50	13
5/09/2014	13:00	66.6	***59.5***	***57.6***	50.4	0	50	15
5/09/2014	14:00	65.3	59.3	57.4	50.4	0	30	13
5/09/2014	15:00	67.7	59.8	58	50.7	0	30	11
5/09/2014	16:00	68.5	61.1	58.5	51.6	0	270	11
5/09/2014	17:00	68.9	60.7	58.8	51.2	0	290	11
5/09/2014	18:00	66.2	59.6	58.2	50.2	0	280	11
5/09/2014	19:00	66.9	***58.9***	***57.4***	52.1	0	290	8
5/09/2014	20:00	65.2	58.2	56.6	47.7	0	0	0
5/09/2014	21:00	65.9	57.9	55.3	46.4	0	290	5
5/09/2014	22:00	65.6	57.3	***54.4***	46.1	0	290	8
5/09/2014	23:00	61.3	55.7	***53.5***	43.9	0	290	5
5/09/2014	0:00	62.4	54.7	52.2	42.4	0	290	5



Reference: 13122623

Table A6 – Results of Noise Logging 48 Alfreda Avenue, Morley

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
8 September 2014*	60.6	58.3	58.5	57.9
9 September 2014	58.5	55.7	56.7	52.3
10 September 2014	58.6	55.1	56.1	52.2
11 September 2014	60.0	56.6	57.6	53.9
12 September 2014	60.2	57.1	57.9	55.2
Weekday Average	**59.3**	**56.1**	**57.1**	**53.4**

*Day excluded from the Average due to unacceptable weather conditions.



Photograph A6 – Noise Logger at 48 Alfreda Avenue, Morley

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	48 Alfreda Way.
Locality	Morley
Occupier	Marco Comito 0438990059
Dates	8/9/2014 to 12/9/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	70m to Tonkin Hwy
Height of the road in relation to the ground	0m
Road surface type	DGA
Speed zone	90 km/hr
Absorbing ground	80%
Angle of view	180
Road gradient	flat
Traffic flow	Vehicles per day. Main Roads to provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	East
Carriageways & lanes.	2,4;
COMMENT	
Comment	Microphone placed on East façade at front of house Vegetation buffer between Alfreda Ave and Tonkin Hwy.
REFERENCES	
AMG Z50 E/N	
Road name	Tonkin Highway.
EXCEL file	48 Alfreda Ave MRWA Logger Sheet.xlsx
Raw data file	48 Alfreda 15-301-468_sta.csv
EQUIPMENT	
Analyser number	15-301-468
Microphone number	15-301-468
Calibrator number	34883971
Calibrator values	94.0, 93.6
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Mt Lawley Data 8/09/14 - High Neg Winds up to 30 km/h All day, some showers, excluded 9/09/14 - Negs winds up to 18km/h in morning, Avg 13 km/h Neg wind during 10/09/14 - Neg winds up to 13km/h, one hour at 15km/h 11/09/14 - Variable winds up to 13km/h 12/09/14 - Negative winds up to 18km/h

Hourly Noise Level Data

48 Alfreda Ave, Morley

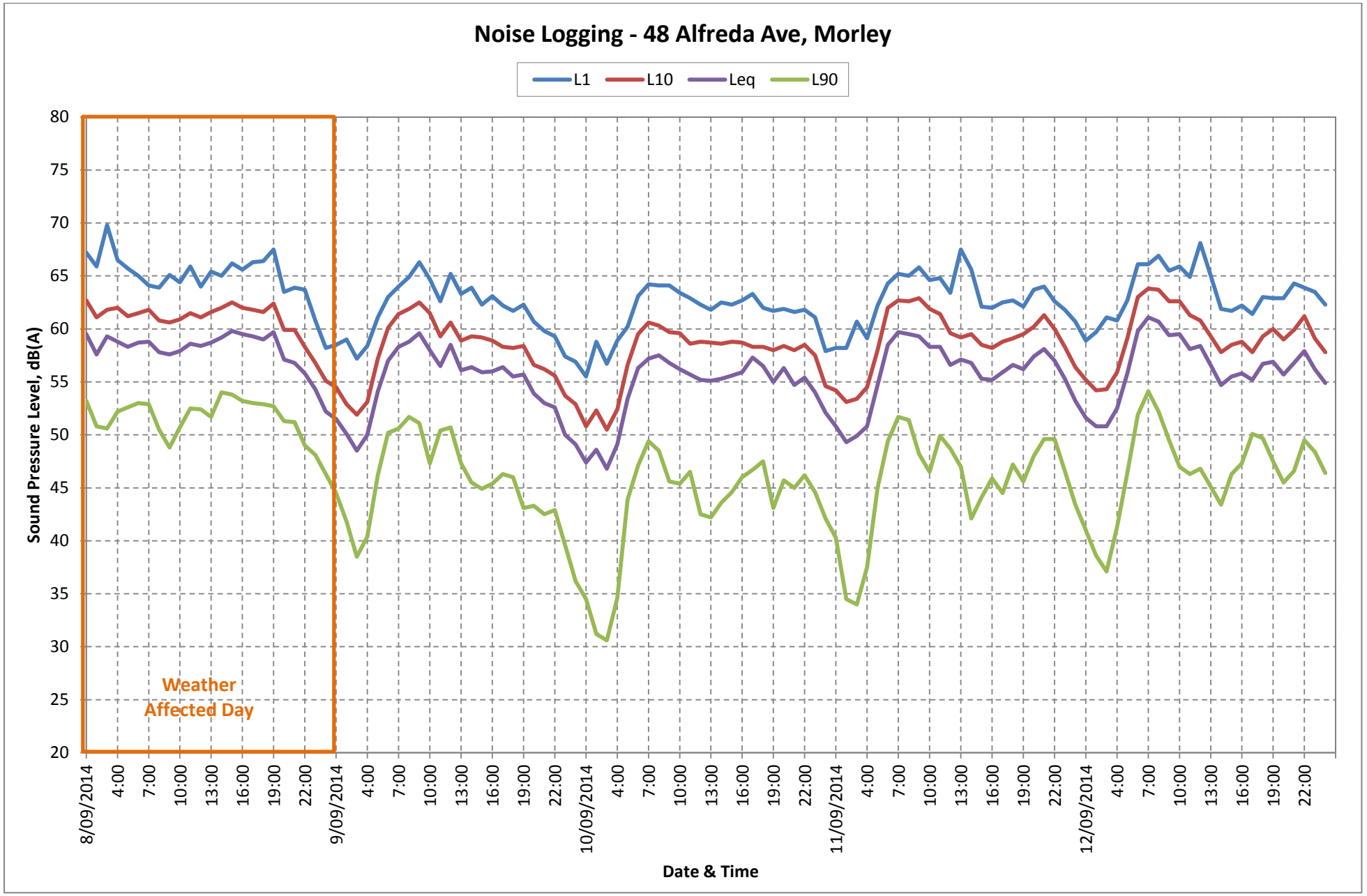
Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
8/09/2014	8/09/2014	67.2	62.7	59.5	53.2	0.4	260	30
8/09/2014	2:00	65.9	61.1	57.6	50.8	0.2	270	26
8/09/2014	3:00	69.8	61.8	59.3	50.6	0	270	21
8/09/2014	4:00	66.5	62	58.8	52.2	0.6	260	31
8/09/2014	5:00	65.7	61.2	58.3	52.6	0	260	22
8/09/2014	6:00	65	61.5	58.7	53	0.2	260	24
8/09/2014	7:00	64.1	61.8	58.8	52.9	0	260	22
8/09/2014	8:00	63.9	60.8	57.8	50.5	0	260	22
8/09/2014	9:00	65.1	60.6	57.6	48.8	0	270	13
8/09/2014	10:00	64.4	60.9	57.9	50.7	0	270	18
8/09/2014	11:00	65.9	61.5	58.6	52.5	0	290	22
8/09/2014	12:00	64	61.1	58.4	52.4	0.2	300	18
8/09/2014	13:00	65.4	61.6	58.7	51.7	0	280	21
8/09/2014	14:00	65	62	59.2	54	0	290	21
8/09/2014	15:00	66.2	62.5	59.8	53.8	0	280	18
8/09/2014	16:00	65.6	62	59.5	53.2	0	290	28
8/09/2014	17:00	66.3	61.8	59.3	53	0	300	21
8/09/2014	18:00	66.4	61.6	59	52.9	0.4	290	22
8/09/2014	19:00	67.5	62.4	59.7	52.7	0	290	24
8/09/2014	20:00	63.5	59.9	57.1	51.3	0	290	21
8/09/2014	21:00	63.9	59.9	56.8	51.2	0	280	22
8/09/2014	22:00	63.7	58.3	55.8	49	0	290	24
8/09/2014	23:00	60.8	56.8	54.3	48.1	0	270	22
8/09/2014	0:00	58.2	55.1	52.2	46.3	0.2	250	22
9/09/2014	9/09/2014	58.5	54.5	51.5	44.5	0	260	21
9/09/2014	2:00	59	52.9	50.1	41.8	0	240	18
9/09/2014	3:00	57.2	51.9	48.5	38.5	0	250	17
9/09/2014	4:00	58.4	53.1	50	40.4	0	250	17
9/09/2014	5:00	61.1	57.2	54.1	46.2	0	230	15
9/09/2014	6:00	63	60.1	57	50.2	0	240	15
9/09/2014	7:00	64	61.4	58.3	50.6	0	250	17
9/09/2014	8:00	64.9	61.9	58.8	51.7	0	250	9
9/09/2014	9:00	66.3	62.5	59.6	51.1	0	250	5
9/09/2014	10:00	64.7	61.5	58	47.3	0	230	2
9/09/2014	11:00	62.6	59.3	56.5	50.4	0	260	13
9/09/2014	12:00	65.2	60.6	58.5	50.7	0	240	15
9/09/2014	13:00	63.3	58.9	56.1	47.3	0	260	15
9/09/2014	14:00	63.9	59.3	56.4	45.5	0	240	13
9/09/2014	15:00	62.3	59.2	55.9	44.9	0	270	13
9/09/2014	16:00	63.1	58.9	56	45.4	0	260	13
9/09/2014	17:00	62.2	58.3	56.4	46.3	0	270	11
9/09/2014	18:00	61.7	58.2	55.5	46	0	250	13
9/09/2014	19:00	62.3	58.4	55.7	43.1	0	270	9
9/09/2014	20:00	60.7	56.6	53.9	43.3	0	240	5
9/09/2014	21:00	59.8	56.2	53	42.5	0	260	5
9/09/2014	22:00	59.3	55.6	52.6	42.9	0	270	4
9/09/2014	23:00	57.4	53.7	50	39.6	0	270	11
9/09/2014	0:00	56.9	52.9	49.1	36.2	0	310	8
10/09/2014	10/09/2014	55.5	50.8	47.4	34.5	0	280	11
10/09/2014	2:00	58.8	52.3	48.6	31.2	0	0	0
10/09/2014	3:00	56.7	50.5	46.8	30.6	0	280	4
10/09/2014	4:00	58.9	52.4	49.1	34.6	0	270	8
10/09/2014	5:00	60.2	56.6	53.4	43.9	0	310	5
10/09/2014	6:00	63.1	59.5	56.3	47.1	0	260	11
10/09/2014	7:00	64.2	60.6	57.2	49.4	0	250	9
10/09/2014	8:00	64.1	60.3	57.5	48.5	0	260	9
10/09/2014	9:00	64.1	59.7	56.8	45.6	0	260	9
10/09/2014	10:00	63.4	59.6	56.2	45.4	0	280	9
10/09/2014	11:00	62.9	58.6	55.7	46.5	0	290	11
10/09/2014	12:00	62.3	58.8	55.2	42.5	0	280	11
10/09/2014	13:00	61.8	58.7	55.1	42.2	0	310	11
10/09/2014	14:00	62.5	58.6	55.3	43.6	0	270	13
10/09/2014	15:00	62.3	58.8	55.6	44.6	0	270	13
10/09/2014	16:00	62.7	58.7	55.9	46	0	280	15
10/09/2014	17:00	63.3	58.3	57.3	46.7	0	270	11
10/09/2014	18:00	62	58.3	56.5	47.5	0	240	9
10/09/2014	19:00	61.7	58	55	43.1	0	230	9
10/09/2014	20:00	61.9	58.4	56.3	45.7	0	210	11
10/09/2014	21:00	61.6	58	54.7	45	0	170	9
10/09/2014	22:00	61.8	58.5	55.4	46.2	0	190	5
10/09/2014	23:00	61.1	57.5	54	44.6	0	190	4
10/09/2014	0:00	57.9	54.6	52.1	42.1	0	0	0

Reference: 13122623

Hourly Noise Level Data

48 Alfreda Ave, Morley

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
11/09/2014	11/09/2014	58.2	54.2	50.8	40.3	0	0	0
11/09/2014	2:00	58.2	53.1	49.3	34.5	0	0	0
11/09/2014	3:00	60.7	53.4	49.9	34	0	0	0
11/09/2014	4:00	59.1	54.5	50.8	37.5	0	20	8
11/09/2014	5:00	62.2	58	54.7	45	0	20	4
11/09/2014	6:00	64.3	62	58.5	49.4	0	10	4
11/09/2014	7:00	65.2	62.7	59.7	51.7	0	30	2
11/09/2014	8:00	65	62.6	59.5	51.4	0	30	2
11/09/2014	9:00	65.8	62.9	59.3	48.2	0	30	8
11/09/2014	10:00	64.6	61.9	58.3	46.5	0	40	8
11/09/2014	11:00	64.8	61.4	58.3	49.9	0	20	9
11/09/2014	12:00	63.4	59.6	56.6	48.7	0	360	8
11/09/2014	13:00	67.5	59.2	57.1	47	0	290	11
11/09/2014	14:00	65.6	59.5	56.8	42.1	0	290	9
11/09/2014	15:00	62.1	58.5	55.3	44.1	0	290	13
11/09/2014	16:00	62	58.2	55.2	45.9	0	270	11
11/09/2014	17:00	62.5	58.8	55.9	44.5	0	260	13
11/09/2014	18:00	62.7	59.1	56.6	47.2	0	250	11
11/09/2014	19:00	62.1	59.5	56.2	45.6	0	240	11
11/09/2014	20:00	63.7	60.2	57.4	48	0	220	9
11/09/2014	21:00	64	61.3	58.1	49.6	0	0	0
11/09/2014	22:00	62.6	60	57	49.6	0	0	0
11/09/2014	23:00	61.8	58.3	55.3	46.6	0	0	0
11/09/2014	0:00	60.7	56.4	53.2	43.4	0	0	0
12/09/2014	12/09/2014	58.9	55.2	51.6	41	0	0	0
12/09/2014	2:00	59.7	54.2	50.8	38.6	0	0	0
12/09/2014	3:00	61.1	54.3	50.8	37.1	0	0	0
12/09/2014	4:00	60.8	55.9	52.5	41.3	0	0	0
12/09/2014	5:00	62.7	59.1	55.8	46.4	0	0	0
12/09/2014	6:00	66.1	63	59.8	51.9	0	0	0
12/09/2014	7:00	66.1	63.8	61.1	54.1	0	220	2
12/09/2014	8:00	66.9	63.7	60.7	52.2	0	210	9
12/09/2014	9:00	65.5	62.6	59.4	49.5	0	30	8
12/09/2014	10:00	65.9	62.6	59.5	47	0	30	9
12/09/2014	11:00	64.9	61.3	58.1	46.3	0	20	9
12/09/2014	12:00	***68.1***	60.8	***58.4***	46.8	0	340	8
12/09/2014	13:00	***65.0***	***59.3***	***56.6***	***45.1***	0	300	5
12/09/2014	14:00	61.9	57.8	54.7	43.4	0	310	11
12/09/2014	15:00	61.7	58.5	55.5	46.3	0	240	15
12/09/2014	16:00	62.2	58.8	55.8	47.3	0	260	17
12/09/2014	17:00	61.4	57.8	55.2	50.1	0	250	17
12/09/2014	18:00	63	59.3	56.7	49.7	0	240	18
12/09/2014	19:00	62.9	60	56.9	47.5	0	230	13
12/09/2014	20:00	62.9	59	55.7	45.5	0	220	13
12/09/2014	21:00	64.3	59.9	56.8	46.6	0	220	9
12/09/2014	22:00	63.9	61.2	57.9	49.5	0	0	0
12/09/2014	23:00	63.5	59.1	56.2	48.4	0	0	0
12/09/2014	0:00	62.3	57.8	54.9	46.4	0	0	0



Reference: 13122623

Table A7 – Results of Noise Logging 100 Alfreda Avenue, Morley

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
8 September 2014*	60.0	57.9	58.3	57.1
9 September 2014	58.4	55.3	56.3	52.3
10 September 2014	58.7	55.4	56.0	54.0
11 September 2014	60.2	57.1	57.6	55.6
12 September 2014	59.9	57.3	57.6	56.6
Weekday Average	**59.3**	**56.3**	**56.9**	**54.6**

*Day excluded from the Average due to unacceptable weather conditions.



Photograph A7 – Noise Logger at 100 Alfreda Avenue, Morley

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 100 Alfreda Way.
Locality	Morley
Occupier	Vivian De Cruz 92762744
Dates	8/9/2014 to 12/9/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	85m to Tonkin Hwy
Height of the road in relation to the ground	+1m
Road surface type	DGA
Speed zone	80 km/hr (Near Intersection)
Absorbing ground	80%
Angle of view	180
Road gradient	flat
Traffic flow	Vehicles per day. Main Roads to provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	East
Carriageways & lanes.	2,4;
COMMENT	
Comment	Microphone placed on East façade at front of house Vegetation buffer between Alfreda Ave and Tonkin Hwy.
REFERENCES	
AMG Z50 E/N	
Road name	Tonkin Highway.
EXCEL file	100 Alfreda Ave MRWA Logger Sheet.xlsx
Raw data file	100 Alfreda 16-707-041_sta.csv
EQUIPMENT	
Analyser number	16-707-041
Microphone number	16-707-041
Calibrator number	34883971
Calibrator values	94.2, 93.9
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Mt Lawley Data 8/09/14 - High Neg Winds up to 30 km/h All day, some showers, excluded 9/09/14 - Negs winds up to 18km/h in morning, Avg 13 km/h Neg wind during 10/09/14 - Neg winds up to 13km/h, one hour at 15km/h 11/09/14 - Variable winds up to 13km/h 12/09/14 - Negative winds up to 18km/h

Hourly Noise Level Data

100 Alfreda Ave, Morley

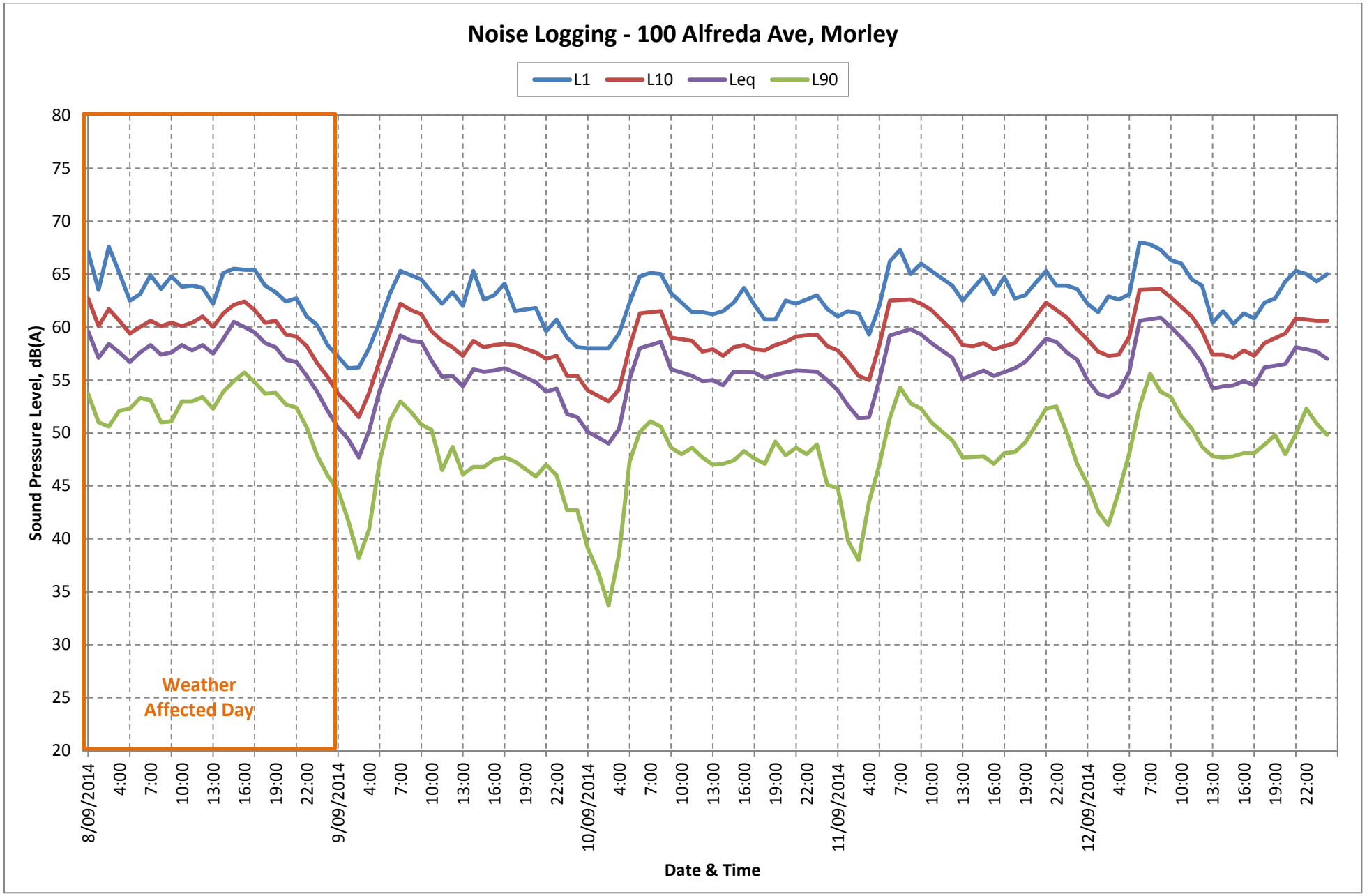
Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
8/09/2014	8/09/2014	67.1	62.7	59.6	53.7	0.4	260	30
8/09/2014	2:00	63.5	60.1	57.1	51	0.2	270	26
8/09/2014	3:00	67.6	61.7	58.4	50.6	0	270	21
8/09/2014	4:00	65.1	60.6	57.6	52.1	0.6	260	31
8/09/2014	5:00	62.5	59.4	56.7	52.3	0	260	22
8/09/2014	6:00	63.1	60	57.6	53.3	0.2	260	24
8/09/2014	7:00	64.9	60.6	58.3	53.1	0	260	22
8/09/2014	8:00	63.6	60.1	57.4	51	0	260	22
8/09/2014	9:00	64.8	60.4	57.6	51.1	0	270	13
8/09/2014	10:00	63.8	60.1	58.3	53	0	270	18
8/09/2014	11:00	63.9	60.4	57.8	53	0	290	22
8/09/2014	12:00	63.7	61	58.3	53.4	0.2	300	18
8/09/2014	13:00	62.2	60	57.5	52.3	0	280	21
8/09/2014	14:00	65.1	61.3	58.9	53.9	0	290	21
8/09/2014	15:00	65.5	62.1	60.5	54.9	0	280	18
8/09/2014	16:00	65.4	62.4	60	55.7	0	290	28
8/09/2014	17:00	65.4	61.6	59.5	54.8	0	300	21
8/09/2014	18:00	63.9	60.4	58.5	53.7	0.4	290	22
8/09/2014	19:00	63.3	60.6	58.1	53.8	0	290	24
8/09/2014	20:00	62.4	59.3	56.9	52.7	0	290	21
8/09/2014	21:00	62.7	59.1	56.7	52.4	0	280	22
8/09/2014	22:00	61	58.2	55.4	50.5	0	290	24
8/09/2014	23:00	60.2	56.6	53.9	47.9	0	270	22
8/09/2014	0:00	58.3	55.3	52.1	46	0.2	250	22
9/09/2014	9/09/2014	57.2	53.7	50.5	44.6	0	260	21
9/09/2014	2:00	56.1	52.7	49.4	41.7	0	240	18
9/09/2014	3:00	56.2	51.5	47.7	38.2	0	250	17
9/09/2014	4:00	58	53.8	50.2	40.9	0	250	17
9/09/2014	5:00	60.5	56.8	54	47.3	0	230	15
9/09/2014	6:00	63.2	***59.5***	***56.6***	51.2	0	240	15
9/09/2014	7:00	65.3	62.2	59.2	53	0	250	17
9/09/2014	8:00	64.9	61.6	58.7	52	0	250	9
9/09/2014	9:00	64.5	61.2	58.6	50.8	0	250	5
9/09/2014	10:00	63.3	59.6	56.8	50.3	0	230	2
9/09/2014	11:00	62.2	58.7	55.3	46.5	0	260	13
9/09/2014	12:00	63.3	58.1	55.4	48.7	0	240	15
9/09/2014	13:00	62	57.3	54.4	46.1	0	260	15
9/09/2014	14:00	65.3	58.7	56	46.8	0	240	13
9/09/2014	15:00	62.6	58.1	55.8	46.8	0	270	13
9/09/2014	16:00	63	58.3	55.9	47.5	0	260	13
9/09/2014	17:00	64.1	58.4	56.1	47.7	0	270	11
9/09/2014	18:00	61.5	58.3	55.7	47.3	0	250	13
9/09/2014	19:00	***61.7***	***58.0***	***55.3***	***46.6***	0	270	9
9/09/2014	20:00	61.8	57.6	54.8	45.9	0	240	5
9/09/2014	21:00	59.6	57	53.9	47	0	260	5
9/09/2014	22:00	60.7	57.3	54.2	46	0	270	4
9/09/2014	23:00	59	55.4	51.8	42.7	0	270	11
9/09/2014	0:00	58.1	55.4	51.5	42.7	0	310	8
10/09/2014	10/09/2014	58	54	50.1	39.1	0	280	11
10/09/2014	2:00	***58.0***	***53.5***	***49.6***	36.8	0	0	0
10/09/2014	3:00	58	53	49	33.7	0	280	4
10/09/2014	4:00	59.4	54.1	50.4	38.6	0	270	8
10/09/2014	5:00	62.3	58.1	55.1	47.3	0	310	5
10/09/2014	6:00	64.8	61.3	58	50.1	0	260	11
10/09/2014	7:00	65.1	***61.4***	***58.3***	51.1	0	250	9
10/09/2014	8:00	65	61.5	58.6	50.6	0	260	9
10/09/2014	9:00	63.2	59	56	48.6	0	260	9
10/09/2014	10:00	***62.3***	***58.9***	***55.7***	48	0	280	9
10/09/2014	11:00	61.4	58.7	55.4	48.6	0	290	11
10/09/2014	12:00	61.4	57.7	54.9	47.7	0	280	11
10/09/2014	13:00	61.2	57.9	55	47	0	310	11
10/09/2014	14:00	61.5	57.3	54.5	47.1	0	270	13
10/09/2014	15:00	62.3	58.1	55.8	47.4	0	270	13
10/09/2014	16:00	63.7	58.3	***55.8***	48.3	0	280	15
10/09/2014	17:00	62.1	57.9	55.7	47.6	0	270	11
10/09/2014	18:00	60.7	57.8	55.2	47.1	0	240	9
10/09/2014	19:00	60.7	58.3	55.5	49.2	0	230	9
10/09/2014	20:00	62.5	58.6	55.7	47.9	0	210	11
10/09/2014	21:00	62.2	59.1	55.9	48.6	0	170	9
10/09/2014	22:00	***62.6***	***59.2***	***55.9***	48	0	190	5
10/09/2014	23:00	63	59.3	55.8	48.9	0	190	4
10/09/2014	0:00	61.7	58.2	55	45.1	0	0	0

Reference: 13122623

Hourly Noise Level Data

100 Alfreda Ave, Morley

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
11/09/2014	11/09/2014	61	57.8	54	44.8	0	0	0
11/09/2014	2:00	61.5	56.7	52.6	39.8	0	0	0
11/09/2014	3:00	61.3	55.4	51.4	38	0	0	0
11/09/2014	4:00	59.3	55	51.5	43.5	0	20	8
11/09/2014	5:00	62	58.3	55	47	0	20	4
11/09/2014	6:00	66.2	62.5	59.2	51.4	0	10	4
11/09/2014	7:00	67.3	***62.6***	***59.5***	54.3	0	30	2
11/09/2014	8:00	65	62.6	59.8	52.8	0	30	2
11/09/2014	9:00	66	62.2	59.3	52.3	0	30	8
11/09/2014	10:00	65.3	61.6	58.5	51	0	40	8
11/09/2014	11:00	***64.6***	***60.7***	***57.8***	***50.2***	0	20	9
11/09/2014	12:00	63.9	59.7	57.1	49.3	0	360	8
11/09/2014	13:00	62.5	58.3	55.1	47.7	0	290	11
11/09/2014	14:00	***63.7***	58.2	***55.5***	***47.8***	0	290	9
11/09/2014	15:00	64.8	58.5	***55.9***	47.8	0	290	13
11/09/2014	16:00	63.1	57.9	55.4	47.1	0	270	11
11/09/2014	17:00	64.7	***58.2***	***55.8***	48.1	0	260	13
11/09/2014	18:00	62.7	58.5	56.1	48.2	0	250	11
11/09/2014	19:00	63	59.7	56.7	49.1	0	240	11
11/09/2014	20:00	***64.2***	***61.0***	***57.8***	50.7	0	220	9
11/09/2014	21:00	65.3	62.3	***58.9***	52.3	0	0	0
11/09/2014	22:00	63.9	61.6	58.6	52.5	0	0	0
11/09/2014	23:00	63.9	60.9	57.6	50	0	0	0
11/09/2014	0:00	63.6	59.8	56.9	47.1	0	0	0
12/09/2014	12/09/2014	62.2	58.8	55	45.2	0	0	0
12/09/2014	2:00	61.4	57.7	53.7	42.6	0	0	0
12/09/2014	3:00	62.9	57.3	53.4	41.3	0	0	0
12/09/2014	4:00	62.6	57.4	53.9	44.5	0	0	0
12/09/2014	5:00	63.1	59.1	55.8	48.1	0	0	0
12/09/2014	6:00	68	63.5	60.6	52.5	0	0	0
12/09/2014	7:00	67.8	***63.6***	***60.8***	55.6	0	220	2
12/09/2014	8:00	67.3	63.6	60.9	53.9	0	210	9
12/09/2014	9:00	66.3	62.8	60	53.4	0	30	8
12/09/2014	10:00	66	61.9	59	51.6	0	30	9
12/09/2014	11:00	64.5	61	57.9	50.4	0	20	9
12/09/2014	12:00	63.9	59.6	56.5	48.7	0	340	8
12/09/2014	13:00	60.4	57.4	54.2	47.8	0	300	5
12/09/2014	14:00	61.5	57.4	54.4	47.7	0	310	11
12/09/2014	15:00	60.3	57.1	54.5	47.8	0	240	15
12/09/2014	16:00	61.3	57.8	54.9	48.1	0	260	17
12/09/2014	17:00	60.8	57.3	54.5	48.1	0	250	17
12/09/2014	18:00	62.3	58.5	56.2	48.9	0	240	18
12/09/2014	19:00	62.7	***59.0***	***56.4***	49.8	0	230	13
12/09/2014	20:00	64.3	59.4	56.5	48	0	220	13
12/09/2014	21:00	65.3	***60.8***	***58.1***	49.9	0	220	9
12/09/2014	22:00	65	***60.7***	***57.9***	52.3	0	0	0
12/09/2014	23:00	64.3	60.6	57.7	50.9	0	0	0
12/09/2014	0:00	65	60.6	***57***	49.8	0	0	0



Reference: 13122623

Table A8 – Results of Noise Logging 8 Wells Court, Noranda

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
8 September 2014*	57.7	55.8	55.6	56.2
9 September 2014	50.8	48.9	49.9	45.7
10 September 2014	51.5	48.3	49.6	43.2
11 September 2014	51.9	48.9	49.9	45.6
12 September 2014	51.7	49.4	50.0	47.6
Weekday Average	**51.5**	**48.9**	**49.9**	**45.5**

*Day excluded from the Average due to unacceptable weather conditions.



Photograph A8 – Noise Logger at 8 Wells Court, Noranda

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 8 Wells Court.
Locality	Noranda
Occupier	Jose Berard 0401546000
Dates	8/9/2014 to 12/9/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	35m to Benara Rd
Height of the road in relation to the ground	0m
Road surface type	DGA
Speed zone	70 km/hr
Absorbing ground	80%
Angle of view	160
Road gradient	flat
Traffic flow	Vehicles per day. Main Roads to provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	South
Carriageways & lanes.	2,4;
COMMENT	
Comment	Microphone placed on South façade at Rear of house Rear Property fence between Microphone and Benara Road.
REFERENCES	
AMG Z50 E/N	
Road name	Benara Road
EXCEL file	8 Wells Court MRWA Logger Sheet.xlsx
Raw data file	8 wells ct 15-203-505_Sta.csv
EQUIPMENT	
Analyser number	15-203-505
Microphone number	15-203-505
Calibrator number	34883971
Calibrator values	93.9, 93.6
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Mt Lawley Data 8/09/14 - High Variable Winds up to 30 km/h All day, some showers, excluded 9/09/14 - Pos winds up to 18km/h in morning, Avg 13 km/h Pos wind during day 10/09/14 - Var winds up to 13km/h, one hour at 15km/h 11/09/14 - Neg Morning winds up to 11km/h, Pos winds to 13km/h afternoon 12/09/14 - Positive Evening winds up to 18km/h

Hourly Noise Level Data

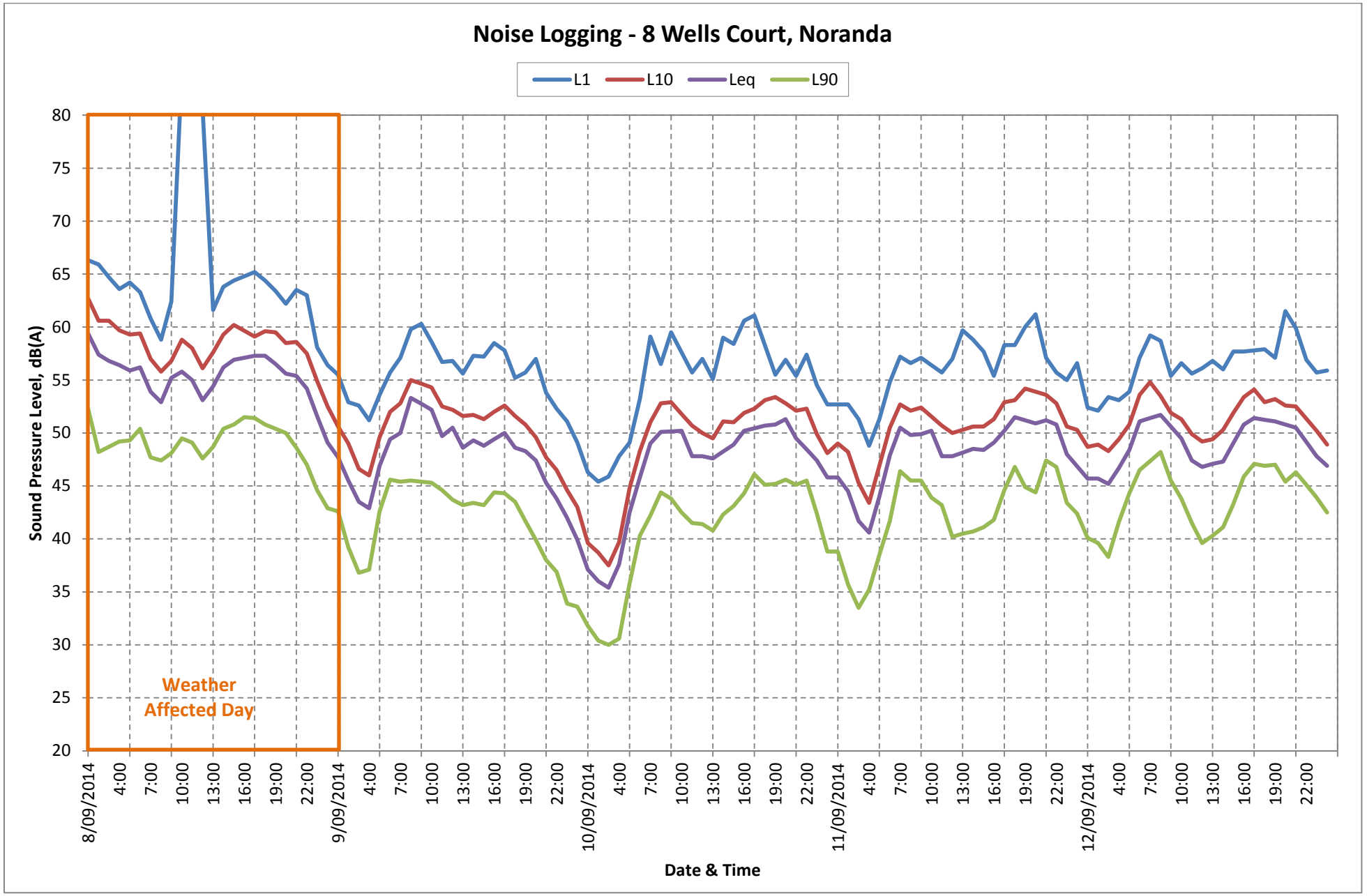
8 Wells Court, Noranda

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
8/09/2014	8/09/2014	66.3	62.7	59.4	52.3	0.4	260	30
8/09/2014	2:00	65.9	60.6	57.4	48.2	0.2	270	26
8/09/2014	3:00	64.7	60.6	56.8	48.7	0	270	21
8/09/2014	4:00	63.6	59.7	56.4	49.2	0.6	260	31
8/09/2014	5:00	64.2	59.3	55.9	49.3	0	260	22
8/09/2014	6:00	63.3	59.4	56.2	50.4	0.2	260	24
8/09/2014	7:00	60.8	57	53.9	47.7	0	260	22
8/09/2014	8:00	58.8	55.8	52.9	47.4	0	260	22
8/09/2014	9:00	62.4	56.8	55.2	48.1	0	270	13
8/09/2014	10:00	84.2	***58.8***	***55.8***	49.5	0	270	18
8/09/2014	11:00	82.3	***58***	***55***	49.1	0	290	22
8/09/2014	12:00	80.6	***56.1***	***53.1***	47.6	0.2	300	18
8/09/2014	13:00	61.6	57.6	54.4	48.7	0	280	21
8/09/2014	14:00	63.8	59.3	56.2	50.4	0	290	21
8/09/2014	15:00	64.4	60.2	56.9	50.8	0	280	18
8/09/2014	16:00	***64.8***	***59.7***	***57.1***	51.5	0	290	28
8/09/2014	17:00	65.2	59.1	57.3	51.4	0	300	21
8/09/2014	18:00	64.4	59.6	57.3	50.8	0.4	290	22
8/09/2014	19:00	63.4	59.5	56.5	50.4	0	290	24
8/09/2014	20:00	62.2	58.5	55.6	50	0	290	21
8/09/2014	21:00	63.5	58.6	55.4	48.6	0	280	22
8/09/2014	22:00	63	57.5	54.2	47	0	290	24
8/09/2014	23:00	58.1	54.9	51.6	44.6	0	270	22
8/09/2014	0:00	56.4	52.5	49.1	42.9	0.2	250	22
9/09/2014	9/09/2014	55.5	50.6	47.7	42.6	0	260	21
9/09/2014	2:00	52.9	49	45.5	39.2	0	240	18
9/09/2014	3:00	52.6	46.6	43.5	36.8	0	250	17
9/09/2014	4:00	51.2	46	42.9	37.1	0	250	17
9/09/2014	5:00	53.6	49.6	46.9	42.6	0	230	15
9/09/2014	6:00	55.7	52	49.4	45.6	0	240	15
9/09/2014	7:00	57.1	52.8	50	45.4	0	250	17
9/09/2014	8:00	59.8	***55***	53.3	45.5	0	250	9
9/09/2014	9:00	60.3	***54.7***	***52.8***	***45.4***	0	250	5
9/09/2014	10:00	58.6	54.3	52.2	45.3	0	230	2
9/09/2014	11:00	56.7	52.5	49.7	44.6	0	260	13
9/09/2014	12:00	56.8	52.2	50.5	43.7	0	240	15
9/09/2014	13:00	55.6	51.6	48.6	43.2	0	260	15
9/09/2014	14:00	57.3	51.7	49.3	43.4	0	240	13
9/09/2014	15:00	57.2	51.3	48.8	43.2	0	270	13
9/09/2014	16:00	58.5	52	***49.4***	44.4	0	260	13
9/09/2014	17:00	57.8	52.6	50	44.3	0	270	11
9/09/2014	18:00	55.2	51.6	48.6	43.5	0	250	13
9/09/2014	19:00	55.7	50.8	48.3	41.7	0	270	9
9/09/2014	20:00	57	49.6	47.4	39.9	0	240	5
9/09/2014	21:00	53.8	47.7	45.3	38	0	260	5
9/09/2014	22:00	52.3	46.5	43.8	36.9	0	270	4
9/09/2014	23:00	51.1	44.6	42	33.9	0	270	11
9/09/2014	0:00	49.1	43	39.9	33.6	0	310	8
10/09/2014	10/09/2014	46.3	39.6	37.1	31.8	0	280	11
10/09/2014	2:00	45.4	38.7	36	30.4	0	0	0
10/09/2014	3:00	45.9	37.5	35.4	30	0	280	4
10/09/2014	4:00	47.8	39.7	37.6	30.6	0	270	8
10/09/2014	5:00	49.1	44.8	42.5	35.8	0	310	5
10/09/2014	6:00	53.2	48.3	45.8	40.3	0	260	11
10/09/2014	7:00	59.1	51	49	42.2	0	250	9
10/09/2014	8:00	56.5	52.8	50.1	44.4	0	260	9
10/09/2014	9:00	59.5	52.9	***50.2***	43.8	0	260	9
10/09/2014	10:00	***57.6***	***51.8***	***50.2***	42.5	0	280	9
10/09/2014	11:00	55.7	50.7	47.8	41.5	0	290	11
10/09/2014	12:00	57	50	47.8	41.4	0	280	11
10/09/2014	13:00	55.1	49.5	47.6	40.8	0	310	11
10/09/2014	14:00	59	51.1	***48.3***	42.3	0	270	13
10/09/2014	15:00	58.4	51	48.9	43.1	0	270	13
10/09/2014	16:00	60.6	***51.9***	***50.2***	44.3	0	280	15
10/09/2014	17:00	61.1	***52.3***	***50.5***	46.1	0	270	11
10/09/2014	18:00	58.3	53.1	50.7	45.1	0	240	9
10/09/2014	19:00	55.5	53.4	50.8	45.2	0	230	9
10/09/2014	20:00	56.9	52.8	51.3	45.6	0	210	11
10/09/2014	21:00	55.4	52.1	49.5	45.1	0	170	9
10/09/2014	22:00	57.4	52.3	***48.5***	45.5	0	190	5
10/09/2014	23:00	54.5	49.9	47.4	42.4	0	190	4
10/09/2014	0:00	52.7	48.1	45.8	38.8	0	0	0

Hourly Noise Level Data

8 Wells Court, Noranda

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
11/09/2014	11/09/2014	52.7	49	45.8	38.8	0	0	0
11/09/2014	2:00	52.7	48.2	44.5	35.7	0	0	0
11/09/2014	3:00	51.3	45.3	41.7	33.5	0	0	0
11/09/2014	4:00	48.8	43.4	40.6	35.2	0	20	8
11/09/2014	5:00	51.3	46.9	44	38.5	0	20	4
11/09/2014	6:00	54.8	50.5	47.9	41.7	0	10	4
11/09/2014	7:00	57.2	52.7	50.5	46.4	0	30	2
11/09/2014	8:00	56.6	52.1	49.8	45.5	0	30	2
11/09/2014	9:00	57.1	52.4	49.9	45.5	0	30	8
11/09/2014	10:00	***56.4***	***51.6***	***50.2***	43.9	0	40	8
11/09/2014	11:00	***55.7***	***50.7***	***47.8***	43.2	0	20	9
11/09/2014	12:00	***57***	***50***	***47.8***	40.2	0	360	8
11/09/2014	13:00	***59.7***	***50.3***	***48.2***	40.5	0	290	11
11/09/2014	14:00	***58.8***	***50.6***	***48.5***	40.7	0	290	9
11/09/2014	15:00	57.7	50.6	48.4	41.1	0	290	13
11/09/2014	16:00	55.4	51.3	49.1	41.8	0	270	11
11/09/2014	17:00	58.3	52.9	***50.2***	44.6	0	260	13
11/09/2014	18:00	***58.3***	***53.1***	***51.5***	46.8	0	250	11
11/09/2014	19:00	***60***	***54.2***	***51.2***	44.9	0	240	11
11/09/2014	20:00	61.2	***53.9***	50.9	44.4	0	220	9
11/09/2014	21:00	57.1	53.6	51.2	47.4	0	0	0
11/09/2014	22:00	55.7	52.8	50.8	46.8	0	0	0
11/09/2014	23:00	55	50.6	48	43.4	0	0	0
11/09/2014	0:00	56.6	50.3	***46.9***	42.4	0	0	0
12/09/2014	12/09/2014	52.4	48.7	45.7	40.1	0	0	0
12/09/2014	2:00	52.1	48.9	45.7	39.6	0	0	0
12/09/2014	3:00	53.4	48.3	45.2	38.3	0	0	0
12/09/2014	4:00	53.1	49.4	46.7	41.6	0	0	0
12/09/2014	5:00	53.9	50.8	48.4	44.3	0	0	0
12/09/2014	6:00	57.1	53.6	51.1	46.5	0	0	0
12/09/2014	7:00	59.2	54.8	***51.4***	***47.4***	0	220	2
12/09/2014	8:00	58.7	53.5	51.7	48.2	0	210	9
12/09/2014	9:00	55.4	51.9	***50.6***	45.5	0	30	8
12/09/2014	10:00	56.6	51.3	***49.5***	43.8	0	30	9
12/09/2014	11:00	55.6	49.9	47.4	41.5	0	20	9
12/09/2014	12:00	56.1	49.2	46.8	39.6	0	340	8
12/09/2014	13:00	56.8	49.4	47.1	40.3	0	300	5
12/09/2014	14:00	56	50.3	47.3	41.1	0	310	11
12/09/2014	15:00	57.7	51.9	***49.1***	43.3	0	240	15
12/09/2014	16:00	57.7	53.4	50.8	45.9	0	260	17
12/09/2014	17:00	***57.8***	54.1	***51.4***	47.1	0	250	17
12/09/2014	18:00	57.9	52.9	***51.3***	46.9	0	240	18
12/09/2014	19:00	57.1	53.2	51.1	47	0	230	13
12/09/2014	20:00	61.5	52.6	***50.8***	45.4	0	220	13
12/09/2014	21:00	59.9	52.5	***50.5***	46.3	0	220	9
12/09/2014	22:00	56.9	***51.4***	***49.2***	***45.1***	0	0	0
12/09/2014	23:00	55.7	50.2	47.8	43.9	0	0	0
12/09/2014	0:00	55.9	48.9	***46.9***	42.5	0	0	0



Reference: 13122623

Table A9 – Results of Noise Logging 15 Davis Court, Morley

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
15 September 2014	50.7	50.5	51.3	48.3
16 September 2014	47.8	48.3	49.5	44.1
17 September 2014	46.8	47.9	49.3	41.4
18 September 2014	48.3	49.4	50.8	42.5
19 September 2014	47.9	48.2	49.3	45.0
Weekday Average	**48.3**	**48.9**	**50.1**	**44.3**



Photograph A9 – Noise Logger at 15 Davis Court, Morley

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 15 Davis Court.
Locality	Morley
Occupier	Mark Murphy 0417188008
Dates	15/9/2014 to 19/9/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	120m to Tonkin Hwy; 60m to Benara Rd
Height of the road in relation to the ground	+1m
Road surface type	DGA
Speed zone	80 km/hr (Tonkin Near Intersection); 70km/h on Benara Rd
Absorbing ground	80%
Angle of view	70; 170
Road gradient	flat
Traffic flow	Vehicles per day. Main Roads to provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	West to Tonkin; North to Benara
Carriageways & lanes.	2,5; 2,4
COMMENT	
Comment	Microphone placed on North façade at Side of house Reserve Land to North and West of house between Benara Rd and Tonkin Property fence between roads and microphone.
REFERENCES	
AMG Z50 E/N	
Road name	Tonkin Highway.
EXCEL file	15 Davis Ct MRWA Logger Sheet.xlsx
Raw data file	15 Davis Ct_sta.csv
EQUIPMENT	
Analyser number	15-203-999
Microphone number	15-203-999
Calibrator number	34883971
Calibrator values	93.8, 93.9
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Mt Lawley Data 15/09/14 - Var Winds up to 17 km/h 16/09/14 - Neg winds, top of 17km/h at 10am for one hour 17/09/14 - Var winds up to 17km/h, one hour at 18km/h 18/09/14 - Positive winds up to 22km/h from 10am to 11pm. 19/09/14 - Var winds up to 13km/h, morning negative, afternoon positive dirn

Hourly Noise Level Data

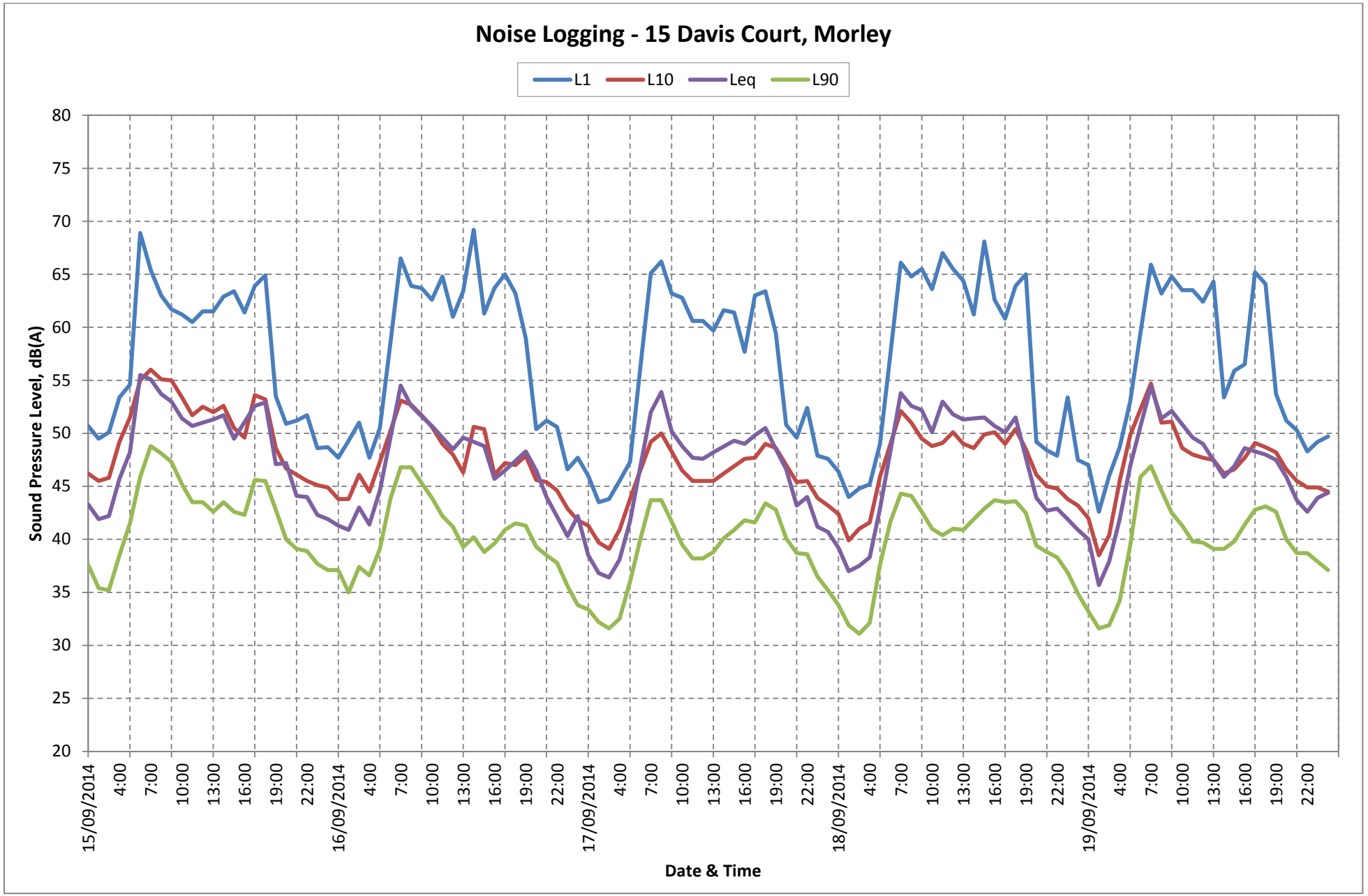
15 Davis Court, Morley

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
15/09/2014	15/09/2014	50.7	46.2	43.3	37.6	0	170	8
15/09/2014	2:00	49.5	45.5	41.9	35.4	0	170	5
15/09/2014	3:00	50.1	45.8	42.2	35.2	0	0	0
15/09/2014	4:00	53.4	49.2	45.7	38.5	0	0	0
15/09/2014	5:00	54.6	51.5	48.2	41.5	0	0	0
15/09/2014	6:00	68.9	55	55.5	45.9	0	0	0
15/09/2014	7:00	65.4	56	55.1	48.8	0	170	5
15/09/2014	8:00	63	55.1	53.7	48.1	0	150	5
15/09/2014	9:00	61.7	55	53	47.3	0	80	4
15/09/2014	10:00	61.2	53.4	51.4	45.2	0	120	9
15/09/2014	11:00	60.5	51.7	50.7	43.5	0	90	8
15/09/2014	12:00	61.5	52.5	51	43.5	0	100	8
15/09/2014	13:00	61.5	52	51.3	42.6	0	140	5
15/09/2014	14:00	62.9	52.6	51.7	43.5	0	140	8
15/09/2014	15:00	63.4	50.5	***49.5***	42.6	0	210	15
15/09/2014	16:00	61.4	49.6	***51.1***	42.3	0	220	15
15/09/2014	17:00	63.9	53.6	52.6	45.6	0	230	17
15/09/2014	18:00	64.9	53.2	52.9	45.5	0	220	17
15/09/2014	19:00	53.5	48.6	47.1	42.8	0	210	13
15/09/2014	20:00	50.9	46.7	47.2	40	0	190	13
15/09/2014	21:00	51.2	46.1	44.1	39.1	0	170	15
15/09/2014	22:00	51.7	45.5	44	38.9	0	170	13
15/09/2014	23:00	48.6	45.1	42.3	37.7	0	170	9
15/09/2014	0:00	48.7	44.9	41.9	37.1	0	170	8
16/09/2014	16/09/2014	47.7	43.8	41.3	37.1	0	170	9
16/09/2014	2:00	49.3	43.8	40.9	35	0	130	8
16/09/2014	3:00	51	46.1	43	37.4	0	110	9
16/09/2014	4:00	47.7	44.5	41.4	36.6	0	110	11
16/09/2014	5:00	50.5	47.3	44.6	39.1	0	90	11
16/09/2014	6:00	***58.5***	***50.2***	***49.6***	43.8	0	100	9
16/09/2014	7:00	66.5	53.1	***54.5***	46.8	0	90	11
16/09/2014	8:00	63.9	52.7	52.6	46.8	0	90	11
16/09/2014	9:00	63.7	51.7	51.6	45.3	0	120	9
16/09/2014	10:00	62.6	50.6	50.7	43.9	0	90	17
16/09/2014	11:00	64.8	49	***49.6***	42.2	0	90	13
16/09/2014	12:00	61	48	48.5	41.2	0	90	13
16/09/2014	13:00	63.4	46.3	49.6	39.3	0	110	11
16/09/2014	14:00	69.2	50.6	***49.2***	40.2	0	100	11
16/09/2014	15:00	61.3	50.4	48.8	38.8	0	100	11
16/09/2014	16:00	63.7	46.1	***45.7***	39.6	0	80	9
16/09/2014	17:00	65	47.2	***46.5***	40.9	0	70	9
16/09/2014	18:00	63.2	47	***47.4***	41.5	0	110	5
16/09/2014	19:00	59	47.9	48.3	41.3	0	110	8
16/09/2014	20:00	50.4	45.6	46.5	39.3	0	110	5
16/09/2014	21:00	51.2	45.4	***44.0***	38.5	0	140	5
16/09/2014	22:00	50.6	44.6	***42.2***	37.8	0	150	8
16/09/2014	23:00	46.6	42.9	40.3	35.6	0	120	4
16/09/2014	0:00	47.7	41.8	42.2	33.8	0	120	5
17/09/2014	17/09/2014	46	41.3	38.5	33.4	0	0	0
17/09/2014	2:00	43.5	39.7	36.8	32.2	0	50	5
17/09/2014	3:00	43.8	39.1	36.4	31.6	0	50	9
17/09/2014	4:00	45.5	40.9	38.1	32.5	0	50	8
17/09/2014	5:00	47.3	43.8	41.7	36	0	80	5
17/09/2014	6:00	***56.2***	***46.5***	***46.9***	40	0	70	2
17/09/2014	7:00	65.1	49.2	52	43.7	0	80	8
17/09/2014	8:00	66.2	50	53.9	43.7	0	70	5
17/09/2014	9:00	63.2	48.3	50.2	41.7	0	90	8
17/09/2014	10:00	62.8	46.5	48.8	39.5	0	100	5
17/09/2014	11:00	60.6	45.5	47.7	38.2	0	180	11
17/09/2014	12:00	60.6	45.5	47.6	38.2	0	170	13
17/09/2014	13:00	59.7	45.5	48.2	38.8	0	170	13
17/09/2014	14:00	61.6	***46.2***	***48.8***	40.1	0	190	13
17/09/2014	15:00	61.4	46.9	49.3	40.9	0	220	18
17/09/2014	16:00	57.7	47.6	49	41.8	0	210	17
17/09/2014	17:00	63	47.7	49.8	41.6	0	210	11
17/09/2014	18:00	63.4	49	50.5	43.4	0	220	17
17/09/2014	19:00	59.4	48.6	48.5	42.8	0	220	11
17/09/2014	20:00	50.8	47	46.6	40.1	0	210	11
17/09/2014	21:00	49.6	45.4	43.2	38.7	0	190	13
17/09/2014	22:00	52.4	45.5	44	38.6	0	180	11
17/09/2014	23:00	47.9	43.9	41.2	36.5	0	170	11
17/09/2014	0:00	47.6	43.2	40.7	35.2	0	170	5

Hourly Noise Level Data

15 Davis Court, Morley

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
18/09/2014	18/09/2014	46.4	42.4	39.2	33.8	0	0	0
18/09/2014	2:00	44	39.9	37	31.9	0	0	0
18/09/2014	3:00	44.8	41	37.5	31.1	0	170	2
18/09/2014	4:00	45.2	41.6	38.3	32.1	0	190	4
18/09/2014	5:00	49	45.9	42.9	37.6	0	180	8
18/09/2014	6:00	***57.6***	***49.0***	***48.4***	41.7	0	180	5
18/09/2014	7:00	66.1	52.1	53.8	44.3	0	0	0
18/09/2014	8:00	64.8	51	52.6	44.1	0	170	2
18/09/2014	9:00	65.5	49.5	52.2	42.6	0	190	5
18/09/2014	10:00	63.6	48.8	50.1	41	0	180	11
18/09/2014	11:00	67	49.1	53	40.4	0	210	11
18/09/2014	12:00	65.5	50.1	51.8	41	0	190	11
18/09/2014	13:00	64.4	49	51.3	40.9	0	220	13
18/09/2014	14:00	61.2	48.6	***51.4***	41.9	0	240	17
18/09/2014	15:00	68.1	49.9	***51.5***	42.9	0	210	18
18/09/2014	16:00	62.6	50.1	***50.7***	43.7	0	210	21
18/09/2014	17:00	60.8	49	50.1	43.5	0	210	22
18/09/2014	18:00	63.9	50.4	51.5	43.6	0	220	17
18/09/2014	19:00	65	48.5	***47.7***	42.5	0	220	15
18/09/2014	20:00	49.2	46.1	43.9	39.4	0	220	17
18/09/2014	21:00	48.4	45	42.7	38.8	0	220	11
18/09/2014	22:00	47.9	44.8	42.9	38.3	0	200	9
18/09/2014	23:00	53.4	43.8	***41.9***	36.9	0	190	11
18/09/2014	0:00	47.5	43.2	40.9	34.9	0	150	5
19/09/2014	19/09/2014	47	42	40	33.2	0	150	2
19/09/2014	2:00	42.6	38.5	35.7	31.6	0	160	8
19/09/2014	3:00	46	40.4	37.9	31.9	0	0	0
19/09/2014	4:00	48.7	45.5	41.9	34.2	0	0	0
19/09/2014	5:00	53	49.8	46.9	39.4	0	0	0
19/09/2014	6:00	***59.5***	***52.3***	***50.7***	45.9	0	0	0
19/09/2014	7:00	65.9	54.7	54.4	46.9	0	0	0
19/09/2014	8:00	63.2	51	51.4	44.6	0	90	2
19/09/2014	9:00	64.8	51.1	52.1	42.5	0	90	5
19/09/2014	10:00	63.5	48.6	***50.9***	41.3	0	140	8
19/09/2014	11:00	63.5	48	49.6	39.8	0	150	5
19/09/2014	12:00	62.4	47.7	49	39.7	0	160	9
19/09/2014	13:00	64.3	47.5	***47.5***	39.1	0	110	8
19/09/2014	14:00	53.4	46.2	45.9	39.1	0	180	9
19/09/2014	15:00	55.9	46.6	46.9	39.8	0	190	13
19/09/2014	16:00	56.5	47.7	48.6	41.4	0	210	11
19/09/2014	17:00	65.2	49.1	***48.3***	42.8	0	230	13
19/09/2014	18:00	64.1	48.7	***48***	43.1	0	230	13
19/09/2014	19:00	53.7	48.2	47.5	42.6	0	230	9
19/09/2014	20:00	51.2	46.6	45.9	40	0	190	8
19/09/2014	21:00	50.3	45.5	43.7	38.7	0	170	9
19/09/2014	22:00	48.3	44.9	42.6	38.7	0	180	9
19/09/2014	23:00	49.2	44.9	43.9	37.9	0	160	9
19/09/2014	0:00	49.7	44.5	44.4	37.1	0	150	8



Reference: 13122623

Table A10 – Results of Noise Logging 6 Acacia Court, Beechboro

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
15 September 2014	57.4	54.2	55.2	51.1
16 September 2014	56.1	52.9	53.9	49.9
17 September 2014	57.3	54.0	55.1	50.2
18 September 2014	58.0	54.7	55.8	51.3
19 September 2014	57.1	54.0	54.7	52.1
Weekday Average	**57.1**	**54.0**	**54.9**	**50.9**



Photograph A10 – Noise Logger at 6 Acacia Court, Beechboro

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 6 Acacia Court.
Locality	Beechboro
Occupier	Ronnie 0423255585
Dates	15/9/2014 to 19/9/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	65m
Height of the road in relation to the ground	+2m
Road surface type	DGA
Speed zone	90 km/hr
Absorbing ground	60%
Angle of view	150
Road gradient	flat
Traffic flow	Vehicles per day. Main Roads to provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	West
Carriageways & lanes.	2,4;
COMMENT	
Comment	Microphone placed on West façade at front of house House is near Pedestrian footbridge (over Tonkin) Earthen Bund/reserve between Tonkin and microphone.
REFERENCES	
AMG Z50 E/N	
Road name	Tonkin Highway.
EXCEL file	6 Acacia Ct MRWA Logger Sheet.xlsx
Raw data file	6 Acacia_sta.csv
EQUIPMENT	
Analyser number	15-203-505
Microphone number	15-203-505
Calibrator number	34883971
Calibrator values	93.6, 93.8
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Mt Lawley Data 15/09/14 - Neg Winds <9 km/h before 2pm, Pos in afternoon <17km/h 16/09/14 - Neg winds, top of 17km/h at 10am for one hour 17/09/14 - Neg Winds <13 km/h before 2pm, Pos in afternoon <18km/h 18/09/14 - Positive winds up to 22km/h from 10am to 11pm. 19/09/14 - Var winds up to 13km/h, morning negative, afternoon positive dirn

Hourly Noise Level Data

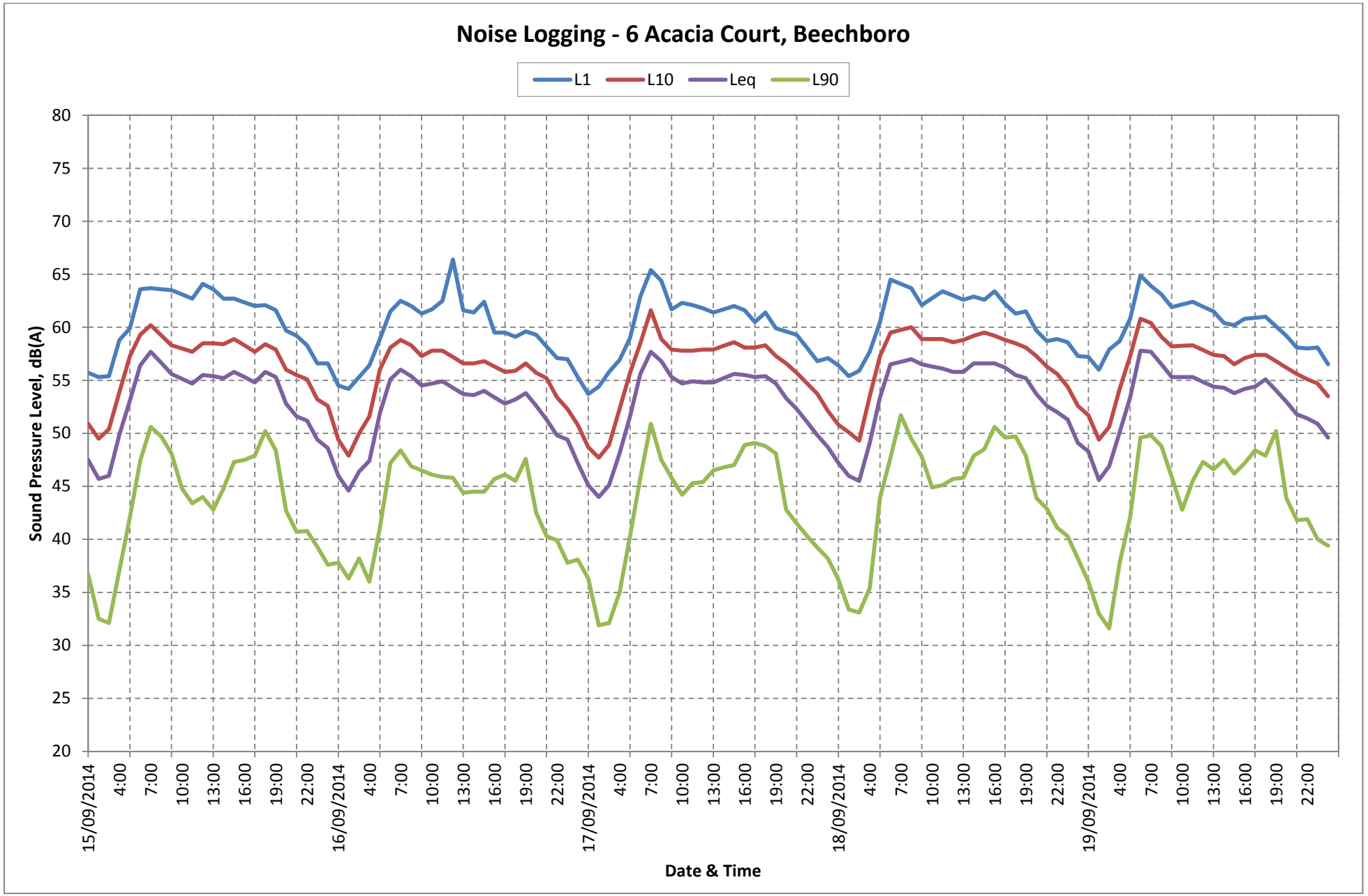
6 Acacia Court, Beechboro

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
15/09/2014	15/09/2014	55.7	50.9	47.5	36.7	0	170	8
15/09/2014	2:00	55.3	49.5	45.7	32.5	0	170	5
15/09/2014	3:00	55.4	50.4	46	32.1	0	0	0
15/09/2014	4:00	58.8	53.9	49.9	37.1	0	0	0
15/09/2014	5:00	59.9	57.3	53.1	42.1	0	0	0
15/09/2014	6:00	63.6	59.3	56.4	47.4	0	0	0
15/09/2014	7:00	63.7	60.2	57.7	50.6	0	170	5
15/09/2014	8:00	***63.6***	***59.3***	***56.7***	49.7	0	150	5
15/09/2014	9:00	63.5	58.3	55.6	48.1	0	80	4
15/09/2014	10:00	***63.1***	***58.0***	***55.2***	44.8	0	120	9
15/09/2014	11:00	62.7	57.7	54.7	43.4	0	90	8
15/09/2014	12:00	64.1	58.5	55.5	44	0	100	8
15/09/2014	13:00	63.6	58.5	55.4	42.8	0	140	5
15/09/2014	14:00	62.7	58.4	55.2	44.8	0	140	8
15/09/2014	15:00	62.7	58.9	55.8	47.3	0	210	15
15/09/2014	16:00	***62.4***	***58.3***	***55.3***	47.5	0	220	15
15/09/2014	17:00	62	57.7	54.8	47.9	0	230	17
15/09/2014	18:00	62.1	58.4	55.8	50.2	0	220	17
15/09/2014	19:00	61.6	57.9	55.3	48.4	0	210	13
15/09/2014	20:00	59.7	56	52.8	42.7	0	190	13
15/09/2014	21:00	59.2	55.5	51.6	40.7	0	170	15
15/09/2014	22:00	58.3	55.1	51.2	40.8	0	170	13
15/09/2014	23:00	56.6	53.2	49.4	39.3	0	170	9
15/09/2014	0:00	56.6	52.6	48.6	37.6	0	170	8
16/09/2014	16/09/2014	54.5	49.4	46	37.8	0	170	9
16/09/2014	2:00	54.2	47.9	44.6	36.3	0	130	8
16/09/2014	3:00	55.3	50	46.4	38.2	0	110	9
16/09/2014	4:00	56.4	51.6	47.4	36	0	110	11
16/09/2014	5:00	58.9	56	51.9	41.1	0	90	11
16/09/2014	6:00	61.5	58.1	55.1	47.2	0	100	9
16/09/2014	7:00	62.5	***58.8***	***56***	48.4	0	90	11
16/09/2014	8:00	62	58.3	55.4	46.9	0	90	11
16/09/2014	9:00	61.3	57.3	54.5	46.5	0	120	9
16/09/2014	10:00	61.7	57.8	54.7	46.1	0	90	17
16/09/2014	11:00	62.5	***57.8***	***54.9***	45.9	0	90	13
16/09/2014	12:00	66.4	***57.2***	***54.3***	45.8	0	90	13
16/09/2014	13:00	61.6	56.6	53.7	44.4	0	110	11
16/09/2014	14:00	61.4	56.6	53.6	44.5	0	100	11
16/09/2014	15:00	62.4	56.8	54	44.5	0	100	11
16/09/2014	16:00	59.5	***56.3***	***53.4***	45.7	0	80	9
16/09/2014	17:00	59.5	55.8	52.8	46.1	0	70	9
16/09/2014	18:00	59.1	55.9	53.2	45.5	0	110	5
16/09/2014	19:00	59.6	56.6	53.8	47.6	0	110	8
16/09/2014	20:00	59.3	55.7	52.6	42.5	0	110	5
16/09/2014	21:00	58.2	55.2	51.3	40.3	0	140	5
16/09/2014	22:00	57.1	53.4	49.8	39.9	0	150	8
16/09/2014	23:00	57	52.3	49.4	37.8	0	120	4
16/09/2014	0:00	55.3	50.8	47.2	38.1	0	120	5
17/09/2014	17/09/2014	53.7	48.7	45.1	36.3	0	0	0
17/09/2014	2:00	54.4	47.7	44	31.9	0	50	5
17/09/2014	3:00	55.8	48.9	45.1	32.1	0	50	9
17/09/2014	4:00	56.9	52.3	48.1	35	0	50	8
17/09/2014	5:00	59	55.7	51.6	40.3	0	80	5
17/09/2014	6:00	62.9	58.5	55.6	45.8	0	70	2
17/09/2014	7:00	65.4	***61.6***	***57.7***	50.9	0	80	8
17/09/2014	8:00	64.4	58.9	56.8	47.5	0	70	5
17/09/2014	9:00	61.7	57.9	55.3	45.8	0	90	8
17/09/2014	10:00	62.3	57.8	54.7	44.2	0	100	5
17/09/2014	11:00	62.1	57.8	54.9	45.3	0	180	11
17/09/2014	12:00	61.8	57.9	54.8	45.4	0	170	13
17/09/2014	13:00	61.4	57.9	54.8	46.5	0	170	13
17/09/2014	14:00	***61.7***	***58.3***	***55.2***	46.8	0	190	13
17/09/2014	15:00	62	58.6	55.6	47	0	220	18
17/09/2014	16:00	61.6	58.1	55.5	48.9	0	210	17
17/09/2014	17:00	60.5	58.1	55.3	49.1	0	210	11
17/09/2014	18:00	61.4	58.3	55.4	48.8	0	220	17
17/09/2014	19:00	59.9	57.3	54.7	48.1	0	220	11
17/09/2014	20:00	59.6	56.6	53.3	42.8	0	210	11
17/09/2014	21:00	59.3	55.7	52.3	41.5	0	190	13
17/09/2014	22:00	***58.1***	***54.7***	***51.1***	40.3	0	180	11
17/09/2014	23:00	56.8	53.7	49.8	39.2	0	170	11
17/09/2014	0:00	57.1	52.1	48.7	38.2	0	170	5

Hourly Noise Level Data

6 Acacia Court, Beechboro

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
18/09/2014	18/09/2014	56.4	50.8	47.2	36.2	0	0	0
18/09/2014	2:00	55.4	50.1	46	33.4	0	0	0
18/09/2014	3:00	55.9	49.3	45.5	33.1	0	170	2
18/09/2014	4:00	57.7	53.5	49.1	35.4	0	190	4
18/09/2014	5:00	60.5	57.3	53.4	43.9	0	180	8
18/09/2014	6:00	64.5	59.5	***56.5***	47.7	0	180	5
18/09/2014	7:00	***64.1***	***59.8***	***56.8***	51.7	0	0	0
18/09/2014	8:00	63.7	60	57	49.5	0	170	2
18/09/2014	9:00	62.1	58.9	56.5	47.8	0	190	5
18/09/2014	10:00	***62.8***	***58.9***	***56.3***	44.9	0	180	11
18/09/2014	11:00	63.4	58.9	56.1	45.1	0	210	11
18/09/2014	12:00	63	58.6	55.8	45.7	0	190	11
18/09/2014	13:00	62.6	58.8	55.8	45.8	0	220	13
18/09/2014	14:00	62.9	59.2	56.6	47.9	0	240	17
18/09/2014	15:00	62.6	59.5	56.6	48.5	0	210	18
18/09/2014	16:00	63.4	59.2	56.6	50.6	0	210	21
18/09/2014	17:00	62.2	58.8	56.2	49.6	0	210	22
18/09/2014	18:00	61.3	58.5	55.5	49.7	0	220	17
18/09/2014	19:00	61.5	58.1	55.2	47.9	0	220	15
18/09/2014	20:00	59.7	57.3	53.7	43.9	0	220	17
18/09/2014	21:00	58.7	56.3	52.6	42.9	0	220	11
18/09/2014	22:00	58.9	55.6	52	41.1	0	200	9
18/09/2014	23:00	58.6	54.4	51.3	40.3	0	190	11
18/09/2014	0:00	57.3	52.6	49.1	38.2	0	150	5
19/09/2014	19/09/2014	57.2	51.7	48.3	36	0	150	2
19/09/2014	2:00	56	49.4	45.6	33	0	160	8
19/09/2014	3:00	57.9	50.6	46.9	31.6	0	0	0
19/09/2014	4:00	58.7	54.2	50.1	37.8	0	0	0
19/09/2014	5:00	60.8	57.3	53.4	42.1	0	0	0
19/09/2014	6:00	64.9	60.8	57.8	49.6	0	0	0
19/09/2014	7:00	63.9	60.4	57.7	49.8	0	0	0
19/09/2014	8:00	63.1	59.1	***56.5***	48.8	0	90	2
19/09/2014	9:00	61.9	58.2	55.3	45.9	0	90	5
19/09/2014	10:00	***62.2***	***58.3***	***55.3***	42.8	0	140	8
19/09/2014	11:00	62.4	58.3	55.3	45.5	0	150	5
19/09/2014	12:00	***62.0***	***57.9***	***54.9***	47.3	0	160	9
19/09/2014	13:00	61.5	57.4	54.4	46.6	0	110	8
19/09/2014	14:00	60.4	57.3	54.3	47.5	0	180	9
19/09/2014	15:00	60.2	56.5	53.8	46.2	0	190	13
19/09/2014	16:00	60.8	57.1	54.2	47.2	0	210	11
19/09/2014	17:00	60.9	57.4	54.4	48.4	0	230	13
19/09/2014	18:00	61	57.4	55.1	47.9	0	230	13
19/09/2014	19:00	***60.1***	***56.8***	***54.1***	50.2	0	230	9
19/09/2014	20:00	59.2	56.2	53	43.9	0	190	8
19/09/2014	21:00	58.1	55.6	51.8	41.8	0	170	9
19/09/2014	22:00	58	55.1	51.4	41.9	0	180	9
19/09/2014	23:00	58.1	54.7	50.9	40	0	160	9
19/09/2014	0:00	56.5	53.5	49.6	39.4	0	150	8



Reference: 13122263

Table A11 – Results of Noise Logging 11 Willow Place, Beechboro

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
27 October 2014	54.7	51.9	52.8	48.9
28 October 2014	53.7	51.1	52.1	48.1
29 October 2014	53.1	50.7	51.6	47.7
30 October 2014	54.4	51.6	52.9	47.1
31 October 2014	53.6	50.8	51.7	48.3
Weekday Average	**53.9**	**51.2**	**52.2**	**48.0**



Photograph A11– Noise Logger at 11 Willow Place, Beechboro

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 11 Willow Place
Locality	Beechboro
Occupier	Andrew Calvert 0499088630
Dates	27/10/2014 to 31/10/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	60m to Tonkin Hwy
Height of the road in relation to the ground	+2m
Road surface type	DGA
Speed zone	90 km/hr
Absorbing ground	60%
Angle of view	150
Road gradient	flat
Traffic flow	Vehicles per day. Main Roads to provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	West
Carriageways & lanes.	2,4;
COMMENT	
Comment	Microphone placed on West façade at Rear of house Rear property fence between microphone and road. Earthen Bund and reserve between Tonkin and microphone. Pool to south of microphone position and small pergola to north.
REFERENCES	
AMG Z50 E/N	
Road name	Tonkin Highway.
EXCEL file	11 Willow Place MRWA Logger Sheet.xlsx
Raw data file	11 Willow Place_Sta.csv
EQUIPMENT	
Analyser number	15-203-999
Microphone number	15-203-999
Calibrator number	34883971
Calibrator values	93.8, 94.0
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Mt Lawley Data 27/10/14 - Neg morning Winds <13 km/h, Pos in afternoon <24km/h 28/10/14 - Neg winds < 17km/h, Pos Afternoon <15 km/h 29/10/14 - Pos Winds <18 km/h most of the day 30/10/14 - Pos Winds <18 km/h most of the day 31/10/14 - Var winds up to 18km/h, one hour at 21 km/h

Hourly Noise Level Data

11 Willow Place, Beechboro

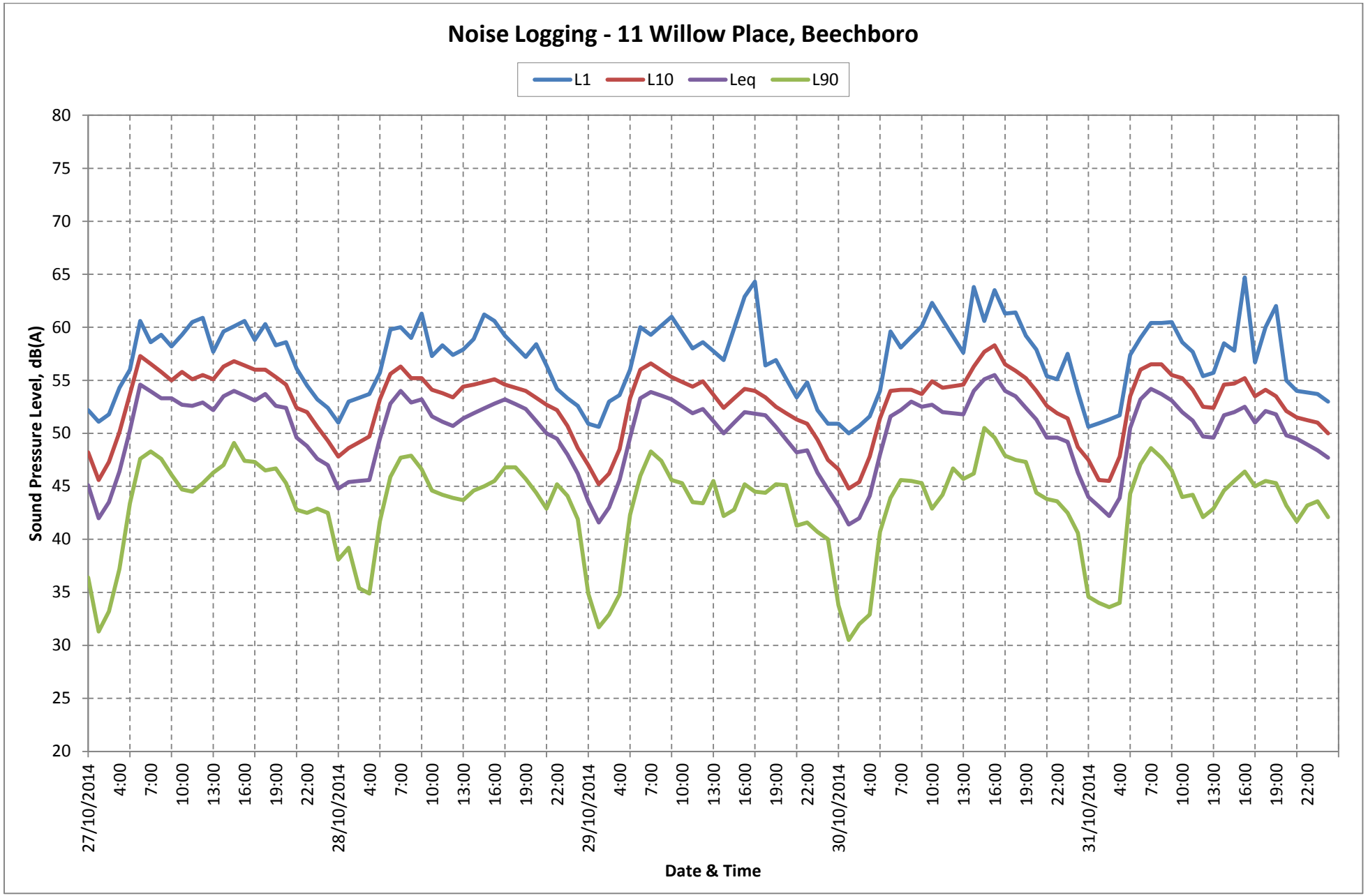
Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
27/10/2014	27/10/2014	52.2	48.2	45.1	36.4	0	180	13
27/10/2014	2:00	51.1	45.6	42	31.3	0	180	9
27/10/2014	3:00	51.8	47.3	43.5	33.2	0	170	8
27/10/2014	4:00	54.3	50.1	46.4	37.2	0	170	9
27/10/2014	5:00	56	53.7	50.3	43.4	0	160	5
27/10/2014	6:00	60.6	57.3	54.6	47.6	0	0	0
27/10/2014	7:00	58.6	***56.6***	***54.0***	48.3	0	70	8
27/10/2014	8:00	59.3	55.8	53.3	47.6	0	100	13
27/10/2014	9:00	58.2	55	53.3	46.1	0	100	8
27/10/2014	10:00	59.3	55.8	52.7	44.7	0	100	5
27/10/2014	11:00	60.5	55.1	52.6	44.5	0	130	8
27/10/2014	12:00	60.9	55.5	52.9	45.3	0	220	11
27/10/2014	13:00	57.7	55.1	52.2	46.3	0	200	15
27/10/2014	14:00	59.6	56.3	53.5	47	0	210	18
27/10/2014	15:00	60.1	***56.8***	***54***	49.1	0	220	24
27/10/2014	16:00	60.6	***56.4***	***53.6***	47.4	0	220	21
27/10/2014	17:00	58.8	56	53.1	47.3	0	210	21
27/10/2014	18:00	60.3	56	53.7	46.5	0	210	15
27/10/2014	19:00	58.3	55.3	52.6	46.7	0	210	13
27/10/2014	20:00	58.6	54.6	52.4	45.3	0	180	15
27/10/2014	21:00	56.1	52.4	49.6	42.8	0	170	17
27/10/2014	22:00	54.5	52	48.8	42.5	0	170	17
27/10/2014	23:00	53.2	50.6	47.6	42.9	0	170	11
27/10/2014	0:00	52.4	49.3	47	42.5	0	160	8
28/10/2014	28/10/2014	51	47.8	44.8	38.1	0	170	13
28/10/2014	2:00	53	48.6	45.4	39.2	0	150	8
28/10/2014	3:00	***53.4***	***49.2***	***45.5***	35.4	0	0	0
28/10/2014	4:00	53.7	49.7	45.6	34.9	0	80	8
28/10/2014	5:00	55.7	53.2	49.5	41.7	0	80	8
28/10/2014	6:00	59.8	55.6	52.8	45.9	0	60	11
28/10/2014	7:00	60	56.3	54	47.7	0	80	13
28/10/2014	8:00	59	55.2	52.9	47.9	0	80	17
28/10/2014	9:00	61.3	55.2	53.2	46.6	0	100	13
28/10/2014	10:00	57.3	54.1	51.6	44.6	0	90	9
28/10/2014	11:00	58.3	53.8	51.1	44.2	0	110	9
28/10/2014	12:00	57.4	53.4	50.7	43.9	0	140	9
28/10/2014	13:00	57.9	54.4	51.4	43.7	0	10	9
28/10/2014	14:00	58.9	54.6	51.9	44.6	0	100	8
28/10/2014	15:00	61.2	***54.9***	***52.4***	45	0	190	11
28/10/2014	16:00	60.6	55.1	52.8	45.5	0	210	15
28/10/2014	17:00	59.2	54.6	53.2	46.8	0	210	13
28/10/2014	18:00	***58.2***	***54.3***	***52.8***	46.8	0	210	13
28/10/2014	19:00	57.2	54	52.3	45.7	0	200	13
28/10/2014	20:00	58.4	***53.4***	***51.2***	44.4	0	190	8
28/10/2014	21:00	56.4	52.7	50	42.9	0	190	13
28/10/2014	22:00	54.2	52.2	49.5	45.2	0	180	11
28/10/2014	23:00	53.3	50.7	48	44.1	0	190	9
28/10/2014	0:00	52.6	48.6	46.2	41.9	0	180	5
29/10/2014	29/10/2014	50.9	47	43.6	34.9	0	190	5
29/10/2014	2:00	50.6	45.2	41.6	31.7	0	170	9
29/10/2014	3:00	53	46.2	43	32.9	0	190	8
29/10/2014	4:00	53.6	48.5	45.6	34.8	0	210	13
29/10/2014	5:00	56	53.3	49.6	42.3	0	180	9
29/10/2014	6:00	60	56	53.3	46	0	190	8
29/10/2014	7:00	59.3	56.6	53.9	48.3	0	200	5
29/10/2014	8:00	***60.2***	***56.0***	***53.6***	47.4	0	170	8
29/10/2014	9:00	61	55.3	53.2	45.6	0	190	11
29/10/2014	10:00	***59.5***	***54.9***	***52.6***	45.3	0	210	8
29/10/2014	11:00	58	54.4	51.9	43.5	0	220	11
29/10/2014	12:00	58.6	54.9	52.3	43.4	0	210	11
29/10/2014	13:00	***57.8***	***53.7***	***51.2***	45.5	0	210	17
29/10/2014	14:00	56.9	52.4	50	42.2	0	230	13
29/10/2014	15:00	***59.9***	***53.3***	***51.0***	42.8	0	230	13
29/10/2014	16:00	62.9	***54.2***	***52***	45.2	0	220	15
29/10/2014	17:00	64.3	54	***51.9***	44.5	0	230	18
29/10/2014	18:00	56.4	53.4	51.7	44.4	0	230	13
29/10/2014	19:00	56.9	52.5	50.6	45.2	0	220	11
29/10/2014	20:00	***55.2***	***51.9***	***49.4***	45.1	0	240	17
29/10/2014	21:00	53.4	51.3	48.2	41.3	0	220	17
29/10/2014	22:00	54.8	50.9	48.4	41.6	0	210	11
29/10/2014	23:00	52.2	49.4	46.3	40.7	0	210	9
29/10/2014	0:00	50.9	47.5	44.7	40	0	230	11

Reference: 13122623

Hourly Noise Level Data

11 Willow Place, Beechboro

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
30/10/2014	30/10/2014	50.9	46.6	43.2	33.8	0	220	15
30/10/2014	2:00	50	44.8	41.4	30.5	0	210	13
30/10/2014	3:00	50.7	45.4	42	32	0	210	9
30/10/2014	4:00	51.6	47.8	44.1	32.9	0	190	9
30/10/2014	5:00	54	51.4	48	40.7	0	190	8
30/10/2014	6:00	59.6	54	51.6	43.9	0	180	2
30/10/2014	7:00	58.1	54.1	52.2	45.6	0	150	9
30/10/2014	8:00	59.1	54.1	53	45.5	0	170	8
30/10/2014	9:00	60.1	53.7	52.5	45.3	0	200	4
30/10/2014	10:00	62.3	54.9	52.7	42.9	0	200	15
30/10/2014	11:00	60.7	54.3	52	44.2	0	210	13
30/10/2014	12:00	***59.2***	***54.5***	***51.9***	46.7	0	230	17
30/10/2014	13:00	57.6	54.6	51.8	45.7	0	240	18
30/10/2014	14:00	63.8	56.3	54	46.2	0	250	17
30/10/2014	15:00	60.6	57.7	55.1	50.5	0	230	18
30/10/2014	16:00	63.5	58.3	55.5	49.6	0	240	17
30/10/2014	17:00	61.3	56.5	54	47.9	0	240	18
30/10/2014	18:00	61.4	55.9	53.5	47.5	0	230	17
30/10/2014	19:00	59.2	55.2	***52.4***	47.3	0	240	18
30/10/2014	20:00	57.9	54	51.3	44.4	0	230	17
30/10/2014	21:00	55.4	52.6	49.6	43.8	0	240	13
30/10/2014	22:00	55.1	51.9	49.6	43.6	0	240	15
30/10/2014	23:00	57.5	51.4	49.2	42.5	0	240	15
30/10/2014	0:00	53.9	48.7	46.3	40.6	0	230	11
31/10/2014	31/10/2014	50.6	47.5	44	34.6	0	240	13
31/10/2014	2:00	***51.0***	45.6	***43.1***	34	0	240	8
31/10/2014	3:00	51.3	45.5	42.2	33.6	0	240	9
31/10/2014	4:00	51.7	47.8	43.9	34	0	240	9
31/10/2014	5:00	57.4	53.5	50.5	44.3	0	190	18
31/10/2014	6:00	59	56	53.2	47.1	0	170	11
31/10/2014	7:00	60.4	56.5	54.2	48.6	0	170	17
31/10/2014	8:00	60.4	56.5	53.7	47.7	0	170	15
31/10/2014	9:00	60.5	55.5	53.1	46.5	0	180	17
31/10/2014	10:00	58.6	55.2	52	44	0	180	15
31/10/2014	11:00	57.7	54.1	51.2	44.2	0	190	15
31/10/2014	12:00	55.4	52.5	49.7	42.1	0	160	13
31/10/2014	13:00	55.7	52.4	49.6	42.9	0	160	11
31/10/2014	14:00	58.5	54.6	51.7	44.6	0	290	13
31/10/2014	15:00	57.8	54.7	52	45.5	0	220	21
31/10/2014	16:00	64.7	55.2	***52.5***	46.4	0	210	17
31/10/2014	17:00	56.7	53.5	51	45	0	200	17
31/10/2014	18:00	60	54.1	***52.1***	45.5	0	210	18
31/10/2014	19:00	62	53.5	***51.8***	45.3	0	230	13
31/10/2014	20:00	55	52.1	49.8	43.2	0	220	9
31/10/2014	21:00	54	51.5	49.5	41.7	0	220	8
31/10/2014	22:00	***53.9***	***51.3***	***49.0***	43.2	0	230	5
31/10/2014	23:00	53.7	51	48.4	43.6	0	220	8
31/10/2014	0:00	53	50	47.7	42.1	0	0	0



Reference: 13122623

Table A12 – Results of Noise Logging 8 Jarrah Court, Beechboro

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
3 November 2014	52.0	49.8	50.7	46.8
4 November 2014	51.2	49.2	50.3	45.7
5 November 2014	51.7	49.3	50.7	44.0
6 November 2014*	57.5	55.2	56.7	48.1
7 November 2014*	55.8	54.1	55.1	50.9
Weekday Average	**51.6**	**49.5**	**50.6**	**45.5**

*Day excluded from the Average due to unacceptable weather conditions.



Photograph A12 – Noise Logger at 8 Jarrah Court, Beechboro

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 8 Jarrah Court
Locality	Beechboro
Occupier	Christina D'Rozario 9377 7456
Dates	03/11/2014 to 07/11/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	100m to Reid Hwy
Height of the road in relation to the ground	+0m
Road surface type	DGA
Speed zone	70 km/h
Absorbing ground	70%
Angle of view	180
Road gradient	Flat
Traffic flow	Vehicles per day. Main Roads to provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	North West
Carriageways & lanes.	2,5
COMMENT	
Comment	Microphone placed on North West façade at Rear of house Rear property fence between microphone and road.
REFERENCES	
AMG Z50 E/N	
Road name	Reid Hwy
EXCEL file	8 Jarrah Ct MRWA Logger Sheet.xlsx
Raw data file	8 Jarrah_Sta.csv
EQUIPMENT	
Analyser number	87803a
Microphone number	87803a
Calibrator number	34883971
Calibrator values	94.0,94.1
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Mt Lawley Data 3/11/14 - Var Winds <18 km/h, 3 hours of Neg at 21 km/h 4/11/14 - Pos Morning winds <11km/h, Afternoon <18 km/h 5/11/14 - Var Winds <18 km/h, 1 hour of Neg at 22 km/h 6/11/14 - Pos Winds 11 to 17 km/h, 2 hours at 21 km/h, night rain 7/11/14 - Continuous Pos winds up to 18km/h, one hour at 21 km/h

Hourly Noise Level Data

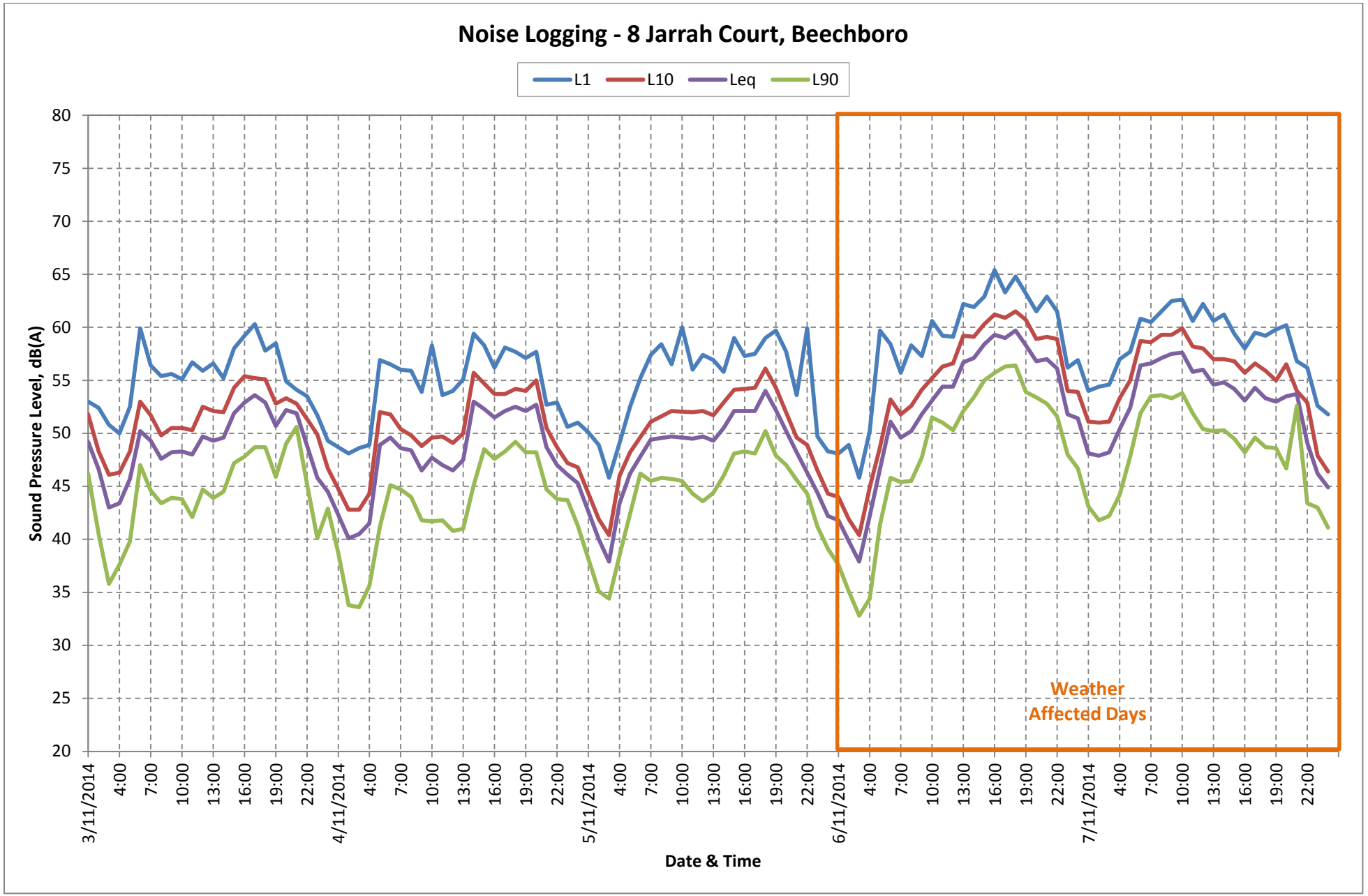
8 Jarrah Court, Beechboro

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
3/11/2014	3/11/2014	53	51.8	49.2	46.2	0	220	15
3/11/2014	2:00	52.4	48.3	46.6	40.5	0	230	13
3/11/2014	3:00	50.8	46.1	43	35.8	0	230	9
3/11/2014	4:00	50	46.3	43.4	37.6	0	190	8
3/11/2014	5:00	52.5	48.3	45.7	39.8	0	190	4
3/11/2014	6:00	59.9	***53***	***50.2***	47	0	190	2
3/11/2014	7:00	56.4	51.7	49.3	44.6	0	140	8
3/11/2014	8:00	55.4	49.8	47.6	43.4	0	160	11
3/11/2014	9:00	55.6	50.5	48.2	43.9	0	150	13
3/11/2014	10:00	55.1	50.5	48.3	43.8	0	190	11
3/11/2014	11:00	56.7	50.3	48	42.1	0	220	11
3/11/2014	12:00	55.9	52.5	49.7	44.7	0	210	15
3/11/2014	13:00	56.6	52.1	49.3	43.9	0	220	15
3/11/2014	14:00	55.2	52	49.6	44.5	0	210	21
3/11/2014	15:00	58	54.3	51.9	47.2	0	210	22
3/11/2014	16:00	59.2	55.4	52.9	47.8	0	210	18
3/11/2014	17:00	60.3	55.2	53.6	48.7	0	220	21
3/11/2014	18:00	57.8	55.1	52.9	48.7	0	220	17
3/11/2014	19:00	58.5	52.8	50.7	45.9	0	190	13
3/11/2014	20:00	54.9	53.3	52.2	49	0	200	13
3/11/2014	21:00	54.1	52.8	51.9	50.6	0	180	11
3/11/2014	22:00	53.5	***51.4***	***48.9***	45.2	0	170	13
3/11/2014	23:00	51.7	49.9	45.8	40.1	0	170	13
3/11/2014	0:00	49.3	46.7	***44.5***	42.9	0	170	9
4/11/2014	4/11/2014	***48.7***	***44.8***	***42.3***	38.7	0	190	9
4/11/2014	2:00	48.1	42.8	40.1	33.8	0	170	11
4/11/2014	3:00	48.6	42.8	40.5	33.6	0	160	9
4/11/2014	4:00	48.9	44.3	41.5	35.6	0	180	5
4/11/2014	5:00	56.9	52	48.9	41.2	0	0	0
4/11/2014	6:00	56.5	51.8	49.6	45.1	0	0	0
4/11/2014	7:00	56	50.4	48.6	44.7	0	80	9
4/11/2014	8:00	55.9	49.8	48.4	44	0	120	11
4/11/2014	9:00	53.9	48.8	46.5	41.8	0	130	9
4/11/2014	10:00	58.3	49.6	47.7	41.7	0	160	5
4/11/2014	11:00	53.6	49.7	47	41.8	0	40	9
4/11/2014	12:00	54	49.1	46.5	40.8	0	170	9
4/11/2014	13:00	55.1	50	47.5	41	0	250	17
4/11/2014	14:00	59.4	55.7	53	45.1	0	240	17
4/11/2014	15:00	58.3	54.7	52.3	48.5	0	200	18
4/11/2014	16:00	56.2	53.7	51.5	47.6	0	230	18
4/11/2014	17:00	58.1	53.7	52.1	48.3	0	220	15
4/11/2014	18:00	57.7	54.2	52.5	49.2	0	220	15
4/11/2014	19:00	57.1	54	52.1	48.2	0	210	15
4/11/2014	20:00	57.7	55	52.7	48.2	0	190	11
4/11/2014	21:00	52.7	50.5	48.7	44.7	0	180	15
4/11/2014	22:00	52.9	48.7	47	43.8	0	180	13
4/11/2014	23:00	50.6	47.2	46.1	43.7	0	190	13
4/11/2014	0:00	51	46.8	45.3	41.3	0	180	13
5/11/2014	5/11/2014	50.1	***44.4***	***42.7***	***38.2***	0	180	9
5/11/2014	2:00	***48.9***	***41.9***	***40***	***35.1***	0	160	8
5/11/2014	3:00	***45.8***	***40.4***	***37.9***	***34.4***	0	180	5
5/11/2014	4:00	49.1	46	43.4	38.5	0	190	2
5/11/2014	5:00	52.5	48.2	46.2	42.4	0	160	5
5/11/2014	6:00	55.2	***49.7***	***47.8***	46.2	0	150	5
5/11/2014	7:00	57.4	51.1	49.4	45.5	0	210	5
5/11/2014	8:00	58.4	51.6	***49.6***	45.8	0	190	8
5/11/2014	9:00	56.5	52.1	49.7	45.7	0	210	9
5/11/2014	10:00	60	***52.1***	***49.6***	45.5	0	210	13
5/11/2014	11:00	56	52	49.5	44.3	0	210	11
5/11/2014	12:00	57.4	52.1	49.7	43.6	0	230	9
5/11/2014	13:00	56.9	51.7	49.3	44.4	0	210	11
5/11/2014	14:00	55.8	52.9	50.5	46	0	240	13
5/11/2014	15:00	59	54.1	52.1	48.1	0	220	13
5/11/2014	16:00	57.3	54.2	52.1	48.3	0	230	15
5/11/2014	17:00	57.5	54.3	52.1	48.1	0	220	22
5/11/2014	18:00	59	56.1	54	50.2	0	220	18
5/11/2014	19:00	59.7	54.3	52.2	47.9	0	200	13
5/11/2014	20:00	57.7	***52.0***	***50.2***	47	0	210	13
5/11/2014	21:00	53.6	49.6	48.2	45.6	0	190	11
5/11/2014	22:00	59.9	48.9	***46.3***	44.3	0	180	13
5/11/2014	23:00	49.7	46.5	44.4	41.2	0	170	9
5/11/2014	0:00	48.3	44.3	42.2	39.1	0	170	2

Hourly Noise Level Data

8 Jarrah Court, Beechboro

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
6/11/2014	6/11/2014	48.1	44	41.8	37.6	0	170	5
6/11/2014	2:00	48.9	41.9	***39.9***	35.1	0	170	9
6/11/2014	3:00	45.8	40.4	37.9	32.8	0	150	8
6/11/2014	4:00	50.2	44.9	42.2	34.4	0	0	0
6/11/2014	5:00	59.7	48.7	***46.7***	41.4	0	170	2
6/11/2014	6:00	58.4	53.2	51.1	45.8	0	0	0
6/11/2014	7:00	55.7	51.8	49.6	45.4	0	0	0
6/11/2014	8:00	58.3	52.6	50.2	45.5	0	80	5
6/11/2014	9:00	57.3	54.1	51.8	47.7	0	260	9
6/11/2014	10:00	60.6	***55.2***	***53.1***	51.5	0	300	11
6/11/2014	11:00	59.2	56.3	54.4	51	0	320	11
6/11/2014	12:00	59.1	56.6	54.4	50.3	0	290	13
6/11/2014	13:00	62.2	59.2	56.7	52.1	0	280	13
6/11/2014	14:00	61.9	59.1	57.1	53.4	0	310	17
6/11/2014	15:00	62.9	60.3	58.4	55	0	310	17
6/11/2014	16:00	65.4	61.2	59.3	55.7	0	300	21
6/11/2014	17:00	63.3	60.9	59	56.3	0	300	17
6/11/2014	18:00	64.8	61.5	59.7	56.4	0	300	15
6/11/2014	19:00	63.2	60.7	58.3	53.9	0	300	13
6/11/2014	20:00	61.5	58.9	56.8	53.4	0	300	17
6/11/2014	21:00	62.9	59.1	57	52.8	0	310	21
6/11/2014	22:00	61.5	58.9	56.1	51.6	1.4	270	5
6/11/2014	23:00	56.2	54	51.8	48	0.2	240	15
6/11/2014	0:00	56.9	53.9	51.4	46.7	0.6	240	11
7/11/2014	7/11/2014	54	51.1	48.1	43.1	0	250	15
7/11/2014	2:00	54.4	51	47.9	41.8	0	250	15
7/11/2014	3:00	54.6	51.1	48.2	42.2	0	250	15
7/11/2014	4:00	57	53.3	50.4	44.2	0	240	17
7/11/2014	5:00	57.7	55	52.4	47.8	0	250	13
7/11/2014	6:00	60.8	58.7	56.4	51.9	0	250	9
7/11/2014	7:00	60.5	58.6	56.6	53.5	0	250	15
7/11/2014	8:00	61.5	59.3	57.1	53.6	0	250	15
7/11/2014	9:00	62.5	59.3	57.5	53.3	0	230	17
7/11/2014	10:00	62.6	59.9	57.6	53.8	0	250	17
7/11/2014	11:00	60.6	58.2	55.8	51.9	0	250	17
7/11/2014	12:00	62.2	58	56	50.4	0	230	18
7/11/2014	13:00	60.6	57	54.6	50.2	0	230	17
7/11/2014	14:00	61.2	57	54.8	50.3	0	210	15
7/11/2014	15:00	59.4	56.8	54.2	49.5	0	220	17
7/11/2014	16:00	58	55.7	53.1	48.2	0	250	17
7/11/2014	17:00	59.5	56.6	54.3	49.6	0	230	21
7/11/2014	18:00	59.2	55.9	53.3	48.7	0	210	17
7/11/2014	19:00	59.8	55	53	48.6	0	210	11
7/11/2014	20:00	60.2	56.5	53.5	46.7	0	200	9
7/11/2014	21:00	56.8	54	53.7	52.6	0	190	11
7/11/2014	22:00	56.2	52.9	49.1	43.4	0	170	9
7/11/2014	23:00	52.6	47.9	46.2	43	0	170	8
7/11/2014	0:00	51.8	46.4	44.9	41.1	0	160	8



Reference: 13122623

Table A13 – Results of Noise Logging 43 Mitra Loop, Beechboro

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
27 October 2014	50.5	51.1	49.2	53.4
28 October 2014	50.9	51.4	50.9	52.2
29 October 2014	51.9	52.9	50.9	55.4
30 October 2014	50.1	49.2	49.2	49.3
31 October 2014	50.9	51.8	50.2	53.9
Weekday Average	**50.9**	**51.3**	**50.1**	**52.8**



Photograph A13– Noise Logger at 43 Mitra Loop, Beechboro

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 43 Mitra Loop
Locality	Beechboro
Occupier	Paul Griffiths 0407980045
Dates	27/10/2014 to 31/10/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	road yet to be constructed
Height of the road in relation to the ground	road yet to be constructed
Road surface type	road yet to be constructed
Speed zone	road yet to be constructed
Absorbing ground	road yet to be constructed
Angle of view	road yet to be constructed
Road gradient	road yet to be constructed
Traffic flow	Vehicles per day. Main Roads to provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	West
Carriageways & lanes.	road yet to be constructed
COMMENT	
Comment	Microphone placed on West façade at Rear of house Rear property fence between microphone and future road.
REFERENCES	
AMG Z50 E/N	
Road name	Future Tonkin Highway.
EXCEL file	43 Mitra Lp MRWA Logger Sheet.xlsx
Raw data file	43 Mitra Loop 87802B_Sta.csv
EQUIPMENT	
Analyser number	15-203-999
Microphone number	15-203-999
Calibrator number	34883971
Calibrator values	94.0,93.8
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Mt Lawley Data 27/10/14 - Neg morning Winds <13 km/h, Pos in afternoon <24km/h 28/10/14 - Neg winds < 17km/h, Pos Afternoon <15 km/h 29/10/14 - Pos Winds <18 km/h most of the day 30/10/14 - Pos Winds <18 km/h most of the day 31/10/14 - Var winds up to 18km/h, one hour at 21 km/h

Hourly Noise Level Data

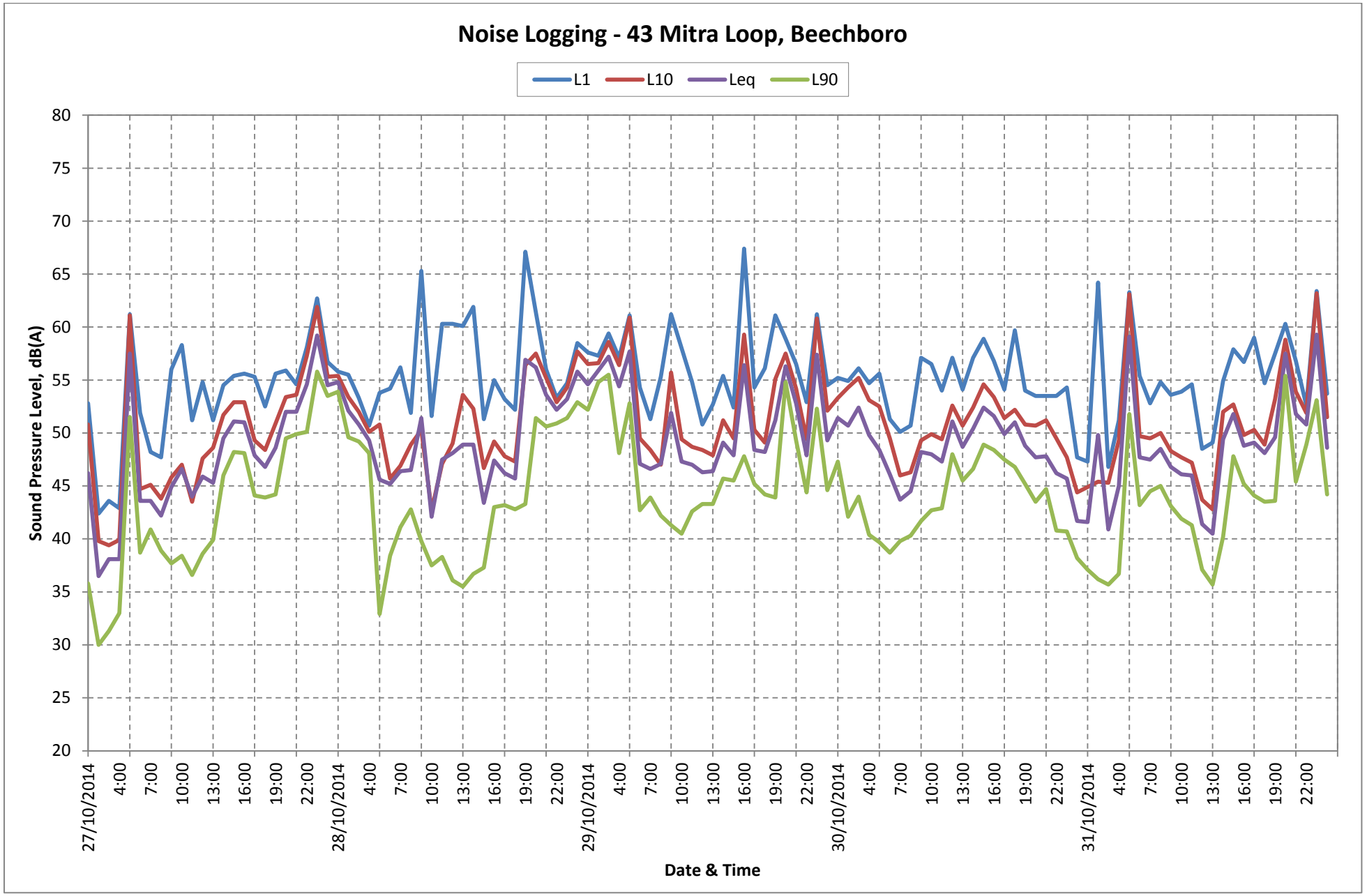
43 Mitra Loop, Beechboro

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
27/10/2014	27/10/2014	52.8	50.8	46.2	35.8	0	180	13
27/10/2014	2:00	42.4	39.8	36.5	30	0	180	9
27/10/2014	3:00	43.6	39.4	38.1	31.3	0	170	8
27/10/2014	4:00	42.9	39.9	38.1	33	0	170	9
27/10/2014	5:00	61.2	61.1	57.5	51.5	0	160	5
27/10/2014	6:00	51.9	44.7	43.6	38.7	0	0	0
27/10/2014	7:00	48.2	45.1	43.6	40.9	0	70	8
27/10/2014	8:00	47.7	43.8	42.2	38.9	0	100	13
27/10/2014	9:00	56	45.8	44.9	37.7	0	100	8
27/10/2014	10:00	58.3	47	46.6	38.4	0	100	5
27/10/2014	11:00	51.2	43.5	44	36.6	0	130	8
27/10/2014	12:00	54.8	47.6	45.9	38.6	0	220	11
27/10/2014	13:00	51.2	48.6	45.3	39.9	0	200	15
27/10/2014	14:00	54.5	51.7	49.5	46	0	210	18
27/10/2014	15:00	55.4	52.9	51.1	48.2	0	220	24
27/10/2014	16:00	55.6	52.9	51	48.1	0	220	21
27/10/2014	17:00	55.3	49.3	47.9	44.1	0	210	21
27/10/2014	18:00	52.5	48.4	46.8	43.9	0	210	15
27/10/2014	19:00	55.6	50.9	48.6	44.2	0	210	13
27/10/2014	20:00	55.9	53.4	52	49.5	0	180	15
27/10/2014	21:00	54.6	53.6	52	49.9	0	170	17
27/10/2014	22:00	58.1	57.3	54.6	50.1	0	170	17
27/10/2014	23:00	62.7	61.9	59.2	55.8	0	170	11
27/10/2014	0:00	56.7	55.3	54.5	53.5	0	160	8
28/10/2014	28/10/2014	55.8	55.4	54.8	53.9	0	170	13
28/10/2014	2:00	55.5	53.4	52.1	49.6	0	150	8
28/10/2014	3:00	53.3	52	50.8	49.2	0	0	0
28/10/2014	4:00	50.7	50.1	49.3	48.1	0	80	8
28/10/2014	5:00	53.8	50.8	45.6	32.9	0	80	8
28/10/2014	6:00	54.2	45.7	45.2	38.4	0	60	11
28/10/2014	7:00	56.2	46.9	46.4	41.1	0	80	13
28/10/2014	8:00	51.9	48.9	46.5	42.8	0	80	17
28/10/2014	9:00	65.3	50.3	51.4	39.8	0	100	13
28/10/2014	10:00	51.6	42.7	42.1	37.5	0	90	9
28/10/2014	11:00	60.3	47.1	47.5	38.3	0	110	9
28/10/2014	12:00	60.3	49	48.1	36.1	0	140	9
28/10/2014	13:00	60.1	53.6	48.9	35.5	0	10	9
28/10/2014	14:00	61.9	52.3	48.9	36.7	0	100	8
28/10/2014	15:00	51.3	46.7	43.4	37.3	0	190	11
28/10/2014	16:00	55	49.2	47.4	43	0	210	15
28/10/2014	17:00	53.2	47.8	46.2	43.2	0	210	13
28/10/2014	18:00	52.2	47.3	45.7	42.8	0	210	13
28/10/2014	19:00	67.1	56.4	56.9	43.3	0	200	13
28/10/2014	20:00	61.4	57.5	56.2	51.4	0	190	8
28/10/2014	21:00	56	55.2	53.6	50.6	0	190	13
28/10/2014	22:00	53.3	52.9	52.2	50.9	0	180	11
28/10/2014	23:00	54.7	54.3	53.2	51.4	0	190	9
28/10/2014	0:00	58.5	57.7	55.8	52.9	0	180	5
29/10/2014	29/10/2014	57.6	56.5	54.6	52.2	0	190	5
29/10/2014	2:00	57.3	56.6	55.9	54.8	0	170	9
29/10/2014	3:00	59.4	58.6	57.2	55.5	0	190	8
29/10/2014	4:00	57.1	56.4	54.4	48.1	0	210	13
29/10/2014	5:00	61.1	60.9	57.7	52.8	0	180	9
29/10/2014	6:00	54.3	49.5	47.1	42.7	0	190	8
29/10/2014	7:00	51.3	48.4	46.6	43.9	0	200	5
29/10/2014	8:00	55.3	47	47.1	42.2	0	170	8
29/10/2014	9:00	61.2	55.7	51.9	41.3	0	190	11
29/10/2014	10:00	58	49.4	47.3	40.5	0	210	8
29/10/2014	11:00	54.8	48.7	47	42.6	0	220	11
29/10/2014	12:00	50.8	48.4	46.3	43.3	0	210	11
29/10/2014	13:00	52.7	47.9	46.4	43.3	0	210	17
29/10/2014	14:00	55.4	51.2	49.1	45.7	0	230	13
29/10/2014	15:00	52.4	49.5	47.9	45.5	0	230	13
29/10/2014	16:00	67.4	59.3	56.4	47.8	0	220	15
29/10/2014	17:00	54.3	50.3	48.4	45.2	0	230	18
29/10/2014	18:00	56.1	49.1	48.2	44.2	0	230	13
29/10/2014	19:00	61.1	55.1	51.2	43.9	0	220	11
29/10/2014	20:00	58.9	57.5	56.3	54.8	0	240	17
29/10/2014	21:00	56.5	54.2	52.8	49.3	0	220	17
29/10/2014	22:00	52.9	49.4	47.9	44.4	0	210	11
29/10/2014	23:00	61.2	60.8	57.4	52.3	0	210	9
29/10/2014	0:00	54.5	52.1	49.3	44.6	0	230	11

Hourly Noise Level Data

43 Mitra Loop, Beechboro

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
30/10/2014	30/10/2014	55.2	53.3	51.4	47.3	0	220	15
30/10/2014	2:00	54.9	54.3	50.7	42.1	0	210	13
30/10/2014	3:00	56.1	55.2	52.4	44	0	210	9
30/10/2014	4:00	54.7	53.1	49.8	40.4	0	190	9
30/10/2014	5:00	55.6	52.5	48.4	39.7	0	190	8
30/10/2014	6:00	51.3	49.5	46.1	38.7	0	180	2
30/10/2014	7:00	50.1	46	43.7	39.8	0	150	9
30/10/2014	8:00	50.7	46.3	44.5	40.3	0	170	8
30/10/2014	9:00	57.1	49.3	48.2	41.7	0	200	4
30/10/2014	10:00	56.5	49.9	48	42.7	0	200	15
30/10/2014	11:00	54	49.4	47.3	42.9	0	210	13
30/10/2014	12:00	57.1	52.6	51.1	48	0	230	17
30/10/2014	13:00	54.1	50.7	48.7	45.5	0	240	18
30/10/2014	14:00	57.1	52.4	50.4	46.6	0	250	17
30/10/2014	15:00	58.9	54.6	52.4	48.9	0	230	18
30/10/2014	16:00	56.8	53.4	51.6	48.4	0	240	17
30/10/2014	17:00	54.1	51.4	49.9	47.5	0	240	18
30/10/2014	18:00	59.7	52.2	51	46.8	0	230	17
30/10/2014	19:00	54	50.8	48.8	45.2	0	240	18
30/10/2014	20:00	53.5	50.7	47.7	43.5	0	230	17
30/10/2014	21:00	53.5	51.2	47.8	44.7	0	240	13
30/10/2014	22:00	53.5	49.5	46.2	40.8	0	240	15
30/10/2014	23:00	54.3	47.7	45.7	40.7	0	240	15
30/10/2014	0:00	47.7	44.4	41.7	38.2	0	230	11
31/10/2014	31/10/2014	47.3	44.9	41.6	37.1	0	240	13
31/10/2014	2:00	64.2	45.4	49.8	36.2	0	240	8
31/10/2014	3:00	46.8	45.3	40.9	35.7	0	240	9
31/10/2014	4:00	51.2	49.3	45	36.7	0	240	9
31/10/2014	5:00	63.3	63.1	59.1	51.8	0	190	18
31/10/2014	6:00	55.4	49.7	47.7	43.2	0	170	11
31/10/2014	7:00	52.8	49.5	47.5	44.5	0	170	17
31/10/2014	8:00	54.8	50	48.5	45	0	170	15
31/10/2014	9:00	53.6	48.3	46.8	43.1	0	180	17
31/10/2014	10:00	53.9	47.7	46.1	41.9	0	180	15
31/10/2014	11:00	54.6	47.2	46	41.3	0	190	15
31/10/2014	12:00	48.5	43.7	41.4	37.1	0	160	13
31/10/2014	13:00	49.1	42.8	40.5	35.7	0	160	11
31/10/2014	14:00	54.9	52	49.4	40.2	0	290	13
31/10/2014	15:00	57.9	52.7	51.8	47.8	0	220	21
31/10/2014	16:00	56.7	49.8	48.8	45.2	0	210	17
31/10/2014	17:00	59	50.3	49.1	44.1	0	200	17
31/10/2014	18:00	54.7	48.9	48.1	43.5	0	210	18
31/10/2014	19:00	57.5	53.2	49.6	43.6	0	230	13
31/10/2014	20:00	60.3	58.8	57.5	55.4	0	220	9
31/10/2014	21:00	56.8	53.9	51.8	45.4	0	220	8
31/10/2014	22:00	52.6	51.9	50.8	48.9	0	230	5
31/10/2014	23:00	63.4	63.2	59.3	53.1	0	220	8
31/10/2014	0:00	53.7	51.5	48.6	44.2	0	0	0



Reference: 13122623

Table A14 – Results of Noise Logging 10 Cootha Court, Ballajura

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
3 November 2014	48.4	46.8	47.9	42.8
4 November 2014	48.1	47.1	48.0	44.3
5 November 2014	47.0	45.2	46.2	42.4
6 November 2014*	46.4	44.6	45.5	41.6
7 November 2014*	47.8	45.0	46.1	41.5
Weekday Average	**47.8**	**46.4**	**47.4**	**43.2**

*Day excluded from the Average due to unacceptable weather conditions.



Photograph A14 – Noise Logger at 10 Cootha Court, Ballajura

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 10 Cootha Court
Locality	Ballajura
Occupier	Cuong Diep 0402003411
Dates	3/11/2014 to 7/11/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	80m to Hepburn
Height of the road in relation to the ground	+0m
Road surface type	DGA
Speed zone	60 km/h
Absorbing ground	70%
Angle of view	180
Road gradient	Flat
Traffic flow	Vehicles per day. Main Roads to provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	East
Carriageways & lanes.	1,2
COMMENT	
Comment	Microphone placed on East façade at Rear of house Rear property fence between microphone and road.
REFERENCES	
AMG Z50 E/N	
Road name	Hepburn Ave
EXCEL file	10 Cootha Ct MRWA Logger Sheet.xlsx
Raw data file	10 Cootha_Sta.csv
EQUIPMENT	
Analyser number	16-004-041
Microphone number	16-004-041
Calibrator number	34883971
Calibrator values	93.8,93.8
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Mt Lawley Data 3/11/14 - Var Winds <18 km/h, 3 hours of Neg at 21 km/h 4/11/14 - Pos morning winds <11km/h, Neg Afternoon <18 km/h 5/11/14 - Var Winds <18 km/h, 1 hour of Neg at 22 km/h 6/11/14 - Neg Winds 11 to 17 km/h, 2 hours at 21 km/h, night rain 7/11/14 - Neg winds up to 18km/h, one hour at 21 km/h

Hourly Noise Level Data

10 Cootha Court, Ballajura

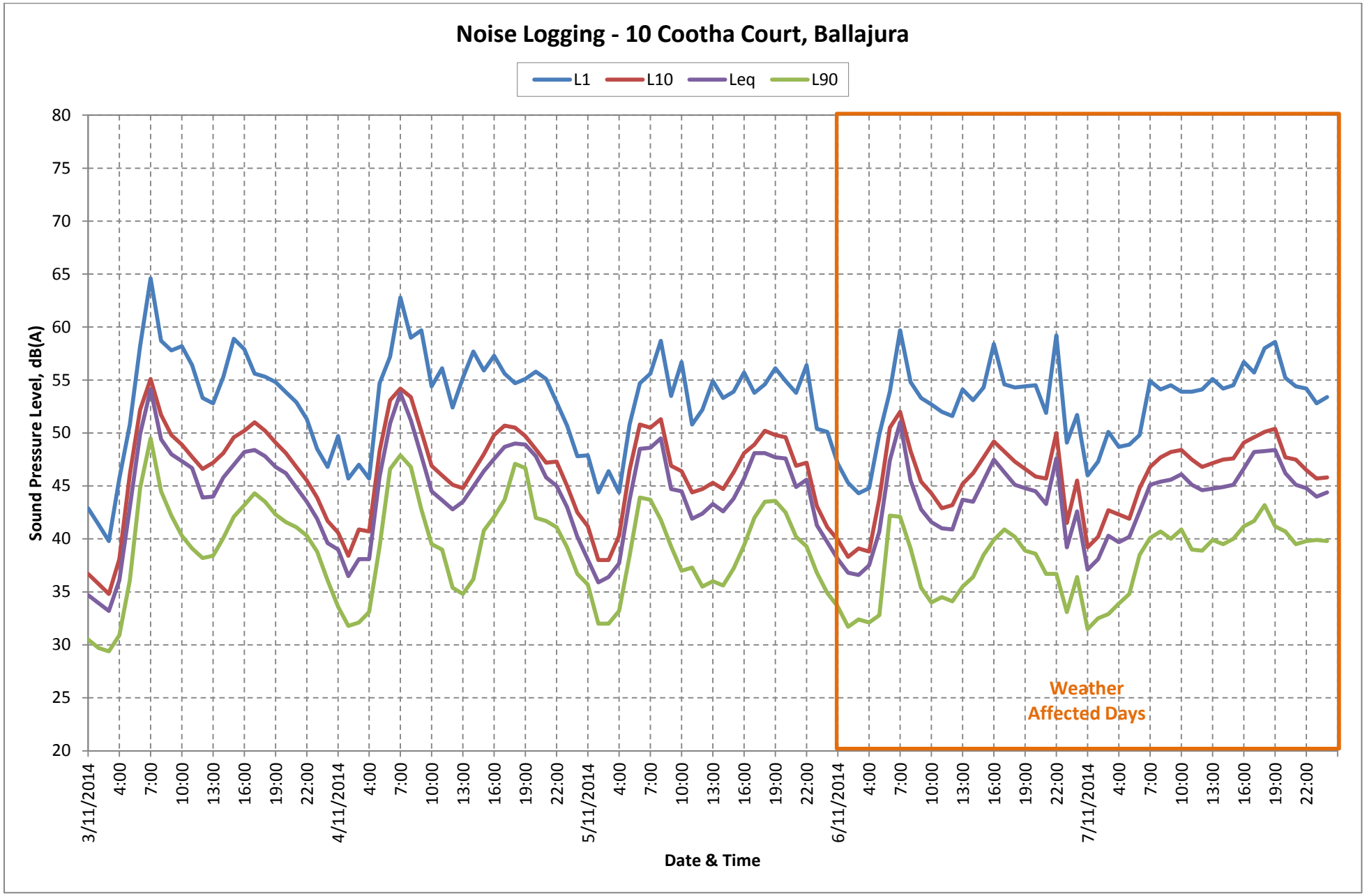
Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
3/11/2014	3/11/2014	42.9	36.7	34.7	30.5	0	220	15
3/11/2014	2:00	***41.4***	***35.8***	***34.0***	29.7	0	230	13
3/11/2014	3:00	39.8	34.8	33.2	29.4	0	230	9
3/11/2014	4:00	45.7	38.1	36.1	30.9	0	190	8
3/11/2014	5:00	50.8	46.1	43	36.1	0	190	4
3/11/2014	6:00	58.2	52.2	49.9	44.8	0	190	2
3/11/2014	7:00	64.6	55.1	***54.1***	49.5	0	140	8
3/11/2014	8:00	58.7	51.7	49.4	44.5	0	160	11
3/11/2014	9:00	57.8	49.8	48	42.2	0	150	13
3/11/2014	10:00	58.2	48.9	***47.4***	40.3	0	190	11
3/11/2014	11:00	56.4	***47.8***	46.7	39.1	0	220	11
3/11/2014	12:00	53.3	46.6	43.9	38.2	0	210	15
3/11/2014	13:00	52.8	47.2	44	38.4	0	220	15
3/11/2014	14:00	55.3	48.1	45.8	40.1	0	210	21
3/11/2014	15:00	58.9	49.6	***47***	42.1	0	210	22
3/11/2014	16:00	57.9	50.2	48.2	43.2	0	210	18
3/11/2014	17:00	55.6	51	48.4	44.3	0	220	21
3/11/2014	18:00	55.3	50.2	47.8	43.5	0	220	17
3/11/2014	19:00	54.8	49.1	46.8	42.3	0	190	13
3/11/2014	20:00	***53.9***	48.1	46.2	41.6	0	200	13
3/11/2014	21:00	52.9	***46.8***	***44.9***	41.1	0	180	11
3/11/2014	22:00	51.3	45.5	43.5	40.3	0	170	13
3/11/2014	23:00	48.5	43.9	41.9	38.8	0	170	13
3/11/2014	0:00	46.8	41.7	39.6	36.1	0	170	9
4/11/2014	4/11/2014	49.7	40.6	39	33.6	0	190	9
4/11/2014	2:00	45.7	38.4	36.5	31.8	0	170	11
4/11/2014	3:00	47	40.9	38.1	32.1	0	160	9
4/11/2014	4:00	45.7	40.7	38.1	33.1	0	180	5
4/11/2014	5:00	54.7	48.3	45.9	39.3	0	0	0
4/11/2014	6:00	57.2	53.1	50.9	46.6	0	0	0
4/11/2014	7:00	62.8	54.2	***53.8***	47.9	0	80	9
4/11/2014	8:00	59	53.4	51.2	46.8	0	120	11
4/11/2014	9:00	59.7	***50.2***	***47.9***	42.8	0	130	9
4/11/2014	10:00	54.4	46.9	44.5	39.5	0	160	5
4/11/2014	11:00	56.1	***46.0***	***43.7***	39	0	40	9
4/11/2014	12:00	52.4	45.1	42.8	35.4	0	170	9
4/11/2014	13:00	55.2	44.8	43.5	34.8	0	250	17
4/11/2014	14:00	57.7	***46.4***	***45.0***	36.2	0	240	17
4/11/2014	15:00	55.9	48	46.4	40.8	0	200	18
4/11/2014	16:00	57.3	49.8	***47.6***	42.1	0	230	18
4/11/2014	17:00	55.6	50.7	48.7	43.7	0	220	15
4/11/2014	18:00	54.7	50.5	49	47.1	0	220	15
4/11/2014	19:00	55.1	49.7	48.9	46.7	0	210	15
4/11/2014	20:00	55.8	***48.5***	47.8	42	0	190	11
4/11/2014	21:00	55.1	47.2	45.8	41.7	0	180	15
4/11/2014	22:00	52.9	47.3	45	41.1	0	180	13
4/11/2014	23:00	50.7	45	43	39.2	0	190	13
4/11/2014	0:00	47.8	42.5	40.2	36.7	0	180	13
5/11/2014	5/11/2014	47.9	41.2	***38.1***	35.7	0	180	9
5/11/2014	2:00	44.4	38	35.9	32	0	160	8
5/11/2014	3:00	46.4	38	36.4	32	0	180	5
5/11/2014	4:00	44.4	40.3	37.7	33.2	0	190	2
5/11/2014	5:00	50.8	46.5	43.7	38.4	0	160	5
5/11/2014	6:00	54.7	50.8	48.5	43.9	0	150	5
5/11/2014	7:00	55.6	50.5	48.6	43.7	0	210	5
5/11/2014	8:00	58.7	51.3	49.5	41.8	0	190	8
5/11/2014	9:00	53.5	46.9	44.7	39.3	0	210	9
5/11/2014	10:00	56.7	46.4	44.5	37	0	210	13
5/11/2014	11:00	50.8	44.4	41.9	37.3	0	210	11
5/11/2014	12:00	52.2	44.7	42.4	35.5	0	230	9
5/11/2014	13:00	54.9	45.3	43.3	36	0	210	11
5/11/2014	14:00	53.3	44.7	42.6	35.6	0	240	13
5/11/2014	15:00	53.9	46.3	43.8	37.2	0	220	13
5/11/2014	16:00	55.7	48.1	45.7	39.4	0	230	15
5/11/2014	17:00	53.8	48.9	48.1	42	0	220	22
5/11/2014	18:00	54.6	50.2	48.1	43.5	0	220	18
5/11/2014	19:00	56.1	49.8	47.7	43.6	0	200	13
5/11/2014	20:00	54.9	49.6	47.6	42.5	0	210	13
5/11/2014	21:00	53.8	46.9	44.9	40.2	0	190	11
5/11/2014	22:00	56.4	47.2	45.6	39.3	0	180	13
5/11/2014	23:00	50.4	43.1	41.3	36.8	0	170	9
5/11/2014	0:00	50.1	41.1	39.7	34.9	0	170	2

Reference: 13122623

Hourly Noise Level Data

10 Cootha Court, Ballajura

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
6/11/2014	6/11/2014	47.1	39.9	38.1	33.6	0	170	5
6/11/2014	2:00	45.3	38.3	36.8	31.7	0	170	9
6/11/2014	3:00	44.3	39.1	36.6	32.4	0	150	8
6/11/2014	4:00	44.8	38.8	37.5	32.1	0	0	0
6/11/2014	5:00	49.9	43.8	40.7	32.8	0	170	2
6/11/2014	6:00	53.9	50.5	47.4	42.2	0	0	0
6/11/2014	7:00	59.7	52	51	42.1	0	0	0
6/11/2014	8:00	54.8	48.3	45.5	39.1	0	80	5
6/11/2014	9:00	53.3	45.4	42.8	35.4	0	260	9
6/11/2014	10:00	52.7	44.3	41.6	34	0	300	11
6/11/2014	11:00	52	42.9	41	34.5	0	320	11
6/11/2014	12:00	51.6	43.2	40.9	34.1	0	290	13
6/11/2014	13:00	54.1	45.2	43.7	35.5	0	280	13
6/11/2014	14:00	53.1	46.2	43.5	36.4	0	310	17
6/11/2014	15:00	54.3	***47.7***	***45.5***	38.5	0	310	17
6/11/2014	16:00	58.4	49.2	***47.5***	39.9	0	300	21
6/11/2014	17:00	54.6	***48.3***	***46.3***	40.9	0	300	17
6/11/2014	18:00	54.3	47.3	45.1	40.2	0	300	15
6/11/2014	19:00	***54.4***	***46.6***	***44.8***	38.9	0	300	13
6/11/2014	20:00	54.5	45.9	44.5	38.6	0	300	17
6/11/2014	21:00	51.9	45.7	43.3	36.7	0	310	21
6/11/2014	22:00	59.2	50	47.6	36.7	1.4	270	5
6/11/2014	23:00	49.1	41.5	39.2	33.1	0.2	240	15
6/11/2014	0:00	51.7	45.5	42.6	36.4	0.6	240	11
7/11/2014	7/11/2014	46	39.2	37.1	31.5	0	250	15
7/11/2014	2:00	47.3	40.2	38.1	32.5	0	250	15
7/11/2014	3:00	50.1	42.7	40.3	32.9	0	250	15
7/11/2014	4:00	48.7	42.3	39.7	33.9	0	240	17
7/11/2014	5:00	48.9	41.9	40.2	34.8	0	250	13
7/11/2014	6:00	49.8	44.8	42.6	38.5	0	250	9
7/11/2014	7:00	54.9	46.8	45.1	40.1	0	250	15
7/11/2014	8:00	54.1	47.7	45.4	40.7	0	250	15
7/11/2014	9:00	54.5	48.2	45.6	40	0	230	17
7/11/2014	10:00	53.9	48.4	46.1	40.9	0	250	17
7/11/2014	11:00	53.9	47.5	45.1	39	0	250	17
7/11/2014	12:00	54.1	46.8	44.6	38.9	0	230	18
7/11/2014	13:00	55.1	***47.2***	***44.8***	39.9	0	230	17
7/11/2014	14:00	54.2	47.5	44.9	39.5	0	210	15
7/11/2014	15:00	54.5	47.6	45.1	40	0	220	17
7/11/2014	16:00	56.7	49.1	***46.7***	41.2	0	250	17
7/11/2014	17:00	55.7	49.6	48.2	41.7	0	230	21
7/11/2014	18:00	58	50.1	***48.3***	43.2	0	210	17
7/11/2014	19:00	58.6	50.4	48.4	41.2	0	210	11
7/11/2014	20:00	55.2	47.7	46.2	40.7	0	200	9
7/11/2014	21:00	54.4	47.5	45.1	39.5	0	190	11
7/11/2014	22:00	54.2	46.5	44.8	39.8	0	170	9
7/11/2014	23:00	52.8	45.7	44	39.9	0	170	8
7/11/2014	0:00	53.4	45.8	44.4	39.8	0	160	8



Reference: 13122623

Table A15 – Results of Noise Logging 21 Madura Close, Ballajura

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
20 November 2014	48.4	47.5	47.8	46.9
21 November 2014*	46.7	45.0	46.4	39.1
24 November 2014	49.6	48.2	49.2	45.4
25 November 2014	52.1	50.1	50.5	49.2
26 November 2014*	56.0	54.8	56.1	49.3
27 November 2014	51.0	49.3	50.3	46.3
Weekday Average	**50.3**	**48.8**	**49.4**	**47.0**

*Day excluded from the Average due to unacceptable weather conditions.



Photograph A15 – Noise Logger at 21 Madura Close, Ballajura

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 21 Madura Close
Locality	Ballajura
Occupier	Florence
Dates	20/11/2014 to 27/11/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	85m to Hepburn
Height of the road in relation to the ground	+0m
Road surface type	DGA
Speed zone	60 km/h
Absorbing ground	70%
Angle of view	170
Road gradient	Flat
Traffic flow	Vehicles per day. Main Roads to provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	East
Carriageways & lanes.	2,5
COMMENT	
Comment	Microphone placed on East façade at Rear of house Rear property fence between microphone and road.
REFERENCES	
AMG Z50 E/N	
Road name	Hepburn Ave
EXCEL file	21 Madura Close MRWA Logger Sheet.xlsx
Raw data file	21 Madura_Sta.csv
EQUIPMENT	
Analyser number	15-301-468
Microphone number	15-301-468
Calibrator number	34883971
Calibrator values	94.0,94.0
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Mt Lawley Data 20/11/14 - Neg Winds <18 km/h from 9am, Morning <9km/h Pos winds 21/11/14 - Neg Winds <18 km/h continuous. 24/11/14 - Var Winds <18 km/h, 3 hour of Neg at 21 km/h 25/11/14 - Pos Winds 15 km/h, 1 hour at 18 km/h, night rain 26/11/14 - Pos winds all day, up to 21km/h, Evening Rain 27/11/14 - Var winds up to 18km/h, Morning Showers

Hourly Noise Level Data

21 Madura Close, Ballajura

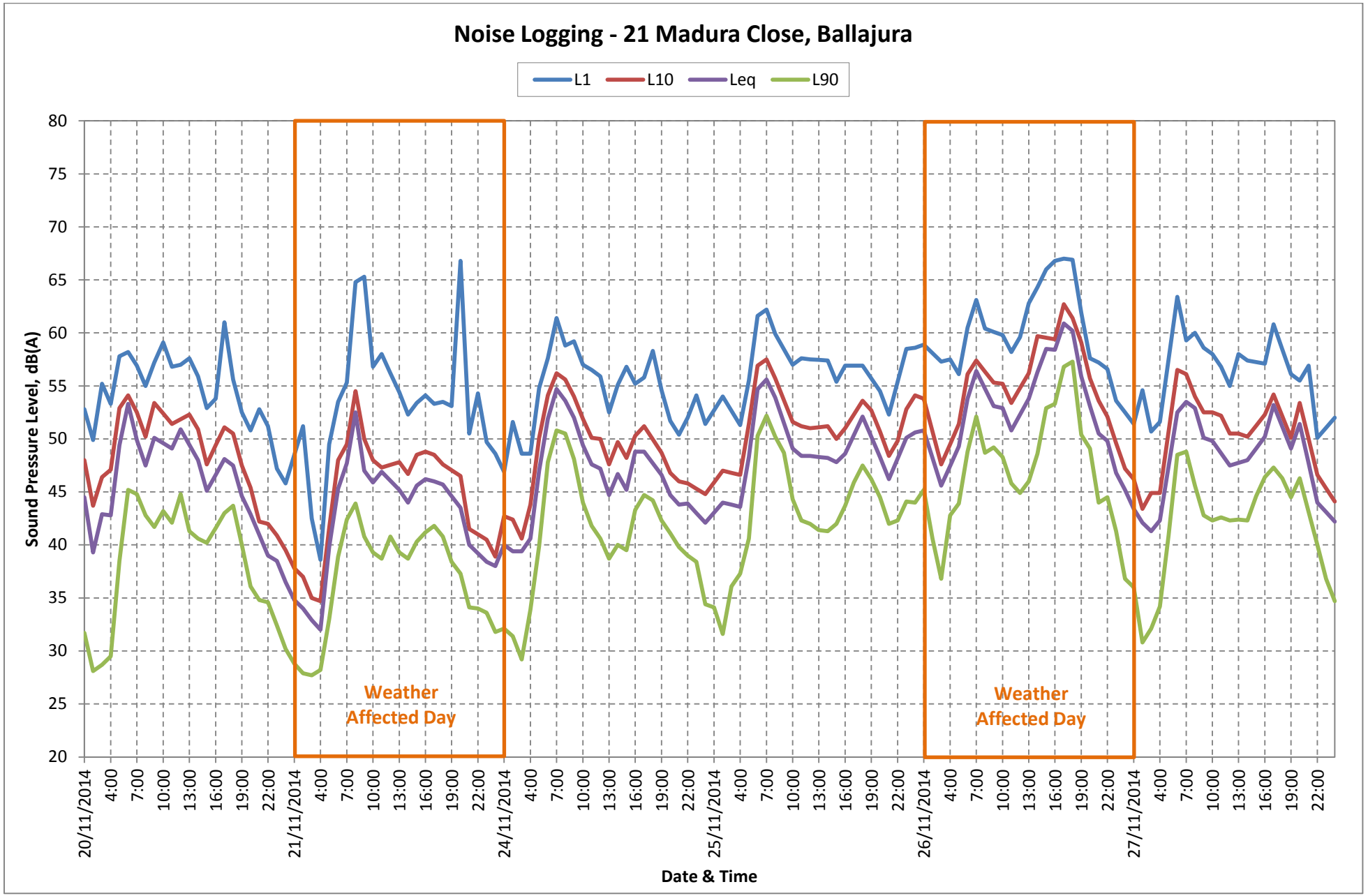
Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
20/11/2014	20/11/2014	52.8	48	44.5	31.7	0	0	0
20/11/2014	2:00	49.9	43.7	39.3	28.1	0	270	5
20/11/2014	3:00	55.2	46.4	42.9	28.7	0	0	0
20/11/2014	4:00	53.3	47.1	42.8	29.5	0	50	5
20/11/2014	5:00	57.8	52.9	49.4	38.5	0	40	4
20/11/2014	6:00	58.2	54.1	***53.3***	45.2	0	20	2
20/11/2014	7:00	56.9	52.5	49.9	44.8	0	0	0
20/11/2014	8:00	55	50.2	47.5	42.8	0	30	8
20/11/2014	9:00	57.2	53.4	50.1	41.7	0	300	13
20/11/2014	10:00	59.1	***52.4***	***49.6***	43.2	0	310	17
20/11/2014	11:00	56.8	51.4	***49.1***	42.1	0	290	17
20/11/2014	12:00	57	***51.9***	***50.9***	44.8	0	320	18
20/11/2014	13:00	57.6	52.3	***49.5***	41.3	0	290	18
20/11/2014	14:00	55.9	50.9	48	40.6	0	260	17
20/11/2014	15:00	52.9	47.6	45.1	40.2	0	270	15
20/11/2014	16:00	53.8	49.4	46.6	41.6	0	290	17
20/11/2014	17:00	61	51.1	***48.1***	43	0	260	15
20/11/2014	18:00	55.6	50.5	***47.5***	43.7	0	270	18
20/11/2014	19:00	52.5	47.5	44.6	40	0	270	17
20/11/2014	20:00	50.8	45.4	42.9	36.1	0	270	11
20/11/2014	21:00	52.8	42.2	***41.0***	34.8	0	270	9
20/11/2014	22:00	51.2	***42***	***39***	34.6	0	280	11
20/11/2014	23:00	47.2	40.9	38.5	32.4	0	280	13
20/11/2014	0:00	45.8	39.5	***36.5***	30.2	0	270	11
21/11/2014	21/11/2014	48.5	***37.8***	***34.8***	28.8	0	280	8
21/11/2014	2:00	51.2	***37***	***34***	27.9	0	270	8
21/11/2014	3:00	42.5	35	32.9	27.7	0	260	9
21/11/2014	4:00	38.6	34.7	32	28.2	0	260	9
21/11/2014	5:00	49.5	41.6	39.8	33	0	280	8
21/11/2014	6:00	53.5	48	45.3	38.9	0	280	8
21/11/2014	7:00	55.3	49.5	47.7	42.4	0	260	9
21/11/2014	8:00	64.8	54.5	52.5	43.9	0	250	13
21/11/2014	9:00	65.3	50	***47***	40.8	0	260	9
21/11/2014	10:00	56.8	48	45.9	39.3	0	240	11
21/11/2014	11:00	58	47.3	46.9	38.7	0	260	13
21/11/2014	12:00	***56.2***	***47.6***	***46.1***	40.8	0	230	17
21/11/2014	13:00	54.4	47.8	45.2	39.3	0	240	18
21/11/2014	14:00	52.3	46.7	44	38.7	0	250	17
21/11/2014	15:00	53.4	48.5	45.6	40.3	0	250	17
21/11/2014	16:00	54.1	48.8	46.2	41.2	0	250	17
21/11/2014	17:00	53.3	48.5	46	41.8	0	220	18
21/11/2014	18:00	53.5	47.6	45.7	40.8	0	250	13
21/11/2014	19:00	53.1	***47.1***	***44.6***	38.4	0	240	15
21/11/2014	20:00	66.8	46.5	***43.5***	37.3	0	240	13
21/11/2014	21:00	50.5	41.5	40	34.1	0	240	9
21/11/2014	22:00	54.3	***41.0***	***39.2***	34	0	230	13
21/11/2014	23:00	49.7	***40.5***	***38.4***	33.6	0	220	11
21/11/2014	0:00	48.6	38.9	38	31.8	0	220	9
24/11/2014	24/11/2014	46.9	42.7	40	32.1	0	170	15
24/11/2014	2:00	51.6	42.4	***39.4***	31.4	0	170	13
24/11/2014	3:00	48.6	40.6	39.4	29.2	0	160	11
24/11/2014	4:00	48.6	43.8	40.6	33.9	0	160	11
24/11/2014	5:00	54.8	50.1	47	39.9	0	140	11
24/11/2014	6:00	57.6	54.1	51.9	47.8	0	140	11
24/11/2014	7:00	61.4	56.2	***54.7***	50.8	0	110	9
24/11/2014	8:00	58.8	55.6	53.6	50.5	0	90	11
24/11/2014	9:00	59.2	54	52	48.1	0	100	13
24/11/2014	10:00	57	51.9	49.4	44	0	100	13
24/11/2014	11:00	56.5	50.1	47.6	41.8	0	110	11
24/11/2014	12:00	55.9	50	47.2	40.6	0	90	11
24/11/2014	13:00	52.5	47.6	44.7	38.7	0	100	9
24/11/2014	14:00	55.1	49.7	46.7	40	0	160	9
24/11/2014	15:00	56.8	48.2	***45.2***	39.5	0	200	15
24/11/2014	16:00	55.2	50.3	***48.8***	43.3	0	220	21
24/11/2014	17:00	55.8	51.2	48.8	44.7	0	230	21
24/11/2014	18:00	58.3	***50.0***	***47.7***	44.2	0	200	21
24/11/2014	19:00	54.6	48.7	46.6	42.3	0	210	18
24/11/2014	20:00	51.7	46.8	44.7	41.1	0	190	15
24/11/2014	21:00	50.4	46	43.8	39.8	0	180	13
24/11/2014	22:00	52	45.8	43.9	39	0	170	11
24/11/2014	23:00	54.1	***45.3***	***43.0***	38.4	0	170	11
24/11/2014	0:00	51.4	44.8	42.1	34.4	0	160	9

Hourly Noise Level Data

21 Madura Close, Ballajura

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
25/11/2014	25/11/2014	***52.7***	***45.9***	***43.1***	34.1	0	0	0
25/11/2014	2:00	54	***47***	***44***	31.6	0	170	2
25/11/2014	3:00	***52.7***	***46.8***	***43.8***	36.1	0	90	9
25/11/2014	4:00	51.3	46.6	43.6	37.3	0	90	9
25/11/2014	5:00	55.5	51.4	48.3	40.6	0	90	9
25/11/2014	6:00	61.6	56.9	54.7	50.3	0	90	11
25/11/2014	7:00	62.2	57.5	55.6	52.2	0	80	15
25/11/2014	8:00	59.9	55.7	53.9	50.2	0	90	13
25/11/2014	9:00	***58.5***	***53.7***	***51.5***	48.7	0	90	13
25/11/2014	10:00	57	51.6	49.1	44.3	0	110	13
25/11/2014	11:00	57.6	51.2	48.4	42.3	0	100	11
25/11/2014	12:00	57.5	51	48.4	42	0	120	11
25/11/2014	13:00	***57.5***	***51.1***	***48.3***	41.4	0	120	11
25/11/2014	14:00	57.4	51.2	48.2	41.3	0	110	11
25/11/2014	15:00	55.4	50	47.8	42	0	120	9
25/11/2014	16:00	56.9	51	48.6	43.7	0	120	11
25/11/2014	17:00	***56.9***	***52.3***	***50.4***	45.9	0	130	9
25/11/2014	18:00	56.9	***53.6***	52.1	47.5	0	130	13
25/11/2014	19:00	***55.7***	52.7	***50.2***	46.2	0	140	15
25/11/2014	20:00	54.5	50.7	48.3	44.5	0	140	13
25/11/2014	21:00	52.3	48.4	46.2	42	0	150	9
25/11/2014	22:00	***55.4***	49.8	***48.2***	42.3	0	140	9
25/11/2014	23:00	58.5	52.8	50.1	44.1	0	130	13
25/11/2014	0:00	58.6	54.1	50.6	44	0	110	18
26/11/2014	26/11/2014	58.9	53.8	50.8	45.2	0	100	21
26/11/2014	2:00	***58.1***	***50.7***	***48.2***	40.6	0	100	21
26/11/2014	3:00	57.3	47.6	45.6	36.8	0	100	11
26/11/2014	4:00	57.5	***49.5***	***47.5***	42.8	0	90	17
26/11/2014	5:00	56.1	51.4	49.3	43.9	0	110	11
26/11/2014	6:00	60.5	56.1	53.8	48.8	0	90	18
26/11/2014	7:00	63.1	57.4	56.4	52.1	0	90	15
26/11/2014	8:00	60.4	***56.4***	***54.8***	48.7	0	100	9
26/11/2014	9:00	60.1	55.3	53.1	49.2	0	100	11
26/11/2014	10:00	59.8	55.2	52.9	48.3	0	80	9
26/11/2014	11:00	58.2	53.4	50.8	45.8	0	110	13
26/11/2014	12:00	59.6	***54.8***	***52.3***	44.9	0	100	9
26/11/2014	13:00	62.8	56.2	53.8	46	0	70	15
26/11/2014	14:00	64.3	59.7	56.3	48.6	0	80	9
26/11/2014	15:00	66	***59.6***	58.5	52.9	0	150	11
26/11/2014	16:00	66.8	59.4	***58.4***	53.3	0.2	130	13
26/11/2014	17:00	67	62.7	60.9	56.8	1.6	60	11
26/11/2014	18:00	66.9	61.4	60.2	57.3	2.8	70	17
26/11/2014	19:00	61.9	59.1	55.9	50.4	2	80	11
26/11/2014	20:00	57.6	55.7	53.1	49.1	0.4	70	8
26/11/2014	21:00	57.2	53.6	50.5	44	1	110	15
26/11/2014	22:00	56.6	52.1	49.8	44.5	0.4	100	5
26/11/2014	23:00	53.6	49.6	46.8	41.3	0	90	9
26/11/2014	0:00	52.5	47.2	45.2	36.8	0	90	11
27/11/2014	27/11/2014	51.4	46.2	43.4	36	0	60	9
27/11/2014	2:00	54.6	43.4	42.1	30.8	0	50	17
27/11/2014	3:00	50.7	44.9	41.3	32.1	0	50	13
27/11/2014	4:00	51.6	44.9	42.3	34.2	0	50	9
27/11/2014	5:00	***57.5***	***50.7***	***47.4***	40.9	0	40	11
27/11/2014	6:00	63.4	56.5	***52.5***	48.5	2	10	13
27/11/2014	7:00	59.3	56.1	53.5	48.8	0.2	10	8
27/11/2014	8:00	60	54	52.9	45.6	0.8	220	5
27/11/2014	9:00	58.6	52.5	50.1	42.8	0	220	4
27/11/2014	10:00	58	52.5	49.8	42.3	0	170	11
27/11/2014	11:00	56.8	52.2	***48.7***	42.6	0	230	9
27/11/2014	12:00	55	50.5	47.5	42.3	0	170	11
27/11/2014	13:00	58	50.5	***47.8***	42.4	0	150	17
27/11/2014	14:00	57.4	50.2	***48***	42.3	0	190	13
27/11/2014	15:00	***57.3***	***51.3***	***49.1***	44.6	0.4	200	9
27/11/2014	16:00	57.1	52.3	50.2	46.4	1	160	13
27/11/2014	17:00	60.8	54.2	***53.2***	47.3	0	150	17
27/11/2014	18:00	***58.5***	***52.2***	***51.2***	46.3	0	150	13
27/11/2014	19:00	56.1	50.1	***49.1***	44.5	0	100	9
27/11/2014	20:00	55.5	53.4	***51.4***	46.3	0	150	2
27/11/2014	21:00	56.9	***50.0***	***47.7***	43.1	0	0	0
27/11/2014	22:00	50.1	46.6	44	40	0	0	0
27/11/2014	23:00	***51.1***	***45.4***	***43.1***	36.8	0	200	8
27/11/2014	0:00	52	44.1	42.2	34.7	0	150	5

Reference: 13122623



Reference: 13122623

Table A16 – Results of Noise Logging 12 Fewson Turn, Ellenbrook

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
20 November 2014	46.1	50.9	52.2	46.0
21 November 2014*	43.3	43.7	44.3	42.0
24 November 2014	45.3	48.7	50.1	42.5
25 November 2014	47.7	48.9	49.8	46.0
26 November 2014*	46.1	50.9	52.2	46.0
Weekday Average	**45.6**	**48.0**	**49.1**	**44.1**

*Day excluded from the Average due to unacceptable weather conditions.



Photograph A16 – Noise Logger at 12 Fewson Turn, Ellenbrook

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 12 Fewson Turn
Locality	Ellenbrook
Occupier	Paul Miller, 0450 733 714
Dates	20/11/2014 to 27/11/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	Road yet to be constructed
Height of the road in relation to the ground	Road yet to be constructed
Road surface type	Road yet to be constructed
Speed zone	Road yet to be constructed
Absorbing ground	Road yet to be constructed
Angle of view	Road yet to be constructed
Road gradient	Road yet to be constructed
Traffic flow	Vehicles per day. Main Roads to provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	West
Carriageways & lanes.	Road yet to be constructed
COMMENT	
Comment	No major road traffic source currently nearby. Microphone placed on West façade at Rear of house. Noise is primarily weather related and local sources (eg. Pool). Large balcony at rear of property, to the south of logger position. Pool located near logger position.
REFERENCES	
AMG Z50 E/N	
Road name	Future Tonkin Highway
EXCEL file	12 Fewson Turn MRWA Logger Sheet.xlsx
Raw data file	12 Fewson_Sta.csv
EQUIPMENT	
Analyser number	16-707-041
Microphone number	16-707-041
Calibrator number	34883971
Calibrator values	94.3, 94.2
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Pearce RAAF Data 20/11/14 - Pos Winds >18 km/h for 12 hours of day, rest of day calm 21/11/14 - 4 hours neg Winds <11 km/h, rest of day Pos winds <24km/h 24/11/14 - Var Winds <18 km/h, 6 hours above 21 km/h 25/11/14 - Neg Winds; morning 15 to 33 km/h, Afternoon 13-40 km/h 26/11/14 - Neg high winds all day, over 18km/h, Evening Rain

Hourly Noise Level Data

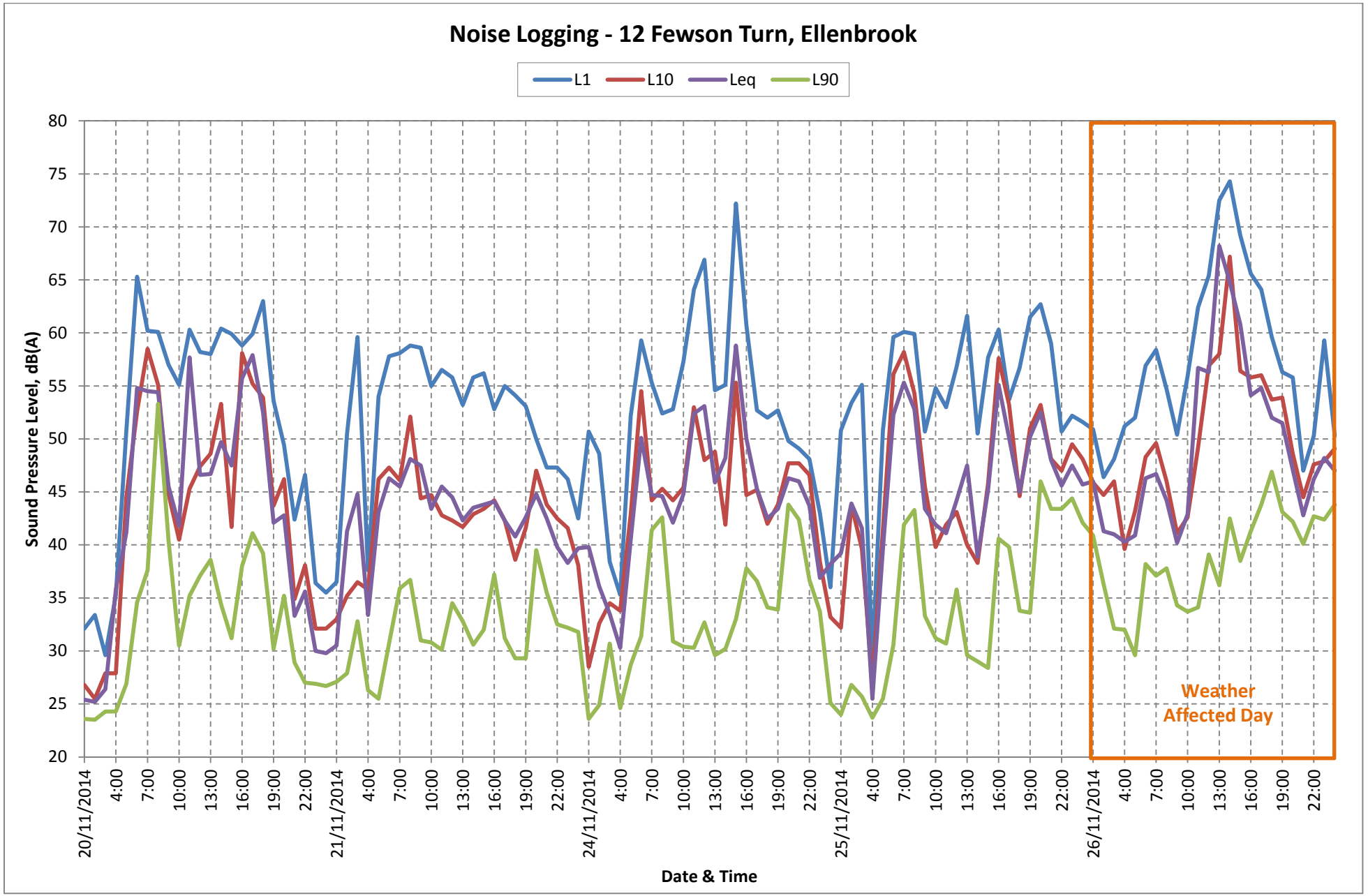
12 Fewson Turn, Ellenbrook

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
20/11/2014	20/11/2014	32.1	26.8	25.4	23.6	0	0	0
20/11/2014	2:00	33.4	25.5	25.2	23.5	0	350	4
20/11/2014	3:00	29.6	27.9	26.4	24.3	0	90	4
20/11/2014	4:00	35.3	27.9	35.8	24.3	0	350	5
20/11/2014	5:00	50.8	44.5	41.2	26.9	0	10	5
20/11/2014	6:00	65.3	52.6	54.8	34.6	0	0	0
20/11/2014	7:00	60.2	58.5	54.5	37.6	0	340	9
20/11/2014	8:00	60.1	55.1	54.4	53.3	0	340	17
20/11/2014	9:00	57	44.8	45.5	40.4	0	290	24
20/11/2014	10:00	55.1	40.5	41.8	30.5	0	310	28
20/11/2014	11:00	60.3	45.3	57.7	35.2	0	310	26
20/11/2014	12:00	58.2	47.4	46.6	37.1	0	300	31
20/11/2014	13:00	58	48.6	46.7	38.6	0	280	31
20/11/2014	14:00	60.4	53.3	49.7	34.4	0	260	35
20/11/2014	15:00	59.9	41.7	47.5	31.2	0	280	22
20/11/2014	16:00	58.8	58.1	55.7	38	0	280	28
20/11/2014	17:00	59.9	55.2	57.9	41.1	0	280	28
20/11/2014	18:00	63	53.9	52.5	39.2	0	260	26
20/11/2014	19:00	53.6	43.7	42.1	30.2	0	260	18
20/11/2014	20:00	49.4	46.2	42.8	35.2	0	320	9
20/11/2014	21:00	42.4	34.9	33.3	28.9	0	340	9
20/11/2014	22:00	46.6	38.1	35.6	27	0	360	11
20/11/2014	23:00	36.4	32.1	30	26.9	0	350	13
20/11/2014	0:00	35.5	32.1	29.8	26.7	0	340	8
21/11/2014	21/11/2014	36.5	33	30.5	27.1	0	350	13
21/11/2014	2:00	50.5	35.2	41.3	27.9	0	360	13
21/11/2014	3:00	59.6	36.5	44.8	32.8	0	10	11
21/11/2014	4:00	37.6	35.8	33.4	26.3	0	10	11
21/11/2014	5:00	54	46.2	43.1	25.5	0	10	11
21/11/2014	6:00	57.8	47.3	46.3	30.7	0	350	15
21/11/2014	7:00	58.1	46.1	45.5	35.9	0	340	17
21/11/2014	8:00	58.8	52.1	48.1	36.7	0	220	24
21/11/2014	9:00	58.6	44.4	47.5	31	0	230	24
21/11/2014	10:00	55	44.7	43.4	30.8	0	250	22
21/11/2014	11:00	56.5	42.8	45.5	30.1	0	250	21
21/11/2014	12:00	55.8	42.3	44.5	34.5	0	220	22
21/11/2014	13:00	53.2	41.7	42.3	32.8	0	230	21
21/11/2014	14:00	55.8	42.9	43.5	30.6	0	230	22
21/11/2014	15:00	56.2	43.4	43.8	32	0	230	21
21/11/2014	16:00	52.8	44.2	44.1	37.2	0	260	31
21/11/2014	17:00	55	42.3	42.3	31.2	0	220	22
21/11/2014	18:00	54.1	38.6	40.8	29.3	0	250	21
21/11/2014	19:00	53.1	41.6	42.6	29.3	0	240	17
21/11/2014	20:00	50	47	44.8	39.5	0	230	9
21/11/2014	21:00	47.3	43.8	42.5	35.5	0	270	8
21/11/2014	22:00	47.3	42.5	39.8	32.5	0	340	8
21/11/2014	23:00	46.2	41.6	38.3	32.2	0	350	5
21/11/2014	0:00	42.5	38.1	39.7	31.8	0	360	8
24/11/2014	24/11/2014	50.7	28.5	39.8	23.6	0	180	11
24/11/2014	2:00	48.6	32.6	36.1	24.9	0	180	13
24/11/2014	3:00	38.4	34.5	33.5	30.7	0	170	13
24/11/2014	4:00	35.3	33.8	30.3	24.6	0	170	15
24/11/2014	5:00	52.2	42.9	40.5	28.7	0	170	15
24/11/2014	6:00	59.3	54.5	50.1	31.4	0	200	8
24/11/2014	7:00	55.3	44.2	44.7	41.4	0	170	9
24/11/2014	8:00	52.4	45.3	44.6	42.6	0	120	11
24/11/2014	9:00	52.8	44.2	42.1	30.9	0	90	28
24/11/2014	10:00	57.3	45.4	44.8	30.4	0	70	13
24/11/2014	11:00	64.1	53	52.4	30.3	0	70	21
24/11/2014	12:00	66.9	48	53.1	32.7	0	70	21
24/11/2014	13:00	54.6	48.8	45.9	29.6	0	110	17
24/11/2014	14:00	55.1	41.9	48.2	30.2	0	90	18
24/11/2014	15:00	72.2	55.3	58.8	33	0	130	13
24/11/2014	16:00	60.7	44.7	50	37.8	0	140	9
24/11/2014	17:00	52.7	45.2	45.3	36.6	0	100	11
24/11/2014	18:00	52	42	42.5	34.1	0	200	30
24/11/2014	19:00	52.7	43.8	43.4	33.9	0	200	28
24/11/2014	20:00	49.8	47.7	46.3	43.8	0	200	21
24/11/2014	21:00	49.1	47.7	46	42.4	0	180	15
24/11/2014	22:00	48.1	46.6	43.7	36.7	0	170	13
24/11/2014	23:00	43	38.4	36.9	33.7	0	150	9
24/11/2014	0:00	36	33.2	38.2	25.1	0	150	9

Hourly Noise Level Data

12 Fewson Turn, Ellenbrook

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
25/11/2014	25/11/2014	50.8	32.2	39.2	24	0	150	5
25/11/2014	2:00	53.4	43.8	43.9	26.8	0	150	15
25/11/2014	3:00	55.1	39.6	41.6	25.7	0	90	24
25/11/2014	4:00	29.1	27	25.5	23.7	0	90	24
25/11/2014	5:00	50.8	41.4	39.6	25.5	0	90	31
25/11/2014	6:00	59.6	56.1	52.3	30.6	0	90	30
25/11/2014	7:00	60.1	58.2	55.3	41.9	0	90	33
25/11/2014	8:00	59.9	54.3	52.8	43.3	0	90	33
25/11/2014	9:00	50.7	45.5	43.4	33.3	0	100	22
25/11/2014	10:00	54.8	39.8	41.9	31.2	0	100	17
25/11/2014	11:00	53	41.9	41.1	30.7	0	130	21
25/11/2014	12:00	56.8	43.1	44.2	35.8	0	90	18
25/11/2014	13:00	61.6	40	47.5	29.6	0	90	13
25/11/2014	14:00	50.5	38.3	38.9	29	0	130	26
25/11/2014	15:00	57.7	45.8	45.2	28.4	0	100	15
25/11/2014	16:00	60.3	57.6	55.1	40.6	0	70	15
25/11/2014	17:00	53.7	53.2	50.1	39.8	0	110	15
25/11/2014	18:00	56.7	44.6	45	33.8	0	130	21
25/11/2014	19:00	61.5	51	50.2	33.6	0	140	21
25/11/2014	20:00	62.7	53.2	52.5	46	0	150	17
25/11/2014	21:00	59	48.1	48	43.4	0	120	18
25/11/2014	22:00	50.7	47	45.6	43.4	0	110	30
25/11/2014	23:00	52.2	49.5	47.5	44.4	0	110	37
25/11/2014	0:00	51.6	48.1	45.7	42.1	0	110	41
26/11/2014	26/11/2014	50.9	45.9	46	40.9	0	100	35
26/11/2014	2:00	46.4	44.7	41.3	36.3	0	100	37
26/11/2014	3:00	48.1	46	41	32.1	0	90	35
26/11/2014	4:00	51.2	39.6	40.3	32	0	90	31
26/11/2014	5:00	52	43.2	40.9	29.6	0	90	26
26/11/2014	6:00	56.9	48.3	46.3	38.2	0	100	30
26/11/2014	7:00	58.4	49.6	46.7	37.1	0	90	31
26/11/2014	8:00	54.7	46	44.2	37.8	0	90	26
26/11/2014	9:00	50.4	41.1	40.2	34.3	0	90	28
26/11/2014	10:00	55.9	42.6	42.9	33.7	0	80	28
26/11/2014	11:00	62.4	49.2	56.7	34.1	0	90	28
26/11/2014	12:00	65.4	56.9	56.3	39.1	0	80	22
26/11/2014	13:00	72.5	58	68.2	36.2	0	50	18
26/11/2014	14:00	74.3	67.2	64.8	42.5	0	100	21
26/11/2014	15:00	69.2	56.4	60.8	38.5	2.4	210	30
26/11/2014	16:00	65.6	55.8	54.1	41.3	1.4	170	21
26/11/2014	17:00	64.1	56	54.8	43.8	2.4	60	18
26/11/2014	18:00	59.6	53.7	52	46.9	2.6	90	24
26/11/2014	19:00	56.3	53.9	51.5	43.1	2.8	80	21
26/11/2014	20:00	55.8	48.6	47.1	42.2	1.8	60	24
26/11/2014	21:00	47	44.5	42.8	40.1	0.6	110	22
26/11/2014	22:00	50.3	47.6	46.2	42.7	0	120	13
26/11/2014	23:00	59.3	47.9	48.2	42.4	0.2	100	31
26/11/2014	0:00	50.3	49.1	47	43.8	0	80	26



Reference: 13122623

Table A17 – Results of Noise Logging 32 Stock Road West, Bullsbrook

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
20 November 2014	51.2	51.9	53.2	46.6
21 November 2014*	53.8	59.9	61.6	47.7
24 November 2014	50.5	52.6	53.8	47.8
25 November 2014	51.8	54.3	55.5	50.3
26 November 2014*	56.0	59.7	61.3	50.2
Weekday Average	**51.1**	**52.9**	**54.2**	**48.2**

*Day excluded from the Average due to unacceptable weather conditions.



Photograph A17 – Noise Logger at 32 Stock Road West, Bullsbrook

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 32 Stock West Road
Locality	Bullsbrook
Occupier	Cody and Diane Lambert. 0448711330
Dates	20/11/2014 to 27/11/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	Road yet to be constructed
Height of the road in relation to the ground	Road yet to be constructed
Road surface type	Road yet to be constructed
Speed zone	Road yet to be constructed
Absorbing ground	Road yet to be constructed
Angle of view	Road yet to be constructed
Road gradient	Road yet to be constructed
Traffic flow	Vehicles per day. Main Roads to provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	West
Carriageways & lanes.	Road yet to be constructed
COMMENT	
Comment	No major road traffic source currently nearby. Microphone placed on West façade at side of house. Noise is primarily weather related and local sources (dogs).
REFERENCES	
AMG Z50 E/N	
Road name	Future Tonkin Highway
EXCEL file	32 Stock West Rd MRWA Logger Sheet.xlsx
Raw data file	32 Stock West Rd_Sta.csv
EQUIPMENT	
Analyser number	16-004-041
Microphone number	16-004-041
Calibrator number	34883971
Calibrator values	94.2, 94.2
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Pearce RAAF Data 20/11/14 - Pos Winds >18 km/h for 12 hours of day, rest of day calm 21/11/14 - 4 hours neg Winds <11 km/h, rest of day Pos winds <24km/h 24/11/14 - Var Winds <18 km/h, 6 hours above 21 km/h 25/11/14 - Neg Winds; morning 15 to 33 km/h, Afternoon 13-40 km/h 26/11/14 - Neg high winds all day, over 18km/h, Evening Rain

Hourly Noise Level Data

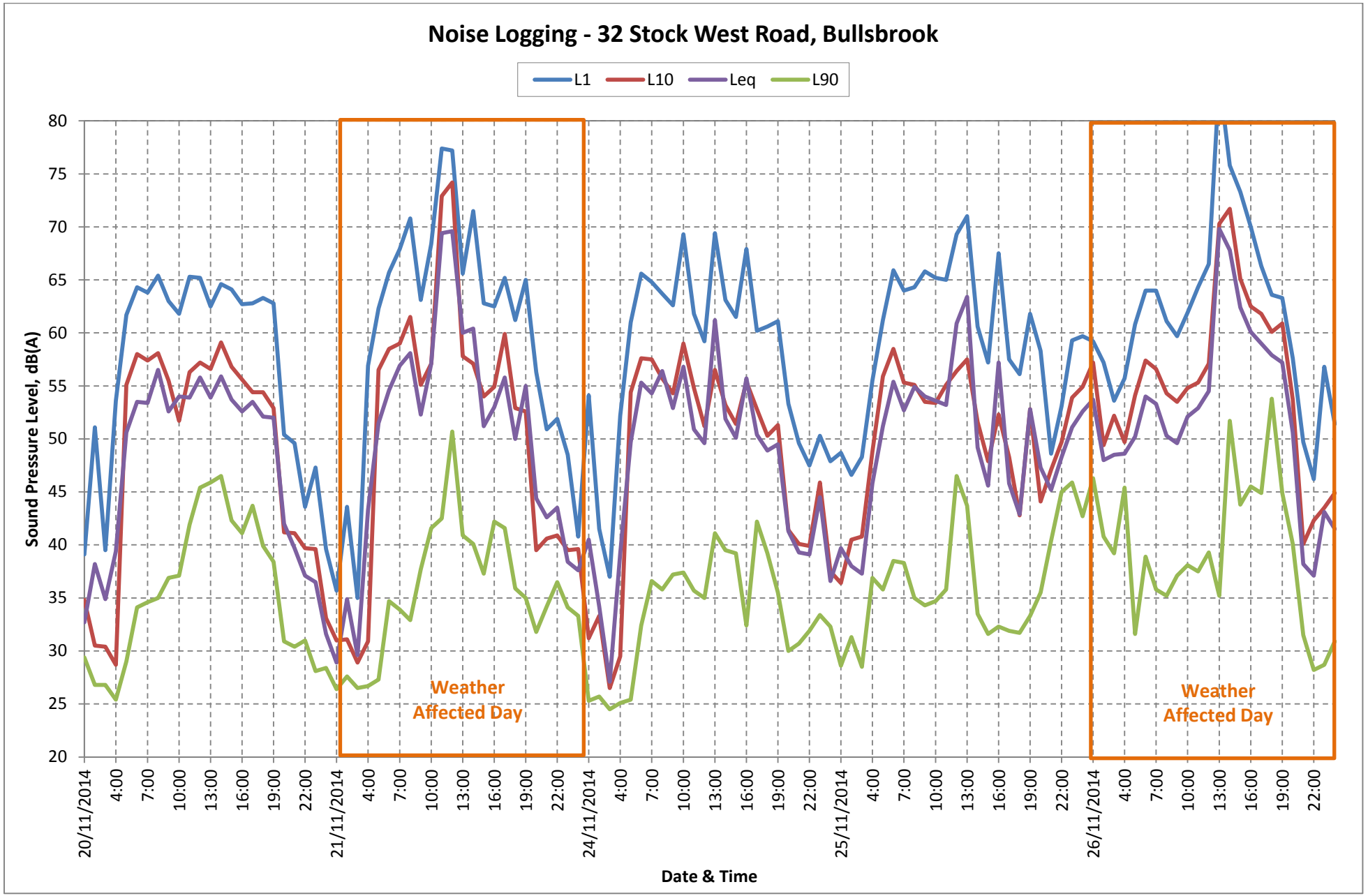
32 Stock West Road, Bullsbrook

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
20/11/2014	20/11/2014	39.1	34.8	32.7	29.4	0	0	0
20/11/2014	2:00	51.1	30.5	38.2	26.8	0	350	4
20/11/2014	3:00	39.5	30.4	34.9	26.8	0	90	4
20/11/2014	4:00	53.6	28.7	39.4	25.4	0	350	5
20/11/2014	5:00	61.7	55.1	50.6	29	0	10	5
20/11/2014	6:00	64.3	58	53.5	34.1	0	0	0
20/11/2014	7:00	63.8	57.4	53.4	34.6	0	340	9
20/11/2014	8:00	65.4	58.1	56.5	35	0	340	17
20/11/2014	9:00	63	55.5	52.6	36.9	0	290	24
20/11/2014	10:00	61.8	51.7	54	37.1	0	310	28
20/11/2014	11:00	65.3	56.3	53.9	41.9	0	310	26
20/11/2014	12:00	65.2	57.2	55.8	45.4	0	300	31
20/11/2014	13:00	62.5	56.6	53.9	45.9	0	280	31
20/11/2014	14:00	64.6	59.1	55.9	46.5	0	260	35
20/11/2014	15:00	64.1	56.8	53.7	42.3	0	280	22
20/11/2014	16:00	62.7	55.6	52.6	41.1	0	280	28
20/11/2014	17:00	62.8	54.4	53.5	43.7	0	280	28
20/11/2014	18:00	63.3	54.4	52.1	39.9	0	260	26
20/11/2014	19:00	62.8	52.9	52	38.4	0	260	18
20/11/2014	20:00	50.4	41.2	42	30.9	0	320	9
20/11/2014	21:00	49.6	41.1	39.7	30.4	0	340	9
20/11/2014	22:00	43.6	39.7	37.1	31	0	360	11
20/11/2014	23:00	47.3	39.6	36.5	28.1	0	350	13
20/11/2014	0:00	39.6	33.1	31.6	28.4	0	340	8
21/11/2014	21/11/2014	35.7	31	28.9	26.4	0	350	13
21/11/2014	2:00	43.6	31.1	34.9	27.6	0	360	13
21/11/2014	3:00	35	28.9	29.6	26.5	0	10	11
21/11/2014	4:00	56.9	30.9	43.3	26.7	0	10	11
21/11/2014	5:00	62.3	56.5	51.5	27.3	0	10	11
21/11/2014	6:00	65.7	58.5	54.6	34.7	0	350	15
21/11/2014	7:00	67.9	59	56.9	33.9	0	340	17
21/11/2014	8:00	70.8	61.5	58.1	32.9	0	220	24
21/11/2014	9:00	63.1	55.1	52.3	37.7	0	230	24
21/11/2014	10:00	68.4	57.1	57.1	41.6	0	250	22
21/11/2014	11:00	77.4	72.9	69.4	42.5	0	250	21
21/11/2014	12:00	77.2	74.2	69.6	50.7	0	220	22
21/11/2014	13:00	65.6	57.8	60	40.9	0	230	21
21/11/2014	14:00	71.5	57.1	60.4	40.1	0	230	22
21/11/2014	15:00	62.8	54	51.2	37.3	0	230	21
21/11/2014	16:00	62.5	54.9	53	42.2	0	260	31
21/11/2014	17:00	65.2	59.9	55.8	41.6	0	220	22
21/11/2014	18:00	61.2	52.9	50	35.9	0	250	21
21/11/2014	19:00	65	52.6	55	35	0	240	17
21/11/2014	20:00	56.3	39.5	44.4	31.8	0	230	9
21/11/2014	21:00	50.9	40.6	42.6	34.2	0	270	8
21/11/2014	22:00	51.9	40.9	43.5	36.5	0	340	8
21/11/2014	23:00	48.5	39.5	38.4	34.1	0	350	5
21/11/2014	0:00	40.8	39.6	37.6	33.3	0	360	8
24/11/2014	24/11/2014	54.1	31.2	40.5	25.3	0	180	11
24/11/2014	2:00	41.5	33.3	34.2	25.7	0	180	13
24/11/2014	3:00	37	26.5	27.1	24.5	0	170	13
24/11/2014	4:00	52.2	29.5	39.2	25.1	0	170	15
24/11/2014	5:00	61	54.4	49.7	25.4	0	170	15
24/11/2014	6:00	65.6	57.6	55.3	32.4	0	200	8
24/11/2014	7:00	64.8	57.5	54.3	36.6	0	170	9
24/11/2014	8:00	63.7	55.7	56.4	35.8	0	120	11
24/11/2014	9:00	62.6	54.3	52.9	37.2	0	90	28
24/11/2014	10:00	69.3	59	56.8	37.4	0	70	13
24/11/2014	11:00	61.8	54.8	50.9	35.7	0	70	21
24/11/2014	12:00	59.2	51.2	49.6	35	0	70	21
24/11/2014	13:00	69.4	56.5	61.2	41.1	0	110	17
24/11/2014	14:00	63.1	53.2	51.9	39.5	0	90	18
24/11/2014	15:00	61.5	51.4	50.1	39.2	0	130	13
24/11/2014	16:00	67.9	55.4	55.7	32.4	0	140	9
24/11/2014	17:00	60.2	52.8	50.4	42.2	0	100	11
24/11/2014	18:00	60.6	50.3	48.9	39.2	0	200	30
24/11/2014	19:00	61.1	51.3	49.5	35.5	0	200	28
24/11/2014	20:00	53.3	41.4	41.3	30	0	200	21
24/11/2014	21:00	49.6	40.1	39.3	30.7	0	180	15
24/11/2014	22:00	47.5	39.9	39.1	31.9	0	170	13
24/11/2014	23:00	50.3	45.9	44.5	33.4	0	150	9
24/11/2014	0:00	47.9	37.5	36.6	32.3	0	150	9

Hourly Noise Level Data

32 Stock West Road, Bullsbrook

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
25/11/2014	25/11/2014	48.7	36.4	39.7	28.6	0	150	5
25/11/2014	2:00	46.6	40.5	38	31.3	0	150	15
25/11/2014	3:00	48.3	40.8	37.3	28.5	0	90	24
25/11/2014	4:00	55.5	48.8	45.8	36.9	0	90	24
25/11/2014	5:00	61.2	55.9	51.2	35.8	0	90	31
25/11/2014	6:00	65.9	58.5	55.4	38.5	0	90	30
25/11/2014	7:00	64	55.3	52.7	38.3	0	90	33
25/11/2014	8:00	64.3	55.1	54.9	35	0	90	33
25/11/2014	9:00	65.8	53.5	54	34.3	0	100	22
25/11/2014	10:00	65.2	53.4	53.6	34.7	0	100	17
25/11/2014	11:00	65	55.1	53.2	35.8	0	130	21
25/11/2014	12:00	69.3	56.4	60.9	46.5	0	90	18
25/11/2014	13:00	71	57.5	63.4	43.7	0	90	13
25/11/2014	14:00	60.6	51.6	49.2	33.5	0	130	26
25/11/2014	15:00	57.2	47.9	45.6	31.6	0	100	15
25/11/2014	16:00	67.5	52.3	57.2	32.3	0	70	15
25/11/2014	17:00	57.5	48.3	45.8	31.9	0	110	15
25/11/2014	18:00	56.1	42.8	42.9	31.7	0	130	21
25/11/2014	19:00	61.8	52.8	52.8	33.3	0	140	21
25/11/2014	20:00	58.3	44.1	47.3	35.5	0	150	17
25/11/2014	21:00	48.6	47.1	45.2	40.4	0	120	18
25/11/2014	22:00	53.1	49.7	48.3	45	0	110	30
25/11/2014	23:00	59.3	53.9	51.1	45.9	0	110	37
25/11/2014	0:00	59.7	54.9	52.6	42.7	0	110	41
26/11/2014	26/11/2014	59.2	57.2	53.7	46.3	0	100	35
26/11/2014	2:00	57.2	49.4	48	40.8	0	100	37
26/11/2014	3:00	53.6	52.2	48.5	39.2	0	90	35
26/11/2014	4:00	55.7	49.7	48.6	45.4	0	90	31
26/11/2014	5:00	60.8	54.1	50.2	31.6	0	90	26
26/11/2014	6:00	64	57.4	54	38.9	0	100	30
26/11/2014	7:00	64	56.6	53.3	35.8	0	90	31
26/11/2014	8:00	61.1	54.3	50.3	35.2	0	90	26
26/11/2014	9:00	59.7	53.5	49.6	37.1	0	90	28
26/11/2014	10:00	61.9	54.8	52.1	38.1	0	80	28
26/11/2014	11:00	64.3	55.3	52.9	37.5	0	90	28
26/11/2014	12:00	66.5	57.1	54.5	39.3	0	80	22
26/11/2014	13:00	84	70.3	69.8	35.2	0	50	18
26/11/2014	14:00	75.8	71.7	67.8	51.7	0	100	21
26/11/2014	15:00	73.3	65.1	62.4	43.8	2.4	210	30
26/11/2014	16:00	70	62.5	60.1	45.5	1.4	170	21
26/11/2014	17:00	66.3	61.8	59	44.9	2.4	60	18
26/11/2014	18:00	63.6	60.1	57.9	53.8	2.6	90	24
26/11/2014	19:00	63.3	60.9	57.2	44.9	2.8	80	21
26/11/2014	20:00	57.6	53.7	50.6	40.1	1.8	60	24
26/11/2014	21:00	49.7	40.1	38.2	31.5	0.6	110	22
26/11/2014	22:00	46.2	42.3	37.1	28.2	0	120	13
26/11/2014	23:00	56.8	43.5	43.1	28.7	0.2	100	31
26/11/2014	0:00	51.4	44.9	41.5	30.9	0	80	26



Reference: 13122623

Table A18 – Results of Noise Logging 144 Strachan Road, Bullsbrook

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
20 November 2014	45.3	47.6	48.4	45.2
21 November 2014	44.6	45.3	46.8	37.4
24 November 2014	45.4	47.8	48.0	47.5
25 November 2014	47.0	46.4	47.5	42.6
26 November 2014*	54.5	59.6	61.4	44.2
Weekday Average	**45.6**	**46.8**	**47.7**	**43.2**

*Day excluded from the Average due to unacceptable weather conditions.



Photograph A18 – Noise Logger at 144 Strachan Road, Bullsbrook

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 144 Strachan Road
Locality	Bullsbrook
Occupier	Bill Hayes 0407 443 856
Dates	20/11/2014 to 27/11/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	Road yet to be constructed
Height of the road in relation to the ground	Road yet to be constructed
Road surface type	Road yet to be constructed
Speed zone	Road yet to be constructed
Absorbing ground	Road yet to be constructed
Angle of view	Road yet to be constructed
Road gradient	Road yet to be constructed
Traffic flow	Vehicles per day. Main Roads to provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	West
Carriageways & lanes.	Road yet to be constructed
COMMENT	
Comment	No major road traffic source nearby. Microphone placed on West façade at Side of house. Noise is primarily weather related and ambient/livestock. Solid verandah wraps around entire dwelling. Microphone placed under verandah.
REFERENCES	
AMG Z50 E/N	
Road name	Future Tonkin Highway
EXCEL file	144 Strachan Rd MRWA Logger Sheet.xlsx
Raw data file	144 Stachan Rd Bullsbrook_Sta.csv
EQUIPMENT	
Analyser number	15-203-505
Microphone number	15-203-505
Calibrator number	34883971
Calibrator values	94.1, 94.0
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Pearce RAAF Data 20/11/14 - Pos Winds >18 km/h for 12 hours of day, rest of day calm 21/11/14 - 4 hours neg Winds <11 km/h, rest of day Pos winds <24km/h 24/11/14 - Var Winds <18 km/h, 6 hours above 21 km/h 25/11/14 - Neg Winds; morning 15 to 33 km/h, Afternoon 13-40 km/h 26/11/14 - Neg high winds all day, over 18km/h, Evening Rain

Hourly Noise Level Data

144 Strachan Road, Bullsbrook

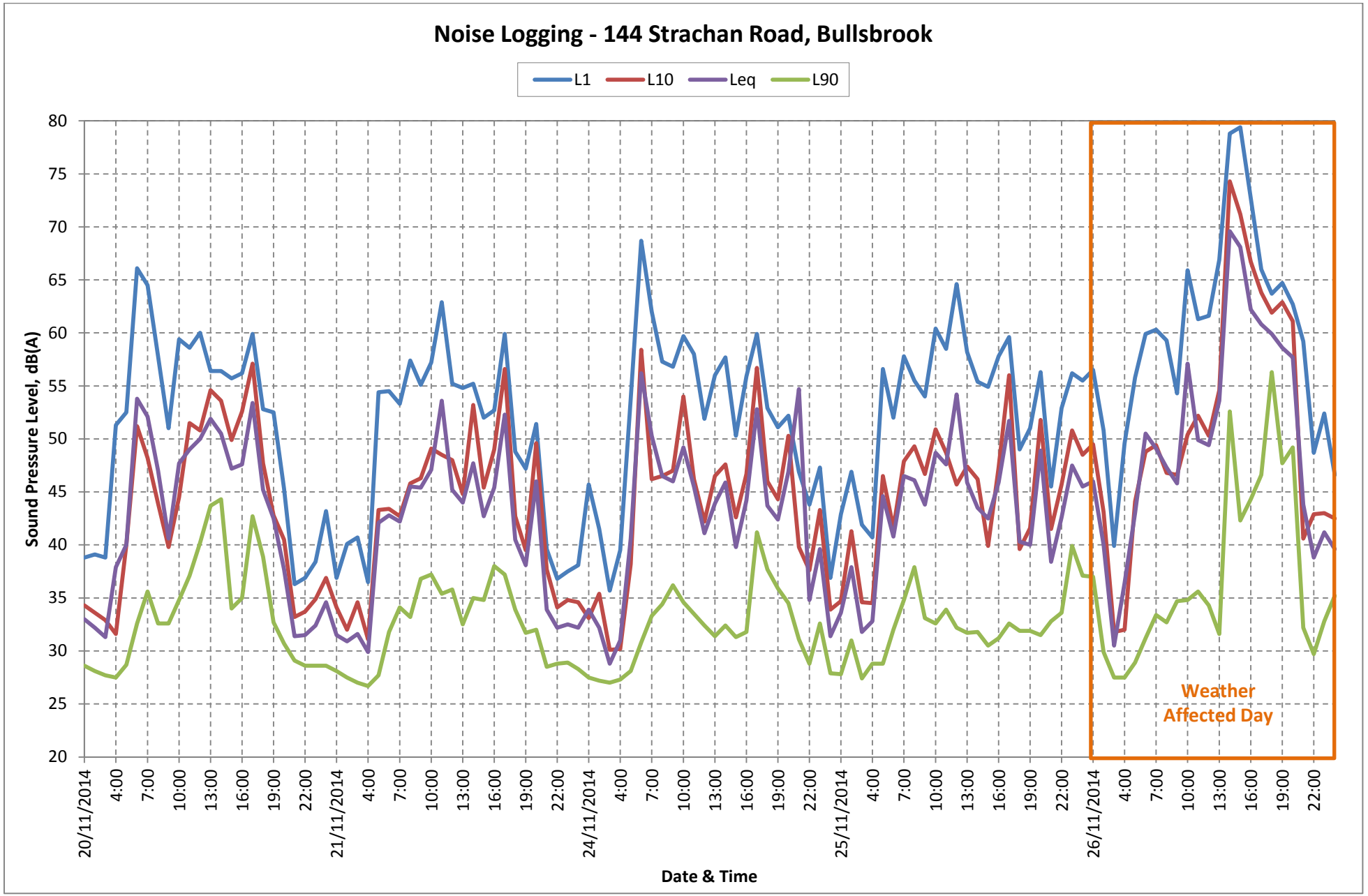
Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
20/11/2014	20/11/2014	38.8	34.3	33	28.6	0	0	0
20/11/2014	2:00	39.1	33.6	32.2	28.1	0	350	4
20/11/2014	3:00	38.8	32.9	31.3	27.7	0	90	4
20/11/2014	4:00	51.3	31.6	37.9	27.5	0	350	5
20/11/2014	5:00	52.5	40	40	28.7	0	10	5
20/11/2014	6:00	66.1	51.2	53.8	32.6	0	0	0
20/11/2014	7:00	64.5	48.2	52.1	35.6	0	340	9
20/11/2014	8:00	57.8	43.9	47	32.6	0	340	17
20/11/2014	9:00	51	39.8	40.6	32.6	0	290	24
20/11/2014	10:00	59.4	44.5	47.7	34.8	0	310	28
20/11/2014	11:00	58.6	51.5	49	37.1	0	310	26
20/11/2014	12:00	60	50.8	50	40.2	0	300	31
20/11/2014	13:00	56.4	54.6	51.9	43.7	0	280	31
20/11/2014	14:00	56.4	53.6	50.5	44.3	0	260	35
20/11/2014	15:00	55.7	49.9	47.2	34	0	280	22
20/11/2014	16:00	56.2	52.6	47.6	35	0	280	28
20/11/2014	17:00	59.9	57.1	53.4	42.7	0	280	28
20/11/2014	18:00	52.8	47.7	45.2	38.9	0	260	26
20/11/2014	19:00	52.5	42.8	42.5	32.7	0	260	18
20/11/2014	20:00	45.3	40.5	37.7	30.7	0	320	9
20/11/2014	21:00	36.3	33.2	31.4	29.1	0	340	9
20/11/2014	22:00	36.9	33.7	31.5	28.6	0	360	11
20/11/2014	23:00	38.4	34.9	32.4	28.6	0	350	13
20/11/2014	0:00	43.2	36.9	34.6	28.6	0	340	8
21/11/2014	21/11/2014	36.9	34.1	31.5	28.1	0	350	13
21/11/2014	2:00	40.1	32	30.9	27.5	0	360	13
21/11/2014	3:00	40.7	34.6	31.6	27	0	10	11
21/11/2014	4:00	36.5	31.1	29.9	26.7	0	10	11
21/11/2014	5:00	54.4	43.3	42.1	27.7	0	10	11
21/11/2014	6:00	54.5	43.4	42.8	31.8	0	350	15
21/11/2014	7:00	53.3	42.7	42.2	34.1	0	340	17
21/11/2014	8:00	57.4	45.8	45.5	33.2	0	220	24
21/11/2014	9:00	55.1	46.3	45.4	36.8	0	230	24
21/11/2014	10:00	57.2	49.1	47.1	37.2	0	250	22
21/11/2014	11:00	62.9	48.5	53.6	35.4	0	250	21
21/11/2014	12:00	55.2	48	45.2	35.8	0	220	22
21/11/2014	13:00	54.8	44.8	44	32.5	0	230	21
21/11/2014	14:00	55.2	53.2	47.7	35	0	230	22
21/11/2014	15:00	52	45.4	42.7	34.8	0	230	21
21/11/2014	16:00	52.7	49	45.4	38	0	260	31
21/11/2014	17:00	59.9	56.6	52.3	37.2	0	220	22
21/11/2014	18:00	48.8	42.7	40.5	33.9	0	250	21
21/11/2014	19:00	47.2	39.5	38.1	31.7	0	240	17
21/11/2014	20:00	51.4	49.6	46	32	0	230	9
21/11/2014	21:00	39.6	37.7	33.9	28.5	0	270	8
21/11/2014	22:00	36.8	34.1	32.2	28.8	0	340	8
21/11/2014	23:00	37.5	34.8	32.5	28.9	0	350	5
21/11/2014	0:00	38.1	34.6	32.2	28.3	0	360	8
24/11/2014	24/11/2014	45.7	33.1	33.9	27.5	0	180	11
24/11/2014	2:00	41.5	35.4	32.2	27.2	0	180	13
24/11/2014	3:00	35.7	30.1	28.8	27	0	170	13
24/11/2014	4:00	39.5	30.2	31	27.3	0	170	15
24/11/2014	5:00	53.8	38.2	40.6	28.1	0	170	15
24/11/2014	6:00	68.7	58.4	56.2	30.8	0	200	8
24/11/2014	7:00	62	46.2	50.3	33.3	0	170	9
24/11/2014	8:00	57.3	46.5	46.5	34.4	0	120	11
24/11/2014	9:00	56.8	47	46	36.2	0	90	28
24/11/2014	10:00	59.7	54	49.2	34.6	0	70	13
24/11/2014	11:00	58	46.2	45.5	33.5	0	70	21
24/11/2014	12:00	51.9	42.2	41.1	32.4	0	70	21
24/11/2014	13:00	56	46.5	43.9	31.4	0	110	17
24/11/2014	14:00	57.7	47.6	45.9	32.4	0	90	18
24/11/2014	15:00	50.3	42.6	39.8	31.3	0	130	13
24/11/2014	16:00	55.9	46.7	44.2	31.8	0	140	9
24/11/2014	17:00	59.9	56.7	52.8	41.2	0	100	11
24/11/2014	18:00	52.9	46	43.7	37.7	0	200	30
24/11/2014	19:00	51.1	44.3	42.4	35.9	0	200	28
24/11/2014	20:00	52.2	50.3	46.9	34.5	0	200	21
24/11/2014	21:00	46.9	39.8	54.7	31.1	0	180	15
24/11/2014	22:00	43.8	37.6	34.8	28.8	0	170	13
24/11/2014	23:00	47.3	43.3	39.6	32.6	0	150	9
24/11/2014	0:00	36.9	33.9	31.4	27.9	0	150	9

Reference: 13122623

Hourly Noise Level Data

144 Strachan Road, Bullsbrook

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
25/11/2014	25/11/2014	42.9	34.7	33.6	27.8	0	150	5
25/11/2014	2:00	46.9	41.3	37.9	31	0	150	15
25/11/2014	3:00	41.9	34.6	31.8	27.4	0	90	24
25/11/2014	4:00	40.7	34.5	32.8	28.8	0	90	24
25/11/2014	5:00	56.6	46.5	44.6	28.8	0	90	31
25/11/2014	6:00	52	41.6	40.8	32	0	90	30
25/11/2014	7:00	57.8	47.9	46.5	34.8	0	90	33
25/11/2014	8:00	55.5	49.3	46.1	37.9	0	90	33
25/11/2014	9:00	54	46.7	43.8	33.1	0	100	22
25/11/2014	10:00	60.4	50.9	48.7	32.6	0	100	17
25/11/2014	11:00	58.5	48.7	47.6	33.9	0	130	21
25/11/2014	12:00	64.6	45.7	54.2	32.2	0	90	18
25/11/2014	13:00	58.2	47.4	45.9	31.7	0	90	13
25/11/2014	14:00	55.4	46.2	43.5	31.8	0	130	26
25/11/2014	15:00	54.9	39.9	42.5	30.5	0	100	15
25/11/2014	16:00	57.8	47.3	45.9	31.2	0	70	15
25/11/2014	17:00	59.6	56	51.7	32.6	0	110	15
25/11/2014	18:00	49	39.6	40.3	31.9	0	130	21
25/11/2014	19:00	51	41.6	40	31.9	0	140	21
25/11/2014	20:00	56.3	51.8	48.9	31.5	0	150	17
25/11/2014	21:00	45.5	41.5	38.4	32.8	0	120	18
25/11/2014	22:00	52.9	45.7	42.6	33.6	0	110	30
25/11/2014	23:00	56.2	50.8	47.5	39.9	0	110	37
25/11/2014	0:00	55.5	48.5	45.5	37.1	0	110	41
26/11/2014	26/11/2014	56.5	49.5	46	37	0	100	35
26/11/2014	2:00	50.8	43.1	40	29.9	0	100	37
26/11/2014	3:00	39.9	31.8	30.5	27.5	0	90	35
26/11/2014	4:00	49.6	32	36.4	27.5	0	90	31
26/11/2014	5:00	55.8	44.1	43	28.9	0	90	26
26/11/2014	6:00	59.9	48.8	50.5	31.2	0	100	30
26/11/2014	7:00	60.3	49.4	49.1	33.4	0	90	31
26/11/2014	8:00	59.3	46.8	47.3	32.7	0	90	26
26/11/2014	9:00	54.3	46.6	45.8	34.7	0	90	28
26/11/2014	10:00	65.9	50.4	57.1	34.8	0	80	28
26/11/2014	11:00	61.3	52.2	49.9	35.6	0	90	28
26/11/2014	12:00	61.6	50.3	49.4	34.3	0	80	22
26/11/2014	13:00	66.9	54.6	53.6	31.6	0	50	18
26/11/2014	14:00	78.8	74.3	69.6	52.6	0	100	21
26/11/2014	15:00	79.4	71.2	68.1	42.3	2.4	210	30
26/11/2014	16:00	72.7	66.7	62.2	44.3	1.4	170	21
26/11/2014	17:00	66	63.8	60.8	46.6	2.4	60	18
26/11/2014	18:00	63.7	61.9	59.9	56.3	2.6	90	24
26/11/2014	19:00	64.7	62.9	58.6	47.7	2.8	80	21
26/11/2014	20:00	62.7	61.1	57.7	49.2	1.8	60	24
26/11/2014	21:00	59.2	40.6	43.8	32.2	0.6	110	22
26/11/2014	22:00	48.7	42.9	38.8	29.7	0	120	13
26/11/2014	23:00	52.4	43	41.2	32.8	0.2	100	31
26/11/2014	0:00	46.6	42.5	39.6	35.2	0	80	26



Reference: 13122623

Table A19 – Results of Noise Logging 591 Muchea South Road, Muchea

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
20 November 2014	51.6	50.3	51.3	46.8
21 November 2014*	49.9	55.3	56.8	48.2
24 November 2014	51.1	49.8	49.9	49.6
25 November 2014	53.6	51.1	51.0	51.3
26 November 2014*	55.6	55.0	55.3	54.3
Weekday Average	**52.1**	**50.4**	**50.7**	**49.3**

*Day excluded from the Average due to unacceptable weather conditions.



Photograph A19 – Noise Logger at 591 Muchea South Road, Muchea

Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth-Darwin Highway NorthlinkWA
Street address	No. 591 Muchea South Road
Locality	Ballajura
Occupier	Pam and Ian Taylor, 0418480117 & 0409480117
Dates	20/11/2014 to 27/11/2014.
Category	*Main Roads will provide this information if required.*
SITE	
Distance from the microphone to the kerb	125m to Muchea South Road
Height of the road in relation to the ground	+0m
Road surface type	DGA
Speed zone	60 km/h
Absorbing ground	80%
Angle of view	170
Road gradient	Flat
Traffic flow	Vehicles per day. Main Roads to provide this information
Heavy vehicles	Percentage. Main Roads to provide this information
House-Road orientation.	East
Carriageways & lanes.	2,5
COMMENT	
Comment	Microphone placed on East façade at Front of house Freight Rail line is at 160m from Microphone (in same direction as road) Rail movements are audible from microphone.
REFERENCES	
AMG Z50 E/N	
Road name	Muchea South Road
EXCEL file	591 Muchea Rd MRWA Logger Sheet.xlsx
Raw data file	591 Muchea Rd_Sta.csv
EQUIPMENT	
Analyser number	16-707-043
Microphone number	16-707-043
Calibrator number	34883971
Calibrator values	94.0,94.1
Operator	Lloyd George Acoustics Pty Ltd - Matt Moyle
WEATHER	
Wind	Wind acceptability based on Pearce RAAF Data 20/11/14 - Neg Winds >18 km/h for 12 hours of day, rest of day calm 21/11/14 - 4 hours pos Winds <11 km/h, rest of day Neg winds <24km/h 24/11/14 - Var Winds <18 km/h, 6 hours above 21 km/h 25/11/14 - Pos Winds; morning 15 to 33 km/h, Afternoon 13-40 km/h 26/11/14 - Pos high winds all day, over 18km/h, Evening Rain

Hourly Noise Level Data

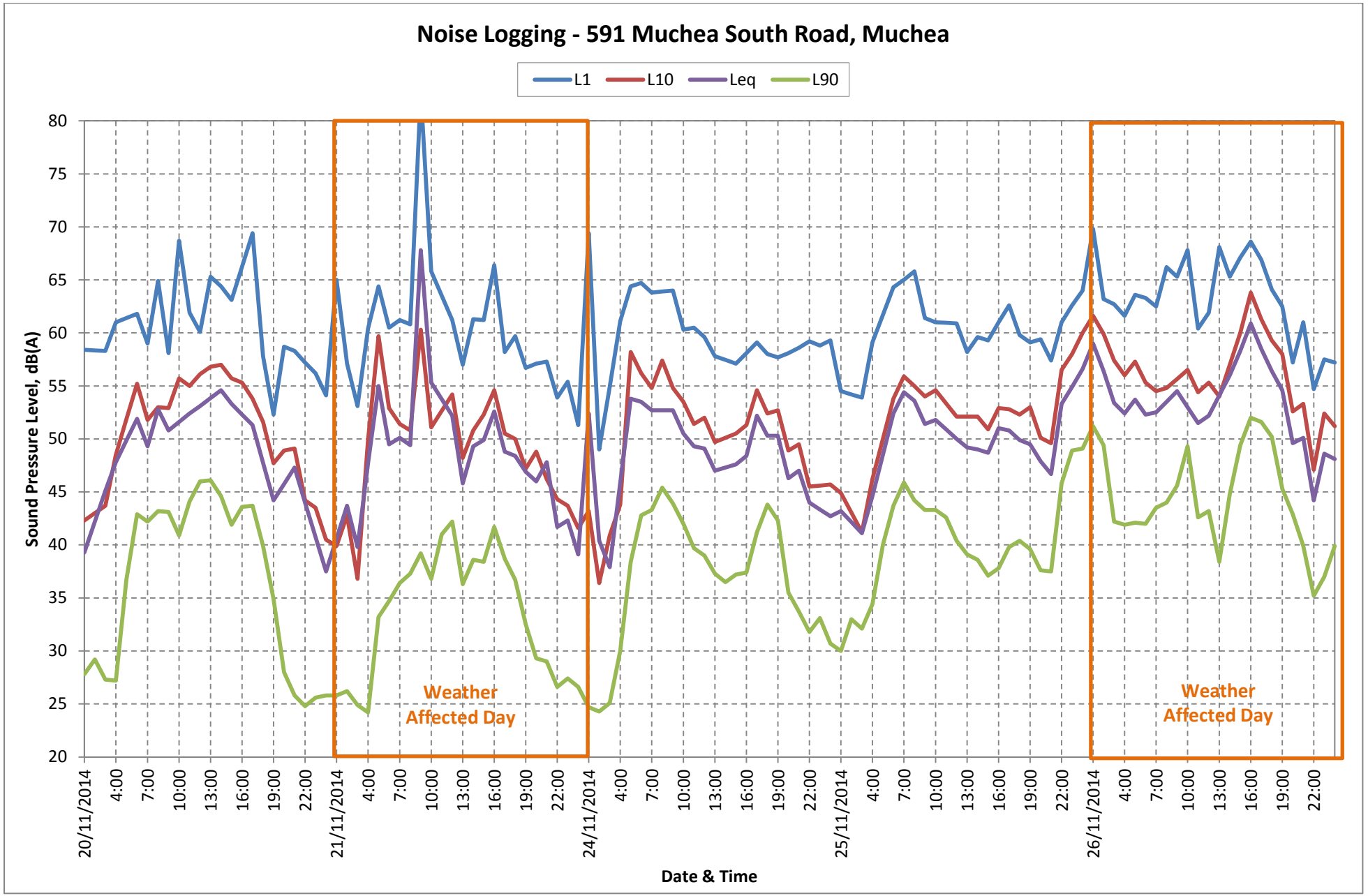
591 Muchea South Road, Muchea

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
20/11/2014	20/11/2014	58.4	42.3	***39.3***	27.8	0	0	0
20/11/2014	2:00	***58.4***	***43.0***	***42.2***	29.2	0	350	4
20/11/2014	3:00	58.3	43.7	45.1	27.3	0	90	4
20/11/2014	4:00	61	48.5	47.8	27.2	0	350	5
20/11/2014	5:00	***61.4***	***51.9***	***49.9***	36.7	0	10	5
20/11/2014	6:00	61.8	55.2	51.9	42.9	0	0	0
20/11/2014	7:00	59	51.8	49.3	42.2	0	340	9
20/11/2014	8:00	64.9	53	52.8	43.2	0	340	17
20/11/2014	9:00	58.1	52.9	50.8	43.1	0	290	24
20/11/2014	10:00	68.7	55.7	***51.6***	40.9	0	310	28
20/11/2014	11:00	61.9	55	52.4	44.1	0	310	26
20/11/2014	12:00	60.1	56.1	53.1	46	0	300	31
20/11/2014	13:00	65.3	56.8	***53.9***	46.1	0	280	31
20/11/2014	14:00	64.4	57	54.6	44.6	0	260	35
20/11/2014	15:00	63.1	55.7	53.3	41.9	0	280	22
20/11/2014	16:00	***66.3***	55.3	***52.3***	43.6	0	280	28
20/11/2014	17:00	69.4	53.8	***51.3***	43.7	0	280	28
20/11/2014	18:00	57.8	51.6	***47.8***	39.9	0	260	26
20/11/2014	19:00	52.3	47.7	44.2	34.9	0	260	18
20/11/2014	20:00	58.7	48.9	***45.8***	28	0	320	9
20/11/2014	21:00	58.3	49.1	47.3	25.8	0	340	9
20/11/2014	22:00	57.2	44.2	44	24.8	0	360	11
20/11/2014	23:00	56.2	43.5	***40.8***	25.6	0	350	13
20/11/2014	0:00	54.1	40.5	37.5	25.8	0	340	8
21/11/2014	21/11/2014	65	39.9	***40.6***	25.8	0	350	13
21/11/2014	2:00	57.1	42.8	43.7	26.2	0	360	13
21/11/2014	3:00	53.1	36.8	39.8	24.9	0	10	11
21/11/2014	4:00	60.4	49.9	47.7	24.2	0	10	11
21/11/2014	5:00	64.4	59.7	55	33.2	0	10	11
21/11/2014	6:00	60.5	52.9	49.5	34.7	0	350	15
21/11/2014	7:00	61.2	51.4	50.1	36.4	0	340	17
21/11/2014	8:00	60.8	50.8	49.4	37.3	0	220	24
21/11/2014	9:00	82.7	60.3	67.8	39.2	0	230	24
21/11/2014	10:00	65.8	51.1	55.3	36.8	0	250	22
21/11/2014	11:00	***63.5***	***52.7***	***53.8***	41	0	250	21
21/11/2014	12:00	61.2	54.2	52.2	42.2	0	220	22
21/11/2014	13:00	57	48.2	45.8	36.3	0	230	21
21/11/2014	14:00	61.3	50.8	49.3	38.6	0	230	22
21/11/2014	15:00	61.2	52.3	49.9	38.4	0	230	21
21/11/2014	16:00	66.4	54.6	***52.6***	41.7	0	260	31
21/11/2014	17:00	58.2	50.5	48.8	38.7	0	220	22
21/11/2014	18:00	59.7	50	48.4	36.7	0	250	21
21/11/2014	19:00	56.7	47.2	46.9	32.5	0	240	17
21/11/2014	20:00	57.1	48.8	46	29.3	0	230	9
21/11/2014	21:00	57.3	46.2	47.8	29	0	270	8
21/11/2014	22:00	53.9	44.3	41.7	26.6	0	340	8
21/11/2014	23:00	55.4	43.7	42.3	27.4	0	350	5
21/11/2014	0:00	51.3	41.6	39.1	26.6	0	360	8
24/11/2014	24/11/2014	69.4	43.2	52.4	24.7	0	180	11
24/11/2014	2:00	49	36.4	40.4	24.3	0	180	13
24/11/2014	3:00	54.9	40.9	37.9	25.1	0	170	13
24/11/2014	4:00	61.1	43.8	***45.9***	30	0	170	15
24/11/2014	5:00	64.4	58.2	53.8	38.4	0	170	15
24/11/2014	6:00	64.7	56.2	53.5	42.8	0	200	8
24/11/2014	7:00	63.8	54.8	52.7	43.3	0	170	9
24/11/2014	8:00	***63.9***	57.4	***52.7***	45.4	0	120	11
24/11/2014	9:00	64	54.8	52.7	43.9	0	90	28
24/11/2014	10:00	60.3	53.5	50.5	42	0	70	13
24/11/2014	11:00	60.5	51.4	49.3	39.7	0	70	21
24/11/2014	12:00	59.6	52	49.1	39	0	70	21
24/11/2014	13:00	57.8	49.7	47	37.3	0	110	17
24/11/2014	14:00	***57.5***	***50.1***	***47.3***	36.5	0	90	18
24/11/2014	15:00	57.1	50.5	47.6	37.2	0	130	13
24/11/2014	16:00	58.1	51.3	48.4	37.4	0	140	9
24/11/2014	17:00	59.1	54.6	52.2	41.2	0	100	11
24/11/2014	18:00	58	52.4	50.3	43.8	0	200	30
24/11/2014	19:00	57.7	52.7	50.3	42.3	0	200	28
24/11/2014	20:00	58.1	48.9	46.3	35.5	0	200	21
24/11/2014	21:00	58.6	49.5	47	33.7	0	180	15
24/11/2014	22:00	59.2	45.5	***44***	31.8	0	170	13
24/11/2014	23:00	58.8	***45.6***	***43.4***	33.1	0	150	9
24/11/2014	0:00	59.3	45.7	***42.7***	30.7	0	150	9

Hourly Noise Level Data

591 Muchea South Road, Muchea

Date	Time	L1	L10	Leq	L90	Rain mm	Wind degrees	Wind km/h
25/11/2014	25/11/2014	54.5	44.9	43.2	30	0	150	5
25/11/2014	2:00	***54.2***	***43.1***	***42.2***	33	0	150	15
25/11/2014	3:00	53.9	41.2	41.1	32.1	0	90	24
25/11/2014	4:00	59.1	46.2	***44.6***	34.4	0	90	24
25/11/2014	5:00	***61.7***	***50.0***	***48.5***	40	0	90	31
25/11/2014	6:00	64.3	53.8	52.4	43.7	0	90	30
25/11/2014	7:00	65	55.9	54.4	45.9	0	90	33
25/11/2014	8:00	65.8	55	53.6	44.2	0	90	33
25/11/2014	9:00	61.4	54	51.4	43.3	0	100	22
25/11/2014	10:00	61	54.6	51.8	43.3	0	100	17
25/11/2014	11:00	***61.0***	***53.4***	***50.9***	42.6	0	130	21
25/11/2014	12:00	60.9	52.1	50	40.4	0	90	18
25/11/2014	13:00	58.2	52.1	49.2	39.1	0	90	13
25/11/2014	14:00	59.6	52.1	49	38.6	0	130	26
25/11/2014	15:00	59.3	50.9	48.7	37.1	0	100	15
25/11/2014	16:00	61	52.9	51	37.8	0	70	15
25/11/2014	17:00	62.6	52.8	50.8	39.8	0	110	15
25/11/2014	18:00	59.8	52.3	49.9	40.4	0	130	21
25/11/2014	19:00	59.1	53	49.5	39.6	0	140	21
25/11/2014	20:00	59.4	50.1	47.9	37.6	0	150	17
25/11/2014	21:00	57.4	49.6	46.7	37.5	0	120	18
25/11/2014	22:00	61	56.5	53.3	45.8	0	110	30
25/11/2014	23:00	62.6	58	54.9	48.9	0	110	37
25/11/2014	0:00	64	60	56.6	49.1	0	110	41
26/11/2014	26/11/2014	69.8	61.6	59	51.2	0	100	35
26/11/2014	2:00	63.2	59.9	56.4	49.4	0	100	37
26/11/2014	3:00	62.7	57.4	53.4	42.2	0	90	35
26/11/2014	4:00	61.6	56	52.4	41.9	0	90	31
26/11/2014	5:00	63.6	57.3	53.7	42.1	0	90	26
26/11/2014	6:00	63.3	55.3	52.3	42	0	100	30
26/11/2014	7:00	62.5	54.5	52.5	43.5	0	90	31
26/11/2014	8:00	66.2	54.8	***53.5***	44	0	90	26
26/11/2014	9:00	65.3	***55.7***	***54.5***	45.6	0	90	28
26/11/2014	10:00	67.8	56.5	***53.0***	49.3	0	80	28
26/11/2014	11:00	60.4	54.4	51.5	42.6	0	90	28
26/11/2014	12:00	61.9	55.3	52.2	43.2	0	80	22
26/11/2014	13:00	68.1	54	***54.1***	38.4	0	50	18
26/11/2014	14:00	65.3	***57.0***	***56***	44.8	0	100	21
26/11/2014	15:00	67.1	60	58.3	49.4	2.4	210	30
26/11/2014	16:00	68.6	63.8	60.9	52	1.4	170	21
26/11/2014	17:00	66.9	61.3	58.5	51.6	2.4	60	18
26/11/2014	18:00	64.1	59.3	56.4	50.2	2.6	90	24
26/11/2014	19:00	62.5	58	54.6	45.3	2.8	80	21
26/11/2014	20:00	57.2	52.6	49.6	42.9	1.8	60	24
26/11/2014	21:00	61	53.3	50.1	39.9	0.6	110	22
26/11/2014	22:00	54.7	47.1	44.2	35.2	0	120	13
26/11/2014	23:00	57.5	52.4	48.6	37	0.2	100	31
26/11/2014	0:00	57.2	51.2	48.1	39.9	0	80	26



Reference: 13122623

Table A20 – Results of Noise Logging 3362 Great Northern Hwy, Muchea

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
4 November 2015	51.2	49.2	50.3	45.7
5 November 2015	51.7	49.3	50.7	44.0
6 November 2015	57.5	55.2	56.7	48.1
Weekday Average	**64.5**	**60.7**	**61.5**	**58.2**

Photograph A20 – Noise Logger at 3362 Great Northern Hwy, Muchea

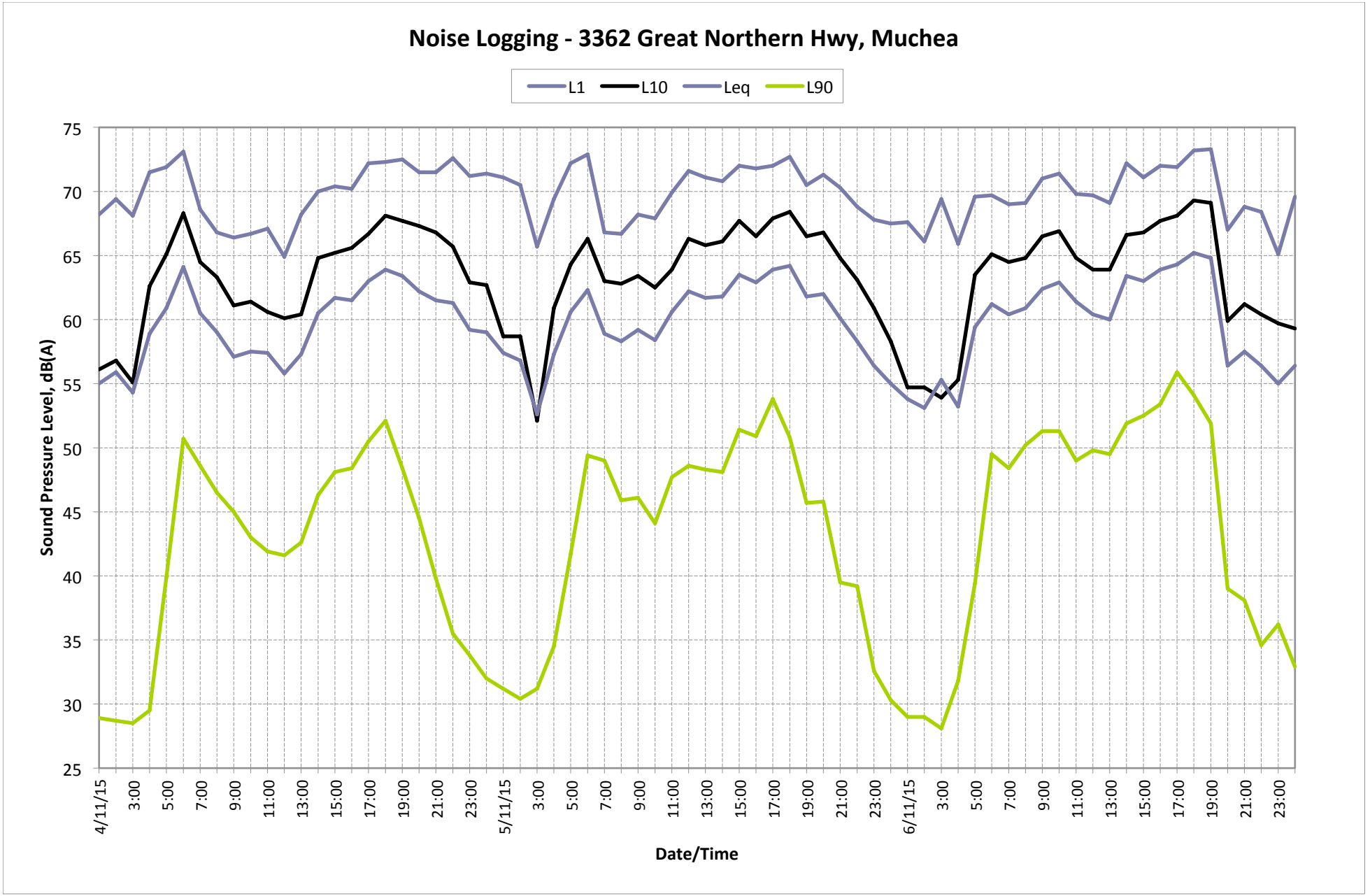


Traffic Noise Measurement Data

Item	Details
LOCATION	
Project	Perth Darwin National Hwy
Street address	3362 Great Northern Hwy
Locality	Muchea
Occupier	Commercial
Dates	4 to 6 Novemeber 2015
Category	*Main Roads to provide this information*
SITE	
Distance from the microphone to the kerb	113m to Reid Hwy and 160m to Malaga Dve
Height of the road in relation to the ground	level
Road surface type	Chip
Speed zone	110 km/hr
Absorbing ground	100%
Angle of view	160
Road gradient	flat
Traffic flow	
Heavy vehicles	
House-Road orientation.	West
Carriageways & lanes.	1cwys, 2lns
COMMENT	
Comment	Microphone located at façade of dwelling. Microphone height 1.4m above ground level
REFERENCES	
AMG Z50 E/N	*Main Roads to provide this information*
Road name	Great Northern Hwy
EXCEL file	3362 GNH
Raw data file	3362 GNH_sta
EQUIPMENT	
Analyser number	15-301-467
Microphone number	15-301-467
Calibrator number	34883971
Calibrator values	93.8 / 93.4
Operator	Lloyd George Acoustics Pty Ltd - Matthew Moyle
WEATHER	
Wind	Wind acceptability based on Peirce BoM data Speed slightly exceeded in afternoons

Hourly Noise Level Data								
3362 Great Northern Hwy, Muchea								
Date	**Time**	**L1**	**L10**	**Leq**	**L90**	**Rain mm**	**Wind degrees**	**Wind km/h**
4-Nov-15	1:00	68.2	56.1	55	28.9	0	190	8
4-Nov-15	2:00	69.4	56.8	55.9	28.7	0	190	4
4-Nov-15	3:00	68.1	55.1	54.3	28.5	0	0	0
4-Nov-15	4:00	71.5	62.6	58.9	29.5	0	0	0
4-Nov-15	5:00	71.9	65.1	60.9	39.9	0	190	2
4-Nov-15	6:00	73.1	68.3	64.1	50.7	0	0	0
4-Nov-15	7:00	68.6	64.5	60.5	48.6	0	190	5
4-Nov-15	8:00	66.8	63.3	59	46.5	0	170	8
4-Nov-15	9:00	66.4	61.1	57.1	45	0	180	5
4-Nov-15	10:00	66.7	61.4	57.5	43	0	310	8
4-Nov-15	11:00	67.1	60.6	57.4	41.9	0	250	9
4-Nov-15	12:00	64.9	60.1	55.8	41.6	0	330	9
4-Nov-15	13:00	68.2	60.4	57.3	42.6	0	240	13
4-Nov-15	14:00	70	64.8	60.5	46.3	0	230	24
4-Nov-15	15:00	70.4	65.2	61.7	48.1	0	230	22
4-Nov-15	16:00	70.2	65.6	61.5	48.4	0	230	21
4-Nov-15	17:00	72.2	66.7	63	50.5	0	220	22
4-Nov-15	18:00	72.3	68.1	63.9	52.1	0	210	22
4-Nov-15	19:00	72.5	67.7	63.4	48.4	0	220	17
4-Nov-15	20:00	71.5	67.3	62.2	44.5	0	220	9
4-Nov-15	21:00	71.5	66.8	61.5	39.8	0	230	9
4-Nov-15	22:00	72.6	65.7	61.3	35.5	0	180	8
4-Nov-15	23:00	71.2	62.9	59.2	33.8	0	160	8
4-Nov-15	0:00	71.4	62.7	59	32	0	150	5
5-Nov-15	1:00	71.1	58.7	57.4	31.2	0	30	9
5-Nov-15	2:00	70.5	58.7	56.8	30.4	0	330	8
5-Nov-15	3:00	65.7	52.1	52.6	31.2	0	30	8
5-Nov-15	4:00	69.4	60.9	57.3	34.5	0	350	8
5-Nov-15	5:00	72.2	64.3	60.6	41.7	0	330	9
5-Nov-15	6:00	72.9	66.3	62.3	49.4	0	360	8
5-Nov-15	7:00	66.8	63	58.9	49	0	360	11
5-Nov-15	8:00	66.7	62.8	58.3	45.9	0	240	4
5-Nov-15	9:00	68.2	63.4	59.2	46.1	0	230	9
5-Nov-15	10:00	67.9	62.5	58.4	44.1	0	240	17
5-Nov-15	11:00	69.9	63.9	60.6	47.7	0	290	15
5-Nov-15	12:00	71.6	66.3	62.2	48.6	0	270	21
5-Nov-15	13:00	71.1	65.8	61.7	48.3	0	250	22
5-Nov-15	14:00	70.8	66.1	61.8	48.1	0	230	22
5-Nov-15	15:00	72	67.7	63.5	51.4	0	260	21
5-Nov-15	16:00	71.8	66.5	62.9	50.9	0	240	24
5-Nov-15	17:00	72	67.9	63.9	53.8	0	240	24
5-Nov-15	18:00	72.7	68.4	64.2	50.8	0	240	18
5-Nov-15	19:00	70.5	66.5	61.8	45.7	0	230	9
5-Nov-15	20:00	71.3	66.8	62	45.8	0	250	11
5-Nov-15	21:00	70.3	64.8	60.1	39.5	0	230	11
5-Nov-15	22:00	68.8	63.1	58.3	39.2	0	210	9
5-Nov-15	23:00	67.8	60.9	56.4	32.6	0	170	8
5-Nov-15	0:00	67.5	58.3	55	30.3	0	160	9

Hourly Noise Level Data								
3362 Great Northern Hwy, Muchea								
Date	**Time**	**L1**	**L10**	**Leq**	**L90**	**Rain mm**	**Wind degrees**	**Wind km/h**
6-Nov-15	1:00	67.6	54.7	53.8	29	0	230	8
6-Nov-15	2:00	66.1	54.7	53.1	29	0	220	8
6-Nov-15	3:00	69.4	53.9	55.3	28.1	0	220	5
6-Nov-15	4:00	65.9	55.3	53.2	31.8	0	330	5
6-Nov-15	5:00	69.6	63.5	59.4	39.4	0	140	4
6-Nov-15	6:00	69.7	65.1	61.2	49.5	0	150	8
6-Nov-15	7:00	69	64.5	60.4	48.4	0	180	15
6-Nov-15	8:00	69.1	64.8	60.9	50.2	0	150	15
6-Nov-15	9:00	71	66.5	62.4	51.3	0	180	21
6-Nov-15	10:00	71.4	66.9	62.9	51.3	0.4	170	13
6-Nov-15	11:00	69.8	64.8	61.4	49	0	190	15
6-Nov-15	12:00	69.7	63.9	60.4	49.8	0	190	15
6-Nov-15	13:00	69.1	63.9	60	49.5	0	190	18
6-Nov-15	14:00	72.2	66.6	63.4	51.9	0	200	26
6-Nov-15	15:00	71.1	66.8	63	52.5	0	210	31
6-Nov-15	16:00	72	67.7	63.9	53.4	0	200	26
6-Nov-15	17:00	71.9	68.1	64.3	55.9	0	230	26
6-Nov-15	18:00	73.2	69.3	65.2	54.1	0	240	24
6-Nov-15	19:00	73.3	69.1	64.8	51.9	0	230	21
6-Nov-15	20:00	67	59.9	56.4	39	0	70	11
6-Nov-15	21:00	68.8	61.2	57.5	38.1	0	330	9
6-Nov-15	22:00	68.4	60.4	56.4	34.6	0	360	8
6-Nov-15	23:00	65.1	59.7	55	36.2	0	30	5
6-Nov-15	0:00	69.6	59.3	56.4	32.9	0	160	17



Reference: 13072450

Appendix C

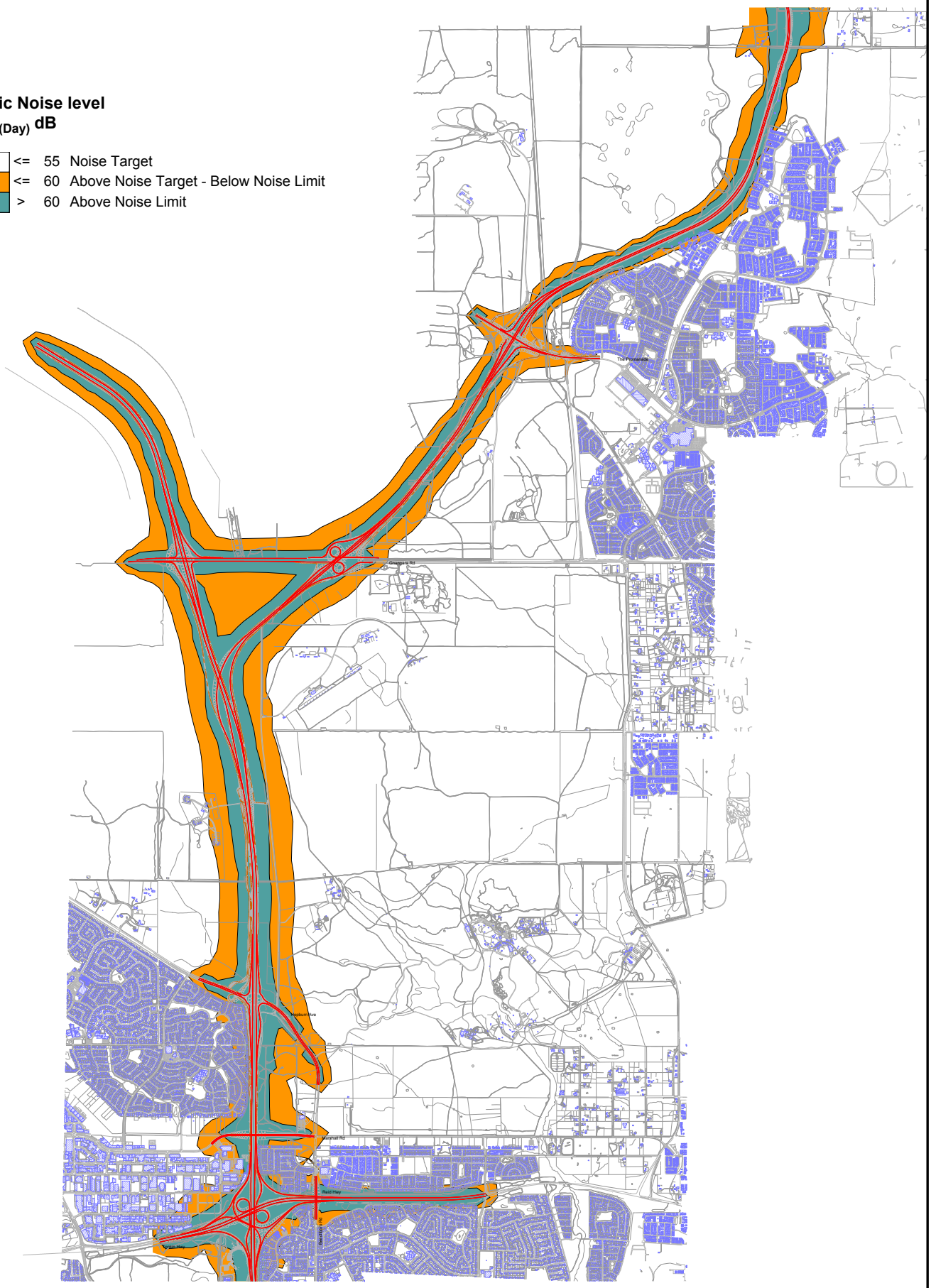
Predicted Noise Levels Without Noise Barriers

Perth Darwin National Highway Project

$L_{Aeq,Day}$ Noise Level Contours - Without Noise Mitigation

Traffic Noise level
$L_{Aeq,(Day)}$ dB

	<=	55	Noise Target
	<=	60	Above Noise Target - Below Noise Limit
	>	60	Above Noise Limit



Appendix D

Terminology

The following is an explanation of the terminology used throughout this report.

Decibel (dB)
The decibel is the unit that describes the sound pressure and sound power levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

A-Weighting
An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A dB.

L_1
An L_1 level is the noise level which is exceeded for 1 per cent of the measurement period and is considered to represent the average of the maximum noise levels measured.

L_{10}
An L_{10} level is the noise level which is exceeded for 10 per cent of the measurement period and is considered to represent the "*intrusive*" noise level.

L_{90}
An L_{90} level is the noise level which is exceeded for 90 per cent of the measurement period and is considered to represent the "*background*" noise level.

L_{eq}
The L_{eq} level represents the average noise energy during a measurement period.

$L_{A10,18hour}$
The $L_{A10,18\ hour}$ level is the arithmetic average of the hourly L_{A10} levels between 6.00 am and midnight. The *CoRTN* algorithms were developed to calculate this parameter.

$L_{Aeq,24hour}$
The $L_{Aeq,24\ hour}$ level is the logarithmic average of the hourly L_{Aeq} levels for a full day (from midnight to midnight).

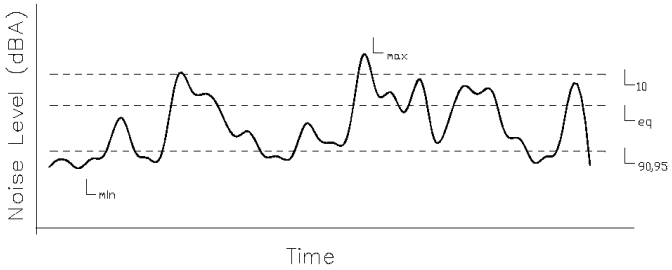
$L_{Aeq,8hour}$ / $L_{Aeq\ (Night)}$
The $L_{Aeq\ (Night)}$ level is the logarithmic average of the hourly L_{Aeq} levels from 10.00 pm to 6.00 am on the same day.

$L_{Aeq,16hour}$ / $L_{Aeq\ (Day)}$
The $L_{Aeq\ (Day)}$ level is the logarithmic average of the hourly L_{Aeq} levels from 6.00 am to 10.00 pm on the same day. This value is typically 1-3 dB less than the $L_{A10,18hour}$.

Satisfactory Design Sound Level
The level of noise that has been found to be acceptable by most people for the environment in question and also to be not intrusive.

Maximum Design Sound Level
The level of noise above which most people occupying the space start to become dissatisfied with the level of noise.

Chart of Noise Level Descriptors



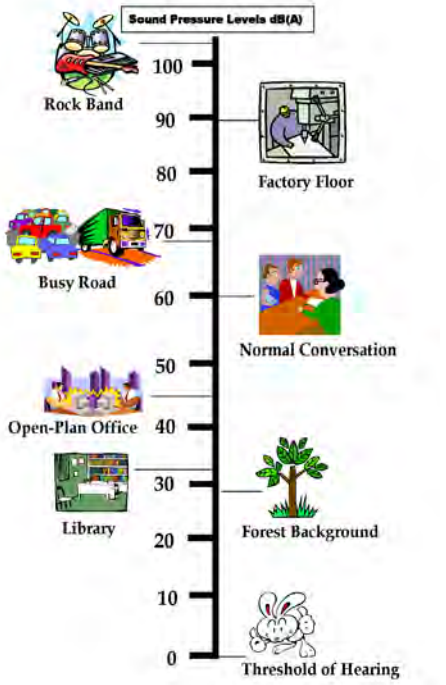
Austroads Vehicle Class

AUSTROADS Vehicle Classification System

Level 1 Length (indicative) Type	Level 2 Axles and Axle Groups Axles	Groups	Level 3 Vehicle Type Typical Description	AUSTROADS Classification Class	Parameters	Typical Configuration
			LIGHT VEHICLES			
Short up to 5.5m		1 or 2	**Short** Sedan, Wagon, 4WD, Utility, Light Van, Bicycle, Motorcycle, etc	1	d(1) < 3.2m and axles = 2	
Medium 5.5m to 14.5m	3, 4 or 5	3	**Short - Towing** Trailer, Caravan, Boat, etc	2	groups = 3 d(1) > 2.1m, d(1) < 3.2m, d(2) > 2.1m and axles = 3, 4 or 5	
			HEAVY VEHICLES			
	2	2	**Two Axle Truck or Bus**	3	c(1) > 3.2m and axles = 2	
	3	2	**Three Axle Truck or Bus**	4	axles = 3 and groups = 2	
	> 3	2	**Four Axle Truck**	5	axles > 3 and groups = 2	
Long 11.5m to 19.0m	3	3	**Three Axle Articulated** Three axle articulated vehicle, or Rigid vehicle and trailer	6	d(1) > 3.2m, axles = 3 and groups = 3	
	4	> 2	**Four Axle Articulated** Four axle articulated vehicle, or Rigid vehicle and trailer	7	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 4 and groups = 2	
	5	> 2	**Five Axle Articulated** Five axle articulated vehicle, or Rigid vehicle and trailer	8	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 5 and groups = 2	
	≥ 6	> 2	**Six Axle Articulated** Six axle articulated vehicle, or Rigid vehicle and trailer	9	axles = 6 and groups > 2 or axles > 6 and groups = 3	
Medium Combination 17.5m to 36.5m	> 5	4	**B Double** B Double, or Heavy truck and trailer	10	groups = 4 and axles > 6	
	> 6	5 or 6	**Double Road Train** Double road train, or Medium articulated vehicle and one dog trailer (M.A.D.)	11	groups = 5 or 6 and axles > 6	
Large Combination Over 33.0m	> 6	> 6	**Triple Road Train** Triple road train, or Heavy truck and three trailers	12	groups > 6 and axles > 6	

Definitions: Group: Axle group, where adjacent axles are less than 2.1m apart. Groups: Number of axle groups. Axles: Number of axles (maximum axle spacing of 10.0m). d(1): Distance between first and second axle. d(2): Distance between second and third axle.

Typical Noise Levels



APPENDIX J

EPBC Act Offset Assessment Guide – Carnaby's Black Cockatoo



Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Carnaby's Black Cockatoo
EPBC Act status	Endangered
Annual probability of extinction Based on IUCN category definitions	**1.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes		**Area**	207.2	Hectares	Impact site for EPBC 2013-7042
			Quality	**6**	Scale 0-10	
			Total quantum of impact	124.32	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																				
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**									
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0								
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**									
Threatened species habitat																				
Area of habitat	Yes	124.32	Adjusted hectares	Long term protection and management of habitat at Ioppolo Road, Chittering, WA	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	673.5	**Risk of loss (%) without offset**	30%	**Risk of loss (%) with offset**	5%	168.38	90%	151.54	119.37	121.22	97.51%	Yes	
									Future area without offset (adjusted hectares)	471.5	**Future area with offset (adjusted hectares)**	639.8								
					Time until ecological benefit	10	**Start quality (scale of 0-10)**	**7**	**Future quality without offset (scale of 0-10)**	**6**	**Future quality with offset (scale of 0-10)**	**7**	1.00	90%	0.90	0.80				
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**	**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Threatened species																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	124.32	121.22	97.51%	**Yes**	$0.00	#DIV/0!	#DIV/0!
Area of community	0				$0.00		$0.00
					$0.00	**#DIV/0!**	**#DIV/0!**

APPENDIX K

EPBC Act Offset Assessment Guide – Forest Red-tailed Black Cockatoo



Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Forest Red-tailed Black Cockatoo
EPBC Act status	Vulnerable
Annual probability of extinction Based on IUCN category definitions	**0.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes		**Area**	120.5	Hectares	Impact site for EPBC 2013-7042
			Quality	**6**	Scale 0-10	
			Total quantum of impact	72.30	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																					
Area of community	Yes		Adjusted hectares		**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**		0.00		0.00	0.00	0.00	#DIV/0!	#DIV/0!		
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0									
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**		0.00		0.00	0.00					
Threatened species habitat																					
Area of habitat	Yes	72.30	Adjusted hectares	Long term protection and management of habitat at Ioppolo Road, Chittering, WA	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	279	**Risk of loss (%) without offset**	30%	**Risk of loss (%) with offset**	5%	69.75	90%	62.78	60.32	59.45	82.23%	No		
									Future area without offset (adjusted hectares)	195.3	**Future area with offset (adjusted hectares)**	265.1									
					Time until ecological benefit	10	**Start quality (scale of 0-10)**	**7**	**Future quality without offset (scale of 0-10)**	**6**	**Future quality with offset (scale of 0-10)**	**7**	1.00	90%	0.90	0.88					
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**		**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																				
Condition of habitat Change in habitat condition, but no change in extent	No																				
Threatened species																					
Birth rate e.g. Change in nest success	No																				
Mortality rate e.g Change in number of road kills per year	No																				
Number of individuals e.g. Individual plants/animals	No																				

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	72.3	59.45	82.23%	**No**	$0.00	#DIV/0!	#DIV/0!
Area of community	0	0.00	#DIV/0!	**#DIV/0!**	$0.00	#DIV/0!	#DIV/0!
					$0.00	**#DIV/0!**	**#DIV/0!**

APPENDIX L

EPBC Act Offset Assessment Guide – SCP20a



Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	State-listed TEC?
EPBC Act status	Endangered
Annual probability of extinction Based on IUCN category definitions	**1.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	Yes	SCP 20a, Banksia attenuate woodland over species rich dense shrublands (Endangered, State-listed TEC)	**Area**	4	Hectares	
			Quality	**8**	Scale 0-10	
			Total quantum of impact	3.20	Adjusted hectares	
Threatened species habitat						
Area of habitat	No		**Area**			Impact site for EPBC 2013-7042
			Quality			
			Total quantum of impact	0.00		
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																					
Area of community	Yes	3.20	Adjusted hectares	22.6	**Risk-related time horizon (max. 20 years)**	20	**Start area (hectares)**	22.6	**Risk of loss (%) without offset**	30%	**Risk of loss (%) with offset**	5%	5.65	90%	5.09	4.01	3.20	100.14%	Yes		
									Future area without offset (adjusted hectares)	15.8	**Future area with offset (adjusted hectares)**	21.5									
					Time until ecological benefit	10	**Start quality (scale of 0-10)**	**8**	**Future quality without offset (scale of 0-10)**	**8**	**Future quality with offset (scale of 0-10)**	**8**	0.00	90%	0.00	0.00					
Threatened species habitat																					
Area of habitat	No			Long term protection and management of habitat at Ioppolo Road, Chittering, WA	**Time over which loss is averted (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**										
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0									
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**										
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**		**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																				
Condition of habitat Change in habitat condition, but no change in extent	No																				
Threatened species																					
Birth rate e.g. Change in nest success	No																				
Mortality rate e.g Change in number of road kills per year	No																				
Number of individuals e.g. Individual plants/animals	No																				

Summary

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	0				$0.00		$0.00
Area of community	3.2	3.20	100.14%	**Yes**	$0.00	N/A	$0.00
					$0.00	**$0.00**	**$0.00**

APPENDIX M

Technical Advice on Fauna Issues



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3rd December 2015

Perth-Darwin National Highway (Swan Valley Section) Public Environment Review
Issue 167 Further information on persistence of fauna in relation to fragmentation

The proposed Perth-Darwin National Highway (PDNH) development will pass through several areas of currently intact native vegetation and thus there are concerns with the persistence of these fragmented areas as habitat for fauna, and the ability of fauna to access these areas even if they do persist. Areas of native vegetation that would be fragmented include 4.3 ha of Bush Forever site 97 which will be isolated from the main bushland, and several occurrences of Mound Springs SCP Threatened Ecological Communities (TEC) associated with that site. Indirect impacts and the likely persistence of TECs, threatened fauna and conservation areas and wetlands are discussed further below.

Persistence of small fragments of native vegetation will depend upon management including exclusion of vehicles, weed control and, where possible, rehabilitation and reconnection with other areas of native vegetation. The management of fragments of native vegetation is provided in PER Chapter 8, Flora and Vegetation, Table 8.16 and PER Chapter 9, Terrestrial Fauna, Table 9.7.

The Bush Forever site 97 is a good example of the potential for rehabilitation. The 4.3 ha fragment is a narrow, outlying section of a much larger area of native vegetation that lies to the west. Through rehabilitation along the road verge, it could be linked to Bush Forever site 100, another fragmented area of native vegetation, located to the south. Bush Forever site 100 will also be bisected by the PDNH in a section where it is currently degraded and where road reserve rehabilitation could be implemented. Management of these areas of fragmentation will require a commitment to rehabilitation (discussed in PER Chapter 12, Rehabilitation and Decommissioning).

Persistence of fragments of native vegetation may be threatened by hydrological change, especially where the fragment is a dampland, wetland or is otherwise groundwater dependent. This is discussed in PER Chapter 10, Hydrological Processes and Inland Water Environment Quality, Section 10.4. The overall conclusion is that the sandy, free-draining substrate for much of the alignment will limit hydrological change, but in the north of the alignment where the soils are clayey there could be some effects due to compaction. Modelling suggests very localised groundwater changes such as +23 cm immediately upstream of the alignment, and -10 cm immediately downstream. These changes are without consideration of the application of management measures. Management measures relating to hydrological processes are provided in PER Chapter 10 Hydrological Processes and Inland Waters Environmental Quality, Table 10.9.

Rehabilitation to enhance connectivity between fragments of native vegetation created by the highway should allow for continued and in some cases enhanced linkage for fauna. This will need to be in conjunction with well-designed wildlife underpasses as are proposed. For example, underpasses are proposed at Bush Forever sites 97 and 100 (PER Chapter 9, Terrestrial Fauna, Figure 9.5C).

There are no underpasses currently proposed for the Reid and Tonkin Highway intersection; this is a large and complex intersection but it falls between Lightning Swamp and Whiteman Park in an area where existing Bush Forever site No. 480 will largely be cleared, and where Quenda (Southern Brown Bandicoots) are already known to be moving along road verges.

Linkage is important for fauna as fragments in isolation may be too small to support some species. Providing the remnant is linked by a corridor such as underpasses and road reserve vegetation, it is likely to remain viable for fauna. Even the largest of local mammals will use underpasses. The long-term ecological function of small fragments may be questionable as, for example, the highway may present a barrier for small insect pollinators. This is a good reason for ensuring road reserve vegetation consists of local native species in order to minimise the gap presented by the road surface.

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25th November 2015

Perth-Darwin National Highway (Swan Valley Section) Public Environment Review
Issue 168 Use of local and regional scale to assess proportional impacts upon habitat of conservation significant species including the Western Carpet Python, Southern Brown Bandicoot and Western Brush Wallaby

PER Chapter 9, Terrestrial Fauna, Section 9.4 describes impacts to fauna at local and regional scales. The local scale covers all Bush Forever sites within 1 km of the proposal footprint. The regional scale covers all Bush Forever sites within 10 km of the proposal footprint. Table 9.4 presents the proportion of habitat loss with respect to the Western Carpet Python, Southern Brown Bandicoot and Western Brush Wallaby.

The Environmental Protection Authority Guidance Statement 56 states that "*desktop study should seek to determine the size of remnants and/or habitat condition relative to those in the local surrounds (<15km radius)*" i.e., a nominal 15 km buffer to the nominal centreline. A 15-km buffer for linear infrastructure would encompass vegetation associations and habitat different to those within the proposal footprint given the diversity of vegetation complexes in the Swan Coastal Plain bioregion. The use of 1 km and 10 km study areas is appropriate to determine local and regional context for linear infrastructure respectively. If the IBRA bio-regional classification system is used, the Swan Coastal Plain extends in a coastal strip from near Geraldton to near Busselton. A more restricted definition of the Swan Coastal Plain extends from the Moore River to south of Bunbury. Both definitions are too extensive and cover too great a variety of environments to be useful for regional assessment.

Where information was available, the wider distribution of conservation significant species was described for context (see PER Chapter 9, Terrestrial Fauna, Section 9.4). The species' distribution in Western Australia (Swan Coastal Plain and Southwest) and across Australia was discussed, where available. This general discussion provides context of impacts to each species' distribution and populations. It is not linked to the regional assessment which is based on the 10 km study area.

The local and regional assessment only considered habitat in Bush Forever sites. Native vegetation outside Bush Forever sites may be in poor condition, have less security and provide suboptimal habitat. The proportion of habitat loss at a local and regional scale will be higher than if all native vegetation areas were included i.e., a conservative approach.

The Western Carpet Python, Quenda (Southern Brown Bandicoot) and Western Brush Wallaby may be in decline in parts of the Swan Coastal Plain, most likely due to habitat loss (mostly due to clearing for urban development). Predation by feral species may also be a factor. The impact upon these species of proportional loss of habitat from the proposal needs to consider regional patterns of distribution; these are briefly described below (based mostly upon personal experience (M. Bamford)).

On the Swan Coastal Plain immediately north of Perth, the Western Carpet Python appears to be mostly restricted to large areas of intact native vegetation of the Spearwood System, often where limestone is exposed (e.g. Neerabup National Park). It also occurs along the Darling Scarp including in the Bindoon/Chittering area. In ongoing studies in Whiteman Park (since 1992) and the Lexia/Gnangara area (since 2003), the Western Carpet Python has never been encountered so it would appear to be very uncommon in the proposal area. Proportional habitat loss within 1km of the proposal footprint may be a realistic reflection of impact, but when extended to 10km this would include higher value habitat.

Both the Western Brush Wallaby and the Southern Brown Bandicoot (Quenda) are locally abundant in native vegetation within the proposal area and across the Swan Coastal Plain north of Perth, especially where dense, low vegetation occurs such as in damplands. The range of the Western Brush Wallaby extends at least to Dongara, whereas that of the Quenda extends only as far north as about Yanchep and Gingin (although with scattered records further north which are mostly the result of relocations). Proportional habitat loss within 1km and 10km of the proposal footprint may be a realistic reflection of impact.

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25th November 2015

Perth-Darwin National Highway (Swan Valley Section) Public Environment Review
Issue 169 (part) Further information on impacts upon locally or regionally significant fauna

In PER Chapter 9, Terrestrial Fauna, Section 9.2.6, fauna species listed as locally or regionally significant (Bush Forever, Government of Western Australia, 2000b) are discussed. Impacts of the proposal on these species are considered only briefly in Section 9.4.1.14. The species list is not exhaustive. The listed species are (with some other species that could be considered locally/regionally significant in parenthesis):

- Frogs: *Crinia insignifera* (also *Pseudophryne guentheri*).
- Reptiles: *Ctenophorus adelaidensis, Hemiergis quadrilineata, Varanus tristis, Parasuta gouldii* (also several other species with limited distributions in the region, such as *Lerista christinae, Pletholax gracilis, Aclys (Delma) concinna, Varanus rosenbergii*).
- Birds: Common Bronzewing, Splendid Fairy-wren, White-browed Scrubwren, Weebill, Western Thornbill, Yellow-rumped Thornbill, Scarlet Robin, Hooded Robin and Grey Shrike-thrush, Emu, Brown Goshawk, Little Eagle, Wedge-tailed Eagle, Brown Falcon, New Holland Honeyeater, Western Wattlebird and Black-faced Woodswallow (also White-breasted Robin, Variegated Fairy-wren, White-winged Fairy-wren and Inland Thornbill are locally uncommon and declining, although widespread elsewhere).
- Mammals. None mentioned, probably as most significant mammals in the area are on statutory lists (the Honey Possum *Tarsipes rostratus* and South-West Pygmy-possum *Cercartetus concinnus* are present in the project area, uncommon on the Coastal Plain north of Perth but widespread elsewhere).

Whether listed in the Bush Forever report or not, these species may all be at risk to the same factors as could impact species on statutory lists such as: habitat loss, habitat fragmentation, habitat degradation (such as due to hydrological change, weed invasion, changes in fire frequency), increased predation, disturbance due to noise and light, and road kill. These impacting processes are listed in PER Chapter 9 Terrestrial Fauna, Section 9.3). The discussion of impacts on these species (Section 9.4.1.14) states:

"All of the locally and regionally significant fauna recorded in the proposal area are considered common either on the SCP or within other portions of their distributions. As such, the proposal will not increase the level of significance of these species. Impacts to these species due to the loss of habitat in the proposal footprint are expected to be negligible at a regional scale due to the widespread occurrence of suitable habitat for these species. Impacts to these species from the loss of habitat, loss of ecological connectivity and habitat fragmentation caused by the proposal are restricted to the local scale and not expected to be significant."

The statement made in this section relies upon PER Chapter 9, Terrestrial Fauna, Section 9.4 where impacting processes and their effect upon significant species and on fauna in general are discussed. Management measures are discussed in Section 9.5 and address processes such as fragmentation, predation, habitat loss, habitat degradation as they apply to the entire fauna assemblage; not just significant species on statutory lists. The intention of the management measures is to minimise

impacts upon the entire fauna assemblage, including species of local and/or regional significance. There is further discussion of hydrological impacts and minimisation in PER Chapter 10, Hydrological Processes and Inland Waters Environmental Quality, Section 10.4.

The PER recognises that there will inevitably be some habitat loss that will affect species of local and/or regional significance with residual impacts discussed in PER Chapter 9, Terrestrial Fauna, Table 9.7. This includes the management actions needed to minimise impacts. Rehabilitation to replace lost habitat and enhance connectivity is important and this is addressed through management measures listed in PER Chapter 12, Rehabilitation and Decommissioning, Section 12.5.

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Perth-Darwin National Highway (Swan Valley Section) Public Environment Review
Issue 169 (part) Further information on impacts upon wetland fauna and wetland fauna habitats

Damplands and wetlands surveyed as part of the fauna study (PER Appendix G, Level 2 Targeted Fauna Assessment) account for a small part of the total 745.7 ha proposal footprint: 19.0 ha and 15.5 ha respectively (see PER Chapter 9, Terrestrial Fauna, Table 9.1). PER Chapter 10 Hydrological Processes and Inland Waters Environmental Quality, Figure 10.2 illustrates the extent of wetlands within and around the proposal footprint based upon the Geomorphic Wetlands Swan Coastal Plain dataset. This set of maps shows wetlands are extensive within 1 km of the PDNH alignment, with approximately 25 wetlands identified within the proposal footprint and an additional 26 wetlands within 100 m (Table 10.3). The largest portion of wetlands were in the 'multiple use wetland' category, i.e., assessed as possessing few remaining ecological attributes and functions, and classified as palusplain and/or damplands that have been cleared for agriculture. According to the geomorphic wetland mapping, approximately 315.9 ha of the total area of the proposal footprint was mapped as associated with wetland environments (Table 10.5).

As presented in PER Chapter 3, Route Selection and Development, Section 3.2.2, key wetlands such as mound springs and wetlands associated with the Western Swamp Tortoise (*Pseudemydura umbrina*) have been avoided by the PDNH alignment. Several drainage lines of the Ellenbrook system are crossed by the alignment and impacts (and impact mitigation) are discussed in PER Chapter 10, Hydrological Processes and Inland Water Environmental Quality, sections 10.4 and 10.6. Impacts upon damplands/wetlands in the Lightning Swamp area are noted in PER Appendix G, Level 2 Targeted Fauna Assessment, Section 7.2 which states "*The clearing of the Dampland and Eucalypt/Corymbia Woodland at the Tonkin Highway/Reid Highway intersection (Micro Gardens Park) will impact the ecological connectivity between Lightning Swamp Bushland, Malaga Regional Space and Koondoola Regional Bushland to the west and Point Reserve to the East.*"

Intact damplands and wetlands are locally significant because they are limited in extent, provide at least seasonal surface water and support distinctive and often very dense vegetation. Overall, damplands and wetlands are likely to be locations of high and distinctive fauna biodiversity. They are important for fauna groups as follows:

Invertebrates. Some potential for Short-Range Endemic Species (SREs). Damplands and wetlands provide habitat for aquatic species and mesic refugia for terrestrial species that require at least seasonally moist conditions. Some wetland plants flower heavily and are thus important for nectar supply for invertebrates.

Fish. The Priority 3 Black-striped Minnow (*Galaxiella nigrostriata*) was at least until recently present in the Melaleuca Park wetland (EPP173) which is outside the development envelope. The Ellenbrook drainage system supports several native and introduced fish, and all the native species should be considered at least of local conservation significance because of the extent of wetland degradation

in the region. These species include the Black-striped Minnow, Mud Minnow (*Galaxiella munda*), Western Pygmy-perch (*Edelia vittata*) and Western Minnow (*Galaxia occidentalis*), with the latter three species recorded in Lake Chandala just north of Muchea (M. Bamford Unpubl. data).

Frogs. With the exception of the Turtle Frog (*Myobatrachus gouldii*), all frogs in the region rely on wetlands to breed. Frog populations in the region are declining; most noticeably Guenther's Toadlet (*Pseudophryne guentheri*) and the Moaning Frog (*Heleioporus eyrei*), with both these species relying upon early winter rains to fill seasonal wetlands (Bamford and Huang, 2009; Bamford and Everard, 2015).

Reptiles. Several reptile species rely upon or are most abundant around damplands and wetlands in the region. In addition to the Western Swamp Tortoise (*Pseudemydura umbrina*) confined to seasonal wetlands near the development envelope, the Long-necked Tortoise (*Chelodina colliei*) occurs in seasonal and permanent wetlands in the region. Reptiles dependent or largely dependent upon dense vegetation and moist conditions around wetlands and damplands include the Tiger Snake (*Notechis scutatus*) and the skink *Acritoscincus trilineatum.* Some other species appear to be more abundant close to wetlands and damplands than in upland environments, including the legless lizard *Aprasia repens* and the skink *Hemiergis quadrilineata*.

Waterbirds. Natural damplands and wetlands in the region support only small numbers of waterbirds and lack the open environments favoured by migratory shorebirds. Cryptic species of dense rushes such as the conservation significant Australasian Bittern are effectively locally extinct due to habitat loss. Seasonally-damp paddocks can support moderate numbers of herons, egrets, ibis and ducks.

Land birds. A suite of land birds relies heavily upon the dense vegetation around damplands and wetlands; these include the Splendid Fairy-wren (*Malurus splendens*) and White-browed Scrubwren (*Sericornis frontalis*). In addition, dampland and wetland vegetation include plant species that are seasonal producers of nectar and thus attract nectarivorous birds (honeyeaters and occasionally the native Purple-crowned Lorikeet *Glossopsitta porphyrocephala*).

Mammals. The dense vegetation around intact wetlands and damplands are vital for the Quenda (*Isoodon obesulus*) in the region, which is at the northern limit of its range around Muchea. Both the Honey Possum (*Tarsipes rostratus*) and Western Pygmy-possum (*Cercartetus concinnus*) have been recorded in dense vegetation close to wetlands in the region (Bamford and Everard, 2015). Although able to live in upland vegetation, these two species may need the seasonal nectar supply of dampland and wetland plants. Similarly, Bamford and Bamford (1999) found the Brush Wallaby (*Macropus irma*) to favour dense vegetation around wetlands in Whiteman Park, and recorded a Chuditch *(Dasyurus geoffroii*) in dampland vegetation in what is now the suburb of Lexia in 2003 (M. Bamford Unpubl. data). The Chuditch was a young male probably dispersing though the area.

From the above outline, it is apparent that dampland and wetland areas in the region, where they are intact and support native vegetation, are likely to be important for biodiversity on at least a local scale. This importance is largely for local species rather than those of national or international significance. Species for which wetlands are important, including those that make seasonal use of a resource such as flowering plants, the continued presence and access to damplands and wetlands may be important for maintaining local populations.

The risk to wetland fauna assemblages has not been discussed specifically in the PER, but impacts to wetlands are discussed in PER Chapter 10, Hydrological Processes and Inland Water Environmental Quality, Section 10.4. This section discusses, by inference, impacts upon wetland fauna due to

habitat loss (sections 10.4.6.1 and 10.4.6.2) and hydrological change, including altered water quality (sections 10.4.4.3 and 10.4.6.3). These sections conclude that impacts upon wetland environments and fauna will be minimal and can be managed through management of drawdown (during construction), and through management and design with respect to compaction and drainage. Section 10.5 discusses the management of hydrological impacts. Habitat fragmentation that may affect species such as the Quenda (Southern Brown Bandicoot) is discussed in PER Chapter 9, Terrestrial Fauna, Section 9.6.2, with wildlife fencing and underpasses located in wetland/dampland areas to facilitate fauna movement and reduce roadkill.

On the basis of the impacts and mitigation measures discussed in the PER, the risk to damplands and wetlands affected by the proposal will be low. In general, only small portions of significant areas will be directly impacted. Key impacts such as hydrological change and fragmentation can be managed through monitoring, design, verge revegetation, fencing and underpasses. The greatest residual risk to wetland fauna may be at the intersection of Reid Hwy and Tonkin Hwy, where almost all of a wetland and a recognised Bush Forever site (No. 480) and most of CCW 15033 will be removed. This wetland area will be predominately lost however the viability of the remaining fragment will depend on connectivity and water supply. The rehabilitation and maintenance of road reserve vegetation, and the maintenance of effective underpasses, may be required to allow species such as the Quenda to be able to continue to move through this area.

References

Bamford, M.J. and Bamford, A.R. (1999). A study of the Brush or Black-gloved Wallaby *Macropus irma* (Jourdan 1837) in Whiteman Park. Whiteman Park Technical Report Series No. 1. Western Australian Planning Commission, Perth.

Bamford, M.J. and Everard, C. (2015). Report on East Lexia Frog Monitoring; 2003 to 2014. Unpubl. report to Water and Rivers Commission, Perth.

Bamford, M.J. and Huang, N (2009). The Occurrence and Status of Frogs in the Gnangara Sustainability Strategy Study Area. Report prepared on behalf of the Department of Environment and Conservation for the Gnangara Sustainability Strategy, Perth.

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